Universal Verification Methodology (UVM) 1.2 Class Reference

June 2014
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Suggestions for improvements to the UVM 1.2 Class Reference are welcome. They should be sent to the UVM email reflector

uvm-wg@lists.accellera.org
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1. Overview

Verification has evolved into a complex project that often spans internal and external teams, but the discontinuity associated with multiple, incompatible methodologies among those teams has limited productivity. The Universal Verification Methodology (UVM) 1.2 Class Reference addresses verification complexity and interoperability within companies and throughout the electronics industry for both novice and advanced teams while also providing consistency. While UVM is revolutionary, being the first verification methodology to be standardized, it is also evolutionary, as it is built on the Open Verification Methodology (OVM), which combined the Advanced Verification Methodology (AVM) with the Universal Reuse Methodology (URM) and concepts from the e Reuse Methodology (eRM). Furthermore, UVM also infuses concepts and code from the Verification Methodology Manual (VMM), plus the collective experience and knowledge of the 300+ members of the Accellera Universal Verification Methodology Work Group (UVMWG) to help standardize verification methodology.

1.1 Scope

The UVM application programming interface (API) defines a standard for the creation, integration, and extension of UVM Verification Components (UVCs) and verification environments that scale from block to system. The UVM 1.2 Class Reference is independent of any specific design processes and is complete for the construction of verification environments. The generator to connect register abstractions, many of which are captured using IP-XACT (IEEE Std 1685™), is not part of the standard, although a register package is.

1.2 Purpose

The purpose of the UVM 1.2 Class Reference is to enable verification interoperability throughout the electronics ecosystem. To further that goal, a reference implementation will be made available, along with the UVM 1.2 User’s Guide. While these materials are neither required to implement UVM, nor considered part of the standard, they help provide consistency when the UVM 1.2 Class Reference is applied and further enable UVM to achieve its purpose.
2. Normative References

The following referenced documents are indispensable for the application of this specification (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.


3. Definitions, Acronyms, and Abbreviations

For the purposes of this document, the following terms and definitions apply. The IEEE Standards Dictionary Online should be consulted for terms not defined in this clause.3

3.1 Definitions

agent: An abstract container used to emulate and verify DUT devices; agents encapsulate a driver, sequencer, and monitor.

blocking: An interface where tasks block execution until they complete. See also: non blocking.

component: A piece of VIP that provides functionality and interfaces. Also referred to as a transactor.

consumer: A verification component that receives transactions from another component.

driver: A component responsible for executing or otherwise processing transactions, usually interacting with the device under test (DUT) to do so.

environment: The container object that defines the testbench topology.

export: A transaction level modeling (TLM) interface that provides the implementation of methods used for communication. Used in UVM to connect to a port.

factory method: A classic software design pattern used to create generic code by deferring, until run time, the exact specification of the object to be created.

foreign methodology: A verification methodology that is different from the methodology being used for the majority of the verification environment.

generator: A verification component that provides transactions to another component. Also referred to as a producer.

monitor: A passive entity that samples DUT signals, but does not drive them.

non blocking: A call that returns immediately. See also: blocking.

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**port**: A TLM interface that defines the set of methods used for communication. Used in UVM to connect to an export.

**primary (host) methodology**: The methodology that manages the top-level operation of the verification environment and with which the user/integrator is presumably more familiar.

**request**: A transaction that provides information to initiate the processing of a particular operation.

**response**: A transaction that provides information about the completion or status of a particular operation.

**scoreboard**: The mechanism used to dynamically predict the response of the design and check the observed response against the predicted response. Usually refers to the entire dynamic response-checking structure.

**sequence**: A UVM object that procedurally defines a set of transactions to be executed and/or controls the execution of other sequences.

**sequencer**: An advanced stimulus generator which executes sequences that define the transactions provided to the driver for execution.

**test**: Specific customization of an environment to exercise required functionality of the DUT.

**testbench**: The structural definition of a set of verification components used to verify a DUT. Also referred to as a verification environment.

**transaction**: A class instance that encapsulates information used to communicate between two or more components.

**transactor**: See component.

**virtual sequence**: A conceptual term for a sequence that controls the execution of sequences on other sequencers.

### 3.2 Acronyms and Abbreviations

- **API**: application programming interface
- **CDV**: coverage-driven verification
- **CBCL**: common base class library
- **CLI**: command line interface
- **DUT**: device under test
- **DUV**: device under verification
- **EDA**: electronic design automation
- **FIFO**: first-in, first-out
- **HDL**: hardware description language
- **HVL**: high-level verification language
- **IP**: intellectual property
OSCI  Open SystemC Initiative
TLM  transaction level modeling
UVC  UVM Verification Component
UVM  Universal Verification Methodology
VIP  verification intellectual property
4. Classes and Utilities

The UVM Class Library provides the building blocks needed to quickly develop well-constructed and reusable verification components and test environments in SystemVerilog.

This UVM Class Reference provides detailed reference information for each user-visible class in the UVM library. For additional information on using UVM, see the UVM User's Guide located in the top level directory within the UVM kit.

We divide the UVM classes and utilities into categories pertaining to their role or function. A more detailed overview of each category-- and the classes comprising them-- can be found in the menu at left.

**Globals**

This category defines a small list of types, variables, functions, and tasks defined in the `uvm_pkg` scope. These items are accessible from any scope that imports the `uvm_pkg`. See Types and Enumerations and Globals for details.

**Base**

This basic building blocks for all environments are components, which do the actual work, transactions, which convey information between components, and ports, which provide the interfaces used to convey transactions. The UVM's core base classes provide these building blocks. See Core Base Classes for more information.

**Reporting**

The reporting classes provide a facility for issuing reports (messages) with consistent formatting and configurable side effects, such as logging to a file or exiting simulation. Users can also filter out reports based on their verbosity, unique ID, or severity. See Reporting Classes for more information.

**Factory**

As the name implies, the UVM factory is used to manufacture (create) UVM objects and components. Users can configure the factory to produce an object of a given type on a global or instance basis. Use of the factory allows dynamically configurable component hierarchies and object substitutions without having to modify their code and without breaking encapsulation. See Factory Classes for details.

**Phasing**

This sections describes the phasing capability providing by UVM. The details can be found in Phasing Overview.

**Configuration and Resources**

The Configuration and Resource Classes are a set of classes which provide a configuration database. The configuration database is used to store and retrieve both configuration time and run time properties.

**Synchronization**

The UVM provides event and barrier synchronization classes for process synchronization. See Synchronization Classes for more information.

**Containers**

The Container Classes are type parameterized
data structures which provide queue and pool services. The class based queue and pool types allow for efficient sharing of the data structures compared with their SystemVerilog built-in counterparts.

**Policies**
Each of UVM’s policy classes performs a specific task for `uvm_object`-based objects: printing, comparing, recording, packing, and unpacking. They are implemented separately from `uvm_object` so that users can plug in different ways to print, compare, etc. without modifying the object class being operated on. The user can simply apply a different printer or compare “policy” to change how an object is printed or compared. See Policy Classes for more information.

**TLM**
The UVM TLM library defines several abstract, transaction-level interfaces and the ports and exports that facilitate their use. Each TLM interface consists of one or more methods used to transport data, typically whole transactions (objects) at a time. Component designs that use TLM ports and exports to communicate are inherently more reusable, interoperable, and modular. See TLM Interfaces for details.

**Components**
Components form the foundation of the UVM. They encapsulate behavior of drivers, scoreboards, and other objects in a testbench. The UVM library provides a set of predefined component types, all derived directly or indirectly from `uvm_component`. See Predefined Component Classes for more information.

**Sequencers**
The sequencer serves as an arbiter for controlling transaction flow from multiple stimulus generators. More specifically, the sequencer controls the flow of `uvm_sequence_item`-based transactions generated by one or more `uvm_sequence #(REQ,RSP)`-based sequences. See Sequencer Classes for more information.

**Sequences**
Sequences encapsulate user-defined procedures that generate multiple `uvm_sequence_item`-based transactions. Such sequences can be reused, extended, randomized, and combined sequentially and hierarchically in interesting ways to produce realistic stimulus to your DUT. See Sequence Classes for more information.

**Macros**
The UVM provides several macros to help increase user productivity. See the set of macro categories in the main menu for a complete list of macros for Reporting, Components, Objects, Sequences, Callbacks, TLM and Registers.
verification. See Register Layer for more information.

**Command Line Processor**

The command line processor provides a general interface to the command line arguments that were provided for the given simulation. The capabilities are detailed in the `uvm_cmdline_processor` section.

**Summary**

**UVM 1.2 Class Reference**

The UVM Class Library provides the building blocks needed to quickly develop well-constructed and reusable verification components and test environments in SystemVerilog.
5. Core Base Classes

The UVM library defines a set of base classes and utilities that facilitate the design of modular, scalable, reusable verification environments.

The basic building blocks for all environments are components and the transactions they use to communicate. The UVM provides base classes for these, as shown below.

- **uvm_object** - All components and transactions derive from *uvm_object*, which defines an interface of core class-based operations: create, copy, compare, print, sprint, record, etc. It also defines interfaces for instance identification (name, type name, unique id, etc.) and random seeding.

- **uvm_component** - The *uvm_component* class is the root base class for all UVM components. Components are quasi-static objects that exist throughout simulation. This allows them to establish structural hierarchy much like *modules* and *program blocks*. Every component is uniquely addressable via a hierarchical path name, e.g. “env1.pci1.master3.driver”. The *uvm_component* also defines a phased test flow that components follow during the course of simulation. Each phase-- **build**, **connect**, **run**, etc.-- is defined by a callback that is executed in precise order. Finally, the *uvm_component* also defines configuration, reporting, transaction recording, and factory interfaces.

- **uvm_transaction** - The *uvm_transaction* is the root base class for UVM transactions, which, unlike *uvm_components*, are transient in nature. It extends *uvm_object* to include a timing and recording interface. Simple transactions can derive directly from *uvm_transaction*, while sequence-enabled transactions derive from *uvm_sequence_item*.

- **uvm_root** - The *uvm_root* class is special *uvm_component* that serves as the top-level component for all UVM components, provides phasing control for all UVM components, and other global services.

**Summary**

Core Base Classes

The UVM library defines a set of base classes and utilities that facilitate the design of modular, scalable, reusable verification environments.
5.1 Miscellaneous Structures

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<td>The <em>uvm_void</em> class is the base class for all UVM classes.</td>
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<tr>
<td>uvm_utils #(TYPE,FIELD)</td>
<td>This class contains useful template functions.</td>
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</table>

**uvm_void**

The *uvm_void* class is the base class for all UVM classes. It is an abstract class with no data members or functions. It allows for generic containers of objects to be created, similar to a void pointer in the C programming language. User classes derived directly from *uvm_void* inherit none of the UVM functionality, but such classes may be placed in *uvm_void*-typed containers along with other UVM objects.

**Summary**

**uvm_void**

The *uvm_void* class is the base class for all UVM classes.

**Class Declaration**

```
virtual class uvm_void
```

**uvm_utils #(TYPE,FIELD)**

This class contains useful template functions.

**Summary**

**uvm_utils #(TYPE,FIELD)**

This class contains useful template functions.

**Class Declaration**

```
class uvm utils #(TYPE,string FIELD = "config")
```

**Methods**

- **find_all**  
  Recursively finds all component instances of the parameter type *TYPE*, starting with the component given by *start*.

- **get_config**  
  This method gets the object config of type *TYPE* associated with
Methods

find_all

```cpp
static function types_t find_all(
    uvm_component start
)
```

Recursively finds all component instances of the parameter type TYPE, starting with the component given by start. Uses uvm_root::find_all.

get_config

```cpp
static function TYPE get_config(
    uvm_component comp,
    bit is_fatal
)
```

This method gets the object config of type TYPE associated with component comp. We check for the two kinds of error which may occur with this kind of operation.
5.2 uvm_object

The uvm_object class is the base class for all UVM data and hierarchical classes. Its primary role is to define a set of methods for such common operations as create, copy, compare, print, and record. Classes deriving from uvm_object must implement the pure virtual methods such as create and get_type_name.

Summary

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<tr>
<td>The uvm_object class is the base class for all UVM data and hierarchical classes.</td>
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**Class Hierarchy**

```
uvm_void  
uvm_object
```

**Class Declaration**

```
virtual class uvm_object extends uvm_void
```

**new**

Creates a new uvm_object with the given instance name.

**Seeding**

```
use_uvm_seeding   This bit enables or disables the UVM seeding mechanism.
reseed   Calls srandom on the object to reseed the object using the UVM seeding mechanism, which sets the seed based on type name and instance name instead of based on instance position in a thread.
```

**Identification**

```
set_name   Sets the instance name of this object, overwriting any previously given name.
get_name   Returns the name of the object, as provided by the name argument in the new constructor or set_name method.
get_full_name   Returns the full hierarchical name of this object.
get_inst_id   Returns the object’s unique, numeric instance identifier.
get_inst_count   Returns the current value of the instance counter, which represents the total number of uvm_object-based objects that have been allocated in simulation.
get_type   Returns the type-proxy (wrapper) for this object.
get_object_type   Returns the type-proxy (wrapper) for this object.
get_type_name   This function returns the type name of the object, which is typically the type identifier enclosed in quotes.
```

**Creation**

```
create   The create method allocates a new object of the same type as this object and returns it via a base uvm_object handle.
clone   The clone method creates and returns an exact copy of this object.
```

**Printing**

```
print   The print method deep-prints this object’s properties in a format and manner governed by the given printer argument; if the printer argument is not provided, the global uvm_default_printer is used.
sprint   The sprint method works just like the print method, except the output is returned in a string rather than displayed.
do_print   The do_print method is the user-definable hook called by print and sprint that allows users to customize what
```
gets printed or sprinted beyond the field information provided by the `uvm_field_* macros, Utility and Field Macros for Components and Objects.

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<td>This virtual function is a user-definable hook, called directly by the user, that allows users to provide object information in the form of a string.</td>
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<td>The record method deep-records this object’s properties according to an optional recorder policy.</td>
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<td>The do_record method is the user-definable hook called by the record method.</td>
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<td>The copy makes this object a copy of the specified object.</td>
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<td>do_copy</td>
<td>The do_copy method is the user-definable hook called by the copy method.</td>
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<td>compare</td>
<td>Deep compares members of this data object with those of the object provided in the rhs (right-hand side) argument, returning 1 on a match, 0 otherwise.</td>
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<tr>
<td>do_compare</td>
<td>The do_compare method is the user-definable hook called by the compare method.</td>
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<tr>
<td>pack_ints</td>
<td>The pack methods bitwise-concatenate this object’s properties into an array of bits, bytes, or ints.</td>
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<td>do_pack</td>
<td>The do_pack method is the user-definable hook called by the pack methods.</td>
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<tr>
<td>unpack_ints</td>
<td>The unpack methods extract property values from an array of bits, bytes, or ints.</td>
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<tr>
<td>do_unpack</td>
<td>The do_unpack method is the user-definable hook called by the unpack method.</td>
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<tr>
<td>set_string_local</td>
<td></td>
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<tr>
<td>set_object_local</td>
<td>These methods provide write access to integral, string, and uvm_object-based properties indexed by a field_name string.</td>
</tr>
</tbody>
</table>

**new**

```python
function new (  
  string name = ""  
)
```

Creates a new uvm_object with the given instance name. If name is not supplied, the object is unnamed.

**Seeding**

**use_uvm_seeding**
This bit enables or disables the UVM seeding mechanism. It globally affects the operation of the `reseed` method.

When enabled, UVM-based objects are seeded based on their type and full hierarchical name rather than allocation order. This improves random stability for objects whose instance names are unique across each type. The `uvm_component` class is an example of a type that has a unique instance name.

### reseed

```plaintext
function void reseed ()
```

Calls `srandom` on the object to reseed the object using the UVM seeding mechanism, which sets the seed based on type name and instance name instead of based on instance position in a thread.

If the `use_uvm_seeding` static variable is set to 0, then `reseed()` does not perform any function.

### IDENTIFICATION

#### set_name

```plaintext
virtual function void set_name ( string name )
```

Sets the instance name of this object, overwriting any previously given name.

#### get_name

```plaintext
virtual function string get_name ()
```

Returns the name of the object, as provided by the `name` argument in the `new` constructor or `set_name` method.

#### get_full_name

```plaintext
virtual function string get_full_name ()
```

Returns the full hierarchical name of this object. The default implementation is the same as `get_name`, as uvm_objects do not inherently possess hierarchy.

Objects possessing hierarchy, such as `uvm_components`, override the default implementation. Other objects might be associated with component hierarchy but are not themselves components. For example, `uvm_sequence #(REQ,RSP)` classes are typically associated with a `uvm_sequencer #(REQ,RSP)`. In this case, it is useful to override `get_full_name` to return the sequencer’s full name concatenated with the sequence’s name. This provides the sequence a full context, which is useful when debugging.
**get_inst_id**

```c
virtual function int get_inst_id()
```

Returns the object's unique, numeric instance identifier.

**get_inst_count**

```c
static function int get_inst_count()
```

Returns the current value of the instance counter, which represents the total number of uvm_object-based objects that have been allocated in simulation. The instance counter is used to form a unique numeric instance identifier.

**get_type**

```c
static function uvm_object_wrapper get_type()
```

Returns the type-proxy (wrapper) for this object. The uvm_factory's type-based override and creation methods take arguments of uvm_object_wrapper. This method, if implemented, can be used as convenient means of supplying those arguments.

The default implementation of this method produces an error and returns `null`. To enable use of this method, a user's subtype must implement a version that returns the subtype's wrapper.

**For example**

```c
class cmd extends uvm_object;
    typedef uvm_object_registry #(cmd) type_id;
    static function type_id get_type();
        return type_id::get();
    endfunction
endclass
```

**Then, to use**

```c
factory.set_type_override(cmd::get_type(),subcmd::get_type());
```

This function is implemented by the `uvm_*_utils macros, if employed.

**get_object_type**

```c
virtual function uvm_object_wrapper get_object_type()
```

Returns the type-proxy (wrapper) for this object. The uvm_factory's type-based override and creation methods take arguments of uvm_object_wrapper. This method, if implemented, can be used as convenient means of supplying those arguments. This method is the same as the static get_type method, but uses an already allocated object
to determine the type-proxy to access (instead of using the static object).

The default implementation of this method does a factory lookup of the proxy using the return value from `get_type_name`. If the type returned by `get_type_name` is not registered with the factory, then a `null` handle is returned.

**For example**

```plaintext
class cmd extends uvm_object;
    typedef uvm_object_registry #(cmd) type_id;
    static function type_id get_type();
        return type_id::get();
    endfunction
    virtual function type_id get_object_type();
        return type_id::get();
    endfunction
endclass
```

This function is implemented by the `uvm_*_utils macros, if employed.

### get_type_name

```plaintext
virtual function string get_type_name ()
```

This function returns the type name of the object, which is typically the type identifier enclosed in quotes. It is used for various debugging functions in the library, and it is used by the factory for creating objects.

This function must be defined in every derived class.

**A typical implementation is as follows**

```plaintext
class mytype extends uvm_object;
    ...
    const static string type_name = "mytype";
    virtual function string get_type_name();
        return type_name;
    endfunction
endclass
```

We define the `type_name` static variable to enable access to the type name without need of an object of the class, i.e., to enable access via the scope operator, `mytype::type_name`.

### CREATION

**create**

```plaintext
virtual function uvm_object create ( string name = "" )
```

The `create` method allocates a new object of the same type as this object and returns it via a base `uvm_object` handle. Every class deriving from `uvm_object`, directly or
indirectly, must implement the create method.

**A typical implementation is as follows**

```
class mytype extends uvm_object;
    ...
    virtual function uvm_object create(string name="");
        mytype t = new(name);
        return t;
    endfunction

    virtual function uvm_object clone ()

    function void print (uvm_printer printer = null)
    {
        // Implementation
    }

    function string sprint (uvm_printer printer = null)
    {
        // Implementation
    }
```

**clone**

The `clone` method creates and returns an exact copy of this object.

The default implementation calls `create` followed by `copy`. As `clone` is virtual, derived classes may override this implementation if desired.

**Printing**

**print**

The `print` method deep-prints this object’s properties in a format and manner governed by the given `printer` argument; if the `printer` argument is not provided, the global `uvm_default_printer` is used. See `uvm_printer` for more information on printer output formatting. See also `uvm_line_printer`, `uvm_tree_printer`, and `uvm_table_printer` for details on the pre-defined printer “policies,” or formatters, provided by the UVM.

The `print` method is not virtual and must not be overloaded. To include custom information in the `print` and `sprint` operations, derived classes must override the `do_print` method and use the provided printer policy class to format the output.

**sprint**

The `sprint` method works just like the `print` method, except the output is returned in a string rather than displayed.

The `sprint` method is not virtual and must not be overloaded. To include additional fields in the `print` and `sprint` operation, derived classes must override the `do_print` method and use the provided printer policy class to format the output. The printer policy will manage all string concatenations and provide the string to `sprint` to return to the caller.
do_print

```cpp
virtual function void do_print (uvm_printer printer)
```

The `do_print` method is the user-definable hook called by `print` and `sprint` that allows users to customize what gets printed or sprinted beyond the field information provided by the `uvm_field_*` macros, *Utility and Field Macros for Components and Objects*. The `printer` argument is the policy object that governs the format and content of the output. To ensure correct `print` and `sprint` operation, and to ensure a consistent output format, the `printer` must be used by all `do_print` implementations. That is, instead of using `$display` or string concatenations directly, a `do_print` implementation must call through the `printer`'s API to add information to be printed or sprinted.

**An example implementation of do_print is as follows**

```cpp
class mytype extends uvm_object;
data obj data;
int f1;
virtaul function void do_print (uvm_printer printer);
super.do_print(printer);
printer.print_field_int("f1", f1, $bits(f1), UVM_DEC);
printer.print_object("data", data);
endfunction

mytype t = new;
t.print();
uvm_report_info("Received", t.sprint());
```

**convert2string**

```cpp
virtual function string convert2string()
```

This virtual function is a user-definable hook, called directly by the user, that allows users to provide object information in the form of a string. Unlike `sprint`, there is no requirement to use a `uvm_printer` policy object. As such, the format and content of the output is fully customizable, which may be suitable for applications not requiring the consistent formatting offered by the `print/sprint/do_print` API.

Fields declared in *Utility Macros* macros (`uvm_field_*`), if used, will not automatically appear in calls to `convert2string`.

**An example implementation of convert2string follows.**

```cpp
class base extends uvm_object;
string field = "foo";
virtual function string convert2string();
   convert2string = {"base_field="+field};
endfunction
endclass

class obj2 extends uvm_object;
```
Then, to display an object, you could write

```cpp
obj o = new;
uvm_report_info("BusMaster",{"Sending:\n ",o.convert2string()});
```

The output will look similar to

```
UVM INFO @ 0: reporter [BusMaster] Sending:
  Base_field=foo write=1 addr=00000123 data=00000456 child_field=bar
```

**RECORDING**

**record**

```cpp
function void record ( 
    uvm_recorder recorder = null
)
```

The `record` method deep-records this object’s properties according to an optional `recorder` policy. The method is not virtual and must not be overloaded. To include additional fields in the record operation, derived classes should override the `do_record` method.

The optional `recorder` argument specifies the recording policy, which governs how recording takes place. See `uvm_recorder` for information.

A simulator’s recording mechanism is vendor-specific. By providing access via a common interface, the `uvm_recorder` policy provides vendor-independent access to a simulator’s recording capabilities.

**do_record**

```cpp
virtual function void do_record ( 
    uvm_recorder recorder
)
```

The `do_record` method is the user-definable hook called by the `record` method. A derived
class should override this method to include its fields in a record operation.

The recorder argument is policy object for recording this object. A do_record implementation should call the appropriate recorder methods for each of its fields. Vendor-specific recording implementations are encapsulated in the recorder policy, thereby insulating user-code from vendor-specific behavior. See uvm_recorder for more information.

**A typical implementation is as follows**

```plaintext
class mytype extends uvm_object;
    data_obj data;
    int f1;
    function void do_record (uvm_recorder recorder);
        recorder.record_field("f1", f1, $bits(f1), UVM_DEC);
        recorder.record_object("data", data);
    endfunction

```

**COPYING**

**copy**

```plaintext
function void copy (uvm_object rhs)

```

The copy makes this object a copy of the specified object.

The copy method is not virtual and should not be overloaded in derived classes. To copy the fields of a derived class, that class should override the do_copy method.

**do_copy**

```plaintext
virtual function void do_copy (uvm_object rhs)

```

The do_copy method is the user-definable hook called by the copy method. A derived class should override this method to include its fields in a copy operation.

**A typical implementation is as follows**

```plaintext
class mytype extends uvm_object;
    ...
    int f1;
    function void do_copy (uvm_object rhs);
        mytype rhs_;
        super.do_copy(rhs);
        $cast(rhs_,rhs);
        field_1 = rhs_.field_1;
    endfunction

```

The implementation must call super.do_copy, and it must $cast the rhs argument to the derived type before copying.
Comparing

compare

```plaintext
function bit compare (  
    uvm_object   rhs,  
    uvm_comparer comparer = null  
)
```

Deep compares members of this data object with those of the object provided in the `rhs` (right-hand side) argument, returning 1 on a match, 0 otherwise.

The `compare` method is not virtual and should not be overloaded in derived classes. To compare the fields of a derived class, that class should override the `do_compare` method.

The optional `comparer` argument specifies the comparison policy. It allows you to control some aspects of the comparison operation. It also stores the results of the comparison, such as field-by-field miscompare information and the total number of miscompares. If a compare policy is not provided, then the global `uvm_default_comparer` policy is used. See `uvm_comparer` for more information.

do_compare

```plaintext
virtual function bit do_compare (  
    uvm_object   rhs,  
    uvm_comparer comparer
)
```

The `do_compare` method is the user-definable hook called by the `compare` method. A derived class should override this method to include its fields in a compare operation. It should return 1 if the comparison succeeds, 0 otherwise.

A typical implementation is as follows

```plaintext
class mytype extends uvm_object;  
    int f1;  
    virtual function bit do_compare (uvm_object rhs, uvm_comparer comparer);  
        mytype rhs_;  
        do_compare = super.do_compare(rhs, comparer);  
        $cast(rhs_, rhs);  
        do_compare &= comparer.compare_field_int("f1", f1, rhs_.f1);  
    endfunction
```

A derived class implementation must call `super.do_compare()` to ensure its base class’ properties, if any, are included in the comparison. Also, the `rhs` argument is provided as a generic `uvm_object`. Thus, you must `$cast` it to the type of this object before comparing.

The actual comparison should be implemented using the `uvm_comparer` object rather than direct field-by-field comparison. This enables users of your class to customize how comparisons are performed and how much miscompare information is collected. See `uvm_comparer` for more details.
Packing

pack

```plaintext
function int pack (ref bit bitstream[],
in input uvm_packer packer = null)
```

pack_bytes

```plaintext
function int pack_bytes (ref byte unsigned bytestream[],
in input uvm_packer packer = null)
```

pack_ints

```plaintext
function int pack_ints (ref int unsigned intstream[],
in input uvm_packer packer = null)
```

The pack methods bitwise-concatenate this object’s properties into an array of bits, bytes, or ints. The methods are not virtual and must not be overloaded. To include additional fields in the pack operation, derived classes should override the do_pack method.

The optional packer argument specifies the packing policy, which governs the packing operation. If a packer policy is not provided, the global uvm_default_packer policy is used. See uvm_packer for more information.

The return value is the total number of bits packed into the given array. Use the array’s built-in size method to get the number of bytes or ints consumed during the packing process.

do_pack

```plaintext
virtual function void do_pack (uvm_packer packer)
```

The do_pack method is the user-definable hook called by the pack methods. A derived class should override this method to include its fields in a pack operation.

The packer argument is the policy object for packing. The policy object should be used to pack objects.

A typical example of an object packing itself is as follows

```plaintext
class mysubtype extends mysupertype;
... shortint myshort;
obj_type myobj;
byte myarray[];
...
function void do_pack (uvm_packer packer);
  super.do_pack(packer); // pack mysupertype properties
```
The implementation must call super.do_pack so that base class properties are packed as well.

If your object contains dynamic data (object, string, queue, dynamic array, or associative array), and you intend to unpack into an equivalent data structure when unpacking, you must include meta-information about the dynamic data when packing as follows.

- For queues, dynamic arrays, or associative arrays, pack the number of elements in the array in the 32 bits immediately before packing individual elements, as shown above.
- For string data types, append a zero byte after packing the string contents.
- For objects, pack 4 bits immediately before packing the object. For null objects, pack 4'b0000. For non-null objects, pack 4'b0001.

When the `uvm_field_* macros are used, Utility and Field Macros for Components and Objects, the above meta information is included provided the uvm_packer::use_metadata variable is set for the packer.

Packing order does not need to match declaration order. However, unpacking order must match packing order.

### Unpacking

#### unpack

```vhdl
function int unpack (ref bit bitstream[],
    input uvm_packer packer = null)
```

#### unpack_bytes

```vhdl
function int unpack_bytes (ref byte unsigned bytestream[],
    input uvm_packer packer = null)
```

#### unpack_ints

```vhdl
function int unpack_ints (ref int unsigned intstream[],
    input uvm_packer packer = null)
```

The unpack methods extract property values from an array of bits, bytes, or ints. The method of unpacking must exactly correspond to the method of packing. This is assured if (a) the same packer policy is used to pack and unpack, and (b) the order of unpacking is the same as the order of packing used to create the input array.
The unpack methods are fixed (non-virtual) entry points that are directly callable by the user. To include additional fields in the unpack operation, derived classes should override the **do_unpack** method.

The optional *packer* argument specifies the packing policy, which governs both the pack and unpack operation. If a packer policy is not provided, then the global *uvm_default_packer* policy is used. See *uvm_packer* for more information.

The return value is the actual number of bits unpacked from the given array.

### do_unpack

```plaintext
virtual function void do_unpack (uvm_packer packer)
```

The **do_unpack** method is the user-definable hook called by the **unpack** method. A derived class should override this method to include its fields in an unpack operation.

The *packer* argument is the policy object for both packing and unpacking. It must be the same packer used to pack the object into bits. Also, do_unpack must unpack fields in the same order in which they were packed. See *uvm_packer* for more information.

The following implementation corresponds to the example given in do_pack.

```
function void do_unpack (uvm_packer packer);
  int sz;
  super.do_unpack(packer); // unpack super's properties
  sz = packer.unpack_field_int(myarray.size(), 32);
  myarray.delete();
  for(int index=0; index<sz; index++)
    myarray[index] = packer.unpack_field_int(8);
  myshort = packer.unpack_field_int($bits(myshort));
  packer.unpack_object(myobj);
endfunction
```

If your object contains dynamic data (object, string, queue, dynamic array, or associative array), and you intend to **unpack** into an equivalent data structure, you must have included meta-information about the dynamic data when it was packed.

- For queues, dynamic arrays, or associative arrays, unpack the number of elements in the array from the 32 bits immediately before unpacking individual elements, as shown above.
- For string data types, unpack into the new string until a *null* byte is encountered.
- For objects, unpack 4 bits into a byte or int variable. If the value is 0, the target object should be set to *null* and unpacking continues to the next property, if any. If the least significant bit is 1, then the target object should be allocated and its properties unpacked.

### Configuration

#### set_int_local

```plaintext
virtual function void set_int_local (string field_name, uvm_bitstream_t value, bit recurse = 1)
```
These methods provide write access to integral, string, and uvm_object-based properties indexed by a `field_name` string. The object designer choose which, if any, properties will be accessible, and overrides the appropriate methods depending on the properties’ types. For objects, the optional clone argument specifies whether to clone the value argument before assignment.

The global `uvm_is_match` function is used to match the field names, so `field_name` may contain wildcards.

An example implementation of all three methods is as follows.

```abap
class mytype extends uvm_object;
   local int myint;
   local byte mybyte;
   local shortint myshort; // no access
   local string mystring;
   local obj_type myobj;

   // provide access to integral properties
   function void set_int_local(string field_name, uvm_bitstream_t value);
      if (uvm_is_match (field_name, "myint"))
         myint = value;
      else if (uvm_is_match (field_name, "mybyte"))
         mybyte = value;
   endfunction

   // provide access to string properties
   function void set_string_local(string field_name, string value);
      if (uvm_is_match (field_name, "mystring"))
         mystring = value;
   endfunction

   // provide access to sub-objects
   function void set_object_local(string field_name, uvm_object value, bit clone=1);
      if (uvm_is_match (field_name, "myobj")) begin
         if (value != null) begin
            obj_type tmp;
            // if provided value is not correct type, produce error
            if (!$cast(tmp, value) )
               /* error */
            else begin
               if(clone)
                  $cast(myobj, tmp.clone());
               else
                  myobj = tmp;
            end
         end
         else
            myobj = null; // value is null, so simply assign null to myobj
      end
   endfunction
```
Although the object designer implements these methods to provide outside access to one or more properties, they are intended for internal use (e.g., for command-line debugging and auto-configuration) and should not be called directly by the user.
The uvm_transaction class is the root base class for UVM transactions. Inheriting all the methods of uvm_object, uvm_transaction adds a timing and recording interface.

This class provides timestamp properties, notification events, and transaction recording support.

Use of this class as a base for user-defined transactions is deprecated. Its subtype, uvm_sequence_item, shall be used as the base class for all user-defined transaction types.

The intended use of this API is via a uvm_driver #(REQ,RSP) to call uvm_component::accept_tr, uvm_component::begin_tr, and uvm_component::end_tr during the course of sequence item execution. These methods in the component base class will call into the corresponding methods in this class to set the corresponding timestamps (accept_time, begin_time, and end_time), trigger the corresponding event (begin_event and end_event, and, if enabled, record the transaction contents to a vendor-specific transaction database.

Note that get_next_item/item_done when called on a uvm_seq_item_pull_port will automatically trigger the begin_event and end_events via calls to begin_tr and end_tr. While convenient, it is generally the responsibility of drivers to mark a transaction’s progress during execution. To allow the driver or layering sequence to control sequence item timestamps, events, and recording, you must call uvm_sqr_if_base#(REQ,RSP)::disable_auto_item_recording at the beginning of the driver’s run_phase task.

Users may also use the transaction’s event pool, events, to define custom events for the driver to trigger and the sequences to wait on. Any in-between events such as marking the beginning of the address and data phases of transaction execution could be implemented via the events pool.

In pipelined protocols, the driver may release a sequence (return from finish_item() or its `uvm_do macro) before the item has been completed. If the driver uses the begin_tr/end_tr API in uvm_component, the sequence can wait on the item’s end_event to block until the item was fully executed, as in the following example.

```verbatim
task uvm_execute(item, ...);
    // Can use the `uvm_do macros as well
    start_item(item);
    item.randomize();
    finish_item(item);
    item.end_event.wait_on();
    // get_response(rsp, item.get_transaction_id()); // if needed
endtask
```
Summary

The uvm_transaction class is the root base class for UVM transactions.

**CLASS HIERARCHY**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
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<tr>
<td>uvm_object</td>
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<tr>
<td><strong>uvm_transaction</strong></td>
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</table>
```

**CLASS DECLARATION**

```
virtual class uvm_transaction extends uvm_object
```

**METHODS**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tr>
<td>new</td>
<td>Creates a new transaction object.</td>
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<tr>
<td>accept_tr</td>
<td>Calling <code>accept_tr</code> indicates that the transaction item has been received by a consumer component.</td>
</tr>
<tr>
<td>do_accept_tr</td>
<td>This user-definable callback is called by <code>accept_tr</code> just before the accept event is triggered.</td>
</tr>
<tr>
<td>begin_tr</td>
<td>This function indicates that the transaction has been started and is not the child of another transaction.</td>
</tr>
<tr>
<td>begin_child_tr</td>
<td>This function indicates that the transaction has been started as a child of a parent transaction given by <code>parent_handle</code>.</td>
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<tr>
<td>do_begin_tr</td>
<td>This user-definable callback is called by <code>begin_tr</code> and <code>begin_child_tr</code> just before the begin event is triggered.</td>
</tr>
<tr>
<td>end_tr</td>
<td>This function indicates that the transaction execution has ended.</td>
</tr>
<tr>
<td>do_end_tr</td>
<td>This user-definable callback is called by <code>end_tr</code> just before the end event is triggered.</td>
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<tr>
<td>get_tr_handle</td>
<td>Returns the handle associated with the transaction, as set by a previous call to <code>begin_child_tr</code> or <code>begin_tr</code> with transaction recording enabled.</td>
</tr>
<tr>
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<td>Turns off recording for the transaction stream.</td>
</tr>
<tr>
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</tr>
<tr>
<td>is_recording_enabled</td>
<td>Returns 1 if recording is currently on, 0 otherwise.</td>
</tr>
<tr>
<td>is_active</td>
<td>Returns 1 if the transaction has been started but has not yet been ended.</td>
</tr>
<tr>
<td>get_event_pool</td>
<td>Returns the event pool associated with this transaction.</td>
</tr>
<tr>
<td>set_initiator</td>
<td>Sets initiator as the initiator of this transaction.</td>
</tr>
</tbody>
</table>
**get_initiator**  Returns the component that produced or started the transaction, as set by a previous call to `set_initiator`.

**get_accept_time**  Returns the time at which this transaction was accepted, begun, or ended, as by a previous call to `accept_tr`, `begin_tr`, `begin_child_tr`, or `end_tr`.

**get_begin_time**

**get_end_time**

**set_transaction_id**  Sets this transaction’s numeric identifier to id.

**get_transaction_id**  Returns this transaction’s numeric identifier, which is -1 if not set explicitly by `set_transaction_id`.

---

**VARIABLES**

**events**  The event pool instance for this transaction.

**begin_event**  A `uvm_event#(uvm_object)` that is triggered when this transaction’s actual execution on the bus begins, typically as a result of a driver calling `uvm_component::begin_tr`.

**end_event**  A `uvm_event#(uvm_object)` that is triggered when this transaction’s actual execution on the bus ends, typically as a result of a driver calling `uvm_component::end_tr`.

---

**METHODS**

**new**

```plaintext
function new ( 
  string name = "", 
  uvm_component initiator = null 
)
```

Creates a new transaction object. The name is the instance name of the transaction. If not supplied, then the object is unnamed.

**accept_tr**

```plaintext
function void accept_tr ( 
  time accept_time = 0 
)
```

Calling `accept_tr` indicates that the transaction item has been received by a consumer component. Typically a `uvm_driver #(REQ,RSP)` would call `uvm_component::accept_tr`, which calls this method-- upon return from a `get_next_item()`, `get()`, or `peek()` call on its sequencer port, `uvm_driver#(REQ,RSP)::seq_item_port`.

With some protocols, the received item may not be started immediately after it is accepted. For example, a bus driver, having accepted a request transaction, may still have to wait for a bus grant before beginning to execute the request.

**This function performs the following actions**

- The transaction’s internal accept time is set to the current simulation time, or to `accept_time` if provided and non-zero. The `accept_time` may be any time, past or future.
- The transaction’s internal accept event is triggered. Any processes waiting on the this event will resume in the next delta cycle.
- The `do_accept_tr` method is called to allow for any post-accept action in derived
classes.

do_accept_tr

virtual protected function void do_accept_tr ()

This user-definable callback is called by accept_tr just before the accept event is triggered. Implementations should call super.do_accept_tr to ensure correct operation.

begin_tr

function integer begin_tr (  
  time begin_time = 0  
)

This function indicates that the transaction has been started and is not the child of another transaction. Generally, a consumer component begins execution of a transactions it receives.

Typically a uvm_driver #(REQ,RSP) would call uvm_component::begin_tr, which calls this method, before actual execution of a sequence item transaction. Sequence items received by a driver are always a child of a parent sequence. In this case, begin_tr obtains the parent handle and delegates to begin_child_tr.

See accept_tr for more information on how the begin-time might differ from when the transaction item was received.

**This function performs the following actions**

- The transaction’s internal start time is set to the current simulation time, or to begin_time if provided and non-zero. The begin_time may be any time, past or future, but should not be less than the accept time.
- If recording is enabled, then a new database-transaction is started with the same begin time as above.
- The do_begin_tr method is called to allow for any post-begin action in derived classes.
- The transaction’s internal begin event is triggered. Any processes waiting on this event will resume in the next delta cycle.

The return value is a transaction handle, which is valid (non-zero) only if recording is enabled. The meaning of the handle is implementation specific.

begin_child_tr

function integer begin_child_tr (  
  time begin_time = 0,  
  integer parent_handle = 0  
)

This function indicates that the transaction has been started as a child of a parent transaction given by parent_handle. Generally, a consumer component calls this method via uvm_component::begin_child_tr to indicate the actual start of execution of this transaction.

The parent handle is obtained by a previous call to begin_tr or begin_child_tr. If the parent_handle is invalid (=0), then this function behaves the same as begin_tr.
This function performs the following actions

- The transaction’s internal start time is set to the current simulation time, or to begin_time if provided and non-zero. The begin_time may be any time, past or future, but should not be less than the accept time.

- If recording is enabled, then a new database-transaction is started with the same begin time as above. The inherited uvm_object::record method is then called, which records the current property values to this new transaction. Finally, the newly started transaction is linked to the parent transaction given by parent_handle.

- The do_begin_tr method is called to allow for any post-begin action in derived classes.

- The transaction’s internal begin event is triggered. Any processes waiting on this event will resume in the next delta cycle.

The return value is a transaction handle, which is valid (non-zero) only if recording is enabled. The meaning of the handle is implementation specific.

**do_begin_tr**

```cpp
virtual protected function void do_begin_tr ()
```

This user-definable callback is called by begin_tr and begin_child_tr just before the begin event is triggered. Implementations should call super.do_begin_tr to ensure correct operation.

**end_tr**

```cpp
function void end_tr ( 
  time end_time = 0, 
  bit free_handle = 1
)
```

This function indicates that the transaction execution has ended. Generally, a consumer component ends execution of the transactions it receives.

You must have previously called begin_tr or begin_child_tr for this call to be successful.

Typically a uvm_driver #(REQ,RSP) would call uvm_component::end_tr, which calls this method, upon completion of a sequence item transaction. Sequence items received by a driver are always a child of a parent sequence. In this case, begin_tr obtain the parent handle and delegate to begin_child_tr.

This function performs the following actions

- The transaction’s internal end time is set to the current simulation time, or to end_time if provided and non-zero. The end_time may be any time, past or future, but should not be less than the begin time.

- If recording is enabled and a database-transaction is currently active, then the record method inherited from uvm_object is called, which records the final property values. The transaction is then ended. If free_handle is set, the transaction is released and can no longer be linked to (if supported by the implementation).

- The do_end_tr method is called to allow for any post-end action in derived classes.

- The transaction’s internal end event is triggered. Any processes waiting on this event will resume in the next delta cycle.
**do_end_tr**

```plaintext
virtual protected function void do_end_tr ()
```

This user-definable callback is called by `end_tr` just before the end event is triggered. Implementations should call `super.do_end_tr` to ensure correct operation.

---

**get_tr_handle**

```plaintext
function integer get_tr_handle ()
```

Returns the handle associated with the transaction, as set by a previous call to `begin_child_tr` or `begin_tr` with transaction recording enabled.

---

**disable_recording**

```plaintext
function void disable_recording ()
```

Turns off recording for the transaction stream. This method does not effect a `uvm_component`'s recording streams.

---

**enable_recording**

```plaintext
function void enable_recording ( uvm_tr_stream stream )
```

Turns on recording to the `stream` specified.

If transaction recording is on, then a call to `record` is made when the transaction is ended.

---

**is_recording_enabled**

```plaintext
function bit is_recording_enabled()
```

Returns 1 if recording is currently on, 0 otherwise.

---

**is_active**

```plaintext
function bit is_active ()
```

Returns 1 if the transaction has been started but has not yet been ended. Returns 0 if the transaction has not been started.

---

**get_event_pool**

```plaintext
function uvm_event_pool get_event_pool ()
```
Returns the event pool associated with this transaction.

By default, the event pool contains the events: begin, accept, and end. Events can also be added by derivative objects. An event pool is a specialization of `uvm_pool#(KEY,T)`, e.g. a `uvm_pool#(uvm_event)`.

**set_initiator**

```plaintext
function void set_initiator ( uvm_component Initiator )
```

Sets initiator as the initiator of this transaction.

The initiator can be the component that produces the transaction. It can also be the component that started the transaction. This or any other usage is up to the transaction designer.

**get_initiator**

```plaintext
function uvm_component get_initiator ()
```

Returns the component that produced or started the transaction, as set by a previous call to set_initiator.

**get_accept_time**

```plaintext
function time get_accept_time ()
```

**get_begin_time**

```plaintext
function time get_begin_time ()
```

**get_end_time**

```plaintext
function time get_end_time ()
```

Returns the time at which this transaction was accepted, begun, or ended, as by a previous call to `accept_tr`, `begin_tr`, `begin_child_tr`, or `end_tr`.

**set_transaction_id**

```plaintext
function void set_transaction_id( integer id )
```

Sets this transaction’s numeric identifier to id. If not set via this method, the transaction ID defaults to -1.

When using sequences to generate stimulus, the transaction ID is used along with the sequence ID to route responses in sequencers and to correlate responses to requests.
get_transaction_id

function integer get_transaction_id()

Returns this transaction’s numeric identifier, which is -1 if not set explicitly by set_transaction_id.

When using a uvm_sequence #(REQ,RSP) to generate stimulus, the transaction ID is used along with the sequence ID to route responses in sequencers and to correlate responses to requests.

**Variables**

**events**

const uvm_event_pool events = new

The event pool instance for this transaction. This pool is used to track various milestones: by default, begin, accept, and end

**begin_event**

uvm_event#(uvm_object) begin_event

A uvm_event#(uvm_object) that is triggered when this transaction’s actual execution on the bus begins, typically as a result of a driver calling uvm_component::begin_tr. Processes that wait on this event will block until the transaction has begun.

For more information, see the general discussion for uvm_transaction. See uvm_event#(T) for details on the event API.

**end_event**

uvm_event#(uvm_object) end_event

A uvm_event#(uvm_object) that is triggered when this transaction’s actual execution on the bus ends, typically as a result of a driver calling uvm_component::end_tr. Processes that wait on this event will block until the transaction has ended.

For more information, see the general discussion for uvm_transaction. See uvm_event#(T) for details on the event API.

virtual task my_sequence::body();
...
  start_item(item);  \
  item.randomize();  } `uvm_do(item)
  finish_item(item);  \
  // return from finish item does not always mean item is completed
  item.end_event.wait_on();
  ...

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5.4 uvm_root

The `uvm_root` class serves as the implicit top-level and phase controller for all UVM components. Users do not directly instantiate `uvm_root`. The UVM automatically creates a single instance of `uvm_root` that users can access via the global (uvm_pkg-scope) variable, `uvm_top`.

The `uvm_top` instance of `uvm_root` plays several key roles in the UVM.

**Implicit top-level** The `uvm_top` serves as an implicit top-level component. Any component whose parent is specified as `null` becomes a child of `uvm_top`. Thus, all UVM components in simulation are descendants of `uvm_top`.

**Phase control** `uvm_top` manages the phasing for all components.

**Search** Use `uvm_top` to search for components based on their hierarchical name. See `find` and `find_all`.

**Report configuration** Use `uvm_top` to globally configure report verbosity, log files, and actions. For example, `uvm_top.set_report_verbosity_level_hier(UVM_FULL)` would set full verbosity for all components in simulation.

**Global reporter** Because `uvm_top` is globally accessible (in uvm_pkg scope), UVM’s reporting mechanism is accessible from anywhere outside `uvm_component`, such as in modules and sequences. See `uvm_report_error`, `uvm_report_warning`, and other global methods.

The `uvm_top` instance checks during the end_of_elaboration phase if any errors have been generated so far. If errors are found a UVM_FATAL error is being generated as result so that the simulation will not continue to the start_of_simulation_phase.

**Summary**

<table>
<thead>
<tr>
<th><strong>uvm_root</strong></th>
<th>The <code>uvm_root</code> class serves as the implicit top-level and phase controller for all UVM components.</th>
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<td>get()</td>
<td>Static accessor for <code>uvm_root</code>.</td>
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<tr>
<td>run_test</td>
<td>Phases all components through all registered phases.</td>
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<tr>
<td>die</td>
<td>This method is called by the report server if a report reaches the maximum quit count or has a UVM_EXIT action associated with it, e.g., as with fatal errors.</td>
</tr>
<tr>
<td>set_timeout</td>
<td>Specifies the timeout for the simulation.</td>
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<tr>
<td>finish_on_completion</td>
<td>If set, then run_test will call $finish after all phases are executed.</td>
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<table>
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<th><strong>Topology</strong></th>
<th>This variable is a list of all of the top level</th>
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components in UVM.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<td>find</td>
<td>Returns the component handle (find) or list of components handles (find_all) matching a given string.</td>
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<td>find_all</td>
<td>Returns the component handle (find) or list of components handles (find_all) matching a given string.</td>
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<tr>
<td>print_topology</td>
<td>Print the verification environment’s component topology.</td>
</tr>
<tr>
<td>enable_print_topology</td>
<td>If set, then the entire testbench topology is printed just after completion of the end_of_elaboration phase.</td>
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**GLOBAL VARIABLES**

<table>
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<tr>
<th>Variable</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>uvm_top</td>
<td>This is the top-level that governs phase execution and provides component search interface.</td>
</tr>
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### get()

```cpp
static function uvm_root get()
```

Static accessor for **uvm_root**.

The static accessor is provided as a convenience wrapper around retrieving the root via the `uvm_coreservice_t::get_root` method.

```cpp
// Using the uvm_coreservice_t:
uvm_coreservice_t cs;
uvm_root r;
cs = uvm_coreservice_t::get();
r = cs.get_root();

// Not using the uvm_coreservice_t:
uvm_root r;
r = uvm_root::get();
```

### SIMULATION CONTROL

### run_test

```cpp
virtual task run_test (string test_name ="")
```

Phases all components through all registered phases. If the optional test_name argument is provided, or if a command-line plusarg, `+UVM_TESTNAME=TEST_NAME`, is found, then the specified component is created just prior to phasing. The test may contain new verification components or the entire testbench, in which case the test and testbench can be chosen from the command line without forcing recompilation. If the global (package) variable, `finish_on_completion`, is set, then `$finish` is called after phasing completes.

### die

```cpp
virtual function void die()
```

This method is called by the report server if a report reaches the maximum quit count or
has a UVM_EXIT action associated with it, e.g., as with fatal errors.

Calls the `uvm_component::pre_abort()` method on the entire `uvm_component` hierarchy in a bottom-up fashion. It then calls `uvm_report_server::report_summarize` and terminates the simulation with `$finish$`.

### set_timeout

```plaintext
function void set_timeout(
  time timeout,
  bit overridable = 1
)
```

Specifies the timeout for the simulation. Default is `UVM_DEFAULT_TIMEOUT`

The timeout is simply the maximum absolute simulation time allowed before a `FATAL` occurs. If the timeout is set to 20ns, then the simulation must end before 20ns, or a `FATAL` timeout will occur.

This is provided so that the user can prevent the simulation from potentially consuming too many resources (Disk, Memory, CPU, etc) when the testbench is essentially hung.

### finish_on_completion

```plaintext
bit finish_on_completion = 1
```

If set, then run_test will call $finish after all phases are executed.

### Topology

#### top_levels

```plaintext
uvm_component top_levels[]
```

This variable is a list of all of the top level components in UVM. It includes the `uvm_test_top` component that is created by `run_test` as well as any other top level components that have been instantiated anywhere in the hierarchy.

#### find

```plaintext
function uvm_component find (string comp_match)
```

#### find_all

```plaintext
function void find_all (string _comp_match,
  ref uvm_component compS[] = null,
  input uvm_component comp = null
)
```
Returns the component handle (find) or list of components handles (find_all) matching a given string. The string may contain the wildcards,

- and ?. Strings beginning with "." are absolute path names. If the optional argument comp is provided, then search begins from that component down (default=all components).

**print_topology**

```plaintext
function void print_topology (uvm_printer printer = null)
```

Print the verification environment’s component topology. The printer is a uvm_printer object that controls the format of the topology printout; a null printer prints with the default output.

**enable_print_topology**

```plaintext
bit enable_print_topology = 0
```

If set, then the entire testbench topology is printed just after completion of the end_of_elaboration phase.

**GLOBAL VARIABLES**

**uvm_top**

```plaintext
const uvm_root uvm_top = uvm_root::get()
```

This is the top-level that governs phase execution and provides component search interface. See uvm_root for more information.
5.5 Port Base Classes

Contents

Port Base Classes

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<th>Class Name</th>
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<td>This class defines an interface for obtaining a port’s connectivity lists after or during the end_of_elaboration phase.</td>
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<tr>
<td>uvm_port_component #(PORT)</td>
<td>See description of uvm_port_component_base for information about this class.</td>
</tr>
<tr>
<td>uvm_port_base # (IF)</td>
<td>Transaction-level communication between components is handled via its ports, exports, and imps, all of which derive from this class.</td>
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</table>

uvm_port_component_base

This class defines an interface for obtaining a port’s connectivity lists after or during the end_of_elaboration phase. The sub-class, uvm_port_component #(PORT), implements this interface.

The connectivity lists are returned in the form of handles to objects of this type. This allowing traversal of any port’s fan-out and fan-in network through recursive calls to get_connected_to and get_provided_to. Each port’s full name and type name can be retrieved using get_full_name and get_type_name methods inherited from uvm_component.

Summary

uvm_port_component_base

This class defines an interface for obtaining a port’s connectivity lists after or during the end_of_elaboration phase.

**Class Hierarchy**

```
uvm_void
uvm_object
uvm_report_object
uvm_component
uvm_port_component_base
```

**Class Declaration**

```
virtual class uvm_port_component_base extends uvm_component
```

**Methods**

- **get_connected_to**
  For a port or export type, this function fills list with all of the ports, exports and implementations that this port is connected to.

- **get_provided_to**
  For an implementation or export type, this function fills list with all of the ports, exports and implementations
that this port is provides its implementation to.

These function determine the type of port.

**METHODS**

**get_connected_to**

```plaintext
pure virtual function void get_connected_to(
    ref uvm_port_list list
)
```

For a port or export type, this function fills `list` with all of the ports, exports and implementations that this port is connected to.

**get_provided_to**

```plaintext
pure virtual function void get_provided_to(
    ref uvm_port_list list
)
```

For an implementation or export type, this function fills `list` with all of the ports, exports and implementations that this port is provides its implementation to.

**is_port**

```plaintext
pure virtual function bit is_port()
```

**is_export**

```plaintext
pure virtual function bit is_export()
```

**is_imp**

```plaintext
pure virtual function bit is_imp()
```

These function determine the type of port. The functions are mutually exclusive; one will return 1 and the other two will return 0.

**uvm_port_component #(PORT)**

See description of `uvm_port_component_base` for information about this class

**Summary**
**uvm_port_component #**(PORT)

See description of uvm_port_component_base for information about this class.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_port_component_base
- uvm_port_component #(PORT)

**Class Declaration**

```plaintext
class uvm_port_component #(
  type PORT = uvm_object
) extends uvm_port_component_base
```

**Methods**

get_port

Retrieve the actual port object that this proxy refers to.

---

**get_port**

```plaintext
function PORT get_port()

Retrieve the actual port object that this proxy refers to.
```

---

**uvm_port_base #**(IF)

Transaction-level communication between components is handled via its ports, exports, and imps, all of which derive from this class.

The uvm_port_base extends IF, which is the type of the interface implemented by derived port, export, or implementation. IF is also a type parameter to uvm_port_base.

**IF**

The interface type implemented by the subtype to this base port

The UVM provides a complete set of ports, exports, and imps for the OSCI-standard TLM interfaces. They can be found in the ../src/tlm/ directory. For the TLM interfaces, the IF parameter is always uvm_tlm_if_base #(T1,T2).

Just before uvm_component::end_of_elaboration_phase, an internal uvm_component::resolve_bindings process occurs, after which each port and export holds a list of all imps connected to it via hierarchical connections to other ports and exports. In effect, we are collapsing the port’s fanout, which can span several levels up and down the component hierarchy, into a single array held local to the port. Once the list is determined, the port’s min and max connection settings can be checked and enforced.
uvm_port_base possesses the properties of components in that they have a hierarchical instance path and parent. Because SystemVerilog does not support multiple inheritance, uvm_port_base cannot extend both the interface it implements and uvm_component. Thus, uvm_port_base contains a local instance of uvm_component, to which it delegates such commands as get_name, get_full_name, and get_parent.

Summary

**uvm_port_base #**(IF)

Transaction-level communication between components is handled via its ports, exports, and imps, all of which derive from this class.

**CLASS HIERARCHY**

| IF | uvm_port_base #**(IF)** |

**CLASS DECLARATION**

```plaintext
virtual class uvm_port_base #(type IF = uvm_void -
) extends IF
```

**METHODS**

- **new**
  The first two arguments are the normal uvm_component constructor arguments.

- **get_name**
  Returns the leaf name of this port.

- **get_full_name**
  Returns the full hierarchical name of this port.

- **get_parent**
  Returns the handle to this port’s parent, or null if it has no parent.

- **get_comp**
  Returns a handle to the internal proxy component representing this port.

- **get_type_name**
  Returns the type name to this port.

- **min_size**
  Returns the minimum number of implementation ports that must be connected to this port by the end_of_elaboration phase.

- **max_size**
  Returns the maximum number of implementation ports that must be connected to this port by the end_of_elaboration phase.

- **is_unbounded**
  Returns 1 if this port has no maximum on the number of implementation ports this port can connect to.

- **is_port**

- **is_export**

- **is_imp**
  Returns 1 if this port is of the type given by the method name, 0 otherwise.

- **size**
  Gets the number of implementation ports connected to this port.

- **set_default_index**
  Sets the default implementation port to use when calling an interface method.

- **connect**
  Connects this port to the given provider port.

- **debug_connected_to**
  The debug_connected_to method outputs a visual text display of the port/export/imp network to which this port connects (i.e., the port’s fanout).

- **debug_provided_to**
  The debug_provided_to method outputs a visual display of the port/export network that ultimately connect to this port (i.e., the port’s fanin).

- **resolve_bindings**
  This callback is called just before entering the end_of_elaboration phase.

- **get_if**
  Returns the implementation (imp) port at the given index from the array of imps this port is connected to.
The first two arguments are the normal `uvm_component` constructor arguments.

The `port_type` can be one of `UVM_PORT`, `UVM_EXPORT`, or `UVM_IMPLEMENTATION`.

The `min_size` and `max_size` specify the minimum and maximum number of implementation (imp) ports that must be connected to this port base by the end of elaboration. Setting `max_size` to `UVM_UNBOUNDED_CONNECTIONS` sets no maximum, i.e., an unlimited number of connections are allowed.

By default, the parent/child relationship of any port being connected to this port is not checked. This can be overridden by configuring the port's `check_connection_relationships` bit via `uvm_config_int::set()`. See `connect` for more information.

**get_name**

```text
function string get_name() ...
```

Returns the leaf name of this port.

**get_full_name**

```text
virtual function string get_full_name() ...
```

Returns the full hierarchical name of this port.

**get_parent**

```text
virtual function uvm_component get_parent() ...
```

Returns the handle to this port's parent, or `null` if it has no parent.

**get_comp**

```text
virtual function uvm_port_component_base get_comp() ...
```

Returns a handle to the internal proxy component representing this port.

Ports are considered components. However, they do not inherit `uvm_component`. Instead, they contain an instance of `uvm_port_component #(PORT)` that serves as a proxy to this port.
get_type_name

virtual function string get_type_name()

Returns the type name to this port. Derived port classes must implement this method to return the concrete type. Otherwise, only a generic “uvm_port”, “uvm_export” or “uvm_implementation” is returned.

min_size

Returns the minimum number of implementation ports that must be connected to this port by the end_of_elaboration phase.

max_size

Returns the maximum number of implementation ports that must be connected to this port by the end_of_elaboration phase.

is_unbounded

function bit is_unbounded ()

Returns 1 if this port has no maximum on the number of implementation ports this port can connect to. A port is unbounded when the max_size argument in the constructor is specified as UVM_UNBOUNDED_CONNECTIONS.

is_port

function bit is_port ()

is_export

function bit is_export ()

is_imp

function bit is_imp ()

Returns 1 if this port is of the type given by the method name, 0 otherwise.

size

function int size ()

Gets the number of implementation ports connected to this port. The value is not valid before the end_of_elaboration phase, as port connections have not yet been resolved.
**set_default_index**

```cpp
function void set_default_index (  
   int index  
)
```

Sets the default implementation port to use when calling an interface method. This method should only be called on UVM_EXPORT types. The value must not be set before the end_of_elaboration phase, when port connections have not yet been resolved.

**connect**

```cpp
virtual function void connect (  
   this_type provider  
)
```

Connects this port to the given provider port. The ports must be compatible in the following ways:

- Their type parameters must match.
- The provider’s interface type (blocking, non-blocking, analysis, etc.) must be compatible. Each port has an interface mask that encodes the interface(s) it supports. If the bitwise AND of these masks is equal to the this port’s mask, the requirement is met and the ports are compatible. For example, a uvm_blocking_put_port #(T) is compatible with a uvm_put_export #(T) and uvm_blocking_put_imp #(T) because the export and imp provide the interface required by the uvm_blocking_put_port.
- Ports of type UVM_EXPORT can only connect to other exports or imps.
- Ports of type UVM_IMPLEMENTATION cannot be connected, as they are bound to the component that implements the interface at time of construction.

In addition to type-compatibility checks, the relationship between this port and the provider port will also be checked if the port’s check_connection_relationships configuration has been set. (See new for more information.)

**Relationships, when enabled, are checked as follows**

- If this port is a UVM_PORT type, the provider can be a parent port, or a sibling export or implementation port.
- If this port is a UVM_EXPORT type, the provider can be a child export or implementation port.

If any relationship check is violated, a warning is issued.

Note- the uvm_component::connect_phase method is related to but not the same as this method. The component’s connect method is a phase callback where port’s connect method calls are made.

**debug_connected_to**

```cpp
function void debug_connected_to (  
   int level = 0,  
   int max_level = -1  
)
```

The debug_connected_to method outputs a visual text display of the port/export/imp network to which this port connects (i.e., the port’s fanout).
This method must not be called before the end_of_elaboration phase, as port connections are not resolved until then.

**debug_provided_to**

```plaintext
default function void debug_provided_to ( 
  int level = 0,
  int max_level = -1
)
```

The `debug_provided_to` method outputs a visual display of the port/export network that ultimately connect to this port (i.e., the port’s fanin).

This method must not be called before the end_of_elaboration phase, as port connections are not resolved until then.

**resolve_bindings**

```plaintext
default virtual function void resolve_bindings()```

This callback is called just before entering the end_of_elaboration phase. It recurses through each port’s fanout to determine all the imp destinations. It then checks against the required min and max connections. After resolution, `size` returns a valid value and `get_if` can be used to access a particular imp.

This method is automatically called just before the start of the end_of_elaboration phase. Users should not need to call it directly.

**get_if**

```plaintext
default function uvm_port_base #( 
  IF
 ) get_if(int index=0)```

Returns the implementation (imp) port at the given index from the array of imps this port is connected to. Use `size` to get the valid range for index. This method can only be called at the end_of_elaboration phase or after, as port connections are not resolved before then.
6. Reporting Classes

The reporting classes provide a facility for issuing reports with consistent formatting. Users can configure what actions to take and what files to send output to based on report severity, ID, or both severity and ID. Users can also filter messages based on their verbosity settings.

The primary interface to the UVM reporting facility is the `uvm_report_object` from which all `uvm_components` extend. The `uvm_report_object` delegates most tasks to its internal `uvm_report_handler`. If the report handler determines the report is not filtered based on the configured verbosity setting, it sends the report to the central `uvm_report_server` for formatting and processing.

**Reporting Classes**

```
| uvm_object |
| uvm_report_object --> 1:* 1 uvm_report_handler --> * 1 uvm_report_server |
| uvm_component |
| user-defined component |
```

**Summary**

**Reporting Classes**

The reporting classes provide a facility for issuing reports with consistent formatting.
6.1 uvm_report_message_element_base

Base class for report message element. Defines common interface.

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<td>uvm_report_message_element_container</td>
<td>A container used by report message to contain the dynamically added elements, with APIs to add and delete the elements.</td>
</tr>
<tr>
<td>uvm_report_message</td>
<td>The uvm_report_message is the basic UVM object message class.</td>
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Methods

get_name

```cpp
virtual function string get_name()
```

set_name

```cpp
virtual function void set_name(
    string name
)
```

Get or set the name of the element

get_action

```cpp
virtual function uvm_action get_action()
```

set_action

```cpp
virtual function void set_action(
    uvm_action action
)
```

Get or set the authorized action for the element
Message element class for integral type

Summary

**uvm_report_message_int_element**

Message element class for integral type

**CLASS HIERARCHY**

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<thead>
<tr>
<th>uvm_report_message_element_base</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_report_message_int_element</td>
</tr>
</tbody>
</table>
```

**CLASS DECLARATION**

```
class uvm_report_message_int_element extends uvm_report_message_element_base
```

**METHODS**

**get_value**

```
virtual function uvm_bitstream_t get_value(
    output int size,
    output uvm_radix_enum radix
)
```

**set_value**

```
virtual function void set_value(
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix
)
```

Get or set the value (integral type) of the element, with size and radix

---

Message element class for string type

Summary

**uvm_report_message_string_element**

Message element class for string type
CLASS HIERARCHY

uvm_report_message_element_base
uvm_report_message_string_element

CLASS DECLARATION

class uvm_report_message_string_element extends uvm_report_message_element_base

METHODS

get_value
set_value

Get or set the value (string type) of the element

 METHODS

get_value

virtual function string get_value()

set_value

virtual function void set_value(
  string value
)

Get or set the value (string type) of the element

uvm_report_message_object_element

Message element class for object type

Summary

uvm_report_message_object_element

Message element class for object type

CLASS HIERARCHY

uvm_report_message_element_base
uvm_report_message_object_element

CLASS DECLARATION

class uvm_report_message_object_element extends uvm_report_message_element_base

METHODS

get_value

Get the value (object reference) of the element

set_value

Get or set the value (object reference) of the element
**METHODS**

**get_value**

```c
virtual function uvm_object get_value()
```

Get the value (object reference) of the element

**set_value**

```c
virtual function void set_value(
    uvm_object value
)
```

Get or set the value (object reference) of the element

**uvm_report_message_element_container**

A container used by report message to contain the dynamically added elements, with APIs to add and delete the elements.

**Summary**

**uvm_report_message_element_container**

A container used by report message to contain the dynamically added elements, with APIs to add and delete the elements.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_report_message_element_container

**Class Declaration**

```c
class uvm_report_message_element_container extends uvm_object
```

**Methods**

- **new**
  - Create a new uvm_report_message_element_container object
- **size**
  - Returns the size of the container
- **delete**
  - Delete the index-th element in the container
- **delete_elements**
  - Delete all the elements in the container
- **get_elements**
  - Get all the elements from the container and put them in a queue
- **add_int**
  - This method adds an integral type of the name name and value value to the container.
- **add_string**
  - This method adds a string of the name name and value value to the message.
- **add_object**
  - This method adds a uvm_object of the name name and
METHODS

new

function new(
    string name = "element_container"
)
Create a new uvm_report_message_element_container object

size

virtual function int size()
Returns the size of the container, i.e. the number of elements

delete

virtual function void delete(
    int index
)
Delete the index-th element in the container

delete_elements

virtual function void delete_elements()
Delete all the elements in the container

get_elements

Get all the elements from the container and put them in a queue

add_int

virtual function void add_int(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)
This method adds an integral type of the name name and value value to the container. The required size field indicates the size of value. The required radix field determines how to display and record the field. The optional print/record bit is to specify whether the element will be printed/recorded.
**add_string**

virtual function void add_string(
    string name,
    string value,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)

This method adds a string of the name `name` and value `value` to the message. The optional print/record bit is to specify whether the element will be printed/recorded.

**add_object**

virtual function void add_object(
    string name,
    uvm_object obj,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)

This method adds a uvm_object of the name `name` and reference `obj` to the message. The optional print/record bit is to specify whether the element will be printed/recorded.

**uvm_report_message**

The uvm_report_message is the basic UVM object message class. It provides the fields that are common to all messages. It also has a message element container and provides the APIs necessary to add integral types, strings and uvm_objects to the container. The report message object can be initialized with the common fields, and passes through the whole reporting system (i.e. report object, report handler, report server, report catcher, etc) as an object. The additional elements can be added/deleted to/from the message object anywhere in the reporting system, and can be printed or recorded along with the common fields.

**Summary**

**uvm_report_message**

The uvm_report_message is the basic UVM object message class.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_report_message

**Class Declaration**

```plaintext
class uvm_report_message extends uvm_object

new Creates a new uvm_report_message object.
new_report_message Creates a new uvm_report_message object.
print The uvm_report_message implements uvm_object::do_print() such that print method provides UVM printer formatted output of the message.
```
**Infrastructure References**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_report_object</td>
<td>Get or set the uvm_report_object that originated the message.</td>
</tr>
<tr>
<td>set_report_object</td>
<td></td>
</tr>
<tr>
<td>get_report_handler</td>
<td>Get or set the uvm_report_handler that is responsible for checking whether the message is enabled, should be upgraded/downgraded, etc.</td>
</tr>
<tr>
<td>set_report_handler</td>
<td></td>
</tr>
<tr>
<td>get_report_server</td>
<td>Get or set the uvm_report_server that is responsible for servicing the message’s actions.</td>
</tr>
<tr>
<td>set_report_server</td>
<td></td>
</tr>
</tbody>
</table>

**Message Fields**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_severity</td>
<td>Get or set the severity (UVM_INFO, UVM_WARNING, UVM_ERROR or UVM_FATAL) of the message.</td>
</tr>
<tr>
<td>set_severity</td>
<td></td>
</tr>
<tr>
<td>get_id</td>
<td>Get or set the id of the message.</td>
</tr>
<tr>
<td>set_id</td>
<td></td>
</tr>
<tr>
<td>get_message</td>
<td>Get or set the user message content string.</td>
</tr>
<tr>
<td>set_message</td>
<td></td>
</tr>
<tr>
<td>get_verbosity</td>
<td>Get or set the message threshold value.</td>
</tr>
<tr>
<td>set_verbosity</td>
<td></td>
</tr>
<tr>
<td>get_filename</td>
<td>Get or set the file from which the message originates.</td>
</tr>
<tr>
<td>set_filename</td>
<td></td>
</tr>
<tr>
<td>get_line</td>
<td>Get or set the line in the file from which the message originates.</td>
</tr>
<tr>
<td>set_line</td>
<td></td>
</tr>
<tr>
<td>get_context</td>
<td>Get or set the optional user-supplied string that is meant to convey the context of the message.</td>
</tr>
<tr>
<td>set_context</td>
<td></td>
</tr>
<tr>
<td>get_action</td>
<td>Get or set the action(s) that the uvm_report_server should perform for this message.</td>
</tr>
<tr>
<td>set_action</td>
<td></td>
</tr>
<tr>
<td>get_file</td>
<td>Get or set the file that the message is to be written to when the message's action is UVM_LOG.</td>
</tr>
<tr>
<td>set_file</td>
<td></td>
</tr>
<tr>
<td>get_element_container</td>
<td>Get the element_container of the message.</td>
</tr>
<tr>
<td>set_report_message</td>
<td>Set all the common fields of the report message in one shot.</td>
</tr>
</tbody>
</table>

**Message Element APIs**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>add_int</td>
<td>This method adds an integral type of the name name and value value to the message.</td>
</tr>
<tr>
<td>add_string</td>
<td>This method adds a string of the name name and value value to the message.</td>
</tr>
<tr>
<td>add_object</td>
<td>This method adds a uvm_object of the name name and reference obj to the message.</td>
</tr>
</tbody>
</table>

**new**

```plaintext
function new(
    string name = "uvm_report_message"
)
```

Creates a new uvm_report_message object.

**new_report_message**

```plaintext
static function uvm_report_message new_report_message()
```
string name = "uvm_report_message"
)

Creates a new uvm_report_message object. This function is the same as new(), but keeps the random stability.

print

virtual function void do_print(uvm_printer printer)

The uvm_report_message implements uvm_object::do_print() such that print method provides UVM printer formatted output of the message. A snippet of example output is shown here:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Size</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_report_message</td>
<td>uvm_report_message</td>
<td>-</td>
<td>@532</td>
</tr>
<tr>
<td>severity</td>
<td>uvm_severity</td>
<td>2</td>
<td>UVM_INFO</td>
</tr>
<tr>
<td>id</td>
<td>string</td>
<td>10</td>
<td>TEST ID</td>
</tr>
<tr>
<td>message</td>
<td>string</td>
<td>12</td>
<td>A message</td>
</tr>
<tr>
<td>verbosity</td>
<td>uvm_verbosity</td>
<td>32</td>
<td>UVM_LOW</td>
</tr>
<tr>
<td>filename</td>
<td>string</td>
<td>7</td>
<td>test.sv</td>
</tr>
<tr>
<td>line</td>
<td>integral</td>
<td>32</td>
<td>'d58</td>
</tr>
<tr>
<td>context_name</td>
<td>string</td>
<td>0</td>
<td>&quot;&quot;</td>
</tr>
<tr>
<td>color</td>
<td>string</td>
<td>3</td>
<td>red</td>
</tr>
<tr>
<td>my_int</td>
<td>integral</td>
<td>32</td>
<td>'d5</td>
</tr>
<tr>
<td>my_string</td>
<td>string</td>
<td>3</td>
<td>foo</td>
</tr>
<tr>
<td>my_obj</td>
<td>my_class</td>
<td>-</td>
<td>@531</td>
</tr>
<tr>
<td>foo</td>
<td>integral</td>
<td>32</td>
<td>'d3</td>
</tr>
<tr>
<td>bar</td>
<td>string</td>
<td>8</td>
<td>hi there</td>
</tr>
</tbody>
</table>

**INFRASTRUCTURE REFERENCES**

get_report_object

virtual function uvm_report_object get_report_object()

set_report_object

virtual function void set_report_object(uvm_report_object ro)

Get or set the uvm_report_object that originated the message.

get_report_handler

virtual function uvm_report_handler get_report_handler()

set_report_handler
Get or set the `uvm_report_handler` that is responsible for checking whether the message is enabled, should be upgraded/downgraded, etc.

**get_report_server**

```cpp
virtual function uvm_report_server get_report_server()
```

Get or set the `uvm_report_server` that is responsible for servicing the message’s actions.

**MESSAGE FIELDS**

**get_severity**

```cpp
virtual function uvm_severity get_severity()
```

Get or set the severity (UVM_INFO, UVM_WARNING, UVM_ERROR or UVM_FATAL) of the message. The value of this field is determined via the API used (`uvm_info()`, `uvm_warning()`, etc.) and populated for the user.

**set_severity**

```cpp
virtual function void set_severity( 
   uvm_severity sev
)
```

**get_id**

```cpp
virtual function string get_id()
```

**set_id**

```cpp
virtual function void set_id( 
   string id
)
```

Get or set the id of the message. The value of this field is completely under user discretion. Users are recommended to follow a consistent convention. Settings in the `uvm_report_handler` allow various messaging controls based on this field. See `uvm_report_handler`.
get_message

```c++
virtual function string get_message()
```

Get or set the user message content string.

set_message

```c++
virtual function void set_message(
    string msg
)
```

Get or set the user message content string.

get_verbosity

```c++
virtual function int get_verbosity()
```

set_verbosity

```c++
virtual function void set_verbosity(
    int ver
)
```

Get or set the message threshold value. This value is compared against settings in the `uvm_report_handler` to determine whether this message should be executed.

get_filename

```c++
virtual function string get_filename()
```

set_filename

```c++
virtual function void set_filename(
    string fname
)
```

Get or set the file from which the message originates. This value is automatically populated by the messaging macros.

get_line

```c++
virtual function int get_line()
```

set_line

```c++
virtual function void set_line(
    int ln
)
```
Get or set the line in the file from which the message originates. This value is automatically populated by the messaging macros.

**get_context**

```cpp
virtual function string get_context()
```

**set_context**

```cpp
virtual function void set_context(  
    string cn
)
```

Get or set the optional user-supplied string that is meant to convey the context of the message. It can be useful in scopes that are not inherently UVM like modules, interfaces, etc.

**get_action**

```cpp
virtual function uvm_action get_action()
```

**set_action**

```cpp
virtual function void set_action(  
    uvm_action act
)
```

Get or set the action(s) that the uvm_report_server should perform for this message. This field is populated by the uvm_report_handler during message execution flow.

**get_file**

```cpp
virtual function UVM_FILE get_file()
```

**set_file**

```cpp
virtual function void set_file(  
    UVM_FILE fl
)
```

Get or set the file that the message is to be written to when the message’s action is UVM_LOG. This field is populated by the uvm_report_handler during message execution flow.

**get_element_container**

```cpp
virtual function uvm_report_message_element_container  
    get_element_containerF()
```

Get the element_container of the message
**set_report_message**

```plaintext
class set_report_message:
  virtual function void set_report_message(
    uvm_severity severity,
    string id,
    string message,
    int verbosity,
    string filename,
    int line,
    string context_name
  )
```

Set all the common fields of the report message in one shot.

---

**MESSAGE ELEMENT APIs**

**add_int**

```plaintext
class add_int:
  virtual function void add_int(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
  )
```

This method adds an integral type of the name `name` and value `value` to the message. The required `size` field indicates the size of `value`. The required `radix` field determines how to display and record the field. The optional print/record bit is to specify whether the element will be printed/recorded.

**add_string**

```plaintext
class add_string:
  virtual function void add_string(
    string name,
    string value,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
  )
```

This method adds a string of the name `name` and value `value` to the message. The optional print/record bit is to specify whether the element will be printed/recorded.

**add_object**

```plaintext
class add_object:
  virtual function void add_object(
    string name,
    uvm_object obj,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
  )
```

This method adds a `uvm_object` of the name `name` and reference `obj` to the message. The optional print/record bit is to specify whether the element will be printed/recorded.
The uvm_report_object provides an interface to the UVM reporting facility. Through this interface, components issue the various messages that occur during simulation. Users can configure what actions are taken and what file(s) are output for individual messages from a particular component or for all messages from all components in the environment. Defaults are applied where there is no explicit configuration.

Most methods in uvm_report_object are delegated to an internal instance of a uvm_report_handler, which stores the reporting configuration and determines whether an issued message should be displayed based on that configuration. Then, to display a message, the report handler delegates the actual formatting and production of messages to a central uvm_report_server.

A report consists of an id string, severity, verbosity level, and the textual message itself. They may optionally include the filename and line number from which the message came. If the verbosity level of a report is greater than the configured maximum verbosity level of its report object, it is ignored. If a report passes the verbosity filter in effect, the report’s action is determined. If the action includes output to a file, the configured file descriptor(s) are determined.

**Actions**

Actions can be set for (in increasing priority) severity, id, and (severity,id) pair. They include output to the screen UVM_DISPLAY, whether the message counters should be incremented UVM_COUNT, and whether a $finish should occur UVM_EXIT.

**Default Actions**

The following provides the default actions assigned to each severity. These can be overridden by any of the set_*_action methods.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVM_INFO</td>
<td>UVM_DISPLAY</td>
</tr>
<tr>
<td>UVM_WARNING</td>
<td>UVM_DISPLAY</td>
</tr>
<tr>
<td>UVM_ERROR</td>
<td>UVM_DISPLAY</td>
</tr>
<tr>
<td>UVM_FATAL</td>
<td>UVM_DISPLAY</td>
</tr>
</tbody>
</table>

**File descriptors**

These can be set by (in increasing priority) default, severity level, an id, or (severity,id) pair. File descriptors are standard SystemVerilog file descriptors; they may refer to more than one file. It is the user’s responsibility to open and close them.

**Default file handle**

The default file handle is 0, which means that reports are not sent to a file even if a UVM_LOG attribute is set in the action associated with the report. This can be overridden by any of the set_*_file methods.

**Summary**

The uvm_report_object provides an interface to the UVM reporting facility.
### uvm_report_object

#### Class Declaration

```
class uvm_report_object extends uvm_object
```

#### Reporting

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_get_report_object</td>
<td>Returns the nearest uvm_report_object when called.</td>
</tr>
<tr>
<td>uvm_report_enabled</td>
<td>Returns 1 if the configured verbosity for this severity/id is greater than or equal to verbosity else returns 0.</td>
</tr>
<tr>
<td>uvm_report</td>
<td>These are the primary reporting methods in the UVM.</td>
</tr>
<tr>
<td>uvm_report_info</td>
<td></td>
</tr>
<tr>
<td>uvm_report_warning</td>
<td></td>
</tr>
<tr>
<td>uvm_report_error</td>
<td></td>
</tr>
<tr>
<td>uvm_report_fatal</td>
<td></td>
</tr>
<tr>
<td>uvm_process_report_message</td>
<td>This method takes a preformed uvm_report_message, populates it with the report object and passes it to the report handler for processing.</td>
</tr>
</tbody>
</table>

#### Verbose Configuration

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_report_verbosity_level</td>
<td>Gets the verbosity level in effect for this object.</td>
</tr>
<tr>
<td>get_report_max_verbosity_level</td>
<td>Gets the maximum verbosity level in effect for this report object.</td>
</tr>
<tr>
<td>set_report_verbosity_level</td>
<td>This method sets the maximum verbosity level for reports for this component.</td>
</tr>
<tr>
<td>set_report_id_verbosity</td>
<td>These methods associate the specified verbosity threshold with reports of the given severity, id, or severity-id pair.</td>
</tr>
<tr>
<td>set_report_severity_id_verbosity</td>
<td></td>
</tr>
</tbody>
</table>

#### Action Configuration

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_report_action</td>
<td>Gets the action associated with reports having the given severity and id.</td>
</tr>
<tr>
<td>set_report_severity_action</td>
<td>These methods associate the specified action or actions with reports of the given severity, id, or severity-id pair.</td>
</tr>
<tr>
<td>set_report_id_action</td>
<td></td>
</tr>
<tr>
<td>set_report_severity_id_action</td>
<td></td>
</tr>
</tbody>
</table>

#### File Configuration

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_report_file_handle</td>
<td>Gets the file descriptor associated with reports having the given severity and id.</td>
</tr>
<tr>
<td>set_report_default_file</td>
<td>These methods configure the report handler to direct some or all of its output to the given file descriptor.</td>
</tr>
<tr>
<td>set_report_id_file</td>
<td></td>
</tr>
<tr>
<td>set_report_severity_file</td>
<td></td>
</tr>
<tr>
<td>set_report_severity_id_file</td>
<td></td>
</tr>
</tbody>
</table>

#### Override Configuration

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>set_report_severity_override</td>
<td>These methods provide the ability to upgrade or downgrade a message in terms of severity given severity and id.</td>
</tr>
<tr>
<td>set_report_severity_id_override</td>
<td></td>
</tr>
</tbody>
</table>

#### Report Handler Configuration

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>set_report_handler</td>
<td>Sets the report handler, overwriting the default instance.</td>
</tr>
<tr>
<td>get_report_handler</td>
<td>Returns the underlying report handler to which most reporting tasks are delegated.</td>
</tr>
<tr>
<td>reset_report_handler</td>
<td>Resets the underlying report handler to its default settings.</td>
</tr>
</tbody>
</table>
**new**

```plaintext
function new(
    string name = ""
)
```

Creates a new report object with the given name. This method also creates a new `uvm_report_handler` object to which most tasks are delegated.

**REPORTING**

**uvm_get_report_object**

```plaintext
function uvm_report_object uvm_get_report_object()
```

Returns the nearest `uvm_report_object` when called. From inside a `uvm_component`, the method simply returns `this`.

See also the global version of `uvm_get_report_object`.

**uvm_report_enabled**

```plaintext
function int uvm_report_enabled(
    int verbosity,
    uvm_severity severity = UVM_INFO,
    string id = ""
)
```

Returns 1 if the configured verbosity for this severity/id is greater than or equal to `verbosity` else returns 0.

See also `get_report_verbosity_level` and the global version of `uvm_report_enabled`.

**uvm_report**

```plaintext
virtual function void uvm_report(
    uvm_severity severity,
    string id,
    string message,
    int verbosity
    = (severity ==
        uvm_severity'(UVM_ERROR)) ?
        UVM_LOW : (severity ==
        uvm_severity'(UVM_FATAL)) ?
        UVM_NONE : UVM_MEDIUM,
    string filename = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```

**uvm_report_info**

```plaintext
virtual function void uvm_report_info(
```

UVM 1.2 Class Reference
These are the primary reporting methods in the UVM. Using these instead of $display and other ad hoc approaches ensures consistent output and central control over where output is directed and any actions that result. All reporting methods have the same arguments, although each has a different default verbosity:

- **id**
  - a unique id for the report or report group that can be used for identification and therefore targeted filtering. You can configure an individual report’s actions and output file(s) using this id string.

- **message**
  - the message body, preformatted if necessary to a single string.

- **verbosity**
  - the verbosity of the message, indicating its relative importance. If this number is less than or equal to the effective verbosity level, see set_report_verbosity_level, then the report is issued, subject to the configured action and file descriptor settings. Verbosity is ignored for warnings, errors,
and fatals. However, if a warning, error or fatal is demoted to an info message using the \texttt{uvm_report_catcher}, then the verbosity is taken into account.

| filename/line | (Optional) The location from which the report was issued. Use the predefined macros, `\_FILE\_` and `\_LINE\_`. If specified, it is displayed in the output. |
| context_name | (Optional) The string context from where the message is originating. This can be the %m of a module, a specific method, etc. |
| report_enabled_checked | (Optional) This bit indicates whether the currently provided message has been checked as to whether the message should be processed. If it hasn’t been checked, it will be checked inside the \texttt{uvm\_report} function. |

**uvm\_process\_report\_message**

```
virtual function void uvm_process_report_message(
    uvm_report_message report_message
)
```

This method takes a preformed \texttt{uvm_report\_message}, populates it with the report object and passes it to the report handler for processing. It is expected to be checked for verbosity and populated.

**Verbosity Configuration**

**get_report_verbosity_level**

```
function int get_report_verbosity_level(
    uvm_severity severity = UVM\_INFO,
    string id = ""
)
```

Gets the verbosity level in effect for this object. Reports issued with verbosity greater than this will be filtered out. The severity and tag arguments check if the verbosity level has been modified for specific severity/tag combinations.

**get_report_max_verbosity_level**

```
function int get_report_max_verbosity_level()
```

Gets the maximum verbosity level in effect for this report object. Any report from this component whose verbosity exceeds this maximum will be ignored.

**set_report_verbosity_level**

```
function void set_report_verbosity_level (int verbosity_level)
```
This method sets the maximum verbosity level for reports for this component. Any report from this component whose verbosity exceeds this maximum will be ignored.

**set_report_id_verbosity**

```plaintext
function void set_report_id_verbosity ( 
    string id,
    int verbosity
)
```

**set_report_severity_id_verbosity**

```plaintext
function void set_report_severity_id_verbosity ( 
    uvm_severity severity,
    string id,
    int verbosity
)
```

These methods associate the specified verbosity threshold with reports of the given severity, id, or severity-id pair. This threshold is compared with the verbosity originally assigned to the report to decide whether it gets processed. A verbosity threshold associated with a particular severity-id pair takes precedence over a verbosity threshold associated with id, which takes precedence over a verbosity threshold associated with a severity.

The verbosity argument can be any integer, but is most commonly a predefined uvm_verbosity value, UVM_NONE, UVM_LOW, UVM_MEDIUM, UVM_HIGH, UVM_FULL.

**ACTION CONFIGURATION**

**get_report_action**

```plaintext
function int get_report_action(
    uvm_severity severity,
    string id
)
```

 Gets the action associated with reports having the given severity and id.

**set_report_severity_action**

```plaintext
function void set_report_severity_action ( 
    uvm_severity severity,
    uvm_action action
)
```

**set_report_id_action**

```plaintext
function void set_report_id_action ( 
    string id,
    uvm_action action
)
```
**set_report_severity_id_action**

```plaintext
function void set_report_severity_id_action (  
    uvm_severity  severity,  
    string        id,  
    uvm_action    action
)
```

These methods associate the specified action or actions with reports of the given `severity`, `id`, or `severity-id` pair. An action associated with a particular `severity-id` pair takes precedence over an action associated with `id`, which takes precedence over an action associated with a `severity`.

The `action` argument can take the value `UVM_NO_ACTION`, or it can be a bitwise OR of any combination of `UVM_DISPLAY`, `UVM_LOG`, `UVM_COUNT`, `UVM_STOP`, `UVM_EXIT`, and `UVM_CALL_HOOK`.

**FILE CONFIGURATION**

**get_report_file_handle**

```plaintext
function int get_report_file_handle (  
    uvm_severity  severity,  
    string        id
)
```

Gets the file descriptor associated with reports having the given `severity` and `id`.

**set_report_default_file**

```plaintext
function void set_report_default_file (  
    UVM_FILE   file
)
```

**set_report_id_file**

```plaintext
function void set_report_id_file (  
    string      id,  
    UVM_FILE    file
)
```

**set_report_severity_file**

```plaintext
function void set_report_severity_file (  
    uvm_severity severity,  
    UVM_FILE    file
)
```

**set_report_severity_id_file**

```plaintext
function void set_report_severity_id_file (  
    uvm_severity severity,  
    string        id,  
    UVM_FILE    file
)
```
These methods configure the report handler to direct some or all of its output to the given file descriptor. The file argument must be a multi-channel descriptor (mcd) or file id compatible with $fdisplay.

A FILE descriptor can be associated with reports of the given severity, id, or severity-id pair. A FILE associated with a particular severity-id pair takes precedence over a FILE associated with id, which take precedence over an a FILE associated with a severity, which takes precedence over the default FILE descriptor.

When a report is issued and its associated action has the UVM_LOG bit set, the report will be sent to its associated FILE descriptor. The user is responsible for opening and closing these files.

**Override Configuration**

**set_report_severity_override**

```plaintext
function void set_report_severity_override(  
  uvm_severity cur_severity,  
  uvm_severity new_severity  
)
```

These methods provide the ability to upgrade or downgrade a message in terms of severity given severity and id. An upgrade or downgrade for a specific id takes precedence over an upgrade or downgrade associated with a severity.

**Report Handler Configuration**

**set_report_handler**

```plaintext
function void set_report_handler(  
  uvm_report_handler handler  
)
```

Sets the report handler, overwriting the default instance. This allows more than one component to share the same report handler.

**get_report_handler**
function uvm_report_handler get_report_handler()

Returns the underlying report handler to which most reporting tasks are delegated.

reset_report_handler

function void reset_report_handler

Resets the underlying report handler to its default settings. This clears any settings made with the set_report_* methods (see below).
6.3 uvm_report_handler

The uvm_report_handler is the class to which most methods in uvm_report_object delegate. It stores the maximum verbosity, actions, and files that affect the way reports are handled.

The report handler is not intended for direct use. See uvm_report_object for information on the UVM reporting mechanism.

The relationship between uvm_report_object (a base class for uvm_component) and uvm_report_handler is typically one to one, but it can be many to one if several uvm_report_objects are configured to use the same uvm_report_handler_object. See uvm_report_object::set_report_handler.

The relationship between uvm_report_handler and uvm_report_server is many to one.

Summary

uvm_report_handler

The uvm_report_handler is the class to which most methods in uvm_report_object delegate.

Class Hierarchy

- uvm_void
- uvm_object
- uvm_report_handler

Class Declaration

class uvm_report_handler extends uvm_object

new

- Creates and initializes a new uvm_report_handler object.

print

- The uvm_report_handler implements the uvm_object::do_print() such that print method provides UVM printer formatted output of the current configuration.

Message Processing

- process_report_message

This is the common handler method used by the four core reporting methods (e.g.

Convenience Methods

- format_action

Returns a string representation of the action, e.g., "DISPLAY".

new

function new(
    string name = "uvm_report_handler"
)

Creates and initializes a new uvm_report_handler object.

print
The uvm_report_handler implements the `uvm_object::do_print()` such that `print` method provides UVM printer formatted output of the current configuration. A snippet of example output is shown here:

```plaintext
virtual function void do_print ( 
  uvm_printer printer
)
```

This is the common handler method used by the four core reporting methods (e.g. `uvm_report_error`) in `uvm_report_object`.

### Convenience Methods

#### format_action

```plaintext
static function string format_action( 
  uvm_action action
)
```

Returns a string representation of the `action`, e.g., “DISPLAY”. 

---

**MESSAGE PROCESSING**

**process_report_message**

```plaintext
virtual function void process_report_message( 
  uvm_report_message report_message
)
```

---

**UVM 1.2 Class Reference**

---

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6.4 UVM Report Server

This page covers the classes that define the UVM report server facility.

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<tr>
<td>uvm_report_server</td>
<td>uvm_report_server is a global server that processes all of the reports generated by a uvm_report_handler.</td>
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<td>uvm_default_report_server</td>
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uvm_report_server

uvm_report_server is a global server that processes all of the reports generated by a uvm_report_handler.

The uvm_report_server is an abstract class which declares many of its methods as pure virtual. The UVM uses the uvm_default_report_server class as its default report server implementation.

Summary

uvm_report_server

uvm_report_server is a global server that processes all of the reports generated by a uvm_report_handler.

Methods

<table>
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<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>set_max_quit_count</td>
<td><code>count</code> is the maximum number of <code>UVM.Quit</code> actions the uvm_report_server will tolerate before invoking client.die().</td>
</tr>
<tr>
<td>get_max_quit_count</td>
<td>Returns the currently configured max quit count.</td>
</tr>
<tr>
<td>set_quit_count</td>
<td>Sets the current number of <code>UVM.Quit</code> actions already passed through this uvm_report_server</td>
</tr>
<tr>
<td>get_quit_count</td>
<td>Returns the current number of <code>UVM.Quit</code> actions already passed through this server</td>
</tr>
<tr>
<td>set_severity_count</td>
<td>Sets the count of already passed messages with severity <code>severity</code> to <code>count</code></td>
</tr>
<tr>
<td>get_severity_count</td>
<td>Returns the count of already passed messages with severity <code>severity</code></td>
</tr>
<tr>
<td>set_id_count</td>
<td>Sets the count of already passed messages with <code>id</code> to <code>count</code></td>
</tr>
<tr>
<td>get_id_count</td>
<td>Returns the count of already passed messages with <code>id</code></td>
</tr>
<tr>
<td>get_id_set</td>
<td>Returns the set of <code>id</code>’s already used by this uvm_report_server</td>
</tr>
<tr>
<td>get_severity_set</td>
<td>Returns the set of severities already used by this uvm_report_server</td>
</tr>
<tr>
<td>set_message_database</td>
<td>Sets the uvm_tr_database used for recording messages</td>
</tr>
<tr>
<td>get_message_database</td>
<td>Returns the uvm_tr_database used for recording messages</td>
</tr>
<tr>
<td>do_copy</td>
<td>Copies all message statistic severity, id counts to</td>
</tr>
</tbody>
</table>
the destination uvm_report_server the copy is
cumulative (only items from the source are
transferred, already existing entries are not
deleted, existing entries/counts are overridden
when they exist in the source set)

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>execute_report_message</td>
<td>Processes the provided message per the actions contained within.</td>
</tr>
</tbody>
</table>
| compose_report_message        | Constructs the actual string sent to the file or command line from the severity, component
                                name, report id, and the message itself.                                    |
| report_summarize              | Outputs statistical information on the reports issued by this central report
                                server.                                                                     |
| set_server                    | Sets the global report server to use for reporting.                         |
| get_server                    | Gets the global report server used for reporting.                           |

**METHODS**

**set_max_quit_count**

```c
pure virtual function void set_max_quit_count(
  int count,
  bit overridable = 1
)
```

count is the maximum number of UVM_QUIT actions the uvm_report_server will tolerate
before invoking client.die(). when overridable = 0 is passed, the set quit count cannot be
changed again

**get_max_quit_count**

```c
pure virtual function int get_max_quit_count()
```

returns the currently configured max quit count

**set_quit_count**

```c
pure virtual function void set_quit_count(
  int quit_count
)
```

sets the current number of UVM_QUIT actions already passed through this
uvm_report_server

**get_quit_count**

```c
pure virtual function int get_quit_count()
```

returns the current number of UVM_QUIT actions already passed through this server

**set_severity_count**
sets the count of already passed messages with severity `severity` to `count`

**get_severity_count**

```cpp
pure virtual function int get_severity_count(uvm_severity severity)
```

returns the count of already passed messages with severity `severity`

**set_id_count**

```cpp
pure virtual function void set_id_count(string id, int count)
```

sets the count of already passed messages with `id` to `count`

**get_id_count**

```cpp
pure virtual function int get_id_count(string id)
```

returns the count of already passed messages with `id`

**get_id_set**

```cpp
pure virtual function void get_id_set(output string q[$])
```

returns the set of id’s already used by this uvm_report_server

**get_severity_set**

```cpp
pure virtual function void get_severity_set(output uvm_severity q[$])
```

returns the set of severities already used by this uvm_report_server

**set_message_database**

```cpp
pure virtual function void set_message_database(uvm_tr_database database)
```
sets the uvm_tr_database used for recording messages

**get_message_database**

```plaintext
pure virtual function uvm_tr_database get_message_database()
```

returns the uvm_tr_database used for recording messages

**do_copy**

```plaintext
function void do_copy (uvm_object rhs)
```

copies all message statistic severity,id counts to the destination uvm_report_server the copy is cumulative (only items from the source are transferred, already existing entries are not deleted, existing entries/counts are overridden when they exist in the source set)

**execute_report_message**

```plaintext
pure virtual function void execute_report_message(uvm_report_message report_message, string composed_message)
```

Processes the provided message per the actions contained within.

Expert users can overload this method to customize action processing.

**compose_report_message**

```plaintext
pure virtual function string compose_report_message(uvm_report_message report_message, string report_object_name = "")
```

Constructs the actual string sent to the file or command line from the severity, component name, report id, and the message itself.

Expert users can overload this method to customize report formatting.

**report_summarize**

```plaintext
pure virtual function void report_summarize(UVM_FILE file = 0)
```

Outputs statistical information on the reports issued by this central report server. This information will be sent to the command line if file is 0, or to the file descriptor file if it is not 0.

The run_test method in uvm_top calls this method.
**set_server**

```cpp
static function void set_server(uvm_report_server server)
```

Sets the global report server to use for reporting.

This method is provided as a convenience wrapper around setting the report server via the `uvm_coreservice_t::set_report_server` method.

In addition to setting the server this also copies the severity/id counts from the current report_server to the new one

```cpp
// Using the uvm_coreservice_t:
uvm_coreservice_t cs;
cs = uvm_coreservice_t::get();
your_server.copy(cs.get_report_server());
cs.set_report_server(your_server);

// Not using the uvm_coreservice_t:
uvm_report_server::set_server(your_server);
```

**get_server**

```cpp
static function uvm_report_server get_server()
```

Gets the global report server used for reporting.

This method is provided as a convenience wrapper around retrieving the report server via the `uvm_coreservice_t::get_report_server` method.

```cpp
// Using the uvm_coreservice_t:
uvm_coreservice_t cs;
uvm_report_server rs;
cs = uvm_coreservice_t::get();
rs = cs.get_report_server();

// Not using the uvm_coreservice_t:
uvm_report_server rs;
rs = uvm_report_server::get_server();
```

**uvm_default_report_server**

Default implementation of the UVM report server.

**Summary**

**uvm_default_report_server**

Default implementation of the UVM report server.

**Class Hierarchy**

```
| uvm_report_server |
```
### uvm_default_report_server

#### Class Declaration

```
class uvm_default_report_server extends uvm_report_server
```

<table>
<thead>
<tr>
<th>Function/Property</th>
<th>Description</th>
</tr>
</thead>
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<td>enable_report_id_count_summary</td>
<td>A flag to enable report count summary for each ID</td>
</tr>
<tr>
<td>record_all_messages</td>
<td>A flag to force recording of all messages (add UVM_RM_RECORD action)</td>
</tr>
<tr>
<td>show_verbosity</td>
<td>A flag to include verbosity in the messages, e.g.</td>
</tr>
<tr>
<td>show_terminator</td>
<td>A flag to add a terminator in the messages, e.g.</td>
</tr>
<tr>
<td>new</td>
<td>Creates an instance of the class.</td>
</tr>
<tr>
<td>print</td>
<td>The uvm_report_server implements the uvm_object::do_print() such that print method provides UVM printer formatted output of the current configuration.</td>
</tr>
<tr>
<td>get_max_quit_count</td>
<td>Get or set the maximum number of COUNT actions that can be tolerated before a UVM_EXIT action is taken.</td>
</tr>
<tr>
<td>set_max_quit_count</td>
<td></td>
</tr>
<tr>
<td>get_quit_count</td>
<td>Set, get, increment, or reset to 0 the quit count, i.e., the number of COUNT actions issued.</td>
</tr>
<tr>
<td>set_quit_count</td>
<td></td>
</tr>
<tr>
<td>incr_quit_count</td>
<td></td>
</tr>
<tr>
<td>reset_quit_count</td>
<td></td>
</tr>
<tr>
<td>is_quit_count_reached</td>
<td>If is_quit_count_reached returns 1, then the quit counter has reached the maximum.</td>
</tr>
<tr>
<td>get_severity_count</td>
<td>Set, get, or increment the counter for the given severity, or reset all severity counters to 0.</td>
</tr>
<tr>
<td>set_severity_count</td>
<td></td>
</tr>
<tr>
<td>incr_severity_count</td>
<td></td>
</tr>
<tr>
<td>reset_severity_counts</td>
<td></td>
</tr>
<tr>
<td>get_id_count</td>
<td>Set, get, or increment the counter for reports with the given id.</td>
</tr>
<tr>
<td>set_id_count</td>
<td></td>
</tr>
<tr>
<td>incr_id_count</td>
<td></td>
</tr>
<tr>
<td>message_recording</td>
<td>The uvm_default_report_server will record messages into the message database, using one transaction per message, and one stream per report object/handler pair.</td>
</tr>
<tr>
<td>set_message_database</td>
<td>sets the uvm_tr_database used for recording messages</td>
</tr>
<tr>
<td>get_message_database</td>
<td>returns the uvm_tr_database used for recording messages</td>
</tr>
<tr>
<td>execute_report_message</td>
<td>Processes the provided message per the actions contained within.</td>
</tr>
<tr>
<td>compose_report_message</td>
<td>Constructs the actual string sent to the file or command line from the severity, component name, report id, and the message itself.</td>
</tr>
<tr>
<td>report_summarize</td>
<td>Outputs statistical information on the reports issued by this central report server.</td>
</tr>
</tbody>
</table>
enable_report_id_count_summary

| bit enable_report_id_count_summary = 1 |

A flag to enable report count summary for each ID

record_all_messages

| bit record_all_messages = 0 |

A flag to force recording of all messages (add UVM_RM_RECORD action)

show_verbosity

| bit show_verbosity = 0 |

A flag to include verbosity in the messages, e.g.

“UVM_INFO(UVM_MEDIUM) file.v(3) @ 60: reporter [ID0] Message 0”

show_terminator

| bit show_terminator = 0 |

A flag to add a terminator in the messages, e.g.

“UVM_INFO file.v(3) @ 60: reporter [ID0] Message 0 -UVM_INFO”

new

| function new( |
| string name = "uvm_report_server" ) |

Creates an instance of the class.

print

The uvm_report_server implements the uvm_object::do_print() such that print method provides UVM printer formatted output of the current configuration. A snippet of example output is shown here:

| uvm_report_server | uvm_report_server | - 013 |
| quit_count | int 32 'd0 |
| max_quit_count | int 32 'd5 |
| max_quit_overridable | bit 1 'b1 |
| severity_count | severity counts 4 - |
| [UVM INFO] | integral 32 'd4 |
| [UVM WARNING] | integral 32 'd2 |
| [UVM ERROR] | integral 32 'd50 |
| [UVM FATAL] | integral 32 'd10 |
| id_count | id counts 4 - |
| [ID1] | integral 32 'd1 |
| [ID2] | integral 32 'd2 |
| [RNTST] | integral 32 'd1 |
| enable_report_id_count_summary | bit 1 'b1 |
get_max_quit_count

```text
function int get_max_quit_count()
```

set_max_quit_count

```text
function void set_max_quit_count(
    int count,
    bit overridable = 1
)
```

Get or set the maximum number of COUNT actions that can be tolerated before a UVM_EXIT action is taken. The default is 0, which specifies no maximum.

get_quit_count

```text
function int get_quit_count()
```

set_quit_count

```text
function void set_quit_count(
    int quit_count
)
```

incr_quit_count

```text
function void incr_quit_count()
```

reset_quit_count

```text
function void reset_quit_count()
```

Set, get, increment, or reset to 0 the quit count, i.e., the number of COUNT actions issued.

is_quit_count_reached

```text
function bit is_quit_count_reached()
```

If is_quit_count_reached returns 1, then the quit counter has reached the maximum.
get_severity_count

```plaintext
function int get_severity_count(
    uvm_severity severity
)
```

set_severity_count

```plaintext
function void set_severity_count(
    uvm_severity severity,
    int        count
)
```

incr_severity_count

```plaintext
function void incr_severity_count(
    uvm_severity severity
)
```

reset_severity_counts

```plaintext
function void reset_severity_counts()
```

Set, get, or increment the counter for the given severity, or reset all severity counters to 0.

id Count

get_id_count

```plaintext
function int get_id_count(
    string id
)
```

set_id_count

```plaintext
function void set_id_count(
    string id, 
    int    count
)
```

incr_id_count

```plaintext
function void incr_id_count(
```
Set, get, or increment the counter for reports with the given id.

**MESSAGE RECORDING**

The *uvm_default_report_server* will record messages into the message database, using one transaction per message, and one stream per report object/handler pair.

**set_message_database**

```cpp
default function void set_message_database(
    uvm_tr_database database
)
```

sets the *uvm_tr_database* used for recording messages

**get_message_database**

```cpp
default function uvm_tr_database get_message_database()
```

returns the *uvm_tr_database* used for recording messages

**MESSAGE PROCESSING**

**execute_report_message**

```cpp
default function void execute_report_message(
    uvm_report_message report_message,
    string composed_message
)
```

Processes the provided message per the actions contained within.

Expert users can overload this method to customize action processing.

**compose_report_message**

```cpp
default function string compose_report_message(
    uvm_report_message report_message,
    string report_object_name = ""
)
```

Constructs the actual string sent to the file or command line from the severity, component name, report id, and the message itself.

Expert users can overload this method to customize report formatting.
virtual function void report_summarize(
  UVM_FILE file = 0
)

Outputs statistical information on the reports issued by this central report server. This information will be sent to the command line if `file` is 0, or to the file descriptor `file` if it is not 0.

The `run_test` method in `uvm_top` calls this method.
6.5 uvm_report_catcher

The uvm_report_catcher is used to catch messages issued by the uvm report server. Catchers are uvm_callbacks#(uvm_report_object, uvm_report_catcher) objects, so all facilities in the uvm_callback and uvm_callbacks#(T,CB) classes are available for registering catchers and controlling catcher state. The uvm_callbacks#(uvm_report_object, uvm_report_catcher) class is aliased to uvm_report_cb to make it easier to use. Multiple report catchers can be registered with a report object. The catchers can be registered as default catchers which catch all reports on all uvm_report_object reporters, or catchers can be attached to specific report objects (i.e. components).

User extensions of uvm_report_catcher must implement the catch method in which the action to be taken on catching the report is specified. The catch method can return CAUGHT, in which case further processing of the report is immediately stopped, or return THROW in which case the (possibly modified) report is passed on to other registered catchers. The catchers are processed in the order in which they are registered.

On catching a report, the catch method can modify the severity, id, action, verbosity or the report string itself before the report is finally issued by the report server. The report can be immediately issued from within the catcher class by calling the issue method.

The catcher maintains a count of all reports with FATAL, ERROR or WARNING severity and a count of all reports with FATAL, ERROR or WARNING severity whose severity was lowered. These statistics are reported in the summary of the uvm_report_server.

This example shows the basic concept of creating a report catching callback and attaching it to all messages that get emitted:

```hierachy
class my_error_demoter extends uvm_report_catcher;
  function new(string name="my_error_demoter");
    super.new(name);
  endfunction
  // This example demotes "MY_ID" errors to an info message
  function action_e catch();
    if(get_severity() == UVM_ERROR && get_id() == "MY_ID")
      set_severity(UVM_INFO);
      return THROW;
  endfunction
endclass
my_error_demoter demoter = new;
initial begin
  // Catchers are callbacks on report objects (components are report objects, so catchers can be attached to components).
  // To affect all reporters, use ~null~ for the object
  uvm_report_cb::add(null, demoter);
  // To affect some specific object use the specific reporter
  uvm_report_cb::add(mytest.myenv.myagent.mydriver, demoter);
  // To affect some set of components (any "*driver" under mytest.myenv) using the component name
  uvm_report_cb::add_by_name("*driver", demoter, mytest.myenv);
end
```

Summary

uvm_report_catcher

The uvm_report_catcher is used to catch messages issued by the uvm report server.
**UVM 1.2 Class Reference**

**Class Declaration**

```cpp
template class uvm_report_catcher extends uvm_callback
```

**New**

Create a new report catcher.

**Current Message State**

- `get_client`
  - Returns the `uvm_report_object` that has generated the message that is currently being processed.

- `get_severity`
  - Returns the `uvm_severity` of the message that is currently being processed.

- `get_context`
  - Returns the context name of the message that is currently being processed.

- `get_verbosity`
  - Returns the verbosity of the message that is currently being processed.

- `get_id`
  - Returns the string id of the message that is currently being processed.

- `get_message`
  - Returns the string message of the message that is currently being processed.

- `get_action`
  - Returns the `uvm_action` of the message that is currently being processed.

- `get_fname`
  - Returns the file name of the message.

- `get_line`
  - Returns the line number of the message.

- `get_element_container`
  - Returns the element container of the message.

**Change Message State**

- `set_severity`
  - Change the severity of the message to `severity`.

- `set_verbosity`
  - Change the verbosity of the message to `verbosity`.

- `set_id`
  - Change the id of the message to `id`.

- `set_message`
  - Change the text of the message to `message`.

- `set_action`
  - Change the action of the message to `action`.

- `set_context`
  - Change the context of the message to `context_str`.

- `add_int`
  - Add an integral type of the name `name` and value `value` to the message.

- `add_string`
  - Adds a string of the name `name` and value `value` to the message.

- `add_object`
  - Adds a `uvm_object` of the name `name` and reference `obj` to the message.

**Debug**

- `get_report_catcher`
  - Returns the first report catcher that has `name`.

- `print_catcher`
  - Prints information about all of the report catchers that are registered.

**Callback Interface**

- `catch`
  - This is the method that is called for each registered report catcher.

**Reporting**

- `uvm_report_fatal`
  - Issues a fatal message using the current message’s report object.

- `uvm_report_error`
  - Issues an error message using the current message’s report object.

- `uvm_report_warning`
  - Issues a warning message using the current message’s report object.

- `uvm_report_info`
  - Issues a info message using the current message’s report object.

- `uvm_report`
  - Issues a message using the current message’s report object.

- `issue`
  - Immediately issues the message which is currently being processed.

- `summarize`
  - This function is called automatically by `uvm_report_server::report_summarize()`.
new

```plaintext
function new(
    string name = "uvm_report_catcher"
)
```

Create a new report catcher. The name argument is optional, but should generally be provided to aid in debugging.

## Current Message State

### get_client

```plaintext
function uvm_report_object get_client()
```

Returns the `uvm_report_object` that has generated the message that is currently being processed.

### get_severity

```plaintext
function uvm_severity get_severity()
```

Returns the `uvm_severity` of the message that is currently being processed. If the severity was modified by a previously executed catcher object (which re-threw the message), then the returned severity is the modified value.

### get_context

```plaintext
function string get_context()
```

Returns the context name of the message that is currently being processed. This is typically the full hierarchical name of the component that issued the message. However, if user-defined context is set from a `uvm_report_message`, the user-defined context will be returned.

### get_verbosity

```plaintext
function int get_verbosity()
```

Returns the verbosity of the message that is currently being processed. If the verbosity was modified by a previously executed catcher (which re-threw the message), then the returned verbosity is the modified value.

### get_id

```plaintext
function string get_id()
```
Returns the string id of the message that is currently being processed. If the id was modified by a previously executed catcher (which re-throw the message), then the returned id is the modified value.

**get_message**

```plaintext
function string get_message()
```

Returns the string message of the message that is currently being processed. If the message was modified by a previously executed catcher (which re-throw the message), then the returned message is the modified value.

**get_action**

```plaintext
function uvm_action get_action()
```

Returns the `uvm_action` of the message that is currently being processed. If the action was modified by a previously executed catcher (which re-throw the message), then the returned action is the modified value.

**get_fname**

```plaintext
function string get_fname()
```

Returns the file name of the message.

**get_line**

```plaintext
function int get_line()
```

Returns the line number of the message.

**get_element_container**

```plaintext
function uvm_report_message_element_container get_element_container()
```

Returns the element container of the message.

---

**CHANGE MESSAGE STATE**

**set_severity**

```plaintext
protected function void set_severity(
    uvm_severity severity
)
```

Change the severity of the message to `severity`. Any other report catchers will see the modified value.
**set_verbosity**

```plaintext
protected function void set_verbosity(
    int verbosity
)
```

Change the verbosity of the message to *verbosity*. Any other report catchers will see the modified value.

**set_id**

```plaintext
protected function void set_id(
    string id
)
```

Change the id of the message to *id*. Any other report catchers will see the modified value.

**set_message**

```plaintext
protected function void set_message(
    string message
)
```

Change the text of the message to *message*. Any other report catchers will see the modified value.

**set_action**

```plaintext
protected function void set_action(
    uvm_action action
)
```

Change the action of the message to *action*. Any other report catchers will see the modified value.

**set_context**

```plaintext
protected function void set_context(
    string context_str
)
```

Change the context of the message to *context_str*. Any other report catchers will see the modified value.

**add_int**

```plaintext
protected function void add_int(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)
```

UVM 1.2 Class Reference

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Add an integral type of the name `name` and value `value` to the message. The required `size` field indicates the size of `value`. The required `radix` field determines how to display and record the field. Any other report catchers will see the newly added element.

### add_string

```plaintext
protected function void add_string(
    string name,
    string value,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)
```

Adds a string of the name `name` and value `value` to the message. Any other report catchers will see the newly added element.

### add_object

```plaintext
protected function void add_object(
    string name,
    uvm_object obj,
    uvm_action action = (UVM_LOG|UVM_RM_RECORD)
)
```

Adds a `uvm_object` of the name `name` and reference `obj` to the message. Any other report catchers will see the newly added element.

### DEBUG

### get_report_catcher

```plaintext
static function uvm_report_catcher get_report_catcher(
    string name
)
```

Returns the first report catcher that has `name`.

### print_catcher

```plaintext
static function void print_catcher(
    UVM_FILE file = 0
)
```

Prints information about all of the report catchers that are registered. For finer grained detail, the `uvm_callbacks #(T,CB)::display` method can be used by calling `uvm_report_cb::display(uvm_report_object)`.

### CALLBACK INTERFACE

### catch
This is the method that is called for each registered report catcher. There are no arguments to this function. The Current Message State interface methods can be used to access information about the current message being processed.

**Reporting**

**uvm_report_fatal**

```plaintext
protected function void uvm_report_fatal(
    string id,
    string message,
    int verbosity,
    string fname = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```

Issues a fatal message using the current message’s report object. This message will bypass any message catching callbacks.

**uvm_report_error**

```plaintext
protected function void uvm_report_error(
    string id,
    string message,
    int verbosity,
    string fname = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```

Issues an error message using the current message’s report object. This message will bypass any message catching callbacks.

**uvm_report_warning**

```plaintext
protected function void uvm_report_warning(
    string id,
    string message,
    int verbosity,
    string fname = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```

Issues a warning message using the current message’s report object. This message will bypass any message catching callbacks.

**uvm_report_info**

```plaintext
protected function void uvm_report_info(
    string id,
    string message,
    int verbosity,
    string fname = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```
Issues a info message using the current message’s report object. This message will bypass any message catching callbacks.

**uvm_report**

```plaintext
protected function void uvm_report(
    uvm_severity severity,
    string id,
    string message,
    int verbosity,
    string fname = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)
```

Issues a message using the current message’s report object. This message will bypass any message catching callbacks.

**issue**

```plaintext
protected function void issue()
```

Immediately issues the message which is currently being processed. This is useful if the message is being *CAUGHT* but should still be emitted.

Issuing a message will update the report_server stats, possibly multiple times if the message is not *CAUGHT*.

**summarize**

```plaintext
static function void summarize()
```

This function is called automatically by `uvm_report_server::report_summarize()`. It prints the statistics for the active catchers.
7. Transaction Recording Classes

The recording classes provide a facility to record transactions into a database using a consistent API. Users can configure what gets sent to the backend database, without knowing exactly how the connection to that database is established.

The primary interface to the UVM recording facility is the `uvm_recorder` class, which serves as a reference to the transaction in the database, as well as the policy which is used to record information into the database.

The UVM provides a default implementation of the recording API, which creates textual logs. This is primarily intended to be used as an example of how to create a recording implementation without the user needing to have tool and/or vendor specific code in their testbench.

Summary

Transaction Recording Classes

The recording classes provide a facility to record transactions into a database using a consistent API.
7.1 Transaction Recording Databases

The UVM "Transaction Recording Database" classes are an abstract representation of the backend tool which is recording information for the user. Usually this tool would be dumping information such that it can be viewed with the waves of the DUT.

Contents

- Transaction Recording Databases
  - uvm_tr_database
  - uvm_text_tr_database

**uvm_tr_database**

The **uvm_tr_database** class is intended to hide the underlying database implementation from the end user, as these details are often vendor or tool-specific.

The **uvm_tr_database** class is pure virtual, and must be extended with an implementation. A default text-based implementation is provided via the **uvm_text_tr_database** class.

**Summary**

**uvm_tr_database**

The **uvm_tr_database** class is intended to hide the underlying database implementation from the end user, as these details are often vendor or tool-specific.

**CLASS HIERARCHY**

```
uvm_void
uvm_object
uvm_tr_database
```

**CLASS DECLARATION**

```
virtual class uvm_tr_database extends uvm_object
```

**new** Constructor

**DATABASE API**

- **open_db**
  - Open the backend connection to the database.
- **close_db**
  - Closes the backend connection to the database.
- **is_open**
  - Returns the open/closed status of the database.

**STREAM API**

- **open_stream**
  - Provides a reference to a *stream* within the database.
- **get_streams**
  - Provides a queue of all streams within the
**Link API**

- `establish_link` Establishes a link between two elements in the database

**Implementation Agnostic API**

- `do_open_db` Backend implementation of `open_db`
- `do_close_db` Backend implementation of `close_db`
- `do_open_stream` Backend implementation of `open_stream`
- `do_establish_link` Backend implementation of `establish_link`

---

**new**

```plaintext
function new(
    string name = "unnamed-uvm_tr_database"
)
```

Constructor

**Parameters**

- `name` Instance name

---

**Database API**

**open_db**

```plaintext
function bit open_db()
```

Open the backend connection to the database.

If the database is already open, then this method will return 1.

Otherwise, the method will call `do_open_db`, and return the result.

**close_db**

```plaintext
function bit close_db()
```

Closes the backend connection to the database.

Closing a database implicitly closes and frees all `uvm_tr_streams` within the database.

If the database is already closed, then this method will return 1.

Otherwise, this method will trigger a `do_close_db` call, and return the result.

**is_open**

```plaintext
function bit is_open()
```

Returns the open/closed status of the database.
This method returns 1 if the database has been successfully opened, but not yet closed.

**Stream API**

**open_stream**

```plaintext
function uvm_tr_stream open_stream(
    string name,
    string scope = "",
    string type_name = ""
)
```

Provides a reference to a stream within the database.

**Parameters**

- **name**: A string name for the stream. This is the name associated with the stream in the database.
- **scope**: An optional scope for the stream.
- **type_name**: An optional name describing the type of records which will be created in this stream.

The method returns a reference to a `uvm_tr_stream` object if successful, `null` otherwise.

This method will trigger a `do_open_stream` call, and if a non `null` stream is returned, then `uvm_tr_stream::do_open` will be called.

Streams can only be opened if the database is open (per `is_open`). Otherwise the request will be ignored, and `null` will be returned.

**get_streams**

```plaintext
function unsigned get_streams(
    ref uvm_tr_stream q[$]
)
```

Provides a queue of all streams within the database.

**Parameters**

- **q**: A reference to a queue of `uvm_tr_streams`

The `get_streams` method returns the size of the queue, such that the user can conditionally process the elements.

```plaintext
uvm_tr_stream stream_q[$];
if (my_db.get_streams(stream_q)) begin
    // Process the queue...
end
```

**Link API**
**establish_link**

```plaintext
function void establish_link(
    uvm_link_base link
)
```

Establishes a *link* between two elements in the database.

Links are only supported between *streams* and *records* within a single database.

This method will trigger a *do_establish_link* call.

---

**IMPLEMENTATION AGNOSTIC API**

**do_open_db**

```plaintext
pure virtual protected function bit do_open_db()
```

Backend implementation of *open_db*

**do_close_db**

```plaintext
pure virtual protected function bit do_close_db()
```

Backend implementation of *close_db*

**do_open_stream**

```plaintext
pure virtual protected function uvm_tr_stream do_open_stream(
    string name,
    string scope,
    string type_name
)
```

Backend implementation of *open_stream*

**do_establish_link**

```plaintext
pure virtual protected function void do_establish_link(
    uvm_link_base link
)
```

Backend implementation of *establish_link*

---

**uvm_text_tr_database**

The *uvm_text_tr_database* is the default implementation for the *uvm_tr_database*. It provides the ability to store recording information into a textual log file.
Summary

**uvm_text_tr_database**

The *uvm_text_tr_database* is the default implementation for the *uvm_tr_database*.

**CLASS HIERARCHY**

```
uvm_void
uvm_object
uvm_tr_database
uvm_text_tr_database
```

**CLASS DECLARATION**

```
class uvm_text_tr_database extends uvm_tr_database
```

**new**

Constructor

**Parameters**

- **name** Instance name

**Implementation Agnostic API**

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>do_open_db</td>
<td>Open the backend connection to the database.</td>
</tr>
<tr>
<td>do_close_db</td>
<td>Close the backend connection to the database.</td>
</tr>
<tr>
<td>do_open_stream</td>
<td>Provides a reference to a <em>stream</em> within the database.</td>
</tr>
<tr>
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<td>Establishes a <em>link</em> between two elements in the database.</td>
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**Implementation Specific API**

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>set_file_name</td>
<td>Sets the file name which will be used for output.</td>
</tr>
</tbody>
</table>

**new**

```
function new(
    string name = "unnamed-uvm_text_tr_database"
)
```

Constructor

**do_open_db**

```
protected virtual function bit do_open_db()
```

Open the backend connection to the database.

Text-Backend implementation of *uvm_tr_database::open_db*. 
The text-backend will open a text file to dump all records in to. The name of this text file is controlled via `set_file_name`.

This will also lock the `file_name`, so that it cannot be modified while the connection is open.

### do_close_db

```controller
protected virtual function bit do_close_db()
```

Close the backend connection to the database.

Text-Backend implementation of `uvm_tr_database::close_db`.

The text-backend will close the text file used to dump all records in to, if it is currently opened.

This unlocks the `file_name`, allowing it to be modified again.

### do_open_stream

```controller
protected virtual function uvm_tr_stream do_open_stream(
    string name,
    string scope,
    string type_name
)
```

Provides a reference to a `stream` within the database.

Text-Backend implementation of `uvm_tr_database::open_stream`.

### do_establish_link

```controller
protected virtual function void do_establish_link(
    uvm_link_base link
)
```

Establishes a `link` between two elements in the database.

Text-Backend implementation of `uvm_tr_database::establish_link`.

## Implementation Specific API

### set_file_name

```controller
function void set_file_name(
    string filename
)
```

Sets the file name which will be used for output.

The `set_file_name` method can only be called prior to `open_db`.

By default, the database will use a file named “tr_db.log”.
7.2 Transaction Recording Streams

Contents

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</table>

**uvm_tr_stream**

The *uvm_tr_stream* base class is a representation of a stream of records within a *uvm_tr_database*.

The record stream is intended to hide the underlying database implementation from the end user, as these details are often vendor or tool-specific.

The *uvm_tr_stream* class is pure virtual, and must be extended with an implementation. A default text-based implementation is provided via the *uvm_text_tr_stream* class.

**Summary**

**uvm_tr_stream**

The *uvm_tr_stream* base class is a representation of a stream of records within a *uvm_tr_database*.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_tr_stream
```

**Class Declaration**

```
virtual class uvm_tr_stream extends uvm_object
```

**Configuration API**

- **get_db**
  
  *Returns a reference to the database which contains this stream.*

- **get_scope**
  
  *Returns the scope supplied when opening this stream.*

- **get_stream_type_name**
  
  *Returns a reference to the database which contains this stream.*

**Stream API**

- **close**
  
  Closes this stream.

- **free**
  
  Frees this stream.

- **is_open**
  
  Returns true if this *uvm_tr_stream* was opened once opened via *uvm_tr_database::open_stream*.
### new

```verilog
define new(
    string name = "unnamed-uvm_tr_stream"
)
```

Constructor

**Parameters**

- **name**  Stream instance name

### CONFIGURATION API

#### get_db

```verilog```
define uvm_tr_database get_db()
```

Returns a reference to the database which contains this stream.

A warning will be asserted if get_db is called prior to the stream being initialized via do_open.

#### get_scope

```verilog```
define string get_scope()
```

Returns the scope supplied when opening this stream.

A warning will be asserted if get_scope is called prior to the stream being initialized via do_open.
**get_stream_type_name**

```plaintext
function string get_stream_type_name()
```

Returns a reference to the database which contains this stream.

A warning will be asserted if `get_stream_type_name` is called prior to the stream being initialized via `do_open`.

---

**Stream API**

Once a stream has been opened via `uvm_tr_database::open_stream`, the user can `close` the stream.

Due to the fact that many database implementations will require crossing a language boundary, an additional step of `freeing` the stream is required.

A `link` can be established within the database any time between “Open” and “Free”, however it is illegal to establish a link after “Freeing” the stream.

```plaintext
function void close()
```

Closes this stream.

Closing a stream closes all open recorders in the stream.

This method will trigger a `do_close` call, followed by `uvm_recorder::close` on all open recorders within the stream.

```plaintext
function void free()
```

Frees this stream.

Freeing a stream indicates that the database can free any references to the stream (including references to records within the stream).

This method will trigger a `do_free` call, followed by `uvm_recorder::free` on all recorders within the stream.

```plaintext
function bit is_open()
```

Returns true if this `uvm_tr_stream` was opened on the database, but has not yet been closed.

```plaintext
function bit is_closed
```
function bit is_closed()

Returns true if this uvm_tr_stream was closed on the database, but has not yet been freed.

Transaction Recorder API

New recorders can be opened prior to the stream being closed.

Once a stream has been closed, requests to open a new recorder will be ignored (open_recorder will return null).

open_recorder

function uvm_recorder open_recorder(
  string name,
  time open_time = 0,
  string type_name = ""
)

Marks the opening of a new transaction recorder on the stream.

Parameters

- **name**: A name for the new transaction
- **open_time**: Optional time to record as the opening of this transaction
- **type_name**: Optional type name for the transaction

If open_time is omitted (or set to 0), then the stream will use the current time.

This method will trigger a do_open_recorder call. If do_open_recorder returns a non-null value, then the uvm_recorder::do_open method will be called in the recorder.

Transaction recorders can only be opened if the stream is open on the database (per is_open). Otherwise the request will be ignored, and null will be returned.

get_recorders

function unsigned get_recorders(
  ref uvm_recorder q[]$
)

Provides a queue of all transactions within the stream.

Parameters

- **q**: A reference to the queue of uvm_recorders

The get_recorders method returns the size of the queue, such that the user can conditionally process the elements.
**Handles**

**get_handle**

```plaintext
function integer get_handle()
```

Returns a unique ID for this stream.

A value of 0 indicates that the recorder has been freed, and no longer has a valid ID.

**get_stream_from_handle**

```plaintext
static function uvm_tr_stream get_stream_from_handle(
    integer id
)
```

Static accessor, returns a stream reference for a given unique id.

If no stream exists with the given id, or if the stream with that id has been freed, then null is returned.

**Implementation Agnostic API**

**do_open**

```plaintext
protected virtual function void do_open(
    uvm_tr_database db,
    string scope,
    string stream_type_name
)
```

Callback triggered via `uvm_tr_database::open_stream`.

**Parameters**

- `db` Database which the stream belongs to
- `scope` Optional scope
- `stream_type_name` Optional type name for the stream

The `do_open` callback can be used to initialize any internal state within the stream, as well as providing a location to record any initial information about the stream.

**do_close**

```plaintext
protected virtual function void do_close()
```

Callback triggered via `close`. 

UVM 1.2 Class Reference
The *do_close* callback can be used to set internal state within the stream, as well as providing a location to record any closing information.

**do_free**

```cpp
protected virtual function void do_free()
```

Callback triggered via `free`.

The *do_free* callback can be used to release the internal state within the stream, as well as providing a location to record any “freeing” information.

**do_open_recorder**

```cpp
protected virtual function uvm_recorder do_open_recorder(
    string name,
    time open_time,
    string type_name
)
```

Marks the beginning of a new record in the stream.

Backend implementation of `open_recorder`

The *uvm_text_tr_stream* is the default stream implementation for the *uvm_text_tr_database*.

### Summary

**uvm_text_tr_stream**

The *uvm_text_tr_stream* is the default stream implementation for the *uvm_text_tr_database*.

**CLASS HIERARCHY**

```
+ uvm_void
  
+ uvm_object
  
+ uvm_tr_stream
  
+ uvm_text_tr_stream
```

**CLASS DECLARATION**

```
class uvm_text_tr_stream extends uvm_tr_stream
```

**new**

Constructor

**IMPLEMENTATION AGNOSTIC API**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td><em>do_open</em></td>
<td>Callback triggered via <code>uvm_tr_database::open_stream</code>.</td>
</tr>
<tr>
<td><em>do_close</em></td>
<td>Callback triggered via <code>uvm_tr_stream::close</code>.</td>
</tr>
<tr>
<td><em>do_free</em></td>
<td>Callback triggered via <code>uvm_tr_stream::free</code>.</td>
</tr>
</tbody>
</table>
new

function new(
    string name = "unnamed-uvm_text_tr_stream"
)

Constructor

Parameters

name Instance name

IMPLEMENTATION AGNOSTIC API

do_open

protected virtual function void do_open(
    uvm_tr_database db,
    string scope,
    string stream_type_name
)

Callback triggered via uvm_tr_database::open_stream.

do_close

protected virtual function void do_close()

Callback triggered via uvm_tr_stream::close.

do_free

protected virtual function void do_free()

Callback triggered via uvm_tr_stream::free.

do_open_recorder

protected virtual function uvm_recorder do_open_recorder(
    string name,
    time open_time,
    string type_name
)

Marks the beginning of a new record in the stream

Text-backend specific implementation.
8. Factory Classes

As the name implies, the `uvm_factory` is used to manufacture (create) UVM objects and components. Only one instance of the factory is present in a given simulation.

User-defined object and component types are registered with the factory via typedef or macro invocation, as explained in `uvm_default_factory::Usage`. The factory generates and stores lightweight proxies to the user-defined objects and components: `uvm_object_registry #(T,Tname)` for objects and `uvm_component_registry #(T,Tname)` for components. Each proxy only knows how to create an instance of the object or component it represents, and so is very efficient in terms of memory usage.

When the user requests a new object or component from the factory (e.g. `uvm_factory::create_object_by_type`), the factory will determine what type of object to create based on its configuration, then ask that type's proxy to create an instance of the type, which is returned to the user.

**Summary**

**Factory Classes**

As the name implies, the `uvm_factory` is used to manufacture (create) UVM objects and components.
This section defines the proxy component and object classes used by the factory. To avoid the overhead of creating an instance of every component and object that get registered, the factory holds lightweight wrappers, or proxies. When a request for a new object is made, the factory calls upon the proxy to create the object it represents.

**uvm_component_registry #(T,Tname)**

The uvm_component_registry serves as a lightweight proxy for a component of type \( T \) and type name \( Tname \), a string. The proxy enables efficient registration with the uvm_factory. Without it, registration would require an instance of the component itself.

See Usage section below for information on using uvm_component_registry.

**Summary**

The uvm_component_registry serves as a lightweight proxy for a component of type \( T \) and type name \( Tname \), a string.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_object_wrapper</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_component_registry #(T,Tname)</td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_component_registry #(T,Tname = "<unknown>" ) extends uvm_object_wrapper
```

**Methods**

- **create_component**
  - Creates a component of type \( T \) having the provided name and parent.

- **get_type_name**
  - Returns the value given by the string parameter,
get
Returns the singleton instance of this type.

create
Returns an instance of the component type, \( T \), represented by this proxy, subject to any factory overrides based on the context provided by the parent’s full name.

set_type_override
Configures the factory to create an object of the type represented by \( \text{override\_type} \) whenever a request is made to create an object of the type, \( T \), represented by this proxy, provided no instance override applies.

set_inst_override
Configures the factory to create a component of the type represented by \( \text{override\_type} \) whenever a request is made to create an object of the type, \( T \), represented by this proxy, with matching instance paths.

**METHODS**

**create_component**

```cpp
virtual function uvm_component create_component (  
    string name,  
    uvm_component parent
)
```

Creates a component of type \( T \) having the provided \( \text{name} \) and \( \text{parent} \). This is an override of the method in \text{uvm\_object\_wrapper}. It is called by the factory after determining the type of object to create. You should not call this method directly. Call \text{create} instead.

**get_type_name**

```cpp
virtual function string get_type_name()
```

Returns the value given by the string parameter, \( T\text{name} \). This method overrides the method in \text{uvm\_object\_wrapper}.

**get**

```cpp
static function this_type get()
```

Returns the singleton instance of this type. Type-based factory operation depends on there being a single proxy instance for each registered type.

**create**

```cpp
static function T create(  
    string name,  
    uvm_component parent,  
    string contxt = ""
)
```

Returns an instance of the component type, \( T \), represented by this proxy, subject to any factory overrides based on the context provided by the \text{parent’s} full name. The \text{contxt} argument, if supplied, supersedes the \text{parent’s} context. The new instance will have the
given leaf name and parent.

**set_type_override**

```plaintext
static function void set_type_override (uvm_object_wrapper override_type, bit replace = 1)
```

Configures the factory to create an object of the type represented by `override_type` whenever a request is made to create an object of the type, `T`, represented by this proxy, provided no instance override applies. The original type, `T`, is typically a super class of the override type.

**set_inst_override**

```plaintext
static function void set_inst_override(uvm_object_wrapper override_type, string inst_path, uvm_component parent = null)
```

Configures the factory to create a component of the type represented by `override_type` whenever a request is made to create an object of the type, `T`, represented by this proxy, with matching instance paths. The original type, `T`, is typically a super class of the override type.

If `parent` is not specified, `inst_path` is interpreted as an absolute instance path, which enables instance overrides to be set from outside component classes. If `parent` is specified, `inst_path` is interpreted as being relative to the `parent`'s hierarchical instance path, i.e. `{parent.get_full_name(), ",", inst_path}` is the instance path that is registered with the override. The `inst_path` may contain wildcards for matching against multiple contexts.

**uvm_object_registry #(T,Tname)**

The `uvm_object_registry` serves as a lightweight proxy for a `uvm_object` of type `T` and type name `Tname`, a string. The proxy enables efficient registration with the `uvm_factory`. Without it, registration would require an instance of the object itself.

See **Usage** section below for information on using `uvm_component_registry`.

**Summary**

**uvm_object_registry #(T,Tname)**

The `uvm_object_registry` serves as a lightweight proxy for a `uvm_object` of type `T` and type name `Tname`, a string.

**Class Hierarchy**

```
uvm_object_wrapper

uvm_object_registry #(T,Tname)
```
**Class Declaration**

```plaintext
class uvm_object_registry #(type T = uvm_object, string Tname = "<unknown>")
  extends uvm_object_wrapper
```

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tr>
<td>create_object</td>
<td>Creates an object of type T and returns it as a handle to a uvm_object. This is an override of the method in uvm_object_wrapper. It is called by the factory after determining the type of object to create. You should not call this method directly. Call create instead.</td>
</tr>
<tr>
<td>get_type_name</td>
<td>Returns the value given by the string parameter, Tname. This method overrides the method in uvm_object_wrapper.</td>
</tr>
<tr>
<td>get</td>
<td>Returns the singleton instance of this type. Type-based factory operation depends on there being a single proxy instance for each registered type.</td>
</tr>
<tr>
<td>create</td>
<td></td>
</tr>
</tbody>
</table>

**Usage**

This section describes usage for the uvm_*_registry classes.

---

**create_object**

```plaintext
virtual function uvm_object create_object(
  string name = ""
)
```

Creates an object of type T and returns it as a handle to a uvm_object. This is an override of the method in uvm_object_wrapper. It is called by the factory after determining the type of object to create. You should not call this method directly. Call create instead.

**get_type_name**

```plaintext
virtual function string get_type_name()
```

Returns the value given by the string parameter, Tname. This method overrides the method in uvm_object_wrapper.

**get**

```plaintext
static function this_type get()
```

Returns the singleton instance of this type. Type-based factory operation depends on there being a single proxy instance for each registered type.

**create**

```plaintext
static function T create {
  string name = "",
  uvm_component parent = null,
  string ctxt = ""
}
```
Returns an instance of the object type, \( T \), represented by this proxy, subject to any factory overrides based on the context provided by the parent's full name. The \( \text{ctx} \) argument, if supplied, supersedes the parent’s context. The new instance will have the given leaf \( \text{name} \), if provided.

**set_type_override**

```plaintext
static function void set_type_override (
    uvm_object_wrapper override_type,
    bit replace = 1
)
```

Configures the factory to create an object of the type represented by \( \text{override_type} \) whenever a request is made to create an object of the type represented by this proxy, provided no instance override applies. The original type, \( T \), is typically a super class of the override type.

**set_inst_override**

```plaintext
static function void set_inst_override(
    uvm_object_wrapper override_type,
    string inst_path,
    uvm_component parent = null
)
```

Configures the factory to create an object of the type represented by \( \text{override_type} \) whenever a request is made to create an object of the type represented by this proxy, with matching instance paths. The original type, \( T \), is typically a super class of the override type.

If \( \text{parent} \) is not specified, \( \text{inst\_path} \) is interpreted as an absolute instance path, which enables instance overrides to be set from outside component classes. If \( \text{parent} \) is specified, \( \text{inst\_path} \) is interpreted as being relative to the parent’s hierarchical instance path, i.e. \{parent.get_full_name(),",",inst_path\} is the instance path that is registered with the override. The \( \text{inst\_path} \) may contain wildcards for matching against multiple contexts.

**Usage**

This section describes usage for the uvm_*_registry classes.

The wrapper classes are used to register lightweight proxies of objects and components.

To register a particular component type, you need only typedef a specialization of its proxy class, which is typically done inside the class.

For example, to register a UVM component of type \( \text{mycomp} \)

```plaintext
class mycomp extends uvm_component;
    typedef uvm_component_registry #(mycomp,"mycomp") type_id;
endclass
```

However, because of differences between simulators, it is necessary to use a macro to ensure vendor interoperability with factory registration. To register a UVM component of type \( \text{mycomp} \) in a vendor-independent way, you would write instead:
The `uvm_component_utils macro is for non-parameterized classes. In this example, the typedef underlying the macro specifies the Tname parameter as "mycomp", and mycomp's get_type_name() is defined to return the same. With Tname defined, you can use the factory's name-based methods to set overrides and create objects and components of non-parameterized types.

For parameterized types, the type name changes with each specialization, so you cannot specify a Tname inside a parameterized class and get the behavior you want; the same type name string would be registered for all specializations of the class! (The factory would produce warnings for each specialization beyond the first.) To avoid the warnings and simulator interoperability issues with parameterized classes, you must register parameterized classes with a different macro.

For example, to register a UVM component of type driver #(T), you would write:

```
class driver #(type T=int) extends uvm_component;
  `uvm_component_param_utils(driver #(T));
  ...
endclass
```

The `uvm_component_param_utils and `uvm_object_param_utils macros are used to register parameterized classes with the factory. Unlike the non-param versions, these macros do not specify the Tname parameter in the underlying uvm_component_registry typedef, and they do not define the get_type_name method for the user class. Consequently, you will not be able to use the factory's name-based methods for parameterized classes.

The primary purpose for adding the factory's type-based methods was to accommodate registration of parameterized types and eliminate the many sources of errors associated with string-based factory usage. Thus, use of name-based lookup in uvm_factory is no longer recommended.
8.2 UVM Factory

This page covers the classes that define the UVM factory facility.

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<tr>
<td>uvm_default_factory</td>
<td>Default implementation of the UVM factory.</td>
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<td>uvm_object_wrapper</td>
<td>The uvm_object_wrapper provides an abstract interface for creating object and component proxies.</td>
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uvm_factory

As the name implies, uvm_factory is used to manufacture (create) UVM objects and components. Object and component types are registered with the factory using lightweight proxies to the actual objects and components being created. The uvm_object_registry #(T,Tname) and uvm_component_registry #(T,Tname) class are used to proxy uvm_objects and uvm_components.

The factory provides both name-based and type-based interfaces.

- **type-based**: The type-based interface is far less prone to errors in usage. When errors do occur, they are caught at compile-time.
- **name-based**: The name-based interface is dominated by string arguments that can be misspelled and provided in the wrong order. Errors in name-based requests might only be caught at the time of the call, if at all. Further, the name-based interface is not portable across simulators when used with parameterized classes.

The uvm_factory is an abstract class which declares many of its methods as pure virtual. The UVM uses the uvm_default_factory class as its default factory implementation.

See uvm_default_factory::Usage section for details on configuring and using the factory.

Summary

uvm_factory

As the name implies, uvm_factory is used to manufacture (create) UVM objects and components.

**Class Declaration**

```
virtual class uvm_factory
```

**Retrieving the factory**

- `get`: Static accessor for uvm_factory

**Registering Types**

- `register`: Registers the given proxy object, obj, with
TYPE & INSTANCE OVERRIDES

**set_inst_override_by_type**
**set_inst_override_by_name**

Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type using a context that matches `full_inst_path`.

**set_type_override_by_type**
**set_type_override_by_name**

Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type, provided no instance override applies.

CREATION

**create_object_by_type**
**create_component_by_type**
**create_object_by_name**
**create_component_by_name**

Creates and returns a component or object of the requested type, which may be specified by type or by name.

DEBUG

**debug_create_by_type**
**debug_create_by_name**

These methods perform the same search algorithm as the `create_*` methods, but they do not create new objects.

**find_override_by_type**
**find_override_by_name**

These methods return the proxy to the object that would be created given the arguments.

**find_wrapper_by_name**

This method returns the `uvm_object_wrapper` associated with a given `type_name`.

**print**

Prints the state of the `uvm_factory`, including registered types, instance overrides, and type overrides.

### RETRIEVING THE FACTORY

**get**

```cpp
static function uvm_factory get()
```

Static accessor for `uvm_factory`

The static accessor is provided as a convenience wrapper around retrieving the factory via the `uvm_coreservice_t::get_factory` method.

```cpp
// Using the uvm_coreservice_t:
uvm_coreservice_t cs;
uvm_factory f;
cs = uvm_coreservice_t::get();
f = cs.get_factory();
```

```cpp
// Not using the uvm_coreservice_t:
uvm_factory f;
f = uvm_factory::get();
```
**Registering Types**

**register**

```cpp
pure virtual function void register (uvm_object_wrapper obj)
```

Registers the given proxy object, `obj`, with the factory. The proxy object is a lightweight substitute for the component or object it represents. When the factory needs to create an object of a given type, it calls the proxy’s create_object or create_component method to do so.

When doing name-based operations, the factory calls the proxy’s `get_type_name` method to match against the `requested_type_name` argument in subsequent calls to `create_component_by_name` and `create_object_by_name`. If the proxy object’s `get_type_name` method returns the empty string, name-based lookup is effectively disabled.

**Type & Instance Overrides**

**set_inst_override_by_type**

```cpp
pure virtual function void set_inst_override_by_type (uvm_object_wrapper original_type, uvm_object_wrapper override_type, string full_inst_path)
```

**set_inst_override_by_name**

```cpp
pure virtual function void set_inst_override_by_name (string original_type_name, string override_type_name, string full_inst_path)
```

Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type using a context that matches `full_inst_path`. The original type is typically a super class of the override type.

When overriding by type, the `original_type` and `override_type` are handles to the types’ proxy objects. Preregistration is not required.

When overriding by name, the `original_type_name` typically refers to a preregistered type in the factory. It may, however, be any arbitrary string. Future calls to any of the `create_*` methods with the same string and matching instance path will produce the type represented by `override_type_name`, which must be preregistered with the factory.

The `full_inst_path` is matched against the concatenation of `{parent_inst_path, ".", name}` provided in future create requests. The `full_inst_path` may include wildcards (*) and ?) such that a single instance override can be applied in multiple contexts. A `full_inst_path` of "*" is effectively a type override, as it will match all contexts.
When the factory processes instance overrides, the instance queue is processed in order of override registrations, and the first override match prevails. Thus, more specific overrides should be registered first, followed by more general overrides.

**set_type_override_by_type**

```cpp
pure virtual function void set_type_override_by_type (
    uvm_object_wrapper original_type,
    uvm_object_wrapper override_type,
    bit replace = 1
)
```

**set_type_override_by_name**

```cpp
pure virtual function void set_type_override_by_name (
    string original_type_name,
    string override_type_name,
    bit replace = 1
)
```

Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type, provided no instance override applies. The original type is typically a super class of the override type.

When overriding by type, the `original_type` and `override_type` are handles to the types’ proxy objects. Preregistration is not required.

When overriding by name, the `original_type_name` typically refers to a preregistered type in the factory. It may, however, be any arbitrary string. Future calls to any of the `create_*` methods with the same string and matching instance path will produce the type represented by `override_type_name`, which must be preregistered with the factory.

When `replace` is 1, a previous override on `original_type_name` is replaced, otherwise a previous override, if any, remains intact.

**Creation**

**create_object_by_type**

```cpp
pure virtual function uvm_object create_object_by_type (
    uvm_object_wrapper requested_type,
    string parent_inst_path = "",
    string name = ""
)
```

**create_component_by_type**

```cpp
pure virtual function uvm_component create_component_by_type (
    uvm_object_wrapper requested_type,
    string parent_inst_path = "",
    string name,
    uvm_component parent
)
```
create_object_by_name

pure virtual function uvm_object create_object_by_name (  
    string requested_type_name,  
    string parent_inst_path = "",  
    string name = ""
)

create_component_by_name

pure virtual function uvm_component create_component_by_name (  
    string requested_type_name,  
    string parent_inst_path = "",  
    string name,  
    uvm_component parent
)

Creates and returns a component or object of the requested type, which may be specified by type or by name. A requested component must be derived from the uvm_component base class, and a requested object must be derived from the uvm_object base class.

When requesting by type, the requested_type is a handle to the type’s proxy object. Preregistration is not required.

When requesting by name, the request_type_name is a string representing the requested type, which must have been registered with the factory with that name prior to the request. If the factory does not recognize the requested_type_name, an error is produced and a null handle returned.

If the optional parent_inst_path is provided, then the concatenation, {parent_inst_path, ".",~name~}, forms an instance path (context) that is used to search for an instance override. The parent_inst_path is typically obtained by calling the uvm_component::get_full_name on the parent.

If no instance override is found, the factory then searches for a type override.

Once the final override is found, an instance of that component or object is returned in place of the requested type. New components will have the given name and parent. New objects will have the given name, if provided.

Override searches are recursively applied, with instance overrides taking precedence over type overrides. If foo overrides bar, and xyz overrides foo, then a request for bar will produce xyz. Recursive loops will result in an error, in which case the type returned will be that which formed the loop. Using the previous example, if bar overrides xyz, then bar is returned after the error is issued.

DEBUG

define debug_create_by_type

pure virtual function void debug_create_by_type (  
    uvm_object_wrapper requested_type,  
    string parent_inst_path = "",  
    string name = ""
)

UVM 1.2 Class Reference
debug_create_by_name

```cpp
pure virtual function void debug_create_by_name (  
    string requested_type_name,  
    string parent_inst_path = "",  
    string name = ""
)
```

These methods perform the same search algorithm as the create_* methods, but they do not create new objects. Instead, they provide detailed information about what type of object it would return, listing each override that was applied to arrive at the result. Interpretation of the arguments are exactly as with the create_* methods.

find_override_by_type

```cpp
pure virtual function uvm_object_wrapper find_override_by_type (  
    uvm_object_wrapper requested_type,  
    string full_inst_path
)
```

find_override_by_name

```cpp
pure virtual function uvm_object_wrapper find_override_by_name (  
    string requested_type_name,  
    string full_inst_path
)
```

These methods return the proxy to the object that would be created given the arguments. The full_inst_path is typically derived from the parent’s instance path and the leaf name of the object to be created, i.e. { parent.get_full_name(), ",." , name }.

find_wrapper_by_name

```cpp
pure virtual function uvm_object_wrapper find_wrapper_by_name (  
    string type_name
)
```

This method returns the uvm_object_wrapper associated with a given type_name.

print

```cpp
pure virtual function void print (  
    int all_types = 1
)
```

Prints the state of the uvm_factory, including registered types, instance overrides, and type overrides.

When all_types is 0, only type and instance overrides are displayed. When all_types is 1 (default), all registered user-defined types are printed as well, provided they have names associated with them. When all_types is 2, the UVM types (prefixed with uvm_) are included in the list of registered types.
Default implementation of the UVM factory.

**Summary**

**uvm_default_factory**

Default implementation of the UVM factory.

**CLASS HIERARCHY**

```
uvm_factory
uvm_default_factory
```

**CLASS DECLARATION**

```
class uvm_default_factory extends uvm_factory
```

**REGISTERING TYPES**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>register</td>
<td>Registers the given proxy object, <code>obj</code>, with the factory.</td>
</tr>
</tbody>
</table>

**TYPE & INSTANCE OVERRIDES**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>set_inst_override_by_type</td>
<td>Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type using a context that matches <code>full_inst_path</code>.</td>
</tr>
<tr>
<td>set_inst_override_by_name</td>
<td></td>
</tr>
<tr>
<td>set_type_override_by_type</td>
<td>Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type, provided no instance override applies.</td>
</tr>
<tr>
<td>set_type_override_by_name</td>
<td></td>
</tr>
</tbody>
</table>

**CREATION**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>create_object_by_type</td>
<td>Creates and returns a component or object of the requested type, which may be specified by type or by name.</td>
</tr>
<tr>
<td>create_component_by_type</td>
<td></td>
</tr>
<tr>
<td>create_object_by_name</td>
<td></td>
</tr>
<tr>
<td>create_component_by_name</td>
<td></td>
</tr>
</tbody>
</table>

**DEBUG**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug_create_by_type</td>
<td>These methods perform the same search algorithm as the <code>create_*</code> methods, but they do not create new objects.</td>
</tr>
<tr>
<td>debug_create_by_name</td>
<td></td>
</tr>
<tr>
<td>find_override_by_type</td>
<td>These methods return the proxy to the object that would be created given the arguments.</td>
</tr>
<tr>
<td>find_override_by_name</td>
<td></td>
</tr>
<tr>
<td>print</td>
<td>Prints the state of the <code>uvm_factory</code>, including registered types, instance overrides, and type overrides.</td>
</tr>
</tbody>
</table>

**USAGE**

Using the factory involves three basic operations
virtual function void register (uvm_object_wrapper obj)

Registers the given proxy object, \textit{obj}, with the factory.

\textbf{Type \& Instance Overrides}

\textbf{set\_inst\_override\_by\_type}

virtual function void set_inst_override_by_type (uvm_object_wrapper original_type,uvm_object_wrapper override_type,string full_inst_path)

Configures the factory to create an object of the override's type whenever a request is made to create an object of the original type using a context that matches \textit{full\_inst\_path}.

\textbf{set\_inst\_override\_by\_name}

virtual function void set_inst_override_by_name (string original_type_name,string override_type_name,string full_inst_path)

\textbf{set\_type\_override\_by\_type}

virtual function void set_type_override_by_type (uvm_object_wrapper original_type,uvm_object_wrapper override_type,bit replace = 1)

\textbf{set\_type\_override\_by\_name}

virtual function void set_type_override_by_name (string original_type_name,string override_type_name,bit replace = 1)

Configures the factory to create an object of the override’s type whenever a request is made to create an object of the original type, provided no instance override applies.

\textbf{Creation}

\textbf{create\_object\_by\_type}
virtual function uvm_object create_object_by_type (uvm_object_wrapper requested_type, string parent_inst_path = "", string name = "")

virtual function uvm_component create_component_by_type (uvm_object_wrapper requested_type, string parent_inst_path = "", string name, uvm_component parent)

virtual function uvm_object create_object_by_name (string requested_type_name, string parent_inst_path = "", string name = "")

virtual function uvm_component create_component_by_name (string requested_type_name, string parent_inst_path = "", string name, uvm_component parent)

virtual function void debug_create_by_type (uvm_object_wrapper requested_type, string parent_inst_path = "", string name = "")

virtual function void debug_create_by_name (string requested_type_name, string parent_inst_path = "", string name = "")

create_component_by_type

create_object_by_name

create_component_by_name

DEBUG

depbug_create_by_type

depbug_create_by_name

Creates and returns a component or object of the requested type, which may be specified by type or by name.

These methods perform the same search algorithm as the create_* methods, but they do not create new objects.
**find_override_by_type**

```cpp
template virtual function uvm_object_wrapper find_override_by_type (uvm_object_wrapper requested_type, string full_inst_path)
```

These methods return the proxy to the object that would be created given the arguments.

**find_override_by_name**

```cpp
template virtual function uvm_object_wrapper find_override_by_name (string requested_type_name, string full_inst_path)
```

**print**

```cpp
template virtual function void print (int all_types = 1)
```

Prints the state of the uvm_factory, including registered types, instance overrides, and type overrides.

**Usage**

Using the factory involves three basic operations

1. Registering objects and components types with the factory
2. Designing components to use the factory to create objects or components
3. Configuring the factory with type and instance overrides, both within and outside components

We’ll briefly cover each of these steps here. More reference information can be found at Utility Macros, uvm_component_registry #(T,Tname), uvm_object_registry #(T,Tname), uvm_component.

**1 -- Registering objects and component types with the factory**

When defining uvm_object and uvm_component-based classes, simply invoke the appropriate macro. Use of macros are required to ensure portability across different vendors’ simulators.

Objects that are not parameterized are declared as

```cpp
class packet extends uvm_object;
`uvm_object_utils(packet)
endclass

class packetD extends packet;
`uvm_object_utils(packetD)
endclass
```
Objects that are parameterized are declared as

```verbatim
class packet #(type T=int, int WIDTH=32) extends uvm_object;
    `uvm_object_param_utils(packet #(T,WIDTH))
endclass
```

Components that are not parameterized are declared as

```verbatim
class comp extends uvm_component;
    `uvm_component_utils(comp)
endclass
```

Components that are parameterized are declared as

```verbatim
class comp #(type T=int, int WIDTH=32) extends uvm_component;
    `uvm_component_param_utils(comp #(T,WIDTH))
endclass
```

The `uvm_*_utils macros for simple, non-parameterized classes will register the type with the factory and define the get_type, get_type_name, and create virtual methods inherited from uvm_object. It will also define a static type_name variable in the class, which will allow you to determine the type without having to allocate an instance.

The `uvm_*_param Utils macros for parameterized classes differ from `uvm_*_utils classes in the following ways:

- The get_type_name method and static type_name variable are not defined. You will need to implement these manually.
- A type name is not associated with the type when registering with the factory, so the factory’s * by_name operations will not work with parameterized classes.
- The factory’s print, debug_create_by_type, and debug_create_by_name methods, which depend on type names to convey information, will list parameterized types as "<unknown>".

It is worth noting that environments that exclusively use the type-based factory methods (* by_type) do not require type registration. The factory’s type-based methods will register the types involved “on the fly,” when first used. However, registering with the `uvm_*_utils macros enables name-based factory usage and implements some useful utility functions.

2 -- Designing components that defer creation to the factory

Having registered your objects and components with the factory, you can now make requests for new objects and components via the factory. Using the factory instead of allocating them directly (via new) allows different objects to be substituted for the original without modifying the requesting class. The following code defines a driver class that is parameterized.

```verbatim
class driverB #(type T=uvm_object) extends uvm_driver;
    // parameterized classes must use the param_utils version
    `uvm_component_param_utils(driverB #(T))
    // our packet type; this can be overridden via the factory
    T pkt;
```
For purposes of illustrating type and instance overrides, we define two subtypes of the
\texttt{driverB} class. The subtypes are also parameterized, so we must again provide an
implementation for \texttt{uvm\_object::get\_type\_name}, which we recommend writing in terms
of a static string constant.

\begin{verbatim}
class \texttt{driverD1 \#(type T=uvm\_object)} extends \texttt{driverB \#(T)};
  `uvm\_component\_param\_utils\texttt{(driverD1 \#(T))}
  function new\texttt{(string name, uvm\_component parent=\texttt{null});}
    super.new\texttt{(name, parent)};
  endfunction
  const static string type\_name = \texttt{"driverD1 \#("T::type\_name,"\")"};
  virtual function string get\_type\_name();
    return type\_name;
  endfunction
endclass

class \texttt{driverD2 \#(type T=uvm\_object)} extends \texttt{driverB \#(T)};
  `uvm\_component\_param\_utils\texttt{(driverD2 \#(T))}
  function new\texttt{(string name, uvm\_component parent=\texttt{null});}
    super.new\texttt{(name, parent)};
  endfunction
  const static string type\_name = \texttt{"driverD2 \#("T::type\_name,"\")"};
  virtual function string get\_type\_name();
    return type\_name;
  endfunction
endclass
\end{verbatim}

Next, we’ll define a agent component, which requires a utils macro for non-
parameterized types. Before creating the drivers using the factory, we override \texttt{driver0}'s
packet type to be \texttt{packetD}.

\begin{verbatim}
class \texttt{agent} extends \texttt{uvm\_agent};
  `uvm\_component\_utils\texttt{(agent)}
  ...\texttt{B\_driver driver0; B\_driver driver1;}
  function new\texttt{(string name, uvm\_component parent=\texttt{null});}
    super.new\texttt{(name, parent)};
  endfunction
  virtual function void build\_phase\texttt{(uvm\_phase phase)};
endclass
\end{verbatim}
Finally we define an environment class, also not parameterized. Its build_phase method shows three methods for setting an instance override on a grandchild component with relative path name, agent1.driver1, all equivalent.

```verilog
class env extends uvm_env;
`uvm_component_utils(env)
agent agent0;
agent agent1;

function new(string name, uvm_component parent=null);
  super.new(name,parent);
endfunction

virtual function void build_phase(uvm_phase phase);
  // three methods to set an instance override for agent1.driver1
  // - via component convenience method...
  set_inst_override_by_type("agent1.driver1",
    B_driver::get_type(),
    D2_driver::get_type());

  // - via the component's proxy (same approach as create)...
  B_driver::type_id::set_inst_override(D2_driver::get_type(),
    "agent1.driver1",this);

  // - via a direct call to a factory method...
  factory.set_inst_override_by_type(B_driver::get_type(),
    D2_driver::get_type(),
    get_full_name(),".agent1.driver1");

  // create agents using the factory; actual agent types may be different
  agent0 = agent::type_id::create("agent0",this);
  agent1 = agent::type_id::create("agent1",this);
endfunction

// at end_of_elaboration, print topology and factory state to verify
virtual function void end_of_elaboration_phase(uvm_phase phase);
  uvm_top.print_topology();
endfunction

virtual task run_phase(uvm_phase phase);
  #100 global_stop_request();
endfunction
endclass
```

3 -- Configuring the factory with type and instance overrides

In the previous step, we demonstrated setting instance overrides and creating components using the factory within component classes. Here, we will demonstrate setting overrides from outside components, as when initializing the environment prior to running the test.

```verilog
module top;
  env env0;

  initial begin
    // Being registered first, the following overrides take precedence
    // over any overrides made within env0's construction & build.
    // Replace all base drivers with derived drivers...
```
When the above example is run, the resulting topology (displayed via a call to `uvm_root::print_topology` in env’s `uvm_component::end_of_elaboration_phase` method) is similar to the following:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Size</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>env0</td>
<td>env</td>
<td>-</td>
<td>env@2</td>
</tr>
<tr>
<td>agent0</td>
<td>agent</td>
<td>-</td>
<td>agent@002</td>
</tr>
<tr>
<td>driver0</td>
<td>driverB #(packet)</td>
<td>-</td>
<td>driver@088</td>
</tr>
<tr>
<td>pkt</td>
<td>packet</td>
<td>-</td>
<td>pkt@021</td>
</tr>
<tr>
<td>driver1</td>
<td>driverD #(packet)</td>
<td>-</td>
<td>driver@014</td>
</tr>
<tr>
<td>pkt</td>
<td>packet</td>
<td>-</td>
<td>pkt@023</td>
</tr>
<tr>
<td>agent1</td>
<td>agent</td>
<td>-</td>
<td>agent@06</td>
</tr>
<tr>
<td>driver0</td>
<td>driverD #(packet)</td>
<td>-</td>
<td>driver@024</td>
</tr>
<tr>
<td>pkt</td>
<td>packet</td>
<td>-</td>
<td>pkt@037</td>
</tr>
<tr>
<td>driver1</td>
<td>driverD2 #(packet)</td>
<td>-</td>
<td>driver@030</td>
</tr>
<tr>
<td>pkt</td>
<td>packet</td>
<td>-</td>
<td>pkt@039</td>
</tr>
</tbody>
</table>

---

**uvm_object_wrapper**

The `uvm_object_wrapper` provides an abstract interface for creating object and component proxies. Instances of these lightweight proxies, representing every `uvm_object`-based and `uvm_component`-based object available in the test environment, are registered with the `uvm_factory`. When the factory is called upon to create an object or component, it finds and delegates the request to the appropriate proxy.

**Summary**

**uvm_object_wrapper**

The `uvm_object_wrapper` provides an abstract interface for creating object and component proxies.

**Class Declaration**

```
virtual class uvm_object_wrapper
```

**Methods**
create_object

Create a new object with the optional name. An object proxy (e.g., uvm_object_registry #(T,Tname)) implements this method to create an object of a specific type, T.

create_component

Create a new component, passing to its constructor the given name and parent. A component proxy (e.g., uvm_component_registry #(T,Tname)) implements this method to create a component of a specific type, T.

get_type_name

Derived classes implement this method to return the type name of the object created by create_component or create_object. The factory uses this name when matching against the requested type in name-based lookups.
9. Phasing Overview

UVM implements an automated mechanism for phasing the execution of the various components in a testbench.

Summary

Phasing Overview

UVM implements an automated mechanism for phasing the execution of the various components in a testbench.

Phasing Implementation

The API described here provides a general purpose testbench phasing solution, consisting of a phaser machine, traversing a master schedule graph, which is built by the integrator from one or more instances of template schedules provided by UVM or by 3rd-party VIP, and which supports implicit or explicit synchronization, runtime control of threads and jumps.

Each schedule leaf node refers to a single phase that is compatible with that VIP’s components and which executes the required behavior via a functor or delegate extending the phase into component context as required.

Execution threads are tracked on a per-component basis.

Class hierarchy

A single class represents both the definition, the state, and the context of a phase. It is instantiated once as a singleton IMP and one or more times as nodes in a graph which represents serial and parallel phase relationships and stores current state as the phaser progresses, and the phase implementation which specifies required component behavior (by extension into component context if non-default behavior required.)

The following classes related to phasing are defined herein

uvm_phase : The base class for defining a phase’s behavior, state, context
uvm_domain : Phasing schedule node representing an independent branch of the schedule

uvm_bottomup_phase : A phase implementation for bottom up function phases.

uvm_topdown_phase : A phase implementation for topdown function phases.

uvm_task_phase : A phase implementation for task phases.

**Common, Run-Time and User-Defined Phases**

The common phases to all uvm_components are described in UVM Common Phases.

The run-time phases are described in UVM Run-Time Phases.

The ability to create user-defined phases is described User-Defined Phases.

**Summary**

**Phasing Implementation**

The API described here provides a general purpose testbench phasing solution, consisting of a phaser machine, traversing a master schedule graph, which is built by the integrator from one or more instances of template schedules provided by UVM or by 3rd-party VIP, and which supports implicit or explicit synchronization, runtime control of threads and jumps.
9.1 Phasing Definition classes

The following class are used to specify a phase and its implied functionality.

Contents

<table>
<thead>
<tr>
<th>Phasing Definition classes</th>
<th>The following class are used to specify a phase and its implied functionality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_phase</td>
<td>This base class defines everything about a phase: behavior, state, and context.</td>
</tr>
<tr>
<td>uvm_phase_state_change</td>
<td>Phase state transition descriptor.</td>
</tr>
<tr>
<td>uvm_phase_cb</td>
<td>This class defines a callback method that is invoked by the phaser during the execution of a specific node in the phase graph or all phase nodes.</td>
</tr>
<tr>
<td>uvm_phase_cb_pool</td>
<td>Convenience type for the uvm_callbacks#(uvm_phase, uvm_phase_cb) class.</td>
</tr>
</tbody>
</table>

**uvm_phase**

This base class defines everything about a phase: behavior, state, and context.

To define behavior, it is extended by UVM or the user to create singleton objects which capture the definition of what the phase does and how it does it. These are then cloned to produce multiple nodes which are hooked up in a graph structure to provide context: which phases follow which, and to hold the state of the phase throughout its lifetime. UVM provides default extensions of this class for the standard runtime phases. VIP Providers can likewise extend this class to define the phase functor for a particular component context as required.

This base class defines everything about a phase: behavior, state, and context.

To define behavior, it is extended by UVM or the user to create singleton objects which capture the definition of what the phase does and how it does it. These are then cloned to produce multiple nodes which are hooked up in a graph structure to provide context: which phases follow which, and to hold the state of the phase throughout its lifetime. UVM provides default extensions of this class for the standard runtime phases. VIP Providers can likewise extend this class to define the phase functor for a particular component context as required.

**Phase Definition**

Singleton instances of those extensions are provided as package variables. These instances define the attributes of the phase (not what state it is in) They are then cloned into schedule nodes which point back to one of these implementations, and calls its virtual task or function methods on each participating component. It is the base class for phase functors, for both predefined and user-defined phases. Per-component overrides can use a customized imp.

To create custom phases, do not extend uvm_phase directly: see the three predefined extended classes below which encapsulate behavior for different phase types: task, bottom-up function and top-down function.

Extend the appropriate one of these to create a uvm_YOURNAME_phase class (or YOURPREFIX_NAME_phase class) for each phase, containing the default implementation
of the new phase, which must be a uvm_component-compatible delegate, and which may be a null implementation. Instantiate a singleton instance of that class for your code to use when a phase handle is required. If your custom phase depends on methods that are not in uvm_component, but are within an extended class, then extend the base YOURPREFIX_NAME_phase class with parameterized component class context as required, to create a specialized functor which calls your extended component class methods. This scheme ensures compile-safety for your extended component classes while providing homogeneous base types for APIs and underlying data structures.

Phase Context

A schedule is a coherent group of one or more phase/state nodes linked together by a graph structure, allowing arbitrary linear/parallel relationships to be specified, and executed by stepping through them in the graph order. Each schedule node points to a phase and holds the execution state of that phase, and has optional links to other nodes for synchronization.

The main operations are: construct, add phases, and instantiate hierarchically within another schedule.

Structure is a DAG (Directed Acyclic Graph). Each instance is a node connected to others to form the graph. Hierarchy is overlaid with m_parent. Each node in the graph has zero or more successors, and zero or more predecessors. No nodes are completely isolated from others. Exactly one node has zero predecessors. This is the root node. Also the graph is acyclic, meaning for all nodes in the graph, by following the forward arrows you will never end up back where you started but you will eventually reach a node that has no successors.

Phase State

A given phase may appear multiple times in the complete phase graph, due to the multiple independent domain feature, and the ability for different VIP to customize their own phase schedules perhaps reusing existing phases. Each node instance in the graph maintains its own state of execution.

Phase Handle

Handles of this type uvm_phase are used frequently in the API, both by the user, to access phasing-specific API, and also as a parameter to some APIs. In many cases, the singleton phase handles can be used (eg. uvm_run_phase::get()) in APIs. For those APIs that need to look up that phase in the graph, this is done automatically.

Summary

```
class uvm_phase

This base class defines everything about a phase: behavior, state, and context.

CLASS HIERARCHY

   uvm_void
   uvm_object
   uvm_phase

CLASS DECLARATION

   class uvm_phase extends uvm_object

CONSTRUCTION

   new

Create a new phase node, with a name and a note of its type name - name of
```
<table>
<thead>
<tr>
<th><strong>get_phase_type</strong></th>
<th>Returns the phase type as defined by <code>uvm_phase_type</code></th>
</tr>
</thead>
</table>

**STATE**

<table>
<thead>
<tr>
<th><strong>get_state</strong></th>
<th>Accessor to return current state of this phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>get_run_count</strong></td>
<td>Accessor to return the integer number of times this phase has executed</td>
</tr>
<tr>
<td><strong>find_by_name</strong></td>
<td>Locate a phase node with the specified <code>name</code> and return its handle.</td>
</tr>
<tr>
<td><strong>find</strong></td>
<td>Locate the phase node with the specified <code>phase</code> IMP and return its handle.</td>
</tr>
<tr>
<td><strong>is</strong></td>
<td>Returns 1 if the containing <code>uvm_phase</code> refers to the same phase as the phase argument, 0 otherwise</td>
</tr>
<tr>
<td><strong>is_before</strong></td>
<td>Returns 1 if the containing <code>uvm_phase</code> refers to a phase that is earlier than the phase argument, 0 otherwise</td>
</tr>
<tr>
<td><strong>is_after</strong></td>
<td>Returns 1 if the containing <code>uvm_phase</code> refers to a phase that is later than the phase argument, 0 otherwise</td>
</tr>
</tbody>
</table>

**CALLBACKS**

<table>
<thead>
<tr>
<th><strong>exec_func</strong></th>
<th>Implements the functor/delegate functionality for a function phase type <code>comp</code> - the component to execute the functionality upon phase - the phase schedule that originated this phase call</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>exec_task</strong></td>
<td>Implements the functor/delegate functionality for a task phase type <code>comp</code> - the component to execute the functionality upon phase - the phase schedule that originated this phase call</td>
</tr>
</tbody>
</table>

**SCHEDULE**

<table>
<thead>
<tr>
<th><strong>add</strong></th>
<th>Build up a schedule structure inserting phase by phase, specifying linkage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>get_parent</strong></td>
<td>Returns the parent schedule node, if any, for hierarchical graph traversal</td>
</tr>
<tr>
<td><strong>get_full_name</strong></td>
<td>Returns the full path from the enclosing domain down to this node.</td>
</tr>
<tr>
<td><strong>get_schedule</strong></td>
<td>Returns the topmost parent schedule node, if any, for hierarchical graph traversal</td>
</tr>
<tr>
<td><strong>get_schedule_name</strong></td>
<td>Returns the schedule name associated with this phase node</td>
</tr>
<tr>
<td><strong>get_domain</strong></td>
<td>Returns the enclosing domain</td>
</tr>
<tr>
<td><strong>get_imp</strong></td>
<td>Returns the phase implementation for this this node.</td>
</tr>
<tr>
<td><strong>get_domain_name</strong></td>
<td>Returns the domain name associated with this phase node</td>
</tr>
<tr>
<td><strong>get_adjacent_predecessor_nodes</strong></td>
<td>Provides an array of nodes which are predecessors to this phase node.</td>
</tr>
<tr>
<td><strong>get_adjacent_successor_nodes</strong></td>
<td>Provides an array of nodes which are successors to this phase node.</td>
</tr>
</tbody>
</table>

**PHASE DONE OBJECTION**

<table>
<thead>
<tr>
<th><strong>get_objection</strong></th>
<th>Return the <code>uvm_objection</code> that gates the termination of the phase.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>raise_objection</strong></td>
<td>Raise an objection to ending this phase</td>
</tr>
<tr>
<td><strong>drop_objection</strong></td>
<td>Drop an objection to ending this phase</td>
</tr>
<tr>
<td><strong>get_objection_count</strong></td>
<td>Returns the current number of objections</td>
</tr>
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</table>
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<th>Description</th>
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</thead>
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<tr>
<td>sync</td>
<td>Synchronize two domains, fully or partially</td>
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<tr>
<td>unsync</td>
<td>Remove synchronization between two domains, fully or partially</td>
</tr>
<tr>
<td>wait_for_state</td>
<td>Wait until this phase compares with the given state and op operand.</td>
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**Jumping**

<table>
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<tr>
<th>Function</th>
<th>Description</th>
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<tbody>
<tr>
<td>jump</td>
<td>Jump to a specified phase.</td>
</tr>
<tr>
<td>set_jump_phase</td>
<td>Specify a phase to transition to when phase is complete.</td>
</tr>
<tr>
<td>end_prematurely</td>
<td>Set a flag to cause the phase to end prematurely.</td>
</tr>
<tr>
<td>get_jump_target</td>
<td>Return handle to the target phase of the current jump, or null if no jump is in progress.</td>
</tr>
</tbody>
</table>

**Construction**

```md
new
```

```plaintext
function new(
    string name = "uvm_phase",
    uvm_phase_type phase_type = UVM_PHASE_SCHEDULE,
    uvm_phase parent = null
)
```

Create a new phase node, with a name and a note of its type name - name of this phase type - a value in `uvm_phase_type`

```md
get_phase_type
```

```plaintext
function uvm_phase_type get_phase_type()
```

Returns the phase type as defined by `uvm_phase_type`

**State**

```md
get_state
```

```plaintext
function uvm_phase_state get_state()
```

Accessor to return current state of this phase

```md
get_run_count
```

```plaintext
function int get_run_count()
```

UVM 1.2 Class Reference
Accessor to return the integer number of times this phase has executed

**find_by_name**

```plaintext
function uvm_phase find_by_name(
    string name,
    bit stay_in_scope = 1
)
```

Locate a phase node with the specified *name* and return its handle. With *stay_in_scope* set, searches only within this phase’s schedule or domain.

**find**

```plaintext
function uvm_phase find(
    uvm_phase phase,
    bit stay_in_scope = 1
)
```

Locate the phase node with the specified *phase* IMP and return its handle. With *stay_in_scope* set, searches only within this phase’s schedule or domain.

**is**

```plaintext
function bit is(
    uvm_phase phase
)
```

returns 1 if the containing uvm_phase refers to the same phase as the phase argument, 0 otherwise

**is_before**

```plaintext
function bit is_before(
    uvm_phase phase
)
```

Returns 1 if the containing uvm_phase refers to a phase that is earlier than the phase argument, 0 otherwise

**is_after**

```plaintext
function bit is_after(
    uvm_phase phase
)
```

returns 1 if the containing uvm_phase refers to a phase that is later than the phase argument, 0 otherwise

**CALLBACKS**
exec_func

```cpp
virtual function void exec_func(
    uvm_component comp,
    uvm_phase phase
)
```

Implements the functor/delegate functionality for a function phase type comp - the component to execute the functionality upon phase - the phase schedule that originated this phase call

exec_task

```cpp
virtual task exec_task(
    uvm_component comp,
    uvm_phase phase
)
```

Implements the functor/delegate functionality for a task phase type comp - the component to execute the functionality upon phase - the phase schedule that originated this phase call

**Schedule**

add

```cpp
function void add(
    uvm_phase phase,
    uvm_phase with_phase = null,
    uvm_phase after_phase = null,
    uvm_phase before_phase = null
)
```

Build up a schedule structure inserting phase by phase, specifying linkage

Phases can be added anywhere, in series or parallel with existing nodes

- **phase**: handle of singleton derived imp containing actual functor. by default the new phase is appended to the schedule
- **with_phase**: specify to add the new phase in parallel with this one
- **after_phase**: specify to add the new phase as successor to this one
- **before_phase**: specify to add the new phase as predecessor to this one

get_parent

```cpp
function uvm_phase get_parent()```

Returns the parent schedule node, if any, for hierarchical graph traversal

get_full_name

```cpp
virtual function string get_full_name()```
Returns the full path from the enclosing domain down to this node. The singleton IMP phases have no hierarchy.

### `get_schedule`

```plaintext
function uvm_phase get_schedule(
    bit hier = 0
)
```

Returns the topmost parent schedule node, if any, for hierarchical graph traversal.

### `get_schedule_name`

```plaintext
function string get_schedule_name(
    bit hier = 0
)
```

Returns the schedule name associated with this phase node.

### `get_domain`

```plaintext
function uvm_domain get_domain()
```

Returns the enclosing domain.

### `get_imp`

```plaintext
function uvm_phase get_imp()
```

Returns the phase implementation for this this node. Returns `null` if this phase type is not a UVM_PHASE_LEAF_NODE.

### `get_domain_name`

```plaintext
function string get_domain_name()
```

Returns the domain name associated with this phase node.

### `get_adjacent_predecessor_nodes`

```plaintext
function void get_adjacent_predecessor_nodes(
    ref uvm_phase pred[]
)
```

Provides an array of nodes which are predecessors to `this` phase node. A `predecessor node` is defined as any phase node which lies prior to `this` node in the phase graph, with no nodes between `this` node and the predecessor node.
Provides an array of nodes which are successors to this phase node. A ‘successor’s node’ is defined as any phase node which comes after this node in the phase graph, with no nodes between this node and the successor node.

**Phase Done Objection**

Task-based phase nodes within the phasing graph provide a uvm_object based interface for prolonging the execution of the phase. All other phase types do not contain an objection, and will report a fatal error if the user attempts to raise, drop, or get_objection_count.

**get_objection**

```plaintext
function uvm_object get_objection()
```

Return the uvm_object that gates the termination of the phase.

**raise_objection**

```plaintext
virtual function void raise_objection (uvm_object obj, string description = "", int count = 1)
```

Raise an objection to ending this phase Provides components with greater control over the phase flow for processes which are not implicit objectors to the phase.

```plaintext
while(1) begin
  some_phase.raise_objection(this);
  ...
  some_phase.drop_objection(this);
end
```

**drop_objection**

```plaintext
virtual function void drop_objection (uvm_object obj, string description = "", int count = 1)
```

Drop an objection to ending this phase

The drop is expected to be matched with an earlier raise.

**get_objection_count**
virtual function int get_objection_count(
    uvm_object obj = null
)

Returns the current number of objections to ending this phase raised by the given object.

**SYNCHRONIZATION**

The functions `sync` and `unsync` add soft sync relationships between nodes.

**Summary of usage**

```cpp
my_phase.sync(.target(domain)
              [.phase(phase) [.with_phase(phase)]]);
my_phase.unsync(.target(domain)
               [.phase(phase) [.with_phase(phase)]]);
```

Components in different schedule domains can be phased independently or in sync with each other. An API is provided to specify synchronization rules between any two domains. Synchronization can be done at any of three levels:

- the domain’s whole phase schedule can be synchronized
- a phase can be specified, to sync that phase with a matching counterpart
- or a more detailed arbitrary synchronization between any two phases

Each kind of synchronization causes the same underlying data structures to be managed. Like other APIs, we use the parameter dot-notation to set optional parameters.

When a domain is synced with another domain, all of the matching phases in the two domains get a ‘with’ relationship between them. Likewise, if a domain is unsynched, all of the matching phases that have a ‘with’ relationship have the dependency removed. It is possible to sync two domains and then just remove a single phase from the dependency relationship by unsyncing just the one phase.

**sync**

```cpp
function void sync(
    uvm_domain target,
    uvm_phase phase = null,
    uvm_phase with_phase = null
)
```

Synchronize two domains, fully or partially

- **target**: handle of target domain to synchronize this one to
- **phase**: optional single phase in this domain to synchronize, otherwise sync all
- **with_phase**: optional different target-domain phase to synchronize with, otherwise use `phase` in the target domain

**unsync**
function void unsync(
    uvm_domain target,
    uvm_phase phase = null,
    uvm_phase with_phase = null
)

Remove synchronization between two domains, fully or partially

**target** handle of target domain to remove synchronization from

**phase** optional single phase in this domain to un-synchronize, otherwise unsync all

**with_phase** optional different target-domain phase to un-synchronize with, otherwise use phase in the target domain

### wait_for_state

```
function void jump(
    uvm_phase phase
)
```

Jump to a specified phase. If the destination phase is within the current phase schedule, a simple local jump takes place. If the jump-to phase is outside of the current schedule then the jump affects other schedules which share the phase.

### set_jump_phase

```
function void set_jump_phase( uvm_phase phase
```
Specify a phase to transition to when phase is complete. Note that this function is part of what jump() does; unlike jump() it does not set the flag to terminate the phase prematurely.

**end_prematurely**

```plaintext
function void end_prematurely()
```

Set a flag to cause the phase to end prematurely. Note that this function is part of what jump() does; unlike jump() it does not set a jump_phase to go to after the phase ends.

**get_jump_target**

```plaintext
function uvm_phase get_jump_target()
```

Return handle to the target phase of the current jump, or null if no jump is in progress. Valid for use during the phase_ended() callback.

**uvm_phase_state_change**

Phase state transition descriptor. Used to describe the phase transition that caused a uvm_phase_state_changed() callback to be invoked.

### Summary

**uvm_phase_state_change**

Phase state transition descriptor.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_phase_state_change

**CLASS DECLARATION**

```plaintext
class uvm_phase_state_change extends uvm_object
```

**METHODS**

- `get_state()` Returns the state the phase just transitioned to.
- `get_prev_state()` Returns the state the phase just transitioned from. If the current state is `UVM_PHASE_ENDED` or `UVM_PHASE_JUMPING` because of a phase jump, returns the phase that is the target of jump.
- `jump_to()`
**get_state()**

```c++
virtual function uvm_phase_state get_state()
```

Returns the state the phase just transitioned to. Functionally equivalent to `uvm_phase::get_state()`.

---

**get_prev_state()**

```c++
virtual function uvm_phase_state get_prev_state()
```

Returns the state the phase just transitioned from.

---

**jump_to()**

```c++
function uvm_phase jump_to()
```

If the current state is `UVM_PHASE_ENDED` or `UVM_PHASE_JUMPING` because of a phase jump, returns the phase that is the target of jump. Returns `null` otherwise.

---

**uvm_phase_cb**

This class defines a callback method that is invoked by the phaser during the execution of a specific node in the phase graph or all phase nodes. User-defined callback extensions can be used to integrate data types that are not natively phase-aware with the UVM phasing.

**Summary**

**uvm_phase_cb**

This class defines a callback method that is invoked by the phaser during the execution of a specific node in the phase graph or all phase nodes.

---

**CLASS HIERARCHY**

- `uvm_void`
- `uvm_object`
- `uvm_callback`
- `uvm_phase_cb`

---

**CLASS DECLARATION**

```
class uvm_phase_cb extends uvm_callback
```

---

**METHODS**

- `new` Constructor
- `phase_state_change` Called whenever a phase changes state.
new

```plaintext
function new(
  string name = "unnamed-uvm_phase_cb"
)
```

Constructor

**phase_state_change**

```plaintext
virtual function void phase_state_change(
  uvm_phase phase,
  uvm_phase_state_change change
)
```

Called whenever a `phase` changes state. The `change` descriptor describes the transition that was just completed. The callback method is invoked immediately after the phase state has changed, but before the phase implementation is executed.

An extension may interact with the phase, such as raising the phase objection to prolong the phase, in a manner that is consistent with the current phase state.

By default, the callback method does nothing. Unless otherwise specified, modifying the phase transition descriptor has no effect on the phasing schedule or execution.

**uvm_phase_cb_pool**

Convenience type for the `uvm_callbacks#(uvm_phase, uvm_phase_cb)` class.

**Summary**

```plaintext
typedef uvm_callbacks#(
  uvm_phase,
  uvm_phase_cb
) uvm_phase_cb_pool
```
9.2 uvm_domain

Phasing schedule node representing an independent branch of the schedule. Handle used to assign domains to components or hierarchies in the testbench

Summary

uvm_domain

Phasing schedule node representing an independent branch of the schedule.

CLASS HIERARCHY

uvm_void
uvm_object
uvm_phase
uvm_domain

CLASS DECLARATION

class uvm_domain extends uvm_phase

METHODS

get_domains Provides a list of all domains in the provided domains argument.

get_uvm_schedule Get the “UVM” schedule, which consists of the run-time phases that all components execute when participating in the “UVM” domain.

get_common_domain Get the “common” domain, which consists of the common phases that all components execute in sync with each other.

add_uvm_phases Appends to the given schedule the built-in UVM phases.

get_uvm_domain Get a handle to the singleton uvm domain

new Create a new instance of a phase domain.

jump Jumps all active phases of this domain to to-phase if there is a path between active-phase and to-phase

METHODS

get_domains

static function void get_domains(
    output uvm_domain domains[string]
)

Provides a list of all domains in the provided domains argument.

get_uvm_schedule

static function uvm_phase get_uvm_schedule()

Get the “UVM” schedule, which consists of the run-time phases that all components
execute when participating in the “UVM” domain.

get_common_domain

static function uvm_domain get_common_domain()

Get the “common” domain, which consists of the common phases that all components execute in sync with each other. Phases in the “common” domain are build, connect, end_of_elaboration, start_of_simulation, run, extract, check, report, and final.

add_uvm_phases

static function void add_uvm_phases(uvm_phase schedule)

Appends to the given schedule the built-in UVM phases.

get_uvm_domain

static function uvm_domain get_uvm_domain()

Get a handle to the singleton uvm domain

new

function new(string name)

Create a new instance of a phase domain.

jump

function void jump(uvm_phase phase)

jumps all active phases of this domain to to-phase if there is a path between active-phase and to-phase
Virtual base class for function phases that operate bottom-up. The pure virtual function `execute()` is called for each component. This is the default traversal so is included only for naming.

A bottom-up function phase completes when the `execute()` method has been called and returned on all applicable components in the hierarchy.

**Summary**

**uvm_bottomup_phase**

Virtual base class for function phases that operate bottom-up.

**Class Hierarchy**

```
| uvm_void |
| uvm_object |
| uvm_phase |
| uvm_bottomup_phase |
```

**Class Declaration**

```
virtual class uvm_bottomup_phase extends uvm_phase
```

**Methods**

**new**

```
function new(
    string name
)
```

Create a new instance of a bottom-up phase.

**traverse**

```
virtual function void traverse(
    uvm_component comp,
    uvm_phase phase,
    uvm_phase_state state
)
```

Traverses the component tree in bottom-up order, calling `execute` for each component.

Execute the bottom-up phase `phase` for the component `comp`.
execute

```c
virtual function void execute(
    uvm_component comp,
    uvm_phase phase
)
```

Executes the bottom-up phase `phase` for the component `comp`. 
9.4 uvm_task_phase

Base class for all task phases. It forks a call to `uvm_phase::exec_task()` for each component in the hierarchy.

The completion of the task does not imply, nor is it required for, the end of phase. Once the phase completes, any remaining forked `uvm_phase::exec_task()` threads are forcibly and immediately killed.

By default, the way for a task phase to extend over time is if there is at least one component that raises an objection.

```plaintext
class my_comp extends uvm_component;
    task main_phase(uvm_phase phase);
        phase.raise_objection(this, "Applying stimulus")
        ...
        phase.drop_objection(this, "Applied enough stimulus")
    endtask
endclass
```

There is however one scenario wherein time advances within a task-based phase without any objections to the phase being raised. If two (or more) phases share a common successor, such as the `uvm_run_phase` and the `uvm_post_shutdown_phase` sharing the `uvm_extract_phase` as a successor, then phase advancement is delayed until all predecessors of the common successor are ready to proceed. Because of this, it is possible for time to advance between `uvm_component::phase_started` and `uvm_component::phase_ended` of a task phase without any participants in the phase raising an objection.

Summary

### uvm_task_phase

Base class for all task phases.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_phase
  uvm_task_phase
```

**Class Declaration**

```
virtual class uvm_task_phase extends uvm_phase
```

**Methods**

- `new`
  - Create a new instance of a task-based phase

- `traverse`
  - Traverses the component tree in bottom-up order, calling `execute` for each component.

- `execute`
  - Fork the task-based phase `phase` for the component `comp`. 
new

```cpp
function new(  
    string name
)
```

Create a new instance of a task-based phase

traverse

```cpp
virtual function void traverse(  
    uvm_component comp,  
    uvm_phase phase,  
    uvm_phase_state state
)
```

Traverses the component tree in bottom-up order, calling `execute` for each component. The actual order for task-based phases doesn’t really matter, as each component task is executed in a separate process whose starting order is not deterministic.

execute

```cpp
virtual function void execute(  
    uvm_component comp,  
    uvm_phase phase
)
```

Fork the task-based phase `phase` for the component `comp`.
9.5 uvm_topdown_phase

Virtual base class for function phases that operate top-down. The pure virtual function `execute()` is called for each component.

A top-down function phase completes when the `execute()` method has been called and returned on all applicable components in the hierarchy.

**Summary**

**uvm_topdown_phase**

Virtual base class for function phases that operate top-down.

**CLASS HIERARCHY**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>uvm_topdown_phase</td>
</tr>
</tbody>
</table>
```

**CLASS DECLARATION**

```
virtual class uvm_topdown_phase extends uvm_phase
```

**METHODS**

**new**

```
function new(
    string name
)
```

Create a new instance of a top-down phase

**traverse**

```
virtual function void traverse(
    uvm_component comp,
    uvm_phase phase,
    uvm_phase_state state
)
```

Traverses the component tree in top-down order, calling `execute` for each component.

**execute**

Executes the top-down phase `phase` for the component `comp`. 
execute

```c
virtual function void execute(
    uvm_component comp,
    uvm_phase phase
)
```

Executes the top-down phase `phase` for the component `comp`. 
9.6 UVM Common Phases

The common phases are the set of function and task phases that all uvm_components execute together. All uvm_components are always synchronized with respect to the common phases.

The names of the UVM phases (which will be returned by get_name() for a phase instance) match the class names specified below with the “uvm_” and “_phase” removed. For example, the build phase corresponds to the uvm_build_phase class below and has the name “build”, which means that the following can be used to call foo() at the end of the build phase (after all lower levels have finished build):

```plaintext
function void phase_ended(uvm_phase phase) {
  if (phase.get_name() == "build") foo();
}
```

The common phases are executed in the sequence they are specified below.

**Contents**

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<th>Description</th>
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</thead>
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<td>Create and configure of testbench structure</td>
</tr>
<tr>
<td>uvm_connect_phase</td>
<td>Establish cross-component connections.</td>
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<tr>
<td>uvm_end_of_elaboration_phase</td>
<td>Fine-tune the testbench.</td>
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<tr>
<td>uvm_start_of_simulation_phase</td>
<td>Get ready for DUT to be simulated.</td>
</tr>
<tr>
<td>uvm_run_phase</td>
<td>Stimulate the DUT.</td>
</tr>
<tr>
<td>uvm_extract_phase</td>
<td>Extract data from different points of the verification environment.</td>
</tr>
<tr>
<td>uvm_check_phase</td>
<td>Check for any unexpected conditions in the verification environment.</td>
</tr>
<tr>
<td>uvm_report_phase</td>
<td>Report results of the test.</td>
</tr>
<tr>
<td>uvm_final_phase</td>
<td>Tie up loose ends.</td>
</tr>
</tbody>
</table>

**uvm_build_phase**

Create and configure of testbench structure

**uvm_topdown_phase** that calls the uvm_component::build_phase method.

**Upon entry**

- The top-level components have been instantiated under uvm_root.
- Current simulation time is still equal to 0 but some “delta cycles” may have occurred

**Typical Uses**

- Instantiate sub-components.
- Instantiate register model.
- Get configuration values for the component being built.
Set configuration values for sub-components.

**Exit Criteria**
- All uvm_components have been instantiated.

**Summary**

### uvm_build_phase

Create and configure of testbench structure

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_phase
- uvm_topdown_phase
- uvm_build_phase

**Class Declaration**

```class uvm_build_phase extends uvm_topdown_phase```

**Methods**

- `get`

  Returns the singleton phase handle

---

**Methods**

- `get`

  ```static function uvm_build_phase get()```

  Returns the singleton phase handle

---

### uvm_connect_phase

Establish cross-component connections.

**uvm_bottomup_phase** that calls the **uvm_component::connect_phase** method.

**Upon Entry**
- All components have been instantiated.
- Current simulation time is still equal to 0 but some “delta cycles” may have occurred.

**Typical Uses**
- Connect TLM ports and exports.
Connect TLM initiator sockets and target sockets.
- Connect register model to adapter components.
- Setup explicit phase domains.

**Exit Criteria**
- All cross-component connections have been established.
- All independent phase domains are set.

**Summary**

```
<table>
<thead>
<tr>
<th>Class Hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_void</code></td>
</tr>
<tr>
<td><code>uvm_object</code></td>
</tr>
<tr>
<td><code>uvm_phase</code></td>
</tr>
<tr>
<td><code>uvm_bottomup_phase</code></td>
</tr>
<tr>
<td><strong>uvm_connect_phase</strong></td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Class Declaration</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>class uvm_connect_phase extends uvm_bottomup_phase</code></td>
</tr>
</tbody>
</table>
```

**Methods**

```
<table>
<thead>
<tr>
<th>get</th>
</tr>
</thead>
<tbody>
<tr>
<td>static function uvm_connect_phase get()</td>
</tr>
</tbody>
</table>
```

Returns the singleton phase handle

---

**uvm_end_of_elaboration_phase**

Fine-tune the testbench.

- `uvm_bottomup_phase` that calls the `uvm_component::end_of_elaboration_phase` method.

**Upon Entry**
- The verification environment has been completely assembled.
- Current simulation time is still equal to 0 but some “delta cycles” may have occurred.
Typical Uses
- Display environment topology.
- Open files.
- Define additional configuration settings for components.

Exit Criteria
- None.

Summary

**uvm_end_of_elaboration_phase**

Fine-tune the testbench.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_phase
- uvm_bottomup_phase
- **uvm_end_of_elaboration_phase**

**CLASS DECLARATION**

class uvm_end_of_elaboration_phase extends uvm_bottomup_phase

**METHODS**

- **get**
  
  Returns the singleton phase handle

**uvm_start_of_simulation_phase**

Get ready for DUT to be simulated.

**uvm_bottomup_phase** that calls the **uvm_component::start_of_simulation_phase** method.

**Upon Entry**
- Other simulation engines, debuggers, hardware assisted platforms and all other run-time tools have been started and synchronized.
The verification environment has been completely configured and is ready to start.
Current simulation time is still equal to 0 but some “delta cycles” may have occurred.

**Typical Uses**
- Display environment topology
- Set debugger breakpoint
- Set initial run-time configuration values.

**Exit Criteria**
- None.

**Summary**

```uvm_start_of_simulation_phase```
Get ready for DUT to be simulated.

**CLASS HIERARCHY**

- `uvm_void`
- `uvm_object`
- `uvm_phase`
- `uvm_bottomup_phase`
- `uvm_start_of_simulation_phase`

**CLASS DECLARATION**

```class uvm_start_of_simulation_phase extends uvm_bottomup_phase```

**METHODS**

- **get**
  
  ```static function uvm_start_of_simulation_phase get()```

  Returns the singleton phase handle

---

**METHODS**

- **uvm_run_phase**

Stimulate the DUT.

This `uvm_task_phase` calls the `uvm_component::run_phase` virtual method. This phase runs in parallel to the runtime phases, `uvm_pre_reset_phase` through...
Upon Entry

- Indicates that power has been applied.
- There should not have been any active clock edges before entry into this phase (e.g. x->1 transitions via initial blocks).
- Current simulation time is still equal to 0 but some “delta cycles” may have occurred.

Typical Uses

- Components implement behavior that is exhibited for the entire run-time, across the various run-time phases.
- Backward compatibility with OVM.

Exit Criteria

- The DUT no longer needs to be simulated, and
- The `uvm_post_shutdown_phase` is ready to end

The run phase terminates in one of two ways.

1. All run_phase objections are dropped

When all objections on the run_phase objection have been dropped, the phase ends and all of its threads are killed. If no component raises a run_phase objection immediately upon entering the phase, the phase ends immediately.

2. Timeout

The phase ends if the timeout expires before all objections are dropped. By default, the timeout is set to 9200 seconds. You may override this via `uvm_root::set_timeout`.

If a timeout occurs in your simulation, or if simulation never ends despite completion of your test stimulus, then it usually indicates that a component continues to object to the end of a phase.

Summary

<table>
<thead>
<tr>
<th><code>uvm_run_phase</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate the DUT.</td>
</tr>
</tbody>
</table>

**Class Hierarchy**

- `uvm_void`
- `uvm_object`
- `uvm_phase`
- `uvm_task_phase`
- `uvm_run_phase`

**Class Declaration**

```cpp
class uvm_run_phase extends uvm_task_phase
```

**Methods**

- `uvm_post_shutdown_phase`. All components in the testbench are synchronized with respect to the run phase regardless of the phase domain they belong to.
get

static function uvm_run_phase get()

Returns the singleton phase handle

uvm_extract_phase

Extract data from different points of the verification environment.

uvm_bottomup_phase that calls the uvm_component::extract_phase method.

Upon Entry

- The DUT no longer needs to be simulated.
- Simulation time will no longer advance.

Typical Uses

- Extract any remaining data and final state information from scoreboard and testbench components
- Probe the DUT (via zero-time hierarchical references and/or backdoor accesses) for final state information.
- Compute statistics and summaries.
- Display final state information
- Close files.

Exit Criteria

- All data has been collected and summarized.

Summary

uvm_extract_phase

Extract data from different points of the verification environment.

Class Hierarchy

```
uvm_void
uvm_object
uvm_phase
uvm_bottomup_phase
uvm_extract_phase
```
**Methods**

**get**

```cpp
static function uvm_extract_phase get()
```

Returns the singleton phase handle

---

### uvm_check_phase

Check for any unexpected conditions in the verification environment.

**uvm_bottomup_phase** that calls the **uvm_component::check_phase** method.

**Upon Entry**
- All data has been collected.

**Typical Uses**
- Check that no unaccounted-for data remain.

**Exit Criteria**
- Test is known to have passed or failed.

**Summary**

`uvm_check_phase`

Check for any unexpected conditions in the verification environment.

**Class Hierarchy**

```
uvm_void
uvm_object
uvm_phase
uvm_bottomup_phase
uvm_check_phase
```

**Class Declaration**

```cpp
class uvm_check_phase extends uvm_bottomup_phase
```

**Methods**

```
class uvm_check_phase extends uvm_bottomup_phase
```

UVM 1.2 Class Reference
**Methods**

**get**

```plaintext
static function uvm_check_phase get()
```

Returns the singleton phase handle

---

**uvm_report_phase**

Report results of the test.

*uvm_bottomup_phase* that calls the *uvm_component::report_phase* method.

**Upon Entry**

- Test is known to have passed or failed.

**Typical Uses**

- Report test results.
- Write results to file.

**Exit Criteria**

- End of test.

**Summary**

**uvm_report_phase**

Report results of the test.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_bottomup_phase</td>
</tr>
<tr>
<td><strong>uvm_report_phase</strong></td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_report_phase extends uvm_bottomup_phase
```

**Methods**

- **get**
  
  Returns the singleton phase handle
**METHODS**

**get**

```plaintext
static function uvm_report_phase get()
```

Returns the singleton phase handle

### uvm_final_phase

Tie up loose ends.

`uvm_topdown_phase` that calls the `uvm_component::final_phase` method.

**Upon Entry**
- All test-related activity has completed.

**Typical Uses**
- Close files.
- Terminate co-simulation engines.

**Exit Criteria**
- Ready to exit simulator.

**Summary**

#### uvm_final_phase

Tie up loose ends.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_phase
- uvm_topdown_phase
- **uvm_final_phase**

**CLASS DECLARATION**

```plaintext
class uvm_final_phase extends uvm_topdown_phase
```

**METHODS**

- **get**
  
  Returns the singleton phase handle
get

**static function uvm_final_phase get()**

Returns the singleton phase handle
9.7 UVM Run-Time Phases

The run-time schedule is the pre-defined phase schedule which runs concurrently to the uvm_run_phase global run phase. By default, all uvm_components using the run-time schedule are synchronized with respect to the pre-defined phases in the schedule. It is possible for components to belong to different domains in which case their schedules can be unsynchronized.

The names of the UVM phases (which will be returned by get_name() for a phase instance) match the class names specified below with the “uvm_” and “_phase” removed. For example, the main phase corresponds to the uvm_main_phase class below and has the name “main”, which means that the following can be used to call foo() at the start of main phase:

```plaintext
function void phase_started(uvm_phase phase) ;
  if (phase.get_name()=="main") foo() ;
endfunction
```

The run-time phases are executed in the sequence they are specified below.

### Contents

<table>
<thead>
<tr>
<th>UVM Run-Time Phases</th>
</tr>
</thead>
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<tr>
<td>uvm_reset_phase</td>
</tr>
<tr>
<td>uvm_post_reset_phase</td>
</tr>
<tr>
<td>uvm_pre_configure_phase</td>
</tr>
<tr>
<td>uvm_configure_phase</td>
</tr>
<tr>
<td>uvm_post_configure_phase</td>
</tr>
<tr>
<td>uvm_pre_main_phase</td>
</tr>
<tr>
<td>uvm_main_phase</td>
</tr>
<tr>
<td>uvm_post_main_phase</td>
</tr>
<tr>
<td>uvm_pre_shutdown_phase</td>
</tr>
<tr>
<td>uvm_shutdown_phase</td>
</tr>
<tr>
<td>uvm_post_shutdown_phase</td>
</tr>
</tbody>
</table>

### uvm_pre_reset_phase

Before reset is asserted.

uvm_task_phase that calls the uvm_component::pre_reset_phase method. This phase starts at the same time as the uvm_run_phase unless a user defined phase is inserted in front of this phase.

#### Upon Entry

- Indicates that power has been applied but not necessarily valid or stable.
- There should not have been any active clock edges before entry into this phase.

#### Typical Uses
• Wait for power good.
• Components connected to virtual interfaces should initialize their output to X's or Z's.
• Initialize the clock signals to a valid value
• Assign reset signals to X (power-on reset).
• Wait for reset signal to be asserted if not driven by the verification environment.

**Exit Criteria**
• Reset signal, if driven by the verification environment, is ready to be asserted.
• Reset signal, if not driven by the verification environment, is asserted.

**Summary**

```plaintext
uvm_pre_reset_phase

Before reset is asserted.

**Class Hierarchy**

```
| uvm_void       |
| uvm_object     |
| uvm_phase      |
| uvm_task_phase |
| uvm_pre_reset_phase |
```

**Class Declaration**

```plaintext
class uvm_pre_reset_phase extends uvm_task_phase
```

**Methods**

```plaintext
get

static function uvm_pre_reset_phase get()
```

Returns the singleton phase handle

---

**uvm_reset_phase**

Reset is asserted.

* uvm_task_phase that calls the uvm_component::reset_phase method.

**Upon Entry**

```plaintext

```
• Indicates that the hardware reset signal is ready to be asserted.

**Typical Uses**

• Assert reset signals.
• Components connected to virtual interfaces should drive their output to their specified reset or idle value.
• Components and environments should initialize their state variables.
• Clock generators start generating active edges.
• De-assert the reset signal(s) just before exit.
• Wait for the reset signal(s) to be de-asserted.

**Exit Criteria**

• Reset signal has just been de-asserted.
• Main or base clock is working and stable.
• At least one active clock edge has occurred.
• Output signals and state variables have been initialized.

**Summary**

```
# uvm_reset_phase
Reset is asserted.

## CLASS HIERARCHY
- uvm_void
- uvm_object
- uvm_phase
- uvm_task_phase
- uvm_reset_phase

## CLASS DECLARATION
- class uvm_reset_phase extends uvm_task_phase

## METHODS
- get
  Returns the singleton phase handle
```

**METHODS**

- get
  ```
  static function uvm_reset_phase get()
  ```
  Returns the singleton phase handle
After reset is de-asserted.

*uvm_task_phase* that calls the *uvm_component::post_reset_phase* method.

**Upon Entry**
- Indicates that the DUT reset signal has been de-asserted.

**Typical Uses**
- Components should start behavior appropriate for reset being inactive. For example, components may start to transmit idle transactions or interface training and rate negotiation. This behavior typically continues beyond the end of this phase.

**Exit Criteria**
- The testbench and the DUT are in a known, active state.

**Summary**

<table>
<thead>
<tr>
<th><strong>Class Hierarchy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_void</td>
</tr>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_task_phase</td>
</tr>
<tr>
<td><strong>uvm_post_reset_phase</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Class Declaration</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>class uvm_post_reset_phase extends uvm_task_phase</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Methods</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>get</em></td>
</tr>
<tr>
<td>Returns the singleton phase handle</td>
</tr>
</tbody>
</table>

**get**

```
static function uvm_post_reset_phase get()
```

Returns the singleton phase handle
Before the DUT is configured by the SW.

\texttt{uvm_task_phase} that calls the \texttt{uvm_component::preConfigurePhase} method.

**Upon Entry**
- Indicates that the DUT has been completed reset and is ready to be configured.

**Typical Uses**
- Procedurally modify the DUT configuration information as described in the environment (and that will be eventually uploaded into the DUT).
- Wait for components required for DUT configuration to complete training and rate negotiation.

**Exit Criteria**
- DUT configuration information is defined.

**Summary**

\textbf{uvm_preConfigurePhase}

Before the DUT is configured by the SW.

\textbf{Class Hierarchy}

<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_task_phase</td>
</tr>
<tr>
<td>\textbf{uvm_preConfigurePhase}</td>
</tr>
</tbody>
</table>

\textbf{Class Declaration}

```plaintext
class uvm_preConfigurePhase extends uvm_task_phase
```

\textbf{Methods}

- \texttt{get}

  Returns the singleton phase handle

\textbf{uvm_configure_phase}

\texttt{get} \hspace{1em}

```plaintext
static function uvm_preConfigurePhase get()
```

Returns the singleton phase handle
The SW configures the DUT. 

`uvm_task_phase` that calls the `uvm_component::configure_phase` method.

**Upon Entry**
- Indicates that the DUT is ready to be configured.

**Typical Uses**
- Components required for DUT configuration execute transactions normally.
- Set signals and program the DUT and memories (e.g. read/write operations and sequences) to match the desired configuration for the test and environment.

**Exit Criteria**
- The DUT has been configured and is ready to operate normally.

**Summary**

```markdown
**uvm_configure_phase**

The SW configures the DUT.

**CLASS HIERARCHY**

<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_task_phase</td>
</tr>
<tr>
<td><strong>uvm_configure_phase</strong></td>
</tr>
</tbody>
</table>
```

**CLASS DECLARATION**

```python
class uvm_configure_phase extends uvm_task_phase
```

**METHODS**

- `get`
  ```python
  static function uvm_configure_phase get()
  ```
  Returns the singleton phase handle

---

**uvm_post_configure_phase**

After the SW has configured the DUT.
Upon Entry

- Indicates that the configuration information has been fully uploaded.

Typical Uses

- Wait for configuration information to fully propagate and take effect.
- Wait for components to complete training and rate negotiation.
- Enable the DUT.
- Sample DUT configuration coverage.

Exit Criteria

- The DUT has been fully configured and enabled and is ready to start operating normally.

Summary

**uvm_post_configure_phase**

After the SW has configured the DUT.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_phase
- uvm_task_phase
- **uvm_post_configure_phase**

**Class Declaration**

```cpp
class uvm_post_configure_phase extends uvm_task_phase
```

**Methods**

- **get**

  ```cpp
  static function uvm_post_configure_phase get()
  ```

  Returns the singleton phase handle

uvm_pre_main_phase

Before the primary test stimulus starts.
uvm_task_phase that calls the uvm_component::pre_main_phase method.

**Upon Entry**
- Indicates that the DUT has been fully configured.

**Typical Uses**
- Wait for components to complete training and rate negotiation.

**Exit Criteria**
- All components have completed training and rate negotiation.
- All components are ready to generate and/or observe normal stimulus.

**Summary**

### uvm_pre_main_phase

Before the primary test stimulus starts.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_phase
- uvm_task_phase
- **uvm_pre_main_phase**

**Class Declaration**

```plaintext
class uvm_pre_main_phase extends uvm_task_phase
```

**Methods**

- **get**
  
  Returns the singleton phase handle

**get**

```plaintext
static function uvm_pre_main_phase get()
```

Returns the singleton phase handle

**uvm_main_phase**

Primary test stimulus.

uvm_task_phase that calls the uvm_component::main_phase method.
Upon Entry
- The stimulus associated with the test objectives is ready to be applied.

Typical Uses
- Components execute transactions normally.
- Data stimulus sequences are started.
- Wait for a time-out or certain amount of time, or completion of stimulus sequences.

Exit Criteria
- Enough stimulus has been applied to meet the primary stimulus objective of the test.

Summary

### uvm_main_phase

Primary test stimulus.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_task_phase</td>
</tr>
<tr>
<td><strong>uvm_main_phase</strong></td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```c
class uvm_main_phase extends uvm_task_phase
```

**Methods**

**get**

```
static function uvm_main_phase get()
```

Returns the singleton phase handle

---

**uvm_post_main_phase**

After enough of the primary test stimulus.

`uvm_task_phase` that calls the `uvm_component::post_main_phase` method.
Upon Entry
- The primary stimulus objective of the test has been met.

Typical Uses
- Included for symmetry.

Exit Criteria
- None.

Summary

```
class uvm_post_main_phase extends uvm_task_phase

static function uvm_post_main_phase get()
    Returns the singleton phase handle

uvm_post_main_phase
```

Before things settle down.

```
uvm_task_phase that calls the uvm_component::pre_shutdown_phase method.
```

Upon Entry
- None.
Typical Uses

- Included for symmetry.

Exit Criteria

- None.

Summary

**uvm_pre_shutdown_phase**

Before things settle down.

**CLASS HIERARCHY**

```
    uvm_void
    uvm_object
    uvm_phase
    uvm_task_phase
    uvm_pre_shutdown_phase
```

**CLASS DECLARATION**

```
    class uvm_pre_shutdown_phase extends uvm_task_phase
```

**METHODS**

- `get` Returns the singleton phase handle

**get**

```
    static function uvm_pre_shutdown_phase get()
```

Returns the singleton phase handle

---

**uvm_shutdown_phase**

Letting things settle down.

`uvm_task_phase` that calls the `uvm_component::shutdown_phase` method.

Upon Entry

- None.

Typical Uses

- Wait for all data to be drained out of the DUT.
- Extract data still buffered in the DUT, usually through read/write operations or
sequences.

Exit Criteria
- All data has been drained or extracted from the DUT.
- All interfaces are idle.

Summary

**uvm_shutdown_phase**
Letting things settle down.

**CLASS HIERARCHY**
- uvm_void
- uvm_object
- uvm_phase
- uvm_task_phase
- **uvm_shutdown_phase**

**CLASS DECLARATION**
```cpp
class uvm_shutdown_phase extends uvm_task_phase
```

**METHODS**
- **get**
  Returns the singleton phase handle

Methods

get

```cpp
static function uvm_shutdown_phase get()
```
Returns the singleton phase handle

**uvm_post_shutdown_phase**
After things have settled down.

**uvm_task_phase** that calls the **uvm_component::post_shutdown_phase** method. The end of this phase is synchronized to the end of the **uvm_run_phase** phase unless a user defined phase is added after this phase.

Upon Entry
- No more “data” stimulus is applied to the DUT.

Typical Uses
- Perform final checks that require run-time access to the DUT (e.g. read accounting
Exit Criteria

- All run-time checks have been satisfied.
- The `uvm_run_phase` phase is ready to end.

Summary

**uvm_post_shutdown_phase**

After things have settled down.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_void</td>
</tr>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_phase</td>
</tr>
<tr>
<td>uvm_task_phase</td>
</tr>
<tr>
<td><strong>uvm_post_shutdown_phase</strong></td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_post_shutdown_phase extends uvm_task_phase
```

**Methods**

- `get` Returns the singleton phase handle

**Methods**

```plaintext
static function uvm_post_shutdown_phase get()
```

Returns the singleton phase handle
9.8 User-Defined Phases

To define your own custom phase, use the following pattern.

1. Extend the appropriate base class for your phase type.

```cpp
class my_PHASE_phase extends uvm_task_phase;
class my_PHASE_phase extends uvm_topdown_phase;
class my_PHASE_phase extends uvm_bottomup_phase;
```

2. Optionally, implement your `exec_task` or `exec_func` method.

```cpp
task exec_task(uvm_component comp, uvm_phase schedule);
function void exec_func(uvm_component comp, uvm_phase schedule);
```

If implemented, these methods usually call the related method on the component

```cpp
comp.PHASE_phase(uvm_phase phase);
```

3. Since the phase class is a singleton, providing an accessor method allows for easy global use, and protecting the constructor prevents misuse.

```cpp
class my_PHASE_phase extends uvm_topdown_phase; or
uvm_task_phase/uvm_bottomup_phase
static local my_PHASE_phase m_inst; Local reference to global IMP
protected function new(string name="PHASE"); Protected constructor for
singleton
super.new(name);
endfunction : new
static function my_PHASE_phase get(); Static method for accessing
singleton
if (m_imp == null)
    m_imp = new();
return m_imp;
endfunction : get
Optionally implement exec_func/exec_task
endclass : my_PHASE_phase
```

4. Insert the phase in a phase schedule or domain using the `uvm_phase::add` method:

```cpp
my_schedule.add(my_PHASE_class::get());
```

Summary

**User-Defined Phases**

To define your own custom phase, use the following pattern.
10. Configuration and Resource Classes

The configuration and resources classes provide access to a centralized database where type specific information can be stored and received. The `uvm_resource_db` is the low level resource database which users can write to or read from. The `uvm_config_db` is layered on top of the resource database and provides a typed interface for configuration setting that is consistent with the `uvm_component::Configuration Interface`.

Information can be read from or written to the database at any time during simulation. A resource may be associated with a specific hierarchical scope of a `uvm_component` or it may be visible to all components regardless of their hierarchical position.

Summary

**Configuration and Resource Classes**

The configuration and resources classes provide access to a centralized database where type specific information can be stored and received.
10.1 Resources

Contents

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<td>A resource is a parameterized container that holds arbitrary data.</td>
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<td>Provides typedefs and enums used throughout the resources facility.</td>
</tr>
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<td><strong>uvm_resource_options</strong></td>
<td>Provides a namespace for managing options for the resources facility.</td>
</tr>
<tr>
<td><strong>uvm_resource_base</strong></td>
<td>Non-parameterized base class for resources.</td>
</tr>
<tr>
<td><strong>uvm_resource_pool</strong></td>
<td>The global (singleton) resource database.</td>
</tr>
<tr>
<td><strong>uvm_resource #(T)</strong></td>
<td>Parameterized resource.</td>
</tr>
</tbody>
</table>

**Intro**

A resource is a parameterized container that holds arbitrary data. Resources can be used to configure components, supply data to sequences, or enable sharing of information across disparate parts of a testbench. They are stored using scoping information so their visibility can be constrained to certain parts of the testbench. Resource containers can hold any type of data, constrained only by the data types available in SystemVerilog. Resources can contain scalar objects, class handles, queues, lists, or even virtual interfaces.

Resources are stored in a resource database so that each resource can be retrieved by name or by type. The database has both a name table and a type table and each resource is entered into both. The database is globally accessible.

Each resource has a set of scopes over which it is visible. The set of scopes is represented as a regular expression. When a resource is looked up the scope of the entity doing the looking up is supplied to the lookup function. This is called the current scope. If the current scope is in the set of scopes over which a resource is visible then the resource can be returned in the lookup.

Resources can be looked up by name or by type. To support type lookup each resource has a static type handle that uniquely identifies the type of each specialized resource container.

Multiple resources that have the same name are stored in a queue. Each resource is pushed into a queue with the first one at the front of the queue and each subsequent one behind it. The same happens for multiple resources that have the same type. The resource queues are searched front to back, so those placed earlier in the queue have precedence over those placed later.

The precedence of resources with the same name or same type can be altered. One way is to set the precedence member of the resource container to any arbitrary value. The search algorithm will return the resource with the highest precedence. In the case where there are multiple resources that match the search criteria and have the same (highest) precedence, the earliest one located in the queue will be one returned. Another way to change the precedence is to use the set_priority function to move a resource to either the front or back of the queue.

The classes defined here form the low level layer of the resource database. The classes include the resource container and the database that holds the containers. The following set of classes are defined here:
**uvm_resource_types**: A class without methods or members, only typedefs and enums. These types and enums are used throughout the resources facility. Putting the types in a class keeps them confined to a specific name space.

**uvm_resource_options**: policy class for setting options, such as auditing, which effect resources.

**uvm_resource_base**: the base (untyped) resource class living in the resource database. This class includes the interface for setting a resource as read-only, notification, scope management, altering search priority, and managing auditing.

**uvm_resource#(T)**: parameterized resource container. This class includes the interfaces for reading and writing each resource. Because the class is parameterized, all the access functions are type safe.

**uvm_resource_pool**: the resource database. This is a singleton class object.

---

### `uvm_resource_types`

Provides typedefs and enums used throughout the resources facility. This class has no members or methods, only typedefs. It’s used in lieu of package-scope types. When needed, other classes can use these types by prefixing their usage with `uvm_resource_types::`. E.g.

```cpp
uvm_resource_types::rsrc_q_t queue;
```

---

### Summary

**uvm_resource_types**

Provides typedefs and enums used throughout the resources facility.

**Class Declaration**

```cpp
class uvm_resource_types
```

---

### `uvm_resource_options`

Provides a namespace for managing options for the resources facility. The only thing allowed in this class is static local data members and static functions for manipulating and retrieving the value of the data members. The static local data members represent options and settings that control the behavior of the resources facility.

---

### Summary

**uvm_resource_options**

Provides a namespace for managing options for the resources facility.
METHODS

**turn_on_auditing**

```plaintext
static function void turn_on_auditing()
```

Turn auditing on for the resource database. This causes all reads and writes to the database to store information about the accesses. Auditing is turned on by default.

**turn_off_auditing**

```plaintext
static function void turn_off_auditing()
```

Turn auditing off for the resource database. If auditing is turned off, it is not possible to get extra information about resource database accesses.

**is_auditing**

```plaintext
static function bit is_auditing()
```

Returns 1 if the auditing facility is on and 0 if it is off.

**uvm_resource_base**

Non-parameterized base class for resources. Supports interfaces for scope matching, and virtual functions for printing the resource and for printing the accessor list.

**Summary**

```plaintext
virtual class uvm_resource_base extends uvm_object
```

UVM 1.2 Class Reference
### precedence

This variable is used to associate a precedence that a resource has with respect to other resources which match the same scope and name. Resources are set to the default precedence initially, and may be set to a higher or lower precedence as desired.

```c
int unsigned precedence
```

### default_precedence

The default precedence for an resource that has been created. When two resources have the same precedence, the first resource found has precedence.

```c
static int unsigned default_precedence = 1000
```

### new

```c
function new()
```
constructor for uvm_resource_base. The constructor takes two arguments, the name of the resource and a regular expression which represents the set of scopes over which this resource is visible.

```plaintext
string name = "",
string s  = "*"
)
```

get_type_handle

```plaintext
pure virtual function uvm_resource_base get_type_handle()
```

Pure virtual function that returns the type handle of the resource container.

Read-only Interface

set_read_only

```plaintext
function void set_read_only()
```

Establishes this resource as a read-only resource. An attempt to call uvm_resource#(T)::write on the resource will cause an error.

is_read_only

```plaintext
function bit is_read_only()
```

Returns one if this resource has been set to read-only, zero otherwise.

Notification

wait_modified

```plaintext
task wait_modified()
```

This task blocks until the resource has been modified -- that is, a uvm_resource#(T)::write operation has been performed. When a uvm_resource#(T)::write is performed the modified bit is set which releases the block. Wait_modified() then clears the modified bit so it can be called repeatedly.

Scope Interface

Each resource has a name, a value and a set of scopes over which it is visible. A scope is a hierarchical entity or a context. A scope name is a multi-element string that identifies a scope. Each element refers to a scope context and the elements are separated by dots (.)

```plaintext
string name = "",
string s  = "*"
```
Consider the example above of a scope name. It consists of four elements: “top”, “env”, “agent”, and “monitor”. The elements are strung together with a dot separating each element. top.env.agent is the parent of top.env.agent.monitor, top.env is the parent of top.env.agent, and so on. A set of scopes can be represented by a set of scope name strings. A very straightforward way to represent a set of strings is to use regular expressions. A regular expression is a special string that contains placeholders which can be substituted in various ways to generate or recognize a particular set of strings. Here are a few simple examples:

<table>
<thead>
<tr>
<th>regular expression</th>
<th>glob equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>top.*</td>
<td>top.*</td>
</tr>
<tr>
<td>top..*.\monitor</td>
<td>top.env.*.monitor</td>
</tr>
<tr>
<td>.*.monitor</td>
<td>*.monitor</td>
</tr>
<tr>
<td>top.[1-5].*</td>
<td>top.*</td>
</tr>
</tbody>
</table>

u4, or u5, and any of their subscopes.

The examples above use POSIX regular expression notation. This is a very general and expressive notation. It is not always the case that so much expressiveness is required. Sometimes an expression syntax that is easy to read and easy to write is useful, even if the syntax is not as expressive as the full power of POSIX regular expressions. A popular substitute for regular expressions is globs. A glob is a simplified regular expression. It only has three metacharacters -- *, +, and ?. Character ranges are not allowed and dots are not a metacharacter in globs as they are in regular expressions. The following table shows glob metacharacters.

<table>
<thead>
<tr>
<th>char</th>
<th>meaning</th>
<th>regular expression equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>0 or more characters</td>
<td>.*</td>
</tr>
<tr>
<td>+</td>
<td>1 or more characters</td>
<td>.+</td>
</tr>
<tr>
<td>?</td>
<td>exactly one character</td>
<td>.</td>
</tr>
</tbody>
</table>

Of the examples above, the first three can easily be translated into globs. The last one cannot. It relies on notation that is not available in glob syntax.

The resource facility supports both regular expression and glob syntax. Regular expressions are identified as such when they surrounded by '/' characters. For example, /^top\.*$/ is interpreted as the regular expression ^top\.*, where the surrounding '/' characters have been removed. All other expressions are treated as glob expressions. They are converted from glob notation to regular expression notation internally. Regular expression compilation and matching as well as glob-to-regular expression conversion are handled by two DPI functions:
uvm_re_match both compiles and matches the regular expression. All of the matching is done using regular expressions, so globs are converted to regular expressions and then processed.

**set_scope**

```plaintext
function void set_scope(
    string s
)
```

Set the value of the regular expression that identifies the set of scopes over which this resource is visible. If the supplied argument is a glob it will be converted to a regular expression before it is stored.

**get_scope**

```plaintext
function string get_scope()
```

Retrieve the regular expression string that identifies the set of scopes over which this resource is visible.

**match_scope**

```plaintext
function bit match_scope(
    string s
)
```

Using the regular expression facility, determine if this resource is visible in a scope. Return one if it is, zero otherwise.

**PRI ORITY**

Functions for manipulating the search priority of resources. The function definitions here are pure virtual and are implemented in derived classes. The definitions serve as a priority management interface.

**set priority**

Change the search priority of the resource based on the value of the priority enum argument.

**UTILITY FUNCTIONS**

**do_print**

```plaintext
function void do_print (uvm_printer printer)
```
Implementation of do_print which is called by print().

**Audit Trail**

To find out what is happening as the simulation proceeds, an audit trail of each read and write is kept. The `uvm_resource#(T)::read` and `uvm_resource#(T)::write` methods each take an accessor argument. This is a handle to the object that performed that resource access.

```plaintext
function T read(uvm_object accessor = null);
function void write(T t, uvm_object accessor = null);
```

The accessor can be anything as long as it is derived from `uvm_object`. The accessor object can be a component or a sequence or whatever object from which a read or write was invoked. Typically the `this` handle is used as the accessor. For example:

```plaintext
uvm_resource#(int) rint;
int i;
... rint.write(7, this);
i = rint.read(this);
```

The accessor’s `get_full_name()` is stored as part of the audit trail. This way you can find out what object performed each resource access. Each audit record also includes the time of the access (simulation time) and the particular operation performed (read or write).

Auditing is controlled through the `uvm_resource_options` class.

**record_read_access**

```plaintext
function void record_read_access(
    uvm_object accessor = null
)
```

**record_write_access**

```plaintext
function void record_write_access(
    uvm_object accessor = null
)
```

**print_accessors**

```plaintext
virtual function void print_accessors()
```

Dump the access records for this resource.
init_access_record

function void init_access_record (  
    inout uvm_resource_types::access_t access_record  
)

Initialize a new access record

uvm_resource_pool

The global (singleton) resource database.

Each resource is stored both by primary name and by type handle. The resource pool contains two associative arrays, one with name as the key and one with the type handle as the key. Each associative array contains a queue of resources. Each resource has a regular expression that represents the set of scopes over which it is visible.

The above diagrams illustrates how a resource whose name is A and type is T is stored in the pool. The pool contains an entry in the type map for type T and an entry in the name map for name A. The queues in each of the arrays each contain an entry for the resource A whose type is T. The name map can contain in its queue other resources whose name is A which may or may not have the same type as our resource A. Similarly, the type map can contain in its queue other resources whose type is T and whose name may or may not be A.

Resources are added to the pool by calling set; they are retrieved from the pool by calling get_by_name or get_by_type. When an object creates a new resource and calls set the resource is made available to be retrieved by other objects outside of itself; an object gets a resource when it wants to access a resource not currently available in its scope.

The scope is stored in the resource itself (not in the pool) so whether you get by name or by type the resource’s visibility is the same.

As an auditing capability, the pool contains a history of gets. A record of each get, whether by get_by_type or get_by_name, is stored in the audit record. Both successful and failed gets are recorded. At the end of simulation, or any time for that matter, you can dump the history list. This will tell which resources were successfully located and which were not. You can use this information to determine if there is some error in name, type, or scope that has caused a resource to not be located or to be incorrectly located (i.e. the wrong resource is located).

Summary
# uvm_resource_pool

The global (singleton) resource database.

## Class Declaration

```plaintext
class uvm_resource_pool
```

### get

Returns the singleton handle to the resource pool.

### spell_check

Invokes the spell checker for a string s.

## Set

### set

Add a new resource to the resource pool.

### set_override

The resource provided as an argument will be entered into the pool and will override both by name and type.

### set_name_override

The resource provided as an argument will entered into the pool using normal precedence in the type map and will override the name.

### set_type_override

The resource provided as an argument will be entered into the pool using normal precedence in the name map and will override the type.

## Lookup

This group of functions is for finding resources in the resource database.

### lookup_name

Lookup resources by name.

### get_highest_precedence

Traverse a queue, q, of resources and return the one with the highest precedence.

### sort_by_precedence

Given a list of resources, obtained for example from `lookup_scope`, sort the resources in precedence order.

### get_by_name

Lookup a resource by name, scope, and type_handle.

### get_by_type

Lookup a resource by type_handle and scope.

### lookup_regex_names

This utility function answers the question, for a given name, scope, and type_handle, what are all of the resources with requested name, a matching scope (where the resource scope may be a regular expression), and a matching type?

### lookup_regex

Looks for all the resources whose name matches the regular expression argument and whose scope matches the current scope.

### lookup_scope

This is a utility function that answers the question: For a given scope, what resources are visible to it?

## Set Priority

Functions for altering the search priority of resources.

### set_priority_type

Change the priority of the rsrc based on the value of pri, the priority enum argument.

### set_priority_name

Change the priority of the rsrc based on the value of pri, the priority enum argument.

### set_priority

Change the search priority of the rsrc based on the value of pri, the priority enum argument.

## Debug

### find_unused_resources

Locate all the resources that have at least one write and no reads

### print_resources

Print the resources that are in a single queue, rq.

### dump

Dump the entire resource pool.

---

**get**

```plaintext
static function uvm_resource_pool get()
```
Returns the singleton handle to the resource pool

**spell_check**

```plaintext
function bit spell_check(
    string s
)
```

Invokes the spell checker for a string s. The universe of correctly spelled strings -- i.e. the dictionary -- is the name map.

**SET**

**set**

```plaintext
function void set (uvm_resource_base rsrc,
    uvm_resource_types::override_t override = 0)
```

Add a new resource to the resource pool. The resource is inserted into both the name map and type map so it can be located by either.

An object creates a resources and sets it into the resource pool. Later, other objects that want to access the resource must get it from the pool.

Overrides can be specified using this interface. Either a name override, a type override or both can be specified. If an override is specified then the resource is entered at the front of the queue instead of at the back. It is not recommended that users specify the override parameter directly, rather they use the set_override, set_name_override, or set_type_override functions.

**set_override**

```plaintext
function void set_override(uvm_resource_base rsrc)
```

The resource provided as an argument will be entered into the pool and will override both by name and type.

**set_name_override**

```plaintext
function void set_name_override(uvm_resource_base rsrc)
```

The resource provided as an argument will entered into the pool using normal precedence in the type map and will override the name.

**set_type_override**
The resource provided as an argument will be entered into the pool using normal precedence in the name map and will override the type.

## Lookup

This group of functions is for finding resources in the resource database.

`lookup_name` and `lookup_type` locate the set of resources that matches the name or type (respectively) and is visible in the current scope. These functions return a queue of resources.

`get_highest_precedence` traverse a queue of resources and returns the one with the highest precedence -- i.e. the one whose precedence member has the highest value.

`get_by_name` and `get_by_type` use `lookup_name` and `lookup_type` (respectively) and `get_highest_precedence` to find the resource with the highest priority that matches the other search criteria.

### lookup_name

```cpp
function uvm_resource_types::rsrc_q_t lookup_name(
    string scope = "",
    string name,
    uvm_resource_base type_handle = null,
    bit rpterr = 1
)
```

Lookup resources by `name`. Returns a queue of resources that match the `name`, `scope`, and `type_handle`. If no resources match the queue is returned empty. If `rpterr` is set then a warning is issued if no matches are found, and the spell checker is invoked on `name`. If `type_handle` is `null` then a type check is not made and resources are returned that match only `name` and `scope`.

### get_highest_precedence

```cpp
function uvm_resource_base get_highest_precedence(
    ref uvm_resource_types::rsrc_q_t q
)
```

Traverse a queue, `q`, of resources and return the one with the highest precedence. In the case where there exists more than one resource with the highest precedence value, the first one that has that precedence will be the one that is returned.

### sort_by_precedence

```cpp
static function void sort_by_precedence(
    ref uvm_resource_types::rsrc_q_t q
)
```

Given a list of resources, obtained for example from `lookup_scope`, sort the resources in precedence order. The highest precedence resource will be first in the list and the lowest precedence will be last. Resources that have the same precedence and the same name
will be ordered by most recently set first.

get_by_name

```markdown
function uvm_resource_base get_by_name(
  string scoped = "",  
  string name,          
  uvm_resource_base type_handle, 
  bit rpterr = 1
)
```

Lookup a resource by *name*, *scope*, and *type_handle*. Whether the get succeeds or fails, save a record of the get attempt. The *rpterr* flag indicates whether to report errors or not. Essentially, it serves as a verbose flag. If set then the spell checker will be invoked and warnings about multiple resources will be produced.

lookup_type

```markdown
function uvm_resource_types::rsrc_q_t lookup_type(
  string scoped = "",  
  uvm_resource_base type_handle
)
```

Lookup resources by type. Return a queue of resources that match the *type_handle* and *scope*. If no resources match then the returned queue is empty.

get_by_type

```markdown
function uvm_resource_base get_by_type(
  string scoped = "",  
  uvm_resource_base type_handle
)
```

Lookup a resource by *type_handle* and *scope*. Insert a record into the get history list whether or not the get succeeded.

lookup_regex_names

```markdown
function uvm_resource_types::rsrc_q_t lookup_regex_names(
  string scoped,          
  string name,            
  uvm_resource_base type_handle = null
)
```

This utility function answers the question, for a given *name*, *scope*, and *type_handle*, what are all of the resources with requested name, a matching scope (where the resource scope may be a regular expression), and a matching type? *name* and *scope* are explicit values.

lookup_regex

```markdown
function uvm_resource_types::rsrc_q_t lookup_regex(   
  string re,          
  scope
)
```
Looks for all the resources whose name matches the regular expression argument and whose scope matches the current scope.

**lookup_scope**

```cpp
function uvm_resource_types::rsrc_q_t lookup_scope(
    string__ scope
)
```

This is a utility function that answers the question: For a given scope, what resources are visible to it? Locate all the resources that are visible to a particular scope. This operation could be quite expensive, as it has to traverse all of the resources in the database.

**Set Priority**

Functions for altering the search priority of resources. Resources are stored in queues in the type and name maps. When retrieving resources, either by type or by name, the resource queue is searched from front to back. The first one that matches the search criteria is the one that is returned. The `set_priority` functions let you change the order in which resources are searched. For any particular resource, you can set its priority to UVM_HIGH, in which case the resource is moved to the front of the queue, or to UVM_LOW in which case the resource is moved to the back of the queue.

**set_priority_type**

```cpp
function void set_priority_type(
    uvm_resource_base rsrc,
    uvm_resource_types::priority_e pri
)
```

Change the priority of the `rsrc` based on the value of `pri`, the priority enum argument. This function changes the priority only in the type map, leaving the name map untouched.

**set_priority_name**

```cpp
function void set_priority_name(
    uvm_resource_base rsrc,
    uvm_resource_types::priority_e pri
)
```

Change the priority of the `rsrc` based on the value of `pri`, the priority enum argument. This function changes the priority only in the name map, leaving the type map untouched.

**set_priority**

```cpp
function void set_priority (
    uvm_resource_base rsrc,
    uvm_resource_types::priority_e pri
)
```

Change the search priority of the `rsrc` based on the value of `pri`, the priority enum
argument. This function changes the priority in both the name and type maps.

### DEBUG

**find_unused_resources**

```plaintext
function uvm_resource_types::rsrc_q_t find_unused_resources()
```

Locate all the resources that have at least one write and no reads.

**print_resources**

```plaintext
function void print_resources(
    uvm_resource_types::rsrc_q_t rq,
    bit audit = 0
)
```

Print the resources that are in a single queue, `rq`. This is a utility function that can be used to print any collection of resources stored in a queue. The `audit` flag determines whether or not the audit trail is printed for each resource along with the name, value, and scope regular expression.

**dump**

```plaintext
function void dump(
    bit audit = 0
)
```

dump the entire resource pool. The resource pool is traversed and each resource is printed. The utility function `print_resources()` is used to initiate the printing. If the `audit` bit is set then the audit trail is dumped for each resource.

---

**uvm_resource #(T)**

Parameterized resource. Provides essential access methods to read from and write to the resource database.

**Summary**

```plaintext
uvm_resource #(T)
```

Parameterized resource.
Resources can be identified by type using a static type handle. The parent class provides the virtual function interface `get_type_handle`. Here we implement it by returning the static type handle.

**Get Type**

```plaintext
static function this_type get_type()
```

Static function that returns the static type handle. The return type is `this_type`, which is the type of the parameterized class.

**Get Type Handle**

```plaintext
function uvm_resource_base get_type_handle()
```

Returns the static type handle of this resource in a polymorphic fashion. The return type of `get_type_handle()` is `uvm_resource_base`. This function is not static and therefore can only be used by instances of a parameterized resource.
**Set/Get Interface**

*uvm_resource#(T)* provides an interface for setting and getting a resources. Specifically, a resource can insert itself into the resource pool. It doesn’t make sense for a resource to get itself, since you can’t call a function on a handle you don’t have. However, a static get interface is provided as a convenience. This obviates the need for the user to get a handle to the global resource pool as this is done for him here.

**set**

```plaintext
function void set()
```

Simply put this resource into the global resource pool

**set_override**

```plaintext
function void set_override(
)
```

Put a resource into the global resource pool as an override. This means it gets put at the head of the list and is searched before other existing resources that occupy the same position in the name map or the type map. The default is to override both the name and type maps. However, using the *override* argument you can specify that either the name map or type map is overridden.

**get_by_name**

```plaintext
static function this_type get_by_name(
    string scope,
    string name,
    bit rpterr = 1
)
```

looks up a resource by *name* in the name map. The first resource with the specified name, whose type is the current type, and is visible in the specified *scope* is returned, if one exists. The *rpterr* flag indicates whether or not an error should be reported if the search fails. If *rpterr* is set to one then a failure message is issued, including suggested spelling alternatives, based on resource names that exist in the database, gathered by the spell checker.

**get_by_type**

```plaintext
static function this_type get_by_type(
    string scope = "",
    uvm_resource_base type_handle
)
```

looks up a resource by *type_handle* in the type map. The first resource with the specified *type_handle* that is visible in the specified *scope* is returned, if one exists. If there is no resource matching the specifications, *null* is returned.

**Read/Write Interface**
read and write provide a type-safe interface for getting and setting the object in the resource container. The interface is type safe because the value argument for write and the return value of read are T, the type supplied in the class parameter. If either of these functions is used in an incorrect type context the compiler will complain.

**read**

```plaintext
function T read(
    uvm_object accessor = null
)
```

Return the object stored in the resource container. If an accessor object is supplied then also update the accessor record for this resource.

**write**

```plaintext
function void write(
    T t,
    uvm_object accessor = null
)
```

Modify the object stored in this resource container. If the resource is read-only then issue an error message and return without modifying the object in the container. If the resource is not read-only and an accessor object has been supplied then also update the accessor record. Lastly, replace the object value in the container with the value supplied as the argument, t, and release any processes blocked on uvm_resource_base::wait_modified. If the value to be written is the same as the value already present in the resource then the write is not done. That also means that the accessor record is not updated and the modified bit is not set.

**Priority**

Functions for manipulating the search priority of resources. These implementations of the interface defined in the base class delegate to the resource pool.

**set priority**

Change the search priority of the resource based on the value of the priority enum argument, pri.

**get_highest_precedence**

```plaintext
static function this_type get_highest_precedence(
    ref uvm_resource_types::rsrc_q_t q
)
```

In a queue of resources, locate the first one with the highest precedence whose type is T. This function is static so that it can be called from anywhere.
# 10.2 UVM Resource Database

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## Intro

The `uvm_resource_db` class provides a convenience interface for the resources facility. In many cases basic operations such as creating and setting a resource or getting a resource could take multiple lines of code using the interfaces in `uvm_resource_base` or `uvm_resource#(T)`. The convenience layer in `uvm_resource_db` reduces many of those operations to a single line of code.

If the run-time `+UVMRESOURCE_DB_TRACE` command line option is specified, all resource DB accesses (read and write) are displayed.

## `uvm_resource_db`

All of the functions in `uvm_resource_db#(T)` are static, so they must be called using the `::` operator. For example:

```plaintext
uvm_resource_db#(int)::set("A", "+", 17, this);
```

The parameter value “int” identifies the resource type as `uvm_resource#(int)`. Thus, the type of the object in the resource container is int. This maintains the type-safety characteristics of resource operations.

## Summary

### `uvm_resource_db`

All of the functions in `uvm_resource_db#(T)` are static, so they must be called using the `::` operator.

#### Class Declaration

```plaintext
class uvm_resource_db #(
    type T = uvm_object
)
```

#### Methods

- `get_by_type`  Get a resource by type.
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<td>Write a val into the resources database.</td>
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<td>Write a val into the resources database.</td>
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<tr>
<td>dump</td>
<td>Dump all the resources in the resource pool.</td>
</tr>
</tbody>
</table>

### Methods

#### get_by_type

```cpp
static function rsrc_t get_by_type(
    string scope
)
```

Get a resource by type. The type is specified in the db class parameter so the only argument to this function is the `scope`.

#### get_by_name

```cpp
static function rsrc_t get_by_name(
    string scope,
    string name,
    bit rpterr = 1
)
```

Imports a resource by name. The first argument is the current `scope` of the resource to be retrieved and the second argument is the `name`. The `rpterr` flag indicates whether or not to generate a warning if no matching resource is found.

#### set_default

```cpp
static function rsrc_t set_default(
    string scope,
    string name
)
```

Add a new item into the resources database. The item will not be written to so it will have its default value. The resource is created using `name` and `scope` as the lookup parameters.

#### set

```cpp
static function void set(
    input string scope,
    input string name,
    T val,
    input uvm_object accessor = null
)
```

UVM 1.2 Class Reference
Create a new resource, write a val to it, and set it into the database using name and scope as the lookup parameters. The accessor is used for auditing.

**set_anonymous**

```plaintext
static function void set_anonymous(
    input string scope,
    T val,
    input uvm_object accessor = null
)
```

Create a new resource, write a val to it, and set it into the database. The resource has no name and therefore will not be entered into the name map. But it does have a scope for lookup purposes. The accessor is used for auditing.

**read_by_name**

```plaintext
static function bit read_by_name(
    input string scope,
    input string name,
    inout T val,
    input uvm_object accessor = null
)
```

locate a resource by name and scope and read its value. The value is returned through the output argument val. The return value is a bit that indicates whether or not the read was successful. The accessor is used for auditing.

**read_by_type**

```plaintext
static function bit read_by_type(
    input string scope,
    inout T val,
    input uvm_object accessor = null
)
```

Read a value by type. The value is returned through the output argument val. The scope is used for the lookup. The return value is a bit that indicates whether or not the read is successful. The accessor is used for auditing.

**write_by_name**

```plaintext
static function bit write_by_name(
    input string scope,
    input string name,
    input T val,
    input uvm_object accessor = null
)
```

write a val into the resources database. First, look up the resource by name and scope. If it is not located then add a new resource to the database and then write its value.

Because the scope is matched to a resource which may be a regular expression, and consequently may target other scopes beyond the scope argument. Care must be taken with this function. If a get_by_name match is found for name and scope then val will be written to that matching resource and thus may impact other scopes which also match the resource.
**write_by_type**

```plaintext
static function bit write_by_type(
    input string  scope,
    input T       val,
    input uvm_object accessor = null
)
```

Write a `val` into the resources database. First, look up the resource by type. If it is not located then add a new resource to the database and then write its value.

Because the `scope` is matched to a resource which may be a regular expression, and consequently may target other scopes beyond the `scope` argument. Care must be taken with this function. If a `get_by_name` match is found for `name` and `scope` then `val` will be written to that matching resource and thus may impact other scopes which also match the resource.

**dump**

```plaintext
static function void dump()
```

Dump all the resources in the resource pool. This is useful for debugging purposes. This function does not use the parameter `T`, so it will dump the same thing -- the entire database -- no matter the value of the parameter.

**uvm_resource_db_options**

Provides a namespace for managing options for the resources DB facility. The only thing allowed in this class is static local data members and static functions for manipulating and retrieving the value of the data members. The static local data members represent options and settings that control the behavior of the resources DB facility.

**Summary**

**uvm_resource_db_options**

Provides a namespace for managing options for the resources DB facility.

**METHODS**

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<th>Turn tracing on for the resource database.</th>
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<td>Turn tracing off for the resource database.</td>
</tr>
<tr>
<td>is_tracing</td>
<td>Returns 1 if the tracing facility is on and 0 if it is off.</td>
</tr>
</tbody>
</table>

**METHODS**

**turn_on_tracing**

```plaintext
static function void turn_on_tracing()
```
Turn tracing on for the resource database. This causes all reads and writes to the database to display information about the accesses. Tracing is off by default.

This method is implicitly called by the `+UVMRESOURCE_DB_TRACE`.

**turn_off_tracing**

```plaintext
static function void turn_off_tracing()
```

Turn tracing off for the resource database.

**is_tracing**

```plaintext
static function bit is_tracing()
```

Returns 1 if the tracing facility is on and 0 if it is off.
10.3 UVM Configuration Database

Contents

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Intro

The uvm_config_db class provides a convenience interface on top of the uvm_resource_db to simplify the basic interface that is used for configuring uvm_component instances.

If the run-time +UVM_CONFIG_DB_TRACE command line option is specified, all configuration DB accesses (read and write) are displayed.

uvm_config_db

All of the functions in uvm_config_db#(T) are static, so they must be called using the :: operator. For example:

```
uvm_config_db#(int)::set(this, "*", "A");
```

The parameter value "int" identifies the configuration type as an int property.

The set and get methods provide the same API and semantics as the set/get_config_* functions in uvm_component.

Summary

<table>
<thead>
<tr>
<th>uvm_config_db</th>
</tr>
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<tbody>
<tr>
<td>All of the functions in uvm_config_db#(T) are static, so they must be called using the :: operator.</td>
</tr>
</tbody>
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UVM 1.2 Class Reference

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**Methods**

### get

```protobuf
define static function bit get(
    uvm_component cntxt,
    string inst_name,
    string field_name,
    inout T value
)
```

Get the value for `field_name` in `inst_name`, using component `cntxt` as the starting search point. 

**inst_name** is an explicit instance name relative to `cntxt` and may be an empty string if the `cntxt` is the instance that the configuration object applies to. **field_name** is the specific field in the scope that is being searched for.

The basic `get_config_*` methods from `uvm_component` are mapped to this function as:

```text
get_config_int(...) => uvm_config_db#(uvm_bitstream_t)::get(cntxt,...)
get_config_string(...) => uvm_config_db#(string)::get(cntxt,...)
get_config_object(...) => uvm_config_db#(uvm_object)::get(cntxt,...)
```

### set

```protobuf
define static function void set(
    uvm_component cntxt,
    string inst_name,
    string field_name,
    T value
)
```

Create a new or update an existing configuration setting for `field_name` in `inst_name` from `cntxt`. The setting is made at `cntxt`, with the full scope of the set being `{cntxt,"","~inst_name~}`. If `cntxt` is null then `inst_name` provides the complete scope.
information of the setting. field_name is the target field. Both inst_name and field_name may be glob style or regular expression style expressions.

If a setting is made at build time, the cntxt hierarchy is used to determine the setting’s precedence in the database. Settings from hierarchically higher levels have higher precedence. Settings from the same level of hierarchy have a last setting wins semantic. A precedence setting of uvm_resource_base::default_precedence is used for uvm_top, and each hierarchical level below the top is decremented by 1.

After build time, all settings use the default precedence and thus have a last wins semantic. So, if at run time, a low level component makes a runtime setting of some field, that setting will have precedence over a setting from the test level that was made earlier in the simulation.

The basic set_config_* methods from uvm_component are mapped to this function as:

```
set_config_int(...) => uvm_config_db#(uvm_bitstream_t)::set(cntxt,...)
set_config_string(...) => uvm_config_db#(string)::set(cntxt,...)
set_config_object(...) => uvm_config_db#(uvm_object)::set(cntxt,...)
```

**exists**

```plaintext
static function bit exists(
    uvm_component cntxt,
    string inst_name,
    string field_name,
    bit spell_chk =
)
```

Check if a value for field_name is available in inst_name, using component cntxt as the starting search point. inst_name is an explicit instance name relative to cntxt and may be an empty string if the cntxt is the instance that the configuration object applies to. field_name is the specific field in the scope that is being searched for. The spell_chk arg can be set to 1 to turn spell checking on if it is expected that the field should exist in the database. The function returns 1 if a config parameter exists and 0 if it doesn’t exist.

**wait_modified**

```plaintext
static task wait_modified(
    uvm_component cntxt,
    string inst_name,
    string field_name
)
```

Wait for a configuration setting to be set for field_name in cntxt and inst_name. The task blocks until a new configuration setting is applied that effects the specified field.

**Types**

**Summary**

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</table>
**uvm_config_int**

Convenience type for `uvm_config_db#(uvm_bitstream_t)`

```cpp
typedef uvm_config_db#(uvm_bitstream_t) uvm_config_int;
```

**uvm_config_string**

Convenience type for `uvm_config_db#(string)`

```cpp
typedef uvm_config_db#(string) uvm_config_string;
```

**uvm_config_object**

Convenience type for `uvm_config_db#(uvm_object)`

```cpp
typedef uvm_config_db#(uvm_object) uvm_config_object;
```

**uvm_config_wrapper**

Convenience type for `uvm_config_db#(uvm_object_wrapper)`

```cpp
typedef uvm_config_db#(uvm_object_wrapper) uvm_config_wrapper;
```

**uvm_config_db_options**

Provides a namespace for managing options for the configuration DB facility. The only thing allowed in this class is static local data members and static functions for manipulating and retrieving the value of the data members. The static local data members represent options and settings that control the behavior of the configuration DB facility.

**Summary**

---

UVM 1.2 Class Reference
uvm_config_db_options

Provides a namespace for managing options for the configuration DB facility.

**Methods**

<table>
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<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>turn_on_tracing</strong></td>
<td>Turn tracing on for the configuration database. This causes all reads and writes to the database to display information about the accesses. Tracing is off by default.</td>
</tr>
<tr>
<td><strong>turn_off_tracing</strong></td>
<td>Turn tracing off for the configuration database.</td>
</tr>
<tr>
<td><strong>is_tracing</strong></td>
<td>Returns 1 if the tracing facility is on and 0 if it is off.</td>
</tr>
</tbody>
</table>

**turn_on_tracing**

```plaintext
static function void turn_on_tracing()
```

Turn tracing on for the configuration database. This causes all reads and writes to the database to display information about the accesses. Tracing is off by default.

This method is implicitly called by the +UVM_CONFIG_DB_TRACE.

**turn_off_tracing**

```plaintext
static function void turn_off_tracing()
```

Turn tracing off for the configuration database.

**is_tracing**

```plaintext
static function bit is_tracing()
```

Returns 1 if the tracing facility is on and 0 if it is off.
11. Synchronization Classes

The UVM provides event and barrier synchronization classes for managing concurrent processes.

- **uvm_event#(T)** - UVM’s event class augments the SystemVerilog event datatype with such services as setting callbacks and data delivery.

- **uvm_barrier** - A barrier is used to prevent a pre-configured number of processes from continuing until all have reached a certain point in simulation.

- **uvm_event_pool and uvm_barrier_pool** - The event and barrier pool classes are specializations of `uvm_object_string_pool #(T)` used to store collections of `uvm_event#(uvm_object)` and `uvm_barriers`, respectively, indexed by string name. Each pool class contains a static, “global” pool instance for sharing across all processes.

- **uvm_event_callback** - The event callback is used to create callback objects that may be attached to `uvm_event#(T)`.

**Summary**

| Synchronization Classes |
11.1 uvm_event_base

The uvm_event_base class is an abstract wrapper class around the SystemVerilog event construct. It provides some additional services such as setting callbacks and maintaining the number of waiters.

Contents

<table>
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<td>The uvm_event class is an extension of the abstract uvm_event_base class.</td>
</tr>
</tbody>
</table>

Methods

**new**

```
function new (string name = "")
```

Creates a new event object.

**wait_on**

```
virtual task wait_on (bit delta = 0 - )
```

Waits for the event to be activated for the first time.

If the event has already been triggered, this task returns immediately. If `delta` is set, the caller will be forced to wait a single delta #0 before returning. This prevents the caller from returning before previously waiting processes have had a chance to resume.

Once an event has been triggered, it will be remain “on” until the event is `reset`.

**wait_off**

```
virtual task wait_off (bit delta = 0 - )
```

If the event has already triggered and is “on”, this task waits for the event to be turned “off” via a call to `reset`.

If the event has not already been triggered, this task returns immediately. If `delta` is set, the caller will be forced to wait a single delta #0 before returning. This prevents the caller from returning before previously waiting processes have had a chance to resume.
**wait_trigger**

```plaintext
virtual task wait_trigger ()
```

Waits for the event to be triggered.

If one process calls `wait_trigger` in the same delta as another process calls `uvm_event#(T)::trigger`, a race condition occurs. If the call to `wait_trigger` occurs before the trigger, this method will return in this delta. If the call occurs after the trigger, this method will not return until the next trigger, which may never occur and thus cause deadlock.

**wait_ptrigger**

```plaintext
virtual task wait_ptrigger ()
```

Waits for a persistent trigger of the event. Unlike `wait_trigger`, this views the trigger as persistent within a given time-slice and thus avoids certain race conditions. If this method is called after the trigger but within the same time-slice, the caller returns immediately.

**get_trigger_time**

```plaintext
virtual function time get_trigger_time ()
```

Gets the time that this event was last triggered. If the event has not been triggered, or the event has been reset, then the trigger time will be 0.

**is_on**

```plaintext
virtual function bit is_on ()
```

Indicates whether the event has been triggered since it was last reset.

A return of 1 indicates that the event has triggered.

**is_off**

```plaintext
virtual function bit is_off ()
```

Indicates whether the event has been triggered or been reset.

A return of 1 indicates that the event has not been triggered.

**reset**

```plaintext
virtual function void reset ( 
    bit wakeup = 0
)
```

Resets the event to its off state. If `wakeup` is set, then all processes currently waiting for the event are activated before the reset.
No callbacks are called during a reset.

**cancel**

```
virtual function void cancel ()
```

Decrement the number of waiters on the event.

This is used if a process that is waiting on an event is disabled or activated by some other means.

**get_num_waiters**

```
virtual function int get_num_waiters ()
```

Returns the number of processes waiting on the event.

---

**uvm_event#(T)**

The uvm_event class is an extension of the abstract uvm_event_base class.

The optional parameter \( T \) allows the user to define a data type which can be passed during an event trigger.

---

**Summary**

---

### uvm_event#(T)

The uvm_event class is an extension of the abstract uvm_event_base class.

#### Class Hierarchy

- uvm_void
- uvm_object
- uvm_event_base
- **uvm_event#(T)**

#### Class Declaration

```
class uvm_event#(
  type T = uvm_object
) extends uvm_event_base
```

#### Methods

- **new**
  - Creates a new event object.

- **wait_trigger_data**
  - This method calls **uvm_event_base::wait_trigger** followed by **get_trigger_data**.

- **wait_ptrigger_data**
  - This method calls **uvm_event_base::wait_ptrigger** followed by **get_trigger_data**.

- **trigger**
  - Triggers the event, resuming all waiting processes.

- **get_trigger_data**
  - Gets the data, if any, provided by the last call to **trigger**.

- **add_callback**
  - Registers a callback object, \( cb \), with this event.

- **delete_callback**
  - Unregisters the given callback, \( cb \), from this event.
**METHODS**

**new**

```plaintext
function new (    
    string name = ""
}
```

Creates a new event object.

**wait_trigger_data**

```plaintext
virtual task wait_trigger_data (    
    output T data
)
```

This method calls `uvm_event_base::wait_trigger` followed by `get_trigger_data`.

**wait_ptrigger_data**

```plaintext
virtual task wait_ptrigger_data (    
    output T data
)
```

This method calls `uvm_event_base::wait_ptrgger` followed by `get_trigger_data`.

**trigger**

```plaintext
virtual function void trigger (    
    T data = null
)
```

Triggers the event, resuming all waiting processes.

An optional `data` argument can be supplied with the enable to provide trigger-specific information.

**get_trigger_data**

```plaintext
virtual function T get_trigger_data ()
```

Gets the data, if any, provided by the last call to `trigger`.

**add_callback**

```plaintext
virtual function void add_callback (    
    uvm_event_callback#(T)`cb, bit append = 1
)
```
Registers a callback object, \( cb \), with this event. The callback object may include \texttt{pre} \textit{trigger} and \texttt{post} \textit{trigger} functionality. If \texttt{append} is set to 1, the default, \( cb \) is added to the back of the callback list. Otherwise, \( cb \) is placed at the front of the callback list.

\textbf{delete\_callback}

\begin{verbatim}
virtual function void delete_callback ( 
    uvm_event_callback#(T) cb
)
\end{verbatim}

Unregisters the given callback, \( cb \), from this event.
11.2 uvm_event_callback

The uvm_event_callback class is an abstract class that is used to create callback objects which may be attached to uvm_event#(T)s. To use, you derive a new class and override any or both pre_trigger and post_trigger.

Callbacks are an alternative to using processes that wait on events. When a callback is attached to an event, that callback object’s callback function is called each time the event is triggered.

Summary

**uvm_event_callback**

The uvm_event_callback class is an abstract class that is used to create callback objects which may be attached to uvm_event#(T)s.

**CLASS HIERARCHY**

```
  uvm_void
  uvm_object
  uvm_event_callback
```

**CLASS DECLARATION**

```
  virtual class uvm_event_callback#(
      type T = uvm_object
  ) extends uvm_object
```

**METHODS**

<table>
<thead>
<tr>
<th>METHOD</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new callback object.</td>
</tr>
<tr>
<td>pre_trigger</td>
<td>This callback is called just before triggering the associated event.</td>
</tr>
<tr>
<td>post_trigger</td>
<td>This callback is called after triggering the associated event.</td>
</tr>
</tbody>
</table>

**new**

```
  function new ()
      string name = ""
  }
```

Creates a new callback object.

**pre_trigger**

```
  virtual function bit pre_trigger (uvm_event#(T) e, T data)
```

This callback is called just before triggering the associated event. In a derived class, override this method to implement any pre-trigger functionality.
If your callback returns 1, then the event will not trigger and the post-trigger callback is not called. This provides a way for a callback to prevent the event from triggering.

In the function, e is the `uvm_event#(T)` that is being triggered, and `data` is the optional data associated with the event trigger.

### post_trigger

```c
virtual function void post_trigger (uvm_event#(T) e, T data)
```

This callback is called after triggering the associated event. In a derived class, override this method to implement any post-trigger functionality.

In the function, e is the `uvm_event#(T)` that is being triggered, and `data` is the optional data associated with the event trigger.
11.3 uvm_barrier

The uvm_barrier class provides a multiprocess synchronization mechanism. It enables a set of processes to block until the desired number of processes get to the synchronization point, at which time all of the processes are released.

**Summary**

**uvm_barrier**

The uvm_barrier class provides a multiprocess synchronization mechanism.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
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<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>uvm_barrier</td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_barrier extends uvm_object
```

**Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new barrier object.</td>
</tr>
<tr>
<td>wait_for</td>
<td>Waits for enough processes to reach the barrier before continuing.</td>
</tr>
<tr>
<td>reset</td>
<td>Resets the barrier.</td>
</tr>
<tr>
<td>set_auto_reset</td>
<td>Determines if the barrier should reset itself after the threshold is reached.</td>
</tr>
<tr>
<td>set_threshold</td>
<td>Sets the process threshold.</td>
</tr>
<tr>
<td>get_threshold</td>
<td>Gets the current threshold setting for the barrier.</td>
</tr>
<tr>
<td>get_num_waiters</td>
<td>Returns the number of processes currently waiting at the barrier.</td>
</tr>
<tr>
<td>cancel</td>
<td>Decrements the waiter count by one.</td>
</tr>
</tbody>
</table>

**Methods**

**new**

```
function new (
    string name = "",
    int threshold = 0
)
```

Creates a new barrier object.

**wait_for**

```
virtual task wait_for()
```

Waits for enough processes to reach the barrier before continuing.

The number of processes to wait for is set by the `set_threshold` method.
reset

virtual function void reset {
    bit wakeup = 1
}

Resets the barrier. This sets the waiter count back to zero.

The threshold is unchanged. After reset, the barrier will force processes to wait for the threshold again.

If the `wakeup` bit is set, any currently waiting processes will be activated.

set_auto_reset

virtual function void set_auto_reset {
    bit value = 1
}

Determines if the barrier should reset itself after the threshold is reached.

The default is on, so when a barrier hits its threshold it will reset, and new processes will block until the threshold is reached again.

If auto reset is off, then once the threshold is achieved, new processes pass through without being blocked until the barrier is reset.

set_threshold

virtual function void set_threshold {
    int threshold
}

Sets the process threshold.

This determines how many processes must be waiting on the barrier before the processes may proceed.

Once the `threshold` is reached, all waiting processes are activated.

If `threshold` is set to a value less than the number of currently waiting processes, then the barrier is reset and waiting processes are activated.

get_threshold

virtual function int get_threshold ()

Gets the current threshold setting for the barrier.

get_num_waiters

virtual function int get_num_waiters ()

Returns the number of processes currently waiting at the barrier.
cancel

virtual function void cancel ()

Decrements the waiter count by one. This is used when a process that is waiting on the barrier is killed or activated by some other means.
11.4 Objection Mechanism

The following classes define the objection mechanism and end-of-test functionality, which is based on `uvm_objection`.

**Contents**

<table>
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<th>Objection Mechanism</th>
<th>The following classes define the objection mechanism and end-of-test functionality, which is based on <code>uvm_objection</code>.</th>
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<tbody>
<tr>
<td>uvm_objection</td>
<td>Objections provide a facility for coordinating status information between two or more participating components, objects, and even module-based IP.</td>
</tr>
<tr>
<td>uvm_objection_callback</td>
<td>The <code>uvm_objection</code> is the callback type that defines the callback implementations for an objection callback.</td>
</tr>
</tbody>
</table>

**uvm_objection**

Objections provide a facility for coordinating status information between two or more participating components, objects, and even module-based IP.

Tracing of objection activity can be turned on to follow the activity of the objection mechanism. It may be turned on for a specific objection instance with `uvm_objection::trace_mode`, or it can be set for all objections from the command line using the option `+UVM_OBJECTION_TRACE`.

**Summary**

<table>
<thead>
<tr>
<th>uvm_objection</th>
<th>Objections provide a facility for coordinating status information between two or more participating components, objects, and even module-based IP.</th>
</tr>
</thead>
</table>

**CLASS HIERARCHY**

- `uvm_void`
- `uvm_object`
- `uvm_report_object`
- `uvm_objection` (extends `uvm_report_object`)

**CLASS DECLARATION**

```cpp
class uvm_objection extends uvm_report_object
```

**new**

Creates a new objection instance.

**trace_mode**

Set or get the trace mode for the objection object.

**OBJECTION CONTROL**

- `set_propagate_mode`
- `get_propagate_mode`
- `raise_objection`
- `drop_objection`

Sets the propagation mode for this objection.

Returns the propagation mode for this objection.

Raises the number of objections for the source object by `count`, which defaults to 1.

Drops the number of objections for the source object by `count`, which defaults to 1.
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>clear</td>
<td>Immediately clears the objection state.</td>
</tr>
<tr>
<td>set_drain_time</td>
<td>Sets the drain time on the given object to drain.</td>
</tr>
<tr>
<td><strong>Callback Hooks</strong></td>
<td></td>
</tr>
<tr>
<td>raised</td>
<td>Objection callback that is called when a raise_objection has reached obj.</td>
</tr>
<tr>
<td>dropped</td>
<td>Objection callback that is called when a drop_objection has reached obj.</td>
</tr>
<tr>
<td>all_dropped</td>
<td>Objection callback that is called when a drop_objection has reached obj,</td>
</tr>
<tr>
<td></td>
<td>and the total count for obj goes to zero.</td>
</tr>
<tr>
<td><strong>Objection Status</strong></td>
<td></td>
</tr>
<tr>
<td>get_objectors</td>
<td>Returns the current list of objecting objects (objects that raised an</td>
</tr>
<tr>
<td></td>
<td>objection but have not dropped it).</td>
</tr>
<tr>
<td>wait_for</td>
<td>Waits for the raised, dropped, or all_dropped event to occur in the given</td>
</tr>
<tr>
<td></td>
<td>obj.</td>
</tr>
<tr>
<td>get_objection_count</td>
<td>Returns the current number of objections raised by the given object.</td>
</tr>
<tr>
<td>get_objection_total</td>
<td>Returns the current number of objections raised by the given object and all</td>
</tr>
<tr>
<td></td>
<td>descendants.</td>
</tr>
<tr>
<td>get_drain_time</td>
<td>Returns the current drain time set for the given object (default: 0 ns).</td>
</tr>
<tr>
<td>display_objections</td>
<td>Displays objection information about the given object.</td>
</tr>
</tbody>
</table>

**new**

```plaintext
define new(
    string name = ""
)
```

Creates a new objection instance. Accesses the command line argument +UVM_OBJECTION_TRACE to turn tracing on for all objection objects.

**trace_mode**

```plaintext
define bit trace_mode (    int mode = -1    )
```

Set or get the trace mode for the objection object. If no argument is specified (or an argument other than 0 or 1) the current trace mode is unaffected. A trace_mode of 0 turns tracing off. A trace_mode of 1 turns tracing on. The return value is the mode prior to being reset.

**Objection Control**

**set_propagate_mode**

```plaintext
define void set_propagate_mode (        bit propagate_mode        )
```

Sets the propagation mode for this objection.

By default, objections support hierarchical propagation for components. For example, if
we have the following basic component tree:

<table>
<thead>
<tr>
<th></th>
<th>count</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_top.parent.child</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>uvm_top.parent</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>uvm_top</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Any objections raised by ‘child’ would get propagated down to parent, and then to `uvm_test_top`. Resulting in the following counts and totals:

<table>
<thead>
<tr>
<th></th>
<th>count</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_top.parent.child</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>uvm_top.parent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>uvm_top</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

While propagations such as these can be useful, if they are unused by the testbench then they are simply an unnecessary performance hit. If the testbench is not going to use this functionality, then the performance can be improved by setting the propagation mode to 0.

When propagation mode is set to 0, all intermediate callbacks between the source and top will be skipped. This would result in the following counts and totals for the above objection:

<table>
<thead>
<tr>
<th></th>
<th>count</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_top.parent.child</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>uvm_top.parent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>uvm_top</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Since the propagation mode changes the behavior of the objection, it can only be safely changed if there are no objections raised or draining. Any attempts to change the mode while objections are raised or draining will result in an error.

**get_propagate_mode**

```
function bit get_propagate_mode()
```

Returns the propagation mode for this objection.

**raise_objection**

```
virtual function void raise_objection (uvm_object obj = null, string description = "", int count = 1)
```

Raises the number of objections for the source object by count, which defaults to 1. The object is usually the this handle of the caller. If object is not specified or null, the implicit top-level component, uvm_root, is chosen.

Raising an objection causes the following.

- The source and total objection counts for object are increased by count.
  - description is a string that marks a specific objection and is used in tracing/debug.
- The objection’s raised virtual method is called, which calls the
uvm_component::raised method for all of the components up the hierarchy.

drop_objection

```c++
virtual function void drop_objection (uvm_object obj = null,
         string description = "",
         int count = 1)
```

Drops the number of objections for the source object by count, which defaults to 1. The object is usually the this handle of the caller. If object is not specified or null, the implicit top-level component, uvm_root, is chosen.

Dropping an objection causes the following.

- The source and total objection counts for object are decreased by count. It is an error to drop the objection count for object below zero.
- The objection’s dropped virtual method is called, which calls the uvm_component::dropped method for all of the components up the hierarchy.
- If the total objection count has not reached zero for object, then the drop is propagated up the object hierarchy as with raise_objection. Then, each object in the hierarchy will have updated their source counts--objections that they originated--and total counts--the total number of objections by them and all their descendants.

If the total objection count reaches zero, propagation up the hierarchy is deferred until a configurable drain-time has passed and the uvm_component::all_dropped callback for the current hierarchy level has returned. The following process occurs for each instance up the hierarchy from the source caller:

A process is forked in a non-blocking fashion, allowing the drop call to return. The forked process then does the following:

- If a drain time was set for the given object, the process waits for that amount of time.
- The objection’s all_dropped virtual method is called, which calls the uvm_component::all_dropped method (if object is a component).
- The process then waits for the all_dropped callback to complete.
- After the drain time has elapsed and all_dropped callback has completed, propagation of the dropped objection to the parent proceeds as described in raise_objection, except as described below.

If a new objection for this object or any of its descendants is raised during the drain time or during execution of the all_dropped callback at any point, the hierarchical chain described above is terminated and the dropped callback does not go up the hierarchy. The raised objection will propagate up the hierarchy, but the number of raised propagated up is reduced by the number of drops that were pending waiting for the all_dropped/drain time completion. Thus, if exactly one objection caused the count to go to zero, and during the drain exactly one new objection comes in, no raises or drops are propagated up the hierarchy.

As an optimization, if the object has no set drain-time and no registered callbacks, the forked process can be skipped and propagation proceeds immediately to the parent as described.

clear
Immediately clears the objection state. All counts are cleared and the any processes waiting on a call to wait_for(UVM_ALL_DROPPED, uvm_top) are released.

The caller, if a uvm_object-based object, should pass its ‘this’ handle to the obj argument to document who cleared the objection. Any drain_times set by the user are not affected.

**set_drain_time**

Sets the drain time on the given object to drain.

The drain time is the amount of time to wait once all objections have been dropped before calling the all_dropped callback and propagating the objection to the parent.

If a new objection for this object or any of its descendants is raised during the drain time or during execution of the all_dropped callbacks, the drain_time/all_dropped execution is terminated.

**Callback Hooks**

**raised**

```cpp
virtual function void raised ( 
    uvm_object obj, 
    uvm_object source_obj, 
    string description, 
    int count
)
```

Objection callback that is called when a raise_objection has reached obj. The default implementation calls uvm_component::raised.

**dropped**

```cpp
virtual function void dropped ( 
    uvm_object obj, 
    uvm_object source_obj, 
    string description, 
    int count
)
```

Objection callback that is called when a drop_objection has reached obj. The default implementation calls uvm_component::dropped.

**all_dropped**

```cpp
virtual task all_dropped ( 
    uvm_object obj, 
    uvm_object source_obj, 
    string description, 
    int count
)
```
Objection callback that is called when a drop objection has reached obj, and the total count for obj goes to zero. This callback is executed after the drain time associated with obj. The default implementation calls uvm_component::all_dropped.

**Objection Status**

**get_objectors**

```plaintext
function void get_objectors(
    ref uvm_object-list[$]
)
```

Returns the current list of objecting objects (objects that raised an objection but have not dropped it).

**wait_for**

```plaintext
task wait_for(
    uvm_objection_event objt_event,
    uvm_object obj = null
)
```

Waits for the raised, dropped, or all_dropped event to occur in the given obj. The task returns after all corresponding callbacks for that event have been executed.

**get_objection_count**

```plaintext
function int get_objection_count (
    uvm_object obj = null
)
```

Returns the current number of objections raised by the given object.

**get_objection_total**

```plaintext
function int get_objection_total (
    uvm_object obj = null
)
```

Returns the current number of objections raised by the given object and all descendants.

**get_drain_time**

```plaintext
function time get_drain_time (
    uvm_object obj = null
)
```

Returns the current drain time set for the given object (default: 0 ns).

**display_objections**
function void display_objections(
    uvm_object obj = null,
    bit show_header = 1
)

Displays objection information about the given object. If object is not specified or null, the implicit top-level component, uvm_root, is chosen. The show_header argument allows control of whether a header is output.

## uvm_objection_callback

The uvm_objection is the callback type that defines the callback implementations for an objection callback. A user uses the callback type uvm_objection_cbs_t to add callbacks to specific objections.

For example

```verilog
class my_objection_cb extends uvm_objection_callback;  
    function new(string name);  
        super.new(name);  
    endfunction  
    virtual function void raised (uvm_objection objection, uvm_object obj, uvm_object source_obj, string description, int count);  
        `uvm_info("RAISED","%0t: Objection %s: Raised for %s", $time, objection.get_name(), obj.get_full_name());  
    endfunction  
endclass

initial begin  
    my_objection_cb cb = new("cb");  
    uvm_objection_cbs_t::add(null, cb); //typewide callback
end
```

## Summary

### uvm_objection_callback

The uvm_objection is the callback type that defines the callback implementations for an objection callback.

#### Class Hierarchy

- `uvm_void`
- `uvm_object`
- `uvm_callback`
- `uvm_objection_callback`

#### Class Declaration

```verilog
class uvm_objection_callback extends uvm_callback
```

#### Methods

- `raised` Objection raised callback function.
- `dropped` Objection dropped callback function.
- `all_dropped` Objection all_dropped callback function.
## Methods

### raised

```cpp
class raised {
    virtual function void raised (
        uvm_object objection,
        uvm_object obj,
        uvm_object source_obj,
        string description,
        int count
    )
}
```

Objection raised callback function. Called by `uvm_object::raised`.

### dropped

```cpp
class dropped {
    virtual function void dropped (
        uvm_object objection,
        uvm_object obj,
        uvm_object source_obj,
        string description,
        int count
    )
}
```

Objection dropped callback function. Called by `uvm_object::dropped`.

### all_dropped

```cpp
class all_dropped {
    virtual task all_dropped (
        uvm_object objection,
        uvm_object obj,
        uvm_object source_obj,
        string description,
        int count
    )
}
```

Objection all_dropped callback function. Called by `uvm_object::all_dropped`.
Heartbeats provide a way for environments to easily ensure that their descendants are alive. A `uvm_heartbeat` is associated with a specific objection object. A component that is being tracked by the heartbeat object must raise (or drop) the synchronizing objection during the heartbeat window.

The `uvm_heartbeat` object has a list of participating objects. The heartbeat can be configured so that all components (UVM_ALL_ACTIVE), exactly one (UVM_ONE_ACTIVE), or any component (UVM_ANY_ACTIVE) must trigger the objection in order to satisfy the heartbeat condition.

**Summary**

**uvm_heartbeat**

Heartbeats provide a way for environments to easily ensure that their descendants are alive.

**Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new heartbeat instance associated with <code>cntxt</code>.</td>
</tr>
<tr>
<td>set_mode</td>
<td>Sets or retrieves the heartbeat mode.</td>
</tr>
<tr>
<td>set_heartbeat</td>
<td>Sets up the heartbeat event and assigns a list of objects to watch.</td>
</tr>
<tr>
<td>add</td>
<td>Add a single component to the set of components to be monitored.</td>
</tr>
<tr>
<td>remove</td>
<td>Remove a single component to the set of components being monitored.</td>
</tr>
<tr>
<td>start</td>
<td>Starts the heartbeat monitor.</td>
</tr>
<tr>
<td>stop</td>
<td>Stops the heartbeat monitor.</td>
</tr>
</tbody>
</table>

**new**

```plaintext
function new(
    string name,
    uvm_component cntxt,
    uvm_objection objection = null
)
```

Creates a new heartbeat instance associated with `cntxt`. The context is the hierarchical location that the heartbeat objections will flow through and be monitored at. The `objection` associated with the heartbeat is optional, if it is left `null` but it must be set before the heartbeat monitor will activate.

```plaintext
uvm_objection myobjection = new("myobjection"); //some shared objection
class myenv extends uvm_env;
    uvm_heartbeat hb = new("hb", this, myobjection);
endclass
```
set_mode

```plaintext
function uvm_heartbeat_modes set_mode {
    uvm_heartbeat_modes mode = UVM_NO_HB_MODE
}
```

Sets or retrieves the heartbeat mode. The current value for the heartbeat mode is returned. If an argument is specified to change the mode then the mode is changed to the new value.

set_heartbeat

```plaintext
function void set_heartbeat {
    uvm_event#(uvm_object) e,
    ref uvm_component comps[$]
}
```

Sets up the heartbeat event and assigns a list of objects to watch. The monitoring is started as soon as this method is called. Once the monitoring has been started with a specific event, providing a new monitor event results in an error. To change trigger events, you must first stop the monitor and then start with a new event trigger.

If the trigger event `e` is `null` and there was no previously set trigger event, then the monitoring is not started. Monitoring can be started by explicitly calling `start`.

add

```plaintext
function void add {
    uvm_component comp
}
```

Add a single component to the set of components to be monitored. This does not cause monitoring to be started. If monitoring is currently active then this component will be immediately added to the list of components and will be expected to participate in the currently active event window.

remove

```plaintext
function void remove {
    uvm_component comp
}
```

Remove a single component to the set of components being monitored. Monitoring is not stopped, even if the last component has been removed (an explicit stop is required).

start

```plaintext
function void start {
    uvm_event#(uvm_object) e = null
}
```

Starts the heartbeat monitor. If `e` is `null` then whatever event was previously set is used. If no event was previously set then a warning is issued. It is an error if the monitor is currently running and `e` is specifying a different trigger event from the current event.
**stop**

```c
function void stop ()
```

Stops the heartbeat monitor. Current state information is reset so that if `start` is called again the process will wait for the first event trigger to start the monitoring.
This section defines the classes used for callback registration, management, and user-defined callbacks.

**Contents**

<table>
<thead>
<tr>
<th>Callbacks Classes</th>
<th>This section defines the classes used for callback registration, management, and user-defined callbacks.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>uvmcallbacks #(T,CB)</strong></td>
<td>The <code>uvmcallbacks</code> class provides a base class for implementing callbacks, which are typically used to modify or augment component behavior without changing the component class.</td>
</tr>
<tr>
<td><strong>uvmcallback_iter</strong></td>
<td>The <code>uvmcallback_iter</code> class is an iterator class for iterating over callback queues of a specific callback type.</td>
</tr>
<tr>
<td><strong>uvmcallback</strong></td>
<td>The <code>uvmcallback</code> class is the base class for user-defined callback classes.</td>
</tr>
</tbody>
</table>

**uvmcallbacks #(T,CB)**

The `uvmcallbacks` class provides a base class for implementing callbacks, which are typically used to modify or augment component behavior without changing the component class. To work effectively, the developer of the component class defines a set of “hook” methods that enable users to customize certain behaviors of the component in a manner that is controlled by the component developer. The integrity of the component’s overall behavior is intact, while still allowing certain customizable actions by the user.

To enable compile-time type-safety, the class is parameterized on both the user-defined callback interface implementation as well as the object type associated with the callback. The object type-callback type pair are associated together using the `uvm_register_cb` macro to define a valid pairing; valid pairings are checked when a user attempts to add a callback to an object.

To provide the most flexibility for end-user customization and reuse, it is recommended that the component developer also define a corresponding set of virtual method hooks in the component itself. This affords users the ability to customize via inheritance/factory overrides as well as callback object registration. The implementation of each virtual method would provide the default traversal algorithm for the particular callback being called. Being virtual, users can define subtypes that override the default algorithm, perform tasks before and/or after calling super.method to execute any registered callbacks, or to not call the base implementation, effectively disabling that particular hook. A demonstration of this methodology is provided in an example included in the kit.

**Summary**

**uvmcallbacks #(T,CB)**

The `uvmcallbacks` class provides a base class for implementing callbacks, which are typically used to modify or augment component behavior without changing the component class.
This type parameter specifies the base object type with which the CB callback objects will be registered. This object must be a derivative of `uvm_object`.

This type parameter specifies the base callback type that will be managed by this callback class. The callback type is typically an interface class, which defines one or more virtual method prototypes that users can override in subtypes. This type must be a derivative of `uvm_callback`.

**Add/Delete Interface**

**add**

Registers the given callback object, `cb`, with the given `obj` handle.

**add_by_name**

Registers the given callback object, `cb`, with one or more `uvm_components`.

**delete**

Deletes the given callback object, `cb`, from the queue associated with the given `obj` handle.

**delete_by_name**

Removes the given callback object, `cb`, associated with one or more `uvm_component` callback queues.

**Iterator Interface**

This set of functions provide an iterator interface for callback queues.

**get_first**

Returns the first enabled callback of type CB which resides in the queue for `obj`.

**get_last**

Returns the last enabled callback of type CB which resides in the queue for `obj`.

**get_next**

Returns the next enabled callback of type CB which resides in the queue for `obj`, using `itr` as the starting point.

**get_prev**

Returns the previous enabled callback of type CB which resides in the queue for `obj`, using `itr` as the starting point.

**Debug**

**display**

This function displays callback information for `obj`. 
Registers the given callback object, `cb`, with the given `obj` handle. The `obj` handle can be `null`, which allows registration of callbacks without an object context. If `ordering` is `UVM_APPEND` (default), the callback will be executed after previously added callbacks, else the callback will be executed ahead of previously added callbacks. The `cb` is the callback handle; it must be non-`null`, and if the callback has already been added to the object instance then a warning is issued. Note that the CB parameter is optional. For example, the following are equivalent:

```plaintext
uvm_callbacks#(my_comp)::add(comp_a, cb);
uvm_callbacks#(my_comp, my_callback)::add(comp_a, cb);
```

**add_by_name**

Registers the given callback object, `cb`, with one or more `uvm_components`. The components must already exist and must be type `T` or a derivative. As with `add` the CB parameter is optional. `root` specifies the location in the component hierarchy to start the search for `name`. See `uvm_root::find_all` for more details on searching by name.

**delete**

Deletes the given callback object, `cb`, from the queue associated with the given `obj` handle. The `obj` handle can be `null`, which allows de-registration of callbacks without an object context. The `cb` is the callback handle; it must be non-`null`, and if the callback has already been removed from the object instance then a warning is issued. Note that the CB parameter is optional. For example, the following are equivalent:

```plaintext
uvm_callbacks#(my_comp)::delete(comp_a, cb);
uvm_callbacks#(my_comp, my_callback)::delete(comp_a, cb);
```

**delete_by_name**

```plaintext
static function void delete_by_name(
  string name,
  uvm_callback cb,
  uvm_component root,
  uvm_appprepend ordering = UVM_APPEND
)
```
Removes the given callback object, \( cb \), associated with one or more uvm_component callback queues. As with delete the CB parameter is optional. \( root \) specifies the location in the component hierarchy to start the search for \( name \). See uvm_root::find_all for more details on searching by name.

**Iterator Interface**

This set of functions provide an iterator interface for callback queues. A facade class, uvm_callback_iter is also available, and is the generally preferred way to iterate over callback queues.

**get_first**

```plaintext
static function CB get_first (
  ref int itr,
  input T obj
)
```

Returns the first enabled callback of type CB which resides in the queue for \( obj \). If \( obj \) is \( null \) then the typewide queue for \( T \) is searched. \( itr \) is the iterator; it will be updated with a value that can be supplied to get_next to get the next callback object.

If the queue is empty then \( null \) is returned.

The iterator class uvm_callback_iter may be used as an alternative, simplified, iterator interface.

**get_last**

```plaintext
static function CB get_last (
  ref int itr,
  input T obj
)
```

Returns the last enabled callback of type CB which resides in the queue for \( obj \). If \( obj \) is \( null \) then the typewide queue for \( T \) is searched. \( itr \) is the iterator; it will be updated with a value that can be supplied to get_prev to get the previous callback object.

If the queue is empty then \( null \) is returned.

The iterator class uvm_callback_iter may be used as an alternative, simplified, iterator interface.

**get_next**

```plaintext
static function CB get_next (
  ref int itr,
  input T obj
)
```

Returns the next enabled callback of type CB which resides in the queue for \( obj \), using \( itr \) as the starting point. If \( obj \) is \( null \) then the typewide queue for \( T \) is searched. \( itr \) is the iterator; it will be updated with a value that can be supplied to get_next to get the next callback object.

If no more callbacks exist in the queue, then \( null \) is returned. get_next will continue to
return null in this case until get_first or get_last has been used to reset the iterator.

The iterator class uvm_callback_iter may be used as an alternative, simplified, iterator interface.

### get_prev

```plaintext
static function CB get_prev (
    ref int itr,
    input T obj
)
```

Returns the previous enabled callback of type CB which resides in the queue for obj, using itr as the starting point. If obj is null then the typewide queue for T is searched. itr is the iterator; it will be updated with a value that can be supplied to get_prev to get the previous callback object.

If no more callbacks exist in the queue, then null is returned. get_prev will continue to return null in this case until get_first or get_last has been used to reset the iterator.

The iterator class uvm_callback_iter may be used as an alternative, simplified, iterator interface.

### Debug

### display

```plaintext
static function void display(
    T obj = null
)
```

This function displays callback information for obj. If obj is null, then it displays callback information for all objects of type T, including typewide callbacks.

### uvm_callback_iter

The uvm_callback_iter class is an iterator class for iterating over callback queues of a specific callback type. The typical usage of the class is:

```plaintext
uvm_callback_iter#(mycomp,mycb) iter = new(this);
for(mycb cb = iter.first(); cb != null; cb = iter.next())
    cb.dosomething();
```

The callback iteration macros, `uvm_do_callbacks` and `uvm_do_callbacks_exit_on` provide a simple method for iterating callbacks and executing the callback methods.

### Summary

uvm_callback_iter
The `uvm_callback_iter` class is an iterator class for iterating over callback queues of a specific callback type.

**Class Declaration**

```plaintext
class uvm_callback_iter#(
    type T = uvm_object,
    type CB = uvm_callback
)
```

**Methods**

- **new**
  
  ```plaintext
  function new(
    T obj
  )
  ```

  Creates a new callback iterator object. It is required that the object context be provided.

- **first**
  
  ```plaintext
  function CB first()
  ```

  Returns the first valid (enabled) callback of the callback type (or a derivative) that is in the queue of the context object. If the queue is empty then `null` is returned.

- **last**
  
  ```plaintext
  function CB last()
  ```

  Returns the last valid (enabled) callback of the callback type (or a derivative) that is in the queue of the context object. If the queue is empty then `null` is returned.

- **next**
  
  ```plaintext
  function CB next()
  ```

  Returns the next valid (enabled) callback of the callback type (or a derivative) that is in the queue of the context object. If there are no more valid callbacks in the queue, then `null` is returned.
**prev**

```plaintext
function CB prev()
```

Returns the previous valid (enabled) callback of the callback type (or a derivative) that is in the queue of the context object. If there are no more valid callbacks in the queue, then `null` is returned.

**get_cb**

```plaintext
function CB get_cb()
```

Returns the last callback accessed via a first() or next() call.

---

**uvm_callback**

The `uvm_callback` class is the base class for user-defined callback classes. Typically, the component developer defines an application-specific callback class that extends from this class. In it, he defines one or more virtual methods, called a **callback interface**, that represent the hooks available for user override.

Methods intended for optional override should not be declared `pure`. Usually, all the callback methods are defined with empty implementations so users have the option of overriding any or all of them.

The prototypes for each hook method are completely application specific with no restrictions.

**Summary**

---

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_callback
```

**Class Declaration**

```
class uvm_callback extends uvm_object
```

**Methods**

- `new` Creates a new `uvm_callback` object, giving it an optional name.
- `callback_mode` Enable/disable callbacks (modeled like `rand_mode` and `constraint_mode`).
- `is_enabled` Returns 1 if the callback is enabled, 0 otherwise.
- `get_type_name` Returns the type name of this callback object.
**METHODS**

**new**

```plaintext
function new(
    string name = "uvm_callback"
)
```

Creates a new uvm_callback object, giving it an optional name.

**callback_mode**

```plaintext
function bit callback_mode(
    int on = -1
)
```

Enable/disable callbacks (modeled like rand_mode and constraint_mode).

**is_enabled**

```plaintext
function bit is_enabled()
```

Returns 1 if the callback is enabled, 0 otherwise.

**get_type_name**

```plaintext
virtual function string get_type_name()
```

Returns the type name of this callback object.
The container classes are type parameterized data structures. The `uvm_queue #(T)` class implements a queue datastructure similar to the SystemVerilog queue construct. And the `uvm_pool #(KEY,T)` class implements a pool datastructure similar to the SystemVerilog associative array. The class based data structures allow the objects to be shared by reference; for example, a copy of a `uvm_pool #(KEY,T)` object will copy just the class handle instead of the entire associative array.

**Summary**

**Container Classes**

The container classes are type parameterized data structures.
12.1 Pool Classes

This section defines the `uvm_pool #(KEY, T)` class and derivative.

**Contents**

<table>
<thead>
<tr>
<th>Pool Classes</th>
<th>This section defines the <code>uvm_pool #(KEY, T)</code> class and derivative.</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_pool #(KEY,T)</code></td>
<td>Implements a class-based dynamic associative array.</td>
</tr>
<tr>
<td><code>uvm_object_string_pool #(T)</code></td>
<td>This provides a specialization of the generic <code>uvm_pool #(KEY,T)</code> class for an associative array of <code>uvm_object</code>-based objects indexed by string.</td>
</tr>
</tbody>
</table>

**Summary**

**uvm_pool #(KEY,T)**

Implements a class-based dynamic associative array. Allows sparse arrays to be allocated on demand, and passed and stored by reference.

**Class Hierarchy**

```
class uvm_void extends uvm_object; /* ... */
class uvm_object extends uvm_object; /* ... */
class uvm_pool#(KEY,T) extends uvm_object; /* ... */
```

**Class Declaration**

```cpp
class uvm_pool #(
    type KEY = int,
    T = uvm_void
) extends uvm_object;
```

**Methods**

- `new`: Creates a new pool with the given `name`.
- `get_global_pool`: Returns the singleton global pool for the item type, `T`.
- `get_global`: Returns the specified item instance from the global item pool.
- `get`: Returns the item with the given `key`.
- `add`: Adds the given `(key, item)` pair to the pool.
- `num`: Returns the number of uniquely keyed items stored in the pool.
- `delete`: Removes the item with the given `key` from the pool.
- `exists`: Returns 1 if an item with the given `key` exists in the pool, 0 otherwise.
- `first`: Returns the key of the first item stored in the pool.
- `last`: Returns the key of the last item stored in the pool.
- `next`: Returns the key of the next item in the pool.
- `prev`: Returns the key of the previous item in the pool.
**METHODS**

**new**

```plaintext
function new (
    string name = ""
)
```

Creates a new pool with the given *name*.

**get_global_pool**

```plaintext
static function this_type get_global_pool ()
```

Returns the singleton global pool for the item type, T.

This allows items to be shared amongst components throughout the verification environment.

**get_global**

```plaintext
static function T get_global (  
    KEY key
)
```

Returns the specified item instance from the global item pool.

**get**

```plaintext
virtual function T get (  
    KEY key
)
```

Returns the item with the given *key*.

If no item exists by that key, a new item is created with that key and returned.

**add**

```plaintext
virtual function void add (  
    KEY key,  
    T item
)
```

Adds the given *(key, item)* pair to the pool. If an item already exists at the given *key* it is overwritten with the new *item*.

**num**

```plaintext
virtual function int num ()
```
Returns the number of uniquely keyed items stored in the pool.

**delete**

```c
virtual function void delete (KEY key)
```

Removes the item with the given `key` from the pool.

**exists**

```c
virtual function int exists (KEY key)
```

Returns 1 if an item with the given `key` exists in the pool, 0 otherwise.

**first**

```c
virtual function int first (ref KEY key)
```

Returns the key of the first item stored in the pool.

If the pool is empty, then `key` is unchanged and 0 is returned.

If the pool is not empty, then `key` is set to the key of the first item and 1 is returned.

**last**

```c
virtual function int last (ref KEY key)
```

Returns the key of the last item stored in the pool.

If the pool is empty, then 0 is returned and `key` is unchanged.

If the pool is not empty, then `key` is set to the last key in the pool and 1 is returned.

**next**

```c
virtual function int next (ref KEY key)
```

Returns the key of the next item in the pool.

If the input `key` is the last key in the pool, then `key` is left unchanged and 0 is returned.

If a next key is found, then `key` is updated with that key and 1 is returned.
prev

```
virtual function int prev (ref KEY key)
```

Returns the key of the previous item in the pool.

If the input `key` is the first key in the pool, then `key` is left unchanged and 0 is returned.

If a previous key is found, then `key` is updated with that key and 1 is returned.

**uvm_object_string_pool #(T)**

This provides a specialization of the generic `uvm_pool #(KEY,T)` class for an associative array of `uvm_object`-based objects indexed by string. Specializations of this class include the `uvm_event_pool` (a `uvm_object_string_pool` storing `uvm_event#(uvm_object)`) and `uvm_barrier_pool` (a `uvm_object_string_pool` storing `uvm_barrier`).

**Summary**

**uvm_object_string_pool #(T)**

This provides a specialization of the generic `uvm_pool #(KEY,T)` class for an associative array of `uvm_object`-based objects indexed by string.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_pool#(string,T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object_string_pool#(T)</td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_object_string_pool #(
  type T = uvm_object
) extends uvm_pool # (string,T)
```

**Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new pool with the given <code>name</code></td>
</tr>
<tr>
<td>get_type_name</td>
<td>Returns the type name of this object.</td>
</tr>
<tr>
<td>get_global_pool</td>
<td>Returns the singleton global pool for the item type, T.</td>
</tr>
<tr>
<td>get_global</td>
<td>Returns the specified item instance from the global item pool.</td>
</tr>
<tr>
<td>get</td>
<td>Returns the object item at the given string <code>key</code>.</td>
</tr>
<tr>
<td>delete</td>
<td>Removes the item with the given string <code>key</code> from the pool.</td>
</tr>
</tbody>
</table>

**METHODS**

**new**

```
function new (string name = "")
```

UVM 1.2 Class Reference
Creates a new pool with the given name.

**get_type_name**

```cpp
virtual function string get_type_name()
```

Returns the type name of this object.

**get_global_pool**

```cpp
static function this_type get_global_pool()
```

Returns the singleton global pool for the item type, T.

This allows items to be shared amongst components throughout the verification environment.

**get_global**

```cpp
static function T get_global (string key)
```

Returns the specified item instance from the global item pool.

**get**

```cpp
virtual function T get (string key)
```

Returns the object item at the given string key.

If no item exists by the given key, a new item is created for that key and returned.

**delete**

```cpp
virtual function void delete (string key)
```

Removes the item with the given string key from the pool.
12.2 uvm_queue #(T)

Implements a class-based dynamic queue. Allows queues to be allocated on demand, and passed and stored by reference.

Summary

**uvm_queue #(T)**

Implements a class-based dynamic queue.

**CLASS HIERARCHY**

```
| uvm_void   |
| uvm_object |
| uvm_queue#(T) |
```

**CLASS DECLARATION**

```
class uvm_queue #(T)
    extends uvm_object
```

**METHODS**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new queue with the given name.</td>
</tr>
<tr>
<td>get_global_queue</td>
<td>Returns the singleton global queue for the item type, T.</td>
</tr>
<tr>
<td>get_global</td>
<td>Returns the specified item instance from the global item queue.</td>
</tr>
<tr>
<td>get</td>
<td>Returns the item at the given index.</td>
</tr>
<tr>
<td>size</td>
<td>Returns the number of items stored in the queue.</td>
</tr>
<tr>
<td>insert</td>
<td>Inserts the item at the given index in the queue.</td>
</tr>
<tr>
<td>delete</td>
<td>Removes the item at the given index from the queue; if index is not provided, the entire contents of the queue are deleted.</td>
</tr>
<tr>
<td>pop_front</td>
<td>Returns the first element in the queue (index=0), or null if the queue is empty.</td>
</tr>
<tr>
<td>pop_back</td>
<td>Returns the last element in the queue (index=size()-1), or null if the queue is empty.</td>
</tr>
<tr>
<td>push_front</td>
<td>Inserts the given item at the front of the queue.</td>
</tr>
<tr>
<td>push_back</td>
<td>Inserts the given item at the back of the queue.</td>
</tr>
</tbody>
</table>

**METHODS**

**new**

```
function new (  
    string name = ""
)
```

Creates a new queue with the given name.

**get_global_queue**

```
static function this_type get_global_queue ()
```
Returns the singleton global queue for the item type, T.

This allows items to be shared amongst components throughout the verification environment.

**get_global**

```cpp
static function T get_global (int index)
```

Returns the specified item instance from the global item queue.

**get**

```cpp
virtual function T get (int index)
```

Returns the item at the given index.

If no item exists by that key, a new item is created with that key and returned.

**size**

```cpp
virtual function int size ()
```

Returns the number of items stored in the queue.

**insert**

```cpp
virtual function void insert (int index, T item)
```

Inserts the item at the given index in the queue.

**delete**

```cpp
virtual function void delete (int index = -1)
```

Removes the item at the given index from the queue; if index is not provided, the entire contents of the queue are deleted.

**pop_front**

```cpp
virtual function T pop_front()
```

Returns the first element in the queue (index=0), or null if the queue is empty.
**pop_back**

```cpp
virtual function T pop_back()
```

Returns the last element in the queue (index=size()-1), or `null` if the queue is empty.

**push_front**

```cpp
virtual function void push_front(T item)
```

Inserts the given `item` at the front of the queue.

**push_back**

```cpp
virtual function void push_back(T item)
```

Inserts the given `item` at the back of the queue.
The UVM TLM library defines several abstract, transaction-level interfaces and the ports and exports that facilitate their use. Each TLM interface consists of one or more methods used to transport data, typically whole transactions (objects) at a time. Component designs that use TLM ports and exports to communicate are inherently more reusable, interoperable, and modular.

The UVM TLM library specifies the required behavior (semantic) of each interface method. Classes (components) that implement a TLM interface must meet the specified semantic.

Summary

<table>
<thead>
<tr>
<th>TLM Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>The UVM TLM library defines several abstract, transaction-level interfaces and the ports and exports that facilitate their use.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TLM1</th>
</tr>
</thead>
<tbody>
<tr>
<td>The TLM1 ports provide blocking and non-blocking pass-by-value transaction-level interfaces.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TLM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>The TLM2 sockets provide blocking and non-blocking transaction-level interfaces with well-defined completion semantics.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequencer Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>A push or pull port, with well-defined completion semantics. It is used to connect sequencers with drivers and layering sequences.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>The analysis interface is used to perform non-blocking broadcasts of transactions to connected components. It is typically used by such components as monitors to publish transactions observed on a bus to its subscribers, which are typically scoreboards and response/coverage collectors.</td>
</tr>
</tbody>
</table>
14. TLM1 Interfaces, Ports, Exports and Transport Interfaces

Each TLM1 interface is either blocking, non-blocking, or a combination of these two.

**blocking**

A blocking interface conveys transactions in blocking fashion; its methods do not return until the transaction has been successfully sent or retrieved. Because delivery may consume time to complete, the methods in such an interface are declared as tasks.

**non-blocking**

A non-blocking interface attempts to convey a transaction without consuming simulation time. Its methods are declared as functions. Because delivery may fail (e.g. the target component is busy and cannot accept the request), the methods may return with failed status.

**combination**

A combination interface contains both the blocking and non-blocking variants. In SystemC, combination interfaces are defined through multiple inheritance. Because SystemVerilog does not support multiple inheritance, the UVM emulates hierarchical interfaces via a common base class and interface mask.

Like their SystemC counterparts, the UVM’s TLM port and export implementations allow connections between ports whose interfaces are not an exact match. For example, a *uvm_blocking_get_port* can be connected to any port, export or imp port that provides at the least an implementation of the blocking_get interface, which includes the *uvm_get_* ports and exports, *uvm_blocking_get.peek_* ports and exports, and *uvm_get.peek_* ports and exports.

The sections below provide an overview of the unidirectional and bidirectional TLM interfaces, ports, and exports.

**Summary**

<table>
<thead>
<tr>
<th><strong>TLM1 Interfaces, Ports, Exports and Transport Interfaces</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Each TLM1 interface is either blocking, non-blocking, or a combination of these two.</td>
</tr>
</tbody>
</table>

**Unidirectional Interfaces & Ports**

- **Put**
  - The *put* interfaces are used to send, or *put*, transactions to other components.

- **Get and Peek**
  - The *get* interfaces are used to retrieve transactions from other components.

- **Ports, Exports, and Imps**
  - The UVM provides unidirectional ports, exports, and implementation ports for connecting your components via the TLM interfaces.

**Bidirectional Interfaces & Ports**

- **Transport**
  - The *transport* interface sends a request transaction and returns a response transaction in a single task call, thereby enforcing an in-order execution semantic.

- **Master and Slave**
  - The primitive, unidirectional *put, get, and peek* interfaces are combined to form bidirectional master and slave interfaces.
The UVM provides bidirectional ports, exports, and implementation ports for connecting your components via the TLM interfaces.

This example illustrates basic TLM connectivity using the blocking put interface.

**Unidirectional Interfaces & Ports**

The unidirectional TLM interfaces consist of blocking, non-blocking, and combined blocking and non-blocking variants of the *put*, *get* and *peek* interfaces, plus a non-blocking *analysis* interface.

**Put**

The *put* interfaces are used to send, or *put*, transactions to other components. Successful completion of a put guarantees its delivery, not execution.

**Get and Peek**

The *get* interfaces are used to retrieve transactions from other components. The *peek* interfaces are used for the same purpose, except the retrieved transaction is not consumed; successive calls to *peek* will return the same object. Combined *get.peek* interfaces are also defined.
Ports, Exports, and Imps

The UVM provides unidirectional ports, exports, and implementation ports for connecting your components via the TLM interfaces.

**Ports** instantiated in components that *require*, or *use*, the associate interface to initiate transaction requests.

**Exports** instantiated by components that *forward* an implementation of the methods defined in the associated interface. The implementation is typically provided by an *imp* port in a child component.

**Imps** instantiated by components that *provide* or *implement* an implementation of the methods defined in the associated interface.
A summary of port, export, and imp declarations are

```plaintext
class uvm_*_export #(type T=int)
extends uvm_port_base #(tlm_if_base #(T,T));
class uvm_*_port #(type T=int)
extends uvm_port_base #(tlm_if_base #(T,T));
class uvm_*_imp #(type T=int)
extends uvm_port_base #(tlm_if_base #(T,T));
```

where the asterisk can be any of

```plaintext
blocking_put
nonblocking_put
put
blocking_get
nonblocking_get
get
blocking_peek
nonblocking_peek
peek
blocking_get_peek
nonblocking_get_peek
get_peek
analysis
```

**Bidirectional Interfaces & Ports**

The bidirectional interfaces consist of blocking, non-blocking, and combined blocking and non-blocking variants of the `transport`, `master`, and `slave` interfaces.

Bidirectional interfaces involve both a transaction request and response.

**Transport**

The `transport` interface sends a request transaction and returns a response transaction in a single task call, thereby enforcing an in-order execution semantic. The request and response transactions can be different types.

**Master and Slave**

The primitive, unidirectional `put`, `get`, and `peek` interfaces are combined to form
bidirectional master and slave interfaces. The master puts requests and gets or peeks responses. The slave gets or peeks requests and puts responses. Because the put and the get come from different function interface methods, the requests and responses are not coupled as they are with the transport interface.

**Ports, Exports, and Imps**

The UVM provides bidirectional ports, exports, and implementation ports for connecting your components via the TLM interfaces.

- **Ports** instantiated in components that require, or use, the associate interface to initiate transaction requests.

- **Exports** instantiated by components that forward an implementation of the methods defined in the associated interface. The implementation is typically provided by an imp port in a child component.

- **Imps** instantiated by components that provide or implement an implementation of the methods defined in the associated interface. 
A summary of port, export, and imp declarations are

```plaintext
class uvm_*_port #(type REQ=int, RSP=int) extends uvm_port_base #(tlm_if_base #(REQ, RSP));
class uvm_*_export #(type REQ=int, RSP=int) extends uvm_port_base #(tlm_if_base #(REQ, RSP));
class uvm_*_imp #(type REQ=int, RSP=int) extends uvm_port_base #(tlm_if_base #(REQ, RSP));
```

where the asterisk can be any of

```plaintext
transport
  blocking_transport
  nonblocking_transport
blocking_master
  nonblocking_master
  master
blocking_slave
  nonblocking_slave
  slave
```

### Usage

This example illustrates basic TLM connectivity using the blocking put interface.
Hierarchical port connections are resolved and optimized just before `uvm_component::end_of_elaboration_phase`. After optimization, calling any port’s interface method (e.g. `leaf1.out.put(trans)`) incurs a single hop to get to the implementation (e.g. `leaf2`’s put task), no matter how far up and down the hierarchy the implementation resides.

```verilog
`include "uvm_pkg.sv"
import uvm_pkg::*;

class trans extends uvm_transaction;
rand int addr;
rand int data;
rnd bit write;
endclass

class leaf1 extends uvm_component;
  `uvm_component_utils(leaf1)
  uvm_blocking_put_port #(trans) out;
function new(string name, uvm_component parent=null);
  super.new(name,parent);
  out = new("out",this);
endfunction

virtual task run_phase(uvm_phase phase);
  trans t;
  phase.raise_objection(this, "prolonging run_phase");
  t = new;
  t.randomize();
  out.put(t);
  phase.drop_objection(this, "prolonging run_phase");
endtask

endclass

class comp1 extends uvm_component;
  `uvm_component_utils(comp1)
  uvm_blocking_put_port #(trans) out;
  leaf1 leaf;
function new(string name, uvm_component parent=null);
  super.new(name,parent);
endfunction

virtual function void build_phase(uvm_phase phase);
  out = new("out",this);
  leaf = new("leaf1",this);
endfunction

// connect port to port
virtual function void connect_phase(uvm_phase phase);
  leaf.out.connect(out);
endfunction
endclass

class leaf2 extends uvm_component;
  `uvm_component_utils(leaf2)
  uvm_blocking_put_imp #(trans,leaf2) in;
function new(string name, uvm_component parent=null);
  super.new(name,parent);
endfunction
```
// connect imp to implementation (this)
in = new("in", this);
endfunction

virtual task put(trans t);
$display("Got trans: addr=%0d, data=%0d, write=%0d", t.addr, t.data, t.write);
endtask
endclass

class subcomp2 extends uvm_component;
`uvm_component_utils(subcomp2)
uvm_blocking_put_export #(trans) in;
leaf2 leaf;
function new(string name, uvm_component parent=null);
super.new(name, parent);
endfunction
virtual function void build_phase(uvm_phase phase);
in = new("in", this);
leaf = new("leaf2", this);
endfunction
// connect export to imp
virtual function void connect_phase(uvm_phase phase);
in.connect(leaf.in);
endfunction
endclass

class comp2 extends uvm_component;
`uvm_component_utils(comp2)
uvm_blocking_put_export #(trans) in;
subcomp2 subcomp;
function new(string name, uvm_component parent=null);
super.new(name, parent);
endfunction
virtual function void build_phase(uvm_phase phase);
in = new("in", this);
subcomp = new("subcomp2", this);
endfunction
// connect export to export
virtual function void connect_phase(uvm_phase phase);
in.connect(subcomp.in);
endfunction
endclass

class env extends uvm_component;
`uvm_component_utils(comp1)
comp1 comp1_i;
comp2 comp2_i;
function new(string name, uvm_component parent=null);
super.new(name, parent);
endfunction
virtual function void build_phase(uvm_phase phase);
comp1_i = new("comp1", this);
comp2_i = new("comp2", this);
endfunction
// connect port to export
virtual function void connect_phase(uvm_phase phase);
comp1_i.out.connect(comp2_i.in);
endfunction
endclass

module top;
env e = new("env");
initial run_test();
initial #10 uvm_top.stop_request();
endmodule
14.1 uvm_tlm_if_base #(T1,T2)

This class declares all of the methods of the TLM API.

Various subsets of these methods are combined to form primitive TLM interfaces, which are then paired in various ways to form more abstract "combination" TLM interfaces. Components that require a particular interface use ports to convey that requirement. Components that provide a particular interface use exports to convey its availability.

Communication between components is established by connecting ports to compatible exports, much like connecting module signal-level output ports to compatible input ports. The difference is that UVM ports and exports bind interfaces (groups of methods), not signals and wires. The methods of the interfaces so bound pass data as whole transactions (e.g. objects). The set of primitive and combination TLM interfaces afford many choices for designing components that communicate at the transaction level.

Summary

uvm_tlm_if_base #(T1,T2)

This class declares all of the methods of the TLM API.

**CLASS DECLARATION**

```
virtual class uvm_tlm_if_base #(type T1 = int, type T2 = int)
```

**Blocking put**

*put* Sends a user-defined transaction of type T.

**Blocking get**

*get* Provides a new transaction of type T.

**Blocking peek**

*peek* Obtain a new transaction without consuming it.

**Non-blocking put**

*try_put* Sends a transaction of type T, if possible.

*can_put* Returns 1 if the component is ready to accept the transaction; 0 otherwise.

**Non-blocking get**

*try_get* Provides a new transaction of type T.

*can_get* Returns 1 if a new transaction can be provided immediately upon request, 0 otherwise.

**Non-blocking peek**

*try_peek* Provides a new transaction without consuming it.

*can_peek* Returns 1 if a new transaction is available; 0 otherwise.

**Blocking transport**

*transport* Executes the given request and returns the response in the given output argument.

**Non-blocking transport**

*nb_transport* Executes the given request and returns the response in the given output argument.
BROADCASTING PUT

put

```virtual task put(
    input T1 t
)
```

Sends a user-defined transaction of type T.

Components implementing the put method will block the calling thread if it cannot immediately accept delivery of the transaction.

BROADCASTING GET

get

```virtual task get(
    output T2 t
)
```

Provides a new transaction of type T.

The calling thread is blocked if the requested transaction cannot be provided immediately. The new transaction is returned in the provided output argument.

The implementation of get must regard the transaction as consumed. Subsequent calls to get must return a different transaction instance.

BROADCASTING PEEK

peek

```virtual task peek(
    output T2 t
)
```

Obtain a new transaction without consuming it.

If a transaction is available, then it is written to the provided output argument. If a transaction is not available, then the calling thread is blocked until one is available.

The returned transaction is not consumed. A subsequent peek or get will return the same transaction.
**Non-blocking put**

**try_put**

```vhdl
virtual function bit try_put(
    input T1 t
)
```

Sends a transaction of type T, if possible.

If the component is ready to accept the transaction argument, then it does so and returns 1, otherwise it returns 0.

**can_put**

```vhdl
virtual function bit can_put()
```

Returns 1 if the component is ready to accept the transaction; 0 otherwise.

**Non-blocking get**

**try_get**

```vhdl
virtual function bit try_get(
    output T2 t
)
```

Provides a new transaction of type T.

If a transaction is immediately available, then it is written to the output argument and 1 is returned. Otherwise, the output argument is not modified and 0 is returned.

**can_get**

```vhdl
virtual function bit can_get()
```

Returns 1 if a new transaction can be provided immediately upon request, 0 otherwise.

**Non-blocking peek**

**try_peek**

```vhdl
virtual function bit try_peek(
    output T2 t
)
```

Provides a new transaction without consuming it.

If available, a transaction is written to the output argument and 1 is returned. A
subsequent peek or get will return the same transaction. If a transaction is not available, then the argument is unmodified and 0 is returned.

**can_peek**

```c
virtual function bit can_peek()
```

Returns 1 if a new transaction is available; 0 otherwise.

**BLOCKING TRANSPORT**

**transport**

```c
virtual task transport(
    input T1 req,
    output T2 rsp
)
```

Executes the given request and returns the response in the given output argument. The calling thread may block until the operation is complete.

**NON-BLOCKING TRANSPORT**

**nb_transport**

```c
virtual function bit nb_transport(
    input T1 req,
    output T2 rsp
)
```

Executes the given request and returns the response in the given output argument. Completion of this operation must occur without blocking.

If for any reason the operation could not be executed immediately, then a 0 must be returned; otherwise 1.

**ANALYSIS**

**write**

```c
virtual function void write(
    input T1 t
)
```

Broadcasts a user-defined transaction of type T to any number of listeners. The operation must complete without blocking.
14.2 TLM Export Classes

The following classes define the TLM export classes.

## Contents

<table>
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<tr>
<th>TLM Export Classes</th>
<th>The following classes define the TLM export classes.</th>
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<tr>
<td>uvm_*_export # (T)</td>
<td>The unidirectional uvm_*_export is a port that forwards or promotes an interface implementation from a child component to its parent.</td>
</tr>
<tr>
<td>uvm_*_export #(REQ,RSP)</td>
<td>The bidirectional uvm_*_export is a port that forwards or promotes an interface implementation from a child component to its parent.</td>
</tr>
</tbody>
</table>

## uvm_*_export # (T)

The unidirectional uvm_*_export is a port that forwards or promotes an interface implementation from a child component to its parent. An export can be connected to any compatible child export or imp port. It must ultimately be connected to at least one implementation of its associated interface.

The interface type represented by the asterisk is any of the following:

- blocking_put
- nonblocking_put
- put
- blocking_get
- nonblocking_get
- get
- blocking_peek
- nonblocking_peek
- peek
- blocking_get_peek
- nonblocking_get_peek
- get_peek

**Type parameters**

T  The type of transaction to be communicated by the export

Exports are connected to interface implementations directly via uvm_*_imp #(T,IMP) ports or indirectly via other uvm_*_export #(T) exports.

## Summary

<table>
<thead>
<tr>
<th>uvm_*_export # (T)</th>
<th>The unidirectional uvm_*_export is a port that forwards or promotes an interface implementation from a child component to its parent.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods</strong></td>
<td></td>
</tr>
</tbody>
</table>
The name and parent are the standard uvm_component constructor arguments. The min_size and max_size specify the minimum and maximum number of interfaces that must have been supplied to this port by the end of elaboration.

```haskell
function new(string name,
            uvm_component parent,
            int min_size=1,
            int max_size=1)
```

The bidirectional uvm_*_export is a port that forwards or promotes an interface implementation from a child component to its parent. An export can be connected to any compatible child export or imp port. It must ultimately be connected to at least one implementation of its associated interface.

The interface type represented by the asterisk is any of the following:

```haskell
blocking_transport
nonblocking_transport
transport
blocking_master
nonblocking_master
master
blocking_slave
nonblocking_slave
slave
```

Type parameters

- **REQ**: The type of request transaction to be communicated by the export
- **RSP**: The type of response transaction to be communicated by the export

Exports are connected to interface implementations directly via uvm_*_imp #(REQ, RSP, IMP, REQ_IMP, RSP_IMP) ports or indirectly via other uvm_*_export #(REQ,RSP) exports.

**Summary**

uvm_*_export #(REQ,RSP)

The bidirectional uvm_*_export is a port that forwards or promotes an interface.
**METHODS**

**new**

The *name* and *parent* are the standard *uvm_component* constructor arguments. The *min_size* and *max_size* specify the minimum and maximum number of interfaces that must have been supplied to this port by the end of elaboration.

```plaintext
function new (string name,
              uvm_component parent,
              int min_size=1,
              int max_size=1)
```


### 14.3 TLM Port Classes

The following classes define the TLM port classes.

<table>
<thead>
<tr>
<th>TLM Port Classes</th>
<th>The following classes define the TLM port classes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_*_port #(T)</td>
<td>These unidirectional ports are instantiated by components that require, or use, the associated interface to convey transactions.</td>
</tr>
<tr>
<td>uvm_*_port #(REQ,RSP)</td>
<td>These bidirectional ports are instantiated by components that require, or use, the associated interface to convey transactions.</td>
</tr>
</tbody>
</table>

---

#### uvm_\*_port #\(T\)

These unidirectional ports are instantiated by components that require, or use, the associated interface to convey transactions. A port can be connected to any compatible port, export, or imp port. Unless its min_size is 0, a port must be connected to at least one implementation of its associated interface.

The asterisk in uvm_\*_port is any of the following:

- blocking_put
- nonblocking_put
- put
- blocking_get
- nonblocking_get
- get
- blocking_peek
- nonblocking_peek
- peek
- blocking_get_peek
- nonblocking_get_peek
- get_peek

**Type parameters**

\(T\)  
The type of transaction to be communicated by the export. The type T is not restricted to class handles and may be a value type such as int, enum, struct or similar.

Ports are connected to interface implementations directly via uvm_\*_imp #(T,IMP) ports or indirectly via hierarchical connections to uvm_\*_port #(T) and uvm_\*_export #(T) ports.

**Summary**

<table>
<thead>
<tr>
<th>uvm_*_port #(T)</th>
<th>These unidirectional ports are instantiated by components that require, or use, the associated interface to convey transactions.</th>
</tr>
</thead>
</table>
**METHODS**

### new

The `name` and `parent` are the standard `uvm_component` constructor arguments. The `min_size` and `max_size` specify the minimum and maximum number of interfaces that must have been connected to this port by the end of elaboration.

```
function new (string name,
             uvm_component parent,
             int min_size=1,
             int max_size=1)
```

### uvm_*_port #(REQ,RSP)

These bidirectional ports are instantiated by components that `require`, or `use`, the associated interface to convey transactions. A port can be connected to any compatible port, export, or imp port. Unless its `min_size` is 0, a port must be connected to at least one implementation of its associated interface.

The asterisk in `uvm_*_port` is any of the following

- blocking_transport
- nonblocking_transport
- transport
- blocking_master
- nonblocking_master
- master
- blocking_slave
- nonblocking_slave
- slave

Ports are connected to interface implementations directly via `uvm_*_imp #(REQ,RSP,IMP,REQ_IMP,RSP_IMP)` ports or indirectly via hierarchical connections to `uvm_*_port #(REQ,RSP)` and `uvm_*_export #(REQ,RSP)` ports.

**Type parameters**

- `REQ`  The type of request transaction to be communicated by the export
- `RSP`  The type of response transaction to be communicated by the export

**Summary**

`uvm_*_port #(REQ,RSP)`
These bidirectional ports are instantiated by components that require, or use, the associated interface to convey transactions.

**Methods**

**new**

The `name` and `parent` are the standard `uvm_component` constructor arguments. The `min_size` and `max_size` specify the minimum and maximum number of interfaces that must have been supplied to this port by the end of elaboration.

```plaintext
function new (string name, uvm_component parent, int min_size=1, int max_size=1)
```


14.4 uvm_*_imp ports

The following defines the TLM implementation (imp) classes.

Contents

<table>
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<tr>
<th>uvm_*_imp ports</th>
<th>The following defines the TLM implementation (imp) classes.</th>
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<tr>
<td>uvm_*_imp #(T,IMP)</td>
<td>Unidirectional implementation (imp) port classes--An imp port provides access to an implementation of the associated interface to all connected ports and exports.</td>
</tr>
<tr>
<td>uvm_*_imp #(REQ, RSP, IMP, REQ_IMP, RSP_IMP)</td>
<td>Bidirectional implementation (imp) port classes--An imp port provides access to an implementation of the associated interface to all connected ports and exports.</td>
</tr>
</tbody>
</table>

uvm_*_imp #(T,IMP)

Unidirectional implementation (imp) port classes--An imp port provides access to an implementation of the associated interface to all connected ports and exports. Each imp port instance must be connected to the component instance that implements the associated interface, typically the imp port’s parent. All other connections-- e.g. to other ports and exports-- are prohibited.

The asterisk in uvm_*_imp may be any of the following

```plaintext
blocking_put
nonblocking_put
put
blocking_get
nonblocking_get
get
blocking.peek
nonblocking.peek
peek
blocking.get.peek
nonblocking.get.peek
get.peek
```

Type parameters

- **T** The type of transaction to be communicated by the imp
- **IMP** The type of the component implementing the interface. That is, the class to which this imp will delegate.

The interface methods are implemented in a component of type IMP, a handle to which is passed in a constructor argument. The imp port delegates all interface calls to this component.

Summary

uvm_*_imp #(T,IMP)
Unidirectional implementation (imp) port classes--An imp port provides access to an implementation of the associated interface to all connected ports and exports.

**METHODS**

**new**

Creates a new unidirectional imp port with the given name and parent. The parent must implement the interface associated with this port. Its type must be the type specified in the imp's type-parameter, IMP.

```plaintext
function new (string name, IMP parent);
```

Bidirectional implementation (imp) port classes--An imp port provides access to an implementation of the associated interface to all connected ports and exports. Each imp port instance must be connected to the component instance that implements the associated interface, typically the imp port's parent. All other connections-- e.g. to other ports and exports-- are prohibited.

The interface represented by the asterisk is any of the following:

- blocking_transport
- nonblocking_transport
- transport
- blocking_master
- nonblocking_master
- master
- blocking_slave
- nonblocking_slave
- slave

**Type parameters**

- **REQ** Request transaction type
- **RSP** Response transaction type
- **IMP** Component type that implements the interface methods, typically the parent of this imp port.
- **REQ_IMP** Component type that implements the request side of the interface. Defaults to IMP. For master and slave imps only.
Component type that implements the response side of the interface. Defaults to IMP. For master and slave imps only.

The interface methods are implemented in a component of type IMP, a handle to which is passed in a constructor argument. The imp port delegates all interface calls to this component.

The master and slave imps have two modes of operation.

- A single component of type IMP implements the entire interface for both requests and responses.
- Two sibling components of type REQ_IMP and RSP_IMP implement the request and response interfaces, respectively. In this case, the IMP parent instantiates this imp port and the REQ_IMP and RSP_IMP components.

The second mode is needed when a component instantiates more than one imp port, as in the `uvm_tlm_req rsp_channel #(REQ,RSP)` channel.

**Summary**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>new</code></td>
<td>Creates a new bidirectional imp port with the given name and parent.</td>
</tr>
</tbody>
</table>

**ME**

`new` Creates a new bidirectional imp port with the given name and parent. The parent, whose type is specified by IMP type parameter, must implement the interface associated with this port.

Transport imp constructor

```plaintext
function new(string name, IMP imp)
```

Master and slave imp constructor

The optional `req_imp` and `rsp_imp` arguments, available to master and slave imp ports, allow the requests and responses to be handled by different subcomponents. If they are specified, they must point to the underlying component that implements the request and response methods, respectively.

```plaintext
function new(string name, IMP imp, 
             REQ_IMP req_imp=imp, RSP_IMP rsp_imp=imp)
```
14.5 TLM FIFO Classes

This section defines TLM-based FIFO classes.

Contents

<table>
<thead>
<tr>
<th>TLM FIFO Classes</th>
<th>This section defines TLM-based FIFO classes.</th>
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<tbody>
<tr>
<td>uvm_tlm_fifo#(T)</td>
<td>This class provides storage of transactions between two independently running processes.</td>
</tr>
<tr>
<td>uvm_tlm_analysis_fifo#(T)</td>
<td>An analysis_fifo is a uvm_tlm_fifo#(T) with an unbounded size and a write interface.</td>
</tr>
</tbody>
</table>

uvm_tlm_fifo#(T)

This class provides storage of transactions between two independently running processes. Transactions are put into the FIFO via the put_export. transactions are fetched from the FIFO in the order they arrived via the get_peek_export. The put_export and get_peek_export are inherited from the uvm_tlm_fifo_base #(T) super class, and the interface methods provided by these exports are defined by the uvm_tlm_if_base #(T1,T2) class.

Summary

uvm_tlm_fifo#(T)

This class provides storage of transactions between two independently running processes.

<table>
<thead>
<tr>
<th>METHODS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>The name and parent are the normal uvm_component constructor arguments.</td>
</tr>
<tr>
<td>size</td>
<td>Returns the capacity of the FIFO-- that is, the number of entries the FIFO is capable of holding.</td>
</tr>
<tr>
<td>used</td>
<td>Returns the number of entries put into the FIFO.</td>
</tr>
<tr>
<td>is_empty</td>
<td>Returns 1 when there are no entries in the FIFO, 0 otherwise.</td>
</tr>
<tr>
<td>is_full</td>
<td>Returns 1 when the number of entries in the FIFO is equal to its size, 0 otherwise.</td>
</tr>
<tr>
<td>flush</td>
<td>Removes all entries from the FIFO, after which used returns 0 and is_empty returns 1.</td>
</tr>
</tbody>
</table>

Methods

new

function new(
    string name,
    uvm_component parent = null,
    int size = 1
)
The name and parent are the normal uvm_component constructor arguments. The parent should be null if the uvm_tlm_fifo#(T) is going to be used in a statically elaborated construct (e.g., a module). The size indicates the maximum size of the FIFO; a value of zero indicates no upper bound.

size

```c
virtual function int size()
```

Returns the capacity of the FIFO— that is, the number of entries the FIFO is capable of holding. A return value of 0 indicates the FIFO capacity has no limit.

used

```c
virtual function int used()
```

Returns the number of entries put into the FIFO.

is_empty

```c
virtual function bit is_empty()
```

Returns 1 when there are no entries in the FIFO, 0 otherwise.

is_full

```c
virtual function bit is_full()
```

Returns 1 when the number of entries in the FIFO is equal to its size, 0 otherwise.

flush

```c
virtual function void flush()
```

Removes all entries from the FIFO, after which used returns 0 and is_empty returns 1.

**uvm_tlm_analysis_fifo#(T)**

An analysis_fifo is a uvm_tlm_fifo#(T) with an unbounded size and a write interface. It can be used any place a uvm_analysis_imp is used. Typical usage is as a buffer between a uvm_analysis_port in an initiator component and TLM1 target component.

Summary

```c
uvm_tlm_analysis_fifo#(T)
```

An analysis_fifo is a uvm_tlm_fifo#(T) with an unbounded size and a write
The analysis_export provides the write method to all connected analysis ports and parent exports:

```plaintext
function void write (T t)
```

Access via ports bound to this export is the normal mechanism for writing to an analysis FIFO. See write method of uvm_tlm_if_base #(T1,T2) for more information.

This is the standard uvm_component constructor. name is the local name of this component. The parent should be left unspecified when this component is instantiated in statically elaborated constructs and must be specified when this component is a child of another UVM component.
14.6 uvm_tlm_fifo_base #(T)

This class is the base for uvm_tlm_fifo#(T). It defines the TLM exports through which all transaction-based FIFO operations occur. It also defines default implementations for each interface method provided by these exports.

The interface methods provided by the put_export and the get_peek_export are defined and described by uvm_tlm_if_base #(T1,T2). See the TLM Overview section for a general discussion of TLM interface definition and usage.

Parameter type

T  The type of transactions to be stored by this FIFO.

Summary

uvm_tlm_fifo_base #(T)

This class is the base for uvm_tlm_fifo#(T).

CLASS HIERARCHY

| uvm_void |
| uvm_object |
| uvm_report_object |
| uvm_component |
| uvm_tlm_fifo_base#(T) |

CLASS DECLARATION

| virtual class uvm_tlm_fifo_base #( |
| type T = int |
| ) extends uvm_component |

PORTS

| put_export | The put_export provides both the blocking and non-blocking put interface methods to any attached port: |
| get_peek_export | The get_peek_export provides all the blocking and non-blocking get and peek interface methods: |
| put_ap | Transactions passed via put or try_put (via any port connected to the put_export) are sent out this port via its write method. |
| get_ap | Transactions passed via get, try_get, peek, or try_peek (via any port connected to the get_peek_export) are sent out this port via its write method. |

METHODS

| new | The name and parent are the normal uvm_component constructor arguments. |
The *put_export* provides both the blocking and non-blocking put interface methods to any attached port:

```verilog
task put (input T t)
function bit can_put ()
function bit try_put (input T t)
```

Any *put* port variant can connect and send transactions to the FIFO via this export, provided the transaction types match. See `uvm_tlm_if_base #(T1,T2)` for more information on each of the above interface methods.

### get_peek_export

The *get_peek_export* provides all the blocking and non-blocking get and peek interface methods:

```verilog
task get (output T t)
function bit can_get ()
function bit try_get (output T t)
task peek (output T t)
function bit can_peek ()
function bit try_peek (output T t)
```

Any *get* or *peek* port variant can connect to and retrieve transactions from the FIFO via this export, provided the transaction types match. See `uvm_tlm_if_base #(T1,T2)` for more information on each of the above interface methods.

### put_ap

Transactions passed via *put* or *try_put* (via any port connected to the *put_export*) are sent out this port via its *write* method.

```verilog
function void write (T t)
```

All connected analysis exports and imps will receive put transactions. See `uvm_tlm_if_base #(T1,T2)` for more information on the *write* interface method.

### get_ap

Transactions passed via *get*, *try_get*, *peek*, or *try_peek* (via any port connected to the *get_peek_export*) are sent out this port via its *write* method.

```verilog
function void write (T t)
```

All connected analysis exports and imps will receive get transactions. See `uvm_tlm_if_base #(T1,T2)` for more information on the *write* method.
### new

```plaintext
function new(
    string name,
    uvm_component parent = null
)
```

The `name` and `parent` are the normal `uvm_component` constructor arguments. The `parent` should be `null` if the `uvm_tlm_fifo` is going to be used in a statically elaborated construct (e.g., a module). The `size` indicates the maximum size of the FIFO. A value of zero indicates no upper bound.
14.7 TLM Channel Classes

This section defines built-in TLM channel classes.

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<th>This section defines built-in TLM channel classes.</th>
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<td>uvm_tlm_req_rsp_channel #(REQ,RSP)</td>
<td>The uvm_tlm_req_rsp_channel contains a request FIFO of type \textit{REQ} and a response FIFO of type \textit{RSP}.</td>
</tr>
<tr>
<td>uvm_tlm_transport_channel #(REQ,RSP)</td>
<td>A uvm_tlm_transport_channel is a uvm_tlm_req_rsp_channel #(REQ,RSP) that implements the transport interface.</td>
</tr>
</tbody>
</table>

uvm_tlm_req_rsp_channel #(REQ,RSP)

The uvm_tlm_req_rsp_channel contains a request FIFO of type \textit{REQ} and a response FIFO of type \textit{RSP}. These FIFOs can be of any size. This channel is particularly useful for dealing with pipelined protocols where the request and response are not tightly coupled.

Type parameters

- \textit{REQ}  Type of the request transactions conveyed by this channel.
- \textit{RSP}  Type of the response transactions conveyed by this channel.

Summary

uvm_tlm_req_rsp_channel #(REQ,RSP)

The uvm_tlm_req_rsp_channel contains a request FIFO of type \textit{REQ} and a response FIFO of type \textit{RSP}.

Class Hierarchy

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_tlm_req_rsp_channel#(REQ,RSP)

Class Declaration

```plaintext
class uvm_tlm_req_rsp_channel #(
    type REQ = int,
    type RSP = REQ
) extends uvm_component
```

Ports

- put_request_export  The put_export provides both the blocking and non-blocking put interface methods to the request FIFO:
- get_peek_response_export  The get_peek_response_export provides all the blocking and non-blocking get and peek
interface methods to the response FIFO:

**get_peek_request_export**
The get_peek_export provides all the blocking and non-blocking get and peek interface methods to the response FIFO:

**put_response_export**
The put_export provides both the blocking and non-blocking put interface methods to the response FIFO:

**request_ap**
Transactions passed via `put` or `try_put` (via any port connected to the put_request_export) are sent out this port via its write method.

**response_ap**
Transactions passed via `put` or `try_put` (via any port connected to the put_response_export) are sent out this port via its write method.

**master_export**
Exports a single interface that allows a master to put requests and get or peek responses.

**slave_export**
Exports a single interface that allows a slave to get or peek requests and to put responses.

**METHODS**
new

The `name` and `parent` are the standard `uvm_component` constructor arguments.

---

**PUTS**

**put_request_export**
The put_export provides both the blocking and non-blocking put interface methods to the request FIFO:

```plaintext
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>task put (input T t);</td>
<td>sends transactions to the request FIFO via this export, provided the transaction types match.</td>
</tr>
<tr>
<td>function bit can_put ();</td>
<td></td>
</tr>
<tr>
<td>function bit try_put (input T t);</td>
<td></td>
</tr>
</tbody>
</table>
```

**get_peek_response_export**
The get_peek_response_export provides all the blocking and non-blocking get and peek interface methods to the response FIFO:

```plaintext
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>task get (output T t);</td>
<td>retrieves transactions from the response FIFO via this export, provided the transaction types match.</td>
</tr>
<tr>
<td>function bit can_get ();</td>
<td></td>
</tr>
<tr>
<td>function bit try_get (output T t);</td>
<td></td>
</tr>
<tr>
<td>task peek (output T t);</td>
<td></td>
</tr>
<tr>
<td>function bit can_peek ();</td>
<td></td>
</tr>
<tr>
<td>function bit try_peek (output T t);</td>
<td></td>
</tr>
</tbody>
</table>
```

---

**get_peek_request_export**

---

UVM 1.2 Class Reference
The `get_peek_export` provides all the blocking and non-blocking get and peek interface methods to the response FIFO:

```verilog
task get (output T t);
function bit can_get ();
function bit try_get (output T t);
task peek (output T t);
function bit can_peek ();
function bit try_peek (output T t);
```

Any get or peek port variant can connect to and retrieve transactions from the response FIFO via this export, provided the transaction types match.

**put_response_export**

The `put_export` provides both the blocking and non-blocking put interface methods to the response FIFO:

```verilog
task put (input T t);
function bit can_put ();
function bit try_put (input T t);
```

Any put port variant can connect and send transactions to the response FIFO via this export, provided the transaction types match.

**request_ap**

Transactions passed via `put` or `try_put` (via any port connected to the `put_request_export`) are sent out this port via its write method.

```verilog
function void write (T t);
```

All connected analysis exports and imps will receive these transactions.

**response_ap**

Transactions passed via `put` or `try_put` (via any port connected to the `put_response_export`) are sent out this port via its write method.

```verilog
function void write (T t);
```

All connected analysis exports and imps will receive these transactions.

**master_export**

Exports a single interface that allows a master to put requests and get or peek
responses. It is a combination of the put_request_export and get_peek_response_export.

slave_export

Exports a single interface that allows a slave to get or peek requests and to put responses. It is a combination of the get_peek_request_export and put_response_export.

**Methods**

**new**

```language
function new (string name, uvm_component parent = null, int request_fifo_size = 1, int response_fifo_size = 1)
```

The *name* and *parent* are the standard `uvm_component` constructor arguments. The *parent* must be *null* if this component is defined within a static component such as a module, program block, or interface. The last two arguments specify the request and response FIFO sizes, which have default values of 1.

**Summary**

A `uvm_tlm_transport_channel #(REQ,RSP)` is a `uvm_tlm_req_rsp_channel #(REQ,RSP)` that implements the transport interface. It is useful when modeling a non-pipelined bus at the transaction level. Because the requests and responses have a tightly coupled one-to-one relationship, the request and response FIFO sizes are both set to one.
class uvm_tlm_transport_channel #(
    type REQ = int,
    type RSP = REQ,
) extends uvm_tlm_req_rsp_channel #(REQ, RSP)

**Ports**

**transport_export**

The `transport_export` provides both the blocking and non-blocking transport interface methods to the response FIFO:

```plaintext
task transport(REQ request, output RSP response);
function bit nb_transport(REQ request, output RSP response);
```

Any transport port variant can connect to and send requests and retrieve responses via this export, provided the transaction types match. Upon return, the response argument carries the response to the request.

**Methods**

**new**

```plaintext
function new (string name, uvm_component parent = null)
```

The `name` and `parent` are the standard `uvm_component` constructor arguments. The `parent` must be `null` if this component is defined within a statically elaborated construct such as a module, program block, or interface.
14.8 Sequence Item Pull Ports

This section defines the port, export, and imp port classes for communicating sequence items between `uvm_sequencer #(REQ,RSP)` and `uvm_driver #(REQ,RSP)`.

Contents

<table>
<thead>
<tr>
<th>Sequence Item Pull Ports</th>
<th>This section defines the port, export, and imp port classes for communicating sequence items between <code>uvm_sequencer #(REQ,RSP)</code> and <code>uvm_driver #(REQ,RSP)</code>.</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_seq_item_pull_port #(REQ,RSP)</code></td>
<td>UVM provides a port, export, and imp connector for use in sequencer-driver communication. This export type is used in sequencer-driver communication.</td>
</tr>
<tr>
<td><code>uvm_seq_item_pull_export #(REQ,RSP)</code></td>
<td>This export type is used in sequencer-driver communication. It has the standard constructor for exports.</td>
</tr>
<tr>
<td><code>uvm_seq_item_pull_imp #(REQ,RSP,IMP)</code></td>
<td>This imp type is used in sequencer-driver communication.</td>
</tr>
</tbody>
</table>

### uvm_seq_item_pull_port #(REQ,RSP)

UVM provides a port, export, and imp connector for use in sequencer-driver communication. All have standard port connector constructors, except that `uvm_seq_item_pull_port`’s default min_size argument is 0; it can be left unconnected.

**Summary**

**uvm_seq_item_pull_port #(REQ,RSP)**

UVM provides a port, export, and imp connector for use in sequencer-driver communication.

**Class Hierarchy**

```
uvm_port_base#(uvm_sqr_if_base#(REQ,RSP))
uvm_seq_item_pull_port#(REQ,RSP)
```

**Class Declaration**

```
class uvm_seq_item_pull_port #(
    type REQ = int,
    type RSP = REQ
) extends uvm_port_base#(uvm_sqr_if_base #(REQ, RSP))
```

### uvm_seq_item_pull_export #(REQ,RSP)

This export type is used in sequencer-driver communication. It has the standard constructor for exports.

**Summary**
uvm_seq_item_pull_export #(REQ,RSP)

This export type is used in sequencer-driver communication.

**Class Hierarchy**

```
    uvm_port_base#(uvm_sqr_if_base#(REQ,RSP))
    uvm_seq_item_pull_export#(REQ,RSP)
```

**Class Declaration**

```
class uvm_seq_item_pull_export #(                 
    type REQ = int, 
    type RSP = REQ 
) extends uvm_port_base #(uvm_sqr_if_base #(REQ, RSP))
```

uvm_seq_item_pull_imp #(REQ,RSP,IMP)

This imp type is used in sequencer-driver communication. It has the standard constructor for imp-type ports.

**Summary**

**uvm_seq_item_pull_imp #(REQ,RSP,IMP)**

This imp type is used in sequencer-driver communication.

**Class Hierarchy**

```
    uvm_port_base#(uvm_sqr_if_base#(REQ,RSP))
    uvm_seq_item_pull_imp#(REQ,RSP,IMP)
```

**Class Declaration**

```
class uvm_seq_item_pull_imp #(                 
    type REQ = int, 
    type RSP = REQ, 
    type IMP = int
) extends uvm_port_base #(uvm_sqr_if_base #(REQ, RSP))
```

**Methods**

- `new`
14.9 uvm_sqr_if_base #(REQ,RSP)

This class defines an interface for sequence drivers to communicate with sequencers. The driver requires the interface via a port, and the sequencer implements it and provides it via an export.

Summary

**uvm_sqr_if_base #(REQ,RSP)**

This class defines an interface for sequence drivers to communicate with sequencers.

**CLASS DECLARATION**

```plaintext
virtual class uvm_sqr_if_base #(  
    type T1 = uvm_object,  
    T2 = T1  
)
```

**METHODS**

- **get_next_item**
  
  Retrieves the next available item from a sequence.

- **try_next_item**
  
  Retrieves the next available item from a sequence if one is available.

- **item_done**
  
  Indicates that the request is completed to the sequencer.

- **wait_for_sequences**
  
  Waits for a sequence to have a new item available.

- **has_do_available**
  
  Indicates whether a sequence item is available for immediate processing.

- **get**
  
  Retrieves the next available item from a sequence.

- **peek**
  
  Returns the current request item if one is in the sequencer FIFO.

- **put**
  
  Sends a response back to the sequence that issued the request.

- **put_response**
  
  Sends a response back to the sequence that issued the request.

- **disable_auto_item_recording**
  
  By default, item recording is performed automatically when get_next_item() and item_done() are called.

- **is_auto_item_recording_enabled**
  
  Return TRUE if automatic item recording is enabled for this port instance.

**METHODS**

**get_next_item**

```plaintext
virtual task get_next_item(
  output T1 t  
)
```

Retrieves the next available item from a sequence. The call will block until an item is available. The following steps occur on this call:

1. Arbitrate among requesting, unlocked, relevant sequences - choose the highest priority sequence based on the current sequencer arbitration
mode. If no sequence is available, wait for a requesting unlocked relevant sequence, then re-arbitrate.

2 The chosen sequence will return from wait_for_grant

3 The chosen sequence uvm_sequence_base::pre_do is called

4 The chosen sequence item is randomized

5 The chosen sequence uvm_sequence_base::post_do is called

6 Return with a reference to the item

Once get_next_item is called, item_done must be called to indicate the completion of the request to the sequencer. This will remove the request item from the sequencer FIFO.

**try_next_item**

```virtual task try_next_item(
    output T1 t
)
```

Retrieves the next available item from a sequence if one is available. Otherwise, the function returns immediately with request set to null. The following steps occur on this call:

1 Arbitrate among requesting, unlocked, relevant sequences - choose the highest priority sequence based on the current sequencer arbitration mode. If no sequence is available, return null.

2 The chosen sequence will return from wait_for_grant

3 The chosen sequence uvm_sequence_base::pre_do is called

4 The chosen sequence item is randomized

5 The chosen sequence uvm_sequence_base::post_do is called

6 Return with a reference to the item

Once try_next_item is called, item_done must be called to indicate the completion of the request to the sequencer. This will remove the request item from the sequencer FIFO.

**item_done**

```virtual function void item_done(
    input T2 t = null
)
```

Indicates that the request is completed to the sequencer. Any uvm_sequence_base::wait_for_item_done calls made by a sequence for this item will return.

The current item is removed from the sequencer FIFO.

If a response item is provided, then it will be sent back to the requesting sequence. The response item must have its sequence ID and transaction ID set correctly, using the uvm_sequence_item::set_id_info method:

```rsp.set_id_info(req);
```

Before item_done is called, any calls to peek will retrieve the current item that was
obtained by `get_next_item`. After `item_done` is called, `peek` will cause the sequencer to arbitrate for a new item.

**wait_for_sequences**

```plaintext
virtual task wait_for_sequences()
```

Waits for a sequence to have a new item available. The default implementation in the sequencer calls `uvm_wait_for_nba_region`. User-derived sequencers may override its `wait_for_sequences` implementation to perform some other application-specific implementation.

**has_do_available**

```plaintext
virtual function bit has_do_available()
```

Indicates whether a sequence item is available for immediate processing. Implementations should return 1 if an item is available, 0 otherwise.

**get**

```plaintext
virtual task get(
    output T1 t
)
```

Retrieves the next available item from a sequence. The call blocks until an item is available. The following steps occur on this call:

1. Arbitrate among requesting, unlocked, relevant sequences - choose the highest priority sequence based on the current sequencer arbitration mode. If no sequence is available, wait for a requesting unlocked relevant sequence, then re-arbitrate.
2. The chosen sequence will return from `uvm_sequence_base::wait_for_grant`
3. The chosen sequence `uvm_sequence_base::pre_do` is called
4. The chosen sequence item is randomized
5. The chosen sequence `uvm_sequence_base::post_do` is called
6. Indicate `item_done` to the sequencer
7. Return with a reference to the item

When `get` is called, `item_done` may not be called. A new item can be obtained by calling `get` again, or a response may be sent using either `put`, or `uvm_driver::rsp_port.write()`.

**peek**

```plaintext
virtual task peek(
    output T1 t
)
```

Returns the current request item if one is in the sequencer FIFO. If no item is in the FIFO, then the call will block until the sequencer has a new request. The following steps will occur if the sequencer FIFO is empty:

1. Arbitrate among requesting, unlocked, relevant sequences - choose the
highest priority sequence based on the current sequencer arbitration mode. If no sequence is available, wait for a requesting unlocked relevant sequence, then re-arbitrate.

2 The chosen sequence will return from `uvm_sequence_base::wait_for_grant`
3 The chosen sequence `uvm_sequence_base::pre_do` is called
4 The chosen sequence item is randomized
5 The chosen sequence `uvm_sequence_base::post_do` is called

Once a request item has been retrieved and is in the sequencer FIFO, subsequent calls to `peek` will return the same item. The item will stay in the FIFO until either `get` or `item_done` is called.

### put

```plaintext
virtual task put(
    input T2 t
)
```

Sends a response back to the sequence that issued the request. Before the response is put, it must have its sequence ID and transaction ID set to match the request. This can be done using the `uvm_sequence_item::set_id_info` call:

```plaintext
rsp.set_id_info(req);
```

While this is a task, it will not consume time (including delta cycles). The response will be put into the sequence response queue or it will be sent to the sequence response handler.

### put_response

```plaintext
virtual function void put_response(
    input T2 t
)
```

Sends a response back to the sequence that issued the request. Before the response is put, it must have its sequence ID and transaction ID set to match the request. This can be done using the `uvm_sequence_item::set_id_info` call:

```plaintext
rsp.set_id_info(req);
```

### disable_auto_item_recording

```plaintext
virtual function void disable_auto_item_recording()
```

By default, item recording is performed automatically when `get_next_item()` and `item_done()` are called. However, this works only for simple, in-order, blocking transaction execution. For pipelined and out-of-order transaction execution, the driver must turn off this automatic recording and call `uvm_transaction::accept_tr`, `uvm_transaction::begin_tr` and `uvm_transaction::end_tr` explicitly at appropriate points in time.

This methods be called at the beginning of the driver's `run_phase()` method. Once disabled, automatic recording cannot be re-enabled.

For backward-compatibility, automatic item recording can be globally turned off at
compile time by defining UVM_DISABLE_AUTO_ITEM_RECORDING

**is_auto_item_recording_enabled**

```c
virtual function bit is_auto_item_recording_enabled()
```

Return TRUE if automatic item recording is enabled for this port instance.
Sockets group together all the necessary core interfaces for transportation and binding, allowing more generic usage models than just TLM core interfaces.

A socket is like a port or export; in fact it is derived from the same base class as ports and export, namely `uvm_port_base #(IF)`. However, unlike a port or export a socket provides both a forward and backward path. Thus you can enable asynchronous (pipelined) bi-directional communication by connecting sockets together. To enable this, a socket contains both a port and an export. Components that initiate transactions are called initiators, and components that receive transactions sent by an initiator are called targets. Initiators have initiator sockets and targets have target sockets. Initiator sockets can connect to target sockets. You cannot connect initiator sockets to other initiator sockets and you cannot connect target sockets to target sockets.

**The UVM TLM2 subset provides the following two transport interfaces**

- **Blocking (`b_transport`)** completes the entire transaction within a single method call.
- **Non-blocking (`nb_transport`)** describes the progress of a transaction using multiple `nb_transport()` method calls going back-and-forth between initiator and target.

In general, any component might modify a transaction object during its lifetime (subject to the rules of the protocol). Significant timing points during the lifetime of a transaction (for example: start of response-phase) are indicated by calling `nb_transport()` in either forward or backward direction, the specific timing point being given by the phase argument. Protocol-specific rules for reading or writing the attributes of a transaction can be expressed relative to the phase. The phase can be used for flow control, and for that reason might have a different value at each hop taken by a transaction; the phase is not an attribute of the transaction object.

A call to `nb_transport()` always represents a phase transition. However, the return from `nb_transport()` might or might not do so, the choice being indicated by the value returned from the function (`UVM_TLM_ACCEPTED` versus `UVM_TLM_UPDATED`). Generally, you indicate the completion of a transaction over a particular hop using the value of the phase argument. As a shortcut, a target might indicate the completion of the transaction by returning a special value of `UVM_TLM_COMPLETED`. However, this is an option, not a necessity.

The transaction object itself does not contain any timing information by design. Or even events and status information concerning the API. You can pass the delays as arguments to `b_transport()`/ `nb_transport()` and push the actual realization of any delay in the simulator kernel downstream and defer (for simulation speed).

**Use Models**

Since sockets are derived from `uvm_port_base #(IF)` they are created and connected in the same way as port, and exports. Create them in the build phase and connect them in the connect phase by calling `connect()`. Initiator and target termination sockets are on the ends of any connection. There can be an arbitrary number of pass-through sockets in the path between initiator and target. Some socket types must be bound to imps implementations of the transport tasks and functions. Blocking terminator sockets must be bound to an implementation of `b_transport()`, for example. Nonblocking initiator sockets must be bound to an implementation of `nb_transport_bw()` and nonblocking target sockets must be bound to an implementation of `nb_transport_fw()`. Typically, the
task or function is implemented in the component in which the socket is instantiated and the component type and instance are provided to complete the binding.

Consider for example a consumer component with a blocking target socket.

Example

class consumer extends uvm_component;
    tlm2_b_target_socket #(consumer, trans) target_socket;
function new(string name, uvm_component parent);
    super.new(name, parent);
endfunction
function void build();
    target_socket = new("target_socket", this, this);
endfunction

task b_transport(trans t, uvm_tlm_time delay);
    #5;
    uvm_report_info("consumer", t.convert2string());
endtask
endclass

The interface task b_transport() is implemented in the consumer component. The consumer component type is used in the declaration of the target socket. This informs the socket object the type of the object that contains the interface task, in this case b_transport(). When the socket is instantiated “this” is passed in twice, once as the parent just like any other component instantiation and again to identify the object that holds the implementation of b_transport(). Finally, in order to complete the binding, an implementation of b_transport() must be present in the consumer component. Any component that has either a blocking termination socket, a nonblocking initiator socket, or a nonblocking termination socket must provide implementations of the relevant components. This includes initiator and target components as well as interconnect components that have these kinds of sockets. Components with pass-through sockets do not need to provide implementations of any sort. Of course, they must ultimately be connected to sockets that do that the necessary implementations.

In summary

- **Call to b_transport()**
  - start-of-life of transaction
- **Return from b_transport()**
  - end-of-life of transaction
- **Phase argument to nb_transport()**
  - timing point within lifetime of transaction
- **Return value of nb_transport()**
  - whether return path is being used
  - (also shortcut to final phase)
- **Response status within transaction object**
  - protocol-specific status,
  - success/failure of transaction

On top of this, TLM-2.0 defines a generic payload and base protocol to enhance interoperability for models with a memory-mapped bus interface.

It is possible to use the interfaces described above with user-defined transaction types and protocols for the sake of interoperability. However, TLM-2.0 strongly recommends either using the base protocol off-the-shelf or creating models of specific protocols on top of the base protocol.

The UVM 1.2 standard only defines and supports this TLM2 style interface for SystemVerilog to SystemVerilog communication. Mixed language TLM communication is saved for future extension.

**Summary**
TLM2 Interfaces, Ports, Exports and Transport Interfaces Subset

Sockets group together all the necessary core interfaces for transportation and binding, allowing more generic usage models than just TLM core interfaces.
### 15.1 Interface Masks

Each of the following macros is a mask that identifies which interfaces a particular port requires or export provides. The interfaces are identified by bit position and can be OR’ed together for combination ports/exports. The mask is used to do run-time interface type checking of port/export connections.

#### Summary

<table>
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<th>Interface Masks</th>
<th>Description</th>
<th>Assignment</th>
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</thead>
<tbody>
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<td></td>
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<tr>
<td><code>UVM_TLM_NB_FW_MASK</code></td>
<td>Define Non blocking Forward mask onehot</td>
<td><code>b001</code></td>
</tr>
<tr>
<td><code>UVM_TLM_NB_BW_MASK</code></td>
<td>Define Non blocking backward mask onehot</td>
<td><code>b010</code></td>
</tr>
<tr>
<td><code>UVM_TLM_B_MASK</code></td>
<td>Define blocking mask onehot</td>
<td><code>b100</code></td>
</tr>
</tbody>
</table>

#### Macros

**`UVM_TLM_NB_FW_MASK`**

Define Non blocking Forward mask onehot assignment = `b001`

**`UVM_TLM_NB_BW_MASK`**

Define Non blocking backward mask onehot assignment = `b010`

**`UVM_TLM_B_MASK`**

Define blocking mask onehot assignment = `b100`
# 15.2 TLM2 Types

## Summary

<table>
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<th>TLM2 Types</th>
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<td><strong>MACROS</strong></td>
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<td><code>UVM_TLM_TASK_ERROR</code></td>
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<tr>
<td><code>UVM_TLM_FUNCTION_ERROR</code></td>
</tr>
</tbody>
</table>

## ENUMERATIONS

### `uvm_tlm_phase_e`
Nonblocking transport synchronization state values between an initiator and a target.

- **UNINITIALIZED_PHASE** Defaults for constructor
- **BEGIN_REQ** Beginning of request phase
- **END_REQ** End of request phase
- **BEGIN_RESP** Beginning of response phase
- **END_RESP** End of response phase

### `uvm_tlm_sync_e`
Pre-defined phase state values for the nonblocking transport Base Protocol between an initiator and a target.

- **UVM_TLM_ACCEPTED** Transaction has been accepted
- **UVM_TLM_UPDATED** Transaction has been modified
- **UVM_TLM_COMPLETED** Execution of transaction is complete

## MACROS

### `UVM_TLM_TASK_ERROR`
Defines Not-Yet-Implemented TLM tasks
`UVM_TLM_FUNCTION_ERROR
Defines Not-Yet-Implemented TLM functions

**uvm_tlm_if**

Base class type to define the transport functions.

- nb_transport_fw
- nb_transport_bw
- b_transport

**Summary**

**uvm_tlm_if**

Base class type to define the transport functions.

**Class Declaration**

```markdown
class uvm_tlm_if #(type T = uvm_tlm_generic_payload,
                  type P = uvm_tlm_phase_e)
```

**TLM TRANSPORT METHODS**

Each of the interface methods take a handle to the transaction to be transported and a reference argument for the delay. In addition, the nonblocking interfaces take a reference argument for the phase.

**nb_transport_fw**

```markdown
virtual function uvm_tlm_sync_e nb_transport_fw(T t,
                                                ref P p,
                                                input uvm_tlm_time delay)
```

Forward path call. The first call to this method for a transaction marks the initial timing point. Every call to this method may mark a timing point in the execution of the transaction. The timing annotation argument allows the timing points to be offset from the simulation times at which the forward path is used. The final timing point of a transaction may be marked by a call to `nb_transport_bw` or a return from this or subsequent call to `nb_transport_fw`.

See [TLM2 Interfaces, Ports, Exports and Transport Interfaces Subset](#) for more details on...
the semantics and rules of the nonblocking transport interface.

### nb_transport_bw

```plaintext
virtual function uvm_tlm_sync_e nb_transport_bw(
    T t,
    ref P p,
    input uvm_tlm_time delay
)
```

Implementation of the backward path. This function MUST be implemented in the INITIATOR component class.

Every call to this method may mark a timing point, including the final timing point, in the execution of the transaction. The timing annotation argument allows the timing point to be offset from the simulation times at which the backward path is used. The final timing point of a transaction may be marked by a call to `nb_transport_fw` or a return from this or subsequent call to `nb_transport_bw`.

See TLM2 Interfaces, Ports, Exports and Transport Interfaces Subset for more details on the semantics and rules of the nonblocking transport interface.

### Example

```plaintext
class master extends uvm_component;

uvm_tlm_nb_initiator_socket #(trans, uvm_tlm_phase_e, this_t) initiator_socket;

function void build_phase(uvm_phase phase);
endfunction

function uvm_tlm_sync_e nb_transport_bw(ref trans t, ref uvm_tlm_phase_e p, input uvm_tlm_time delay);
    transaction = t;
    state = p;
    return UVM_TLM_ACCEPTED;
endfunction

initiator_socket = new("initiator_socket", this, this);

endfunction
```

### b_transport

```plaintext
virtual task b_transport(
    T t,
    uvm_tlm_time delay
)
```

Execute a blocking transaction. Once this method returns, the transaction is assumed to have been executed. Whether that execution is successful or not must be indicated by
the transaction itself.

The callee may modify or update the transaction object, subject to any constraints imposed by the transaction class. The initiator may re-use a transaction object from one call to the next and across calls to b_transport().

The call to b_transport shall mark the first timing point of the transaction. The return from b_transport shall mark the final timing point of the transaction. The timing annotation argument allows the timing points to be offset from the simulation times at which the task call and return are executed.
15.3 TLM Generic Payload & Extensions

The Generic Payload transaction represents a generic bus read/write access. It is used as the default transaction in TLM2 blocking and nonblocking transport interfaces.

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**GLOBALS**

Defines, Constants, enums.

**uvm_tlm_command_e**

Command attribute type definition

- **UVM_TLM_READ_COMMAND**  Bus read operation
- **UVM_TLM_WRITE_COMMAND**  Bus write operation
- **UVM_TLM_IGNORE_COMMAND**  No bus operation.

**uvm_tlm_response_status_e**

Response status attribute type definition

- **UVM_TLM_OK_RESPONSE**  Bus operation completed successfully
- **UVM_TLM_INCOMPLETE_RESPONSE**  Transaction was not delivered to target
- **UVM_TLM_GENERIC_ERROR_RESPONSE**  Bus operation had an error
- **UVM_TLM_ADDRESS_ERROR_RESPONSE**  Invalid address specified
- **UVM_TLM_COMMAND_ERROR_RESPONSE**  Invalid command specified
- **UVM_TLM_BURST_ERROR_RESPONSE**  Invalid burst specified
- **UVM_TLM_BYTE_ENABLE_ERROR_RESPONSE**  Invalid byte enabling specified
**uvm_tlm_generic_payload**

This class provides a transaction definition commonly used in memory-mapped bus-based systems. It's intended to be a general purpose transaction class that lends itself to many applications. The class is derived from uvm_sequence_item which enables it to be generated in sequences and transported to drivers through sequencers.

**Summary**

This class provides a transaction definition commonly used in memory-mapped bus-based systems.

### Class Hierarchy

```
  uvm_void
  uvm_object
  uvm_transaction
  uvm_sequence_item
  uvm_tlm_generic_payload
```

### Class Declaration

```
class uvm_tlm_generic_payload extends uvm_sequence_item
```

- **m_address**
  - Address for the bus operation.

- **m_command**
  - Bus operation type.

- **m_data**
  - Data read or to be written.

- **m_length**
  - The number of bytes to be copied to or from the **m_data** array, inclusive of any bytes disabled by the **m_byte_enable** attribute.

- **m_response_status**
  - Status of the bus operation.

- **m_dmi**
  - DMI mode is not yet supported in the UVM TLM2 subset.

- **m_byte_enable**
  - Indicates valid **m_data** array elements.

- **m_byte_enable_length**
  - The number of elements in the **m_byte_enable** array.

- **m_streaming_width**
  - Number of bytes transferred on each beat.

- **new**
  - Create a new instance of the generic payload.

### Accessors

- **get_command**
  - Get the value of the **m_command** variable.

- **set_command**
  - Set the value of the **m_command** variable.

- **is_read**
  - Returns true if the current value of the **m_command** variable is **UVM_TLM_READ_COMMAND**.

- **set_read**
  - Set the current value of the **m_command** variable to **UVM_TLM_READ_COMMAND**.

- **is_write**
  - Returns true if the current value of the **m_command** variable is **UVM_TLM_WRITE_COMMAND**.

- **set_write**
  - Set the current value of the **m_command** variable.
Address for the bus operation. Should be set or read using the `set_address` and `get_address` methods. The variable should be used only when constraining.

For a read command or a write command, the target shall interpret the current value of the address attribute as the start address in the system memory map of the contiguous block of data being read or written. The address associated with any given byte in the data array is dependent upon the address attribute, the array index, the streaming width attribute, the endianness and the width of the physical bus.

If the target is unable to execute the transaction with the given address attribute (because the address is out-of-range, for example) it shall generate a standard error response. The recommended response status is `UVM_TLM_ADDRESS_ERROR_RESPONSE`.

**m_address**

```
rand bit [63:0] m_address
```

**m_command**
Bus operation type. Should be set using the `set_command`, `set_read` or `set_write` methods and read using the `get_command`, `is_read` or `is_write` methods. The variable should be used only when constraining.

If the target is unable to execute a read or write command, it shall generate a standard error response. The recommended response status is `UVM_TLM_COMMAND_ERROR_RESPONSE`.

On receipt of a generic payload transaction with the command attribute equal to `UVM_TLM_IGNORE_COMMAND`, the target shall not execute a write command or a read command not modify any data. The target may, however, use the value of any attribute in the generic payload, including any extensions.

The command attribute shall be set by the initiator, and shall not be overwritten by any interconnect

### m_data

Data read or to be written. Should be set and read using the `set_data` or `get_data` methods. The variable should be used only when constraining.

For a read command or a write command, the target shall copy data to or from the data array, respectively, honoring the semantics of the remaining attributes of the generic payload.

For a write command or `UVM_TLM_IGNORE_COMMAND`, the contents of the data array shall be set by the initiator, and shall not be overwritten by any interconnect component or target. For a read command, the contents of the data array shall be overwritten by the target (honoring the semantics of the byte enable) but by no other component.

Unlike the OSCI TLM-2.0 LRM, there is no requirement on the endianness of multi-byte data in the generic payload to match the host endianness. Unlike C++, it is not possible in SystemVerilog to cast an arbitrary data type as an array of bytes. Therefore, matching the host endianness is not necessary. In contrast, arbitrary data types may be converted to and from a byte array using the streaming operator and `uvm_object` objects may be further converted using the `uvm_object::pack_bytes()` and `uvm_object::unpack_bytes()` methods. All that is required is that a consistent mechanism is used to fill the payload data array and later extract data from it.

Should a generic payload be transferred to/from a SystemC model, it will be necessary for any multi-byte data in that generic payload to use/be interpreted using the host endianness. However, this process is currently outside the scope of this standard.

### m_length

The number of bytes to be copied to or from the `m_data` array, inclusive of any bytes disabled by the `m_byte_enable` attribute.

The data length attribute shall be set by the initiator, and shall not be overwritten by any interconnect component or target.

The data length attribute shall not be set to 0. In order to transfer zero bytes, the
**m_command** attribute should be set to **UVM_TLM_IGNORE_COMMAND**.

---

**m_response_status**

```markdown
rand uvm_tlm_response_status_e m_response_status
```

Status of the bus operation. Should be set using the `set_response_status` method and read using the `get_response_status`, `get_response_string`, `is_response_ok` or `is_response_error` methods. The variable should be used only when constraining.

The response status attribute shall be set to **UVM_TLM_INCOMPLETE_RESPONSE** by the initiator, and may be overwritten by the target. The response status attribute should not be overwritten by any interconnect component, because the default value **UVM_TLM_INCOMPLETE_RESPONSE** indicates that the transaction was not delivered to the target.

The target may set the response status attribute to **UVM_TLM_OK_RESPONSE** to indicate that it was able to execute the command successfully, or to one of the five error responses to indicate an error. The target should choose the appropriate error response depending on the cause of the error. If a target detects an error but is unable to select a specific error response, it may set the response status to **UVM_TLM GENERIC_ERROR RESPONSE**.

The target shall be responsible for setting the response status attribute at the appropriate point in the lifetime of the transaction. In the case of the blocking transport interface, this means before returning control from `b_transport`. In the case of the non-blocking transport interface and the base protocol, this means before sending the `BEGIN_RESP` phase or returning a value of **UVM_TLM_COMPLETED**.

It is recommended that the initiator should always check the response status attribute on receiving a transition to the `BEGIN_RESP` phase or after the completion of the transaction. An initiator may choose to ignore the response status if it is known in advance that the value will be **UVM_TLM_OK_RESPONSE**, perhaps because it is known in advance that the initiator is only connected to targets that always return **UVM_TLM_OK_RESPONSE**, but in general this will not be the case. In other words, the initiator ignores the response status at its own risk.

---

**m_dmi**

```markdown
bit m_dmi
```

DMI mode is not yet supported in the UVM TLM2 subset. This variable is provided for completeness and interoperability with SystemC.

---

**m_byte_enable**

```markdown
rand byte unsigned m_byte_enable[]
```

Indicates valid `m_data` array elements. Should be set and read using the `set_byte_enable` or `get_byte_enable` methods. The variable should be used only when constraining.

The elements in the byte enable array shall be interpreted as follows. A value of `8'h00` shall indicate that the corresponding byte is disabled, and a value of `8'hFF` shall indicate that the corresponding byte is enabled.
Byte enables may be used to create burst transfers where the address increment between each beat is greater than the number of significant bytes transferred on each beat, or to place words in selected byte lanes of a bus. At a more abstract level, byte enables may be used to create “lacy bursts” where the data array of the generic payload has an arbitrary pattern of holes punched in it.

The byte enable mask may be defined by a small pattern applied repeatedly or by a large pattern covering the whole data array. The byte enable array may be empty, in which case byte enables shall not be used for the current transaction.

The byte enable array shall be set by the initiator and shall not be overwritten by any interconnect component or target.

If the byte enable pointer is not empty, the target shall either implement the semantics of the byte enable as defined below or shall generate a standard error response. The recommended response status is UVM_TLM_BYTE_ENABLE_ERROR_RESPONSE.

In the case of a write command, any interconnect component or target should ignore the values of any disabled bytes in the m_data array. In the case of a read command, any interconnect component or target should not modify the values of disabled bytes in the m_data array.

---

**m_byte_enable_length**

```c
rand int unsigned m_byte_enable_length
```

The number of elements in the m_byte_enable array.

It shall be set by the initiator, and shall not be overwritten by any interconnect component or target.

**m_streaming_width**

```c
rand int unsigned m_streaming_width
```

Number of bytes transferred on each beat. Should be set and read using the `set_streaming_width` or `get_streaming_width` methods. The variable should be used only when constraining.

Streaming affects the way a component should interpret the data array. A stream consists of a sequence of data transfers occurring on successive notional beats, each beat having the same start address as given by the generic payload address attribute. The streaming width attribute shall determine the width of the stream, that is, the number of bytes transferred on each beat. In other words, streaming affects the local address associated with each byte in the data array. In all other respects, the organization of the data array is unaffected by streaming.

The bytes within the data array have a corresponding sequence of local addresses within the component accessing the generic payload transaction. The lowest address is given by the value of the address attribute. The highest address is given by the formula `address_attribute + streaming_width - 1`. The address to or from which each byte is being copied in the target shall be set to the value of the address attribute at the start of each beat.

With respect to the interpretation of the data array, a single transaction with a streaming width shall be functionally equivalent to a sequence of transactions each having the same address as the original transaction, each having a data length attribute equal to the streaming width of the original, and each with a data array that is a different subset of
the original data array on each beat. This subset effectively steps down the original data array maintaining the sequence of bytes.

A streaming width of 0 indicates that a streaming transfer is not required. It is equivalent to a streaming width value greater than or equal to the size of the m_data array.

Streaming may be used in conjunction with byte enables, in which case the streaming width would typically be equal to the byte enable length. It would also make sense to have the streaming width a multiple of the byte enable length. Having the byte enable length a multiple of the streaming width would imply that different bytes were enabled on each beat.

If the target is unable to execute the transaction with the given streaming width, it shall generate a standard error response. The recommended response status is TLM_BURST_ERROR_RESPONSE.

```
new
```

```cpp
definition new(
    string name = ""
)
```

Create a new instance of the generic payload. Initialize all the members to their default values.

**Accessors**

The accessor functions let you set and get each of the members of the generic payload. All of the accessor methods are virtual. This implies a slightly different use model for the generic payload than in SystemC. The way the generic payload is defined in SystemC does not encourage you to create new transaction types derived from uvm_tlm_generic_payload. Instead, you would use the extensions mechanism. Thus in SystemC none of the accessors are virtual.

```
get_command
```

```cpp
virtual function uvm_tlm_command_e get_command()
```

Get the value of the m_command variable

```
set_command
```

```cpp
virtual function void set_command(
    uvm_tlm_command_e command
)
```

Set the value of the m_command variable

```
is_read
```

```cpp
virtual function bit is_read()
```

Returns true if the current value of the m_command variable is
set_read

virtual function void set_read()

Set the current value of the m_command variable to `UVM_TLM_READ_COMMAND`.

is_write

virtual function bit is_write()

Returns true if the current value of the m_command variable is `UVM_TLM_WRITE_COMMAND`.

set_write

virtual function void set_write()

Set the current value of the m_command variable to `UVM_TLM_WRITE_COMMAND`.

set_address

virtual function void set_address(
  bit [63:0] addr
)

Set the value of the m_address variable

geren_address

virtual function bit [63:0] get_address()

Get the value of the m_address variable

geren_data

virtual function void get_data (
  output byte unsigned p[]
)

Return the value of the m_data array

set_data

virtual function void set_data(
  ref byte unsigned p[]
)

Set the value of the m_data array
**get_data_length**

virtual function int unsigned get_data_length()

Return the current size of the m_data array

**set_data_length**

virtual function void set_data_length( int unsigned length )

Set the value of the m_length

**get_streaming_width**

virtual function int unsigned get_streaming_width()

Get the value of the m_streaming_width array

**set_streaming_width**

virtual function void set_streaming_width( int unsigned width )

Set the value of the m_streaming_width array

**get_byte_enable**

virtual function void get_byte_enable( output byte unsigned p[] )

Return the value of the m_byte_enable array

**set_byte_enable**

virtual function void set_byte_enable( ref byte unsigned p[] )

Set the value of the m_byte_enable array

**get_byte_enable_length**

virtual function int unsigned get_byte_enable_length()

Return the current size of the m_byte_enable array
set_byte_enable_length

```cpp
virtual function void set_byte_enable_length(
    int unsigned length
)
```

Set the size `m_byte_enable_length` of the `m_byte_enable` array i.e. `m_byte_enable.size()`

set_dmi_allowed

```cpp
virtual function void set_dmi_allowed(
    bit dmi
)
```

DMI hint. Set the internal flag `m_dmi` to allow dmi access

is_dmi_allowed

```cpp
virtual function bit is_dmi_allowed()
```

DMI hint. Query the internal flag `m_dmi` if allowed dmi access

get_response_status

```cpp
virtual function uvm_tlm_response_status_e get_response_status()
```

Return the current value of the `m_response_status` variable

set_response_status

```cpp
virtual function void set_response_status(
    uvm_tlm_response_status_e status
)
```

Set the current value of the `m_response_status` variable

is_response_ok

```cpp
virtual function bit is_response_ok()
```

Return TRUE if the current value of the `m_response_status` variable is `UVM_TLM_OK_RESPONSE`

is_response_error

```cpp
virtual function bit is_response_error()
```

Return TRUE if the current value of the `m_response_status` variable is not `UVM_TLM_OK_RESPONSE`
**get_response_string**

Virtual function string get_response_string()

Return the current value of the m_response_status variable as a string.

**EXTENSIONS MECHANISM**

**set_extension**

Function uvm_tlm_extension_base set_extension(uvm_tlm_extension_base ext)

Add an instance-specific extension. Only one instance of any given extension type is allowed. If there is an existing extension instance of the type of ext, ext replaces it and its handle is returned. Otherwise, null is returned.

**get_num_extensions**

Function int get_num_extensions()

Return the current number of instance specific extensions.

**get_extension**

Function uvm_tlm_extension_base get_extension(uvm_tlm_extension_base ext_handle)

Return the instance specific extension bound under the specified key. If no extension is bound under that key, null is returned.

**clear_extension**

Function void clear_extension(uvm_tlm_extension_base ext_handle)

Remove the instance-specific extension bound under the specified key.

**clear_extensions**

Function void clear_extensions()

Remove all instance-specific extensions.

**pre_randomize()**
function void pre_randomize()

Prepare this class instance for randomization

**post_randomize()**

function void post_randomize()

Clean-up this class instance after randomization

**uvm_tlm_gp**

This typedef provides a short, more convenient name for the `uvm_tlm_generic_payload` type.

### Summary

**uvm_tlm_gp**

This typedef provides a short, more convenient name for the `uvm_tlm_generic_payload` type.

**Class Declaration**

```
typedef uvm_tlm_generic_payload uvm_tlm_gp
```

**uvm_tlm_extension_base**

The class `uvm_tlm_extension_base` is the non-parameterized base class for all generic payload extensions. It includes the utility `do_copy()` and `create()`. The pure virtual function `get_type_handle()` allows you to get a unique handle that represents the derived type. This is implemented in derived classes.

This class is never used directly by users. The `uvm_tlm_extension` class is used instead.

### Summary

**uvm_tlm_extension_base**

The class `uvm_tlm_extension_base` is the non-parameterized base class for all generic payload extensions.

**Class Hierarchy**

```
uvm_void
uvm_object
uvm_tlm_extension_base
```

**Class Declaration**
virtual class uvm_tlm_extension_base extends uvm_object

**Methods**

**new**

```plaintext
function new(
    string name = ""
)
```

**get_type_handle**

```plaintext
pure virtual function uvm_tlm_extension_base get_type_handle()
```

An interface to polymorphically retrieve a handle that uniquely identifies the type of the sub-class

**get_type_handle_name**

```plaintext
pure virtual function string get_type_handle_name()
```

An interface to polymorphically retrieve the name that uniquely identifies the type of the sub-class

**create**

```plaintext
virtual function uvm_object create ( 
    string name = ""
)
```

**uvm_tlm_extension**

TLM extension class. The class is parameterized with arbitrary type which represents the type of the extension. An instance of the generic payload can contain one extension object of each type; it cannot contain two instances of the same extension type.

The extension type can be identified using the **ID()** method.

To implement a generic payload extension, simply derive a new class from this class and specify the name of the derived class as the extension parameter.
class my_ID extends uvm_tlm_extension#(my_ID);
  int ID;

  `uvm_object_utils_begin(my_ID)
  `uvm_field_int(ID, UVM_ALL_ON)
  `uvm_object_utils_end

  function new(string name = "my_ID");
    super.new(name);
  endfunction

endclass

Summary

**uvm_tlm_extension**

TLM extension class.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_tlm_extension_base
  uvm_tlm_extension
```

**Class Declaration**

```
class uvm_tlm_extension #(type T=int)
  extends uvm_tlm_extension_base
endclass
```

**Methods**

**new**

```
function new();
  string name = ""
endfunction
```

creates a new extension object.

**ID()**

```
static function this_type ID();
```

Return the unique ID of this TLM extension type. This method is used to identify the type of the extension to retrieve from a uvm_tlm_generic_payload instance, using the uvm_tlm_generic_payload::get_extension() method.
15.4 TLM Socket Base Classes

A collection of base classes, one for each socket type. The reason for having a base class for each socket is that all the socket (base) types must be known before connect is defined. Socket connection semantics are provided in the derived classes, which are user visible.

**Termination Sockets**
A termination socket must be the terminus of every TLM path. A transaction originates with an initiator socket and ultimately ends up in a target socket. There may be zero or more pass-through sockets between initiator and target.

**Pass-through Sockets**
Pass-through initiators are ports and contain exports for instance IS-A port and HAS-A export. Pass-through targets are the opposite, they are exports and contain ports.

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---

**uvm_tlm_b_target_socket_base**

IS-A forward imp; has no backward path except via the payload contents.

### Summary

**uvm_tlm_b_target_socket_base**

IS-A forward imp; has no backward path except via the payload contents.

**CLASS HIERARCHY**

```
  uvm_port_base#(uvm_tlm_if#(T))
  uvm_tlm_b_target_socket_base
```
**uvm_tlm_b_initiator_socket_base**

IS-A forward port; has no backward path except via the payload contents

**Summary**

**Class Hierarchy**

```
class uvm_tlm_b_initiator_socket_base #(
    type T = uvm_tlm_generic_payload
) extends uvm_port_base #(uvm_tlm_if #(T))
```

**uvm_tlm_nb_target_socket_base**

IS-A forward imp; HAS-A backward port

**Summary**

**Class Hierarchy**

```
class uvm_tlm_nb_target_socket_base #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

---

**CLASS DECLARATION**

```
class uvm_tlm_b_target_socket_base #(
    type T = uvm_tlm_generic_payload
) extends uvm_port_base #(uvm_tlm_if #(T))
```

---

UVM 1.2 Class Reference

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**uvm_tlm Nb Initiator Socket Base**

IS-A forward port; HAS-A backward imp

**Summary**

**uvm_tlm_nb_initiator_socket_base**

IS-A forward port; HAS-A backward imp

**CLASS HIERARCHY**

```
uvm_port_base#(uvm_tlm_if#(T,P))
```

**CLASS DECLARATION**

```
class uvm_tlm_nb_initiator_socket_base #(  
    type T = uvm_tlm_generic_payload,  
    type P = uvm_tlm_phase_e  
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

---

**uvm_tlm_nb_passthrough_initiator_socket_base**

IS-A forward port; HAS-A backward export

**Summary**

**uvm_tlm_nb_passthrough_initiator_socket_base**

IS-A forward port; HAS-A backward export

**CLASS HIERARCHY**

```
uvm_port_base#(uvm_tlm_if#(T,P))
```

**CLASS DECLARATION**

```
class uvm_tlm_nb_passthrough_initiator_socket_base #(  
    type T = uvm_tlm_generic_payload,  
    type P = uvm_tlm_phase_e  
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

---

**uvm_tlm_nb_passthrough_target_socket_base**

IS-A forward export; HAS-A backward port

**Summary**
**uvm_tlm_nb_passthrough_target_socket_base**

IS-A forward export; HAS-A backward port

**Class Hierarchy**

```plaintext
uvm_port_base#(uvm_tlm_if#(T,P))

uvm_tlm_nb_passthrough_target_socket_base
```

**Class Declaration**

```plaintext
class uvm_tlm_nb_passthrough_target_socket_base #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

---

**uvm_tlm_b_passthrough_initiator_socket_base**

IS-A forward port

**Summary**

**uvm_tlm_b_passthrough_initiator_socket_base**

IS-A forward port

**Class Hierarchy**

```plaintext
uvm_port_base#(uvm_tlm_if#(T))

uvm_tlm_b_passthrough_initiator_socket_base
```

**Class Declaration**

```plaintext
class uvm_tlm_b_passthrough_initiator_socket_base #(
    type T = uvm_tlm_generic_payload
) extends uvm_port_base #(uvm_tlm_if #(T))
```

---

**uvm_tlm_b_passthrough_target_socket_base**

IS-A forward export

**Summary**

**uvm_tlm_b_passthrough_target_socket_base**

IS-A forward export

**Class Hierarchy**

```plaintext
uvm_port_base#(uvm_tlm_if#(T))

uvm_tlm_b_passthrough_target_socket_base
```
class uvm_tlm_b_passthrough_target_socket_base #(type T = uvm_tlm_generic_payload) extends uvm_port_base #(uvm_tlm_if #(T))
15.5 TLM Sockets

Each uvm_tlm_*_socket class is derived from a corresponding uvm_tlm_*_socket_base class. The base class contains most of the implementation of the class. The derived classes (in this file) contain the connection semantics.

Sockets come in several flavors: Each socket is either an initiator or a target, a pass-through or a terminator. Further, any particular socket implements either the blocking interfaces or the nonblocking interfaces. Terminator sockets are used on initiators and targets as well as interconnect components as shown in the figure above. Pass-through sockets are used to enable connections to cross hierarchical boundaries.

There are eight socket types: the cross of blocking and nonblocking, pass-through and termination, target and initiator.

Sockets are specified based on what they are (IS-A) and what they contains (HAS-A). IS-A and HAS-A are types of object relationships. IS-A refers to the inheritance relationship and HAS-A refers to the ownership relationship. For example if you say D is a B that means that D is derived from base B. If you say object A HAS-A B that means that B is a member of A.

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uvm_tlm_b_initiator_socket

IS-A forward port; has no backward path except via the payload contents.

Summary

| uvm_tlm_b_initiator_socket | IS-A forward port; has no backward path except via the payload contents. |

Class Hierarchy

```
| uvm_tlm_b_initiator_socket_base#(T) |
```
**uvm_tlm_b_initiator_socket**

**CLASS DECLARATION**

```
class uvm_tlm_b_initiator_socket #(type T = uvm_tlm_generic_payload ) extends uvm_tlm_b_initiator_socket_base #(T)
```

**METHODS**

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<td>Construct a new instance of this socket</td>
</tr>
<tr>
<td><strong>Connect</strong></td>
<td>Connect this socket to the specified uvm_tlm_b_target_socket</td>
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</table>

**uvm_tlm_b_target_socket**

IS-A forward imp; has no backward path except via the payload contents.

The component instantiating this socket must implement a b_transport() method with the following signature:

```
task b_transport(T t, uvm_tlm_time delay);
```

**Summary**

**uvm_tlm_b_target_socket**

IS-A forward imp; has no backward path except via the payload contents.

**CLASS HIERARCHY**

```
  uvm_tlm_b_target_socket_base#(T)
  uvm_tlm_b_target_socket
```

**CLASS DECLARATION**

```
class uvm_tlm_b_target_socket #(T)
```
**new**

Construct a new instance of this socket. `imp` is a reference to the class implementing the `b_transport()` method. If not specified, it is assumed to be the same as `parent`.

**Connect**

Connect this socket to the specified `uvm_tlm_b_initiator_socket`.

---

**uvm_tlm_nb_initiator_socket**

IS-A forward port; HAS-A backward `imp`.

The component instantiating this socket must implement an `nb_transport_bw()` method with the following signature:

```cpp
function uvm_tlm_sync_e nb_transport_bw(T t, ref P p, input uvm_tlm_time delay);
```

**Summary**

**uvm_tlm_nb_initiator_socket**

IS-A forward port; HAS-A backward `imp`.

**Class Hierarchy**

```
  uvm_tlm_nb_initiator_socket_base#(T,P)
  uvm_tlm_nb_initiator_socket
```

**Class Declaration**

```
class uvm_tlm_nb_initiator_socket #(
```
new

function new(
    string name,
    uvm_component parent,
    IMP imp = null
)

Construct a new instance of this socket \textit{imp} is a reference to the class implementing the \texttt{nb\_transport\_bw()} method. If not specified, it is assumed to be the same as \textit{parent}.

Connect

Connect this socket to the specified \texttt{uvm\_tlm\_nb\_target\_socket}

**uvm\_tlm\_nb\_target\_socket**

IS-A forward imp; HAS-A backward port

The component instantiating this socket must implement a \texttt{nb\_transport\_fw()} method with the following signature

\begin{verbatim}
function uvm\_tlm\_sync\_e nb\_transport\_fw(T t, ref P p, input uvm\_tlm\_time delay);
\end{verbatim}

Summary

**uvm\_tlm\_nb\_target\_socket**

IS-A forward imp; HAS-A backward port

\textbf{Class Hierarchy}

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</table>

\textbf{Class Declaration}
Methods

new

```java
function new (
    string name,
    uvm_component parent,
    IMP imp = null
)
```

Construct a new instance of this socket *imp* is a reference to the class implementing the `nb_transport_fw()` method. If not specified, it is assumed to be the same as *parent*.

connect

```java
function void connect(
    this_type provider
)
```

Connect this socket to the specified `uvm_tlm_nb_initiator_socket`

### uvm_tlm_b_passthrough_initiator_socket

IS-A forward port;

**Summary**

#### uvm_tlm_b_passthrough_initiator_socket

IS-A forward port;

**Class Hierarchy**

```
  uvm_tlm_b_passthrough_initiator_socket_base#(T)
  
  uvm_tlm_b_passthrough_initiator_socket
```

**Class Declaration**

```java
class uvm_tlm_nb_target_socket #(
    type IMP = int,
    type T  = uvm_tlm_generic_payload,
    type P  = uvm_tlm_phase_e
) extends uvm_tlm_nb_target_socket_base #(T,P)
```
uvm_tlm_b_passthrough_target_socket

IS-A forward export;

Summary

class uvm_tlm_b_passthrough_target_socket #(
    type T = uvm_tlm_generic_payload
) extends uvm_tlm_b_passthrough_target_socket_base #(T)

uvm_tlm_nb_passthrough_initiator_socket

IS-A forward port; HAS-A backward export

Summary

class uvm_tlm_nb_passthrough_initiator_socket #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e
) extends uvm_tlm_nb_passthrough_initiator_socket_base #(T,P)

uvm_tlm_nb_passthrough_target_socket

IS-A forward export; HAS-A backward port
Summary

**uvm_tlm_nb_passthrough_target_socket**

IS-A forward export; HAS-A backward port

**Class Hierarchy**

```
<table>
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<th>uvm_tlm_nb_passthrough_target_socket_base#(T,P)</th>
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</tbody>
</table>
```

**Class Declaration**

```
class uvm_tlm_nb_passthrough_target_socket #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e
) extends uvm_tlm_nb_passthrough_target_socket_base #(T,P)
```

**Methods**

**connect**

```
function void connect(
    this_type provider
)
```

Connect this socket to the specified **uvm_tlm_nb_initiator_socket**
### 15.6 TLM2 Export Classes

This section defines the export classes for connecting TLM2 interfaces.

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#### uvm_tlm_b_transport_export

Blocking transport export class.

**Summary**

```plaintext
uvm_tlm_b_transport_export

Blocking transport export class.

**CLASS HIERARCHY**

```uvm_port_base#(uvm_tlm_if#(T))```

```uvm_tlm_b_transport_export```

**CLASS DECLARATION**

```plaintext
class uvm_tlm_b_transport_export {
  type T = uvm_tlm_generic_payload
  extends uvm_port_base #(uvm_tlm_if #(T))
}
```

#### uvm_tlm_nb_transport_fw_export

Non-blocking forward transport export class

**Summary**

```plaintext
uvm_tlm_nb_transport_fw_export

Non-blocking forward transport export class

**CLASS HIERARCHY**

```uvm_port_base#(uvm_tlm_if#(T,P))```

```uvm_tlm_nb_transport_fw_export```
uvm_tlm_nb_transport_bw_export

Non-blocking backward transport export class

Summary

uvm_tlm_nb_transport_bw_export

Non-blocking backward transport export class

Class Hierarchy

uvm_port_base#(uvm_tlm_if#(T,P))
uvm_tlm_nb_transport_bw_export

Class Declaration

class uvm_tlm_nb_transport_bw_export #(type T = uvm_tlm_generic_payload,
       type P = uvm_tlm_phase_e)
    extends uvm_port_base #(uvm_tlm_if#(T,P))

Methods

new
This section defines the implementation classes for connecting TLM2 interfaces.

TLM imps bind a TLM interface with the object that contains the interface implementation. In addition to the transaction type and the phase type, the imps are parameterized with the type of the object that will provide the implementation. Most often this will be the type of the component where the imp resides. The constructor of the imp takes as an argument an object of type IMP and installs it as the implementation object. Most often the imp constructor argument is “this”.

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<td>Used like exports, except an additional class parameter specifies the type of the implementation object.</td>
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**IMP binding macros**

`UVM_TLM_NB_TRANSPORT_FW_IMP

The macro wraps the forward path call function nb_transport_fw()

The first call to this method for a transaction marks the initial timing point. Every call to this method may mark a timing point in the execution of the transaction. The timing annotation argument allows the timing points to be offset from the simulation times at which the forward path is used. The final timing point of a transaction may be marked by a call to nb_transport_bw() within `UVM_TLM_NB_TRANSPORT_BW_IMP or a return from this or subsequent call to nb_transport_fw().

See TLM2 Interfaces, Ports, Exports and Transport Interfaces Subset for more details on the semantics and rules of the nonblocking transport interface.

`UVM_TLM_NB_TRANSPORT_BW_IMP

Implementation of the backward path. The macro wraps the function called
nb_transport_bw(). This function MUST be implemented in the INITIATOR component class.

Every call to this method may mark a timing point, including the final timing point, in the execution of the transaction. The timing annotation argument allows the timing point to be offset from the simulation times at which the backward path is used. The final timing point of a transaction may be marked by a call to nb_transport_fw() within `UVM_TLM_NB_TRANSPORT_FW_IMP or a return from this or subsequent call to nb_transport_bw().

See TLM2 Interfaces, Ports, Exports and Transport Interfaces Subset for more details on the semantics and rules of the nonblocking transport interface.

Example

```verilog
class master extends uvm_component;
    uvm_tlm_nb_initiator_socket
        #(trans, uvm_tlm_phase_e, this_t) initiator_socket;

    function void build_phase(uvm_phase phase);
        initiator_socket = new("initiator_socket", this, this);
    endfunction

    function uvm_tlm_sync_e nb_transport_bw(trans t,
        ref uvm_tlm_phase_e p,
        input uvm_tlm_time delay);
        transaction = t;
        state = p;
        return UVM_TLM_ACCEPTED;
    endfunction

    ...
endclass
```

`UVM_TLM_B_TRANSPORT_IMP

The macro wraps the function b_transport(). Execute a blocking transaction. Once this method returns, the transaction is assumed to have been executed. Whether that execution is successful or not must be indicated by the transaction itself.

The callee may modify or update the transaction object, subject to any constraints imposed by the transaction class. The initiator may re-use a transaction object from one call to the next and across calls to b_transport().

The call to b_transport shall mark the first timing point of the transaction. The return from b_transport() shall mark the final timing point of the transaction. The timing annotation argument allows the timing points to be offset from the simulation times at which the task call and return are executed.

IMP BINDING CLASSES

uvm_tlm_b_transport_imp

Used like exports, except an additional class parameter specifies the type of the implementation object. When the imp is instantiated the implementation object is bound.
### uvm_tlm_b_transport_imp

Used like exports, except an additional class parameter specifies the type of the implementation object.

**Class Hierarchy**

```
class uvm_port_base#(uvm_tlm_if#(T))
    uvm_tlm_b_transport_imp
```

**Class Declaration**

``` Aviv
class uvm_tlm_b_transport_imp #(
    type T = uvm_tlm_generic_payload,
    type IMP = int
) extends uvm_port_base #(uvm_tlm_if #(T))
```

---

### uvm_tlm_nb_transport_fw_imp

Used like exports, except an additional class parameter specifies the type of the implementation object. When the imp is instantiated the implementation object is bound.

**Class Hierarchy**

```
class uvm_port_base#(uvm_tlm_if#(T,P))
    uvm_tlm_nb_transport_fw_imp
```

**Class Declaration**

``` Aviv
class uvm_tlm_nb_transport_fw_imp #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e,
    type IMP = int
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

---

### uvm_tlm_nb_transport_bw_imp

Used like exports, except an additional class parameter specifies the type of the implementation object. When the imp is instantiated the implementation object is bound.

**Class Hierarchy**

```
class uvm_port_base#(uvm_tlm_if#(T))
    uvm_tlm_nb_transport_bw_imp
```

**Class Declaration**

``` Aviv
class uvm_tlm_nb_transport_bw_imp #(
    type T = uvm_tlm_generic_payload,
    type IMP = int
) extends uvm_port_base #(uvm_tlm_if #(T))
```
Summary

**uvm_tlm_nb_transport_bw_imp**

Used like exports, except an additional class parameter specifies the type of the implementation object.

**Class Hierarchy**

```
  uvm_port_base#(uvm_tlm_if#(T,P))
  uvm_tlm_nb_transport_bw_imp
```

**Class Declaration**

```plaintext
class uvm_tlm_nb_transport_bw_imp #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e,
    type IMP = int
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```
15.8 TLM2 ports

The following defines TLM2 port classes.

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<td>Class providing the non-blocking backward transport port.</td>
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uvm_tlm_b_transport_port

Class providing the blocking transport port. The port can be bound to one export. There is no backward path for the blocking transport.

Summary

Class providing the blocking transport port.

CLASS HIERARCHY

```java
uvm_port_base#(uvm_tlm_if#(T))

uvm_tlm_b_transport_port
```

CLASS DECLARATION

```java
class uvm_tlm_b_transport_port {
    type T = uvm_tlm_generic_payload
} extends uvm_port_base #(uvm_tlm_if #(T))
```

uvm_tlm_nb_transport_fw_port

Class providing the non-blocking backward transport port. Transactions received from the producer, on the forward path, are sent back to the producer on the backward path using this non-blocking transport port. The port can be bound to one export.

Summary

Class providing the non-blocking backward transport port.

CLASS HIERARCHY

```java
uvm_port_base#(uvm_tlm_if#(T))

uvm_tlm_nb_transport_fw_port
```
Class providing the non-blocking backward transport port. Transactions received from the producer, on the forward path, are sent back to the producer on the backward path using this non-blocking transport port. The port can be bound to one export.

**Summary**

```plaintext
uvm_tlm_nb_transport_bw_port

Class providing the non-blocking backward transport port.
```

**Class Hierarchy**

```plaintext
uvm_port_base#(uvm_tlm_if#(T,P))

uvm_tlm_nb_transport_bw_port
```

**Class Declaration**

```plaintext
class uvm_tlm_nb_transport_bw_port #(
    type T = uvm_tlm_generic_payload,
    type P = uvm_tlm_phase_e
) extends uvm_port_base #(uvm_tlm_if #(T,P))
```

**Methods**

```plaintext
new
```
15.9 uvm_tlm_time

Canonical time type that can be used in different timescales

This time type is used to represent time values in a canonical form that can bridge initiators and targets located in different timescales and time precisions.

For a detailed explanation of the purpose for this class, see Why is this necessary.

Summary

### uvm_tlm_time

Canonical time type that can be used in different timescales

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<td>Set the default canonical time resolution.</td>
</tr>
<tr>
<td>new</td>
<td>Create a new canonical time value.</td>
</tr>
<tr>
<td>get_name</td>
<td>Return the name of this instance</td>
</tr>
<tr>
<td>reset</td>
<td>Reset the value to 0</td>
</tr>
<tr>
<td>get_realtime</td>
<td>Return the current canonical time value, scaled for the caller’s timescale</td>
</tr>
<tr>
<td>incr</td>
<td>Increment the time value by the specified number of scaled time unit</td>
</tr>
<tr>
<td>decr</td>
<td>Decrement the time value by the specified number of scaled time unit</td>
</tr>
<tr>
<td>get_abstime</td>
<td>Return the current canonical time value, in the number of specified time unit, regardless of the current timescale of the caller.</td>
</tr>
<tr>
<td>set_abstime</td>
<td>Set the current canonical time value, to the number of specified time unit, regardless of the current timescale of the caller.</td>
</tr>
</tbody>
</table>

**Why is this necessary**

Integers are not sufficient, on their own, to represent time without any ambiguity: you need to know the scale of that integer value.

---

**set_time_resolution**

static function void set_time_resolution( 
    real res
)

Set the default canonical time resolution.

Must be a power of 10. When co-simulating with SystemC, it is recommended that default canonical time resolution be set to the SystemC time resolution.

By default, the default resolution is 1.0e-12 (ps)

**new**

function new( 
    string name = "uvm_tlm_time", 
    real res = 0
)
Create a new canonical time value.

The new value is initialized to 0. If a resolution is not specified, the default resolution, as specified by `set_time_resolution()`, is used.

**get_name**

```plaintext
function string get_name()
```

Return the name of this instance

**reset**

```plaintext
function void reset()
```

Reset the value to 0

**get_realtime**

```plaintext
function real get_realtime(
    time scaled,
    real secs = 1.0e-9
)
```

Return the current canonical time value, scaled for the caller’s timescale

`scaled` must be a time literal value that corresponds to the number of seconds specified in `secs` (1ns by default). It must be a time literal value that is greater or equal to the current timescale.

```plaintext
#(delay.get_realtime(1ns));
#(delay.get_realtime(1fs, 1.0e-15));
```

**incr**

```plaintext
function void incr(
    real t,
    time scaled,
    real secs = 1.0e-9
)
```

Increment the time value by the specified number of scaled time unit

`t` is a time value expressed in the scale and precision of the caller. `scaled` must be a time literal value that corresponds to the number of seconds specified in `secs` (1ns by default). It must be a time literal value that is greater or equal to the current timescale.

```plaintext
delay.incr(1.5ns, 1ns);
delay.incr(1.5ns, 1ps, 1.0e-12);
```
### decr

**Function:**

```vhls
function void decr(
    real t,
    time scaled,
    real secs
)
```

Decrement the time value by the specified number of scaled time unit.

- **t** is a time value expressed in the scale and precision of the caller. **scaled** must be a time literal value that corresponds to the number of seconds specified in **secs** (1ns by default). It must be a time literal value that is greater or equal to the current timescale.

```vhls
delay.decr(200ps, 1ns);
```

### get_abstime

**Function:**

```vhls
function real get_abstime(
    real secs
)
```

Return the current canonical time value, in the number of specified time unit, regardless of the current timescale of the caller.

- **secs** is the number of seconds in the desired time unit e.g. 1e-9 for nanoseconds.

```vhls
$write("%.3f ps\n", delay.get_abstime(1e-12));
```

### set_abstime

**Function:**

```vhls
function void set_abstime(
    real t,
    real secs
)
```

Set the current canonical time value, to the number of specified time unit, regardless of the current timescale of the caller.

- **secs** is the number of seconds in the time unit in the value **t** e.g. 1e-9 for nanoseconds.

```vhls
delay.set_abstime(1.5, 1e-12);
```

---

**Why Is This Necessary**

Integers are not sufficient, on their own, to represent time without any ambiguity: you need to know the scale of that integer value. That scale is information conveyed outside of that integer. In SystemVerilog, it is based on the timescale that was active when the code was compiled. SystemVerilog properly scales time literals, but not integer values.
That’s because it does not know the difference between an integer that carries an integer value and an integer that carries a time value. The ‘time’ variables are simply 64-bit integers, they are not scaled back and forth to the underlying precision.

```systemverilog`
`timescale 1ns/1ps
module m();
time t;
initial
begin
    #1.5;
    $write("T=%f ns (1.5)\n", $realtime());
t = 1.5;
    #t;
    $write("T=%f ns (3.0)\n", $realtime());
    #10ps;
    $write("T=%f ns (3.010)\n", $realtime());
t = 10ps;
    #t;
    $write("T=%f ns (3.020)\n", $realtime());
end
endmodule
```

yields

```
T=1.500000 ns (1.5)
T=3.500000 ns (3.0)
T=3.510000 ns (3.010)
T=3.510000 ns (3.020)
```

Within SystemVerilog, we have to worry about

- different time scale
- different time precision

Because each endpoint in a socket could be coded in different packages and thus be executing under different timescale directives, a simple integer cannot be used to exchange time information across a socket.

For example

```systemverilog`
`timescale 1ns/1ps
package a_pkg;
class a;
    function void f(inout time t);
        t += 10ns;
    endfunction
endclass
endpackage
`timescale 1ps/1ps
program p;
import a_pkg::*;
time t;
initial
begin
    a A = new;
    A.f(t);
    #t;
    $write("T=%0d ps (10,000)\n", $realtime());
end
endprogram
```

UVM 1.2 Class Reference
Scaling is needed every time you make a procedural call to code that may interpret a time value in a different timescale.

Using the `uvm_tlm_time` type

```vhls
`timescale 1ns/1ps

package a_pkg;
import uvm_pkg::*;

class a;
  function void f(uvm_tlm_time t);
    t.incr(10ns, 1ns);
  endfunction
endclass
endpackage

`timescale 1ps/1ps

program p;
import uvm_pkg::*;
import a_pkg::*;

uvm_tlm_time t = new;

initial
begin
  a A = new;
  A.f(t);
  #(t.get_realtime(1ns));
  $write("T=%0d ps (10,000)\n", $realtime());
end
endprogram
```

Yields

T=10000 ps (10,000)

A similar procedure is required when crossing any simulator or language boundary, such as interfacing between SystemVerilog and SystemC.
16. Analysis Ports

This section defines the port, export, and imp classes used for transaction analysis.

Contents

<table>
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<th>Analysis Ports</th>
<th>This section defines the port, export, and imp classes used for transaction analysis.</th>
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</thead>
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<td>Broadcasts a value to all subscribers implementing a uvm_analysis_imp.</td>
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</tr>
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<td>Exports a lower-level uvm_analysis_imp to its parent.</td>
</tr>
</tbody>
</table>

uvm_analysis_port

Broadcasts a value to all subscribers implementing a uvm_analysis_imp.

```verilog
class mon extends uvm_component;
  uvm_analysis_port#(trans) ap;
  function new(string name = "sb", uvm_component parent = null);
    super.new(name, parent);
    ap = new("ap", this);
  endfunction
  task run_phase(uvm_phase phase);
    trans t;
    ...
    ap.write(t);
    ...
  endfunction
endclass
```

Summary

uvm_analysis_port

Broadcasts a value to all subscribers implementing a uvm_analysis_imp.

**CLASS HIERARCHY**

```
uvm_port_base#(uvm_tlm_if_base#(T,T))
uvm_analysis_port
```

**CLASS DECLARATION**

```verilog
class uvm_analysis_port # (type T = int ) extends uvm_port_base # (uvm_tlm_if_base #(T,T))
```

**METHODS**

- `write`  Send specified value to all connected interface
**Write**

function void write (input T t)

Send specified value to all connected interface

## uvm_analysis_imp

Receives all transactions broadcasted by a `uvm_analysis_port`. It serves as the termination point of an analysis port/export/imp connection. The component attached to the `imp` class--called a subscriber--implements the analysis interface.

Will invoke the `write(T)` method in the parent component. The implementation of the `write(T)` method must not modify the value passed to it.

```verilog
class sb extends uvm_component;
    uvm_analysis_imp#(trans, sb) ap;

    function new(string name = "sb", uvm_component parent = null);
        super.new(name, parent);
        ap = new("ap", this);
    endfunction

    function void write(trans t);
        ...
    endfunction
endclass
```

## Summary

### uvm_analysis_imp

Receives all transactions broadcasted by a `uvm_analysis_port`.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_port_base#(uvm_tlm_if_base#(T,T))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>uvm_analysis_imp</strong></td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_analysis_imp #(
    type T = int,
    type IMP = int
) extends uvm_port_base #(uvm_tlm_if_base #(T,T))
```
Exports a lower-level uvm_analysis_imp to its parent.

**Summary**

**uvm_analysis_export**

Exports a lower-level uvm_analysis_imp to its parent.

**CLASS HIERARCHY**

```plaintext
uvm_port_base#(uvm_tlm_if_base#(T,T))

uvm_analysis_export
```

**CLASS DECLARATION**

```plaintext
class uvm_analysis_export #(
    type T = int
) extends uvm_port_base #(uvm_tlm_if_base #(T,T))
```

**METHODS**

- **new**

  ```plaintext
  function new (    
      string name,    
      uvm_component parent = null    
  )
  ```

  Instantiate the export.

  Instantiate the export.
Components form the foundation of the UVM. They encapsulate behavior of drivers, scoreboards, and other objects in a testbench. The UVM library provides a set of predefined component types, all derived directly or indirectly from `uvm_component`.

**Predefined Components**

---

**Summary**

**Predefined Component Classes**

Components form the foundation of the UVM.
17.1 uvm_component

The uvm_component class is the root base class for UVM components. In addition to the features inherited from uvm_object and uvm_report_object, uvm_component provides the following interfaces:

- **Hierarchy**: provides methods for searching and traversing the component hierarchy.
- **Phasing**: defines a phased test flow that all components follow, with a group of standard phase methods and an API for custom phases and multiple independent phasing domains to mirror DUT behavior e.g. power.
- **Reporting**: provides a convenience interface to the uvm_report_handler. All messages, warnings, and errors are processed through this interface.
- **Transaction recording**: provides methods for recording the transactions produced or consumed by the component to a transaction database (vendor specific).
- **Factory**: provides a convenience interface to the uvm_factory. The factory is used to create new components and other objects based on type-wide and instance-specific configuration.

The uvm_component is automatically seeded during construction using UVM seeding, if enabled. All other objects must be manually reseeded, if appropriate. See uvm_object:::reseed for more information.

**Summary**

<table>
<thead>
<tr>
<th>uvm_component</th>
</tr>
</thead>
</table>

The uvm_component class is the root base class for UVM components.

### Class Hierarchy

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component

### Class Declaration

```cpp
virtual class uvm_component extends uvm_report_object
```

### new

Creates a new component with the given leaf instance name and handle to its parent.

### Hierarchy Interface

<table>
<thead>
<tr>
<th>Method</th>
</tr>
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<tbody>
<tr>
<td>get_parent</td>
</tr>
<tr>
<td>get_full_name</td>
</tr>
<tr>
<td>get_children</td>
</tr>
<tr>
<td>get_child</td>
</tr>
</tbody>
</table>

These methods provide user access to information about the component hierarchy, i.e., topology.

- `get_parent`: Returns a handle to this component’s parent, or `null` if it has no parent.
- `get_full_name`: Returns the full hierarchical name of this object.
- `get_children`: This function populates the end of the `children` array with the list of this component’s children.
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get_next_child</td>
<td>These methods are used to iterate through this component’s children, if any.</td>
</tr>
<tr>
<td>get_first_child</td>
<td></td>
</tr>
<tr>
<td>get_num_children</td>
<td>Returns the number of this component’s children.</td>
</tr>
<tr>
<td>has_child</td>
<td>Returns 1 if this component has a child with the given name, 0 otherwise.</td>
</tr>
<tr>
<td>lookup</td>
<td>Looks for a component with the given hierarchical name relative to this component.</td>
</tr>
<tr>
<td>get_depth</td>
<td>Returns the component’s depth from the root level.</td>
</tr>
</tbody>
</table>

**Phasing Interface**

These methods implement an interface which allows all components to step through a standard schedule of phases, or a customized schedule, and also an API to allow independent phase domains which can jump like state machines to reflect behavior e.g.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>build_phase</td>
<td>The uvm_build_phase phase implementation method.</td>
</tr>
<tr>
<td>connect_phase</td>
<td>The uvm_connect_phase phase implementation method.</td>
</tr>
<tr>
<td>end_of_elaboration_phase</td>
<td>The uvm_end_of_elaboration_phase phase implementation method.</td>
</tr>
<tr>
<td>start_of_simulation_phase</td>
<td>The uvm_start_of_simulation_phase phase implementation method.</td>
</tr>
<tr>
<td>run_phase</td>
<td>The uvm_run_phase phase implementation method.</td>
</tr>
<tr>
<td>pre_reset_phase</td>
<td>The uvm_pre_reset_phase phase implementation method.</td>
</tr>
<tr>
<td>reset_phase</td>
<td>The uvm_reset_phase phase implementation method.</td>
</tr>
<tr>
<td>post_reset_phase</td>
<td>The uvm_post_reset_phase phase implementation method.</td>
</tr>
<tr>
<td>pre_configure_phase</td>
<td>The uvm_pre_configure_phase phase implementation method.</td>
</tr>
<tr>
<td>configure_phase</td>
<td>The uvm_configure_phase phase implementation method.</td>
</tr>
<tr>
<td>post_configure_phase</td>
<td>The uvm_post_configure_phase phase implementation method.</td>
</tr>
<tr>
<td>pre_main_phase</td>
<td>The uvm_pre_main_phase phase implementation method.</td>
</tr>
<tr>
<td>main_phase</td>
<td>The uvm_main_phase phase implementation method.</td>
</tr>
<tr>
<td>post_main_phase</td>
<td>The uvm_post_main_phase phase implementation method.</td>
</tr>
<tr>
<td>pre_shutdown_phase</td>
<td>The uvm_pre_shutdown_phase phase implementation method.</td>
</tr>
<tr>
<td>shutdown_phase</td>
<td>The uvm_shutdown_phase phase implementation method.</td>
</tr>
<tr>
<td>post_shutdown_phase</td>
<td>The uvm_post_shutdown_phase phase implementation method.</td>
</tr>
<tr>
<td>extract_phase</td>
<td>The uvm_extract_phase phase implementation method.</td>
</tr>
<tr>
<td>check_phase</td>
<td>The uvm_check_phase phase implementation method.</td>
</tr>
<tr>
<td>report_phase</td>
<td>The uvm_report_phase phase implementation method.</td>
</tr>
<tr>
<td>final_phase</td>
<td>The uvm_final_phase phase implementation method.</td>
</tr>
<tr>
<td>phase_started</td>
<td>Invoked at the start of each phase.</td>
</tr>
<tr>
<td>phase_ready_to_end</td>
<td>Invoked when all objections to ending the given phase and all sibling phases have been dropped, thus indicating that phase is ready to begin a clean exit.</td>
</tr>
<tr>
<td>phase_ended</td>
<td>Invoked at the end of each phase.</td>
</tr>
</tbody>
</table>
**set_domain**
Apply a phase domain to this component and, if `hier` is set, recursively to all its children.

**get_domain**
Return handle to the phase domain set on this component.

**define_domain**
Builds custom phase schedules into the provided `domain` handle.

**set_phase_imp**
Override the default implementation for a phase on this component (tree) with a custom one, which must be created as a singleton object extending the default one and implementing required behavior in `exec` and `traverse` methods.

**suspend**
Suspend this component.

**resume**
Resume this component.

**resolve_bindings**
Processes all port, export, and imp connections.

**Configuration Interface**
Components can be designed to be user-configurable in terms of its topology (the type and number of children it has), mode of operation, and run-time parameters (knobs).

**check_config_usage**
Check all configuration settings in a components configuration table to determine if the setting has been used, overridden or not used.

**apply_config_settings**
Searches for all config settings matching this component's instance path.

**print_config_settings**
Called without arguments, `print_config_settings` prints all configuration information for this component, as set by previous calls to `uvm_config_db#(T)::set()`.

**print_config**
Print `config` settings prints all configuration information for this component, as set by previous calls to `uvm_config_db#(T)::set()` and exports to the resources pool.

**print_config_with_audit**
Operates the same as `print_config` except that the audit bit is forced to 1.

**print_config_matches**
Setting this static variable causes `uvm_config_db#(T)::get()` to print info about matching configuration settings as they are being applied.

**Objection Interface**
These methods provide object level hooks into the `uvm_object` mechanism.

**raised**
The `raised` callback is called when this or a descendant of this component instance raises the specified `objection`.

**dropped**
The `dropped` callback is called when this or a descendant of this component instance drops the specified `objection`.

**all_dropped**
The `all_dropped` callback is called when all objections have been dropped by this component and all its descendants.

**Factory Interface**
The factory interface provides convenient access to a portion of UVM's `uvm_factory` interface.

**create_component**
A convenience function for `uvm_factory::create_component_by_name`, this method calls upon the factory to create a new child component whose type corresponds to the preregistered type name, `requested_type_name`, and instance name, `name`.

**create_object**
A convenience function for `uvm_factory::create_object_by_name`, this
method calls upon the factory to create a new object whose type corresponds to the preregistered type name, `requested_type_name`, and instance name, `name`.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_type_override_by_type</code></td>
<td>A convenience function for <code>uvm_factory::set_type_override_by_type</code>, this method registers a factory override for components and objects created at this level of hierarchy or below.</td>
</tr>
<tr>
<td><code>set_inst_override_by_type</code></td>
<td>A convenience function for <code>uvm_factory::set_inst_override_by_type</code>, this method registers a factory override for components and objects created at this level of hierarchy or below.</td>
</tr>
<tr>
<td><code>set_type_override</code></td>
<td>A convenience function for <code>uvm_factory::set_type_override_by_name</code>, this method configures the factory to create an object of type <code>override_type_name</code> whenever the factory is asked to produce a type represented by <code>original_type_name</code>.</td>
</tr>
<tr>
<td><code>set_inst_override</code></td>
<td>A convenience function for <code>uvm_factory::set_inst_override_by_name</code>, this method registers a factory override for components created at this level of hierarchy or below.</td>
</tr>
<tr>
<td><code>print_override_info</code></td>
<td>This factory debug method performs the same lookup process as <code>create_object</code> and <code>create_component</code>, but instead of creating an object, it prints information about what type of object would be created given the provided arguments.</td>
</tr>
</tbody>
</table>

**Hierarchical Reporting Interface**

This interface provides versions of the `set_report_*` methods in the `uvm_report_object` base class that are applied recursively to this component and all its children.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_report_id_verbosity_hier</code></td>
<td>These methods recursively associate the specified verbosity with reports of the given severity, <code>id</code>, or <code>severity-id</code> pair.</td>
</tr>
<tr>
<td><code>set_report_severity_id_verbosity_hier</code></td>
<td>These methods recursively associate the specified action with reports of the given severity, <code>id</code>, or <code>severity-id</code> pair.</td>
</tr>
<tr>
<td><code>set_report_severity_file_hier</code></td>
<td>These methods recursively associate the specified FILE descriptor with reports of the given severity, <code>id</code>, or <code>severity-id</code> pair.</td>
</tr>
<tr>
<td><code>set_report_verbosity_level_hier</code></td>
<td>This method recursively sets the maximum verbosity level for reports for this component and all those below it.</td>
</tr>
<tr>
<td><code>pre_abort</code></td>
<td>This callback is executed when the message system is executing a <code>UVM_EXIT</code> action.</td>
</tr>
</tbody>
</table>

**Recording Interface**

These methods comprise the component-based transaction recording interface.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>accept_tr</code></td>
<td>This function marks the acceptance of a transaction, <code>tr</code>, by this component.</td>
</tr>
<tr>
<td><code>do_accept_tr</code></td>
<td>The <code>accept_tr</code> method calls this function to accommodate any user-defined post-accept action.</td>
</tr>
<tr>
<td><code>begin_tr</code></td>
<td>This function marks the start of a transaction, <code>tr</code>, by this component.</td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>begin_child_tr</td>
<td>This function marks the start of a child transaction, \textit{tr}, by this component.</td>
</tr>
<tr>
<td>do_begin_tr</td>
<td>The \textit{begin_tr} and \textit{begin_child_tr} methods call this function to accommodate any user-defined post-begin action.</td>
</tr>
<tr>
<td>end_tr</td>
<td>This function marks the end of a transaction, \textit{tr}, by this component.</td>
</tr>
<tr>
<td>do_end_tr</td>
<td>The \textit{end_tr} method calls this function to accommodate any user-defined post-end action.</td>
</tr>
<tr>
<td>record_error_tr</td>
<td>This function marks an error transaction by a component.</td>
</tr>
<tr>
<td>record_event_tr</td>
<td>This function marks an event transaction by a component.</td>
</tr>
<tr>
<td>get_tr_stream</td>
<td>Returns a \textit{tr} stream with this component’s full name as a scope.</td>
</tr>
<tr>
<td>free_tr_stream</td>
<td>Frees the internal references associated with \textit{stream}.</td>
</tr>
<tr>
<td>print_enabled</td>
<td>This bit determines if this component should automatically be printed as a child of its parent object.</td>
</tr>
<tr>
<td>tr_database</td>
<td>Specifies the \textbf{uvm_tr_database} object to use for \textit{begin_tr} and other methods in the \textit{Recording Interface}.</td>
</tr>
</tbody>
</table>

### new

```plaintext
function new (  
  string name,  
  uvm_component parent
)
```

Creates a new component with the given leaf instance \textit{name} and handle to its \textit{parent}. If the component is a top-level component (i.e. it is created in a static module or interface), \textit{parent} should be \textit{null}.

The component will be inserted as a child of the \textit{parent} object, if any. If \textit{parent} already has a child by the given \textit{name}, an error is produced.

If \textit{parent} is \textit{null}, then the component will become a child of the implicit top-level component, \textit{uvm_top}.

All classes derived from \textit{uvm_component} must call super.new(name,parent).

### Hierarchy Interface

These methods provide user access to information about the component hierarchy, i.e., topology.

#### get_parent

```plaintext
virtual function uvm_component get_parent ()
```

Returns a handle to this component’s parent, or \textit{null} if it has no parent.

#### get_full_name
virtual function string get_full_name ()

Returns the full hierarchical name of this object. The default implementation concatenates the hierarchical name of the parent, if any, with the leaf name of this object, as given by uvm_object::get_name.

get_children

function void get_children(
    ref uvm_component children[])

This function populates the end of the children array with the list of this component’s children.

```plaintext
uvm_component array[];
my_comp.get_children(array);
foreach(array[i])
do_something(array[i]);
```

get_child

function uvm_component get_child ( string name )

get_next_child

function int get_next_child ( ref string name )

get_first_child

function int get_first_child ( ref string name )

These methods are used to iterate through this component’s children, if any. For example, given a component with an object handle, comp, the following code calls uvm_object::print for each child:

```plaintext
string name;
uvm_component child;
if (comp.get_first_child(name))
dobegin
    child = comp.get_child(name);
    child.print();
endwhile (comp.get_next_child(name));
```

get_num_children
function int get_num_children ()

    Returns the number of this component’s children.

**has_child**

function int has_child ( 
    string name
)

    Returns 1 if this component has a child with the given *name*, 0 otherwise.

**lookup**

function uvm_component lookup ( 
    string name
)

    Looks for a component with the given hierarchical *name* relative to this component. If the given *name* is preceded with a `'.'` (dot), then the search begins relative to the top level (absolute lookup). The handle of the matching component is returned, else *null*. The name must not contain wildcards.

**get_depth**

function int unsigned get_depth()

    Returns the component’s depth from the root level. uvm_top has a depth of 0. The test and any other top level components have a depth of 1, and so on.

### Phasing Interface

These methods implement an interface which allows all components to step through a standard schedule of phases, or a customized schedule, and also an API to allow independent phase domains which can jump like state machines to reflect behavior e.g. power domains on the DUT in different portions of the testbench. The phase tasks and functions are the phase name with the `_phase` suffix. For example, the build phase function is `build_phase`.

All processes associated with a task-based phase are killed when the phase ends. See `uvm_task_phase` for more details.

**build_phase**

    virtual function void build_phase( 
        uvm_phase phase
    )

    The *uvm_build_phase* phase implementation method.

    Any override should call `super.build_phase(phase)` to execute the automatic configuration of fields registered in the component by calling `apply_config_settings`. To turn off automatic configuration for a component, do not call `super.build_phase(phase).`
This method should never be called directly.

**connect_phase**

```plaintext
virtual function void connect_phase(uvm_phase phase)
```

The `uvm_connect_phase` phase implementation method.

This method should never be called directly.

**end_of_elaboration_phase**

```plaintext
virtual function void end_of_elaboration_phase(uvm_phase phase)
```

The `uvm_end_of_elaboration_phase` phase implementation method.

This method should never be called directly.

**start_of_simulation_phase**

```plaintext
virtual function void start_of_simulation_phase(uvm_phase phase)
```

The `uvm_start_of_simulation_phase` phase implementation method.

This method should never be called directly.

**run_phase**

```plaintext
virtual task run_phase(uvm_phase phase)
```

The `uvm_run_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. Thus the phase will automatically end once all objections are dropped using `phase.drop_objection()`.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

The `run_phase` task should never be called directly.

**pre_reset_phase**

```plaintext
virtual task pre_reset_phase(uvm_phase phase)
```
The **uvm_pre_reset_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_object()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_object()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

```virtual task reset_phase( 
    uvm_phase phase 
)```

The **uvm_reset_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_object()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_object()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

```virtual task post_reset_phase( 
    uvm_phase phase 
)```

The **uvm_post_reset_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_object()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_object()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

```virtual task pre_configure_phase( 
    uvm_phase phase 
)```

The **uvm_pre_configure_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_object()` to cause the phase to
persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**configure_phase**

```virtual task configure_phase(
    uvm_phase phase
)
```

The `uvm_configure_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**post_configure_phase**

```virtual task post_configure_phase(
    uvm_phase phase
)
```

The `uvm_post_configure_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**pre_main_phase**

```virtual task pre_main_phase(
    uvm_phase phase
)
```

The `uvm_pre_main_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be
killed once the phase ends.

This method should not be called directly.

**main_phase**

```plaintext
virtual task main_phase(
    uvm_phase phase
)
```

The `uvm_main_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**post_main_phase**

```plaintext
virtual task post_main_phase(
    uvm_phase phase
)
```

The `uvm_post_main_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**pre_shutdown_phase**

```plaintext
virtual task pre_shutdown_phase(
    uvm_phase phase
)
```

The `uvm_pre_shutdown_phase` phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.
**shutdown_phase**

```plaintext
virtual task shutdown_phase(
  uvm_phase phase
)
```

The **uvm_shutdown_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**post_shutdown_phase**

```plaintext
virtual task post_shutdown_phase(
  uvm_phase phase
)
```

The **uvm_post_shutdown_phase** phase implementation method.

This task returning or not does not indicate the end or persistence of this phase. It is necessary to raise an objection using `phase.raise_objection()` to cause the phase to persist. Once all components have dropped their respective objection using `phase.drop_objection()`, or if no components raises an objection, the phase is ended.

Any processes forked by this task continue to run after the task returns, but they will be killed once the phase ends.

This method should not be called directly.

**extract_phase**

```plaintext
virtual function void extract_phase(
  uvm_phase phase
)
```

The **uvm_extract_phase** phase implementation method.

This method should never be called directly.

**check_phase**

```plaintext
virtual function void check_phase(
  uvm_phase phase
)
```

The **uvm_check_phase** phase implementation method.

This method should never be called directly.
**report_phase**

```cpp
virtual function void report_phase(uvm_phase phase)
```

The uvm_report_phase phase implementation method.

This method should never be called directly.

**final_phase**

```cpp
virtual function void final_phase(uvm_phase phase)
```

The uvm_final_phase phase implementation method.

This method should never be called directly.

**phase_started**

```cpp
virtual function void phase Started (uvm_phase phase)
```

Invoked at the start of each phase. The phase argument specifies the phase being started. Any threads spawned in this callback are not affected when the phase ends.

**phase_ready_to_end**

```cpp
virtual function void phase_ready_to_end (uvm_phase phase)
```

Invoked when all objections to ending the given phase and all sibling phases have been dropped, thus indicating that phase is ready to begin a clean exit. Sibling phases are any phases that have a common successor phase in the schedule plus any phases that sync’d to the current phase. Components needing to consume delta cycles or advance time to perform a clean exit from the phase may raise the phase’s objection.

```cpp
phase.raise_objection(this,"Reason");
```

It is the responsibility of this component to drop the objection once it is ready for this phase to end (and processes killed). If no objection to the given phase or sibling phases are raised, then phaseEnded() is called after a delta cycle. If any objection is raised, then when all objections to ending the given phase and siblings are dropped, another iteration of phase_ready_to_end is called. To prevent endless iterations due to coding error, after 20 iterations, phase ended() is called regardless of whether previous iteration had any objections raised.

**phase_ended**
Invoked at the end of each phase. The `phase` argument specifies the phase that is ending. Any threads spawned in this callback are not affected when the phase ends.

### set_domain

```plaintext
function void set_domain(
    uvm_domain domain,
    int    hier = 1
)
```

Apply a phase domain to this component and, if `hier` is set, recursively to all its children.

Calls the virtual `define_domain` method, which derived components can override to augment or replace the domain definition of its base class.

### get_domain

```plaintext
function uvm_domain get_domain()
```

Return handle to the phase domain set on this component.

### define_domain

```plaintext
virtual protected function void define_domain(
    uvm_domain domain
)
```

Builds custom phase schedules into the provided `domain` handle.

This method is called by `set_domain`, which integrators use to specify this component belongs in a domain apart from the default 'uvm' domain.

Custom component base classes requiring a custom phasing schedule can augment or replace the domain definition they inherit by overriding their `defined_domain`. To augment, overrides would call `super.define_domain()`. To replace, overrides would not call `super.define_domain()`.

The default implementation adds a copy of the `uvm` phasing schedule to the given `domain`, if one doesn’t already exist, and only if the domain is currently empty.

Calling `set_domain` with the default `uvm` domain (i.e. `uvm_domain::get_uvm_domain`) on a component with no `define_domain` override effectively reverts the that component to using the default `uvm` domain. This may be useful if a branch of the testbench hierarchy defines a custom domain, but some child sub-branch should remain in the default `uvm` domain, call `set_domain` with a new domain instance handle with `hier` set. Then, in the sub-branch, call `set_domain` with the default `uvm` domain handle, obtained via `uvm_domain::get_uvm_domain`.

Alternatively, the integrator may define the graph in a new domain externally, then call `set_domain` to apply it to a component.

### set_phase_imp

```plaintext
virtual function void phase_ended ( uvm_phase phase )
```
Override the default implementation for a phase on this component (tree) with a custom one, which must be created as a singleton object extending the default one and implementing required behavior in exec and traverse methods.

The `hier` specifies whether to apply the custom functor to the whole tree or just this component.

**suspend**

```plaintext
virtual task suspend(){
}
```

Suspend this component.

This method must be implemented by the user to suspend the component according to the protocol and functionality it implements. A suspended component can be subsequently resumed using `resume()`.

**resume**

```plaintext
virtual task resume(){
}
```

Resume this component.

This method must be implemented by the user to resume a component that was previously suspended using `suspend()`. Some component may start in the suspended state and may need to be explicitly resumed.

**resolve_bindings**

```plaintext
virtual function void resolve_bindings(){
}
```

Processes all port, export, and imp connections. Checks whether each port’s min and max connection requirements are met.

It is called just before the end_of_elaboration phase.

Users should not call directly.

**Configuration Interface**

Components can be designed to be user-configurable in terms of its topology (the type and number of children it has), mode of operation, and run-time parameters (knobs). The configuration interface accommodates this common need, allowing component composition and state to be modified without having to derive new classes or new class hierarchies for every configuration scenario.

**check_config_usage**
Check all configuration settings in a components configuration table to determine if the setting has been used, overridden or not used. When `recurse` is 1 (default), configuration for this and all child components are recursively checked. This function is automatically called in the check phase, but can be manually called at any time.

To get all configuration information prior to the run phase, do something like this in your top object:

```script
function void check_config_usage (bit recurse = 1)

function void start_of_simulation_phase(uvm_phase phase);
    check_config_usage();
endfunction
```

### apply_config_settings

```script
virtual function void apply_config_settings (bit verbose = 0)
```

Searches for all config settings matching this component’s instance path. For each match, the appropriate set_*_local method is called using the matching config setting’s field_name and value. Provided the set_*_local method is implemented, the component property associated with the field_name is assigned the given value.

This function is called by `uvm_component::build_phase`.

The apply_config_settings method determines all the configuration settings targeting this component and calls the appropriate set_*_local method to set each one. To work, you must override one or more set_*_local methods to accommodate setting of your component’s specific properties. Any properties registered with the optional `uvm_*_field macros do not require special handling by the set_*_local methods; the macros provide the set_*_local functionality for you.

If you do not want apply_config_settings to be called for a component, then the build_phase() method should be overloaded and you should not call super.build_phase(phase). Likewise, apply_config_settings can be overloaded to customize automated configuration.

When the `verbose` bit is set, all overrides are printed as they are applied. If the component’s `print_config_matches` property is set, then apply_config_settings is automatically called with `verbose = 1`.

### print_config_settings

```script
function void print_config_settings (string field = "", uvm_component comp = null, bit recurse = 0)
```

Called without arguments, print_config_settings prints all configuration information for this component, as set by previous calls to `uvm_config_db#(T)::set()`. The settings are printing in the order of their precedence.
If `field` is specified and non-empty, then only configuration settings matching that field, if any, are printed. The field may not contain wildcards.

If `comp` is specified and non-null, then the configuration for that component is printed.

If `recurse` is set, then configuration information for all `comp`’s children and below are printed as well.

This function has been deprecated. Use `print_config` instead.

**print_config**

```plaintext
function void print_config(
    bit recurse = 0,
    bit audit = 0
)
```

Print_config_settings prints all configuration information for this component, as set by previous calls to `uvm_config_db#(T)::set()` and exports to the resources pool. The settings are printing in the order of their precedence.

If `recurse` is set, then configuration information for all children and below are printed as well.

if `audit` is set then the audit trail for each resource is printed along with the resource name and value

**print_config_with_audit**

```plaintext
function void print_config_with_audit(
)
```

Operates the same as `print_config` except that the audit bit is forced to 1. This interface makes user code a bit more readable as it avoids multiple arbitrary bit settings in the argument list.

If `recurse` is set, then configuration information for all children and below are printed as well.

**print_config_matches**

```plaintext
static bit print_config_matches
```

Setting this static variable causes `uvm_config_db#(T)::get()` to print info about matching configuration settings as they are being applied.

**Objection Interface**

These methods provide object level hooks into the `uvm_object` mechanism.

**raised**

```plaintext
virtual function void raised()
```
The *raised* callback is called when this or a descendant of this component instance raises the specified *objection*. The *source_obj* is the object that originally raised the objection. The *description* is optionally provided by the *source_obj* to give a reason for raising the objection. The *count* indicates the number of objections raised by the *source_obj*.

**dropped**

```plaintext
virtual function void dropped (
    uvm_objection objection,
    uvm_object source_obj,
    string description,
    int count
)
```

The *dropped* callback is called when this or a descendant of this component instance drops the specified *objection*. The *source_obj* is the object that originally dropped the objection. The *description* is optionally provided by the *source_obj* to give a reason for dropping the objection. The *count* indicates the number of objections dropped by the *source_obj*.

**all_dropped**

```plaintext
virtual task all_dropped (
    uvm_objection objection,
    uvm_object source_obj,
    string description,
    int count
)
```

The *all_dropped* callback is called when all objections have been dropped by this component and all its descendants. The *source_obj* is the object that dropped the last objection. The *description* is optionally provided by the *source_obj* to give a reason for raising the objection. The *count* indicates the number of objections dropped by the *source_obj*.

**Factory Interface**

The factory interface provides convenient access to a portion of UVM’s *uvm_factory* interface. For creating new objects and components, the preferred method of accessing the factory is via the object or component wrapper (see *uvm_component_registry #(T,Tname)* and *uvm_object_registry #(T,Tname)*). The wrapper also provides functions for setting type and instance overrides.

**create_component**

```plaintext
function uvm_component create_component (
    string requested_type_name,
    string name
)
```

A convenience function for *uvm_factory::create_component_by_name*, this method calls
upon the factory to create a new child component whose type corresponds to the preregistered type name, `requested_type_name`, and instance name, `name`. This method is equivalent to:

```c
factory.create_component_by_name(requested_type_name,
        get_full_name(), name, this);
```

If the factory determines that a type or instance override exists, the type of the component created may be different than the requested type. See `set_type_override` and `set_inst_override`. See also `uvm_factory` for details on factory operation.

**create_object**

```c
define uvm object create object (  
        string requested_type_name,  
        string name = "")
```

A convenience function for `uvm_factory::create_object_by_name`, this method calls upon the factory to create a new object whose type corresponds to the preregistered type name, `requested_type_name`, and instance name, `name`. This method is equivalent to:

```c
factory.create_object_by_name(requested_type_name,
        get_full_name(), name);
```

If the factory determines that a type or instance override exists, the type of the object created may be different than the requested type. See `uvm_factory` for details on factory operation.

**set_type_override_by_type**

```c
static define void set_type_override_by_type (  
        uvm_object_wrapper original_type,  
        uvm_object_wrapper override_type,  
        bit replace = 1
        )
```

A convenience function for `uvm_factory::set_type_override_by_type`, this method registers a factory override for components and objects created at this level of hierarchy or below. This method is equivalent to:

```c
factory.set_type_override_by_type(original_type, override_type,replace);
```

The `relative_inst_path` is relative to this component and may include wildcards. The `original_type` represents the type that is being overridden. In subsequent calls to `uvm_factory::create_object_by_type` or `uvm_factory::create_component_by_type`, if the requested_type matches the `original_type` and the instance paths match, the factory will produce the `override_type`.

The original and override type arguments are lightweight proxies to the types they represent. See `set_inst_override_by_type` for information on usage.
set_inst_override_by_type

A convenience function for uvm_factory::set_inst_override_by_type, this method registers
a factory override for components and objects created at this level of hierarchy or
below. In typical usage, this method is equivalent to:

```literate
function void set_inst_override_by_type(
    string relative_inst_path,
    uvm_object_wrapper original_type,
    uvm_object_wrapper override_type
)
```

factory.set_inst_override_by_type( original_type,
                                  override_type,
                                  {get_full_name(),".","relative_inst_path});

The `relative_inst_path` is relative to this component and may include wildcards. The
`original_type` represents the type that is being overridden. In subsequent calls to
uvm_factory::create_object_by_type or uvm_factory::create_component_by_type, if the
requested_type matches the `original_type` and the instance paths match, the factory will
produce the `override_type`.

The original and override types are lightweight proxies to the types they represent. They
can be obtained by calling type::get_type(), if implemented by type, or by directly calling
type::type_id::get(), where type is the user type and type_id is the name of the typedef
to uvm_object_registry #(T,Tname) or uvm_component_registry #(T,Tname).

If you are employing the `uvm_*_utils macros, the typedef and the get_type method
will be implemented for you. For details on the utils macros refer to Utility and Field
Macros for Components and Objects.

The following example shows `uvm_*_utils usage

```literate
class comp extends uvm_component;
    `uvm_component_utils(comp)
    ...
endclass

class mycomp extends uvm_component;
    `uvm_component_utils(mycomp)
    ...
endclass

class block extends uvm_component;
    `uvm_component_utils(block)
    comp@c_inst;
    virtual function void build_phase(uvm_phase phase);
        set_inst_override_by_type("c_inst",comp::get_type(),mycomp::get_type());
    endfunction
    ...
endclass
```

set_type_override

```literate
static function void set_type_override(
    string original_type_name,
    string override_type_name,
    bit replace = 1
)
```
A convenience function for `uvm_factory::set_type_override_by_name`, this method configures the factory to create an object of type `override_type_name` whenever the factory is asked to produce a type represented by `original_type_name`. This method is equivalent to:

```
factory.set_type_override_by_name(original_type_name, override_type_name, replace);
```

The `original_type_name` typically refers to a preregistered type in the factory. It may, however, be any arbitrary string. Subsequent calls to create_component or create_object with the same string and matching instance path will produce the type represented by `override_type_name`. The `override_type_name` must refer to a preregistered type in the factory.

### set_inst_override

```
function void set_inst_override(
    string relative_inst_path,
    string original_type_name,
    string override_type_name
)
```

A convenience function for `uvm_factory::set_inst_override_by_name`, this method registers a factory override for components created at this level of hierarchy or below. In typical usage, this method is equivalent to:

```
factory.set_inst_override_by_name(original_type_name, override_type_name, {get_full_name(),"."", relative_inst_path});
```

The `relative_inst_path` is relative to this component and may include wildcards. The `original_type_name` typically refers to a preregistered type in the factory. It may, however, be any arbitrary string. Subsequent calls to create_component or create_object with the same string and matching instance path will produce the type represented by `override_type_name`. The `override_type_name` must refer to a preregistered type in the factory.

### print_override_info

```
function void print_override_info(
    string requested_type_name,
    string name = ""
)
```

This factory debug method performs the same lookup process as create_object and create_component, but instead of creating an object, it prints information about what type of object would be created given the provided arguments.

### Hierarchical Reporting Interface

This interface provides versions of the set_report_* methods in the `uvm_report_object`...
base class that are applied recursively to this component and all its children.

When a report is issued and its associated action has the LOG bit set, the report will be sent to its associated FILE descriptor.

**set_report_id_verbosity_hier**

```plaintext
function void set_report_id_verbosity_hier ( 
    string id,
    int verbosity 
)
```

**set_report_severity_id_verbosity_hier**

```plaintext
function void set_report_severity_id_verbosity_hier( 
    uvm_severity severity,
    string id,
    int verbosity 
)
```

These methods recursively associate the specified verbosity with reports of the given severity, id, or severity-id pair. A verbosity associated with a particular severity-id pair takes precedence over a verbosity associated with id, which takes precedence over a verbosity associated with a severity.

For a list of severities and their default verbosities, refer to uvm_report_handler.

**set_report_severity_action_hier**

```plaintext
function void set_report_severity_action_hier ( 
    uvm_severity severity,
    uvm_action action 
)
```

**set_report_id_action_hier**

```plaintext
function void set_report_id_action_hier ( 
    string id,
    uvm_action action 
)
```

**set_report_severity_id_action_hier**

```plaintext
function void set_report_severity_id_action_hier( 
    uvm_severity severity,
    string id,
    uvm_action action 
)
```

These methods recursively associate the specified action with reports of the given severity, id, or severity-id pair. An action associated with a particular severity-id pair takes precedence over an action associated with id, which takes precedence over an action associated with a severity.

For a list of severities and their default actions, refer to uvm_report_handler.
set_report_default_file_hier

```cpp
function void set_report_default_file_hier (UVM_FILE file)
```

set_report_severity_file_hier

```cpp
function void set_report_severity_file_hier (uvm_severity severity, UVM_FILE file)
```

set_report_id_file_hier

```cpp
function void set_report_id_file_hier (string id, UVM_FILE file)
```

set_report_severity_id_file_hier

```cpp
function void set_report_severity_id_file_hier(uvm_severity severity, string id, UVM_FILE file)
```

These methods recursively associate the specified FILE descriptor with reports of the given severity, id, or severity-id pair. A FILE associated with a particular severity-id pair takes precedence over a FILE associated with id, which take precedence over an a FILE associated with a severity, which takes precedence over the default FILE descriptor.

For a list of severities and other information related to the report mechanism, refer to uvm_report_handler.

set_report_verbosity_level_hier

```cpp
function void set_report_verbosity_level_hier (int verbosity)
```

This method recursively sets the maximum verbosity level for reports for this component and all those below it. Any report from this component subtree whose verbosity exceeds this maximum will be ignored.

See uvm_report_handler for a list of predefined message verbosity levels and their meaning.

pre_abort

```cpp
virtual function void pre_abort
```

This callback is executed when the message system is executing a UVM_EXIT action.
The exit action causes an immediate termination of the simulation, but the pre_abort callback hook gives components an opportunity to provide additional information to the user before the termination happens. For example, a test may want to executed the report function of a particular component even when an error condition has happened to force a premature termination you would write a function like:

```
function void mycomponent::pre_abort();
  report();
endfunction
```

The pre_abort() callback hooks are called in a bottom-up fashion.

**Recording Interface**

These methods comprise the component-based transaction recording interface. The methods can be used to record the transactions that this component “sees”, i.e. produces or consumes.

The API and implementation are subject to change once a vendor-independent use-model is determined.

**accept_tr**

```
function void accept_tr (uvm_transaction tr, time accept_time = 0)
```

This function marks the acceptance of a transaction, tr, by this component. Specifically, it performs the following actions:

- Calls the tr’s `uvm_transaction::accept_tr` method, passing to it the `accept_time` argument.
- Calls this component’s `do_accept_tr` method to allow for any post-begin action in derived classes.
- Triggers the component’s internal accept_tr event. Any processes waiting on this event will resume in the next delta cycle.

**do_accept_tr**

```
virtual protected function void do_accept_tr (uvm_transaction tr)
```

The `accept_tr` method calls this function to accommodate any user-defined post-accept action. Implementations should call `super.do_accept_tr` to ensure correct operation.

**begin_tr**

```
function integer begin_tr (uvm_transaction tr, string stream_name = "main", string label = "", string desc = "")
```

UVM 1.2 Class Reference
This function marks the start of a transaction, \( tr \), by this component. Specifically, it performs the following actions:

- Calls \( tr \)'s `uvm_transaction::begin_tr` method, passing to it the `begin_time` argument. The `begin_time` should be greater than or equal to the accept time. By default, when `begin_time = 0`, the current simulation time is used.

If recording is enabled (recording_detail != UVM_OFF), then a new database-transaction is started on the component’s transaction stream given by the stream argument. No transaction properties are recorded at this time.

- Calls the component’s `do_begin_tr` method to allow for any post-begin action in derived classes.
- Triggers the component’s internal begin_tr event. Any processes waiting on this event will resume in the next delta cycle.

A handle to the transaction is returned. The meaning of this handle, as well as the interpretation of the arguments `stream_name`, `label`, and `desc` are vendor specific.

**begin_child_tr**

```plaintext
define integer begin_child_tr (uvm_transaction tr,
                              integer parent_handle = 0,
                              string stream_name = "main",
                              string label = "",
                              string desc = "",
                              time begin_time = 0)
```

This function marks the start of a child transaction, \( tr \), by this component. Its operation is identical to that of `begin_tr`, except that an association is made between this transaction and the provided parent transaction. This association is vendor-specific.

**do_begin_tr**

```plaintext
define virtual protected function void do_begin_tr (uvm_transaction tr,
                                                   string stream_name,
                                                   integer tr_handle)
```

The `begin_tr` and `begin_child_tr` methods call this function to accommodate any user-defined post-begin action. Implementations should call super.do_begin_tr to ensure correct operation.

**end_tr**

```plaintext
define function void end_tr (uvm_transaction tr,
                             time end_time = 0,
                             bit free_handle = 1)
```

This function marks the end of a transaction, \( tr \), by this component. Specifically, it performs the following actions:
• Calls tr’s `uvm_transaction::end_tr` method, passing to it the `end_time` argument. The `end_time` must at least be greater than the begin time. By default, when `end_time = 0`, the current simulation time is used.

The transaction’s properties are recorded to the database-transaction on which it was started, and then the transaction is ended. Only those properties handled by the transaction’s `do_record` method (and optional `uvm_*_field` macros) are recorded.

• Calls the component’s `do_end_tr` method to accommodate any post-end action in derived classes.

• Triggers the component’s internal `end_tr` event. Any processes waiting on this event will resume in the next delta cycle.

The `free_handle` bit indicates that this transaction is no longer needed. The implementation of `free_handle` is vendor-specific.

**do_end_tr**

```plaintext
virtual protected function void do_end_tr ( 
    uvm_transaction tr,
    integer tr_handle
)
```

The `end_tr` method calls this function to accommodate any user-defined post-end action. Implementations should call `super.do_end_tr` to ensure correct operation.

**record_error_tr**

```plaintext
function integer record_error_tr ( 
    string stream_name = "Main",
    uvm_object info = null,
    string label = "error_tr",
    string desc = "",
    time error_time = 0,
    bit keep_active = 0
)
```

This function marks an error transaction by a component. Properties of the given `uvm_object`, `info`, as implemented in its `uvm_object::do_record` method, are recorded to the transaction database.

An `error_time` of 0 indicates to use the current simulation time. The `keep_active` bit determines if the handle should remain active. If 0, then a zero-length error transaction is recorded. A handle to the database-transaction is returned.

Interpretation of this handle, as well as the strings `stream_name`, `label`, and `desc`, are vendor-specific.

**record_event_tr**

```plaintext
function integer record_event_tr ( 
    string stream_name = "Main",
    uvm_object info = null,
    string label = "event_tr",
    string desc = "",
    time event_time = 0,
    bit keep_active = 0
)
```

This function marks an event transaction by a component.
An `event_time` of 0 indicates to use the current simulation time.

A handle to the transaction is returned. The `keep_active` bit determines if the handle may be used for other vendor-specific purposes.

The strings for `stream_name`, `label`, and `desc` are vendor-specific identifiers for the transaction.

**get_tr_stream**

```
virtual function uvm_tr_stream get_tr_stream(
    string name,
    string stream_type_name = ""
)
```

Returns a tr stream with this component’s full name as a scope.

Streams which are retrieved via this method will be stored internally, such that later calls to `get_tr_stream` will return the same stream reference.

The stream can be removed from the internal storage via a call to `free_tr_stream`.

**Parameters**

- `name` Name for the stream
- `stream_type_name` Type name for the stream (Default = "")

**free_tr_stream**

```
virtual function void free_tr_stream(
    uvm_tr_stream stream
)
```

Frees the internal references associated with `stream`.

The next call to `get_tr_stream` will result in a newly created `uvm_tr_stream`. If the current stream is open (or closed), then it will be freed.

**print_enabled**

```bit print_enabled = 1```

This bit determines if this component should automatically be printed as a child of its parent object.

By default, all children are printed. However, this bit allows a parent component to disable the printing of specific children.

**tr_database**

```uvm_tr_database tr_database```

Specifies the `uvm_tr_database` object to use for `begin_tr` and other methods in the Recording Interface. Default is `uvm_coreservice_t::get_default_tr_database`. 
17.2 uvm_test

This class is the virtual base class for the user-defined tests.

The uvm_test virtual class should be used as the base class for user-defined tests. Doing so provides the ability to select which test to execute using the UVM_TESTNAME command line or argument to the `uvm_root::run_test` task.

For example

```plaintext
prompt> SIM_COMMAND +UVM_TESTNAME=test_bus_retry
```

The global `run_test()` task should be specified inside an initial block such as

```plaintext
initial run_test();
```

Multiple tests, identified by their type name, are compiled in and then selected for execution from the command line without need for recompilation. Random seed selection is also available on the command line.

If `+UVM_TESTNAME=test_name` is specified, then an object of type 'test_name' is created by factory and phasing begins. Here, it is presumed that the test will instantiate the test environment, or the test environment will have already been instantiated before the call to `run_test()`.

If the specified test_name cannot be created by the `uvm_factory`, then a fatal error occurs. If `run_test()` is called without UVM_TESTNAME being specified, then all components constructed before the call to `run_test` will be cycled through their simulation phases.

Deriving from uvm_test will allow you to distinguish tests from other component types that inherit from uvm_component directly. Such tests will automatically inherit features that may be added to uvm_test in the future.

**Summary**

**uvm_test**

This class is the virtual base class for the user-defined tests.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_report_object
  uvm_component
  uvm_test
```

**Class Declaration**

```plaintext
virtual class uvm_test extends uvm_component
```
new

function new (string name, uvm_component parent)

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.
17.3 uvm_env

The base class for hierarchical containers of other components that together comprise a complete environment. The environment may initially consist of the entire testbench. Later, it can be reused as a sub-environment in even larger system-level environments.

Summary

**uvm_env**

The base class for hierarchical containers of other components that together comprise a complete environment.

**CLASS HIERARCHY**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_report_object</td>
</tr>
<tr>
<td>uvm_component</td>
</tr>
<tr>
<td>uvm_env</td>
</tr>
</tbody>
</table>
```

**CLASS DECLARATION**

```
virtual class uvm_env extends uvm_component
```

**METHODS**

**new**

```
function new (    
    string name = "env",  
    uvm_component parent = null  
)
```

Creates and initializes an instance of this class using the normal constructor arguments for **uvm_component**: *name* is the name of the instance, and *parent* is the handle to the hierarchical parent, if any.

METHODS

**new**

```
function new (    
    string name = "env",  
    uvm_component parent = null  
)
```

Creates and initializes an instance of this class using the normal constructor arguments for **uvm_component**: *name* is the name of the instance, and *parent* is the handle to the hierarchical parent, if any.
17.4 uvm_agent

The `uvm_agent` virtual class should be used as the base class for the user-defined agents. Deriving from `uvm_agent` will allow you to distinguish agents from other component types also using its inheritance. Such agents will automatically inherit features that may be added to `uvm_agent` in the future.

While an agent’s build function, inherited from `uvm_component`, can be implemented to define any agent topology, an agent typically contains three subcomponents: a driver, sequencer, and monitor. If the agent is active, subtypes should contain all three subcomponents. If the agent is passive, subtypes should contain only the monitor.

Summary

**uvm_agent**

The `uvm_agent` virtual class should be used as the base class for the user-defined agents.

**CLASS HIERARCHY**

```
| uvm_void          |
| uvm_object        |
| uvm_report_object |
| uvm_component     |
| uvm_agent         |
```

**CLASS DECLARATION**

```
virtual class uvm_agent extends uvm_component
```

**METHODS**

**new**

```
function new (
    string name,
    uvm_component parent
)
```

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.

Returns UVM_ACTIVE is the agent is acting as an active agent and UVM_PASSIVE if it is acting as a passive agent.

The int configuration parameter `is_active` is used to identify whether this agent should be...
acting in active or passive mode. This parameter can be set by doing:

```c
uvm_config_int::set(this, "<relative_path_to_agent>, "is_active", UVM_ACTIVE);
```

---

**get_is_active**

```c
virtual function uvm_active_passive_enum get_is_active()
```

Returns UVM_ACTIVE is the agent is acting as an active agent and UVM_PASSIVE if it is acting as a passive agent. The default implementation is to just return the is_active flag, but the component developer may override this behavior if a more complex algorithm is needed to determine the active/passive nature of the agent.
17.5 uvm_monitor

This class should be used as the base class for user-defined monitors.

Deriving from uvm_monitor allows you to distinguish monitors from generic component types inheriting from uvm_component. Such monitors will automatically inherit features that may be added to uvm_monitor in the future.

Summary

**uvm_monitor**

This class should be used as the base class for user-defined monitors.

**CLASS HIERARCHY**

```
  uvm_void
  uvm_object
  uvm_report_object
  uvm_component
  uvm_monitor
```

**CLASS DECLARATION**

```
virtual class uvm_monitor extends uvm_component
```

**METHODS**

**new**

`function new ( string name, uvm_component parent )`

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.

**METHODS**

**new**

`function new ( string name, uvm_component parent )`

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.
17.6 uvm_scoreboard

The uvm_scoreboard virtual class should be used as the base class for user-defined scoreboards.

Deriving from uvm_scoreboard will allow you to distinguish scoreboards from other component types inheriting directly from uvm_component. Such scoreboards will automatically inherit and benefit from features that may be added to uvm_scoreboard in the future.

**Summary**

### uvm_scoreboard

The uvm_scoreboard virtual class should be used as the base class for user-defined scoreboards.

#### CLASS HIERARCHY

```
  uvm_void
  uvm_object
  uvm_report_object
  uvm_component
  uvm_scoreboard
```

#### CLASS DECLARATION

```
virtual class uvm_scoreboard extends uvm_component
```

#### METHODS

**new**

```
function new (   string name,   uvm_component parent )
```

Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.
17.7 uvm_driver #(REQ,RSP)

The base class for drivers that initiate requests for new transactions via a uvm_seq_item_pull_port. The ports are typically connected to the exports of an appropriate sequencer component.

This driver operates in pull mode. Its ports are typically connected to the corresponding exports in a pull sequencer as follows:

```plaintext
driver.seq_item_port.connect(sequencer.seq_item_export);
driver.rsp_port.connect(sequencer.rsp_export);
```

The rsp_port needs connecting only if the driver will use it to write responses to the analysis export in the sequencer.

Summary

### uvm_driver #(REQ,RSP)

The base class for drivers that initiate requests for new transactions via a uvm_seq_item_pull_port.

#### Class Hierarchy

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_driver#(REQ,RSP)

#### Class Declaration

```plaintext
class uvm_driver #(
    type REQ = uvm_sequence_item,
    type RSP = REQ
) extends uvm_component
```

#### Ports

- **seq_item_port**: Derived driver classes should use this port to request items from the sequencer.
- **rsp_port**: This port provides an alternate way of sending responses back to the originating sequencer.

#### Methods

- **new**: Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: name is the name of the instance, and parent is the handle to the hierarchical parent, if any.

### Ports

**seq_item_port**

UVM 1.2 Class Reference
Derived driver classes should use this port to request items from the sequencer. They may also use it to send responses back.

**rsp_port**

This port provides an alternate way of sending responses back to the originating sequencer. Which port to use depends on which export the sequencer provides for connection.

**METHODS**

**new**

```plaintext
function new (string name, uvm_component parent)
```

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.
17.8 uvm_push_driver #(REQ,RSP)

Base class for a driver that passively receives transactions, i.e. does not initiate requests transactions. Also known as push mode. Its ports are typically connected to the corresponding ports in a push sequencer as follows:

```
push_sequencer.req_port.connect(push_driver.req_export);
push_driver.rsp_port.connect(push_sequencer.rsp_export);
```

The rsp_port needs connecting only if the driver will use it to write responses to the analysis export in the sequencer.

Summary

**uvm_push_driver #(REQ,RSP)**

Base class for a driver that passively receives transactions.

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- **uvm_push_driver#(REQ,RSP)**

**Class Declaration**

```java
class uvm_push_driver #(type REQ = uvm_sequence_item, type RSP = REQ)
    extends uvm_component
```

**Ports**

- **req_export**
  This export provides the blocking put interface whose default implementation produces an error.

- **rsp_port**
  This analysis port is used to send response transactions back to the originating sequencer.

**Methods**

- **new**
  Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: name is the name of the instance, and parent is the handle to the hierarchical parent, if any.

**Ports**

**req_export**

This export provides the blocking put interface whose default implementation produces an error. Derived drivers must override put with an appropriate implementation (and not call super.put). Ports connected to this export will supply the driver with transactions.
**rsp_port**

This analysis port is used to send response transactions back to the originating sequencer.

**Methods**

**new**

```plaintext
function new ( 
    string name, 
    uvm_component parent 
)
```

Creates and initializes an instance of this class using the normal constructor arguments for **uvm_component**: *name* is the name of the instance, and *parent* is the handle to the hierarchical parent, if any.
A general purpose unidirectional random stimulus class.

The uvm_random_stimulus class generates streams of T transactions. These streams may be generated by the randomize method of T, or the randomize method of one of its subclasses. The stream may go indefinitely, until terminated by a call to stop_stimulus_generation, or we may specify the maximum number of transactions to be generated.

By using inheritance, we can add directed initialization or tidy up after random stimulus generation. Simply extend the class and define the run task, calling super.run() when you want to begin the random stimulus phase of simulation.

While very useful in its own right, this component can also be used as a template for defining other stimulus generators, or it can be extended to add additional stimulus generation methods and to simplify test writing.

Summary

<table>
<thead>
<tr>
<th>uvm_random_stimulus #(T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A general purpose unidirectional random stimulus class.</td>
</tr>
</tbody>
</table>

**CLASS HIERARCHY**

| uvm_void |
| uvm_object |
| uvm_report_object |
| uvm_component |
| uvm_random_stimulus#(T) |

**CLASS DECLARATION**

```
class uvm_random_stimulus #(type T = uvm_transaction) extends uvm_component
```

**PORTS**

<table>
<thead>
<tr>
<th>blocking_put_port</th>
</tr>
</thead>
<tbody>
<tr>
<td>The blocking_put_port is used to send the generated stimulus to the rest of the testbench.</td>
</tr>
</tbody>
</table>

**METHODS**

| new |
| Creates a new instance of a specialization of this class. |

| generate_stimulus |
| Generate up to max_count transactions of type T. |

| stop_stimulus_generation |
| Stops the generation of stimulus. |

**Ports**

**blocking_put_port**

The blocking_put_port is used to send the generated stimulus to the rest of the...
testbench.

## Methods

### new

```plaintext
function new(
    string name,
    uvm_component parent
)
```

Creates a new instance of a specialization of this class. Also, displays the random state obtained from a get_randstate call. In subsequent simulations, set_randstate can be called with the same value to reproduce the same sequence of transactions.

### generate_stimulus

```plaintext
virtual task generate_stimulus(
    T t = null,
    int max_count = 0
)
```

Generate up to max_count transactions of type T. If t is not specified, a default instance of T is allocated and used. If t is specified, that transaction is used when randomizing. It must be a subclass of T.

max_count is the maximum number of transactions to be generated. A value of zero indicates no maximum - in this case, generate_stimulus will go on indefinitely unless stopped by some other process.

The transactions are cloned before they are sent out over the blocking_put_port.

### stop_stimulus_generation

```plaintext
virtual function void stop_stimulus_generation
```

Stops the generation of stimulus. If a subclass of this method has forked additional processes, those processes will also need to be stopped in an overridden version of this method.
17.10 uvm_subscriber

This class provides an analysis export for receiving transactions from a connected
analysis export. Making such a connection "subscribes" this component to any
transactions emitted by the connected analysis port.

Subtypes of this class must define the write method to process the incoming
transactions. This class is particularly useful when designing a coverage collector that
attaches to a monitor.

Summary

**uvm_subscriber**

This class provides an analysis export for receiving transactions from a connected
analysis export.

**CLASS HIERARCHY**

```
    uvm_void
    uvm_object
    uvm_report_object
    uvm_component
    uvm_subscriber
```

**CLASS DECLARATION**

```
virtual class uvm_subscriber #(type T = int)
  extends uvm_component
```

**PORTS**

- **analysis_export**
  This export provides access to the write method, which
derived subscribers must implement.

**METHODS**

- **new**
  Creates and initializes an instance of this class using the
  normal constructor arguments for `uvm_component`: `name`
is the name of the instance, and `parent` is the handle to
  the hierarchical parent, if any.

- **write**
  A pure virtual method that must be defined in each
  subclass.
new

```cpp
function new (  
    string name,  
    uvm_component parent
)
```

Creates and initializes an instance of this class using the normal constructor arguments for `uvm_component`: `name` is the name of the instance, and `parent` is the handle to the hierarchical parent, if any.

write

```cpp
pure virtual function void write(  
    T t
)
```

A pure virtual method that must be defined in each subclass. Access to this method by outside components should be done via the analysis_export.
A common function of testbenches is to compare streams of transactions for equivalence. For example, a testbench may compare a stream of transactions from a DUT with expected results.

The UVM library provides a base class called `uvm_in_order_comparator` and two derived classes: `uvm_in_orderBuilt_in_comparator` for comparing streams of built-in types and `uvm_in_order_class_comparator` for comparing streams of class objects.

The `uvm_algorithmic_comparator` also compares two streams of transactions, but the transaction streams might be of different type objects. Thus, this comparator will employ a user-defined transformation function to convert one type to another before performing a comparison.

**Comparators**

```
    uvm_object
      ^
    uvm_report_object
      ^
    uvm_component
      ^
    uvm_algorithmic_comparator
      |____________________|
      |                  |
      |                  |
      |  before_after_transformer  |
    uvm_in_order_comparator
      |____________________|
      |                  |
      |                  |
      | T, comp, convert, pair_type |
    uvm_in_orderBuilt_in_comparator
      |____________________|
      |                  |
      |                  |
      | T |
    uvm_in_order_class_comparator
      |____________________|
      |                  |
      |                  |
      | T |
```

**Summary**

**Comparators**

A common function of testbenches is to compare streams of transactions for equivalence.
18.1 Comparators

The following classes define comparators for objects and built-in types.

<table>
<thead>
<tr>
<th>Comparators</th>
<th>The following classes define comparators for objects and built-in types.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_in_order_comparator #(T,comp_type,convert,pair_type)</td>
<td>Compares two streams of data objects of the type parameter, T.</td>
</tr>
<tr>
<td>uvm_in_order_built_in_comparator #(T)</td>
<td>This class uses the uvm_built_in_* comparison, converter, and pair classes.</td>
</tr>
<tr>
<td>uvm_in_order_class_comparator #(T)</td>
<td>This class uses the uvm_class_* comparison, converter, and pair classes.</td>
</tr>
</tbody>
</table>

**uvm_in_order_comparator #(T,comp_type,convert,pair_type)**

Compares two streams of data objects of the type parameter, T. These transactions may either be classes or built-in types. To be successfully compared, the two streams of data must be in the same order. Apart from that, there are no assumptions made about the relative timing of the two streams of data.

Type parameters

- **T** Specifies the type of transactions to be compared.
- **comp_type** A policy class to compare the two transaction streams. It must provide the static method "function bit comp(T a, T b)" which returns TRUE if a and b are the same.
- **convert** A policy class to convert the transactions being compared to a string. It must provide the static method "function string convert2string(T a)".
- **pair_type** A policy class to allow pairs of transactions to be handled as a single uvm_object type.

Built in types (such as ints, bits, logic, and structs) can be compared using the default values for comp_type, convert, and pair_type. For convenience, you can use the subtype, uvm_in_order_built_in_comparator #(T) for built-in types.

When T is a uvm_object, you can use the convenience subtype uvm_in_order_class_comparator #(T).

Comparisons are commutative, meaning it does not matter which data stream is connected to which export, before_export or after_export.

Comparisons are done in order and as soon as a transaction is received from both streams. Internal fifos are used to buffer incoming transactions on one stream until a transaction to compare arrives on the other stream.

**Summary**

**uvm_in_order_comparator #(T,comp_type,convert,pair_type)**

Compares two streams of data objects of the type parameter, T.

**Ports**

- **before_export** The export to which one stream of data is written.
**Ports**

**before_export**

The export to which one stream of data is written. The port must be connected to an analysis port that will provide such data.

**after_export**

The export to which the other stream of data is written. The port must be connected to an analysis port that will provide such data.

**pair_ap**

The comparator sends out pairs of transactions across this analysis port. Both matched and unmatched pairs are published via a pair_type objects. Any connected analysis export(s) will receive these transaction pairs.

**Methods**

**flush**

Virtual function void flush()

This method sets m_matches and m_mismatches back to zero. The uvm_tlm_fifo::flush takes care of flushing the FIFOs.

**uvm_in_orderBuiltInComparator #(T)**

This class uses the uvmBuiltIn_* comparison, converter, and pair classes. Use this class for built-in types (int, bit, string, etc.)

**Summary**

**uvm_in_orderBuiltInComparator #(T)**

This class uses the uvmBuiltIn_* comparison, converter, and pair classes.
This class uses the uvm_class_* comparison, converter, and pair classes. Use this class for comparing user-defined objects of type T, which must provide compare() and convert2string() method.

**Summary**

**uvm_in_order_class_comparator #(T)**

This class uses the uvm_class_* comparison, converter, and pair classes.

**Class Hierarchy**

```
class uvm_in_order_class_comparator #(T)
  extends uvm_in_order_comparator #(T, uvm_class_comp #(T), uvm_class_converter #(T), uvm_class_pair #(T, T))

class uvm_in_order_class_comparator #(T)
  extends uvm_in_order_comparator #(T,
    uvm_class_comp #(T), uvm_class_converter #(T), uvm_class_pair #(T, T))
```

**Class Declaration**

```
class uvm_in_order_class_comparator #(T)
  extends uvm_in_order_comparator #(T, uvm_class_comp #(T), uvm_class_converter #(T), uvm_class_pair #(T, T))
```
18.2 Algorithmic Comparator

A common function of testbenches is to compare streams of transactions for equivalence. For example, a testbench may compare a stream of transactions from a DUT with expected results.

The UVM library provides a base class called `uvm_in_order_comparator #(T,comp_type,convert,pair_type)` and two derived classes, which are `uvm_in_order_builtin_comparator #(T)` for comparing streams of built-in types and `uvm_in_order_class_comparator #(T)` for comparing streams of class objects.

The `uvm_algorithmic_comparator` also compares two streams of transactions; however, the transaction streams might be of different type objects. This device will use a user-written transformation function to convert one type to another before performing a comparison.

**Summary**

**Algorithmic Comparator**

A common function of testbenches is to compare streams of transactions for equivalence.

**uvm_algorithmic_comparator #(BEFORE,AFTER,TRANSFORMER)**

Compares two streams of data objects of different types, BEFORE and AFTER.

The algorithmic comparator is a wrapper around `uvm_in_order_class_comparator #(T)`. Like the in-order comparator, the algorithmic comparator compares two streams of transactions, the BEFORE stream and the AFTER stream. It is often the case when two streams of transactions need to be compared that the two streams are in different forms. That is, the type of the BEFORE transaction stream is different than the type of the AFTER transaction stream.

The `uvm_algorithmic_comparator`’s TRANSFORMER type parameter specifies the class responsible for converting transactions of type BEFORE into those of type AFTER. This transformer class must provide a transform() method with the following prototype:

```plaintext
function AFTER transform (BEFORE b);
```

Matches and mismatches are reported in terms of the AFTER transactions. For more information, see the `uvm_in_order_comparator #(T,comp_type,convert,pair_type)` class.

**Summary**

**uvm_algorithmic_comparator #(BEFORE,AFTER,TRANSFORMER)**
Compares two streams of data objects of different types, **BEFORE** and **AFTER**.

### Class Hierarchy

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- **uvm_algorithmic_comparator**(BEFORE,AFTER,TRANSFORMER)

### Class Declaration

```plaintext
class uvm_algorithmic_comparator#(
  type BEFORE = int,
  type AFTER  = int,
  type TRANSFORMER = int
) extends uvm_component
```

### Ports

- **before_export**
  The export to which a data stream of type **BEFORE** is sent via a connected analysis port. Publishers (monitors) can send in an ordered stream of transactions against which the transformed **BEFORE** transactions will be compared.

- **after_export**
  The export to which a data stream of type **AFTER** is sent via a connected analysis port. Publishers (monitors) can send in an ordered stream of transactions to be transformed and compared to the **AFTER** transactions.

### Methods

- **new**
  Creates an instance of a specialization of this class. In addition to the standard
uvm_component constructor arguments, name and parent, the constructor takes a handle to a transformer object, which must already be allocated (handles can't be null) and must implement the transform() method.
18.3 uvm_pair classes

This section defines container classes for handling value pairs.

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uvm_class_pair #(T1,T2)

Container holding handles to two objects whose types are specified by the type parameters, T1 and T2.

Summary

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</table>
The handle to the first object in the pair

The handle to the second object in the pair

**METHODS**

**new**

```plaintext
function new (  
    string name = "",  
    T1 f = null,  
    T2 s = null  
)

```

Creates an instance that holds a handle to two objects. The optional name argument gives a name to the new pair object.

**Summary**

**uvm_built_in_pair #(T1,T2)**

Container holding two variables of built-in types (int, string, etc.). The types are specified by the type parameters, T1 and T2.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- **uvm_built_in_pair#(T1,T2)**

**CLASS DECLARATION**

```plaintext
class uvm_built_in_pair #(  
    type T1 = int,  
    T2 = T1  
) extends uvm_object
```

**VARIABLES**

- **T1 first**
  - The first value in the pair
- **T2 second**
  - The second value in the pair

**METHODS**

- **new**
  - Creates an instance that holds two built-in type values.
**VARIABLES**

**T1 first**

T1 first

The first value in the pair

**T2 second**

T2 second

The second value in the pair

**METHODS**

**new**

```plaintext
function new (string name = "")
```

Creates an instance that holds two built-in type values. The optional name argument gives a name to the new pair object.
Policy classes are used to implement polymorphic operations that differ between built-in types and class-based types. Generic components can then be built that work with either classes or built-in types, depending on what policy class is used.

### Contents

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<td>This policy class is used to clone class objects.</td>
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### `uvm_built_in_comp #(T)`

This policy class is used to compare built-in types.

Provides a comp method that compares the built-in type, T, for which the `==` operator is defined.

#### Summary

`uvm_built_in_comp #(T)`

This policy class is used to compare built-in types.

**Class Declaration**

```plaintext
class uvm_built_in_comp 
  type T = int 
```

### `uvm_built_in_converter #(T)`

This policy class is used to convert built-in types to strings.

Provides a convert2string method that converts the built-in type, T, to a string using the `%p` format specifier.
# Summary

**uvm_built_in_converter #(T)**

This policy class is used to convert built-in types to strings.

**Class Declaration**

```
class uvm_built_in_converter #(type T = int)
```

---

**uvm_built_in_clone #(T)**

This policy class is used to clone built-in types via the = operator.

Provides a clone method that returns a copy of the built-in type, T.

**Summary**

**uvm_built_in_clone #(T)**

This policy class is used to clone built-in types via the = operator.

**Class Declaration**

```
class uvm_built_in_clone #(type T = int)
```

---

**uvm_class_comp #(T)**

This policy class is used to compare two objects of the same type.

Provides a comp method that compares two objects of type T. The class T must provide the method “function bit compare(T rhs)”, similar to the `uvm_object:::compare` method.

**Summary**

**uvm_class_comp #(T)**

This policy class is used to compare two objects of the same type.

**Class Declaration**

```
class uvm_class_comp #(type T = int)
```
uvm_class_converter #(T)

This policy class is used to convert a class object to a string.

Provides a convert2string method that converts an instance of type T to a string. The class T must provide the method “function string convert2string()”, similar to the uvm_object::convert2string method.

Summary

uvm_class_converter #(T)

This policy class is used to convert a class object to a string.

CLASS DECLARATION

class uvm_class_converter #(
   type T = Int
)

uvm_class_clone #(T)

This policy class is used to clone class objects.

Provides a clone method that returns a copy of the built-in type, T. The class T must implement the clone method, to which this class delegates the operation. If T is derived from uvm_object, then T must instead implement uvm_object::do_copy, either directly or indirectly through use of the `uvm_field macros.

Summary

uvm_class_clone #(T)

This policy class is used to clone class objects.

CLASS DECLARATION

class uvm_class_clone #(
   type T = int
)
19. Sequencer Classes

The sequencer serves as an arbiter for controlling transaction flow from multiple stimulus generators. More specifically, the sequencer controls the flow of `uvm_sequenceItem`-based transactions generated by one or more `uvm_sequence #(REQ,RSP)`-based sequences.

There are two sequencer variants available.

- **uvm_sequencer #(REQ,RSP)** - Requests for new sequence items are initiated by the driver. Upon such requests, the sequencer selects a sequence from a list of available sequences to produce and deliver the next item to execute. This sequencer is typically connected to a user-extension of `uvm_driver #(REQ,RSP)`.

- **uvm_push_sequencer #(REQ,RSP)** - Sequence items (from the currently running sequences) are pushed by the sequencer to the driver, which blocks item flow when it is not ready to accept new transactions. This sequencer is typically connected to a user-extension of `uvm_push_driver #(REQ,RSP)`.

Sequencer-driver communication follows a pull or push semantic, depending on which sequencer type is used. However, sequence-sequencer communication is always initiated by the user-defined sequence, i.e. follows a push semantic.

See **Sequence Classes** for an overview on sequences and sequence items.

Sequence Item Ports

As with all UVM components, the sequencers and drivers described above use TLM Interfaces to communicate transactions.

The `uvm_sequencer #(REQ,RSP)` and `uvm_driver #(REQ,RSP)` pair also uses a sequence item pull port to achieve the special execution semantic needed by the sequencer-driver pair.
Sequencers and drivers use a `seq_item_port` specifically supports sequencer-driver communication. Connections to these ports are made in the same fashion as the TLM ports.

**Summary**

**Sequencer Classes**

The sequencer serves as an arbiter for controlling transaction flow from multiple stimulus generators.
19.1 uvm_sequencer_base

Controls the flow of sequences, which generate the stimulus (sequence item transactions) that is passed on to drivers for execution.

Summary

**uvm_sequencer_base**

Controls the flow of sequences, which generate the stimulus (sequence item transactions) that is passed on to drivers for execution.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_sequencer_base

**CLASS DECLARATION**

```class uvm_sequencer_base extends uvm_component```

**METHODS**

- **new**
  Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: name is the name of the instance, and parent is the handle to the hierarchical parent.

- **is_child**
  Returns 1 if the child sequence is a child of the parent sequence, 0 otherwise.

- **user_priority_arbitration**
  When the sequencer arbitration mode is set to UVM_SEQ_ARB_USER (via the set_arbitration method), the sequencer will call this function each time that it needs to arbitrate among sequences.

- **execute_item**
  Executes the given transaction item directly on this sequencer.

- **start_phase_sequence**
  Start the default sequence for this phase, if any.

- **stop_phase_sequence**
  Stop the default sequence for this phase, if any exists, and it is still executing.

- **wait_for_grant**
  This task issues a request for the specified sequence.

- **wait_for_item_done**
  A sequence may optionally call wait_for_item_done.

- **is_blocked**
  Returns 1 if the sequence referred to by sequence_ptr is currently locked out of the sequencer.

- **has_lock**
  Returns 1 if the sequence referred to in the parameter currently has a lock on this sequencer, 0 otherwise.
<table>
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<tr>
<td>stop_sequences</td>
<td>Tells the sequencer to kill all sequences and child sequences currently operating on the sequencer, and remove all requests, locks and responses that are currently queued.</td>
</tr>
<tr>
<td>is_grabbed</td>
<td>Returns 1 if any sequence currently has a lock or grab on this sequencer, 0 otherwise.</td>
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<td>Returns 1 if any sequence running on this sequencer is ready to supply a transaction, 0 otherwise.</td>
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<td>wait_for_sequences</td>
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<td>send_request</td>
<td>Derived classes implement this function to send a request item to the sequencer, which will forward it to the driver.</td>
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<tr>
<td>set_max_zero_time_wait_relevant_count</td>
<td>Can be called at any time to change the maximum number of times wait_for_relevant() can be called by the sequencer in zero time before an error is declared.</td>
</tr>
</tbody>
</table>

## Methods

### new

```verilog
function new (
    string name,
    uvm_component parent
)
```

Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: name is the name of the instance, and parent is the handle to the hierarchical parent.

### is_child

```verilog
function bit is_child (uvm_sequence_base parent, uvm_sequence_base child)
```
Returns 1 if the child sequence is a child of the parent sequence, 0 otherwise.

**user_priority_arbitration**

```cpp
virtual function integer user_priority_arbitration(
    integer avail_sequences[$]
)
```

When the sequencer arbitration mode is set to UVM_SEQ_ARB_USER (via the `set_arbitration` method), the sequencer will call this function each time that it needs to arbitrate among sequences.

Derived sequencers may override this method to perform a custom arbitration policy. The override must return one of the entries from the `avail_sequences` queue, which are indexes into an internal queue, `arb_sequence_q`.

The default implementation behaves like UVM_SEQ_ARB_FIFO, which returns the entry at `avail_sequences[0].`

**execute_item**

```cpp
virtual task execute_item(
    uvm_sequence_item item
)
```

Executes the given transaction `item` directly on this sequencer. A temporary parent sequence is automatically created for the `item`. There is no capability to retrieve responses. If the driver returns responses, they will accumulate in the sequencer, eventually causing response overflow unless `uvm_sequence_base::set_response_queue_error_report_disabled` is called.

**start_phase_sequence**

```cpp
virtual function void start_phase_sequence(
    uvm_phase phase
)
```

Start the default sequence for this phase, if any. The default sequence is configured via resources using either a sequence instance or sequence type (object wrapper). If both are used, the sequence instance takes precedence. When attempting to override a previous default sequence setting, you must override both the instance and type (wrapper) resources, else your override may not take effect.

When setting the resource using `set`, the 1st argument specifies the context pointer, usually `this` for components or `null` when executed from outside the component hierarchy (i.e. in module). The 2nd argument is the instance string, which is a path name to the target sequencer, relative to the context pointer. The path must include the name of the phase with a “_phase” suffix. The 3rd argument is the resource name, which is “default_sequence”. The 4th argument is either an object wrapper for the sequence type, or an instance of a sequence.

Configuration by instances allows pre-initialization, setting rand_mode, use of inline constraints, etc.
Configuration by type is shorter and can be substituted via the factory.

```verilog
driver is currently waiting for the next item to be sent via the send_request call.
```

The uvm_resource_db can similarly be used.

```verilog
virtual function void stop_phase_sequence(
    uvm_phase phase
)
Stop the default sequence for this phase, if any exists, and it is still executing.

wait_for_grant

```verilog
virtual task wait_for_grant(
    uvm_sequence_base sequence_ptr,
    int item_priority = -1,
    bit lock_request = 0
)
This task issues a request for the specified sequence. If item_priority is not specified,
then the current sequence priority will be used by the arbiter. If a lock_request is made,
then the sequencer will issue a lock immediately before granting the sequence. (Note
that the lock may be granted without the sequence being granted if is_relevant is not
asserted).

When this method returns, the sequencer has granted the sequence, and the sequence
must call send_request without inserting any simulation delay other than delta cycles.
The driver is currently waiting for the next item to be sent via the send_request call.
```
**wait_for_item_done**

```plaintext
virtual task wait_for_item_done(
    uvm_sequence_base sequence_ptr,
    int transaction_id
)
```

A sequence may optionally call `wait_for_item_done`. This task will block until the driver calls `item_done()` or `put()` on a transaction issued by the specified sequence. If no `transaction_id` parameter is specified, then the call will return the next time that the driver calls `item_done()` or `put()`. If a specific `transaction_id` is specified, then the call will only return when the driver indicates that it has completed that specific item.

Note that if a specific `transaction_id` has been specified, and the driver has already issued an `item_done` or `put` for that transaction, then the call will hang waiting for that specific `transaction_id`.

**is_blocked**

```plaintext
function bit is_blocked(
    uvm_sequence_base sequence_ptr
)
```

Returns 1 if the sequence referred to by `sequence_ptr` is currently locked out of the sequencer. It will return 0 if the sequence is currently allowed to issue operations.

Note that even when a sequence is not blocked, it is possible for another sequence to issue a lock before this sequence is able to issue a request or lock.

**has_lock**

```plaintext
function bit has_lock(
    uvm_sequence_base sequence_ptr
)
```

Returns 1 if the sequence referred to in the parameter currently has a lock on this sequencer, 0 otherwise.

Note that even if this sequence has a lock, a child sequence may also have a lock, in which case the sequence is still blocked from issuing operations on the sequencer.

**lock**

```plaintext
virtual task lock(
    uvm_sequence_base sequence_ptr
)
```

Requests a lock for the sequence specified by `sequence_ptr`.

A lock request will be arbitrated the same as any other request. A lock is granted after all earlier requests are completed and no other locks or grabs are blocking this sequence.

The lock call will return when the lock has been granted.

**grab**

```plaintext
virtual task grab(
)
```
Requests a lock for the sequence specified by sequence_ptr.

A grab request is put in front of the arbitration queue. It will be arbitrated before any other requests. A grab is granted when no other grabs or locks are blocking this sequence.

The grab call will return when the grab has been granted.

```cpp
virtual function void unlock(uvm_sequence_base sequence_ptr)
```

Removes any locks and grabs obtained by the specified sequence_ptr.

```cpp
virtual function void ungrab(uvm_sequence_base sequence_ptr)
```

Removes any locks and grabs obtained by the specified sequence_ptr.

```cpp
virtual function void stop_sequences()
```

Tells the sequencer to kill all sequences and child sequences currently operating on the sequencer, and remove all requests, locks and responses that are currently queued. This essentially resets the sequencer to an idle state.

```cpp
virtual function bit is_grabbed()
```

Returns 1 if any sequence currently has a lock or grab on this sequencer, 0 otherwise.

```cpp
virtual function uvm_sequence_base current_grabber()
```

Returns a reference to the sequence that currently has a lock or grab on the sequence. If multiple hierarchical sequences have a lock, it returns the child that is currently allowed to perform operations on the sequencer.

```cpp
virtual function bit has_do_available()
```
Returns 1 if any sequence running on this sequencer is ready to supply a transaction, 0 otherwise. A sequence is ready if it is not blocked (via grab or lock and is_relevant returns 1.

**set_arbitration**

```cpp
function void set_arbitration(
    UVM_SEQ_ARB_TYPE val
)
```

Specifies the arbitration mode for the sequencer. It is one of

- **UVM_SEQ_ARB_FIFO**: Requests are granted in FIFO order (default)
- **UVM_SEQ_ARB_WEIGHTED**: Requests are granted randomly by weight
- **UVM_SEQ_ARB_RANDOM**: Requests are granted randomly
- **UVM_SEQ_ARB_STRICT_FIFO**: Requests at highest priority granted in FIFO order
- **UVM_SEQ_ARB_STRICT_RANDOM**: Requests at highest priority granted in randomly
- **UVM_SEQ_ARB_USER**: Arbitration is delegated to the user-defined function, user_priority_arbitration. That function will specify the next sequence to grant.

The default user function specifies FIFO order.

**get_arbitration**

```cpp
function UVM_SEQ_ARB_TYPE get_arbitration()
```

Return the current arbitration mode set for this sequencer. See set_arbitration for a list of possible modes.

**wait_for_sequences**

```cpp
virtual task wait_for_sequences()
```

Waits for a sequence to have a new item available. Uses uvm_wait_for_nba_region to give a sequence as much time as possible to deliver an item before advancing time.

**send_request**

```cpp
virtual function void send_request(
    uvm_sequence_base sequence_ptr,
    uvm_sequence_item t,
    bit rerandomize = 0
)
```

Derived classes implement this function to send a request item to the sequencer, which will forward it to the driver. If the rerandomize bit is set, the item will be randomized before being sent to the driver.
This function may only be called after a `wait_for_grant` call.

**set_max_zero_time_wait_relevant_count**

```cpp
virtual function void set_max_zero_time_wait_relevant_count(
    int new_val
)
```

Can be called at any time to change the maximum number of times `wait_for_relevant()` can be called by the sequencer in zero time before an error is declared. The default maximum is 10.
19.2 uvm_sequencer_param_base #(REQ,RSP)

Extends uvm_sequencer_base with an API depending on specific request (REQ) and response (RSP) types.

Summary

uvm_sequencer_param_base #(REQ,RSP)

Extends uvm_sequencer_base with an API depending on specific request (REQ) and response (RSP) types.

Class Hierarchy

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<tr>
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</tr>
<tr>
<td>uvm_object</td>
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</tr>
<tr>
<td>uvm_sequencer_param_base#(REQ,RSP)</td>
</tr>
</tbody>
</table>

Class Declaration

```cpp
class uvm_sequencer_param_base #(t
  type REQ = uvm_sequence_item,
  type RSP = REQ)
  extends uvm_sequencer_base
new
send_request
get_current_item

Requests
get_num_reqs_sent
set_num_last_reqs
get_num_last_reqs
last_req

Responses
rsp_export
get_num_rsps_received
set_num_last_rsps
get_num_last_rsps
last_rsp
```

new
function new (string name, uvm_component parent)

Creates and initializes an instance of this class using the normal constructor arguments for uvm_component: name is the name of the instance, and parent is the handle to the hierarchical parent, if any.

**send_request**

virtual function void send_request(
    uvm_sequence_base sequence_ptr,
    uvm_sequence_item t,
    bit rerandomize = 0)

The send_request function may only be called after a wait_for_grant call. This call will send the request item, t, to the sequencer pointed to by sequence_ptr. The sequencer will forward it to the driver. If rerandomize is set, the item will be randomized before being sent to the driver.

**get_current_item**

function REQ get_current_item()

Returns the request_item currently being executed by the sequencer. If the sequencer is not currently executing an item, this method will return null.

The sequencer is executing an item from the time that get_next_item or peek is called until the time that get or item_done is called.

Note that a driver that only calls get() will never show a current item, since the item is completed at the same time as it is requested.

**Requests**

**get_num_reqs_sent**

function int get_num_reqs_sent()

Returns the number of requests that have been sent by this sequencer.

**set_num_last_reqs**

function void set_num_last_reqs(
    int unsigned max)

Sets the size of the last_requests buffer. Note that the maximum buffer size is 1024. If max is greater than 1024, a warning is issued, and the buffer is set to 1024. The default value is 1.
get_num_last_reqs

function int unsigned get_num_last_reqs()

Returns the size of the last requests buffer, as set by set_num_last_reqs.

last_req

function REQ last_req(
    int unsigned n = 0
)

Returns the last request item by default. If n is not 0, then it will get the n\textsuperscript{\textfrac{1}{2}}th before last request item. If n is greater than the last request buffer size, the function will return null.

Responses

rsp_export

Drivers or monitors can connect to this port to send responses to the sequencer. Alternatively, a driver can send responses via its seq_item_port.

seq_item_port.item_done(response)
seq_item_port.put(response)
rsp_port.write(response)  <--- via this export

The rsp_port in the driver and/or monitor must be connected to the rsp_export in this sequencer in order to send responses through the response analysis port.

get_num_rsps_received

function int get_num_rsps_received()

Returns the number of responses received thus far by this sequencer.

set_num_last_rsp

function void set_num_last_rsp(
    int unsigned max
)

Sets the size of the last_responses buffer. The maximum buffer size is 1024. If max is greater than 1024, a warning is issued, and the buffer is set to 1024. The default value is 1.
Returns the max size of the last responses buffer, as set by `set_num_last_rsp`s.

**last_rsp**

```c
function RSP last_rsp(
    int unsigned n = 0
)
```

Returns the last response item by default. If `n` is not 0, then it will get the `n`-th-before-last response item. If `n` is greater than the last response buffer size, the function will return *null*. 
Summary

uvm_sequencer #(REQ,RSP)

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_sequencer_base
- uvm_sequencer_param_base#(REQ,RSP)
- uvm_sequencer#(REQ,RSP)

**Class Declaration**

```markdown
class uvm_sequencer #(
  type REQ = uvm_sequence_item,
  RSP = REQ
) extends uvm_sequencer_param_base #(REQ, RSP)
```

**new**

Standard component constructor that creates an instance of this class using the given `name` and `parent`, if any.

**stop_sequences**

Tells the sequencer to kill all sequences and child sequences currently operating on the sequencer, and remove all requests, locks and responses that are currently queued.

**Sequencer Interface**

- **seq_item_export**
  This is an interface for communicating with sequencers.
- **get_next_item**
  Retrieves the next available item from a sequence.
- **try_next_item**
  Retrieves the next available item from a sequence if one is available.
- **item_done**
  Indicates that the request is completed.
- **put**
  Sends a response back to the sequence that issued the request.
- **get**
  Retrieves the next available item from a sequence.
- **peek**
  Returns the current request item if one is in the FIFO.
- **wait_for_sequences**
  Waits for a sequence to have a new item available.
- **has_do_available**
  Returns 1 if any sequence running on this sequencer is ready to supply a transaction, 0 otherwise.

**new**

```markdown
function new (  
    string name,  
    uvm_component parent = null  
)
```

Standard component constructor that creates an instance of this class using the given `name` and `parent`, if any.
stop_sequences

```cpp
virtual function void stop_sequences()
```

Tells the sequencer to kill all sequences and child sequences currently operating on the sequencer, and remove all requests, locks and responses that are currently queued. This essentially resets the sequencer to an idle state.

## Sequencer Interface

This is an interface for communicating with sequencers.

### The interface is defined as

```
Requests:
virtual task          get_next_item      (output REQ request);
virtual task          try_next_item      (output REQ request);
virtual task          get               (output REQ request);
virtual task          peek             (output REQ request);
Responses:
virtual function void item_done          (input RSP response=null);
virtual task          put             (input RSP response);
Sync Control:
virtual task          wait_for_sequences ()
virtual function bit  has_do_available ()
```

See `uvm_sqr_if_base #(REQ,RSP)` for information about this interface.

## seq_item_export

```
uvm_seq_item_pull_imp #(
    REQ,
    RSP,
    this_type
) seq_item_export
```

This export provides access to this sequencer’s implementation of the sequencer interface.

## get_next_item

```
virtual task get_next_item ( 
    output REQ t
)
```

Retrieves the next available item from a sequence.

## try_next_item

```
virtual task try_next_item ( 
    output REQ t
)
```

Retrieves the next available item from a sequence if one is available.
item_done

```c
virtual function void item_done (  
    RSP item = null  
)
```

Indicates that the request is completed.

put

```c
virtual task put (  
    RSP t  
)
```

Sends a response back to the sequence that issued the request.

get

```c
task get (  
    output REQ t  
)
```

Retrieves the next available item from a sequence.

peek

```c
task peek (  
    output REQ t  
)
```

Returns the current request item if one is in the FIFO.

wait_for_sequences

Waits for a sequence to have a new item available.

has_do_available

Returns 1 if any sequence running on this sequencer is ready to supply a transaction, 0 otherwise.
19.4 uvm_push_sequencer #(REQ,RSP)

Summary

**uvm_push_sequencer #(REQ,RSP)**

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_report_object
- uvm_component
- uvm_sequencer_base
- uvm_sequencer_param_base#(REQ,RSP)
- **uvm_push_sequencer#(REQ,RSP)**

**CLASS DECLARATION**

```
class uvm_push_sequencer #(  
    type REQ = uvm_sequence_item,  
    RSP = REQ  
) extends uvm_sequencer_param_base #(REQ, RSP)
```

**PORTS**

- **req_port**

  The push sequencer requires access to a blocking put interface.

**METHODS**

- **new**

  Standard component constructor that creates an instance of this class using the given `name` and `parent`, if any.

- **run_phase**

  The push sequencer continuously selects from its list of available sequences and sends the next item from the selected sequence out its `req_port` using `req_port.put(item)`.

**PORTS**

- **req_port**

  The push sequencer requires access to a blocking put interface. A continuous stream of sequence items are sent out this port, based on the list of available sequences loaded into this sequencer.

**METHODS**

- **new**

  ```
  function new (  
    string name,  
    uvm_component parent = null
  ```
Standard component constructor that creates an instance of this class using the given name and parent, if any.

**run_phase**

```verilog
task run_phase(
   uvm_phase phase
)
```

The push sequencer continuously selects from its list of available sequences and sends the next item from the selected sequence out its req_port using req_port.put(item). Typically, the req_port would be connected to the req_export on an instance of a uvm_push_driver #(REQ,RSP), which would be responsible for executing the item.
20. Sequence Classes

Sequences encapsulate user-defined procedures that generate multiple `uvm_sequence_item`-based transactions. Such sequences can be reused, extended, randomized, and combined sequentially and hierarchically in interesting ways to produce realistic stimulus to your DUT.

With `uvm_sequence` objects, users can encapsulate DUT initialization code, bus-based stress tests, network protocol stacks-- anything procedural-- then have them all execute in specific or random order to more quickly reach corner cases and coverage goals.

The UVM sequence item and sequence class hierarchy is shown below.

- **`uvm_sequence_item`** - The `uvm_sequence_item` is the base class for user-defined transactions that leverage the stimulus generation and control capabilities of the sequence-sequencer mechanism.

- **`uvm_sequence #(REQ,RSP)`** - The `uvm_sequence` extends `uvm_sequence_item` to add the ability to generate streams of `uvm_sequence_items`, either directly or by recursively executing other `uvm_sequences`.

**Summary**

**Sequence Classes**

Sequences encapsulate user-defined procedures that generate multiple `uvm_sequence_item`-based transactions.
20.1 uvm_sequence_item

The base class for user-defined sequence items and also the base class for the uvm_sequence class. The uvm_sequence_item class provides the basic functionality for objects, both sequence items and sequences, to operate in the sequence mechanism.

Summary

uvm_sequence_item

The base class for user-defined sequence items and also the base class for the uvm_sequence class.

Class Hierarchy

uvm_void
uvm_object
uvm_transaction
uvm_sequence_item

Class Declaration

class uvm_sequence_item extends uvm_transaction

new The constructor method for uvm_sequence_item.
get_sequence_id private
set_item_context Set the sequence and sequencer execution context for a sequence item
set_use_sequence_info These methods are used to set and get the status of the use_sequence_info bit.
get_use_sequence_info
set_id_info Copies the sequence_id and transaction_id from the referenced item into the calling item.
set_sequencer Sets the default sequencer for the sequence to sequencer.
get_sequencer Returns a reference to the default sequencer used by this sequence.
set_parent_sequence Sets the parent sequence of this sequence_item.
get_parent_sequence Returns a reference to the parent sequence of any sequence on which this method was called.
set_depth The depth of any sequence is calculated automatically.
get_depth Returns the depth of a sequence from its parent.
is_item This function may be called on any sequence_item or sequence.
get_root_sequence_name Provides the name of the root sequence (the top-most parent sequence).
get_root_sequence Provides a reference to the root sequence (the top-most parent sequence).
get_sequence_path Provides a string of names of each sequence in the full hierarchical path.

Reporting Interface

Sequence items and sequences will use the sequencer which they are associated with for reporting messages.

uvm_report
uvm_report_info
uvm_report_warning
uvm_report_error
uvm_report_fatal

These are the primary reporting methods in the UVM.
The constructor method for `uvm_sequence_item`.

### `get_sequence_id`

```plaintext
function int get_sequence_id()
```

Private

`Get_sequence_id` is an internal method that is not intended for user code. The `sequence_id` is not a simple integer. The `get_transaction_id` is meant for users to identify specific transactions.

These methods allow access to the `sequence_item` sequence and transaction IDs. `get_transaction_id` and `set_transaction_id` are methods on the `uvm_transaction base_class`. These IDs are used to identify sequences to the sequencer, to route responses back to the sequence that issued a request, and to uniquely identify transactions.

The `sequence_id` is assigned automatically by a sequencer when a sequence initiates communication through any sequencer calls (i.e. `uvm_do_*, wait_for_grant`). A `sequence_id` will remain unique for this sequence until it ends or it is killed. However, a single sequence may have multiple valid sequence ids at any point in time. Should a sequence start again after it has ended, it will be given a new unique `sequence_id`.

The `transaction_id` is assigned automatically by the sequence each time a transaction is sent to the sequencer with the `transaction_id` in its default (-1) value. If the user sets the `transaction_id` to any non-default value, that value will be maintained.

Responses are routed back to this sequences based on `sequence_id`. The sequence may use the `transaction_id` to correlate responses with their requests.

### `set_item_context`

```plaintext
function void set_item_context(
    uvm_sequence_base parent_seq,
    uvm_sequence_base sequencer = null
)
```

Set the sequence and sequencer execution context for a sequence item.

### `set_use_sequence_info`

```plaintext
function void set_use_sequence_info(
    bit value
)
```

### `get_use_sequence_info`

```plaintext
function void get_use_sequence_info()
```
function bit get_use_sequence_info()

These methods are used to set and get the status of the use_sequence_info bit. Use_sequence_info controls whether the sequence information (sequencer, parent_sequence, sequence_id, etc.) is printed, copied, or recorded. When use_sequence_info is the default value of 0, then the sequence information is not used. When use_sequence_info is set to 1, the sequence information will be used in printing and copying.

**set_id_info**

```verilog
function void set_id_info(
    uvm_sequence_item item
)
```

Copies the sequence_id and transaction_id from the referenced item into the calling item. This routine should always be used by drivers to initialize responses for future compatibility.

**set_sequencer**

```verilog
virtual function void set_sequencer(
    uvm_sequencer_base sequencer
)
```

Sets the default sequencer for the sequence to sequencer. It will take effect immediately, so it should not be called while the sequence is actively communicating with the sequencer.

**get_sequencer**

```verilog
function uvm_sequencer_base get_sequencer()
```

Returns a reference to the default sequencer used by this sequence.

**set_parent_sequence**

```verilog
function void set_parent_sequence(
    uvm_sequence_base parent
)
```

Sets the parent sequence of this sequence_item. This is used to identify the source sequence of a sequence_item.

**get_parent_sequence**

```verilog
function uvm_sequence_base get_parent_sequence()
```

Returns a reference to the parent sequence of any sequence on which this method was called. If this is a parent sequence, the method returns *null*. 
The depth of any sequence is calculated automatically. However, the user may use `set_depth` to specify the depth of a particular sequence. This method will override the automatically calculated depth, even if it is incorrect.

### get_depth

```plaintext
function int get_depth()
```

Returns the depth of a sequence from its parent. A parent sequence will have a depth of 1, its child will have a depth of 2, and its grandchild will have a depth of 3.

### is_item

```plaintext
virtual function bit is_item()
```

This function may be called on any `sequence_item` or `sequence`. It will return 1 for items and 0 for sequences (which derive from this class).

### get_root_sequence_name

```plaintext
function string get_root_sequence_name()
```

Provides the name of the root sequence (the top-most parent sequence).

### get_root_sequence

```plaintext
function uvm_sequence_base get_root_sequence()
```

Provides a reference to the root sequence (the top-most parent sequence).

### get_sequence_path

```plaintext
function string get_sequence_path()
```

Provides a string of names of each sequence in the full hierarchical path. A “.” is used as the separator between each sequence.

**Reporting Interface**

Sequence items and sequences will use the sequencer which they are associated with for reporting messages. If no sequencer has been set for the item/sequence using `set_sequencer` or indirectly via `uvm_sequence_base::start_item` or `uvm_sequence_base::start`, then the global reporter will be used.
uvm_report

```c
virtual function void uvm_report(
    uvm_severity severity,
    string id,
    string message,
    int verbosity
)

```

uvm_report_info

```c
virtual function void uvm_report_info(
    string id,
    string message,
    int verbosity
)

```

uvm_report_warning

```c
virtual function void uvm_report_warning(
    string id,
    string message,
    int verbosity
)

```

uvm_report_error

```c
virtual function void uvm_report_error(
    string id,
    string message,
    int verbosity
)

```

uvm_report_fatal

```c
virtual function void uvm_report_fatal(
    string id,
    string message,
    int verbosity
)

```
These are the primary reporting methods in the UVM. uvm_sequence_item derived types delegate these functions to their associated sequencer if they have one, or to the global reporter. See uvm_report_object::Reporting for details on the messaging functions.
20.2 uvm_sequence_base

The uvm_sequence_base class provides the interfaces needed to create streams of sequence items and/or other sequences.

A sequence is executed by calling its start method, either directly or invocation of any of the `uvm_do_* macros.

Executing sequences via start

A sequence’s start method has a parent_sequence argument that controls whether pre_do, mid_do, and post_do are called in the parent sequence. It also has a call_pre_post argument that controls whether its pre_body and post_body methods are called. In all cases, its pre_start and post_start methods are always called.

When start is called directly, you can provide the appropriate arguments according to your application.

The sequence execution flow looks like this

User code

```
sub_seq.randomize(...); // optional
sub_seq.start(seqr, parent_seq, priority, call_pre_post)
```

The following methods are called, in order

```
sub_seq.pre_start() (task)
sub_seq.pre_body() (task) if call_pre_post==1
  parent_seq.pre_do(0) (task) if parent_sequence!=null
  parent_seq.mid_do(this) (func) if parent_sequence!=null
sub_seq.Body (task) YOUR STIMULUS CODE
  parent_seq.post_do(this) (func) if parent_sequence!=null
sub_seq.post_body() (task) if call_pre_post==1
sub_seq.post_start() (task)
```

Executing sub-sequences via `uvm_do macros

A sequence can also be indirectly started as a child in the body of a parent sequence. The child sequence’s start method is called indirectly by invoking any of the `uvm_do macros. In these cases, start is called with call_pre_post set to 0, preventing the started sequence’s pre_body and post_body methods from being called. During execution of the child sequence, the parent’s pre_do, mid_do, and post_do methods are called.

The sub-sequence execution flow looks like

User code

```
`uvm_do_with_prior(seq_seq, { constraints }, priority)
```

The following methods are called, in order

```
sub_seq.pre_start() (task)
parent_seq.pre_do(0) (task)
```
Remember, it is the parent sequence’s pre|mid|post_do that are called, not the sequence being executed.

**Executing sequence items via start_item/finish_item or `uvm_do macros**

Items are started in the body of a parent sequence via calls to start_item/finish_item or invocations of any of the `uvm_do macros. The pre_do, mid_do, and post_do methods of the parent sequence will be called as the item is executed.

The sequence-item execution flow looks like

User code

```plaintext
parent_seq.start_item(item, priority);
item.randomize(...) [with {constraints}];
parent_seq.finish_item(item);

or

`uvm_do_with_prior(item, constraints, priority)
```

The following methods are called, in order

```plaintext
sequencer.wait_for_grant(prior) (task) \ start_item \ 
parent_seq.pre_do(I) (task) / \ `uvm_do* macros 
parent_seq.mid_do(item) (func) \ / 
sequencer.send_request(item) (func) \finish_item / 
sequencer.wait_for_item_done() (task) / 
parent_seq.post_do(item) (func) / 
```

Attempting to execute a sequence via start_item/finish_item will produce a run-time error.

**Summary**

**uvm_sequence_base**

The uvm_sequence_base class provides the interfaces needed to create streams of sequence items and/or other sequences.

**Class Hierarchy**

```plaintext
class uvm_sequence_base extends uvm_sequence_item
```

**Class Declaration**

```plaintext
class uvm_sequence_base extends uvm_sequence_item
```
do_not_randomize | If set, prevents the sequence from being randomized before being executed by the `uvm_do*()` and `uvm_rand_send*()` macros, or as a default sequence.
---|---
new | The constructor for `uvm_sequence_base`.
is_item | Returns 1 on items and 0 on sequences.
get_sequence_state | Returns the sequence state as an enumerated value.
wait_for_sequence_state | Waits until the sequence reaches one of the given state.
get_tr_handle | Returns the integral recording transaction handle for this sequence.

**Sequence Execution**

start | Executes this sequence, returning when the sequence has completed.
pre_start | This task is a user-definable callback that is called before the optional execution of `pre_body`.
pre_body | This task is a user-definable callback that is called before the execution of `body` only when the sequence is started with `start`.
pre_do | This task is a user-definable callback task that is called on the parent sequence, if any sequence has issued a `wait_for_grant()` call and after the sequencer has selected this sequence, and before the item is randomized.
mid_do | This function is a user-definable callback function that is called after the sequence item has been randomized, and just before the item is sent to the driver.
body | This is the user-defined task where the main sequence code resides.
post_do | This function is a user-definable callback function that is called after the driver has indicated that it has completed the item, using either this `item_done` or `put` methods.
post_body | This task is a user-definable callback task that is called after the execution of `body` only when the sequence is started with `start`.
post_start | This task is a user-definable callback that is called after the optional execution of `post_body`.

**Run-Time Phasing**

get_starting_phase | Returns the ‘starting phase’.
set_starting_phase | Sets the ‘starting phase’.
set_automatic_phase_object | Sets the ‘automatically object to starting phase’ bit.
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<tr>
<th>Function</th>
<th>Description</th>
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<td>get_automatic_phase_object</td>
<td>Returns (and locks) the value of the ‘automatically object to starting phase’ bit.</td>
</tr>
<tr>
<td><strong>Sequence Control</strong></td>
<td></td>
</tr>
<tr>
<td>set_priority</td>
<td>The priority of a sequence may be changed at any point in time.</td>
</tr>
<tr>
<td>get_priority</td>
<td>This function returns the current priority of the sequence.</td>
</tr>
<tr>
<td>is_relevant</td>
<td>The default is_relevant implementation returns 1, indicating that the sequence is always relevant.</td>
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<tr>
<td>wait_for_relevant</td>
<td>This method is called by the sequencer when all available sequences are not relevant.</td>
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<tr>
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<td>Requests a lock on the specified sequencer.</td>
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<td>grab</td>
<td>Requests a lock on the specified sequencer.</td>
</tr>
<tr>
<td>unlock</td>
<td>Removes any locks or grabs obtained by this sequence on the specified sequencer.</td>
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<td>ungrab</td>
<td>Removes any locks or grabs obtained by this sequence on the specified sequencer.</td>
</tr>
<tr>
<td>is_blocked</td>
<td>Returns a bit indicating whether this sequence is currently prevented from running due to another lock or grab.</td>
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<td>has_lock</td>
<td>Returns 1 if this sequence has a lock, 0 otherwise.</td>
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<td>This function will kill the sequence, and cause all current locks and requests in the sequence’s default sequencer to be removed.</td>
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<td>do_kill</td>
<td>This function is a user hook that is called whenever a sequence is terminated by using either sequence.kill() or sequencer.stop_sequences() (which effectively calls sequence.kill()).</td>
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<td>start_item and finish_item together will initiate operation of a sequence item.</td>
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<td>finish_item, together with start_item together will initiate operation of a sequence_item.</td>
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<td>A sequence may optionally call wait_for_item_done.</td>
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<td>Method</td>
<td>Description</td>
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<td>---------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><code>get_use_response_handler</code></td>
<td>Returns the state of the use_response_handler bit.</td>
</tr>
<tr>
<td><code>response_handler</code></td>
<td>Returns the state of the use_response_handler bit. When the use_response_handler bit is set to 1, this virtual task is called by the sequencer for each response that arrives for this sequence.</td>
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<tr>
<td><code>set_response_queue_error_report_disabled</code></td>
<td>By default, if the response_queue overflows, an error is reported. When this bit is 0 (default value), error reports are generated when the response queue overflows.</td>
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<tr>
<td><code>get_response_queue_error_report_disabled</code></td>
<td>Returns the current depth setting for the response queue.</td>
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<tr>
<td><code>set_response_queue_depth</code></td>
<td>The default maximum depth of the response queue is 8.</td>
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<td><code>get_response_queue_depth</code></td>
<td>Empties the response queue for this sequence.</td>
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**do_not_randomize**

```cpp
bit do_not_randomize
```

If set, prevents the sequence from being randomized before being executed by the `uvm_do*()` and `uvm_rand_send*()` macros, or as a default sequence.

**new**

```cpp
function new (
    string name = "uvm_sequence"
)
```

The constructor for `uvm_sequence_base`.

**is_item**

```cpp
virtual function bit is_item()
```

Returns 1 on items and 0 on sequences. As this object is a sequence, `is_item` will always return 0.

**get_sequence_state**

```cpp
function uvm_sequence_state_enum get_sequence_state()
```

Returns the sequence state as an enumerated value. Can use to wait on the sequence reaching or changing from one or more states.

```cpp
wait(get_sequence_state() & (UVM_STOPPED|UVM_FINISHED));
```
wait_for_sequence_state

```yaml
wait_for_sequence_state(UVM_STOPPED|UVM_FINISHED);
```

Waits until the sequence reaches one of the given state. If the sequence is already in one of the state, this method returns immediately.

get_tr_handle

```yaml
function integer get_tr_handle()
```

Returns the integral recording transaction handle for this sequence. Can be used to associate sub-sequences and sequence items as child transactions when calling `uvm_component::begin_child_tr`.

Sequence Execution

start

```yaml
virtual task start ( 
    uvm_sequencer_base sequencer, 
    uvm_sequence_base parent_sequence = null, 
    int    this_priority = -1, 
    bit    call_pre_post = 1
)
```

Executes this sequence, returning when the sequence has completed.

The `sequencer` argument specifies the sequencer on which to run this sequence. The sequencer must be compatible with the sequence.

If `parent_sequence` is `null`, then this sequence is a root parent, otherwise it is a child of `parent_sequence`. The `parent_sequence`'s pre_do, mid_do, and post_do methods will be called during the execution of this sequence.

By default, the `priority` of a sequence is the priority of its parent sequence. If it is a root sequence, its default priority is 100. A different priority may be specified by `this_priority`. Higher numbers indicate higher priority.

If `call_pre_post` is set to 1 (default), then the `pre_body` and `post_body` tasks will be called before and after the sequence `body` is called.

pre_start

```yaml
virtual task pre_start()
```
This task is a user-definable callback that is called before the optional execution of `pre_body`. This method should not be called directly by the user.

**pre_body**

```verbatim
class custom_sequence extends uvm_sequence;
virtual task pre_body();
endclass
```

This task is a user-definable callback that is called before the execution of `body` only when the sequence is started with `start`. If `start` is called with `call_pre_post` set to 0, `pre_body` is not called. This method should not be called directly by the user.

**pre_do**

```verbatim
class custom_sequence extends uvm_sequence;
virtual task pre_do(bit is_item);
endclass
```

This task is a user-definable callback task that is called on the parent sequence, if any sequence has issued a `wait_for_grant()` call and after the sequencer has selected this sequence, and before the item is randomized.

Although `pre_do` is a task, consuming simulation cycles may result in unexpected behavior on the driver.

This method should not be called directly by the user.

**mid_do**

```verbatim
class custom_sequence extends uvm_sequence;
virtual function void mid_do(uvm_sequence_item this_item);
endclass
```

This function is a user-definable callback function that is called after the sequence item has been randomized, and just before the item is sent to the driver. This method should not be called directly by the user.

**body**

```verbatim
class custom_sequence extends uvm_sequence;
virtual task body();
endclass
```

This is the user-defined task where the main sequence code resides. This method should not be called directly by the user.

**post_do**

```verbatim
class custom_sequence extends uvm_sequence;
virtual function void post_do(uvm_sequence_item this_item);
endclass
```

This function is a user-definable callback function that is called after the driver has indicated that it has completed the item, using either this item done or put methods. This method should not be called directly by the user.
### post_body

```plaintext
virtual task post_body()
```

This task is a user-definable callback task that is called after the execution of `body` only when the sequence is started with `start`. If `start` is called with `call_pre_post` set to 0, `post_body` is not called. This task is a user-definable callback task that is called after the execution of the body, unless the sequence is started with `call_pre_post=0`. This method should not be called directly by the user.

### post_start

```plaintext
virtual task post_start()
```

This task is a user-definable callback that is called after the optional execution of `post_body`. This method should not be called directly by the user.

### Run-Time Phasing

#### get_starting_phase

```plaintext
function uvm_phase get_starting_phase()
```

Returns the ‘starting phase’.

If non-null, the starting phase specifies the phase in which this sequence was started. The starting phase is set automatically when this sequence is started as the default sequence on a sequencer. See `uvm_sequencer_base::start_phase_sequence` for more information.

Internally, the `uvm_sequence_base` uses a `uvm_get_to_lock_dap` to protect the starting phase value from being modified after the reference has been read. Once the sequence has ended its execution (either via natural termination, or being killed), then the starting phase value can be modified again.

#### set_starting_phase

```plaintext
function void set_starting_phase(
    uvm_phase phase
)
```

Sets the ‘starting phase’.

Internally, the `uvm_sequence_base` uses a `uvm_get_to_lock_dap` to protect the starting phase value from being modified after the reference has been read. Once the sequence has ended its execution (either via natural termination, or being killed), then the starting phase value can be modified again.

#### set_automatic_phase_objection

```plaintext
function void set_automatic_phase_objection(
    bit value
)
```


Sets the ‘automatically object to starting phase’ bit.

The most common interaction with the starting phase within a sequence is to simply *raise* the phase’s objection prior to executing the sequence, and *drop* the objection after ending the sequence (either naturally, or via a call to *kill*). In order to simplify this interaction for the user, the UVM provides the ability to perform this functionality automatically.

**For example**

```plaintext
function my_sequence::new(string name="unnamed");
    super.new(name);
    set_automatic_phase_objection(1);
endfunction : new
```

From a timeline point of view, the automatic phase objection looks like:

```
start() is executed
--! Objection is raised !--
pre_start() is executed
pre_body() is optionally executed
body() is executed
post_body() is optionally executed
post_start() is executed
--! Objection is dropped !--
start() unblocks
```

This functionality can also be enabled in sequences which were not written with UVM Run-Time Phasing in mind:

```plaintext
my_legacy_seq_type seq = new("seq");
seq.set_automatic_phase_objection(1);
seq.start(my_sequencer);
```

Internally, the *uvm_sequence_base* uses a *uvm_get_to_lock_dap* to protect the *automatic_phase_objection* value from being modified after the reference has been read. Once the sequence has ended its execution (either via natural termination, or being killed), then the *automatic_phase_objection* value can be modified again.

NEVER set the automatic phase objection bit to 1 if your sequence runs with a forever loop inside of the body, as the objection will never get dropped!

**get_automatic_phase_objection**

```plaintext
function bit get_automatic_phase_objection()
```

Returns (and locks) the value of the ‘automatically object to starting phase’ bit.

If 1, then the sequence will automatically raise an objection to the starting phase (if the starting phase is not *null*) immediately prior to *pre_start* being called. The objection will be dropped after *post_start* has executed, or *kill* has been called.
**Sequence Control**

**set_priority**

```plaintext
function void set_priority (int value)
```

The priority of a sequence may be changed at any point in time. When the priority of a sequence is changed, the new priority will be used by the sequencer the next time that it arbitrates between sequences.

The default priority value for a sequence is 100. Higher values result in higher priorities.

**get_priority**

```plaintext
function int get_priority()
```

This function returns the current priority of the sequence.

**is_relevant**

```plaintext
virtual function bit is_relevant()
```

The default is_relevant implementation returns 1, indicating that the sequence is always relevant.

Users may choose to override with their own virtual function to indicate to the sequencer that the sequence is not currently relevant after a request has been made.

When the sequencer arbitrates, it will call is_relevant on each requesting, unblocked sequence to see if it is relevant. If a 0 is returned, then the sequence will not be chosen.

If all requesting sequences are not relevant, then the sequencer will call wait_for_relevant on all sequences and re-arbitrate upon its return.

Any sequence that implements is_relevant must also implement wait_for_relevant so that the sequencer has a way to wait for a sequence to become relevant.

**wait_for_relevant**

```plaintext
virtual task wait_for_relevant()
```

This method is called by the sequencer when all available sequences are not relevant. When wait_for_relevant returns the sequencer attempt to re-arbitrate.

Returning from this call does not guarantee a sequence is relevant, although that would be the ideal. The method provide some delay to prevent an infinite loop.

If a sequence defines is_relevant so that it is not always relevant (by default, a sequence is always relevant), then the sequence must also supply a wait_for_relevant method.
lock

task lock(
  uvm_sequencer_base sequencer = null
)

Requests a lock on the specified sequencer. If sequencer is null, the lock will be requested on the current default sequencer.

A lock request will be arbitrated the same as any other request. A lock is granted after all earlier requests are completed and no other locks or grabs are blocking this sequence.

The lock call will return when the lock has been granted.

grab

task grab(
  uvm_sequencer_base sequencer = null
)

Requests a lock on the specified sequencer. If no argument is supplied, the lock will be requested on the current default sequencer.

A grab request is put in front of the arbitration queue. It will be arbitrated before any other requests. A grab is granted when no other grabs or locks are blocking this sequence.

The grab call will return when the grab has been granted.

unlock

function void unlock(
  uvm_sequencer_base sequencer = null
)

Removes any locks or grabs obtained by this sequence on the specified sequencer. If sequencer is null, then the unlock will be done on the current default sequencer.

ungrab

function void ungrab(
  uvm_sequencer_base sequencer = null
)

Removes any locks or grabs obtained by this sequence on the specified sequencer. If sequencer is null, then the unlock will be done on the current default sequencer.

is_blocked

function bit is_blocked()

Returns a bit indicating whether this sequence is currently prevented from running due to another lock or grab. A 1 is returned if the sequence is currently blocked. A 0 is returned if no lock or grab prevents this sequence from executing. Note that even if a sequence is not blocked, it is possible for another sequence to issue a lock or grab before this sequence can issue a request.
**has_lock**

```plaintext
function bit has_lock()
```

Returns 1 if this sequence has a lock, 0 otherwise.

Note that even if this sequence has a lock, a child sequence may also have a lock, in which case the sequence is still blocked from issuing operations on the sequencer.

**kill**

```plaintext
function void kill()
```

This function will kill the sequence, and cause all current locks and requests in the sequence’s default sequencer to be removed. The sequence state will change to UVM_STOPPED, and the post_body() and post_start() callback methods will not be executed.

If a sequence has issued locks, grabs, or requests on sequencers other than the default sequencer, then care must be taken to unregister the sequence with the other sequencer(s) using the sequencer unregister_sequence() method.

**do_kill**

```plaintext
virtual function void do_kill()
```

This function is a user hook that is called whenever a sequence is terminated by using either sequence.kill() or sequencer.stop_sequences() (which effectively calls sequence.kill()).

---

**SEQUENCE ITEM EXECUTION**

**create_item**

```plaintext
protected function uvm_sequence_item create_item(
    uvm_object_wrapper Type_var,
    uvm_sequencer_base l_sequencer,
    string name
)
```

Create_item will create and initialize a sequence_item or sequence using the factory. The sequence_item or sequence will be initialized to communicate with the specified sequencer.

**start_item**

```plaintext
virtual task start_item (    uvm_sequence_item item,
    int set_priority = -1,
    uvm_sequencer_base sequencer = null
)
```
start_item and finish_item together will initiate operation of a sequence item. If the item has not already been initialized using create_item, then it will be initialized here to use the default sequencer specified by m_sequencer. Randomization may be done between start_item and finish_item to ensure late generation

**finish_item**

```cpp
class finish_item {
public:
    virtual task finish_item (uvm_sequence_item item, int set_priority = -1) {
    }
}
```

finish_item, together with start_item together will initiate operation of a sequence_item. Finish_item must be called after start_item with no delays or delta-cycles. Randomization, or other functions may be called between the start_item and finish_item calls.

**wait_for_grant**

```cpp
class wait_for_grant {
public:
    virtual task wait_for_grant (int item_priority = -1, bit lock_request = 0) {
    }
}
```

This task issues a request to the current sequencer. If item_priority is not specified, then the current sequence priority will be used by the arbiter. If a lock_request is made, then the sequencer will issue a lock immediately before granting the sequence. (Note that the lock may be granted without the sequence being granted if is_relevant is not asserted).

When this method returns, the sequencer has granted the sequence, and the sequence must call send_request without inserting any simulation delay other than delta cycles. The driver is currently waiting for the next item to be sent via the send_request call.

**send_request**

```cpp
class send_request {
public:
    virtual function void send_request (uvm_sequence_item request, bit rerandomize = 0) {
    }
}
```

The send_request function may only be called after a wait_for_grant call. This call will send the request item to the sequencer, which will forward it to the driver. If the rerandomize bit is set, the item will be randomized before being sent to the driver.

**wait_for_item_done**

```cpp
class wait_for_item_done {
public:
    virtual task wait_for_item_done (int transaction_id = -1) {
    }
}
```

A sequence may optionally call wait_for_item_done. This task will block until the driver calls item_done or put. If no transaction_id parameter is specified, then the call will return the next time that the driver calls item_done or put. If a specific transaction_id is specified, then the call will return when the driver indicates completion of that specific item.
Note that if a specific transaction_id has been specified, and the driver has already issued an item_done or put for that transaction, then the call will hang, having missed the earlier notification.

**Response API**

**use_response_handler**

```plaintext
function void use_response_handler(
    bit enable
)
```

When called with enable set to 1, responses will be sent to the response handler. Otherwise, responses must be retrieved using `get_response`.

By default, responses from the driver are retrieved in the sequence by calling `get_response`.

An alternative method is for the sequencer to call the `response_handler` function with each response.

**get_use_response_handler**

```plaintext
function bit get_use_response_handler()
```

Returns the state of the `use_response_handler` bit.

**response_handler**

```plaintext
virtual function void response_handler(
    uvm_sequence_item response
)
```

When the `use_response_handler` bit is set to 1, this virtual task is called by the sequencer for each response that arrives for this sequence.

**set_response_queue_error_report_disabled**

```plaintext
function void set_response_queue_error_report_disabled(
    bit value
)
```

By default, if the response_queue overflows, an error is reported. The response_queue will overflow if more responses are sent to this sequence from the driver than `get_response` calls are made. Setting value to 0 disables these errors, while setting it to 1 enables them.

**get_response_queue_error_report_disabled**

```plaintext
function bit get_response_queue_error_report_disabled()
```
When this bit is 0 (default value), error reports are generated when the response queue overflows. When this bit is 1, no such error reports are generated.

**set_response_queue_depth**

```c
function void set_response_queue_depth(
    int value
)
```

The default maximum depth of the response queue is 8. These method is used to examine or change the maximum depth of the response queue.

Setting the `response_queue_depth` to -1 indicates an arbitrarily deep response queue. No checking is done.

**get_response_queue_depth**

```c
function int get_response_queue_depth()
```

Returns the current depth setting for the response queue.

**clear_response_queue**

```c
virtual function void clear_response_queue()
```

Empties the response queue for this sequence.
20.3 uvm_sequence #(REQ,RSP)

The uvm_sequence class provides the interfaces necessary in order to create streams of sequence items and/or other sequences.

### Summary

**uvm_sequence #(REQ,RSP)**

The uvm_sequence class provides the interfaces necessary in order to create streams of sequence items and/or other sequences.

#### Class Hierarchy

- uvm_void
- uvm_object
- uvm_transaction
- uvm_sequence_item
- uvm_sequence_base
- uvm_sequence#(REQ,RSP)

#### Class Declaration

```cpp
virtual class uvm_sequence #(  
    type REQ = uvm_sequence_item,  
    type RSP = REQ  
) extends uvm_sequence_base
```

#### Variables

<table>
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<tr>
<th>Variable</th>
<th>Description</th>
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</thead>
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<tr>
<td>req</td>
<td>The sequence contains a field of the request type called req. The user can use this field, if desired, or create another field to use. The default <em>do_print</em> will print this field.</td>
</tr>
<tr>
<td>rsp</td>
<td>The sequence contains a field of the response type called rsp.</td>
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#### Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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</thead>
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<tr>
<td>new</td>
<td>Creates and initializes a new sequence object.</td>
</tr>
<tr>
<td>send_request</td>
<td>This method will send the request item to the sequencer, which will forward it to the driver.</td>
</tr>
<tr>
<td>get_current_item</td>
<td>Returns the request item currently being executed by the sequencer.</td>
</tr>
<tr>
<td>get_response</td>
<td>By default, sequences must retrieve responses by calling get_response.</td>
</tr>
</tbody>
</table>
**The sequence contains a field of the response type called rsp. The user can use this field, if desired, or create another field to use. The default do_print will print this field.**

**Methods**

**new**

```plaintext
default new (
    string name = "uvm_sequence"
)
```

Creates and initializes a new sequence object.

**send_request**

```plaintext
default void send_request(
    uvm_sequence_item request,
    bit rerandomize = 0
)
```

This method will send the request item to the sequencer, which will forward it to the driver. If the rerandomize bit is set, the item will be randomized before being sent to the driver. The send_request function may only be called after uvm_sequence_base::wait_for_grant returns.

**get_current_item**

```plaintext
default function REQ get_current_item()
```

Returns the request item currently being executed by the sequencer. If the sequencer is not currently executing an item, this method will return null.

The sequencer is executing an item from the time that get_next_item or peek is called until the time that get or item_done is called.

Note that a driver that only calls get will never show a current item, since the item is completed at the same time as it is requested.

**get_response**

```plaintext
default virtual task get_response(
    output RSP response,
    input int transaction_id = -1
)
```

By default, sequences must retrieve responses by calling get_response. If no transaction_id is specified, this task will return the next response sent to this sequence. If no response is available in the response queue, the method will block until a response is received.
If a transaction_id is parameter is specified, the task will block until a response with that transaction_id is received in the response queue.

The default size of the response queue is 8. The get_response method must be called soon enough to avoid an overflow of the response queue to prevent responses from being dropped.

If a response is dropped in the response queue, an error will be reported unless the error reporting is disabled via set_response_queue_error_report_disabled.
The `uvm_sequence_library` is a sequence that contains a list of registered sequence types. It can be configured to create and execute these sequences any number of times using one of several modes of operation, including a user-defined mode.

When started (as any other sequence), the sequence library will randomly select and execute a sequence from its `sequences` queue. If in `UVM_SEQ_LIB_RAND` mode, its `select_rand` property is randomized and used as an index into `sequences`. When in `UVM_SEQ_LIB_RANDC` mode, the `select_randc` property is used. When in `UVM_SEQ_LIB_ITEM` mode, only sequence items of the `REQ` type are generated and executed—no sequences are executed. Finally, when in `UVM_SEQ_LIB_USER` mode, the `select_sequence` method is called to obtain the index for selecting the next sequence to start. Users can override this method in subtypes to implement custom selection algorithms.

Creating a subtype of a sequence library requires invocation of the `\uvm_sequence_library_utils` macro in its declaration and calling the `init_sequence_library` method in its constructor. The macro and function are needed to populate the sequence library with any sequences that were statically registered with it or any of its base classes.

```verilog
class my_seq_lib extends uvm_sequence_library #(my_item);
  `uvm_object_utils(my_seq_lib)
  `uvm_sequence_library_utils(my_seq_lib)
  function new(string name="");
    super.new(name);
    init_sequence_library();
  endfunction
  ...
endclass
```

### Contents

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<th><strong>uvm_sequence_library</strong></th>
<th>The <code>uvm_sequence_library</code> is a sequence that contains a list of registered sequence types.</th>
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<tr>
<td><strong>uvm_sequence_library_cfg</strong></td>
<td>A convenient container class for configuring all the sequence library parameters using a single <code>set</code> command.</td>
</tr>
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</table>

**new**

Function `new`

```verilog
function new(
  string name = ""
)
```

Create a new instance of this class

**get_type_name**

Virtual function `get_type_name`

```verilog
virtual function string get_type_name()
```

Get the type name of this class
SEQUENCE SELECTION

**selection_mode**

```uvm_sequence_lib_mode selection_mode```

Specifies the mode used to select sequences for execution.

If you do not have access to an instance of the library, use the configuration resource interface.

The following example sets the `config_seq_lib` as the default sequence for the `main` phase on the sequencer to be located at “env.agent.sequencer” and set the selection mode to `UVM_SEQ_LIB_RANDC`. If the settings are being done from within a component, the first argument must be `this` and the second argument a path relative to that component.

```uvm_config_db #(uvm_object_wrapper)::set(null, 
   "env.agent.sequencer.main_phase", 
   "default_sequence", 
   main_seq_lib::get_type());
```

```uvm_config_db #(uvm_sequence_lib_mode)::set(null, 
   "env.agent.sequencer.main_phase", 
   "default_sequence.selection_mode", 
   UVM_SEQ_LIB_RANDC);
```

Alternatively, you may create an instance of the sequence library a priori, initialize all its parameters, randomize it, then set it to run as-is on the sequencer.

```main_seq_lib my_seq_lib;
my_seq_lib = new("my_seq_lib");
my_seq_lib.selection_mode = UVM_SEQ_LIB_RANDC;
my_seq_lib.min_random_count = 500;
my_seq_lib.max_random_count = 1000;
void'(my_seq_lib.randomize());
```

```uvm_config_db #(uvm_sequence_base)::set(null, 
   "env.agent.sequencer.main_phase", 
   "default_sequence", 
   my_seq_lib);
```

**min_random_count**

```int unsigned min_random_count=10```

Sets the minimum number of items to execute. Use the configuration mechanism to set. See `selection_mode` for an example.

**max_random_count**

```int unsigned max_random_count=10```

Sets the maximum number of items to execute. Use the configuration mechanism to set. See `selection_mode` for an example.
sequences_executed

```cpp
protected int unsigned sequences_executed
```

Indicates the number of sequences executed, not including the currently executing sequence, if any.

sequence_count

```cpp
rand int unsigned sequence_count = 10
```

Specifies the number of sequences to execute when this sequence library is started. If in UVM_SEQ_LIB_ITEM mode, specifies the number of sequence items that will be generated.

select_rand

```cpp
rand int unsigned select_rand
```

The index variable that is randomized to select the next sequence to execute when in UVM_SEQ_LIB_RAND mode.

Extensions may place additional constraints on this variable.

select_randc

```cpp
randc bit [15:0] select_randc
```

The index variable that is randomized to select the next sequence to execute when in UVM_SEQ_LIB_RANDC mode.

Extensions may place additional constraints on this variable.

select_sequence

```cpp
virtual function int unsigned select_sequence(
    int unsigned max
)
```

Generates an index used to select the next sequence to execute. Overrides must return a value between 0 and `max`, inclusive. Used only for UVM_SEQ_LIB_USER selection mode. The default implementation returns 0, incrementing on successive calls, wrapping back to 0 when reaching `max`.

SEQUENCE REGISTRATION

add_typewide_sequence

```cpp
static function void add typewide sequence(
```

UVM 1.2 Class Reference
Registers the provided sequence type with this sequence library type. The sequence type will be available for selection by all instances of this class. Sequence types already registered are silently ignored.

**add_typewide_sequences**

```plaintext
static function void add_typewide_sequences(
    uvm_object_wrapper seq_types[$]
)
```

Registers the provided sequence types with this sequence library type. The sequence types will be available for selection by all instances of this class. Sequence types already registered are silently ignored.

**add_sequence**

```plaintext
function void add_sequence(
    uvm_object_wrapper seq_type
)
```

Registers the provided sequence type with this sequence library instance. Sequence types already registered are silently ignored.

**add_sequences**

```plaintext
virtual function void add_sequences(
    uvm_object_wrapper seq_types[$]
)
```

Registers the provided sequence types with this sequence library instance. Sequence types already registered are silently ignored.

**remove_sequence**

```plaintext
virtual function void remove_sequence(
    uvm_object_wrapper seq_type
)
```

Removes the given sequence type from this sequence library instance. If the type was registered statically, the sequence queues of all instances of this library will be updated accordingly. A warning is issued if the sequence is not registered.

**get_sequences**

```plaintext
virtual function void get_sequences(
    ref uvm_object_wrapper seq_types[$]
)
```

Append to the provided `seq_types` array the list of registered `sequences`.
**init_sequence_library**

```plaintext
function void init_sequence_library()
```

All subtypes of this class must call `init_sequence_library` in its constructor.

**uvm_sequence_library_utils**

All subtypes of this class must invoke the `uvm_sequence_library_utils` macro.

```plaintext
class my_seq_lib extends uvm_sequence_library #(my_item);
  `uvm_object_utils(my_seq_lib)
  `uvm_sequence_library_utils(my_seq_lib)
  function new(string name="")
    super.new(name);
    init_sequence_library();
  endfunction
endclass
```

**uvm_sequence_library_cfg**

A convenient container class for configuring all the sequence library parameters using a single `set` command.

```plaintext
uvm_sequence_library_cfg cfg;
cfg = new("seqlib_cfg", UVM_SEQ_LIB_RANDC, 1000, 2000);
```

```plaintext
uvm_config_db #(uvm_sequence_library_cfg)::set(null,
  "env.agent.sequencer.main_ph",
  "default_sequence.config",
  cfg);
```

**Summary**

**uvm_sequence_library_cfg**

A convenient container class for configuring all the sequence library parameters using a single `set` command.

**Class Hierarchy**

```
| uvm_void |
| uvm_object |
| **uvm_sequence_library_cfg** |
```

**Class Declaration**

```
class uvm_sequence_library_cfg extends uvm_object
```
21. Macros and Defines

UVM includes some macros to allow the user to specify intent without the need to specify multiple types of SystemVerilog constructs. These macros assist with reporting, object behavior (interaction with the factory and field usage in comparing/copying/etc), sequence specification, and TLM connection.

UVM also includes some defines to specify sizing in the register space and to determine version of the UVM standard and/or implementation.

Summary

**Macros and Defines**

UVM includes some macros to allow the user to specify intent without the need to specify multiple types of SystemVerilog constructs.
21.1 Report Macros

This set of macros provides wrappers around the uvm_report_* Reporting functions. The macros serve two essential purposes:

- To reduce the processing overhead associated with filtered out messages, a check is made against the report’s verbosity setting and the action for the id/severity pair before any string formatting is performed. This affects only `uvm_info reports.
- The `__FILE__ and `__LINE__ information is automatically provided to the underlying uvm_report_* call. Having the file and line number from where a report was issued aides in debug. You can disable display of file and line information in reports by defining UVM_REPORT_DISABLE_FILE_LINE on the command line.

The macros also enforce a verbosity setting of UVM_NONE for warnings, errors and fatals so that they cannot be mistakenly turned off by setting the verbosity level too low (warning and errors can still be turned off by setting the actions appropriately).

To use the macros, replace the previous call to uvm_report_* with the corresponding macro.

```cpp
//Previous calls to uvm_report_*
uvm_report_info("MYINFO1", $sformatf("val: %0d", val), UVM_LOW);
uvm_report_warning("MYWARN1", "This is a warning");
uvm_report_error( "MYERR", "This is an error");
uvm_report_fatal("MYFATAL", "A fatal error has occurred");
```

The above code is replaced by

```cpp
//New calls to `uvm_*
`uvm_info("MYINFO1", $sformatf("val: %0d", val), UVM_LOW)
`uvm_warning("MYWARN1", "This is a warning")
`uvm_error("MYERR", "This is an error")
`uvm_fatal("MYFATAL", "A fatal error has occurred")
```

Macros represent text substitutions, not statements, so they should not be terminated with semi-colons.

Summary

**Report Macros**

This set of macros provides wrappers around the uvm_report_* Reporting functions.

<table>
<thead>
<tr>
<th>BASIC MESSAGING MACROS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_info</code></td>
<td>Calls uvm_report_info if VERBOSITY is lower than the configured verbosity of the associated reporter.</td>
</tr>
<tr>
<td><code>uvm_warning</code></td>
<td>Calls uvm_report_warning with a verbosity of UVM_NONE.</td>
</tr>
<tr>
<td><code>uvm_error</code></td>
<td>Calls uvm_report_error with a verbosity of UVM_NONE.</td>
</tr>
<tr>
<td><code>uvm_fatal</code></td>
<td>Calls uvm_report_fatal with a verbosity of UVM_NONE.</td>
</tr>
<tr>
<td><code>uvm_info_context</code></td>
<td></td>
</tr>
</tbody>
</table>
MESSAGE TRACE MACROS

`uvm_info_begin
`uvm_info_end

This macro pair provides the ability to add elements to messages.

`uvm_warning_begin
`uvm_warning_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_WARNING and has no verbosity threshold.

`uvm_error_begin
`uvm_error_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_ERROR and has no verbosity threshold.

`uvm_fatal_begin
`uvm_fatal_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_FATAL and has no verbosity threshold.

MESSAGE ELEMENT MACROS

`uvm_message_add_tag
`uvm_message_add_int
`uvm_message_add_string
`uvm_message_add_object

These macros allow the user to provide elements that are associated with uvm_report_messages.

BASIC MESSAGING MACROS

`uvm_info

Calls uvm_report_info if VERBOSITY is lower than the configured verbosity of the associated reporter. ID is given as the message tag and MSG is given as the message text. The file and line are also sent to the uvm_report_info call.

`uvm_info(ID, MSG, VERBOSITY)

`uvm_warning

Calls uvm_report_warning with a verbosity of UVM_NONE. The message cannot be turned off using the reporter's verbosity setting, but can be turned off by setting the
action for the message. \textit{ID} is given as the message tag and \textit{MSG} is given as the message text. The file and line are also sent to the \texttt{uvm_report_warning} call.

```
\texttt{\textasciitilde uvm_warning(ID, MSG)}
```

\textbf{\texttt{\textasciitilde uvm_error}}

Calls \texttt{uvm_report_error} with a verbosity of UVM\_NONE. The message cannot be turned off using the reporter’s verbosity setting, but can be turned off by setting the action for the message. \textit{ID} is given as the message tag and \textit{MSG} is given as the message text. The file and line are also sent to the \texttt{uvm_report_error} call.

```
\texttt{\textasciitilde uvm_error(ID, MSG)}
```

\textbf{\texttt{\textasciitilde uvm_fatal}}

Calls \texttt{uvm_report_fatal} with a verbosity of UVM\_NONE. The message cannot be turned off using the reporter’s verbosity setting, but can be turned off by setting the action for the message. \textit{ID} is given as the message tag and \textit{MSG} is given as the message text. The file and line are also sent to the \texttt{uvm_report_fatal} call.

```
\texttt{\textasciitilde uvm_fatal(ID, MSG)}
```

\textbf{\texttt{\textasciitilde uvm_info_context}}

```
\texttt{\textasciitilde uvm_info_context(ID, MSG, VERBOSITY, RO)}
```

Operates identically to \texttt{\textasciitilde uvm_info} but requires that the context, or \texttt{uvm_report_object}, in which the message is printed be explicitly supplied as a macro argument.

\textbf{\texttt{\textasciitilde uvm_warning_context}}

```
\texttt{\textasciitilde uvm_warning_context(ID, MSG, RO)}
```

Operates identically to \texttt{\textasciitilde uvm_warning} but requires that the context, or \texttt{uvm_report_object}, in which the message is printed be explicitly supplied as a macro argument.
**`uvm_error_context`**

`uvm_error_context(ID, MSG, RO)

Operates identically to `uvm_error but requires that the context, or uvm_report_object in which the message is printed be explicitly supplied as a macro argument.

**`uvm_fatal_context`**

`uvm_fatal_context(ID, MSG, RO)

Operates identically to `uvm_fatal but requires that the context, or uvm_report_object, in which the message is printed be explicitly supplied as a macro argument.

**MESSAGE TRACE MACROS**

**`uvm_info_begin`**

`uvm_info_begin(ID, MSG, VERBOSITY, RM = __uvm_msg)

**`uvm_info_end`**

This macro pair provides the ability to add elements to messages.

Example usage is shown here.

```python
... task my_task();
    ...
    `uvm_info_begin("MY_ID", "This is my message...", UVM_LOW)
    `uvm_message_add_tag("my_color", "red")
    `uvm_message_add_int(my_int, UVM_DEC)
    `uvm_message_add_string(my_string)
    `uvm_message_add_object(my_obj)
    `uvm_info_end
    ...
endtask
```
`uvm_warning_begin

`uvm_warning_begin(ID, MSG, RM = __uvm_msg)

`uvm_warning_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_WARNING and has no verbosity threshold.

The usage shown in `uvm_info_end works identically for this pair.

`uvm_error_begin

`uvm_error_begin(ID, MSG, RM = __uvm_msg)

`uvm_error_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_ERROR and has no verbosity threshold.

The usage shown in `uvm_info_end works identically for this pair.

`uvm_fatal_begin

`uvm_fatal_begin(ID, MSG, RM = __uvm_msg)

`uvm_fatal_end

This macro pair operates identically to `uvm_info_begin/`uvm_info_end with exception that the message severity is UVM_FATAL and has no verbosity threshold.
The usage shown in `uvm_info_end works identically for this pair.

```
`uvm_info_context_begin

`uvm_info_context_begin(ID, MSG, UVM_NONE, RO, RM = __uvm_msg)

`uvm_info_context_end

`uvm_info_context_end
```

This macro pair operates identically to `uvm_info_begin/`uvm_info_end, but requires that the context, or uvm_report_object in which the message is printed be explicitly supplied as a macro argument.

```
`uvm_warning_context_begin

`uvm_warning_context_begin(ID, MSG, RO, RM = __uvm_msg)

`uvm_warning_context_end

`uvm_warning_context_end
```

This macro pair operates identically to `uvm_warning_begin/`uvm_warning_end, but requires that the context, or uvm_report_object in which the message is printed be explicitly supplied as a macro argument.

```
`uvm_error_context_begin

`uvm_error_context_begin(ID, MSG, RO, RM = __uvm_msg)

`uvm_error_context_end

`uvm_error_context_end
```
This macro pair operates identically to `uvm_error_begin/`uvm_error_end, but requires that the context, or uvm_report_object in which the message is printed be explicitly supplied as a macro argument.

`uvm_fatal_context_begin

`uvm_fatal_context_end

This macro pair operates identically to `uvm_fatal_begin/`uvm_fatal_end, but requires that the context, or uvm_report_object in which the message is printed be explicitly supplied as a macro argument.

**MESSAGE ELEMENT MACROS**

`uvm_message_add_tag

`uvm_message_add_int

`uvm_message_add_string
`uvm_message_add_object

These macros allow the user to provide elements that are associated with `uvm_report_messages. Separate macros are provided such that the user can supply arbitrary string/string pairs using `uvm_message_add_tag, integral types along with a radix using `uvm_message_add_int, string using `uvm_message_add_string and `uvm_objects using `uvm_message_add_object.

Example usage is shown in `uvm_info_end.

```
`uvm_message_add_object(VAR, LABEL = "", ACTION=(UVM_LOG|UVM_RM_RECORD))
```
# 21.2 Utility and Field Macros for Components and Objects

## Summary

### Utility and Field Macros for Components and Objects

<table>
<thead>
<tr>
<th>Utility Macros</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_field_utils_begin</code></td>
<td>The <code>utils</code> macros define the infrastructure needed to enable the object/component for correct factory operation.</td>
</tr>
<tr>
<td><code>uvm_field_utils_end</code></td>
<td>These macros form a block in which <code>uvm_field_*</code> macros can be placed.</td>
</tr>
<tr>
<td><code>uvm_object_utils</code></td>
<td><code>uvm_object</code>-based class declarations may contain one of the above forms of utility macros.</td>
</tr>
<tr>
<td><code>uvm_object_param_utils</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_object_utils_begin</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_object_param_utils_begin</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_object_utils_end</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_component_utils</code></td>
<td>uvm_component-based class declarations may contain one of the above forms of utility macros.</td>
</tr>
<tr>
<td><code>uvm_component_param_utils</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_component_utils_begin</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_component_param_utils_begin</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_component_end</code></td>
<td></td>
</tr>
<tr>
<td><code>uvm_object_registry</code></td>
<td>Registers a uvm_object-based class with the factory</td>
</tr>
<tr>
<td><code>uvm_component_registry</code></td>
<td>Registers a uvm_component-based class with the factory</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field Macros</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_field_*</code></td>
<td>The <code>uvm_field_*</code> macros are invoked inside of the <code>uvm_*_utils_begin</code> and <code>uvm_*_utils_end</code> macro blocks to form “automatic” implementations of the core data methods: copy, compare, pack, unpack, record, print, and sprint.</td>
</tr>
</tbody>
</table>

### `uvm_field_*` Macros

<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_field_int</code></td>
<td>Implements the data operations for any packed integral property.</td>
</tr>
<tr>
<td><code>uvm_field_object</code></td>
<td>Implements the data operations for a <code>uvm_object</code>-based property.</td>
</tr>
<tr>
<td><code>uvm_field_string</code></td>
<td>Implements the data operations for a string property.</td>
</tr>
<tr>
<td><code>uvm_field_enum</code></td>
<td>Implements the data operations for an enumerated property.</td>
</tr>
<tr>
<td><code>uvm_field_real</code></td>
<td>Implements the data operations for any real property.</td>
</tr>
<tr>
<td><code>uvm_field_event</code></td>
<td>Implements the data operations for an event property.</td>
</tr>
</tbody>
</table>

### `uvm_field_sarray_*` Macros

<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_field_sarray_int</code></td>
<td>Implements the data operations for a one-dimensional static array of integrals.</td>
</tr>
</tbody>
</table>
A one-dimensional static array of `uvm_object`-based objects.

- `uvm_field_sarray_string`: Implements the data operations for a one-dimensional static array of strings.
- `uvm_field_sarray_enum`: Implements the data operations for a one-dimensional static array of enums.

UVM FIELD ARRAY MACROS

Macros that implement data operations for one-dimensional dynamic array properties.

- `uvm_field_array_int`: Implements the data operations for a one-dimensional dynamic array of integrals.
- `uvm_field_array_object`: Implements the data operations for a one-dimensional dynamic array of `uvm_object`-based objects.
- `uvm_field_array_string`: Implements the data operations for a one-dimensional dynamic array of strings.
- `uvm_field_array_enum`: Implements the data operations for a one-dimensional dynamic array of enums.

UVM FIELD QUEUE MACROS

Macros that implement data operations for dynamic queues.

- `uvm_field_queue_int`: Implements the data operations for a queue of integrals.
- `uvm_field_queue_object`: Implements the data operations for a queue of `uvm_object`-based objects.
- `uvm_field_queue_string`: Implements the data operations for a queue of strings.
- `uvm_field_queue_enum`: Implements the data operations for a one-dimensional queue of enums.

UVM FIELD AA STRING MACROS

Macros that implement data operations for associative arrays indexed by `string`.

- `uvm_field_aa_int_string`: Implements the data operations for an associative array of integrals indexed by `string`.
- `uvm_field_aa_object_string`: Implements the data operations for an associative array of `uvm_object`-based objects indexed by `string`.
- `uvm_field_aa_string_string`: Implements the data operations for an associative array of strings indexed by `string`.

UVM FIELD AA INT MACROS

Macros that implement data operations for associative arrays indexed by an integral type.

- `uvm_field_aa_object_int`: Implements the data operations for an associative array of `uvm_object`-based objects indexed by the `int` data type.
- `uvm_field_aa_int_int`: Implements the data operations for an associative array of `int` data type.
- `uvm_field_aa_int_int_unsigned`: Implements the data operations for an associative array of `int` unsigned data type.
- `uvm_field_aa_int_integer`: Implements the data operations for an associative array of `integer` data type.
- `uvm_field_aa_int_integer_unsigned`: Implements the data operations for an associative array of `integer` unsigned data type.
<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_field_aa_int_byte</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>byte</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_byte_unsigned</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>byte unsigned</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_shortint</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>shortint</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_shortint_unsigned</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>shortint unsigned</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_longint</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>longint</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_longint_unsigned</code></td>
<td>Implements the data operations for an associative array of integral types indexed by the <code>longint unsigned</code> data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_key</code></td>
<td>Implements the data operations for an associative array of integral types indexed by any integral key data type.</td>
</tr>
<tr>
<td><code>uvm_field_aa_int_enumkey</code></td>
<td>Implements the data operations for an associative array of integral types indexed by any enumeration key data type.</td>
</tr>
</tbody>
</table>

**Recording Macros**

The recording macros assist users who implement the `uvm_object::do_record` method.

- `uvm_record_attribute` Vendor-independent macro to hide tool-specific interface for recording attributes (fields) to a transaction database.
- `uvm_record_int`  
- `uvm_record_string`  
- `uvm_record_time`  
- `uvm_record_real`  
- `uvm_record_field`  

**Packing Macros**

The packing macros assist users who implement the `uvm_object::do_pack` method.

- `uvm_pack_intN` Pack an integral variable.
- `uvm_pack_enumN` Pack an integral variable.
- `uvm_pack_sarrayN` Pack a static array of integrals.
- `uvm_pack_arrayN` Pack a dynamic array of integrals.
- `uvm_pack_queueN` Pack a queue of integrals.
- `uvm_pack_int` Pack an integral variable without having to also specify the bit size.
- `uvm_pack_enum` Pack an enumeration value.
- `uvm_pack_string` Pack a string variable.
- `uvm_pack_real` Pack a variable of type real.
- `uvm_pack_sarray` Pack a static array without having to also specify the bit size of its elements.
- `uvm_pack_array` Pack a dynamic array without having to also specify the bit size of its elements.
- `uvm_pack_queue` Pack a queue without having to also
**Unpacking Macros**

The unpacking macros assist users who implement the `uvm_object::do_unpack` method.

### Unpacking - With Size Info

- `uvm_unpack_intN` - Unpack into an integral variable.
- `uvm_unpack_enumN` - Unpack enum of type `TYPE` into `VAR`.
- `uvm_unpack_sarrayN` - Unpack a static (fixed) array of integrals.
- `uvm_unpack_arrayN` - Unpack into a dynamic array of integrals.
- `uvm_unpack_queueN` - Unpack into a queue of integrals.

### Unpacking - No Size Info

- `uvm_unpack_int` - Unpack an integral variable without having to also specify the bit size.
- `uvm_unpack_enum` - Unpack an enumeration value, which requires its type be specified.
- `uvm_unpack_string` - Unpack a string variable.
- `uvm_unpack_real` - Unpack a variable of type `real`.
- `uvm_unpack_sarray` - Unpack a static array without having to also specify the bit size of its elements.
- `uvm_unpack_array` - Unpack a dynamic array without having to also specify the bit size of its elements.
- `uvm_unpack_queue` - Unpack a queue without having to also specify the bit size of its elements.

---

**Utility Macros**

The `utils` macros define the infrastructure needed to enable the object/component for correct factory operation. See `uvm_object_utils` and `uvm_component_utils` for details.

A `utils` macro should be used inside *every* user-defined class that extends `uvm_object` directly or indirectly, including `uvm_sequence_item` and `uvm_component`.

Below is an example usage of the `utils` macro for a user-defined object.

```verbatim
class mydata extends uvm_object;
    `uvm_object_utils(mydata)
    // declare data properties
    function new(string name="mydata_inst");
        super.new(name);
    endfunction
endclass
```

Below is an example usage of a `utils` macro for a user-defined component.

```verbatim
class my_comp extends uvm_component;
    `uvm_component_utils(my_comp)
    // declare data properties
    function new(string name, uvm_component parent=null);
        super.new(name,parent);
    endfunction
endclass
```
These macros form a block in which `uvm_field_* macros can be placed. Used as

`uvm_field_utils_begin(TYPE)
`uvm_field_* macros here
`uvm_field_utils_end

These macros do not perform factory registration nor implement the get_type_name and create methods. Use this form when you need custom implementations of these two methods, or when you are setting up field macros for an abstract class (i.e. virtual class).

`uvm_object_utils

`uvm_object_param_utils

`uvm_object_utils_begin

`uvm_object_param_utils_begin

`uvm_object_utils_end

`uvm_object-param-utils-begin

`uvm_object-param-utils-end

uvm_object-based class declarations may contain one of the above forms of utility macros.

For simple objects with no field macros, use

`uvm_object_utils(TYPE)

For simple objects with field macros, use

`uvm_object_utils_begin(TYPE)
`uvm_field_* macro invocations here
`uvm_object_utils_end
For parameterized objects with no field macros, use

```
`uvm_object_param_utils(TYPE)
```

For parameterized objects, with field macros, use

```
`uvm_object_param_utils_begin(TYPE)
  `uvm_field_* macro invocations here
`uvm_object_utils_end
```

Simple (non-parameterized) objects use the `uvm_object_utils* versions, which do the following:

- Implements `get_type_name`, which returns `TYPE` as a string
- Implements `create`, which allocates an object of type `TYPE` by calling its constructor with no arguments. `TYPE`'s constructor, if defined, must have default values on all its arguments.
- Registers the `TYPE` with the factory, using the string `TYPE` as the factory lookup string for the type.
- Implements the static `get_type()` method which returns a factory proxy object for the type.
- Implements the virtual `get_object_type()` method which works just like the static `get_type()` method, but operates on an already allocated object.

Parameterized classes must use the `uvm_object_param_utils* versions. They differ from `uvm_object_utils only in that they do not supply a type name when registering the object with the factory. As such, name-based lookup with the factory for parameterized classes is not possible.

The macros with `_begin suffixes are the same as the non-suffixed versions except that they also start a block in which `uvm_field_* macros can be placed. The block must be terminated by `uvm_object_utils_end.

```
`uvm_component_utils

`uvm_component_param_utils

`uvm_component_utils_begin

`uvm_component_param_utils_begin

`uvm_component_end
```

UVM 1.2 Class Reference

uvm_component-based class declarations may contain one of the above forms of utility macros.

For simple components with no field macros, use
For simple components with field macros, use

```
`uvm_component_utils(TYPE)
`uvm_component_utils_begin(TYPE)
`UVM_field_* macro invocations here
`uvm_component_utils_end
```

For parameterized components with no field macros, use

```
`uvm_component_param_utils(TYPE)
```

For parameterized components with field macros, use

```
`uvm_component_param_utils_begin(TYPE)
`UVM_field_* macro invocations here
`uvm_component_utils_end
```

Simple (non-parameterized) components must use the `uvm_components_utils* versions, which do the following:

- Implements `get_type_name`, which returns `TYPE` as a string.
- Implements `create`, which allocates a component of type `TYPE` using a two argument constructor. `TYPE`'s constructor must have a name and a parent argument.
- Registers the `TYPE` with the factory, using the string `TYPE` as the factory lookup string for the type.
- Implements the static `get_type()` method which returns a factory proxy object for the type.
- Implements the virtual `get_object_type()` method which works just like the static `get_type()` method, but operates on an already allocated object.

Parameterized classes must use the `uvm_object_param_utils*` versions. They differ from `uvm_object_utils` only in that they do not supply a type name when registering the object with the factory. As such, name-based lookup with the factory for parameterized classes is not possible.

The macros with `_begin` suffixes are the same as the non-suffixed versions except that they also start a block in which `uvm_field_*` macros can be placed. The block must be terminated by `uvm_component_utils_end`.

```
`uvm_object_registry
```

Register a `uvm_object`-based class with the factory

```
`uvm_object_registry(T,S)
```
Registers a uvm_object-based class $T$ and lookup string $S$ with the factory. $S$ typically is the name of the class in quotes. The `uvm_object_utils family of macros uses this macro.

```vhdl
`uvm_component_registry(T,S)
```

Registers a uvm_component-based class $T$ and lookup string $S$ with the factory. $S$ typically is the name of the class in quotes. The `uvm_object_utils family of macros uses this macro.

## Field Macros

The `uvm_field_* macros are invoked inside of the `uvm_*_utils_begin and `uvm_*_utils_end macro blocks to form “automatic” implementations of the core data methods: copy, compare, pack, unpack, record, print, and sprint.

By using the macros, you do not have to implement any of the do_* methods inherited from uvm_object. However, be aware that the field macros expand into general inline code that is not as run-time efficient nor as flexible as direct implementations of the do_* methods.

Below is an example usage of the field macros for a sequence item.

```vhdl
class my_trans extends uvm_sequence_item;
   cmd t  cmd;
   int addr;
   int data[$];
   my_ext ext;
   string str;

   `uvm_object_utils_begin(my_trans)
      `uvm_field_enum     (cmd_t, cmd, UVM_ALL_ON)
      `uvm_field_int      (addr, UVM_ALL_ON)
      `uvm_field_queue_int(data, UVM_ALL_ON)
      `uvm_field_object   (ext, UVM_ALL_ON)
      `uvm_field_string   (str, UVM_ALL_ON)
   `uvm_object_utils_end

   function new(string name="mydata_inst");
      super.new(name);
   endfunction
endclass
```

Below is an example usage of the field macros for a component.

```vhdl
class my_comp extends uvm_component;
   my_comp_cfg cfg;

   `uvm_component_utils_begin(my_comp)
      `uvm_field_object   (cfg, UVM_ALL_ON)
   `uvm_object_utils_end

   function new(string name="my_comp_inst", uvm_component parent=null);
      super.new(name);
   endfunction
endclass
```
Each `uvm_field_* macro is named according to the particular data type it handles: integrals, strings, objects, queues, etc., and each has at least two arguments: ARG and FLAG.

ARG is the instance name of the variable, whose type must be compatible with the macro being invoked. In the example, class variable `addr` is an integral type, so we use the `uvm_field_int` macro.

FLAG if set to `UVM_ALL_ON`, as in the example, the ARG variable will be included in all data methods. If FLAG is set to something other than `UVM_ALL_ON` or `UVM_DEFAULT`, it specifies which data method implementations will not include the given variable. Thus, if FLAG is specified as `NO_COMPARE`, the ARG variable will not affect comparison operations, but it will be included in everything else.

All possible values for FLAG are listed and described below. Multiple flag values can be bitwise OR'ed together (in most cases they may be added together as well, but care must be taken when using the + operator to ensure that the same bit is not added more than once).

- **UVM_ALL_ON**: Set all operations on.
- **UVM_DEFAULT**: This is the recommended set of flags to pass to the field macros. Currently, it enables all of the operations, making it functionally identical to `UVM_ALL_ON`. In the future however, additional flags could be added with a recommended default value of `off`.
- **UVM_NOCOPY**: Do not copy this field.
- **UVM_NOCOMPARE**: Do not compare this field.
- **UVM_NOPRINT**: Do not print this field.
- **UVM_NOPACK**: Do not pack or unpack this field.
- **UVM_REFERENCE**: For object types, operate only on the handle (e.g. no deep copy)
- **UVM_PHYSICAL**: Treat as a physical field. Use physical setting in policy class for this field.
- **UVM_ABSTRACT**: Treat as an abstract field. Use the abstract setting in the policy class for this field.
- **UVM_READONLY**: Do not allow setting of this field from the set_*_local methods or during `uvm_component::apply_config_settings` operation.

A radix for printing and recording can be specified by OR’ing one of the following constants in the FLAG argument

- **UVM_BIN**: Print / record the field in binary (base-2).
- **UVM_DEC**: Print / record the field in decimal (base-10).
- **UVM_UNSIGNED**: Print / record the field in unsigned decimal (base-10).
- **UVM_OCT**: Print / record the field in octal (base-8).
- **UVM_HEX**: Print / record the field in hexadecimal (base-16).
- **UVM_STRING**: Print / record the field in string format.
- **UVM_TIME**: Print / record the field in time format.
Radix settings for integral types. Hex is the default radix if none is specified.

A UVM component should not be specified using the `uvm_field_object` macro unless its flag includes UVM_REFERENCE. Otherwise, the field macro will implement deep copy, which is an illegal operation for uvm_components. You will get a FATAL error if you tried to copy or clone an object containing a component handle that was registered with a field macro without the UVM_REFERENCE flag. You will also get duplicate entries when printing component topology, as this functionality is already provided by UVM.

```
UVM_FIELD_* MACROS
```

Macros that implement data operations for scalar properties.

```
uvm_field_int
```

Implements the data operations for any packed integral property.

`uvm_field_int(ARG,FLAG)

ARG is an integral property of the class, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

```
uvm_field_object
```

Implements the data operations for a uvm_object-based property.

`uvm_field_object(ARG,FLAG)

ARG is an object property of the class, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

```
uvm_field_string
```

Implements the data operations for a string property.

`uvm_field_string(ARG,FLAG)

ARG is a string property of the class, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

```
uvm_field_enum
```

Implements the data operations for an enumerated property.
\texttt{\textbackslash uvm\_field\_enum(T,ARG,FLAG)}

$T$ is an enumerated type, \textit{ARG} is an instance of that type, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\texttt{\textbackslash uvm\_field\_real}

Implements the data operations for any real property.

\texttt{\textbackslash uvm\_field\_real(ARG,FLAG)}

\textit{ARG} is a real property of the class, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\texttt{\textbackslash uvm\_field\_event}

Implements the data operations for an event property.

\texttt{\textbackslash uvm\_field\_event(ARG,FLAG)}

\textit{ARG} is an event property of the class, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\texttt{UVM\_FIELD\_SARRAY\_\* MACROS}

Macros that implement data operations for one-dimensional static array properties.

\texttt{\textbackslash uvm\_field\_sarray\_int}

Implements the data operations for a one-dimensional static array of integrals.

\texttt{\textbackslash uvm\_field\_sarray\_int(ARG,FLAG)}

\textit{ARG} is a one-dimensional static array of integrals, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\texttt{\textbackslash uvm\_field\_sarray\_object}

Implements the data operations for a one-dimensional static array of \texttt{uvm\_object}-based objects.
ARG is a one-dimensional static array of uvm_object-based objects, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_sarray_string

Implements the data operations for a one-dimensional static array of strings.

ARG is a one-dimensional static array of strings, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_sarray_enum

Implements the data operations for a one-dimensional static array of enums.

T is a one-dimensional dynamic array of enums type, ARG is an instance of that type, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`UVM_FIELD_ARRAY_* MACROS

Macros that implement data operations for one-dimensional dynamic array properties.

Implementation note

lines flagged with empty multi-line comments, /**/, are not needed or need to be different for fixed arrays, which cannot be resized. Fixed arrays do not need to pack/unpack their size either, because their size is known; wouldn't hurt though if it allowed code consolidation. Unpacking would necessarily be different. */

`uvm_field_array_int

Implements the data operations for a one-dimensional dynamic array of integrals.

ARG is a one-dimensional dynamic array of integrals, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.
\`uvm_field_array_object

Implements the data operations for a one-dimensional dynamic array of \texttt{uvm_object}-based objects.

\`
\texttt{uvm_field_array_object}\texttt{(\texttt{ARG},\texttt{FLAG})}
``

\textit{ARG} is a one-dimensional dynamic array of \texttt{uvm_object}-based objects, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\`uvm_field_array_string

Implements the data operations for a one-dimensional dynamic array of strings.

\`
\texttt{uvm_field_array_string}\texttt{(\texttt{ARG},\texttt{FLAG})}
``

\textit{ARG} is a one-dimensional dynamic array of strings, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

\`uvm_field_array_enum

Implements the data operations for a one-dimensional dynamic array of enums.

\`
\texttt{uvm_field_array_enum}\texttt{(\texttt{T},\texttt{ARG},\texttt{FLAG})}
``

\textit{T} is a one-dimensional dynamic array of enums type, \textit{ARG} is an instance of that type, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.

**\`UVM\_FIELD\_QUEUE\_\*\** MACROS

Macros that implement data operations for dynamic queues.

\`uvm_field_queue_int

Implements the data operations for a queue of integrals.

\`
\texttt{uvm_field_queue_int}\texttt{(\texttt{ARG},\texttt{FLAG})}
``

\textit{ARG} is a one-dimensional queue of integrals, and \textit{FLAG} is a bitwise OR of one or more flag settings as described in Field Macros above.
`uvm_field_queue_object

Implements the data operations for a queue of uvm_object-based objects.

`uvm_field_queue_object(ARG,FLAG)

ARG is a one-dimensional queue of uvm_object-based objects, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_queue_string

Implements the data operations for a queue of strings.

`uvm_field_queue_string(ARG,FLAG)

ARG is a one-dimensional queue of strings, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_queue_enum

Implements the data operations for a one-dimensional queue of enums.

`uvm_field_queue_enum(T,ARG,FLAG)

T is a queue of enums type, ARG is an instance of that type, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`UVM_FIELD_AA_*_STRING MACROS

Macros that implement data operations for associative arrays indexed by string.

`uvm_field_aa_int_string

Implements the data operations for an associative array of integrals indexed by string.

`uvm_field_aa_int_string(ARG,FLAG)

ARG is the name of a property that is an associative array of integrals with string key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.
Implements the data operations for an associative array of `uvm_object`-based objects indexed by `string`.

`\uvm_field_aa_object_string(ARG,FLAG)`

`ARG` is the name of a property that is an associative array of objects with string key, and `FLAG` is a bitwise OR of one or more flag settings as described in Field Macros above.

---

`\uvm_field_aa_string_string`  
Implements the data operations for an associative array of strings indexed by `string`.

`\uvm_field_aa_string_string(ARG,FLAG)`

`ARG` is the name of a property that is an associative array of strings with string key, and `FLAG` is a bitwise OR of one or more flag settings as described in Field Macros above.

---

`\uvm_FIELD_AA_*_INT Macros`  
Macros that implement data operations for associative arrays indexed by an integral type.

---

`\uvm_field_aa_object_int`  
Implements the data operations for an associative array of `uvm_object`-based objects indexed by the `int` data type.

`\uvm_field_aa_object_int(ARG,FLAG)`

`ARG` is the name of a property that is an associative array of objects with `int` key, and `FLAG` is a bitwise OR of one or more flag settings as described in Field Macros above.

---

`\uvm_field_aa_int_int`  
Implements the data operations for an associative array of integral types indexed by the `int` data type.

`\uvm_field_aa_int_int(ARG,FLAG)`

`ARG` is the name of a property that is an associative array of integrals with `int` key, and `FLAG` is a bitwise OR of one or more flag settings as described in Field Macros above.
`uvm_field_aa_int_int_unsigned

Implements the data operations for an associative array of integral types indexed by the
int unsigned data type.

```
`uvm_field_aa_int_int_unsigned(ARG,FLAG)
```

ARG is the name of a property that is an associative array of integrals with int unsigned key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_integer

Implements the data operations for an associative array of integral types indexed by the
integer data type.

```
`uvm_field_aa_int_integer(ARG,FLAG)
```

ARG is the name of a property that is an associative array of integrals with integer key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_integer_unsigned

Implements the data operations for an associative array of integral types indexed by the
integer unsigned data type.

```
`uvm_field_aa_int_integer_unsigned(ARG,FLAG)
```

ARG is the name of a property that is an associative array of integrals with integer unsigned key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_byte

Implements the data operations for an associative array of integral types indexed by the
byte data type.

```
`uvm_field_aa_int_byte(ARG,FLAG)
```

ARG is the name of a property that is an associative array of integrals with byte key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_byte_unsigned
Implements the data operations for an associative array of integral types indexed by the 
*byte unsigned* data type.

```
`uvm_field_aa_int_byte_unsigned(ARG,FLAG)
```

*ARG* is the name of a property that is an associative array of integrals with *byte unsigned* key, and *FLAG* is a bitwise OR of one or more flag settings as described in *Field Macros* above.

```
`uvm_field_aa_int_shortint
```

Implements the data operations for an associative array of integral types indexed by the *shortint* data type.

```
`uvm_field_aa_int_shortint(ARG,FLAG)
```

*ARG* is the name of a property that is an associative array of integrals with *shortint* key, and *FLAG* is a bitwise OR of one or more flag settings as described in *Field Macros* above.

```
`uvm_field_aa_int_shortint_unsigned
```

Implements the data operations for an associative array of integral types indexed by the *shortint unsigned* data type.

```
`uvm_field_aa_int_shortint_unsigned(ARG,FLAG)
```

*ARG* is the name of a property that is an associative array of integrals with *shortint unsigned* key, and *FLAG* is a bitwise OR of one or more flag settings as described in *Field Macros* above.

```
`uvm_field_aa_int_longint
```

Implements the data operations for an associative array of integral types indexed by the *longint* data type.

```
`uvm_field_aa_int_longint(ARG,FLAG)
```

*ARG* is the name of a property that is an associative array of integrals with *longint* key, and *FLAG* is a bitwise OR of one or more flag settings as described in *Field Macros* above.

```
`uvm_field_aa_int_longint_unsigned
```

Implements the data operations for an associative array of integral types indexed by the *longint unsigned* data type.
ARG is the name of a property that is an associative array of integrals with longint unsigned key, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_key

Implements the data operations for an associative array of integral types indexed by any integral key data type.

`uvm_field_aa_int_key(KEY,ARG,FLAG)

KEY is the data type of the integral key, ARG is the name of a property that is an associative array of integrals, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

`uvm_field_aa_int_enumkey

Implements the data operations for an associative array of integral types indexed by any enumeration key data type.

`uvm_field_aa_int_enumkey(KEY, ARG,FLAG)

KEY is the enumeration type of the key, ARG is the name of a property that is an associative array of integrals, and FLAG is a bitwise OR of one or more flag settings as described in Field Macros above.

Recording Macros

The recording macros assist users who implement the uvm_object::do_record method. They help ensure that the fields are recorded using a vendor-independent API. Unlike the uvm_recorder policy, fields recorded using the macros do not lose type information—they are passed directly to the vendor-specific API. This results in more efficient recording and no artificial limit on bit-widths. See your simulator vendor’s documentation for more information on its transaction recording capabilities.

`uvm_record_attribute

Vendor-independent macro to hide tool-specific interface for recording attributes (fields) to a transaction database.

`uvm_record_attribute(TR_HANDLE, NAME, VALUE)
The default implementation of the macro passes *NAME* and *VALUE* through to the `uvm_recorder::record_generic` method.

This macro should not be called directly by the user, the other recording macros will call it automatically if `uvm_recorder::use_record_attribute` returns true.

`\uvm_record_int(NAME,VALUE,SIZE[,RADIX])`

The `\uvm_record_int` macro takes the same arguments as the `uvm_recorder::record_field` method (including the optional *RADIX*).

The default implementation will pass the name/value pair to `\uvm_record_attribute` if enabled, otherwise the information will be passed to `uvm_recorder::record_field`.

`\uvm_record_string(NAME,VALUE)`

The `\uvm_record_string` macro takes the same arguments as the `uvm_recorder::record_string` method.

The default implementation will pass the name/value pair to `\uvm_record_attribute` if enabled, otherwise the information will be passed to `uvm_recorder::record_string`.

`\uvm_record_time(NAME,VALUE)`

The `\uvm_record_time` macro takes the same arguments as the `uvm_recorder::record_time` method.

The default implementation will pass the name/value pair to `\uvm_record_attribute` if enabled, otherwise the information will be passed to `uvm_recorder::record_time`.

`\uvm_record_real(NAME,VALUE)`
The `uvm_record_real` macro takes the same arguments as the `uvm_recorder::record_field_real` method.

The default implementation will pass the name/value pair to `uvm_record_attribute` if enabled, otherwise the information will be passed to `uvm_recorder::record_field_real`.

```
`uvm_record_field(NAME, VALUE)
```

The `uvm_record_field` macro is for recording arbitrary name-value pairs into a transaction recording database. Requires a valid transaction handle, as provided by the `uvm_transaction::begin_tr` and `uvm_component::begin_tr` methods.

The default implementation will pass the name/value pair to `uvm_record_attribute` if enabled, otherwise the information will be passed to `uvm_recorder::record_generic`, with the `VALUE` being converted to a string using `%p` notation.

```
recorder.record_generic(NAME,$sformatf("%p",VALUE));
```

---

**Packing Macros**

The packing macros assist users who implement the `uvm_object::do_pack` method. They help ensure that the pack operation is the exact inverse of the unpack operation. See also [Unpacking Macros](#).

```
virtual function void do_pack(uvm_packer packer);
  `uvm_pack_int(cmd)
  `uvm_pack_int(addr)
  `uvm_pack_array(data)
endfunction
```

The `N` versions of these macros take an explicit size argument, which must be compile-time constant value greater than 0.

---

**Packing - With Size Info**

```
`uvm_pack_intN(VAR,SIZE)
```

Pack an integral variable.
\uvm_pack_enum

Pack an integral variable.

\uvm_pack_sarray

Pack a static array of integrals.

\uvm_pack_array

Pack a dynamic array of integrals.

\uvm_pack_queue

Pack a queue of integrals.

\uvm_pack_int

Pack an integral variable without having to also specify the bit size.

\uvm_pack_enum

Pack an enumeration value. Packing does not require its type be specified.
`uvm_pack_string

Pack a string variable.

`uvm_pack_real

Pack a variable of type real.

`uvm_pack_sarray

Pack a static array without having to also specify the bit size of its elements.

`uvm_pack_array

Pack a dynamic array without having to also specify the bit size of its elements. Array size must be non-zero.

`uvm_pack_queue

Pack a queue without having to also specify the bit size of its elements. Queue must not be empty.
UNPACKING MACROS

The unpacking macros assist users who implement the uvm_object::do_unpack method. They help ensure that the unpack operation is the exact inverse of the pack operation. See also Packing Macros.

```cpp
virtual function void do_unpack(uvm_packer packer);
'`uvm_unpack_enum(cmd,cmd_t)
'`uvm_unpack_int(addr)
'`uvm_unpack_array(data)
endfunction
```

The ‘N’ versions of these macros take an explicit size argument, which must be a compile-time constant value greater than 0.

UNPACKING - WITH SIZE INFO

`uvm_unpack_intN

Unpack into an integral variable.

```
'`uvm_unpack_intN(VAR,SIZE)
```

`uvm_unpack_enumN

Unpack enum of type TYPE into VAR.

```
'`uvm_unpack_enumN(VAR,SIZE,TYPE)
```

`uvm_unpack_sarrayN

Unpack a static (fixed) array of integrals.

```
'`uvm_unpack_sarrayN(VAR,SIZE)
```

`uvm_unpack_arrayN

Unpack into a dynamic array of integrals.

```
'`uvm_unpack_arrayN(VAR,SIZE)
```
\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_queue\_N}}}}}

Unpack into a queue of integrals.

\begin{verbatim}
\texttt{``uvm\_unpack\_queue(VAR,SIZE)}
\end{verbatim}

\textbf{Unpacking - No Size Info}

\texttt{\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_int}}}}}}

Unpack an integral variable without having to also specify the bit size.

\begin{verbatim}
\texttt{``uvm\_unpack\_int(VAR)}
\end{verbatim}

\texttt{\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_enum}}}}}}

Unpack an enumeration value, which requires its type be specified.

\begin{verbatim}
\texttt{``uvm\_unpack\_enum(VAR,TYPE)}
\end{verbatim}

\texttt{\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_string}}}}}}

Unpack a string variable.

\begin{verbatim}
\texttt{``uvm\_unpack\_string(VAR)}
\end{verbatim}

\texttt{\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_real}}}}}}

Unpack a variable of type real.

\begin{verbatim}
\texttt{``uvm\_unpack\_real(VAR)}
\end{verbatim}

\texttt{\texttt{\texttt{\texttt{\texttt{\texttt{`uvm\_unpack\_sarray}}}}}}

Unpack a static array without having to also specify the bit size of its elements.

\begin{verbatim}
\texttt{``uvm\_unpack\_sarray(VAR,SIZE)}
\end{verbatim}
`uvm_unpack_array

Unpack a dynamic array without having to also specify the bit size of its elements. Array size must be non-zero.

`uvm_unpack_queue

Unpack a queue without having to also specify the bit size of its elements. Queue must not be empty.
### 21.3 Sequence-Related Macros

#### Summary

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<td>These macros are used to start sequences and sequence items on a specific sequencer.</td>
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<td><code>uvm_create_on</code></td>
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<td><strong>SEQUENCE ACTION MACROS FOR PRE-EXISTING SEQUENCES</strong></td>
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<td><code>uvm_add_to_sequence_library</code></td>
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<td><strong>SEQUENCER SUBTYPES</strong></td>
<td>This macro is used to declare a variable p_sequencer whose type is specified by SEQUENCER.</td>
</tr>
<tr>
<td><code>uvm_declare_p_sequencer</code></td>
<td></td>
</tr>
</tbody>
</table>

#### SEQUENCE ACTION MACROS

These macros are used to start sequences and sequence items on the default sequencer, *m_sequencer*. This is determined a number of ways:

- the sequencer handle provided in the `uvm_sequence_base::start` method
- the sequencer used by the parent sequence
- the sequencer that was set using the `uvm_sequence_item::set_sequencer` method

---

**`uvm_create`**

`uvm_create(SEQ_OR_ITEM)`
This action creates the item or sequence using the factory. It intentionally does zero processing. After this action completes, the user can manually set values, manipulate rand_mode and constraint_mode, etc.

`uvm_do

`uvm_do(SEQ_OR_ITEM)

This macro takes as an argument a uvm_sequence_item variable or object. The argument is created using `uvm_create if necessary, then randomized. In the case of an item, it is randomized after the call to uvm_sequence_base::start_item() returns. This is called late-randomization. In the case of a sequence, the sub-sequence is started using uvm_sequence_base::start() with call_pre_post set to 0. In the case of an item, the item is sent to the driver through the associated sequencer.

For a sequence item, the following are called, in order

`uvm_create(item)
sequencer.wait_for_grant(prior)   (task)
this.pre_do(item)                (task)
item.randomize()                 (task)
this.mid_do(item)                (func)
sequencer.send_request(item)     (func)
sequencer.wait_for_item_done()   (task)
this.post_do(item)               (func)

For a sequence, the following are called, in order

`uvm_create(sub_seq)
sub_seq.randomize()              (task)
sub_seq.pre_start()              (task)
this.pre_do(0)                  (task)
this.mid_do(sub_seq)            (func)
sub_seq.Body()                  (task)
this.post_do(sub_seq)           (func)
sub_seq.post_start()            (task)

`uvm_do_pri

`uvm_do_pri(SEQ_OR_ITEM, PRIORITY)

This is the same as `uvm_do except that the sequence item or sequence is executed with the priority specified in the argument

`uvm_do_with

`uvm do with(SEQ OR ITEM, CONSTRAINTS)
This is the same as `uvm_do except that the constraint block in the 2nd argument is applied to the item or sequence in a randomize with statement before execution.

```
`uvm_do_pri_with
```

This is the same as `uvm_do_pri except that the given constraint block is applied to the item or sequence in a randomize with statement before execution.

**SEQUENCE ON SEQUENCER ACTION MACROS**

These macros are used to start sequences and sequence items on a specific sequencer. The sequence or item is created and executed on the given sequencer.

```
`uvm_create_on
```

This is the same as `uvm_create except that it also sets the parent sequence to the sequence in which the macro is invoked, and it sets the sequencer to the specified SEQR argument.

```
`uvm_do_on
```

This is the same as `uvm_do except that it also sets the parent sequence to the sequence in which the macro is invoked, and it sets the sequencer to the specified SEQR argument.

```
`uvm_do_on_pri
```

This is the same as `uvm_do_pri except that it also sets the parent sequence to the
sequence in which the macro is invoked, and it sets the sequencer to the specified \textit{SEQR} argument.

\textbf{\texttt{\textbackslash uvm\_do\_on\_with}}

\begin{verbatim}
\texttt{\textbackslash uvm\_do\_on\_with(SEQ\\_OR\\_ITEM, SEQR, CONSTRAINTS)}
\end{verbatim}

This is the same as \texttt{\textbackslash uvm\_do\_with} except that it also sets the parent sequence to the sequence in which the macro is invoked, and it sets the sequencer to the specified \textit{SEQR} argument. The user must supply brackets around the constraints.

\textbf{\texttt{\textbackslash uvm\_do\_on\_pri\_with}}

\begin{verbatim}
\texttt{\textbackslash uvm\_do\_on\_pri\_with(SEQ\\_OR\\_ITEM, SEQR, PRIORITY, CONSTRAINTS)}
\end{verbatim}

This is the same as \texttt{\textbackslash uvm\_do\_pri\_with} except that it also sets the parent sequence to the sequence in which the macro is invoked, and it sets the sequencer to the specified \textit{SEQR} argument.

\section*{Sequence Action Macros for Pre-Existing Sequences}

These macros are used to start sequences and sequence items that do not need to be created.

\textbf{\texttt{\textbackslash uvm\_send}}

\begin{verbatim}
\texttt{\textbackslash uvm\_send(SEQ\\_OR\\_ITEM)}
\end{verbatim}

This macro processes the item or sequence that has been created using \texttt{\textbackslash uvm\_create}. The processing is done without randomization. Essentially, an \texttt{\textbackslash uvm\_do} without the create or randomization.

\textbf{\texttt{\textbackslash uvm\_send\_pri}}

\begin{verbatim}
\texttt{\textbackslash uvm\_send\_pri(SEQ\\_OR\\_ITEM, PRIORITY)}
\end{verbatim}

This is the same as \texttt{\textbackslash uvm\_send} except that the sequence item or sequence is executed with the priority specified in the argument.
`uvm_rand_send

`uvm_rand_send(SEQ_OR_ITEM)

This macro processes the item or sequence that has been already been allocated (possibly with `uvm_create). The processing is done with randomization. Essentially, an `uvm_do without the create.

`uvm_rand_send_pri

`uvm_rand_sendPri(SEQ_OR_ITEM, PRIORITY)

This is the same as `uvm_rand_send except that the sequence item or sequence is executed with the priority specified in the argument.

`uvm_rand_send_with

`uvm_rand_send_with(SEQ_OR_ITEM, CONSTRAINTS)

This is the same as `uvm_rand_send except that the given constraint block is applied to the item or sequence in a randomize with statement before execution.

`uvm_rand_send_pri_with

`uvm_rand_send_pri_with(SEQ_OR_ITEM, PRIORITY, CONSTRAINTS)

This is the same as `uvm_rand_send_pri except that the given constraint block is applied to the item or sequence in a randomize with statement before execution.

`uvm_add_to_sequence_library

Adds the given sequence TYPE to the given sequence library LIBTYPE

`uvm_add_to_seq_lib(TYPE,LIBTYPE)

Invoke any number of times within a sequence declaration to statically add that sequence to one or more sequence library types. The sequence will then be available for selection and execution in all instances of the given sequencer types.
Declares the infrastructure needed to define extensions to the `uvm_sequence_library class. You define new sequence library subtypes to statically specify sequence membership from within sequence definitions. See also `uvm_add_to_sequence_library for more information.

Each library, itself a sequence, can then be started independently on different sequencers or in different phases of the same sequencer. See `uvm_sequencer_base::start_phase_sequence for information on starting default sequences.

**SEQUENCER SUBTYPES**

```
`uvm_declare_p_sequencer
```

This macro is used to declare a variable `p_sequencer whose type is specified by `SEQUENCER.
The example below shows using the `uvm_declare_p_sequencer macro along with the `uvm_object_utils macros to set up the sequence but not register the sequence in the sequencer's library.

class mysequence extends uvm_sequence#(mydata);
    `uvm_object_utils(mysequence)
    `uvm_declare_p_sequencer(some_seqr_type)
    task body;
        //Access some variable in the user's custom sequencer
        if(p_sequencer.some_variable) begin
            ...
        end
    endtask
endclass
21.4 Callback Macros

These macros are used to register and execute callbacks extending from `uvm_callbacks`.

### Summary

**Callback Macros**

These macros are used to register and execute callbacks extending from `uvm_callbacks`.

**Macros**

- `uvm_register_cb`
- `uvm_set_super_type`
- `uvm_do_callbacks`
- `uvm_do_obj_callbacks`
- `uvm_do_callbacks_exit_on`
- `uvm_do_obj_callbacks_exit_on`

---

**`uvm_register_cb`**

```verbatim`
uvm_register_cb(T,CB)
```

Registers the given CB callback type with the given T object type. If a type-callback pair is not registered then a warning is issued if an attempt is made to use the pair (add, delete, etc.).

The registration will typically occur in the component that executes the given type of callback. For instance:

```verbatim`
virtual class mycb extends uvm_callback;
    virtual function void doit();
endclass

class my_comp extends uvm_component;
    `uvm_register_cb(my_comp,mycb)
    ...
    task run_phase(uvm_phase phase);
    ...
    `uvm_do_callbacks(my_comp, mycb, doit())
endtask
endclass
```

---

**`uvm_set_super_type`**

```verbatim`
uvm_set_super_type(T,ST)
```

---
Defines the super type of $T$ to be $ST$. This allows for derived class objects to inherit typewide callbacks that are registered with the base class.

The registration will typically occur in the component that executes the given type of callback. For instance:

```plaintext
virtual class mycb extend uvm_callback;
  virtual function void doit();
endclass

class my_comp extends uvm_component;
  `uvm_register_cb(my_comp,mycb)
  ...
  task run_phase(uvm_phase phase);
  ...
  `uvm_do_callbacks(my_comp, mycb, doit())
endtask
endclass

class my_derived_comp extends my_comp;
  `uvm_set_super_type(my_derived_comp,my_comp)
  ...
  task run_phase(uvm_phase phase);
  ...
  `uvm_do_callbacks(my_comp, mycb, doit())
endtask
endclass
```

### `uvm_do_callbacks`

Calls the given $METHOD$ of all callbacks of type $CB$ registered with the calling object (i.e. $this$ object), which is or is based on type $T$.

This macro executes all of the callbacks associated with the calling object (i.e. $this$ object). The macro takes three arguments:

- **CB** is the class type of the callback objects to execute. The class type must have a function signature that matches the $METHOD$ argument.
- **$T$** is the type associated with the callback. Typically, an instance of type $T$ is passed as one the arguments in the $METHOD$ call.
- **$METHOD$** is the method call to invoke, with all required arguments as if they were invoked directly.

**For example, given the following callback class definition**

```plaintext
virtual class mycb extends uvm_cb;
  pure function void my_function (mycomp comp, int addr, int data);
endclass
```

A component would invoke the macro as

```plaintext
task mycomp::run_phase(uvm_phase phase);
  int curr_addr, curr_data;
  ...
  `uvm_do_callbacks(mycb, mycomp, my_function(this, curr_addr, curr_data))
endtask
```
\`uvm\_do\_obj\_callbacks

\`uvm\_do\_obj\_callbacks(T, CB, OBJ, METHOD)

Calls the given \textit{METHOD} of all callbacks based on type \textit{CB} registered with the given object, \textit{OBJ}, which is or is based on type \textit{T}.

This macro is identical to \`uvm\_do\_callbacks\ macro, but it has an additional \textit{OBJ} argument to allow the specification of an external object to associate the callback with. For example, if the callbacks are being applied in a sequence, \textit{OBJ} could be specified as the associated sequencer or parent sequence.

\`
\ldots
\`uvm\_do\_callbacks(mycb, mycomp, seqr, my\_function(seqr, curr\_addr, curr\_data))
\ldots
``

\`uvm\_do\_callbacks\_exit\_on

\`uvm\_do\_callbacks\_exit\_on(T, CB, METHOD, VAL)

Calls the given \textit{METHOD} of all callbacks of type \textit{CB} registered with the calling object (i.e. \textit{this} object), which is or is based on type \textit{T}, returning upon the first callback returning the bit value given by \textit{VAL}.

This macro executes all of the callbacks associated with the calling object (i.e. \textit{this} object). The macro takes three arguments:

- \textit{CB} is the class type of the callback objects to execute. The class type must have a function signature that matches the \textit{METHOD} argument.
- \textit{T} is the type associated with the callback. Typically, an instance of type \textit{T} is passed as one the arguments in the \textit{METHOD} call.
- \textit{METHOD} is the method call to invoke, with all required arguments as if they were invoked directly.
- \textit{VAL}, if 1, says return upon the first callback invocation that returns 1. If 0, says return upon the first callback invocation that returns 0.

\textbf{For example, given the following callback class definition}

```
virtual class mycb extends uvm\_cb;
  `pure\_function bit drop\_trans\_(mycomp comp, my\_trans trans);
endclass
```

UVM 1.2 Class Reference
A component would invoke the macro as

```plaintext
task mycomp::run_phase(uvm_phase phase);
    my_trans trans;
    forever begin
        get_port.get(trans);
        if(do_callbacks(trans) == 0)
            uvm_report_info("DROPPED",{"trans dropped: %s",trans.convert2string()});
        else
            // execute transaction
        end
endtask
```

Because this macro calls `return`, its use is restricted to implementations of functions that return a `bit` value, as in the above example.

```
`uvm_do_obj_callbacks_exit_on
```

Calls the given `METHOD` of all callbacks of type `CB` registered with the given object `OBJ`, which must be or be based on type `T`, and returns upon the first callback that returns the bit value given by `VAL`. It is exactly the same as the ``uvm_do_callbacks_exit_on but has a specific object instance (instead of the implicit this instance) as the third argument.

```
... // Exit if a callback returns a 1
    `uvm_do_callbacks_exit_on(mycomp, mycb, seqr, drop_trans(seqr,trans), 1)
...
```

Because this macro calls `return`, its use is restricted to implementations of functions that return a `bit` value, as in the above example.
The TLM implementation declaration macros provide a way for components to provide multiple implementation ports of the same implementation interface. When an implementation port is defined using the built-in set of imps, there must be exactly one implementation of the interface.

For example, if a component needs to provide a put implementation then it would have an implementation port defined like:

```plaintext
class mycomp extends uvm_component;
    uvm_put_imp#(data_type, mycomp) put_imp;
    ...
    virtual task put (data_type t);
    ...
endtask
endclass
```

There are times, however, when you need more than one implementation for an interface. This set of declarations allow you to easily create a new implementation class to allow for multiple implementations. Although the new implementation class is a different class, it can be bound to the same types of exports and ports as the original class. Extending the put example above, let’s say that mycomp needs to provide two put implementation ports. In that case, you would do something like:

```plaintext
//Define two new put interfaces which are compatible with uvm_put_ports
//and uvm_put_exports.
`uvm_put_imp_decl(_1)
`uvm_put_imp_decl(_2)

class my_put_imp#(type T=int) extends uvm_component;
    uvm_put_imp_1#(T,my_put_imp#(T)) put_imp1;
    uvm_put_imp_2#(T,my_put_imp#(T)) put_imp2;
    ...
    function void put_1 (input T t);
    //puts coming into put_imp1
    endfunction
    function void put_2(input T t);
    //puts coming into put_imp2
    ...
endfunction
endclass
```

The important thing to note is that each `uvm_<interface>_imp_decl creates a new class of type uvm_<interface>_imp<suffix>, where suffix is the input argument to the macro. For this reason, you will typically want to put these macros in a separate package to avoid collisions and to allow sharing of the definitions.

**Summary**

**TLM Implementation Port Declaration Macros**

The TLM implementation declaration macros provide a way for components to provide multiple implementation ports of the same implementation interface.

**Macros**

- `uvm_blocking_put_imp_decl`
- `uvm_nonblocking_put_imp_decl`
- `uvm_put_imp_decl`
- `uvm_blocking_get_imp_decl`
Define the class `uvm_blocking_put_imp_SFX` for providing blocking put implementations. *SFX* is the suffix for the new class type.

Define the class `uvm_nonblocking_put_imp_SFX` for providing non-blocking put implementations. *SFX* is the suffix for the new class type.

Define the class `uvm_put_imp_SFX` for providing both blocking and non-blocking put implementations. *SFX* is the suffix for the new class type.
Define the class `uvm_blocking_get_impSFX` for providing blocking get implementations. `SFX` is the suffix for the new class type.

```
`uvm_blocking_get_imp_decl(SFX)
```

Define the class `uvm_nonblocking_get_impSFX` for providing non-blocking get implementations. `SFX` is the suffix for the new class type.

```
`uvm_nonblocking_get_imp_decl(SFX)
```

Define the class `uvm_get_impSFX` for providing both blocking and non-blocking get implementations. `SFX` is the suffix for the new class type.

```
`uvm_get_imp_decl(SFX)
```

Define the class `uvm_blocking_peek_impSFX` for providing blocking peek implementations. `SFX` is the suffix for the new class type.

```
`uvm_blocking_peek_imp_decl(SFX)
```

Define the class `uvm_nonblocking_peek_impSFX` for providing non-blocking peek implementations. `SFX` is the suffix for the new class type.

```
`uvm_nonblocking_peek_imp_decl(SFX)
```

Define the class `uvm_peek_impSFX` for providing both blocking and non-blocking peek implementations. `SFX` is the suffix for the new class type.

```
`uvm_peek_imp_decl(SFX)
```
Define the class `uvm_peek_impSFX` for providing both blocking and non-blocking peek implementations. *SFX* is the suffix for the new class type.

```verilog
`uvm_blocking_get_peek_imp_decl

Define the class `uvm_blocking_get_peek_impSFX` for providing the blocking get_peek implementation.

```verilog
`uvm_nonblocking_get_peek_imp_decl

Define the class `uvm_nonblocking_get_peek_impSFX` for providing non-blocking get_peek implementation.

```verilog
`uvm_get_peek_imp_decl

Define the class `uvm_get_peek_impSFX` for providing both blocking and non-blocking get_peek implementations. *SFX* is the suffix for the new class type.

```verilog
`uvm_blocking_master_imp_decl

Define the class `uvm_blocking_master_impSFX` for providing the blocking master implementation.

```verilog
`uvm_nonblocking_master_imp_decl

Define the class `uvm_nonblocking_master_impSFX` for providing the non-blocking master implementation.
Define the class `uvm_nonblocking_master_impSFX` for providing the non-blocking master implementation.

```
`uvm_master_imp_decl
```

Define the class `uvm_master_impSFX` for providing both blocking and non-blocking master implementations. `SFX` is the suffix for the new class type.

```
`uvm_blocking_slave_imp_decl
```

Define the class `uvm_blocking_slave_impSFX` for providing the blocking slave implementation.

```
`uvm_nonblocking_slave_imp_decl
```

Define the class `uvm_nonblocking_slave_impSFX` for providing the non-blocking slave implementation.

```
`uvm_slave_imp_decl
```

Define the class `uvm_slave_impSFX` for providing both blocking and non-blocking slave implementations. `SFX` is the suffix for the new class type.

```
`uvm_blocking_transport_imp_decl
```

Define the class `uvm_blocking_transport_impSFX` for providing both blocking and non-blocking slave implementations.
Define the class `uvm_blocking_transport_impSFX` for providing the blocking transport implementation.

```verilog
`uvm_nonblocking_transport_imp_decl
```

Define the class `uvm_nonblocking_transport_impSFX` for providing the non-blocking transport implementation.

```verilog
`uvm_transport_imp_decl
```

Define the class `uvm_transport_impSFX` for providing both blocking and non-blocking transport implementations. *SFX* is the suffix for the new class type.

```verilog
`uvm_analysis_imp_decl
```

Define the class `uvm_analysis_impSFX` for providing an analysis implementation. *SFX* is the suffix for the new class type. The analysis implementation is the write function. The `uvm_analysis_imp_decl` allows for a scoreboard (or other analysis component) to support input from many places. For example:

```verilog
`uvm_analysis_imp_decl(_ingress)
`uvm_analysis_imp_decl(_egress)

class myscoreboard extends uvm_component;
  uvm_analysis_imp_ingress#(mydata, myscoreboard) ingress;
  uvm_analysis_imp_egress#(mydata, myscoreboard) egress;
  mydata ingress_list[];
  ...
  function new(string name, uvm_component parent);
    super.new(name,parent);
    ingress = new("ingress", this);
    egress = new("egress", this);
    endfunction
  function void write_ingress(mydata t);
    ingress_list.push_back(t);
    endfunction
  function void write_egress(mydata t);
    find_match_in_ingress_list(t);
    endfunction
  function void find_match_in_ingress_list(mydata t);
    //implement scoreboarding for this particular dut
    endfunction
endclass
```
21.6 Register Defines

Summary

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<td>`UVM_REG_DATA_WIDTH</td>
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<td>`UVM_REG_BYTEENABLE_WIDTH</td>
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<tr>
<td>`UVM_REG_CVR_WIDTH</td>
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</table>

MACROS

`UVM_REG_ADDR_WIDTH

Maximum address width in bits
Default value is 64. Used to define the uvm_reg_addr_t type.

`UVM_REG_DATA_WIDTH

Maximum data width in bits
Default value is 64. Used to define the uvm_reg_data_t type.

`UVM_REG_BYTEENABLE_WIDTH

Maximum number of byte enable bits
Default value is one per byte in `UVM_REG_DATA_WIDTH. Used to define the uvm_reg_byte_en_t type.

`UVM_REG_CVR_WIDTH

Maximum number of bits in a uvm_reg_cvr_t coverage model set.
Default value is 32.
## 21.7 UVM Version Defines

### Summary

#### UVM Version Defines

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<th><strong>UVM Revision Values</strong></th>
<th>Description</th>
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<td>UVM_MAJOR_REV</td>
<td>Defines the MAJOR revision number.</td>
</tr>
<tr>
<td>UVM_MINOR_REV</td>
<td>Defines the MINOR revision number.</td>
</tr>
<tr>
<td>UVM_FIX_REV</td>
<td>(Optionally) Defines the FIX revision letter.</td>
</tr>
<tr>
<td>UVM_NAME</td>
<td>The name used by the library when displaying the name of the library.</td>
</tr>
<tr>
<td>UVM_VERSION_STRING</td>
<td>Provides a string-ized version of the UVM Library version number.</td>
</tr>
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</table>

#### Conditional Compilation

<table>
<thead>
<tr>
<th><strong>UVM Version Ladder</strong></th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>UVM_MAJOR_REV_1</td>
<td>Indicates that the MAJOR version of this release is '1'.</td>
</tr>
<tr>
<td>UVM_MINOR_REV_2</td>
<td>Indicates that the MINOR version of this release is '2'.</td>
</tr>
<tr>
<td>UVM_VERSION_1_2</td>
<td>Indicates that the version of this release is '1.2'.</td>
</tr>
<tr>
<td>UVM_POST_VERSION_1_1</td>
<td>Indicates that this version of the UVM came after the 1.1 versions, including the various 1.1 fix revisions.</td>
</tr>
</tbody>
</table>

### UVM Revision Values

These macros provide the current values for the **MAJOR, MINOR**, and optionally the **FIX** revision.

#### Example with UVM version 1.2

- **UVM_MAJOR_REV**  
  '1'
- **UVM_MINOR_REV**  
  '2'
- **UVM_FIX_REV**  
  ‘undefined’

#### Example with UVM version 1.1a

- **UVM_MAJOR_REV**  
  '1'
- **UVM_MINOR_REV**  
  '1'
- **UVM_FIX_REV**  
  ‘a’

### UVM_MAJOR_REV

Defines the MAJOR revision number.

For UVM version 1.2, the MAJOR revision number is ‘1’
UVM_MINOR_REV

Defines the MINOR revision number.

For UVM version 1.2, the MINOR revision number is '2'

```
define UVM_MINOR_REV 2
```

UVM_FIX_REV

(Optionally) Defines the FIX revision letter.

For the first “X.Y” release of the UVM, there is no FIX revision letter. In these cases, the UVM_FIX_REV is left undefined.

For any subsequent “X.Y” fix releases, the UVM_FIX_REV value is set to the appropriate fix release letter.

Example

1.1 First release, UVM_FIX_REV is undefined
1.1a Fix release, UVM_FIX_REV is ‘a’

UVM_NAME

The name used by the library when displaying the name of the library.

```
define UVM_NAME UVM
```

UVM_VERSION_STRING

Provides a string-ized version of the UVM Library version number.

When there is a FIX_REV, the string is “<name>-<major>.<minor><fix>” (such as “UVM-1.1d”). When there is NO FIX_REV, the string is “<name>-<major>.<minor>” (such as “UVM-1.2”).

Conditional Compilation

These macros provide the ability to conditionally compile based on the revision of the library which is being used.
These macros are required for conditional compilation, as SystemVerilog does not support conditionals with `ifdefs.

For example

```verilog
// Illegal:
`if (UVM_MAJOR_REV == 1)
// Legal:
`ifdef UVM_MAJOR_REV_1
```

**UVM_MAJOR_REV_1**

Indicates that the MAJOR version of this release is ‘1’.

```
define UVM_MAJOR_REV_1
```

**UVM_MINOR_REV_2**

Indicates that the MINOR version of this release is ‘2’.

```
define UVM_MINOR_REV_2
```

**UVM_VERSION_1_2**

Indicates that the version of this release is ‘1.2’.

```
define UVM_VERSION_1_2
```

**UVM VERSION LADDER**

**UVM_POST_VERSION_1_1**

Indicates that this version of the UVM came after the 1.1 versions, including the various 1.1 fix revisions.

The first UVM version wherein this macro is defined is 1.2, and the macro will continue to be defined for all future revisions of the UVM library.

```
define UVM_POST_VERSION_1_1
```
22. Policy Classes

Each of UVM’s policy classes perform a specific task for uvm_object-based objects: printing, comparing, recording, packing, and unpacking. They are implemented separately from uvm_object so that users can plug in different ways to print, compare, etc. without modifying the object class being operated on. The user can simply apply a different printer or compare “policy” to change how an object is printed or compared.

Each policy class includes several user-configurable parameters that control the operation. Users may also customize operations by deriving new policy subtypes from these base types. For example, the UVM provides four different uvm_printer-based policy classes, each of which print objects in a different format.

- **uvm_printer** - performs deep printing of uvm_object-based objects. The UVM provides several subtypes to uvm_printer that print objects in a specific format: uvm_table_printer, uvm_tree_printer, and uvm_line_printer. Each such printer has many configuration options that govern what and how object members are printed.

- **uvm_comparer** - performs deep comparison of uvm_object-based objects. Users may configure what is compared and how miscompares are reported.

- **uvm_recorder** - performs the task of recording uvm_object-based objects to a transaction data base. The implementation is vendor-specific.

- **uvm_packer** - used to pack (serialize) and unpack uvm_object-based properties into bit, byte, or int arrays and back again.

**Summary**

<table>
<thead>
<tr>
<th>Policy Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each of UVM’s policy classes perform a specific task for uvm_object-based objects: printing, comparing, recording, packing, and unpacking.</td>
</tr>
</tbody>
</table>
22.1 uvm_printer

The uvm_printer class provides an interface for printing uvm_objects in various formats. Subtypes of uvm_printer implement different print formats, or policies.

A user-defined printer format can be created, or one of the following four built-in printers can be used:

- `uvm_printer` - provides base printer functionality; must be overridden.
- `uvm_table_printer` - prints the object in a tabular form.
- `uvm_tree_printer` - prints the object in a tree form.
- `uvm_line_printer` - prints the information on a single line, but uses the same object separators as the tree printer.

Printers have knobs that you use to control what and how information is printed. These knobs are contained in a separate knob class:

- `uvm_printer_knobs` - common printer settings

For convenience, global instances of each printer type are available for direct reference in your testbenches:

- `uvm_default_tree_printer`
- `uvm_default_line_printer`
- `uvm_default_table_printer`
- `uvm_default_printer` (set to default_table_printer by default)

When `uvm_object::print` and `uvm_object::sprint` are called without specifying a printer, the `uvm_default_printer` is used.

### Contents

<table>
<thead>
<tr>
<th>uvm_printer</th>
<th>The uvm_printer class provides an interface for printing uvm_objects in various formats.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_table_printer</td>
<td>The table printer prints output in a tabular format.</td>
</tr>
<tr>
<td>uvm_tree_printer</td>
<td>By overriding various methods of the uvm_printer super class, the tree printer prints output in a tree format.</td>
</tr>
<tr>
<td>uvm_line_printer</td>
<td>The line printer prints output in a line format.</td>
</tr>
<tr>
<td>uvm_printer_knobs</td>
<td>The uvm_printer_knobs class defines the printer settings available to all printer subtypes.</td>
</tr>
</tbody>
</table>

### knobs

```c
uvm_printer_knobs knobs = new
```

The knob object provides access to the variety of knobs associated with a specific printer instance.

### Methods for Printer Usage

**print_field**
virtual function void print_field (  
string    name,  
uvm_bitstream_t value,  
int    size,  
uvm_radix_enum radix = UVM_NORADIX,  
byte    scope_separator = ".",  
string   type_name = ""
)

Prints an integral field (up to 4096 bits).

name The name of the field.
value The value of the field.
size The number of bits of the field (maximum is 4096).
radix The radix to use for printing. The printer knob for radix is 
used if no radix is specified.
scope_separator is used to find the leaf name since many printers only print 
the leaf name of a field. Typical values for the separator 
are . (dot) or [ (open bracket).

print_field_int

virtual function void print_field_int (  
string    name,  
uvm_integral_t value,  
int    size,  
uvm_radix_enum radix = UVM_NORADIX,  
byte    scope_separator = ".",  
string   type_name = ""
)

Prints an integral field (up to 64 bits).

name The name of the field.
value The value of the field.
size The number of bits of the field (maximum is 64).
radix The radix to use for printing. The printer knob for radix is 
used if no radix is specified.
scope_separator is used to find the leaf name since many printers only print 
the leaf name of a field. Typical values for the separator 
are . (dot) or [ (open bracket).

print_object

virtual function void print_object (  
string    name,  
uvm_object value,  
byte    scope_separator = "."
)

Prints an object. Whether the object is recursed depends on a variety of knobs, such as 
the depth knob; if the current depth is at or below the depth setting, then the object is 
not recursed.

By default, the children of uvm_components are printed. To turn this behavior off, you 
must set the uvm_component::print_enabled bit to 0 for the specific children you do not 
want automatically printed.
**print_string**

```c
virtual function void print_string (  
    string name,  
    string value,  
    byte scope_separator = "."  
)
```

Prints a string field.

**print_time**

```c
virtual function void print_time (  
    string name,  
    time value,  
    byte scope_separator = "."  
)
```

Prints a time value. name is the name of the field, and value is the value to print. The print is subject to the $timeformat system task for formatting time values.

**print_real**

```c
virtual function void print_real (  
    string name,  
    real value,  
    byte scope_separator = "."  
)
```

Prints a real field.

**print_generic**

```c
virtual function void print_generic (  
    string name,  
    string type_name,  
    int size,  
    string value,  
    byte scope_separator = "."  
)
```

Prints a field having the given name, type_name, size, and value.

**METHODS FOR PRINTER SUBTYPING**

**emit**

```c
virtual function string emit ()
```

Emits a string representing the contents of an object in a format defined by an extension of this object.
**format_row**

```plaintext
virtual function string format_row (uvm_printer_row_info row)
```

Hook for producing custom output of a single field (row).

**format_row**

Hook to override base header with a custom header.

**format_header**

Hook to override base footer with a custom footer.

**adjust_name**

```plaintext
virtual protected function string adjust_name (string id, byte scope_separator = ".")
```

Prints a field’s name, or *id*, which is the full instance name.

The intent of the separator is to mark where the leaf name starts if the printer if configured to print only the leaf name of the identifier.

**print_array_header**

```plaintext
virtual function void print_array_header(string name, int size, string arraytype = "array", byte scope_separator = ".")
```

Prints the header of an array. This function is called before each individual element is printed. *print_array_footer* is called to mark the completion of array printing.

**print_array_range**

```plaintext
virtual function void print_array_range (int min, int max)
```

Prints a range using ellipses for values. This method is used when honoring the array knobs for partial printing of large arrays, *uvm_printer_knobs::begin_elements* and *uvm_printer_knobs::end_elements*.

This function should be called after *begin_elements* have been printed and before *end_elements* have been printed.
**print_array_footer**

```cpp
virtual function void print_array_footer ( 
    int size = 0 
)
```

Prints the header of a footer. This function marks the end of an array print. Generally, there is no output associated with the array footer, but this method let's the printer know that the array printing is complete.

**uvm_table_printer**

The table printer prints output in a tabular format.

The following shows sample output from the table printer.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Size</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>container</td>
<td>-</td>
<td>@1013</td>
</tr>
<tr>
<td>d1</td>
<td>mydata</td>
<td>-</td>
<td>@1022</td>
</tr>
<tr>
<td>v1</td>
<td>integral</td>
<td>32</td>
<td>'hcb8f1c97</td>
</tr>
<tr>
<td>e1</td>
<td>enum</td>
<td>32</td>
<td>THREE</td>
</tr>
<tr>
<td>str</td>
<td>string</td>
<td>2</td>
<td>hi</td>
</tr>
<tr>
<td>value</td>
<td>integral</td>
<td>12</td>
<td>'h2d</td>
</tr>
</tbody>
</table>

**Summary**

**uvm_table_printer**

The table printer prints output in a tabular format.

**CLASS HIERARCHY**

```
    uvm_printer
    `--- uvm_table_printer
```

**CLASS DECLARATION**

```
class uvm_table_printer extends uvm_printer
```

**VARIABLES**

<table>
<thead>
<tr>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>Creates a new instance of uvm_table_printer.</td>
</tr>
</tbody>
</table>

**METHODS**

<table>
<thead>
<tr>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>emit</td>
<td>Formats the collected information from prior calls to print_* into table format.</td>
</tr>
</tbody>
</table>
Creates a new instance of `uvm_table_printer`.

**METHODS**

**emit**

```c++
virtual function string emit()
```

Formats the collected information from prior calls to `print_*` into table format.

---

**uvm_tree_printer**

By overriding various methods of the `uvm_printer` super class, the tree printer prints output in a tree format.

The following shows sample output from the tree printer.

```plaintext
  c1: (container@1013) {
    d1: (mydata@1022) {
      v1: 'hcb8f1c97
      e1: THREE
      str: hi
    }
    value: 'h2d
  }
```

**Summary**

**uvm_tree_printer**

By overriding various methods of the `uvm_printer` super class, the tree printer prints output in a tree format.

**CLASS HIERARCHY**

```
  uvm Printer
  uvm_tree_printer
```

**CLASS DECLARATION**

```
class uvm_tree_printer extends uvm_printer
```

**VARIABLES**

- **new**
  Creates a new instance of `uvm_tree_printer`.

- **emit**
  Formats the collected information from prior calls to `print_*` into hierarchical tree format.
new

function new()

Creates a new instance of `uvm_tree_printer`.

**METHODS**

**emit**

virtual function string emit()

Formats the collected information from prior calls to `print_*` into hierarchical tree format.

---

**uvm_line_printer**

The line printer prints output in a line format.

The following shows sample output from the line printer.

```
c1: (container@1013) { d1: (mydata@1022) { v1: 'hcb8f1c97 e1: THREE str: hi } value: 'h2d }
```

### Summary

**uvm_line_printer**

The line printer prints output in a line format.

**CLASS HIERARCHY**

```
  uvm_printer
  uvm_tree_printer
  uvm_line_printer
```

**CLASS DECLARATION**

```
class uvm_line_printer extends uvm_tree_printer
```

**VARIABLES**

- `new` Creates a new instance of `uvm_line_printer`.

---

UVM 1.2 Class Reference 498
function new()

Creates a new instance of `uvm_line_printer`. It differs from the `uvm_tree_printer` only in that the output contains no line-feeds and indentation.

### uvm_printer_knobs

The `uvm_printer_knobs` class defines the printer settings available to all printer subtypes.

#### Summary

The `uvm_printer_knobs` class defines the printer settings available to all printer subtypes.

**Class Declaration**

```
class uvm_printer_knobs

```

**Variables**

- **header**: Indicates whether the `uvm_printer::format_header` function should be called when printing an object.
- **footer**: Indicates whether the `uvm_printer::format_footer` function should be called when printing an object.
- **full_name**: Indicates whether `uvm_printer::adjust_name` should print the full name of an identifier or just the leaf name.
- **identifier**: Indicates whether `uvm_printer::adjust_name` should print the identifier.
- **type_name**: Controls whether to print a field’s type name.
- **size**: Controls whether to print a field’s size.
- **depth**: Indicates how deep to recurse when printing objects.
- **reference**: Controls whether to print a unique reference ID for object handles.
- **begin_elements**: Defines the number of elements at the head of a list to print.
- **end_elements**: This defines the number of elements at the end of a list that should be printed.
- **prefix**: Specifies the string prepended to each output line
- **indent**: This knob specifies the number of spaces to use for level indentation.
- **show_root**: This setting indicates whether or not the initial object that is printed (when current depth is 0) prints the full path name.
- **mcd**: This is a file descriptor, or multi-channel descriptor, that specifies where the print output should be directed.
- **separator**: For tree printers only, determines the opening and closing separators used for nested objects.
- **show_radix**: Indicates whether the radix string ('h, and so on) should be prepended to an integral value when one is printed.
- **default_radix**: This knob sets the default radix to use for integral values when no radix enum is explicitly supplied to the `uvm_printer::print_field` or `uvm_printer::print_field_int` methods.
- **dec_radix**: This string should be prepended to the value of an integral type when a radix of `UVM_DEC` is used for the radix of the integral object.
- **bin_radix**: This string should be prepended to the value of an integral type when a radix of `UVM_BIN` is used for the radix of the object.
VARIABLES

header

bit header = 1

Indicates whether the `uvm_printer::format_header` function should be called when printing an object.

footer

bit footer = 1

Indicates whether the `uvm_printer::format_footer` function should be called when printing an object.

full_name

bit full_name = 0

Indicates whether `uvm_printer::adjust_name` should print the full name of an identifier or just the leaf name.

identifier

bit identifier = 1

Indicates whether `uvm_printer::adjust_name` should print the identifier. This is useful in cases where you just want the values of an object, but no identifiers.

type_name

bit type_name = 1

Controls whether to print a field’s type name.
**size**

```
bit size = 1
```

Controls whether to print a field’s size.

**depth**

```
int depth = -1
```

Indicates how deep to recurse when printing objects. A depth of -1 means to print everything.

**reference**

```
bit reference = 1
```

Controls whether to print a unique reference ID for object handles. The behavior of this knob is simulator-dependent.

**begin_elements**

```
int begin_elements = 5
```

Defines the number of elements at the head of a list to print. Use -1 for no max.

**end_elements**

```
int end_elements = 5
```

This defines the number of elements at the end of a list that should be printed.

**prefix**

```
string prefix = ""
```

Specifies the string prepended to each output line

**indent**

```
int indent = 2
```

This knob specifies the number of spaces to use for level indentation. The default level indentation is two spaces.

**show_root**
This setting indicates whether or not the initial object that is printed (when current depth is 0) prints the full path name. By default, the first object is treated like all other objects and only the leaf name is printed.

**mcd**

```
int mcd = UVM_STDOUT
```

This is a file descriptor, or multi-channel descriptor, that specifies where the print output should be directed.

By default, the output goes to the standard output of the simulator.

**separator**

```
string separator = "{}"
```

For tree printers only, determines the opening and closing separators used for nested objects.

**show_radix**

```
bit show_radix = 1
```

Indicates whether the radix string (‘h, and so on) should be prepended to an integral value when one is printed.

**default_radix**

```
uvm_radix_enum default_radix = UVM_HEX
```

This knob sets the default radix to use for integral values when no radix enum is explicitly supplied to the `uvm_printer::print_field` or `uvm_printer::print_field_int` methods.

**dec_radix**

```
string dec_radix = "'d"
```

This string should be prepended to the value of an integral type when a radix of UVM_DEC is used for the radix of the integral object.

When a negative number is printed, the radix is not printed since only signed decimal values can print as negative.

**bin_radix**

```
string bin_radix = "'b"
```
This string should be prepended to the value of an integral type when a radix of `UVM_BIN` is used for the radix of the integral object.

```
oct_radix
```

This string should be prepended to the value of an integral type when a radix of `UVM_OCT` is used for the radix of the integral object.

```
unsigned_radix
```

This is the string which should be prepended to the value of an integral type when a radix of `UVM_UNSIGNED` is used for the radix of the integral object.

```
hex_radix
```

This string should be prepended to the value of an integral type when a radix of `UVM_HEX` is used for the radix of the integral object.

**METHODS**

```
get_radix_str
```

Converts the radix from an enumerated to a printable radix according to the radix printing knobs (bin_radix, and so on).
The uvm_comparer class provides a policy object for doing comparisons. The policies determine how miscompares are treated and counted. Results of a comparison are stored in the comparer object. The `uvm_object::compare` and `uvm_object::do_compare` methods are passed a uvm_comparer policy object.

**Summary**

### uvm_comparer

The uvm_comparer class provides a policy object for doing comparisons.

#### Class Declaration

```cpp
class uvm_comparer
```

#### Variables

- **policy**
  
  Determines whether comparison is UVM_DEEP, UVM_REFERENCE, or UVM_SHALLOW.

- **show_max**
  
  Sets the maximum number of messages to send to the printer for miscompares of an object.

- **verbosity**
  
  Sets the verbosity for printed messages.

- **sev**
  
  Sets the severity for printed messages.

- **miscompares**
  
  This string is reset to an empty string when a comparison is started.

- **physical**
  
  This bit provides a filtering mechanism for fields.

- **abstract**
  
  This bit provides a filtering mechanism for fields.

- **check_type**
  
  This bit determines whether the type, given by `uvm_object::get_type_name`, is used to verify that the types of two objects are the same.

- **result**
  
  This bit stores the number of miscompares for a given compare operation.

#### Methods

- **compare_field**
  
  Compares two integral values.

- **compare_field_int**
  
  This method is the same as `compare_field` except that the arguments are small integers, less than or equal to 64 bits.

- **compare_field_real**
  
  This method is the same as `compare_field` except that the arguments are real numbers.

- **compare_object**
  
  Compares two class objects using the `policy` knob to determine whether the comparison should be deep, shallow, or reference.

- **compare_string**
  
  Compares two string variables.

- **print_msg**
  
  Causes the error count to be incremented and the message, `msg`, to be appended to the `miscompares` string (a newline is used to separate messages).

### Variables

#### policy

```cpp
uvm_recursion_policy_enum policy = UVM_DEFAULT_POLICY
```

Determines whether comparison is UVM_DEEP, UVM_REFERENCE, or UVM_SHALLOW.
**show_max**

```plaintext
int unsigned show_max = 1
```

Sets the maximum number of messages to send to the printer for miscompares of an object.

**verbosity**

```plaintext
int unsigned verbosity = UVM_LOW
```

Sets the verbosity for printed messages.

The verbosity setting is used by the messaging mechanism to determine whether messages should be suppressed or shown.

**sev**

```plaintext
uvm_severity sev = UVM_INFO
```

Sets the severity for printed messages.

The severity setting is used by the messaging mechanism for printing and filtering messages.

**miscompares**

```plaintext
string miscompares = ""
```

This string is reset to an empty string when a comparison is started.

The string holds the last set of miscompares that occurred during a comparison.

**physical**

```plaintext
bit physical = 1
```

This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different classes of fields.

It is up to you, in the `uvm_object::do_compare` method, to test the setting of this field if you want to use the physical trait as a filter.

**abstract**

```plaintext
bit abstract = 1
```

This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different
classes of fields.

It is up to you, in the `uvm_object::do_compare` method, to test the setting of this field if you want to use the abstract trait as a filter.

### check_type

```plaintext
bit check_type = 1
```

This bit determines whether the type, given by `uvm_object::get_type_name`, is used to verify that the types of two objects are the same.

This bit is used by the `compare_object` method. In some cases it is useful to set this to 0 when the two operands are related by inheritance but are different types.

### result

```plaintext
int unsigned result = 0
```

This bit stores the number of miscompares for a given compare operation. You can use the result to determine the number of miscompares that were found.

## Methods

### compare_field

```plaintext
virtual function bit compare_field (  
    string name,  
    uvm_bitstream_t lhs,  
    uvm_bitstream_t rhs,  
    int size,  
    uvm_radix_enum radix = UVM_NORADIX
)
```

Compares two integral values.

The `name` input is used for purposes of storing and printing a miscompare.

The left-hand-side `lhs` and right-hand-side `rhs` objects are the two objects used for comparison.

The size variable indicates the number of bits to compare; size must be less than or equal to 4096.

The radix is used for reporting purposes, the default radix is hex.

### compare_field_int

```plaintext
virtual function bit compare_field_int (  
    string name,  
    uvm_integral_t lhs,  
    uvm_integral_t rhs,  
    int size,  
    uvm_radix_enum radix = UVM_NORADIX
)
```
This method is the same as `compare_field` except that the arguments are small integers, less than or equal to 64 bits. It is automatically called by `compare_field` if the operand size is less than or equal to 64.

**compare_field_real**

```cpp
virtual function bit compare_field_real (string name, real lhs, real rhs)
```

This method is the same as `compare_field` except that the arguments are real numbers.

**compare_object**

```cpp
virtual function bit compare_object (string name, uvm_object lhs, uvm_object rhs)
```

Compares two class objects using the `policy` knob to determine whether the comparison should be deep, shallow, or reference.

The `name` input is used for purposes of storing and printing a miscompare.

The `lhs` and `rhs` objects are the two objects used for comparison.

The `check_type` determines whether or not to verify the object types match (the return from `lhs.get_type_name()` matches `rhs.get_type_name()`).

**compare_string**

```cpp
virtual function bit compare_string (string name, string lhs, string rhs)
```

Compares two string variables.

The `name` input is used for purposes of storing and printing a miscompare.

The `lhs` and `rhs` objects are the two objects used for comparison.

**print_msg**

```cpp
function void print_msg (string msg)
```

Causes the error count to be incremented and the message, `msg`, to be appended to the `miscompares` string (a newline is used to separate messages).

If the message count is less than the `show_max` setting, then the message is printed to standard-out using the current verbosity and severity settings. See the `verbosity` and `sev` variables for more information.
The uvm_recorder class serves two purposes

- Firstly, it is an abstract representation of a record within a uvm_tr_stream.
- Secondly, it is a policy object for recording fields into that record within the stream.

Contents

UVM Recorders

- uvm_recorder: Abstract class which defines the recorder API.
- uvm_text_recorder: The uvm_text_recorder is the default recorder implementation for the uvm_text_tr_database.

uvm_recorder

Abstract class which defines the recorder API.

Summary

uvm_recorder

Abstract class which defines the recorder API.

CLASS HIERARCHY

uvm_void
uvm_object
uvm_recorder

CLASS DECLARATION

virtual class uvm_recorder extends uvm_object

default_radix
physical
abstract
identifier
recursion_policy

This is the default radix setting if record_field is called without a radix.

This bit provides a filtering mechanism for fields.

This bit provides a filtering mechanism for fields.

This bit is used to specify whether or not an object’s reference should be recorded when the object is recorded.

Sets the recursion policy for recording objects.

CONFIGURATION API

get_stream

Returns a reference to the stream which created this record.

TRANSACTION RECORDER API

close
free

Once a recorder has been opened via
uvm_tr_stream::open_recorder, the user can
close the recorder.

Closes this recorder.

Frees this recorder.
<table>
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<tr>
<th>Method</th>
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<tr>
<td><code>is_open</code></td>
<td>Returns true if this <code>uvm_recorder</code> was opened on its stream, but has not yet been closed.</td>
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<tr>
<td><code>get_open_time</code></td>
<td>Returns the <code>open_time</code></td>
</tr>
<tr>
<td><code>is_closed</code></td>
<td>Returns true if this <code>uvm_recorder</code> was closed on its stream, but has not yet been freed.</td>
</tr>
<tr>
<td><code>get_close_time</code></td>
<td>Returns the <code>close_time</code></td>
</tr>
</tbody>
</table>

**Handles**

- **get_handle** Returns a unique ID for this recorder.
- **get_recorder_from_handle** Static accessor, returns a recorder reference for a given unique id.

**Attribute Recording**

- **record_field** Records an integral field (less than or equal to 4096 bits).
- **record_field_int** Records an integral field (less than or equal to 64 bits).
- **record_field_real** Records a real field.
- **record_object** Records an object field.
- **record_string** Records a string field.
- **record_time** Records a time field.
- **record_generic** Records a name/value pair, where `value` has been converted to a string.
- **use_record_attribute** Indicates that this recorder does (or does not) support usage of the `uvm_record_attribute` macro.
- **get_record_attribute_handle** Provides a tool-specific handle which is compatible with `uvm_record_attribute`.

**Implementation Agnostic API**

- **do_open** Callback triggered via `uvm_tr_stream::open_recorder`.
- **do_close** Callback triggered via `close`.
- **do_free** Callback triggered via `free`.
- **do_record_field** Records an integral field (less than or equal to 4096 bits).
- **do_record_field_int** Records an integral field (less than or equal to 64 bits).
- **do_record_field_real** Records a real field.
- **do_record_object** Records an object field.
- **do_record_string** Records a string field.
- **do_record_time** Records a time field.
- **do_record_generic** Records a name/value pair, where `value` has been converted to a string.

**default_radix**

```plaintext
uvm_radix_enum default_radix = UVM_HEX
```

This is the default radix setting if `record_field` is called without a radix.

**physical**

```plaintext
bit physical = 1
```

This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different classes of fields.

It is up to you, in the `uvm_object::do_record` method, to test the setting of this field if you want to use the physical trait as a filter.
**abstract**

```plaintext
bit abstract = 1
```

This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different classes of fields.

It is up to you, in the `uvm_object::do_record` method, to test the setting of this field if you want to use the abstract trait as a filter.

**identifier**

```plaintext
bit identifier = 1
```

This bit is used to specify whether or not an object’s reference should be recorded when the object is recorded.

**recursion_policy**

```plaintext
uvm_recursion_policy_enum policy = UVM_DEFAULT_POLICY
```

Sets the recursion policy for recording objects.

The default policy is deep (which means to recurse an object).

---

**Configuration API**

**get_stream**

```plaintext
function uvm_tr_stream get_stream()
```

Returns a reference to the stream which created this record.

A warning will be asserted if `get_stream` is called prior to the record being initialized via `do_open`.

---

**Transaction Recorder API**

Once a recorder has been opened via `uvm_tr_stream::open_recorder`, the user can `close` the recorder.

Due to the fact that many database implementations will require crossing a language boundary, an additional step of `freeing` the recorder is required.

A `link` can be established within the database any time between `open` and `free`, however it is illegal to establish a link after `freeing` the recorder.
close

```vhls
function void close(
    time close_time = 0
)
```

Closes this recorder.

Closing a recorder marks the end of the transaction in the stream.

**Parameters**

- `close_time` Optional time to record as the closing time of this transaction.

This method will trigger a `do_close` call.

free

```vhls
function void free(
    time close_time = 0
)
```

Frees this recorder.

Freeing a recorder indicates that the stream and database can release any references to the recorder.

**Parameters**

- `close_time` Optional time to record as the closing time of this transaction.

If a recorder has not yet been closed (via a call to `close`), then `close` will automatically be called, and passed the `close_time`. If the recorder has already been closed, then the `close_time` will be ignored.

This method will trigger a `do_free` call.

is_open

```vhls
function bit is_open()
```

Returns true if this `uvm_recorder` was opened on its stream, but has not yet been closed.

get_open_time

```vhls
function time get_open_time()
```

Returns the `open_time`

is_closed

```vhls
function bit is_closed()
```

Returns true if this `uvm_recorder` was closed on its stream, but has not yet been freed.
**get_close_time**

```
function time get_close_time()
```

Returns the close_time

---

**get_handle**

```
function integer get_handle()
```

Returns a unique ID for this recorder.

A value of 0 indicates that the recorder has been freed, and no longer has a valid ID.

---

**get_recorder_from_handle**

```
static function uvm_recorder get_recorder_from_handle(
    integer id
)
```

Static accessor, returns a recorder reference for a given unique id.

If no recorder exists with the given id, or if the recorder with that id has been freed, then null is returned.

This method can be used to access the recorder associated with a call to uvm_transaction::begin_tr or uvm_component::begin_tr.

```
integer handle = tr.begin_tr();
uvm_recorder recorder = uvm_recorder::get_recorder_from_handle(handle);
if (recorder != null) begin
    recorder.record_string("begin_msg", "Started recording transaction!");
end
```

---

**ATTRIBUTE RECORDING**

**record_field**

```
function void record_field(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix = UVM_NORADIX
)
```

Records an integral field (less than or equal to 4096 bits).

**Parameters**
name Name of the field
value Value of the field to record.
size Number of bits of the field which apply (Usually obtained via $bits).
radix The uvm_radix_enum to use.

This method will trigger a do_record_field call.

**record_field_int**

```plaintext
function void record_field_int(
    string name,
    uvm_integral_t value,
    int size,
    uvm_radix_enum radix = UVM_NORADIX
)
```

Records an integral field (less than or equal to 64 bits).

This optimized version of record_field is useful for sizes up to 64 bits.

**Parameters**

- **name** Name of the field
- **value** Value of the field to record
- **size** Number of bits of the field which apply (Usually obtained via $bits).
- **radix** The uvm_radix_enum to use.

This method will trigger a do_record_field_int call.

**record_field_real**

```plaintext
function void record_field_real(
    string name,
    real value
)
```

Records a real field.

**Parameters**

- **name** Name of the field
- **value** Value of the field to record

This method will trigger a do_record_field_real call.

**record_object**

```plaintext
function void record_object(
    string name,
    uvm_object value
)
```

Records an object field.

**Parameters**
The implementation must use the recursion_policy and identifier to determine exactly what should be recorded.

**record_string**

```plaintext
function void record_string(
    string name,
    string value
)
```

Records a string field.

**Parameters**

- `name` Name of the field
- `value` Value of the field

**record_time**

```plaintext
function void record_time(
    string name,
    time value
)
```

Records a time field.

**Parameters**

- `name` Name of the field
- `value` Value of the field

**record_generic**

```plaintext
function void record_generic(
    string name,
    string value,
    string type_name = ""
)
```

Records a name/value pair, where value has been converted to a string.

**For example**

```plaintext
recorder.record_generic("myvar","var_type", $sformatf("%0d",myvar), 32);
```

**Parameters**

- `name` Name of the field
- `value` Value of the field
**use_record_attribute**

```plaintext
virtual function bit use_record_attribute()
```

Indicates that this recorder does (or does not) support usage of the `uvm_record_attribute` macro.

The default return value is 0 (not supported), developers can optionally extend `uvm_recorder` and set the value to 1 if they support the `uvm_record_attribute` macro.

**get_record_attribute_handle**

```plaintext
virtual function integer get_record_attribute_handle()
```

Provides a tool-specific handle which is compatible with `uvm_record_attribute`.

By default, this method will return the same value as `get_attribute`, however tool vendors can override this method to provide tool-specific handles which will be passed to the `uvm_record_attribute` macro.

---

**Implementation Agnostic API**

**do_open**

```plaintext
protected virtual function void do_open(
    uvm_tr_stream stream,
    time open_time,
    string type_name
)
```

Callback triggered via `uvm_tr_stream::open_recorder`.

The `do_open` callback can be used to initialize any internal state within the recorder, as well as providing a location to record any initial information.

**do_close**

```plaintext
protected virtual function void do_close(
    time close_time
)
```

Callback triggered via `close`.

The `do_close` callback can be used to set internal state within the recorder, as well as providing a location to record any closing information.

**do_free**

```plaintext
protected virtual function void do_free()
```
Callback triggered via **free**.

The `do_free` callback can be used to release the internal state within the recorder, as well as providing a location to record any "freeing" information.

**do_record_field**

```cpp
pure virtual protected function void do_record_field(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix
)
```

Records an integral field (less than or equal to 4096 bits).

*Mandatory* Backend implementation of `record_field`

**do_record_field_int**

```cpp
pure virtual protected function void do_record_field_int(
    string name,
    uvm_integral_t value,
    int size,
    uvm_radix_enum radix
)
```

Records an integral field (less than or equal to 64 bits).

*Mandatory* Backend implementation of `record_field_int`

**do_record_field_real**

```cpp
pure virtual protected function void do_record_field_real(
    string name,
    real value
)
```

Records a real field.

*Mandatory* Backend implementation of `record_field_real`

**do_record_object**

```cpp
pure virtual protected function void do_record_object(
    string name,
    uvm_object value
)
```

Records an object field.

*Mandatory* Backend implementation of `record_object`

**do_record_string**

```cpp
pure virtual protected function void do_record_string(
    string name,
)
```
Records a string field.

*Mandatory* Backend implementation of `record_string`

---

**do_record_time**

```c
pure virtual protected function void do_record_time(
    string name,
    time value
)
```

Records a time field.

*Mandatory* Backend implementation of `record_time`

---

**do_record_generic**

```c
pure virtual protected function void do_record_generic(
    string name,
    string value,
    string type_name
)
```

Records a name/value pair, where `value` has been converted to a string.

*Mandatory* Backend implementation of `record_generic`

---

**UVM 1.2 Class Reference**

The `uvm_text_recorder` is the default recorder implementation for the `uvm_text_tr_database`.

---

**Summary**

The `uvm_text_recorder` is the default recorder implementation for the `uvm_text_tr_database`.

---

**CLASS HIERARCHY**

```
class uvm_text_recorder extends uvm_recorder
```

---

**CLASS DECLARATION**

```
class uvm_text_recorder extends uvm_recorder
```

---

**IMPLEMENTATION**

new Constructor

### Agnostic API

<table>
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<tr>
<td>do_close</td>
<td>Callback triggered via uvm_recorder::close.</td>
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<tr>
<td>do_free</td>
<td>Callback triggered via uvm_recorder::free.</td>
</tr>
<tr>
<td>do_record_field</td>
<td>Records an integral field (less than or equal to 4096 bits).</td>
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<tr>
<td>do_record_field_int</td>
<td>Records an integral field (less than or equal to 64 bits).</td>
</tr>
<tr>
<td>do_record_field_real</td>
<td>Record a real field.</td>
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<tr>
<td>do_record_object</td>
<td>Record an object field.</td>
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<td>Records a name/value pair, where value has been converted to a string.</td>
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### Implementation Specific API

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<td>write_attribute</td>
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<td>write_attribute_int</td>
<td>Outputs an integral attribute to the textual log</td>
</tr>
</tbody>
</table>

### new

```plaintext
function new(
    string name = "unnamed-uvm_text_recorder"
)
```

Constructor

**Parameters**

- **name**: Instance name

### Implementation Agnostic API

**do_open**

```plaintext
protected virtual function void do_open(
    uvm_tr_stream stream,
    time open_time,
    string type_name
)
```

Callback triggered via uvm_tr_stream::open_recorder.

Text-backend specific implementation.

**do_close**

```plaintext
protected virtual function void do_close(
    time close_time
)
```

Callback triggered via uvm_recorder::close.

Text-backend specific implementation.
do_free

protected virtual function void do_free()

Callback triggered via uvm_recorder::free.
Text-backend specific implementation.

do_record_field

protected virtual function void do_record_field(
    string name,
    uvm_bitstream_t value,
    int size,
    uvm_radix_enum radix
)

Records an integral field (less than or equal to 4096 bits).
Text-backend specific implementation.

do_record_field_int

protected virtual function void do_record_field_int(
    string name,
    uvm_integral_t value,
    int size,
    uvm_radix_enum radix
)

Records an integral field (less than or equal to 64 bits).
Text-backend specific implementation.

do_record_field_real

protected virtual function void do_record_field_real(
    string name,
    real value
)

Record a real field.
Text-backened specific implementation.

do_record_object

protected virtual function void do_record_object(
    string name,
    uvm_object value
)

Record an object field.
Text-backend specific implementation.

The method uses identifier to determine whether or not to record the object instance id,
and recursion_policy to determine whether or not to recurse into the object.

**do_record_string**

```c++
protected virtual function void do_record_string(
    string name,
    string value
)
```

Records a string field.

Text-backend specific implementation.

**do_record_time**

```c++
protected virtual function void do_record_time(
    string name,
    time value
)
```

Records a time field.

Text-backend specific implementation.

**do_record_generic**

```c++
protected virtual function void do_record_generic(
    string name,
    string value,
    string type_name
)
```

Records a name/value pair, where value has been converted to a string.

Text-backend specific implementation.

**Implementation Specific API**

**write_attribute**

```c++
function void write_attribute(
    string nm,
    uvm_bitstream_t value,
    uvm_radix_enum radix,
    int@ger numbits = $bits(uvm_bitstream_t)
)
```

Outputs an integral attribute to the textual log

**Parameters**

- **nm** Name of the attribute
- **value** Value
- **radix** Radix of the output
- **numbits** number of valid bits
write_attribute_int

```c
function void write_attribute_int(
    string nm,
    uvm_integral_t value,
    uvm_radix_enum radix,
    integer numbits = $bits(uvm_bitstream_t)
)
```

Outputs an integral attribute to the textual log

**Parameters**

- `nm` Name of the attribute
- `value` Value
- `radix` Radix of the output
- `numbits` number of valid bits
The uvm_packer class provides a policy object for packing and unpacking uvm_objects. The policies determine how packing and unpacking should be done. Packing an object causes the object to be placed into a bit (byte or int) array. If the `uvm_field_* macro are used to implement pack and unpack, by default no metadata information is stored for the packing of dynamic objects (strings, arrays, class objects).

**Summary**

**uvm_packer**

The uvm_packer class provides a policy object for packing and unpacking uvm_objects.

**Packing**
- **pack_field**: Packs an integral value (less than or equal to 4096 bits) into the packed array.
- **pack_field_int**: Packs the integral value (less than or equal to 64 bits) into the pack array.
- **pack_bits**: Packs bits from upacked array of bits into the pack array.
- **pack_bytes**: Packs bits from an upacked array of bytes into the pack array.
- **pack_ints**: Packs bits from an unpacked array of ints into the pack array.
- **pack_string**: Packs a string value into the pack array.
- **pack_time**: Packs a time value as 64 bits into the pack array.
- **pack_real**: Packs a real value as 64 bits into the pack array.
- **pack_object**: Packs an object value into the pack array.

**Unpacking**
- **is_null**: This method is used during unpack operations to peek at the next 4-bit chunk of the pack data and determine if it is 0.
- **unpack_field**: Unpacks bits from the pack array and returns the bit-stream that was unpacked.
- **unpack_field_int**: Unpacks bits from the pack array and returns the bit-stream that was unpacked.
- **unpack_bits**: Unpacks bits from the pack array into an unpacked array of bits.
- **unpack_bytes**: Unpacks bits from the pack array into an unpacked array of bytes.
- **unpack_ints**: Unpacks bits from the pack array into an unpacked array of ints.
- **unpack_string**: Unpacks a string.
- **unpack_time**: Unpacks the next 64 bits of the pack array and places them into a time variable.
- **unpack_real**: Unpacks the next 64 bits of the pack array and places them into a real variable.
- **unpack_object**: Unpacks an object and stores the result into value.
- **get_packed_size**: Returns the number of bits that were packed.

**Variables**
- **physical**: This bit provides a filtering mechanism for fields.
- **abstract**: This bit provides a filtering mechanism for fields.
- **use_metadata**: This flag indicates whether to encode metadata when packing dynamic data, or to decode metadata when unpacking.
- **big_endian**: This bit determines the order that integral data is packed (using pack_field, pack_field_int, pack_time, or pack_real) and how the data is unpacked from the pack array (using unpack_field, unpack_field_int, unpack_time, or unpack_real).
PACKING

pack_field

```c
virtual function void pack_field (uvm_bitstream_t value, int size)
```

Packs an integral value (less than or equal to 4096 bits) into the packed array. `size` is the number of bits of `value` to pack.

pack_field_int

```c
virtual function void pack_field_int (uvm_integral_t value, int size)
```

Packs the integral value (less than or equal to 64 bits) into the pack array. The `size` is the number of bits to pack, usually obtained by `$bits`. This optimized version of `pack_field` is useful for sizes up to 64 bits.

pack_bits

```c
virtual function void pack_bits(ref bit value[], input int size = -1)
```

Packs bits from upacked array of bits into the pack array.

See `pack_ints` for additional information.

pack_bytes

```c
virtual function void pack_bytes(ref byte value[], input int size = -1)
```

Packs bits from an upacked array of bytes into the pack array.

See `pack_ints` for additional information.

pack_ints

```c
virtual function void pack_ints(ref int value[], input int size = -1)
```
Packs bits from an unpacked array of ints into the pack array.

The bits are appended to the internal pack array. This method allows for fields of arbitrary length to be passed in, using the SystemVerilog stream operator.

For example

```verilog
bit[511:0] my_field;
begint
  int my_stream[];
  { << int {my_stream}} = my_field;
  packer.pack_ints(my_stream);
end
```

When appending the stream to the internal pack array, the packer will obey the value of big_endian (appending the array from MSB to LSB if set).

An optional size parameter is provided, which defaults to '-1'. If set to any value greater than '-1' (including 0), then the packer will use the size as the number of bits to pack, otherwise the packer will simply pack the entire stream.

An error will be asserted if the size has been specified, and exceeds the size of the source array.

**pack_string**

```verilog
virtual function void pack_string (string value)
```

Packs a string value into the pack array.

When the metadata flag is set, the packed string is terminated by a null character to mark the end of the string.

This is useful for mixed language communication where unpacking may occur outside of SystemVerilog UVM.

**pack_time**

```verilog
virtual function void pack_time (time value)
```

Packs a time value as 64 bits into the pack array.

**pack_real**

```verilog
virtual function void pack_real (real value)
```

Packs a real value as 64 bits into the pack array.

The real value is converted to a 6-bit scalar value using the function $real2bits before it is packed into the array.
**pack_object**

```c
virtual function void pack_object (uvm_object value)
```

Packs an object value into the pack array.

A 4-bit header is inserted ahead of the string to indicate the number of bits that was packed. If a **null** object was packed, then this header will be 0.

This is useful for mixed-language communication where unpacking may occur outside of SystemVerilog UVM.

---

**UNPACKING**

**is_null**

```c
virtual function bit is_null ()
```

This method is used during unpack operations to peek at the next 4-bit chunk of the pack data and determine if it is 0.

If the next four bits are all 0, then the return value is a 1; otherwise it is 0.

This is useful when unpacking objects, to decide whether a new object needs to be allocated or not.

---

**unpack_field**

```c
virtual function uvm_bitstream_t unpack_field (int size)
```

Unpacks bits from the pack array and returns the bit-stream that was unpacked. **size** is the number of bits to unpack; the maximum is 4096 bits.

---

**unpack_field_int**

```c
virtual function uvm_integral_t unpack_field_int (int size)
```

Unpacks bits from the pack array and returns the bit-stream that was unpacked.

**size** is the number of bits to unpack; the maximum is 64 bits. This is a more efficient variant than **unpack_field** when unpacking into smaller vectors.

---

**unpack_bits**

```c
virtual function void unpack_bits(ref bit value[],
input int size = -1)
```

---
Unpacks bits from the pack array into an unpacked array of bits.

**unpack_bytes**

```cpp
virtual function void unpack_bytes(
    ref byte value[],
    input int size = -1
)
```

Unpacks bits from the pack array into an unpacked array of bytes.

**unpack_ints**

```cpp
virtual function void unpack_ints(
    ref int value[],
    input int size = -1
)
```

Unpacks bits from the pack array into an unpacked array of ints.

The unpacked array is unpacked from the internal pack array. This method allows for fields of arbitrary length to be passed in without expanding into a pre-defined integral type first.

For example

```cpp
bit[511:0] my_field;
begin
    int my_stream[] = new[16]; // 512/32 = 16
    packer.unpack_ints(my_stream);
    my_field = <<{my_stream};
end
```

When unpacking the stream from the internal pack array, the packer will obey the value of `big_endian` (unpacking the array from MSB to LSB if set).

An optional `size` parameter is provided, which defaults to `-1`. If set to any value greater than `-1` (including 0), then the packer will use the size as the number of bits to unpack, otherwise the packer will simply unpack the entire stream.

An error will be asserted if the `size` has been specified, and exceeds the size of the target array.

**unpack_string**

```cpp
virtual function string unpack_string (int num_chars = -1)
```

Unpacks a string.

`num_chars` bytes are unpacked into a string. If `num_chars` is `-1` then unpacking stops on at the first `null` character that is encountered.
unpack_time

```cpp
virtual function time unpack_time ()
```

Unpacks the next 64 bits of the pack array and places them into a time variable.

unpack_real

```cpp
virtual function real unpack_real ()
```

Unpacks the next 64 bits of the pack array and places them into a real variable.
The 64 bits of packed data are converted to a real using the $bits2real system function.

unpack_object

```cpp
virtual function void unpack_object (
    uvm_object value
)
```

Unpacks an object and stores the result into `value`.

`value` must be an allocated object that has enough space for the data being unpacked.
The first four bits of packed data are used to determine if a null object was packed into the array.
The `is_null` function can be used to peek at the next four bits in the pack array before calling this method.

get_packed_size

```cpp
virtual function int get_packed_size()
```

Returns the number of bits that were packed.

VARIABLES

physical

```cpp
bit physical = 1
```

This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different classes of fields. It is up to you, in the `uvm_object::do_pack` and `uvm_object::do_unpack` methods, to test the setting of this field if you want to use it as a filter.

abstract

```cpp
bit abstract
```
This bit provides a filtering mechanism for fields.

The abstract and physical settings allow an object to distinguish between two different classes of fields. It is up to you, in the `uvm_object::do_pack` and `uvm_object::do_unpack` routines, to test the setting of this field if you want to use it as a filter.

**use_metadata**

```pascal
bit use_metadata
```

This flag indicates whether to encode metadata when packing dynamic data, or to decode metadata when unpacking. Implementations of `uvm_object::do_pack` and `uvm_object::do_unpack` should regard this bit when performing their respective operation. When set, metadata should be encoded as follows:

- For strings, pack an additional `null` byte after the string is packed.
- For objects, pack 4 bits prior to packing the object itself. Use 4'b0000 to indicate the object being packed is `null`, otherwise pack 4'b0001 (the remaining 3 bits are reserved).
- For queues, dynamic arrays, and associative arrays, pack 32 bits indicating the size of the array prior to packing individual elements.

**big_endian**

```pascal
bit big_endian = 1
```

This bit determines the order that integral data is packed (using `pack_field`, `pack_field_int`, `pack_time`, or `pack_real`) and how the data is unpacked from the pack array (using `unpack_field`, `unpack_field_int`, `unpack_time`, or `unpack_real`). When the bit is set, data is associated msb to lsb; otherwise, it is associated lsb to msb.

The following code illustrates how data can be associated msb to lsb and lsb to msb:

```pascal
class mydata extends uvm_object;
    logic[15:0] value = 'h1234;
    function void do_pack (uvm_packer packer);
        packer.pack_field_int(value, 16);
    endfunction
    function void do_unpack (uvm_packer packer);
        value = packer.unpack_field_int(16);
    endfunction
endclass

mydata d = new;
bit bits[];
initial begin
    d.pack(bits); // 'b0001001000110100
    uvm_default_packer.big_endian = 0;
    d.pack(bits); // 'b0010110001001000
end
```
22.5 UVM Links

The uvm_link_base class, and its extensions, are provided as a mechanism to allow for compile-time safety when trying to establish links between records within a uvm_tr_database.

Contents

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uvm_link_base

The uvm_link_base class presents a simple API for defining a link between any two objects.

Using extensions of this class, a uvm_tr_database can determine the type of links being passed, without relying on “magic” string names.

For example

```plaintext
virtual function void do_establish_link(uvm_link_base link);
    uvm_parent_child_link pc_link;
    uvm_cause_effect_link ce_link;
    if ($cast(pc_link, link)) begin
        // Record the parent-child relationship
    end
    else if ($cast(ce_link, link)) begin
        // Record the cause-effect relationship
    end
    else begin
        // Unsupported relationship!
    end
endfunction : do_establish_link
```

Summary

uvm_link_base

The uvm_link_base class presents a simple API for defining a link between any two objects.
## uvm_link_base

### Class Declaration

```
virtual class uvm_link_base extends uvm_object
```

## Constructor

```
function new(
    string name = "unnamed-uvm_link_base"
)
```

Constructor

### Parameters

- **name**  
  Instance name

## Accessors

### set_lhs

```
function void set_lhs(
    uvm_object lhs
)
```

Sets the left-hand-side of the link

Triggers the do_set_lhs callback.

### get_lhs

```
function uvm_object get_lhs()
```

Gets the left-hand-side of the link

Triggers the do_get_lhs callback.

### set_rhs

```
function void set_rhs(
    uvm_object rhs
)
```

Sets the right-hand-side of the link

### get_rhs

```
function uvm_object get_rhs()
```

Gets the right-hand-side of the link

### set

A Convenience method for setting both sides in one call.

### do_set_lhs

Callback for setting the left-hand-side

### do_get_lhs

Callback for retrieving the left-hand-side

### do_set_rhs

Callback for setting the right-hand-side

### do_get_rhs

Callback for retrieving the right-hand-side
**set_rhs**

```plaintext
function void set_rhs(
    uvm_object rhs
)
```

Sets the right-hand-side of the link
Triggers the do_set_rhs callback.

**get_rhs**

```plaintext
function uvm_object get_rhs()
```

Gets the right-hand-side of the link
Triggers the do_get_rhs callback

**set**

```plaintext
function void set(
    uvm_object lhs,
    rhs
)
```

Convenience method for setting both sides in one call.
Triggers both the do_set_lhs and do_set_rhs callbacks.

---

**IMPLEMENTATION CALLBACKS**

**do_set_lhs**

```plaintext
pure virtual function void do_set_lhs(
    uvm_object lhs
)
```

Callback for setting the left-hand-side

**do_get_lhs**

```plaintext
pure virtual function uvm_object do_get_lhs()
```

Callback for retrieving the left-hand-side

**do_set_rhs**

```plaintext
pure virtual function void do_set_rhs(
    uvm_object rhs
)
```
Callback for setting the right-hand-side

\textbf{do\_get\_rhs}

\begin{verbatim}
pure virtual function uvm_object do_get_rhs()
\end{verbatim}

Callback for retrieving the right-hand-side

\textbf{uvm\_parent\_child\_link}

The \textit{uvm\_parent\_child\_link} is used to represent a Parent/Child relationship between two objects.

\textbf{Summary}

\begin{tabular}{|c|}
\hline
\textbf{new \textit{uvm\_parent\_child\_link}} \textit{Constructor} \\
\hline
\textbf{get\_link} \textit{Constructs a pre-filled link} \\
\hline
\textbf{do\_set\_lhs} \textit{Sets the left-hand-side (Parent)} \\
\hline
\textbf{do\_get\_lhs} \textit{Retrieves the left-hand-side (Parent)} \\
\hline
\textbf{do\_set\_rhs} \textit{Sets the right-hand-side (Child)} \\
\hline
\textbf{do\_get\_rhs} \textit{Retrieves the right-hand-side (Child)} \\
\hline
\end{tabular}

\textbf{new}

\begin{verbatim}
function new(
    string name = "unnamed-uvm_parent_child_link"
)
\end{verbatim}

Constructor

\textbf{Parameters}

\begin{tabular}{|c|c|}
\hline
\emph{name} & Instance name \\
\hline
\end{tabular}
**get_link**

```plaintext
static function uvm_parent_child_link get_link(
    uvm_object lhs,
    uvm_object rhs,
    string name = "pc_link"
)
```

Constructs a pre-filled link

This allows for simple one-line link creations.

```plaintext
my_db.establish_link(uvm_parent_child_link::get_link(record1, record2));
```

**Parameters**

- **lhs**  
  Left hand side reference

- **rhs**  
  Right hand side reference

- **name**  
  Optional name for the link object

---

**IMPLEMENTATION CALLBACKS**

**do_set_lhs**

```plaintext
virtual function void do_set_lhs(
    uvm_object lhs
)
```

Sets the left-hand-side (Parent)

**do_get_lhs**

```plaintext
virtual function uvm_object do_get_lhs()
```

Retrieves the left-hand-side (Parent)

**do_set_rhs**

```plaintext
virtual function void do_set_rhs(
    uvm_object rhs
)
```

Sets the right-hand-side (Child)

**do_get_rhs**

```plaintext
virtual function uvm_object do_get_rhs()
```

Retrieves the right-hand-side (Child)
The *uvm_cause_effect_link* is used to represent a Cause/Effect relationship between two objects.

### Summary

#### uvm_cause_effect_link

The *uvm_cause_effect_link* is used to represent a Cause/Effect relationship between two objects.

#### Class Hierarchy

```
<table>
<thead>
<tr>
<th>Class</th>
<th>Subclass</th>
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<tbody>
<tr>
<td>uvm_void</td>
<td></td>
</tr>
<tr>
<td>uvm_object</td>
<td></td>
</tr>
<tr>
<td>uvm_link_base</td>
<td></td>
</tr>
<tr>
<td>uvm_cause_effect_link</td>
<td></td>
</tr>
</tbody>
</table>
```

#### Class Declaration

```
class uvm_cause_effect_link extends uvm_link_base
```

- **new**
  - Function: `function new(
    string name = "unnamed-uvm_cause_effect_link"
  )`
  - Description: Constructor
  - Parameters:
    - `name`: Instance name

- **get_link**
  - Function: `static function uvm_cause_effect_link get_link(
    uvm_object lhs,
    uvm_object rhs,
    string name = "ce_link"
  )`
  - Description: Constructs a pre-filled link

This allows for simple one-line link creations.

```c
my_db.establish_link(uvm_cause_effect_link::get_link(record1, record2));
```

**Parameters**

- *lhs*  
  Left hand side reference

- *rhs*  
  Right hand side reference

- *name*  
  Optional name for the link object

---

**IMPLEMENTATION CALLBACKS**

**do_set_lhs**

```c
virtual function void do_set_lhs(
    uvm_object lhs
)
```

Sets the left-hand-side (Cause)

**do_get_lhs**

```c
virtual function uvm_object do_get_lhs()
```

Retrieves the left-hand-side (Cause)

**do_set_rhs**

```c
virtual function void do_set_rhs(
    uvm_object rhs
)
```

Sets the right-hand-side (Effect)

**do_get_rhs**

```c
virtual function uvm_object do_get_rhs()
```

Retrieves the right-hand-side (Effect)

---

**uvm_related_link**

The *uvm_related_link* is used to represent a generic “is related” link between two objects.
Summary

**uvm_related_link**

The *uvm_related_link* is used to represent a generic “is related” link between two objects.

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_link_base
- **uvm_related_link**

**CLASS DECLARATION**

```plaintext
class uvm_related_link extends uvm_link_base

new Constructor
get_link Constructs a pre-filled link

IMPLEMENTATION CALLBACKS

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>do_set_lhs</td>
<td>Sets the left-hand-side</td>
</tr>
<tr>
<td>do_get_lhs</td>
<td>Retrieves the left-hand-side</td>
</tr>
<tr>
<td>do_set_rhs</td>
<td>Sets the right-hand-side</td>
</tr>
<tr>
<td>do_get_rhs</td>
<td>Retrieves the right-hand-side</td>
</tr>
</tbody>
</table>
```

**new**

```plaintext
function new(
    string name = "unnamed-uvm_related_link"
)
```

Constructor

**Parameters**

- name Instance name

**get_link**

```plaintext
static function uvm_related_link get_link(
    uvm_object lhs,
    uvm_object rhs,
    string name = "ce_link"
)
```

Constructs a pre-filled link

This allows for simple one-line link creations.

```plaintext
my_db.establish_link(uvm_related_link::get_link(record1, record2));
```

**Parameters**

- lhs Left hand side reference
**IMPLEMENTATION CALLBACKS**

**do_set_lhs**

```c
virtual function void do_set_lhs(
    uvm_object lhs
)
```

Sets the left-hand-side

**do_get_lhs**

```c
virtual function uvm_object do_get_lhs()
```

Retrieves the left-hand-side

**do_set_rhs**

```c
virtual function void do_set_rhs(
    uvm_object rhs
)
```

Sets the right-hand-side

**do_get_rhs**

```c
virtual function uvm_object do_get_rhs()
```

Retrieves the right-hand-side
23. Data Access Policies

The UVM provides special objects as utility classes for applying common policies to data access (such as 'locking' data, or ensuring that it remains constant after being read).

This is not intended to be a comprehensive list of all Data Access policies, and the user is encouraged to write their own, and potentially contribute them to the community.

Summary

Data Access Policies

The UVM provides special objects as utility classes for applying common policies to data access (such as 'locking' data, or ensuring that it remains constant after being read).
23.1 uvm_set_get_dap_base

Provides the ‘set’ and ‘get’ interface for Data Access Policies (DAPs)

The ‘Set/Get’ base class simply provides a common interface for the various DAPs to implement. This provides a mechanism for consistent implementations of similar DAPs.

Summary

**uvm_set_get_dap_base**

Provides the ‘set’ and ‘get’ interface for Data Access Policies (DAPs)

### Class Hierarchy

```
| uvm_void                        |
| uvm_object                      |
| uvm_set_get_dap_base            |
```

### Class Declaration

```
virtual class uvm_set_get_dap_base#(
    type T = int
) extends uvm_object
```

### new Constructor

```
function new(
    string name = "unnamed-uvm_set_get_dap_base#{T}"
)
```

Constructor

---

### Set/Get Interface

All implementations of the `uvm_set_get_dap_base` class must provide an implementation of the four basic “Set and Get” accessors.

### set

```
pure virtual function void set(
    T value
)
```

Sets the value contained within the resource.
Depending on the DAP policies, an error may be reported if it is illegal to ‘set’ the value at this time.

**try_set**

```cpp
pure virtual function bit try_set(T value)
```

Attempts to set the value contained within the resource.

If the DAP policies forbid setting at this time, then the method will return 0, however no errors will be reported. Otherwise, the method will return 1, and will be treated like a standard set call.

**get**

```cpp
pure virtual function T get()
```

Retrieves the value contained within the resource.

Depending on the DAP policies, an error may be reported if it is illegal to ‘get’ the value at this time.

**try_get**

```cpp
pure virtual function bit try_get(output T value)
```

Attempts to retrieve the value contained within the resource.

If the DAP policies forbid retrieving at this time, then the method will return 0, however no errors will be reported. Otherwise, the method will return 1, and will be treated like a standard get call.
Provides a ‘Simple Lock’ Data Access Policy.

The ‘Simple Lock’ Data Access Policy allows for any number of ‘sets’, so long as the value is not ‘locked’. The value can be retrieved using ‘get’ at any time.

The UVM uses this policy to protect the file name value in the uvm_text_tr_database.

**Summary**

**uvm_simple_lock_dap**

Provides a ‘Simple Lock’ Data Access Policy.

**Class Hierarchy**

```
class uvm_set_get_dap_base#(T)
    class uvm_simple_lock_dap#(T)
        extends uvm_set_get_dap_base#(T)
    endclass
endclass
```

**Class Declaration**

```
class uvm_simple_lock_dap#(T)
    type
        T = int;
    endtype
    extends uvm_set_get_dap_base#(T)
endclass
```

**New Constructor**

```
function new(
    string name = "unnamed-uvm_simple_lock_dap#(T)"
)
endfunction
```

**Set/Get Interface**

**set**

```
virtual function void set(
)
endfunction
```

The `uvm_simple_lock_dap` cannot support the standard UVM instrumentation methods (`copy`, `clone`, `pack` and `unpack`), due to the fact that they would potentially violate the access policy.
Updates the value stored within the DAP.

set will result in an error if the DAP has been locked.

**try_set**

```cpp
virtual function bit try_set(
    T value
)
```

Attempts to update the value stored within the DAP.

*try_set* will return a 1 if the value was successfully updated, or a 0 if the value cannot be updated due to the DAP being locked. No errors will be reported if *try_set* fails.

**get**

```cpp
virtual function T get()
```

Returns the current value stored within the DAP

**try_get**

```cpp
virtual function bit try_get(
    output T value
)
```

Retrieves the current value stored within the DAP

*try_get* will always return 1.

**Locking**

**lock**

```cpp
function void lock()
```

Locks the data value

The data value cannot be updated via *set* or *try_set* while locked.

**unlock**

```cpp
function void unlock()
```

Unlocks the data value
is_locked

```vhdl
function bit is_locked()
```

Returns the state of the lock.

**Returns**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The value is locked</td>
</tr>
<tr>
<td>0</td>
<td>The value is unlocked</td>
</tr>
</tbody>
</table>

**INTROSPECTION**

The `uvm_simple_lock_dap` cannot support the standard UVM instrumentation methods (`copy`, `clone`, `pack` and `unpack`), due to the fact that they would potentially violate the access policy.

A call to any of these methods will result in an error.
Provides a ‘Get-To-Lock’ Data Access Policy.

The ‘Get-To-Lock’ Data Access Policy allows for any number of ‘sets’, until the value is retrieved via a ‘get’. Once ‘get’ has been called, it is illegal to ‘set’ a new value.

The UVM uses this policy to protect the starting phase and automatic objection values in uvm_sequence_base.

Summary

<table>
<thead>
<tr>
<th><strong>uvm_get_to_lock_dap</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides a ‘Get-To-Lock’ Data Access Policy.</td>
</tr>
</tbody>
</table>

**Class Hierarchy**

```
class uvm_set_get_dap_base#(T) |
```

```
| uvm_set_get_dap_base#(T) |
| uvm_get_to_lock_dap |
```

**Class Declaration**

```
class uvm_get_to_lock_dap#(
    type T = int
) extends uvm_set_get_dap_base#(T)
```

**Set/Get Interface**

**new**

```
function new( |
    string name = "unnamed-uvm_get_to_lock_dap#(T)"
)
```

Constructor

**Set/Get Interface**

**set**

```
virtual function void set( |
    T value
)
```

**try_set**

Attempts to update the value stored within the DAP.

**get**

Returns the current value stored within the DAP, and ‘locks’ the DAP.

**try_get**

Retrieves the current value stored within the DAP, and ‘locks’ the DAP.

**Introspection**

The uvm_get_to_lock_dap cannot support the standard UVM instrumentation methods (copy, clone, pack and unpack), due to the fact that they would potentially violate the access policy.
Updates the value stored within the DAP.

set will result in an error if the value has already been retrieved via a call to get.

**try_set**

```plaintext
virtual function bit try_set(
    T value
)
```

Attempts to update the value stored within the DAP.

try-set will return a 1 if the value was successfully updated, or a 0 if the value cannot be updated due to get having been called. No errors will be reported if try-set fails.

**get**

```plaintext
virtual function T get()
```

Returns the current value stored within the DAP, and 'locks' the DAP.

After a 'get', the value contained within the DAP cannot be changed.

**try_get**

```plaintext
virtual function bit try_get(
    output T value
)
```

Retrieves the current value stored within the DAP, and 'locks' the DAP.

try-get will always return 1.

**INTROSPECTION**

The uvm_get_to_lock_dap cannot support the standard UVM instrumentation methods (copy, clone, pack and unpack), due to the fact that they would potentially violate the access policy.

A call to any of these methods will result in an error.
Provides a ‘Set Before Get’ Data Access Policy.

The ‘Set Before Get’ Data Access Policy enforces that the value must be written at least once before it is read. This DAP can be used to pass shared information to multiple components during standard configuration, even if that information hasn’t yet been determined.

Such DAP objects can be useful for passing a ‘placeholder’ reference, before the information is actually available. A good example of this would be the virtual sequencer:

```verilog
typedef uvm_set_before_get_dap#(uvm_sequencer_base) seqr_dap_t;
virtual_sequencer_type virtual_sequencer;
agent_type my_agent;
seqr_dap_t seqr_dap;

function void my_env::build_phase(uvm_phase phase);
  seqr_dap = seqr_dap_t::type_id::create("seqr_dap");
  // Pass the DAP, because we don't have a reference to the
  // real sequencer yet...
  uvm_config_db#(seqr_dap_t)::set(this, "virtual_sequencer", "seqr_dap",
  seqr_dap);

  // Create the virtual sequencer
  virtual_sequencer =
  virtual_sequencer_type::type_id::create("virtual_sequencer", this);

  // Create the agent
  agent = agent_type::type_id::create("agent", this);
endfunction

function void my_env::connect_phase(uvm_phase phase);
  // Now that we know the value is good, we can set it
  seqr_dap.set(agent.sequencer);
endfunction
```

In the example above, the environment didn’t have a reference to the agent’s sequencer yet, because the agent hadn’t executed its `build_phase`. The environment needed to give the virtual sequencer a “Set before get” DAP so that the virtual sequencer (and any sequences on it), could eventually see the agent’s sequencer, when the reference was finally available. If the virtual sequencer (or any sequences on it) attempted to ‘get’ the reference to the agent’s sequencer prior to the environment assigning it, an error would have been reported.

**Summary**

**uvm_set_before_get_dap**

Provides a ‘Set Before Get’ Data Access Policy.

**Class Hierarchy**

```
uwvm_set_get_dap_base#(T)

uvm_set_before_get_dap
```

**Class Declaration**

```
class uvm_set_before_get_dap#(type T = int)
  extends uwvm_set_get_dap_base#(T)

new Constructor
```

**Set/Get Interface**
**new**

```plaintext
function new(
    string name = "unnamed-uvm_set_before_get_dap#(T)"
)
```

Constructor

### Set/Get Interface

**set**

```plaintext
virtual function void set(
    T value
)
```

Updates the value stored within the DAP.

**try_set**

```plaintext
virtual function bit try_set(
    T value
)
```

Attempts to update the value stored within the DAP.

*try_set* will always return a 1.

**get**

```plaintext
virtual function T get()
```

Returns the current value stored within the DAP.

If ‘get’ is called before a call to *set* or *try_set*, then an error will be reported.

**try_get**

```plaintext
virtual function bit try_get(
    output T value
)
```

Attempts to retrieve the current value stored within the DAP.

---

**Intro**

The *uvm_set_before_get_dap* cannot support the standard UVM instrumentation methods (*copy, clone, pack and unpack*), due to the fact that they would potentially violate the access policy.
If the value has not been ‘set’, then try_get will return a 0, otherwise it will return a 1, and set value to the current value stored within the DAP.

**INTROSPECTION**

The uvm_set_before_get_dap cannot support the standard UVM instrumentation methods (*copy*, *clone*, *pack* and *unpack*), due to the fact that they would potentially violate the access policy.

A call to any of these methods will result in an error.
24.1 Register Layer

The UVM register layer defines several base classes that, when properly extended, abstract the read/write operations to registers and memories in a design-under-verification.

A register model is typically composed of a hierarchy of blocks that usually map to the design hierarchy. Blocks contain registers, register files and memories.

The UVM register layer classes are not usable as-is. They only provide generic and introspection capabilities. They must be specialized via extensions to provide an abstract view that corresponds to the actual registers and memories in a design. Due to the large number of registers in a design and the numerous small details involved in properly configuring the UVM register layer classes, this specialization is normally done by a model generator. Model generators work from a specification of the registers and memories in a design and are thus able to provide an up-to-date, correct-by-construction register model. Model generators are outside the scope of the UVM library.

The class diagram of a register layer model is shown below.

Summary

**Register Layer**

The UVM register layer defines several base classes that, when properly extended, abstract the read/write operations to registers and memories in a design.
design-under-verification.
This section defines globally available types, enums, and utility classes.

### Summary

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#### TYPES

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<td>2-state data value with `UVM_REG_DATA_WIDTH bits</td>
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<td>uvm_reg_data_logic_t</td>
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<td>uvm_reg_addr_t</td>
<td>2-state address value with `UVM_REG_ADDR_WIDTH bits</td>
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<td>uvm_reg_addr_logic_t</td>
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</tr>
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<td>uvm_reg_byte_en_t</td>
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#### UTILITY CLASSES

### TYPES

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</tr>
<tr>
<td>uvm_reg_addr_t</td>
<td>2-state address value with `UVM_REG_ADDR_WIDTH bits</td>
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UVM 1.2 Class Reference
**uvm_reg_addr_logic_t**

4-state address value with `UVM_REG_ADDR_WIDTH` bits

**uvm_reg_byte_en_t**

2-state byte enable value with `UVM_REG_BYTENABLE_WIDTH` bits

**uvm_reg_cvr_t**

Coverage model value set with `UVM_REG_CVR_WIDTH` bits.

Symbolic values for individual coverage models are defined by the `uvm_coverage_model_e` type.

The following bits in the set are assigned as follows:

- **0-7** UVM pre-defined coverage models
- **8-15** Coverage models defined by EDA vendors, implemented in a register model generator.
- **16-23** User-defined coverage models
- **24..** Reserved

**uvm_hdl_path_slice**

Slice of an HDL path

Struct that specifies the HDL variable that corresponds to all or a portion of a register.

- **path** Path to the HDL variable.
- **offset** Offset of the LSB in the register that this variable implements
- **size** Number of bits (toward the MSB) that this variable implements

If the HDL variable implements all of the register, `offset` and `size` are specified as -1. For example:

```c
r1.add_hdl_path('{ '{"r1", -1, -1} });
```

**Enumeration**

**uvm_status_e**

Return status for register operations

- **UVM_IS_OK** Operation completed successfully
**uvm_path_e**

Path used for register operation

- **UVM_FRONTDOOR**: Use the front door
- **UVM_BACKDOOR**: Use the back door
- **UVM_PREDICT**: Operation derived from observations by a bus monitor via the `uvm_reg_predictor` class.
- **UVM_DEFAULT_PATH**: Operation specified by the context

**uvm_check_e**

Read-only or read-and-check

- **UVM_NO_CHECK**: Read only
- **UVM_CHECK**: Read and check

**uvm_endianness_e**

Specifies byte ordering

- **UVM_NO_ENDIAN**: Byte ordering not applicable
- **UVM_LITTLE_ENDIAN**: Least-significant bytes first in consecutive addresses
- **UVM_BIG_ENDIAN**: Most-significant bytes first in consecutive addresses
- **UVM_LITTLE_FIFO**: Least-significant bytes first at the same address
- **UVM_BIG_FIFO**: Most-significant bytes first at the same address

**uvm_elem_kind_e**

Type of element being read or written

- **UVM_REG**: Register
- **UVM_FIELD**: Field
- **UVM_MEM**: Memory location

**uvm_access_e**

Type of operation begin performed

- **UVM_READ**: Read operation
- **UVM_WRITE**: Write operation

**uvm_hier_e**
Whether to provide the requested information from a hierarchical context.

- **UVM_NO_HIER**: Provide info from the local context
- **UVM_HIER**: Provide info based on the hierarchical context

### uvm_predict_e

How the mirror is to be updated

- **UVM_PREDICT_DIRECT**: Predicted value is as-is
- **UVM_PREDICT_READ**: Predict based on the specified value having been read
- **UVM_PREDICT_WRITE**: Predict based on the specified value having been written

### uvm_coverage_model_e

Coverage models available or desired. Multiple models may be specified by bitwise OR'ing individual model identifiers.

- **UVM_NO_COVERAGE**: None
- **UVM_CVR_REG_BITS**: Individual register bits
- **UVM_CVR_ADDR_MAP**: Individual register and memory addresses
- **UVM_CVR_FIELD_VALS**: Field values
- **UVM_CVR_ALL**: All coverage models

### uvm_reg_mem_tests_e

Select which pre-defined test sequence to execute.

Multiple test sequences may be selected by bitwise OR’ing their respective symbolic values.

- **UVM_DO_REG_HW_RESET**: Run `uvm_reg_hw_reset_seq`
- **UVM_DO_REG_BIT_BASH**: Run `uvm_reg_bit_bash_seq`
- **UVM_DO_REG_ACCESS**: Run `uvm_reg_access_seq`
- **UVM_DO_MEM_ACCESS**: Run `uvm_mem_access_seq`
- **UVM_DO_SHARED_ACCESS**: Run `uvm_reg_mem_shared_access_seq`
- **UVM_DO_MEM_WALK**: Run `uvm_mem_walk_seq`
- **UVM_DO_ALL_REG_MEM_TESTS**: Run all of the above

Test sequences, when selected, are executed in the order in which they are specified above.

---

**Utility Classes**
uvm_hdl_path_concat

Concatenation of HDL variables

A dArray of uvm_hdl_path_slice specifying a concatenation of HDL variables that implement a register in the HDL.

Slices must be specified in most-to-least significant order. Slices must not overlap. Gaps may exist in the concatenation if portions of the registers are not implemented.

For example, the following register

```
+---+---+-------------+---+-------+
|A|xxx|      B      |xxx|   C   |
+---+---+-------------+---+-------+
```

If the register is implemented using a single HDL variable, The array should specify a single slice with its offset and size specified as -1. For example:

```
concat.set('{ 'r1", -1, -1}));
```

Summary

**uvm_hdl_path_concat**

Concatenation of HDL variables

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**VARIABLES**

**slices**

```
uvm_hdl_path_slice slices[]
```

Array of individual slices, stored in most-to-least significant order
**METHODS**

**set**

```markdown
function void set(
    uvm_hdl_path_slice t[]
)
```

Initialize the concatenation using an array literal

**add_slice**

```markdown
function void add_slice(
    uvm_hdl_path_slice slice
)
```

Append the specified *slice* literal to the path concatenation

**add_path**

```markdown
function void add_path(
    string path,
    int unsigned offset = -1,
    int unsigned size = -1
)
```

Append the specified *path* to the path concatenation, for the specified number of bits at the specified *offset*. 
# 25.1 uvm_reg_block

Block abstraction base class

A block represents a design hierarchy. It can contain registers, register files, memories and sub-blocks.

A block has one or more address maps, each corresponding to a physical interface on the block.

## Summary

### uvm_reg_block

Block abstraction base class

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<td>Create an address map in this block</td>
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<tr>
<td>default_map</td>
<td>Default address map</td>
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<td>Lock a model and build the address map.</td>
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<td>Finds a sub-block with the specified simple name.</td>
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<tr>
<td>get_map_by_name</td>
<td>Finds an address map with the specified simple name.</td>
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<td>get_reg_by_name</td>
<td>Finds a register with the specified simple name.</td>
</tr>
<tr>
<td>get_field_by_name</td>
<td>Finds a field with the specified simple name.</td>
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</tbody>
</table>
**get_mem_by_name**  Finds a memory with the specified simple name.

**get_vreg_by_name**  Finds a virtual register with the specified simple name.

**get_vfield_by_name**  Finds a virtual field with the specified simple name.

**Coverage**

**build_coverage**  Check if all of the specified coverage model must be built.

**add_coverage**  Specify that additional coverage models are available.

**has_coverage**  Check if block has coverage model(s)

**set_coverage**  Turns on coverage measurement.

**get_coverage**  Check if coverage measurement is on.

**sample**  Functional coverage measurement method

**sample_values**  Functional coverage measurement method for field values

**Access**

**get_default_path**  Default access path

**reset**  Reset the mirror for this block.

**needs_update**  Check if DUT registers need to be written

**update**  Batch update of register.

**mirror**  Update the mirrored values

**write_reg_by_name**  Write the named register

**read_reg_by_name**  Read the named register

**write_mem_by_name**  Write the named memory

**read_mem_by_name**  Read the named memory

**Backdoor**

**get_backdoor**  Get the user-defined backdoor for all registers in this block

**set_backdoor**  Set the user-defined backdoor for all registers in this block

**clear_hdl_path**  Delete HDL paths

**add_hdl_path**  Add an HDL path

**has_hdl_path**  Check if a HDL path is specified

**get_hdl_path**  Get the incremental HDL path(s)

**get_full_hdl_path**  Get the full hierarchical HDL path(s)

**set_default_hdl_path**  Set the default design abstraction

**get_default_hdl_path**  Get the default design abstraction

**set_hdl_path_root**  Specify a root HDL path

**is_hdl_path_root**  Check if this block has an absolute path

---

**default_path**

```plaintext
uvm_path_e default_path = UVM_DEFAULT_PATH
```

Default access path for the registers and memories in this block.

---

**Initialization**

**new**

```plaintext
function new(
    string name = "",
    int has_coverage = UVM_NO_COVERAGE)
```

Create a new instance and type-specific configuration
Creates an instance of a block abstraction class with the specified name.

`has_coverage` specifies which functional coverage models are present in the extension of the block abstraction class. Multiple functional coverage models may be specified by adding their symbolic names, as defined by the `uvm_coverage_model_e` type.

**configure**

```plaintext
function void configure(
    uvm_reg_block parent = null,
    string hdl_path = ""
)
```

Instance-specific configuration

Specify the parent block of this block. A block without parent is a root block.

If the block file corresponds to a hierarchical RTL structure, its contribution to the HDL path is specified as the `hdl_path`. Otherwise, the block does not correspond to a hierarchical RTL structure (e.g. it is physically flattened) and does not contribute to the hierarchical HDL path of any contained registers or memories.

**create_map**

```plaintext
virtual function uvm_reg_map create_map(
    string name,
    uvm_reg_addr_t base_addr,
    int unsigned n_bytes,
    uvm_endianness_e endian,
    bit byte_addressing = 1
)
```

Create an address map in this block

Create an address map with the specified `name`, then configures it with the following properties.

- **base_addr**: the base address for the map. All registers, memories, and sub-blocks within the map will be at offsets to this address.
- **n_bytes**: the byte-width of the bus on which this map is used.
- **endian**: the endian format. See `uvm_endianness_e` for possible values.
- **byte_addressing**: specifies whether consecutive addresses refer are 1 byte apart (TRUE) or `n_bytes` apart (FALSE). Default is TRUE.

```plaintext
APB = create_map("APB", 0, 1, UVM_LITTLE_ENDIAN, 1);
```

**check_data_width**

```plaintext
protected static function bit check_data_width(
    int unsigned width
)
```

Check that the specified data width (in bits) is less than or equal to the value of `UVM_REG_DATA_WIDTH`
This method is designed to be called by a static initializer

class my_blk extends uvm_reg_block;
  local static bit m_data_width = check_data_width(356);
  ...
endclass

**set_default_map**

```plaintext
function void set_default_map (uvm_reg_map map)
```

Defines the default address map

Set the specified address map as the default_map for this block. The address map must be a map of this address block.

**default_map**

```plaintext
uvm_reg_map default_map
```

Default address map

Default address map for this block, to be used when no address map is specified for a register operation and that register is accessible from more than one address map.

It is also the implicit address map for a block with a single, unnamed address map because it has only one physical interface.

**lock_model**

```plaintext
virtual function void lock_model()
```

Lock a model and build the address map.

Recursively lock an entire register model and build the address maps to enable the `uvm_reg_map::get_reg_by_offset()` and `uvm_reg_map::get_mem_by_offset()` methods.

Once locked, no further structural changes, such as adding registers or memories, can be made.

It is not possible to unlock a model.

**is_locked**

```plaintext
function bit is_locked()
```

Return TRUE if the model is locked.

**INTROSPECTION**

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**get_name**

Get the simple name

Return the simple object name of this block.

**get_full_name**

```cpp
virtual function string get_full_name()
```

Get the hierarchical name

Return the hierarchical name of this block. The base of the hierarchical name is the root block.

**get_parent**

```cpp
virtual function uvm_reg_block get_parent()
```

Get the parent block

If this a top-level block, returns `null`.

**get_root_blocks**

```cpp
static function void get_root_blocks(
    ref uvm_reg_block blks[$]
)
```

Get the all root blocks

Returns an array of all root blocks in the simulation.

**find_blocks**

```cpp
static function int find_blocks(
    input string name,
    ref uvm_reg_block blks[$],
    input uvm_reg_block root = null,
    input uvm_object accessor = null
)
```

Find the blocks whose hierarchical names match the specified `name` glob. If a `root` block is specified, the name of the blocks are relative to that block, otherwise they are absolute.

Returns the number of blocks found.

**find_block**

```cpp
static function uvm_reg_block find_block(
    input string name,
    input uvm_reg_block root = null,
)
```
Find the first block whose hierarchical names match the specified name glob. If a root block is specified, the name of the blocks are relative to that block, otherwise they are absolute.

Returns the first block found or null otherwise. A warning is issued if more than one block is found.

**get_blocks**

```cpp
def virtual function void get_blocks (ref uvm_reg_block blks[$], input uvm_hier_e hier = UVM_HIER)
```  
Get the sub-blocks

Get the blocks instantiated in this blocks. If hier is TRUE, recursively includes any sub-blocks.

**get_maps**

```cpp
def virtual function void get_maps (ref uvm_reg_map maps[$])
```  
Get the address maps

Get the address maps instantiated in this block.

**get_registers**

```cpp
def virtual function void get_registers (ref uvm_reg regs[$], input uvm_hier_e hier = UVM_HIER)
```  
Get the registers

Get the registers instantiated in this block. If hier is TRUE, recursively includes the registers in the sub-blocks.

Note that registers may be located in different and/or multiple address maps. To get the registers in a specific address map, use the `uvm_reg_map::get_registers()` method.

**get_fields**

```cpp
def virtual function void get_fields (ref uvm_reg_field fields[$], input uvm_hier_e hier = UVM_HIER)
```  
Get the fields

Get the fields in the registers instantiated in this block. If hier is TRUE, recursively
includes the fields of the registers in the sub-blocks.

**get_memories**

```plaintext
virtual function void get_memories (
    ref uvm_mem mems[$],
    input uvm_hier_e hier = UVM_HIER
)
```

Get the memories

Get the memories instantiated in this block. If `hier` is TRUE, recursively includes the memories in the sub-blocks.

Note that memories may be located in different and/or multiple address maps. To get the memories in a specific address map, use the `uvm_reg_map::get_memories()` method.

**get_virtual_registers**

```plaintext
virtual function void get_virtual_registers(
    ref uvm_vreg regs[$],
    input uvm_hier_e hier = UVM_HIER
)
```

Get the virtual registers

Get the virtual registers instantiated in this block. If `hier` is TRUE, recursively includes the virtual registers in the sub-blocks.

**get_virtual_fields**

```plaintext
virtual function void get_virtual_fields (written in the same manner as get_memories)
```

Get the virtual fields

Get the virtual fields from the virtual registers instantiated in this block. If `hier` is TRUE, recursively includes the virtual fields in the virtual registers in the sub-blocks.

**get_block_by_name**

```plaintext
virtual function uvm_reg_block get_block_by_name (string name)

```

Finds a sub-block with the specified simple name.

The name is the simple name of the block, not a hierarchical name. relative to this block. If no block with that name is found in this block, the sub-blocks are searched for a block of that name and the first one to be found is returned.

If no blocks are found, returns `null`. 
get_map_by_name

virtual function uvm_reg_map get_map_by_name (string name)

Finds an address map with the specified simple name.

The name is the simple name of the address map, not a hierarchical name, relative to this block. If no map with that name is found in this block, the sub-blocks are searched for a map of that name and the first one to be found is returned.

If no address maps are found, returns null.

get_reg_by_name

virtual function uvm_reg get_reg_by_name (string name)

Finds a register with the specified simple name.

The name is the simple name of the register, not a hierarchical name, relative to this block. If no register with that name is found in this block, the sub-blocks are searched for a register of that name and the first one to be found is returned.

If no registers are found, returns null.

get_field_by_name

virtual function uvm_reg_field get_field_by_name (string name)

Finds a field with the specified simple name.

The name is the simple name of the field, not a hierarchical name, relative to this block. If no field with that name is found in this block, the sub-blocks are searched for a field of that name and the first one to be found is returned.

If no fields are found, returns null.

get_mem_by_name

virtual function uvm_mem get_mem_by_name (string name)

Finds a memory with the specified simple name.

The name is the simple name of the memory, not a hierarchical name, relative to this block. If no memory with that name is found in this block, the sub-blocks are searched for a memory of that name and the first one to be found is returned.

If no memories are found, returns null.

get_vreg_by_name
virtual function uvm_vreg get_vreg_by_name (string name)

Finds a virtual register with the specified simple name.

The name is the simple name of the virtual register, not a hierarchical name. relative to this block. If no virtual register with that name is found in this block, the sub-blocks are searched for a virtual register of that name and the first one to be found is returned.

If no virtual registers are found, returns null.

get_vfield_by_name

virtual function uvm_vreg_field get_vfield_by_name (string name)

Finds a virtual field with the specified simple name.

The name is the simple name of the virtual field, not a hierarchical name. relative to this block. If no virtual field with that name is found in this block, the sub-blocks are searched for a virtual field of that name and the first one to be found is returned.

If no virtual fields are found, returns null.

Coverage

build_coverage

protected function uvm_reg_cvr_t build_coverage(uvm_reg_cvr_t models)

Check if all of the specified coverage model must be built.

Check which of the specified coverage model must be built in this instance of the block abstraction class, as specified by calls to uvm_reg::include_coverage().

Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e. Returns the sum of all coverage models to be built in the block model.

add_coverage

virtual protected function void add_coverage(uvm_reg_cvr_t models)

Specify that additional coverage models are available.

Add the specified coverage model to the coverage models available in this class. Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e.
This method shall be called only in the constructor of subsequently derived classes.

**has_coverage**

```c
virtual function bit has_coverage(
    uvm_reg_cvr_t models
)
```

Check if block has coverage model(s)

Returns TRUE if the block abstraction class contains a coverage model for all of the models specified. Models are specified by adding the symbolic value of individual coverage model as defined in `uvm_coverage_model_e`.

**set_coverage**

```c
virtual function uvm_reg_cvr_t set_coverage(
    uvm_reg_cvr_t is_on
)
```

Turns on coverage measurement.

Turns the collection of functional coverage measurements on or off for this block and all blocks, registers, fields and memories within it. The functional coverage measurement is turned on for every coverage model specified using `uvm_coverage_model_e` symbolic identifiers. Multiple functional coverage models can be specified by adding the functional coverage model identifiers. All other functional coverage models are turned off. Returns the sum of all functional coverage models whose measurements were previously on.

This method can only control the measurement of functional coverage models that are present in the various abstraction classes, then enabled during construction. See the `uvm_reg_block::has_coverage()` method to identify the available functional coverage models.

**get_coverage**

```c
virtual function bit get_coverage(
    uvm_reg_cvr_t is_on = UVM_CVR_ALL
)
```

Check if coverage measurement is on.

Returns TRUE if measurement for all of the specified functional coverage models are currently on. Multiple functional coverage models can be specified by adding the functional coverage model identifiers.

See `uvm_reg_block::set_coverage()` for more details.

**sample**

```c
protected virtual function void sample(
    uvm_reg_addr_t offset,
    bit is_read,
    uvm_reg_map map
)
```

Functional coverage measurement method
This method is invoked by the block abstraction class whenever an address within one of its address map is successfully read or written. The specified offset is the offset within the block, not an absolute address.

Empty by default, this method may be extended by the abstraction class generator to perform the required sampling in any provided functional coverage model.

**sample_values**

```cpp
virtual function void sample_values()
```

Functional coverage measurement method for field values

This method is invoked by the user or by the `uvm_reg_block::sample_values()` method of the parent block to trigger the sampling of the current field values in the block-level functional coverage model. It recursively invokes the `uvm_reg_block::sample_values()` and `uvm_reg::sample_values()` methods in the blocks and registers in this block.

This method may be extended by the abstraction class generator to perform the required sampling in any provided field-value functional coverage model. If this method is extended, it MUST call `super.sample_values()`.

**Access**

**get_default_path**

```cpp
virtual function uvm_path_e get_default_path()
```

Default access path

Returns the default access path for this block.

**reset**

```cpp
virtual function void reset(
    string kind = "HARD"
)
```

Reset the mirror for this block.

Sets the mirror value of all registers in the block and sub-blocks to the reset value corresponding to the specified reset event. See `uvm_reg_field::reset()` for more details. Does not actually set the value of the registers in the design, only the values mirrored in their corresponding mirror.

**needs_update**

```cpp
virtual function bit needs_update()
```

Check if DUT registers need to be written

If a mirror value has been modified in the abstraction model without actually updating
the actual register (either through randomization or via the \texttt{uvm_reg::set()} method, the
mirror and state of the registers are outdated. The corresponding registers in the DUT
need to be updated.

This method returns TRUE if the state of at least one register in the block or sub-blocks
needs to be updated to match the mirrored values. The mirror values, or actual content
of registers, are not modified. For additional information, see \texttt{uvm_reg_block::update()}
method.

\textbf{update}

\begin{verbatim}
virtual task update(
   output uvm_status_e status,
   input uvm_path_e path   = UVM_DEFAULT_PATH,
   input uvm_sequence_base parent = null,
   input int prior = -1,
   input uvm_object extension = null,
   input strIng fname = "",
   input int lineno = 0)
\end{verbatim}

Batch update of register.

Using the minimum number of write operations, updates the registers in the design to
match the mirrored values in this block and sub-blocks. The update can be performed
using the physical interfaces (front-door access) or back-door accesses. This method
performs the reverse operation of \texttt{uvm_reg_block::mirror()}.

\textbf{mirror}

\begin{verbatim}
virtual task mirror(
   output uvm_status_e status,
   input uvm_check_e check   = UVM_NO_CHECK,
   input uvm_path_e path     = UVM_DEFAULT_PATH,
   input uvm_sequence_base parent = null,
   input int prior = -1,
   input uvm_object extension = null,
   input strIng fname = "",
   input int lineno = 0)
\end{verbatim}

Update the mirrored values

Read all of the registers in this block and sub-blocks and update their mirror values to
match their corresponding values in the design. The mirroring can be performed using
the physical interfaces (front-door access) or back-door accesses. If the \texttt{check} argument
is specified as \texttt{UVM_CHECK}, an error message is issued if the current mirrored value
does not match the actual value in the design. This method performs the reverse
operation of \texttt{uvm_reg_block::update()}.

\textbf{write_reg_by_name}

\begin{verbatim}
virtual task write_reg_by_name(
   output uvm_status_e status,
   input strIng name,
   input uvm_reg_data_t data,
   input uvm_path_e path     = UVM_DEFAULT_PATH,
   input uvm_reg_map map     = null,
   input uvm_sequence_base parent = null,
   input int prior = -1,
   input uvm_object extension = null,
   input strIng fname = "",
\end{verbatim}
Write the named register

Equivalent to `get_reg_by_name()` followed by `uvm_reg::write()`

**read_reg_by_name**

```verilog
define uvm_status_e

virtual task read_reg_by_name(
    output uvm_status_e status,
    input string name,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Read the named register

Equivalent to `get_reg_by_name()` followed by `uvm_reg::read()`

**write_mem_by_name**

```verilog
define uvm_status_e

virtual task write_mem_by_name(
    output uvm_status_e status,
    input string name,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t data,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Write the named memory

Equivalent to `get_mem_by_name()` followed by `uvm_mem::write()`

**read_mem_by_name**

```verilog
define uvm_status_e

virtual task read_mem_by_name(
    output uvm_status_e status,
    input string name,
    input uvm_reg_addr_t offset,
    output uvm_reg_data_t data,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Read the named memory

Equivalent to `get_mem_by_name()` followed by `uvm_mem::read()`
**BACKDOOR**

**get_backdoor**

```haskell
function uvm_reg_backdoor get_backdoor(
    bit inherited = 1
)
```

Get the user-defined backdoor for all registers in this block

Return the user-defined backdoor for all register in this block and all sub-blocks -- unless overridden by a backdoor set in a lower-level block or in the register itself.

If `inherited` is TRUE, returns the backdoor of the parent block if none have been specified for this block.

**set_backdoor**

```haskell
function void set_backdoor (
    uvm_reg_backdoor bkdr,
    string fname = "",
    int lineno = 0
)
```

Set the user-defined backdoor for all registers in this block

Defines the backdoor mechanism for all registers instantiated in this block and sub-blocks, unless overridden by a definition in a lower-level block or register.

**clear_hdl_path**

```haskell
function void clear_hdl_path (
    string kind = "RTL"
)
```

Delete HDL paths

Remove any previously specified HDL path to the block instance for the specified design abstraction.

**add_hdl_path**

```haskell
function void add_hdl_path (
    string path,
    string kind = "RTL"
)
```

Add an HDL path

Add the specified HDL path to the block instance for the specified design abstraction. This method may be called more than once for the same design abstraction if the block is physically duplicated in the design abstraction.
has_hdl_path

```plaintext
function bit has_hdl_path ( 
    string kind = ""
)
```

Check if a HDL path is specified

Returns TRUE if the block instance has a HDL path defined for the specified design abstraction. If no design abstraction is specified, uses the default design abstraction specified for this block or the nearest block ancestor with a specified default design abstraction.

get_hdl_path

```plaintext
function void get_hdl_path ( 
    ref string paths[$],
    input string kind = ""
)
```

Get the incremental HDL path(s)

Returns the HDL path(s) defined for the specified design abstraction in the block instance. Returns only the component of the HDL paths that corresponds to the block, not a full hierarchical path

If no design abstraction is specified, the default design abstraction for this block is used.

get_full_hdl_path

```plaintext
function void get_full_hdl_path ( 
    ref string paths[$],
    input string kind = "",
    string separator = "."
)
```

Get the full hierarchical HDL path(s)

Returns the full hierarchical HDL path(s) defined for the specified design abstraction in the block instance. There may be more than one path returned even if only one path was defined for the block instance, if any of the parent components have more than one path defined for the same design abstraction

If no design abstraction is specified, the default design abstraction for each ancestor block is used to get each incremental path.

set_default_hdl_path

```plaintext
function void set_default_hdl_path ( 
    string kind
)
```

Set the default design abstraction

Set the default design abstraction for this block instance.

get_default_hdl_path
Get the default design abstraction

Returns the default design abstraction for this block instance. If a default design abstraction has not been explicitly set for this block instance, returns the default design abstraction for the nearest block ancestor. Returns "" if no default design abstraction has been specified.

**set_hdl_path_root**

```plaintext
function void set_hdl_path_root (  
    string path,  
    string kind = "RTL"  
)
```

Specify a root HDL path

Set the specified path as the absolute HDL path to the block instance for the specified design abstraction. This absolute root path is prepended to all hierarchical paths under this block. The HDL path of any ancestor block is ignored. This method overrides any incremental path for the same design abstraction specified using add_hdl_path.

**is_hdl_path_root**

```plaintext
function bit is_hdl_path_root (  
    string kind = ""  
)
```

Check if this block has an absolute path

Returns TRUE if an absolute HDL path to the block instance for the specified design abstraction has been defined. If no design abstraction is specified, the default design abstraction for this block is used.
25.2 uvm_reg_transaction_order_policy

Contents

uvm_reg_transaction_order_policy
uvm_reg_map

Methods

order

```cpp
pure virtual function void order(
    ref uvm_reg_bus_op q[$])
```

The `order()` function may reorder the sequence of bus transactions produced by a single `uvm_reg` transaction (read/write). This can be used in scenarios when the register width differs from the bus width and one register access results in a series of bus transactions. The first item (0) of the queue will be the first bus transaction (the last($) will be the final transaction.

uvm_reg_map

Address map abstraction class

This class represents an address map. An address map is a collection of registers and memories accessible via a specific physical interface. Address maps can be composed into higher-level address maps.

Address maps are created using the `uvm_reg_block::create_map()` method.

Summary

```cpp
class uvm_reg_map
extends uvm_object
```

Class Hierarchy

```
  uvm_void
  uvm_object
  uvm_reg_map
```

Class Declaration

```
class uvm_reg_map extends uvm_object
```
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**backdoor**

```plaintext
static function uvm_reg_map backdoor()
```

Return the backdoor pseudo-map singleton

This pseudo-map is used to specify or configure the backdoor instead of a real address.
**Initialization**

**new**

```plaintext
function new(
    string name = "uvm_reg_map"
)
```

Create a new instance

**configure**

```plaintext
function void configure(
    uvm_reg_block parent,
    uvm_reg_addr_t base_addr,
    int unsigned n_bytes,
    uvm_endianness_e endian,
    bit byte_addressing = 1
)
```

Instance-specific configuration

Configures this map with the following properties.

- **parent** the block in which this map is created and applied
- **base_addr** the base address for this map. All registers, memories, and sub-blocks will be at offsets to this address
- **n_bytes** the byte-width of the bus on which this map is used
- **endian** the endian format. See `uvm_endianness_e` for possible values
- **byte_addressing** specifies whether the address increment is on a per-byte basis. For example, consecutive memory locations with \( n_{\text{bytes}} = 4 \) (32-bit bus) are 4 apart: 0, 4, 8, and so on. Default is TRUE.

**add_reg**

```plaintext
virtual function void add_reg (
    uvm_reg rg,
    uvm_reg_addr_t offset,
    string rights = "RW",
    bit unmapped = 0,
    uvm_reg_frontdoor frontdoor = null
)
```

Add a register

Add the specified register instance `rg` to this address map.

The register is located at the specified address `offset` from this map's configured base address.

The `rights` specify the register's accessibility via this map. Valid values are "RW", "RO", and "WO". Whether a register field can be read or written depends on both the field's
configured access policy (see `uvm_reg_field::configure` and the register’s rights in the map being used to access the field.

The number of consecutive physical addresses occupied by the register depends on the width of the register and the number of bytes in the physical interface corresponding to this address map.

If `unmapped` is TRUE, the register does not occupy any physical addresses and the base address is ignored. Unmapped registers require a user-defined `frontdoor` to be specified.

A register may be added to multiple address maps if it is accessible from multiple physical interfaces. A register may only be added to an address map whose parent block is the same as the register’s parent block.

### add_mem

```cpp
class uvm_reg_map
{
  virtual function void add_mem (uvm_reg_map mem,
                                uvm_reg_addr_t offset,
                                string rights = "RW",
                                bit unmapped = 0,
                                uvm_reg_frontdoor frontdoor = null
  )
}
```

Add a memory

Add the specified memory instance to this address map. The memory is located at the specified base address and has the specified access rights ("RW", "RO" or "WO"). The number of consecutive physical addresses occupied by the memory depends on the width and size of the memory and the number of bytes in the physical interface corresponding to this address map.

If `unmapped` is TRUE, the memory does not occupy any physical addresses and the base address is ignored. Unmapped memories require a user-defined `frontdoor` to be specified.

A memory may be added to multiple address maps if it is accessible from multiple physical interfaces. A memory may only be added to an address map whose parent block is the same as the memory’s parent block.

### add_submap

```cpp
class uvm_reg_map
{
  virtual function void add_submap (uvm_reg_map child_map,
                                    uvm_reg_addr_t offset
  )
}
```

Add an address map

Add the specified address map instance to this address map. The address map is located at the specified base address. The number of consecutive physical addresses occupied by the submap depends on the number of bytes in the physical interface that corresponds to the submap, the number of addresses used in the submap and the number of bytes in the physical interface corresponding to this address map.

An address map may be added to multiple address maps if it is accessible from multiple physical interfaces. An address map may only be added to an address map in the grandparent block of the address submap.
**set_sequencer**

```cpp
class uvm_reg_map {
public:
  virtual function void set_sequencer (uvm_sequencer_base sequencer, uvm_reg_adapter adapter = null);
}
```

Set the sequencer and adapter associated with this map. This method must be called before starting any sequences based on uvm_reg_sequence.

**set_submap_offset**

```cpp
class uvm_reg_map {
public:
  virtual function void set_submap_offset (uvm_reg_map submap, uvm_reg_addr_t offset);
}
```

Set the offset of the given submap to offset.

**get_submap_offset**

```cpp
class uvm_reg_map {
public:
  virtual function uvm_reg_addr_t get_submap_offset (uvm_reg_map submap);
}
```

Return the offset of the given submap.

**set_base_addr**

```cpp
class uvm_reg_map {
public:
  virtual function void set_base_addr (uvm_reg_addr_t offset);
}
```

Set the base address of this map.

**reset**

```cpp
class uvm_reg_map {
public:
  virtual function void reset (string kind = "SOFT");
}
```

Reset the mirror for all registers in this address map.

Sets the mirror value of all registers in this address map and all of its submaps to the reset value corresponding to the specified reset event. See `uvm_reg_field::reset()` for more details. Does not actually set the value of the registers in the design, only the values mirrored in their corresponding mirror.

Note that, unlike the other reset() method, the default reset event for this method is "SOFT".

---

**INTROSPECTION**
**get_name**

Get the simple name

Return the simple object name of this address map.

**get_full_name**

```plaintext
virtual function string get_full_name()
```

Get the hierarchical name

Return the hierarchal name of this address map. The base of the hierarchical name is the root block.

**get_root_map**

```plaintext
virtual function uvm_reg_map get_root_map()
```

Get the externally-visible address map

Get the top-most address map where this address map is instantiated. It corresponds to the externally-visible address map that can be accessed by the verification environment.

**get_parent**

```plaintext
virtual function uvm_reg_block get_parent()
```

Get the parent block

Return the block that is the parent of this address map.

**get_parent_map**

```plaintext
virtual function uvm_reg_map get_parent_map()
```

Get the higher-level address map

Return the address map in which this address map is mapped. returns *null* if this is a top-level address map.

**get_base_addr**

```plaintext
virtual function uvm_reg_addr_t get_base_addr ( 
        uvm_hier_e hier = UVM_HIER
    )
```

Get the base offset address for this map. If this map is the root map, the base address is that set with the *base_addr* argument to *uvm_reg_block::create_map()*). If this map is a submap of a higher-level map, the base address is offset given this submap by the parent map. See *set_submap_offset*.
get_n_bytes

```
virtual function int unsigned get_n_bytes (  
    uvm_hier_e hier = UVM_HIER  
)
```

Get the width in bytes of the bus associated with this map. If `hier` is `UVM_HIER`, then gets the effective bus width relative to the system level. The effective bus width is the narrowest bus width from this map to the top-level root map. Each bus access will be limited to this bus width.

get_addr_unit_bytes

```
virtual function int unsigned get_addr_unit_bytes()
```

Get the number of bytes in the smallest addressable unit in the map. Returns 1 if the address map was configured using byte-level addressing. Returns `get_n_bytes()` otherwise.

get_base_addr

Gets the endianness of the bus associated with this map. If `hier` is set to `UVM_HIER`, gets the system-level endianness.

get_sequencer

```
virtual function uvm_sequencer_base get_sequencer (  
    uvm_hier_e hier = UVM_HIER  
)
```

Gets the sequencer for the bus associated with this map. If `hier` is set to `UVM_HIER`, gets the sequencer for the bus at the system-level. See `set_sequencer`.

get_adapter

```
virtual function uvm_reg_adapter get_adapter (  
    uvm_hier_e hier = UVM_HIER  
)
```

Gets the bus adapter for the bus associated with this map. If `hier` is set to `UVM_HIER`, gets the adapter for the bus used at the system-level. See `set_sequencer`.

get_submaps

```
virtual function void get_submaps (  
    ref uvm_reg_map maps[$],  
    input uvm_hier_e hier = UVM_HIER  
)
```

Get the address sub-maps

Get the address maps instantiated in this address map. If `hier` is `UVM_HIER`, recursively includes the address maps, in the sub-maps.
get_registers

virtual function void get_registers (  
    ref uvm_reg regs[$],  
    input uvm_hier_e hier = UVM_HIER  
)

Get the registers

Get the registers instantiated in this address map. If hier is UVM_HIER, recursively includes the registers in the sub-maps.

get_fields

virtual function void get_fields (  
    ref uvm_reg_field fields[$],  
    input uvm_hier_e hier = UVM_HIER  
)

Get the fields

Get the fields in the registers instantiated in this address map. If hier is UVM_HIER, recursively includes the fields of the registers in the sub-maps.

get_virtual_registers

virtual function void get_virtual_registers (  
    ref uvm_vreg regs[$],  
    input uvm_hier_e hier = UVM_HIER  
)

Get the virtual registers

Get the virtual registers instantiated in this address map. If hier is UVM_HIER, recursively includes the virtual registers in the sub-maps.

get_virtual_fields

virtual function void get_virtual_fields (  
    ref uvm_vreg_field fields][$],  
    input uvm_hier_e hier = UVM_HIER  
)

Get the virtual fields

Get the virtual fields from the virtual registers instantiated in this address map. If hier is UVM_HIER, recursively includes the virtual fields in the virtual registers in the sub-maps.

get_physical_addresses

virtual function int get_physical_addresses(  
    uvm_reg_addr_t base_addr,  
    uvm_reg_addr_t mem_offset,  
    int unsigned n_bytes,  
    ref uvm_reg_addr_t addr[]  
)
Translate a local address into external addresses

Identify the sequence of addresses that must be accessed physically to access the specified number of bytes at the specified address within this address map. Returns the number of bytes of valid data in each access.

Returns in addr a list of address in little endian order, with the granularity of the top-level address map.

A register is specified using a base address with mem_offset as 0. A location within a memory is specified using the base address of the memory and the index of the location within that memory.

**get_reg_by_offset**

```cpp
virtual function uvm_reg get_reg_by_offset(
    uvm_reg_addr_t offset,
    bit read = 1
)
```

Get register mapped at offset

Identify the register located at the specified offset within this address map for the specified type of access. Returns null if no such register is found.

The model must be locked using uvm_reg_block::lock_model() to enable this functionality.

**get_mem_by_offset**

```cpp
virtual function uvm_mem get_mem_by_offset(
    uvm_reg_addr_t offset
)
```

Get memory mapped at offset

Identify the memory located at the specified offset within this address map. The offset may refer to any memory location in that memory. Returns null if no such memory is found.

The model must be locked using uvm_reg_block::lock_model() to enable this functionality.

**Bus Access**

**set_auto_predict**

```cpp
function void set_auto_predict(
    bit on = 1
)
```

Sets the auto-predict mode for his map.

When on is TRUE, the register model will automatically update its mirror (what it thinks should be in the DUT) immediately after any bus read or write operation via this map. Before a uvm_reg::write or uvm_reg::read operation returns, the register’s
`uvm_reg::predict` method is called to update the mirrored value in the register.

When `on` is `FALSE`, bus reads and writes via this map do not automatically update the mirror. For real-time updates to the mirror in this mode, you connect a `uvm_reg_predictor` instance to the bus monitor. The predictor takes observed bus transactions from the bus monitor, looks up the associated `uvm_reg` register given the address, then calls that register’s `uvm_reg::predict` method. While more complex, this mode will capture all register read/write activity, including that not directly descendant from calls to `uvm_reg::write` and `uvm_reg::read`.

By default, auto-prediction is turned off.

**get_auto_predict**

```cpp
function bit get_auto_predict()
```

Gets the auto-predict mode setting for this map.

**set_check_on_read**

```cpp
function void set_check_on_read(
    bit on = 1
)
```

Sets the check-on-read mode for his map and all of its submaps.

When `on` is `TRUE`, the register model will automatically check any value read back from a register or field against the current value in its mirror and report any discrepancy. This effectively combines the functionality of the `uvm_reg::read()` and `uvm_reg::mirror(UVM_CHECK)` method. This mode is useful when the register model is used passively.

When `on` is `FALSE`, no check is made against the mirrored value.

At the end of the read operation, the mirror value is updated based on the value that was read regardless of this mode setting.

By default, auto-prediction is turned off.

**get_check_on_read**

```cpp
function bit get_check_on_read()
```

Gets the check-on-read mode setting for this map.

**do_bus_write**

```cpp
virtual task do_bus_write (  
    uvm_reg_item  rw,  
    uvm_seqencer_base sequencer,  
    uvm_reg_adapter adapter
)
```

Perform a bus write operation.
do_bus_read

```objectivec
virtual task do_bus_read {
    uvm_reg_item rw,
    uvm_sequencer_base sequencer,
    uvm_reg_adapter adapter
}
```

Perform a bus read operation.

do_write

```objectivec
virtual task do_write{
    uvm_reg_item rw
}
```

Perform a write operation.

do_read

```objectivec
virtual task do_read{
    uvm_reg_item rw
}
```

Perform a read operation.

set_transaction_order_policy

```objectivec
function void set_transaction_order_policy(
    uvm_reg_transaction_order_policy pol
)
```

set the transaction order policy

get_transaction_order_policy

```objectivec
function uvm_reg_transaction_order_policy get_transaction_order_policy()
```

set the transaction order policy
25.3 uvm_reg_file

Register file abstraction base class

A register file is a collection of register files and registers used to create regular repeated structures.

Register files are usually instantiated as arrays.

**Summary**

**uvm_reg_file**

Register file abstraction base class

**Class Hierarchy**

```
Classe Hierarchy

uvm_void
uvm_object
uvm_reg_file
```

**Class Declaration**

```
virtual class uvm_reg_file extends uvm_object
```

**Initialization**

```
function new (    
    string name = ""

Create a new instance
```

**Create a new instance**

Creates an instance of a register file abstraction class with the specified name.
configure

function void configure (  
    uvm_reg_block blk_parent,  
    uvm_reg_file regfile_parent,  
    string hdl_path = ""  )

Configure a register file instance

Specify the parent block and register file of the register file instance. If the register file is instantiated in a block, `regfile_parent` is specified as null. If the register file is instantiated in a register file, `blk_parent` must be the block parent of that register file and `regfile_parent` is specified as that register file.

If the register file corresponds to a hierarchical RTL structure, its contribution to the HDL path is specified as the `hdl_path`. Otherwise, the register file does not correspond to a hierarchical RTL structure (e.g. it is physically flattened) and does not contribute to the hierarchical HDL path of any contained registers.

**INTROSPECTION**

get_name

Get the simple name

Return the simple object name of this register file.

get_full_name

Get the hierarchical name

Return the hierarchal name of this register file. The base of the hierarchical name is the root block.

get_parent

Get the parent block

get_regfile

Get the parent register file

Returns null if this register file is instantiated in a block.
**clear_hdl_path**

```plaintext
function void clear_hdl_path (
    string kind = "RTL"
)
```

Delete HDL paths

Remove any previously specified HDL path to the register file instance for the specified design abstraction.

**add_hdl_path**

```plaintext
function void add_hdl_path (
    string path,
    string kind = "RTL"
)
```

Add an HDL path

Add the specified HDL path to the register file instance for the specified design abstraction. This method may be called more than once for the same design abstraction if the register file is physically duplicated in the design abstraction.

**has_hdl_path**

```plaintext
function bit has_hdl_path (
    string kind = ""
)
```

Check if a HDL path is specified

Returns TRUE if the register file instance has a HDL path defined for the specified design abstraction. If no design abstraction is specified, uses the default design abstraction specified for the nearest enclosing register file or block.

If no design abstraction is specified, the default design abstraction for this register file is used.

**get_hdl_path**

```plaintext
function void get_hdl_path (
    ref string paths[],
    input string kind = ""
)
```

Get the incremental HDL path(s)

Returns the HDL path(s) defined for the specified design abstraction in the register file instance. If no design abstraction is specified, uses the default design abstraction specified for the nearest enclosing register file or block. Returns only the component of the HDL paths that corresponds to the register file, not a full hierarchical path.

If no design abstraction is specified, the default design abstraction for this register file is
used.

**get_full_hdl_path**

```plaintext
function void get_full_hdl_path (
    ref string paths[$],
    input string kind = "",
    input string separator = "."
)
```

Get the full hierarchical HDL path(s)

Returns the full hierarchical HDL path(s) defined for the specified design abstraction in the register file instance. If no design abstraction is specified, uses the default design abstraction specified for the nearest enclosing register file or block. There may be more than one path returned even if only one path was defined for the register file instance, if any of the parent components have more than one path defined for the same design abstraction.

If no design abstraction is specified, the default design abstraction for each ancestor register file or block is used to get each incremental path.

**set_default_hdl_path**

```plaintext
function void set_default_hdl_path (
    string kind
)
```

Set the default design abstraction

Set the default design abstraction for this register file instance.

**get_default_hdl_path**

```plaintext
function string get_default_hdl_path ()
```

Get the default design abstraction

Returns the default design abstraction for this register file instance. If a default design abstraction has not been explicitly set for this register file instance, returns the default design abstraction for the nearest register file or block ancestor. Returns "" if no default design abstraction has been specified.
25.4 uvm_reg

Register abstraction base class

A register represents a set of fields that are accessible as a single entity.

A register may be mapped to one or more address maps, each with different access rights and policy.

Summary

**uvm_reg**

Register abstraction base class

**CLASS HIERARCHY**

- uvm_void
- uvm_object
- uvm_reg

**CLASS DECLARATION**

```plaintext
virtual class uvm_reg extends uvm_object
```

**INITIALIZATION**

- **new**
  Create a new instance and type-specific configuration
- **configure**
  Instance-specific configuration
- **set_offset**
  Modify the offset of the register

**INTROSPECTION**

- **get_name**
  Get the simple name
- **get_full_name**
  Get the hierarchical name
- **get_parent**
  Get the parent block
- **get_regfile**
  Get the parent register file
- **get_n_maps**
  Returns the number of address maps this register is mapped in
- **is_in_map**
  Returns 1 if this register is in the specified address map
- **get_maps**
  Returns all of the address maps where this register is mapped
- **get_rights**
  Returns the accessibility ("RW", "RO", or "WO") of this register in the given map.
- **get_n_bits**
  Returns the width, in bits, of this register.
- **get_n_bytes**
  Returns the width, in bytes, of this register.
- **get_max_size**
  Returns the maximum width, in bits, of all registers.
- **get_fields**
  Return the fields in this register
- **get_field_by_name**
  Return the named field in this register
- **get_offset**
  Returns the offset of this register
- **get_address**
  Returns the base external physical address of this register
- **get_addresses**
  Identifies the external physical address(es) of this register

**ACCESS**

- **set**
  Set the desired value for this register
- **get**
  Return the desired value of the fields in the register.
- **get_mirrored_value**
  Return the mirrored value of the fields in the register.
- **needs_update**
  Returns 1 if any of the fields need updating
- **reset**
  Reset the desired/mirrored value for this register.
- **get_reset**
  Get the specified reset value for this register
- **has_reset**
  Check if any field in the register has a reset value specified for the specified reset kind.
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_reset</code></td>
<td>Specify or modify the reset value for this register</td>
</tr>
<tr>
<td><code>write</code></td>
<td>Write the specified value in this register</td>
</tr>
<tr>
<td><code>read</code></td>
<td>Read the current value from this register</td>
</tr>
<tr>
<td><code>poke</code></td>
<td>Deposit the specified value in this register</td>
</tr>
<tr>
<td><code>peek</code></td>
<td>Read the current value from this register</td>
</tr>
<tr>
<td><code>update</code></td>
<td>Updates the content of the register in the design to match the desired value</td>
</tr>
<tr>
<td><code>mirror</code></td>
<td>Read the register and update/check its mirror value</td>
</tr>
<tr>
<td><code>predict</code></td>
<td>Update the mirrored and desired value for this register.</td>
</tr>
<tr>
<td><code>is_busy</code></td>
<td>Returns 1 if register is currently being read or written.</td>
</tr>
</tbody>
</table>

**Frontdoor**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_frontdoor</code></td>
<td>Set a user-defined frontdoor for this register</td>
</tr>
<tr>
<td><code>get_frontdoor</code></td>
<td>Returns the user-defined frontdoor for this register</td>
</tr>
</tbody>
</table>

**Backdoor**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_backdoor</code></td>
<td>Set a user-defined backdoor for this register</td>
</tr>
<tr>
<td><code>get_backdoor</code></td>
<td>Returns the user-defined backdoor for this register</td>
</tr>
<tr>
<td><code>clear_hdl_path</code></td>
<td>Delete HDL paths</td>
</tr>
<tr>
<td><code>add_hdl_path</code></td>
<td>Add an HDL path</td>
</tr>
<tr>
<td><code>add_hdl_path_slice</code></td>
<td>Append the specified HDL slice to the HDL path of the register instance for the specified design abstraction.</td>
</tr>
<tr>
<td><code>has_hdl_path</code></td>
<td>Check if a HDL path is specified</td>
</tr>
<tr>
<td><code>get_hdl_path</code></td>
<td>Get the incremental HDL path(s)</td>
</tr>
<tr>
<td><code>get_hdl_path_kinds</code></td>
<td>Get design abstractions for which HDL paths have been defined</td>
</tr>
<tr>
<td><code>get_full_hdl_path</code></td>
<td>Get the full hierarchical HDL path(s)</td>
</tr>
<tr>
<td><code>backdoor_read</code></td>
<td>User-defined backdoor read access</td>
</tr>
<tr>
<td><code>backdoor_write</code></td>
<td>User-defined backdoor write access</td>
</tr>
<tr>
<td><code>backdoor_read_func</code></td>
<td>User-defined backdoor read access</td>
</tr>
<tr>
<td><code>backdoor_watch</code></td>
<td>User-defined DUT register change monitor</td>
</tr>
</tbody>
</table>

**Coverage**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>include_coverage</code></td>
<td>Specify which coverage model that must be included in various block, register or memory abstraction class instances.</td>
</tr>
<tr>
<td><code>build_coverage</code></td>
<td>Check if all of the specified coverage models must be built.</td>
</tr>
<tr>
<td><code>add_coverage</code></td>
<td>Specify that additional coverage models are available.</td>
</tr>
<tr>
<td><code>has_coverage</code></td>
<td>Check if register has coverage model(s)</td>
</tr>
<tr>
<td><code>set_coverage</code></td>
<td>Turns on coverage measurement.</td>
</tr>
<tr>
<td><code>get_coverage</code></td>
<td>Check if coverage measurement is on.</td>
</tr>
<tr>
<td><code>sample</code></td>
<td>Functional coverage measurement method</td>
</tr>
<tr>
<td><code>sample_values</code></td>
<td>Functional coverage measurement method for field values</td>
</tr>
</tbody>
</table>

**Callbacks**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>pre_write</code></td>
<td>Called before register write.</td>
</tr>
<tr>
<td><code>post_write</code></td>
<td>Called after register write.</td>
</tr>
<tr>
<td><code>pre_read</code></td>
<td>Called before register read.</td>
</tr>
<tr>
<td><code>post_read</code></td>
<td>Called after register read.</td>
</tr>
</tbody>
</table>

### Initialization

**new**

```plaintext
function new {
    string name = "",
    int unsigned n_bits,
    int has_coverage
}
```

Create a new instance and type-specific configuration
Creates an instance of a register abstraction class with the specified name.

\textit{n_bits} specifies the total number of bits in the register. Not all bits need to be implemented. This value is usually a multiple of 8.

\textit{has_coverage} specifies which functional coverage models are present in the extension of the register abstraction class. Multiple functional coverage models may be specified by adding their symbolic names, as defined by the \texttt{uvm_coverage_model_e} type.

\textbf{configure}

\begin{verbatim}
function void configure (  
uvm_reg_block blk_parent,  
uvm_reg_file regfile_parent = null,  
string hdl_path = "")
\end{verbatim}

Instance-specific configuration

Specify the parent block of this register. May also set a parent register file for this register.

If the register is implemented in a single HDL variable, its name is specified as the \textit{hdl_path}. Otherwise, if the register is implemented as a concatenation of variables (usually one per field), then the HDL path must be specified using the \texttt{add_hdl_path()} or \texttt{add_hdl_path_slice} method.

\textbf{set_offset}

\begin{verbatim}
virtual function void set_offset (  
uvm_reg_map map,  
uvm_reg_addr_t offset,  
bit unmapped = 0)
\end{verbatim}

Modify the offset of the register

The offset of a register within an address map is set using the \texttt{uvm_reg_map::add_reg()} method. This method is used to modify that offset dynamically.

Modifying the offset of a register will make the register model diverge from the specification that was used to create it.

\textbf{INTROSPECTION}

\textbf{get_name}

Get the simple name

Return the simple object name of this register.

\textbf{get_full_name}

\begin{verbatim}
virtual function string get_full_name()  
\end{verbatim}
Get the hierarchical name

Return the hierarchical name of this register. The base of the hierarchical name is the root block.

**get_parent**

```
virtual function uvm_reg_block get_parent ()
```

Get the parent block

**get_regfile**

```
virtual function uvm_reg_file get_regfile ()
```

Get the parent register file

Returns *null* if this register is instantiated in a block.

**get_n_maps**

```
virtual function int get_n_maps ()
```

Returns the number of address maps this register is mapped in

**is_in_map**

```
function bit is_in_map (uvm_reg_map map)
```

Returns 1 if this register is in the specified address *map*

**get_maps**

```
virtual function void get_maps (ref uvm_reg_map maps[$])
```

Returns all of the address *maps* where this register is mapped

**get_rights**

```
virtual function string get_rights (uvm_reg_map map = null)
```

Returns the accessibility ("RW", "RO", or "WO") of this register in the given *map*.

If no address map is specified and the register is mapped in only one address map, that address map is used. If the register is mapped in more than one address map, the
default address map of the parent block is used.

Whether a register field can be read or written depends on both the field’s configured access policy (refer to `uvm_reg_field::configure`) and the register’s accessibility rights in the map being used to access the field.

If an address map is specified and the register is not mapped in the specified address map, an error message is issued and ”RW” is returned.

### `get_n_bits`

```c
virtual function int unsigned get_n_bits ()
```

Returns the width, in bits, of this register.

### `get_n_bytes`

```c
virtual function int unsigned get_n_bytes()
```

Returns the width, in bytes, of this register. Rounds up to next whole byte if register is not a multiple of 8.

### `get_max_size`

```c
static function int unsigned get_max_size()
```

Returns the maximum width, in bits, of all registers.

### `get_fields`

```c
virtual function void get_fields ( 
    ref uvm_reg_field fields[:]
)
```

Return the fields in this register

Fills the specified array with the abstraction class for all of the fields contained in this register. Fields are ordered from least-significant position to most-significant position within the register.

### `get_field_by_name`

```c
virtual function uvm_reg_field get_field_by_name( 
    string name
)
```

Return the named field in this register

Finds a field with the specified name in this register and returns its abstraction class. If no fields are found, returns `null`.

### `get_offset`

```c
virtual function int get_offset ()
```

Returns the offset of this register in the root system’s map.
virtual function uvm_reg_addr_t get_offset (uvm_reg_map map = null)
Returns the offset of this register
Returns the offset of this register in an address map.
If no address map is specified and the register is mapped in only one address map, that address map is used. If the register is mapped in more than one address map, the default address map of the parent block is used.
If an address map is specified and the register is not mapped in the specified address map, an error message is issued.

get_address
virtual function uvm_reg_addr_t get_address (uvm_reg_map map = null)
Returns the base external physical address of this register
Returns the base external physical address of this register if accessed through the specified address map.
If no address map is specified and the register is mapped in only one address map, that address map is used. If the register is mapped in more than one address map, the default address map of the parent block is used.
If an address map is specified and the register is not mapped in the specified address map, an error message is issued.

get_addresses
virtual function int get_addresses (uvm_reg_map map = null, ref uvm_reg_addr_t addr[])
Identifies the external physical address(es) of this register
Computes all of the external physical addresses that must be accessed to completely read or write this register. The addressed are specified in little endian order. Returns the number of bytes transferred on each access.
If no address map is specified and the register is mapped in only one address map, that address map is used. If the register is mapped in more than one address map, the default address map of the parent block is used.
If an address map is specified and the register is not mapped in the specified address map, an error message is issued.

Access
set

virtual function void set (  
    uvm_reg_data_t value,  
    string _fname = "",  
    int _lineno = 0 
)

Set the desired value for this register

Sets the desired value of the fields in the register to the specified value. Does not actually set the value of the register in the design, only the desired value in its corresponding abstraction class in the RegModel model. Use the uvm_reg::update() method to update the actual register with the mirrored value or the uvm_reg::write() method to set the actual register and its mirrored value.

Unless this method is used, the desired value is equal to the mirrored value.

Refer uvm_reg_field::set() for more details on the effect of setting mirror values on fields with different access policies.

To modify the mirrored field values to a specific value, and thus use the mirrored as a scoreboard for the register values in the DUT, use the uvm_reg::predict() method.

get

virtual function uvm_reg_data_t get(  
    string _fname = "",  
    int _lineno = 0 
)

Return the desired value of the fields in the register.

Does not actually read the value of the register in the design, only the desired value in the abstraction class. Unless set to a different value using the uvm_reg::set(), the desired value and the mirrored value are identical.

Use the uvm_reg::read() or uvm_reg::peek() method to get the actual register value.

If the register contains write-only fields, the desired/mirrored value for those fields are the value last written and assumed to reside in the bits implementing these fields. Although a physical read operation would something different for these fields, the returned value is the actual content.

get_mirrored_value

virtual function uvm_reg_data_t get_mirrored_value(  
    string _fname = "",  
    int _lineno = 0 
)

Return the mirrored value of the fields in the register.

Does not actually read the value of the register in the design

If the register contains write-only fields, the desired/mirrored value for those fields are the value last written and assumed to reside in the bits implementing these fields. Although a physical read operation would something different for these fields, the returned value is the actual content.
needs_update

```cpp
virtual function bit needs_update()
```

Returns 1 if any of the fields need updating

See uvm_reg_field::needs_update() for details. Use the uvm_reg::update() to actually update the DUT register.

reset

```cpp
virtual function void reset(
    string kind = "HARD"
)
```

Reset the desired/mirrored value for this register.

Sets the desired and mirror value of the fields in this register to the reset value for the specified reset kind. See uvm_reg_field.reset() for more details.

Also resets the semaphore that prevents concurrent access to the register. This semaphore must be explicitly reset if a thread accessing this register array was killed in before the access was completed

get_reset

```cpp
virtual function uvm_reg_data_t get_reset(
    string kind = "HARD"
)
```

Get the specified reset value for this register

Return the reset value for this register for the specified reset kind.

has_reset

```cpp
virtual function bit has_reset(
    string kind = "HARD",
    bit delete = 0
)
```

Check if any field in the register has a reset value specified for the specified reset kind. If delete is TRUE, removes the reset value, if any.

set_reset

```cpp
virtual function void set_reset(
    uvm_reg_data_t value,
    string.kind = "HARD"
)
```

Specify or modify the reset value for this register

Specify or modify the reset value for all the fields in the register corresponding to the cause specified by kind.
**write**

```markdown
virtual task write(
  output uvm_status_e status,
  input uvm_reg_data_t value,
  input uvm_path_e path = UVM_DEFAULT_PATH,
  input uvm_reg_map map = null,
  input uvm_sequence_base parent = null,
  input int prior = -1,
  input uvm_object extension = null,
  input string fname = "",
  input int lineno = 0
)
```

Write the specified value in this register

Write value in the DUT register that corresponds to this abstraction class instance using the specified access path. If the register is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access). If a back-door access path is used, the effect of writing the register through a physical access is mimicked. For example, read-only bits in the registers will not be written.

The mirrored value will be updated using the uvm_reg::predict() method.

**read**

```markdown
virtual task read(
  output uvm_status_e status,
  output uvm_reg_data_t value,
  input uvm_path_e path = UVM_DEFAULT_PATH,
  input uvm_reg_map map = null,
  input uvm_sequence_base parent = null,
  input int prior = -1,
  input uvm_object extension = null,
  input string fname = "",
  input int lineno = 0
)
```

Read the current value from this register

Read and return value from the DUT register that corresponds to this abstraction class instance using the specified access path. If the register is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access). If a back-door access path is used, the effect of reading the register through a physical access is mimicked. For example, clear-on-read bits in the registers will be set to zero.

The mirrored value will be updated using the uvm_reg::predict() method.

**poke**

```markdown
virtual task poke(
  output uvm_status_e status,
  input uvm_reg_data_t value,
  input string kind = "",
  input uvm_sequence_base parent = null,
  input uvm_object extension = null,
  input string fname = "",
  input int lineno = 0
)
```

Deposit the specified value in this register
Deposit the value in the DUT register corresponding to this abstraction class instance, as-is, using a back-door access.

Uses the HDL path for the design abstraction specified by \textit{kind}.

The mirrored value will be updated using the \texttt{uvm_reg::predict()} method.

**peek**

```cpp
class peek {
  virtual task peek(
    output uvm_status_e status,
    output uvm_reg_data_t value,
    input string kind = "",
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
  )
}
```

Read the current value from this register

Sample the value in the DUT register corresponding to this abstraction class instance using a back-door access. The register value is sampled, not modified.

Uses the HDL path for the design abstraction specified by \textit{kind}.

The mirrored value will be updated using the \texttt{uvm_reg::predict()} method.

**update**

```cpp
class update {
  virtual task update(
    output uvm_status_e status,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
  )
}
```

Updates the content of the register in the design to match the desired value

This method performs the reverse operation of \texttt{uvm_reg::mirror()}. Write this register if the DUT register is out-of-date with the desired/mirrored value in the abstraction class, as determined by the \texttt{uvm_reg::needs_update()} method.

The update can be performed using the using the physical interfaces (frontdoor) or \texttt{uvm_reg::poke()} (backdoor) access. If the register is mapped in multiple address maps and physical access is used (front-door), an address \texttt{map} must be specified.

**mirror**

```cpp
class mirror {
  virtual task mirror(
    output uvm_status_e status,
    input uvm_check_e check = UVM_NO_CHECK,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
  )
}
```
Read the register and update/check its mirror value

Read the register and optionally compared the readback value with the current mirrored value if check is UVM_CHECK. The mirrored value will be updated using the uvm_reg::predict() method based on the readback value.

The mirroring can be performed using the physical interfaces (frontdoor) or uvm_reg::peek() (backdoor).

If check is specified as UVM_CHECK, an error message is issued if the current mirrored value does not match the readback value. Any field whose check has been disabled with uvm_reg_field::set_compare() will not be considered in the comparison.

If the register is mapped in multiple address maps and physical access is used (front-door access), an address map must be specified. If the register contains write-only fields, their content is mirrored and optionally checked only if a UVM_BACKDOOR access path is used to read the register.

predict

virtual function bit predict (  
vvm_reg_data_t value,  
vvm_reg_byte_en_t be = -1,  
vvm_predict_e kind = UVM_PREDICT_DIRECT,  
vvm_path_e path = UVM_FRONTDOOR,  
vvm_reg_map map = null,  
string fname = "",  
int lineno = 0  
);

Update the mirrored and desired value for this register.

Predict the mirror (and desired) value of the fields in the register based on the specified observed value on a specified address map, or based on a calculated value. See uvm_reg_field::predict() for more details.

Returns TRUE if the prediction was successful for each field in the register.

is_busy

function bit is_busy()

Returns 1 if register is currently being read or written.

FRONTDOOR

set_frontdoor

function void set_frontdoor(  
vvm_reg_frontdoor ftdr,  
vvm_reg_map map = null,  
string fname = "",  
int lineno = 0  
);
Set a user-defined frontdoor for this register

By default, registers are mapped linearly into the address space of the address maps that instantiate them. If registers are accessed using a different mechanism, a user-defined access mechanism must be defined and associated with the corresponding register abstraction class.

If the register is mapped in multiple address maps, an address map must be specified.

**get_frontdoor**

```plaintext
function uvm_reg_frontdoor get_frontdoor(uvm_reg_map map = null)
```

Returns the user-defined frontdoor for this register.

If *null*, no user-defined frontdoor has been defined. A user-defined frontdoor is defined by using the `uvm_reg::set_frontdoor()` method.

If the register is mapped in multiple address maps, an address map must be specified.

**Backdoor**

**set_backdoor**

```plaintext
function void set_backdoor(uvm_reg_backdoor bkdr, string fname = "", int lineno = 0)
```

Set a user-defined backdoor for this register.

By default, registers are accessed via the built-in string-based DPI routines if an HDL path has been specified using the `uvm_reg::configure()` or `uvm_reg::add_hdl_path()` method.

If this default mechanism is not suitable (e.g. because the register is not implemented in pure SystemVerilog) a user-defined access mechanism must be defined and associated with the corresponding register abstraction class.

A user-defined backdoor is required if active update of the mirror of this register abstraction class, based on observed changes of the corresponding DUT register, is used.

**get_backdoor**

```plaintext
function uvm_reg_backdoor get_backdoor(bit inherited = 1)
```

Returns the user-defined backdoor for this register.

If *null*, no user-defined backdoor has been defined. A user-defined backdoor is defined by using the `uvm_reg::set_backdoor()` method.
If \textit{inherited} is \texttt{TRUE}, returns the backdoor of the parent block if none have been specified for this register.

\textbf{clear\_hdl\_path}

\begin{verbatim}
function void clear_hdl_path (  
  string kind = "RTL"
)
\end{verbatim}

Delete HDL paths

Remove any previously specified HDL path to the register instance for the specified design abstraction.

\textbf{add\_hdl\_path}

\begin{verbatim}
function void add_hdl_path (  
  uvm_hdl_path_slice slices[],
  string kind = "RTL"
)
\end{verbatim}

Add an HDL path

Add the specified HDL path to the register instance for the specified design abstraction. This method may be called more than once for the same design abstraction if the register is physically duplicated in the design abstraction

For example, the following register

\begin{verbatim}
add_hdl_path( '{
  '{"A_reg", 15, 1},
  '{"B_reg",  6, 7},
  '{"C_reg",  0, 4} 
} );
\end{verbatim}

would be specified using the following literal value

\begin{verbatim}
add_hdl_path(''{
  '"A_reg", 15, 1},
  '"B_reg", 6, 7},
  '"C_reg", 0, 4} 
} );
\end{verbatim}

If the register is implemented using a single HDL variable, The array should specify a single slice with its \texttt{offset} and \texttt{size} specified as \texttt{-1}. For example:

\begin{verbatim}
r1.add_hdl_path(''{
  '"r1", -1, -1} 
} );
\end{verbatim}

\textbf{add\_hdl\_path\_slice}

\begin{verbatim}
function void add_hdl_path_slice( 
  string name,
  int    offset,
  int    size,
)
\end{verbatim}
Append the specified HDL slice to the HDL path of the register instance for the specified design abstraction. If first is TRUE, starts the specification of a duplicate HDL implementation of the register.

### has_hdl_path

```vhdl
function bit has_hdl_path (  
    string kind = ""  
)  
```

Check if a HDL path is specified

Returns TRUE if the register instance has a HDL path defined for the specified design abstraction. If no design abstraction is specified, uses the default design abstraction specified for the parent block.

### get_hdl_path

```vhdl
function void get_hdl_path (  
    ref uvm_hdl_path_concat paths[$],  
    input string kind = ""  
)  
```

Get the incremental HDL path(s)

Returns the HDL path(s) defined for the specified design abstraction in the register instance. Returns only the component of the HDL paths that corresponds to the register, not a full hierarchical path

If no design abstraction is specified, the default design abstraction for the parent block is used.

### get_hdl_path_kinds

```vhdl
function void get_hdl_path_kinds (  
    ref string kinds[$]  
)  
```

Get design abstractions for which HDL paths have been defined

### get_full_hdl_path

```vhdl
function void get_full_hdl_path (  
    ref uvm_hdl_path_concat paths[$],  
    input string kind = "",  
    input string separator = "."  
)  
```

Get the full hierarchical HDL path(s)

Returns the full hierarchical HDL path(s) defined for the specified design abstraction in the register instance. There may be more than one path returned even if only one path was defined for the register instance, if any of the parent components have more than
one path defined for the same design abstraction

If no design abstraction is specified, the default design abstraction for each ancestor block is used to get each incremental path.

**backdoor_read**

```plaintext
virtual task backdoor_read(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access read for this register type. By default calls `uvm_reg::backdoor_read_func()`.

**backdoor_write**

```plaintext
virtual task backdoor_write(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access write for this register type.

**backdoor_read_func**

```plaintext
virtual function uvm_status_e backdoor_read_func(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access read for this register type.

**backdoor_watch**

```plaintext
virtual task backdoor_watch()
```

User-defined DUT register change monitor

Watch the DUT register corresponding to this abstraction class instance for any change in value and return when a value-change occurs. This may be implemented as a string-based DPI access if the simulation tool provide a value-change callback facility. Such a facility does not exist in the standard SystemVerilog DPI and thus no default implementation for this method can be provided.

**Coverage**

**include_coverage**
Specify which coverage model that must be included in various block, register or memory abstraction class instances.

The coverage models are specified by OR’ing or adding the `uvm_coverage_model_e` coverage model identifiers corresponding to the coverage model to be included.

The scope specifies a hierarchical name or pattern identifying a block, memory or register abstraction class instances. Any block, memory or register whose full hierarchical name matches the specified scope will have the specified functional coverage models included in them.

The scope can be specified as a POSIX regular expression or simple pattern. See `uvm_resource_base::Scope Interface` for more details.

```cpp
uvm_reg::include_coverage("*", UVM_CVR_ALL);
```

The specification of which coverage model to include in which abstraction class is stored in a `uvm_reg_cvr_t` resource in the `uvm_resource_db` resource database, in the “uvm_reg::” scope namespace.

**build_coverage**

```cpp
protected function uvm_reg_cvr_t build_coverage(  
  uvm_reg_cvr_t models
)
```

Check if all of the specified coverage models must be built.

Check which of the specified coverage model must be built in this instance of the register abstraction class, as specified by calls to `uvm_reg::include_coverage()`.

Models are specified by adding the symbolic value of individual coverage model as defined in `uvm_coverage_model_e`. Returns the sum of all coverage models to be built in the register model.

**add_coverage**

```cpp
virtual protected function void add_coverage(  
  uvm_reg_cvr_t models
)
```

Specify that additional coverage models are available.

Add the specified coverage model to the coverage models available in this class. Models are specified by adding the symbolic value of individual coverage model as defined in `uvm_coverage_model_e`.

This method shall be called only in the constructor of subsequently derived classes.

**has_coverage**
Check if register has coverage model(s)

Returns TRUE if the register abstraction class contains a coverage model for all of the models specified. Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e.

```
virtual function bit has_coverage(
    uvm_reg_cvr_t models
)
```

**set_coverage**

```
virtual function uvm_reg_cvr_t set_coverage(
    uvm_reg_cvr_t is_on
)
```

Turns on coverage measurement.

Turns the collection of functional coverage measurements on or off for this register. The functional coverage measurement is turned on for every coverage model specified using uvm_coverage_model_e symbolic identifiers. Multiple functional coverage models can be specified by adding the functional coverage model identifiers. All other functional coverage models are turned off. Returns the sum of all functional coverage models whose measurements were previously on.

This method can only control the measurement of functional coverage models that are present in the register abstraction classes, then enabled during construction. See the uvm_reg::has_coverage() method to identify the available functional coverage models.

```
virtual function bit get_coverage(
    uvm_reg_cvr_t is_on
)
```

Check if coverage measurement is on.

Returns TRUE if measurement for all of the specified functional coverage models are currently on. Multiple functional coverage models can be specified by adding the functional coverage model identifiers.

See uvm_reg::set_coverage() for more details.

```
protected virtual function void sample(
    uvm_reg_data_t data,
    uvm_reg_data_t byte_en,
    bit is_read,
    uvm_reg_map map
)
```

**sample**

Functional coverage measurement method

This method is invoked by the register abstraction class whenever it is read or written with the specified data via the specified address map. It is invoked after the read or write operation has completed but before the mirror has been updated.
Empty by default, this method may be extended by the abstraction class generator to perform the required sampling in any provided functional coverage model.

**sample_values**

```c
virtual function void sample_values()
```

Functional coverage measurement method for field values

This method is invoked by the user or by the `uvm_reg_block::sample_values()` method of the parent block to trigger the sampling of the current field values in the register-level functional coverage model.

This method may be extended by the abstraction class generator to perform the required sampling in any provided field-value functional coverage model.

### CALLBACKS

**pre_write**

```c
virtual task pre_write(
    uvm_reg_item rw
)
```

Called before register write.

If the specified data value, access path or address map are modified, the updated data value, access path or address map will be used to perform the register operation. If the status is modified to anything other than `UVM_IS_OK`, the operation is aborted.

The registered callback methods are invoked after the invocation of this method. All register callbacks are executed before the corresponding field callbacks.

**post_write**

```c
virtual task post_write(
    uvm_reg_item rw
)
```

Called after register write.

If the specified `status` is modified, the updated status will be returned by the register operation.

The registered callback methods are invoked before the invocation of this method. All register callbacks are executed before the corresponding field callbacks.

**pre_read**

```c
virtual task pre_read(
    uvm_reg_item rw
)
```

Called before register read.
If the specified access path or address map are modified, the updated access path or address map will be used to perform the register operation. If the status is modified to anything other than UVM_IS_OK, the operation is aborted.

The registered callback methods are invoked after the invocation of this method. All register callbacks are executed before the corresponding field callbacks.

**post_read**

```plaintext
virtual task post_read(
    uvm_reg_item rw
)
```

Called after register read.

If the specified readback data or status is modified, the updated readback data or status will be returned by the register operation.

The registered callback methods are invoked before the invocation of this method. All register callbacks are executed before the corresponding field callbacks.
25.5 uvm_reg_field

Field abstraction class

A field represents a set of bits that behave consistently as a single entity.

A field is contained within a single register, but may have different access policies depending on the address map used to access the register (thus the field).

Summary

**uvm_reg_field**

Field abstraction class

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_reg_field</td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_reg_field extends uvm_object

<table>
<thead>
<tr>
<th>value</th>
<th>Mirrored field value.</th>
</tr>
</thead>
</table>

**Initialization**

```
| new | Create a new field instance |
| configure | Instance-specific configuration |
```

**Introspection**

```
| get_name | Get the simple name |
| get_full_name | Get the hierarchical name |
| get_parent | Get the parent register |
| get_lsb_pos | Return the position of the field |
| get_n_bits | Returns the width, in number of bits, of the field. |
| get_max_size | Returns the width, in number of bits, of the largest field. |

| set_access | Modify the access policy of the field |
| define_access | Define a new access policy value |
| get_access | Get the access policy of the field |
| is_known_access | Check if access policy is a built-in one. |
| set_volatility | Modify the volatility of the field to the specified one. |
| is_volatile | Indicates if the field value is volatile |
```

**Access**

```
| set | Set the desired value for this field |
| get | Return the desired value of the field |
| get_mirrored_value | Return the mirrored value of the field |
| reset | Reset the desired/mirrored value for this field |
| get_reset | Get the specified reset value for this field |
| has_reset | Check if the field has a reset value specified |
| set_reset | Specify or modify the reset value for this field |
| needs_update | Check if the abstract model contains different desired and mirrored values. |
| write | Write the specified value in this field |
| read | Read the current value from this field |
| poke | Deposit the specified value in this field |
| peek | Read the current value from this field |
| mirror | Read the field and update/check its mirror value |
| set_compare | Sets the compare policy during a mirror update. |
| get_compare | Returns the compare policy for this field. |
| is_indv_accessible | Check if this field can be written individually |
```
predict Update the mirrored and desired value for this field.

**CALLBACKS**

<table>
<thead>
<tr>
<th>Callback</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre_write</td>
<td>Called before field write.</td>
</tr>
<tr>
<td>post_write</td>
<td>Called after field write.</td>
</tr>
<tr>
<td>pre_read</td>
<td>Called before field read.</td>
</tr>
<tr>
<td>post_read</td>
<td>Called after field read.</td>
</tr>
</tbody>
</table>

**value**

```
rand uvm_reg_data_t value
```

Mirrored field value. This value can be sampled in a functional coverage model or constrained when randomized.

**INITIALIZATION**

**new**

```
function new(
    string name = "uvm_reg_field"
)
```

Create a new field instance

This method should not be used directly. The `uvm_reg_field::type_id::create()` factory method should be used instead.

**configure**

```
function void configure(
    uvm_reg parent,
    int unsigned size,
    int unsigned lsb_pos,
    string access,
    bit volatile,
    uvm_reg_data_t reset,
    bit has_reset,
    bit is_rand,
    bit individually_accessible
)
```

Instance-specific configuration

Specify the `parent` register of this field, its `size` in bits, the position of its least-significant bit within the register relative to the least-significant bit of the register, its `access` policy, volatility, "HARD" `reset` value, whether the field value is actually reset (the `reset` value is ignored if `FALSE`), whether the field value may be randomized and whether the field is the only one to occupy a byte lane in the register.

See `set_access` for a specification of the pre-defined field access policies.

If the field access policy is a pre-defined policy and NOT one of "RW", "WRC", "WRS", "WO", "W1", or "WO1", the value of `is_rand` is ignored and the rand_mode() for the field instance is turned off since it cannot be written.
**INTROSPECTION**

**get_name**
Get the simple name
Return the simple object name of this field

**get_full_name**

```
virtual function string get_full_name()
```
Get the hierarchical name
Return the hierarchal name of this field. The base of the hierarchical name is the root block.

**get_parent**

```
virtual function uvm_reg get_parent()
```
Get the parent register

**get_lsb_pos**

```
virtual function int unsigned get_lsb_pos()
```
Return the position of the field
Returns the index of the least significant bit of the field in the register that instantiates it. An offset of 0 indicates a field that is aligned with the least-significant bit of the register.

**get_n_bits**

```
virtual function int unsigned get_n_bits()
```
Returns the width, in number of bits, of the field.

**get_max_size**

```
static function int unsigned get_max_size()
```
Returns the width, in number of bits, of the largest field.

**set_access**

```
virtual function string set_access()
```
Modify the access policy of the field

Modify the access policy of the field to the specified one and return the previous access policy.

The pre-defined access policies are as follows. The effect of a read operation are applied after the current value of the field is sampled. The read operation will return the current value, not the value affected by the read operation (if any).

- **“RO”**: W: no effect, R: no effect
- **“RW”**: W: as-is, R: no effect
- **“RC”**: W: no effect, R: clears all bits
- **“RS”**: W: no effect, R: sets all bits
- **“WRC”**: W: as-is, R: clears all bits
- **“WRS”**: W: as-is, R: sets all bits
- **“WC”**: W: clears all bits, R: no effect
- **“WS”**: W: sets all bits, R: no effect
- **“WSRC”**: W: sets all bits, R: clears all bits
- **“WCRS”**: W: clears all bits, R: sets all bits
- **“W1C”**: W: 1/0 clears/no effect on matching bit, R: no effect
- **“W1S”**: W: 1/0 sets/no effect on matching bit, R: no effect
- **“W1T”**: W: 1/0 toggles/no effect on matching bit, R: no effect
- **“W0C”**: W: 1/0 no effect on/clears matching bit, R: no effect
- **“W0S”**: W: 1/0 no effect on/sets matching bit, R: no effect
- **“W0T”**: W: 1/0 no effect on/toggles matching bit, R: no effect
- **“W1SRC”**: W: 1/0 sets/no effect on matching bit, R: clears all bits
- **“W1CRS”**: W: 1/0 clears/no effect on matching bit, R: sets all bits
- **“W0SRC”**: W: 1/0 no effect on/sets matching bit, R: clears all bits
- **“W0CRS”**: W: 1/0 no effect on/clears matching bit, R: sets all bits
- **“WO”**: W: as-is, R: error
- **“W0C”**: W: clears all bits, R: error
- **“W0S”**: W: sets all bits, R: error
- **“W1”**: W: first one after **HARD** reset is as-is, other W have no effects, R: no effect
- **“WO1”**: W: first one after **HARD** reset is as-is, other W have no effects, R: error
- **“NOACCESS”**: W: no effect, R: no effect

It is important to remember that modifying the access of a field will make the register model diverge from the specification that was used to create it.
Define a new access policy value

Because field access policies are specified using string values, there is no way for SystemVerilog to verify if a specific access value is valid or not. To help catch typing errors, user-defined access values must be defined using this method to avoid begin reported as an invalid access policy.

The name of field access policies are always converted to all uppercase.

Returns TRUE if the new access policy was not previously defined. Returns FALSE otherwise but does not issue an error message.

**get_access**

```cpp
class uvm_field
{
    virtual function string get_access(
        uvm_reg_map map = null)
}
```

Get the access policy of the field

Returns the current access policy of the field when written and read through the specified address map. If the register containing the field is mapped in multiple address map, an address map must be specified. The access policy of a field from a specific address map may be restricted by the register’s access policy in that address map. For example, a RW field may only be writable through one of the address maps and read-only through all of the other maps. If the field access contradicts the map’s access value (field access of WO, and map access value of RO, etc), the method’s return value is NOACCESS.

**is_known_access**

```cpp
class uvm_field
{
    virtual function bit is_known_access(
        uvm_reg_map map = null)
}
```

Check if access policy is a built-in one.

Returns TRUE if the current access policy of the field, when written and read through the specified address map, is a built-in access policy.

**set_volatility**

```cpp
class uvm_field
{
    virtual function void set_volatility(
        bit volatile)
}
```

Modify the volatility of the field to the specified one.

It is important to remember that modifying the volatility of a field will make the register model diverge from the specification that was used to create it.

**is_volatile**

```cpp
class uvm_field
{
    virtual function bit is_volatile()
}
```

Indicates if the field value is volatile.
UVM uses the IEEE 1685-2009 IP-XACT definition of “volatility”. If TRUE, the value of the register is not predictable because it may change between consecutive accesses. This typically indicates a field whose value is updated by the DUT. The nature or cause of the change is not specified. If FALSE, the value of the register is not modified between consecutive accesses.

### Access

#### set

```cpp
class uvm_reg_field {
public:
  virtual function void set(uvm_reg_data_t value, string fname = "", int lineno = 0);
}
```

Set the desired value for this field

It sets the desired value of the field to the specified value modified by the field access policy. It does not actually set the value of the field in the design, only the desired value in the abstraction class. Use the `uvm_reg::update()` method to update the actual register with the desired value or the `uvm_reg_field::write()` method to actually write the field and update its mirrored value.

The final desired value in the mirror is a function of the field access policy and the set value, just like a normal physical write operation to the corresponding bits in the hardware. As such, this method (when eventually followed by a call to `uvm_reg::update()`) is a zero-time functional replacement for the `uvm_reg_field::write()` method. For example, the desired value of a read-only field is not modified by this method and the desired value of a write-once field can only be set if the field has not yet been written to using a physical (for example, front-door) write operation.

Use the `uvm_reg_field::predict()` to modify the mirrored value of the field.

#### get

```cpp
class uvm_reg_field {
public:
  virtual function uvm_reg_data_t get(string fname = "", int lineno = 0);
}
```

Return the desired value of the field

It does not actually read the value of the field in the design, only the desired value in the abstraction class. Unless set to a different value using the `uvm_reg_field::set()`, the desired value and the mirrored value are identical.

Use the `uvm_reg_field::read()` or `uvm_reg_field::peek()` method to get the actual field value.

If the field is write-only, the desired/mirrored value is the value last written and assumed to reside in the bits implementing it. Although a physical read operation would something different, the returned value is the actual content.

#### get_mirrored_value

```cpp
class uvm_reg_field {
public:
  virtual function void get_mirrored_value(uvm_reg_data_t value, string fname = "", int lineno = 0);
}
```
Return the mirrored value of the field

It does not actually read the value of the field in the design, only the mirrored value in the abstraction class.

If the field is write-only, the desired/mirrored value is the value last written and assumed to reside in the bits implementing it. Although a physical read operation would something different, the returned value is the actual content.

**reset**

```cpp
virtual function void reset(
    string kind = "HARD"
)
```

Reset the desired/mirrored value for this field.

It sets the desired and mirror value of the field to the reset event specified by kind. If the field does not have a reset value specified for the specified reset kind the field is unchanged.

It does not actually reset the value of the field in the design, only the value mirrored in the field abstraction class.

Write-once fields can be modified after a “HARD” reset operation.

**get_reset**

```cpp
virtual function uvm_reg_data_t get_reset(
    string kind = "HARD"
)
```

Get the specified reset value for this field

Return the reset value for this field for the specified reset kind. Returns the current field value is no reset value has been specified for the specified reset event.

**has_reset**

```cpp
virtual function bit has_reset(
    string kind = "HARD",
    bit delete = 0
)
```

Check if the field has a reset value specified

Return TRUE if this field has a reset value specified for the specified reset kind. If delete is TRUE, removes the reset value, if any.
Specify or modify the reset value for this field

Specify or modify the reset value for this field corresponding to the cause specified by `kind`.

### needs_update

```cpp
virtual function bit needs_update()
```

Check if the abstract model contains different desired and mirrored values.

If a desired field value has been modified in the abstraction class without actually updating the field in the DUT, the state of the DUT (more specifically what the abstraction class *thinks* the state of the DUT is) is outdated. This method returns TRUE if the state of the field in the DUT needs to be updated to match the desired value. The mirror values or actual content of DUT field are not modified. Use the `uvm_reg::update()` to actually update the DUT field.

### write

```cpp
virtual task write (
    output uvm_status_e status,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Write the specified value in this field

Write `value` in the DUT field that corresponds to this abstraction class instance using the specified access `path`. If the register containing this field is mapped in more than one address map, an address `map` must be specified if a physical access is used (front-door access). If a back-door access path is used, the effect of writing the field through a physical access is mimicked. For example, read-only bits in the field will not be written.

The mirrored value will be updated using the `uvm_reg_field::predict()` method.

If a front-door access is used, and if the field is the only field in a byte lane and if the physical interface corresponding to the address map used to access the field support byte-enabling, then only the field is written. Otherwise, the entire register containing the field is written, and the mirrored values of the other fields in the same register are used in a best-effort not to modify their value.

If a backdoor access is used, a peek-modify-poke process is used. in a best-effort not to modify the value of the other fields in the register.

### read

```cpp
virtual task read (
    output uvm_status_e status,
    output uvm_reg_data_t value,
    ...
)```
Read the current value from this field

Read and return value from the DUT field that corresponds to this abstraction class instance using the specified access path. If the register containing this field is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access). If a back-door access path is used, the effect of reading the field through a physical access is mimicked. For example, clear-on-read bits in the field will be set to zero.

The mirrored value will be updated using the uvm_reg_field::predict() method.

If a front-door access is used, and if the field is the only field in a byte lane and if the physical interface corresponding to the address map used to access the field support byte-enabling, then only the field is read. Otherwise, the entire register containing the field is read, and the mirrored values of the other fields in the same register are updated.

If a backdoor access is used, the entire containing register is peeked and the mirrored value of the other fields in the register is updated.

**poke**

```plaintext
deposit the specified value in this field

Deposit the specified value in this field corresponding to this abstraction class instance, as-is, using a back-door access. A peek-modify-poke process is used in a best-effort not to modify the value of the other fields in the register.

The mirrored value will be updated using the uvm_reg_field::predict() method.

**peek**

```plaintext```
back-door access. The field value is sampled, not modified.

Uses the HDL path for the design abstraction specified by `kind`.

The entire containing register is peeked and the mirrored value of the other fields in the register are updated using the `uvm_reg_field::predict()` method.

**mirror**

```plaintext
virtual task mirror(
    output uvm_status_e status,
    input uvm_check_e check = UVM_NO_CHECK,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Read the field and update/check its mirror value

Read the field and optionally compared the readback value with the current mirrored value if `check` is UVM_CHECK. The mirrored value will be updated using the `predict()` method based on the readback value.

The `path` argument specifies whether to mirror using the UVM_FRONTDOOR (read) or UVM_BACKDOOR (peek()).

If `check` is specified as UVM_CHECK, an error message is issued if the current mirrored value does not match the readback value, unless `set_compare` was used disable the check.

If the containing register is mapped in multiple address maps and physical access is used (front-door access), an address `map` must be specified. For write-only fields, their content is mirrored and optionally checked only if a UVM_BACKDOOR access path is used to read the field.

**set_compare**

```plaintext
function void set_compare(
    uvm_check_e check = UVM_CHECK
)
```

Sets the compare policy during a mirror update. The field value is checked against its mirror only when both the `check` argument in `uvm_reg_block::mirror`, `uvm_reg::mirror`, or `uvm_reg_field::mirror` and the compare policy for the field is UVM_CHECK.

**get_compare**

```plaintext
function uvm_check_e get_compare()
```

Returns the compare policy for this field.

**is_indv_accessible**

```plaintext
function bit is_indv_accessible ( )
```
Check if this field can be written individually, i.e. without affecting other fields in the containing register.

**predict**

```plaintext
function bit predict (  
  uvm_reg_data_t value,  
  uvm_reg_byte_en_t be = -1,  
  uvm_predict_e kind = UVM_PREDICT_DIRECT,  
  uvm_path_e path = UVM_FRONTDOOR,  
  uvm_reg_map map = null,  
  string fname = "",  
  int lineno = 0)  
)
```

Update the mirrored and desired value for this field.

Predict the mirrored and desired value of the field based on the specified observed value on a bus using the specified address map.

If `kind` is specified as `UVM_PREDICT_READ`, the value was observed in a read transaction on the specified address map or backdoor (if `path` is `UVM_BACKDOOR`). If `kind` is specified as `UVM_PREDICT_WRITE`, the value was observed in a write transaction on the specified address map or backdoor (if `path` is `UVM_BACKDOOR`). If `kind` is specified as `UVM_PREDICT_DIRECT`, the value was computed and is updated as-is, without regard to any access policy. For example, the mirrored value of a read-only field is modified by this method if `kind` is specified as `UVM_PREDICT_DIRECT`.

This method does not allow an update of the mirror (or desired) when the register containing this field is busy executing a transaction because the results are unpredictable and indicative of a race condition in the testbench.

Returns TRUE if the prediction was successful.

**CALLBACKS**

**pre_write**

```plaintext
virtual task pre_write (  
  uvm_reg_item rw  
)
```

Called before field write.

If the specified data value, access `path` or address `map` are modified, the updated data value, access path or address map will be used to perform the register operation. If the `status` is modified to anything other than `UVM_IS_OK`, the operation is aborted.

The field callback methods are invoked after the callback methods on the containing register. The registered callback methods are invoked after the invocation of this method.

**post_write**
Called after field write.

If the specified status is modified, the updated status will be returned by the register operation.

The field callback methods are invoked after the callback methods on the containing register. The registered callback methods are invoked before the invocation of this method.

**pre_read**

```plaintext
virtual task pre_read (uvm_reg_item rw)
```

Called before field read.

If the access path or address map in the rw argument are modified, the updated access path or address map will be used to perform the register operation. If the status is modified to anything other than UVM_IS_OK, the operation is aborted.

The field callback methods are invoked after the callback methods on the containing register. The registered callback methods are invoked after the invocation of this method.

**post_read**

```plaintext
virtual task post_read (uvm_reg_item rw)
```

Called after field read.

If the specified readback data or status in the rw argument is modified, the updated readback data or status will be returned by the register operation.

The field callback methods are invoked after the callback methods on the containing register. The registered callback methods are invoked before the invocation of this method.
25.6 uvm_mem

Memory abstraction base class

A memory is a collection of contiguous locations. A memory may be accessible via more than one address map.

Unlike registers, memories are not mirrored because of the potentially large data space: tests that walk the entire memory space would negate any benefit from sparse memory modelling techniques. Rather than relying on a mirror, it is recommended that backdoor access be used instead.

Summary

uvm_mem

Memory abstraction base class

**Class Hierarchy**

- uvm_void
- uvm_object
- uvm_mem

**Class Declaration**

```cpp
class uvm_mem extends uvm_object
```

**Initialization**

- `new` Create a new instance and type-specific configuration
- `configure` Instance-specific configuration
- `set_offset` Modify the offset of the memory
- `Modifying the offset of a memory will make the abstract model` diverge from the specification that was used to create it.
- `mam` Memory allocation manager

**Introspection**

- `get_name` Get the simple name
- `get_full_name` Get the hierarchical name
- `get_parent` Get the parent block
- `get_n_maps` Returns the number of address maps this memory is mapped in
- `is_in_map` Return TRUE if this memory is in the specified address map
- `get_maps` Returns all of the address maps where this memory is mapped
- `get_rights` Returns the access rights of this memory
- `get_access` Returns the access policy of the memory when written and read via an address map.
- `get_size` Returns the number of unique memory locations in this memory.
- `get_n_bytes` Return the width, in number of bytes, of each memory location
- `get_n_bits` Returns the width, in number of bits, of each memory location
- `get_max_size` Returns the maximum width, in number of bits, of all memories
- `get_virtual_registers` Return the virtual registers in this memory
- `get_virtual_fields` Return the virtual fields in the memory
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
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<td>Find the named virtual field</td>
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</tr>
<tr>
<td>get_offset</td>
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<td>get_address</td>
<td>Returns the base external physical address of a memory location</td>
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<td>get_addresses</td>
<td>Identifies the external physical address(es) of a memory location</td>
</tr>
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</table>

**HDL Access**

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<th>Method</th>
<th>Description</th>
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<tbody>
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<td>write</td>
<td>Write the specified value in a memory location</td>
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<td>read</td>
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<td>burst_write</td>
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</tr>
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<td>burst_read</td>
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<td>poke</td>
<td>Deposit the specified value in a memory location</td>
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</tr>
</tbody>
</table>

**Frontdoor**

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<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>set_frontdoor</td>
<td>Set a user-defined frontdoor for this memory</td>
</tr>
<tr>
<td>get_frontdoor</td>
<td>Returns the user-defined frontdoor for this memory</td>
</tr>
</tbody>
</table>

**Backdoor**

<table>
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<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>set_backdoor</td>
<td>Set a user-defined backdoor for this memory</td>
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<tr>
<td>get_backdoor</td>
<td>Returns the user-defined backdoor for this memory</td>
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<tr>
<td>clear_hdl_path</td>
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<td>add_hdl_path</td>
<td>Add an HDL path</td>
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<td>add_hdl_path_slice</td>
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<td>get_hdl_path</td>
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<tr>
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</tr>
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**Callbacks**

<table>
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<tr>
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<tr>
<td>pre_write</td>
<td>Called before memory write.</td>
</tr>
<tr>
<td>post_write</td>
<td>Called after memory write.</td>
</tr>
<tr>
<td>pre_read</td>
<td>Called before memory read.</td>
</tr>
<tr>
<td>post_read</td>
<td>Called after memory read.</td>
</tr>
</tbody>
</table>

**Coverage**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>build_coverage</td>
<td>Check if all of the specified coverage model must be built.</td>
</tr>
<tr>
<td>add_coverage</td>
<td>Specify that additional coverage models are available.</td>
</tr>
<tr>
<td>has_coverage</td>
<td>Check if memory has coverage model(s)</td>
</tr>
<tr>
<td>set_coverage</td>
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<tr>
<td>sample</td>
<td>Functional coverage measurement method</td>
</tr>
</tbody>
</table>

**Initialization**
new

function new (
    string name,
    longint unsigned size,
    int unsigned n_bits,
    string access = "RW",
    int has_coverage = UVM_NO_COVERAGE
)

Create a new instance and type-specific configuration

Creates an instance of a memory abstraction class with the specified name.

size specifies the total number of memory locations. n_bits specifies the total number of bits in each memory location. access specifies the access policy of this memory and may be one of "RW" for RAMs and "RO" for ROMs.

has_coverage specifies which functional coverage models are present in the extension of the register abstraction class. Multiple functional coverage models may be specified by adding their symbolic names, as defined by the uvm_coverage_model_e type.

configure

function void configure (
    uvm_reg_block parent,
    string hdl_path = ""
)

Instance-specific configuration

Specify the parent block of this memory.

If this memory is implemented in a single HDL variable, its name is specified as the hdl_path. Otherwise, if the memory is implemented as a concatenation of variables (usually one per bank), then the HDL path must be specified using the add_hdl_path() or add_hdl_path_slice() method.

set_offset

Modify the offset of the memory

The offset of a memory within an address map is set using the uvm_reg_map::add_mem() method. This method is used to modify that offset dynamically.

Modifying the offset of a memory will make the abstract model
diverge from the specification that was used to create it.

mam

uvm_mem_mam mam

Memory allocation manager
Memory allocation manager for the memory corresponding to this abstraction class instance. Can be used to allocate regions of consecutive addresses of specific sizes, such as DMA buffers, or to locate virtual register array.

**INTROSPECTION**

**get_name**

Get the simple name

Return the simple object name of this memory.

**get_full_name**

virtual function string get_full_name()

Get the hierarchical name

Return the hierarchal name of this memory. The base of the hierarchical name is the root block.

**get_parent**

virtual function uvm_reg_block get_parent ()

Get the parent block

**get_n_maps**

virtual function int get_n_maps ()

Returns the number of address maps this memory is mapped in

**is_in_map**

function bit is_in_map ( uvm_reg_map map )

Return TRUE if this memory is in the specified address map

**get_maps**

virtual function void get_maps ( ref uvm_reg_map maps[] )

Returns all of the address maps where this memory is mapped
get_rights

virtual function string get_rights {
  uvm_reg_map map = null
}

Returns the access rights of this memory.

Returns “RW”, “RO” or “WO”. The access rights of a memory is always “RW”, unless it is a shared memory with access restriction in a particular address map.

If no address map is specified and the memory is mapped in only one address map, that address map is used. If the memory is mapped in more than one address map, the default address map of the parent block is used.

If an address map is specified and the memory is not mapped in the specified address map, an error message is issued and “RW” is returned.

get_access

virtual function string get_access {
  uvm_reg_map map = null
}

Returns the access policy of the memory when written and read via an address map.

If the memory is mapped in more than one address map, an address map must be specified. If access restrictions are present when accessing a memory through the specified address map, the access mode returned takes the access restrictions into account. For example, a read-write memory accessed through a domain with read-only restrictions would return “RO”.

get_size

function longint unsigned get_size()

Returns the number of unique memory locations in this memory.

get_n_bytes

function int unsigned get_n_bytes()

Return the width, in number of bytes, of each memory location

get_n_bits

function int unsigned get_n_bits()

Returns the width, in number of bits, of each memory location

get_max_size

static function int unsigned get_max_size()
Returns the maximum width, in number of bits, of all memories

### get_virtual_registers

```cpp
virtual function void get_virtual_registers(
    ref uvm_vreg regs[]
)
```

Return the virtual registers in this memory

Fills the specified array with the abstraction class for all of the virtual registers implemented in this memory. The order in which the virtual registers are located in the array is not specified.

### get_virtual_fields

```cpp
virtual function void get_virtual_fields(
    ref uvm_vreg_field fields[]
)
```

Return the virtual fields in the memory

Fills the specified dynamic array with the abstraction class for all of the virtual fields implemented in this memory. The order in which the virtual fields are located in the array is not specified.

### get_vreg_by_name

```cpp
virtual function uvm_vreg get_vreg_by_name(
    string name
)
```

Find the named virtual register

Finds a virtual register with the specified name implemented in this memory and returns its abstraction class instance. If no virtual register with the specified name is found, returns `null`.

### get_vfield_by_name

```cpp
virtual function uvm_vreg_field get_vfield_by_name(
    string name
)
```

Find the named virtual field

Finds a virtual field with the specified name implemented in this memory and returns its abstraction class instance. If no virtual field with the specified name is found, returns `null`.

### get_vreg_by_offset

```cpp
virtual function uvm_vreg get_vreg_by_offset(
    uvm_reg_addr_t offset,
)
```

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Find the virtual register implemented at the specified offset

Finds the virtual register implemented in this memory at the specified offset in the specified address map and returns its abstraction class instance. If no virtual register at the offset is found, returns null.

**get_offset**

```cpp
virtual function uvm_reg_addr_t get_offset (    
    uvm_reg_addr_t offset = 0,    
    uvm_reg_map map = null    
)
```

Returns the base offset of a memory location

Returns the base offset of the specified location in this memory in an address map.

If no address map is specified and the memory is mapped in only one address map, that address map is used. If the memory is mapped in more than one address map, the default address map of the parent block is used.

If an address map is specified and the memory is not mapped in the specified address map, an error message is issued.

**get_address**

```cpp
virtual function uvm_reg_addr_t get_address(    
    uvm_reg_addr_t offset = 0,    
    uvm_reg_map map = null    
)
```

Returns the base external physical address of a memory location

Returns the base external physical address of the specified location in this memory if accessed through the specified address map.

If no address map is specified and the memory is mapped in only one address map, that address map is used. If the memory is mapped in more than one address map, the default address map of the parent block is used.

If an address map is specified and the memory is not mapped in the specified address map, an error message is issued.

**get_addresses**

```cpp
virtual function int get_addresses(    
    uvm_reg_addr_t offset = 0,    
    uvm_reg_map map = null,    
    ref uvm_reg_addr_t addr[]    
)
```

Identifies the external physical address(es) of a memory location

Computes all of the external physical addresses that must be accessed to completely read or write the specified location in this memory. The addresses are specified in little endian order. Returns the number of bytes transferred on each access.
If no address map is specified and the memory is mapped in only one address map, that
address map is used. If the memory is mapped in more than one address map, the
default address map of the parent block is used.

If an address map is specified and the memory is not mapped in the specified address
map, an error message is issued.

**HDL Access**

**write**

```
virtual task write(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Write the specified value in a memory location

Write value in the memory location that corresponds to this abstraction class instance at the specified offset using the specified access path. If the memory is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access). If a back-door access path is used, the effect of writing the register through a physical access is mimicked. For example, a read-only memory will not be written.

**read**

```
virtual task read(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    output uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Read the current value from a memory location

Read and return value from the memory location that corresponds to this abstraction class instance at the specified offset using the specified access path. If the register is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

**burst_write**

```
virtual task burst_write(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input int lineno = 0
)
```
Write the specified values in memory locations

Burst-write the specified values in the memory locations beginning at the specified offset. If the memory is mapped in more than one address map, an address map must be specified if not using the backdoor. If a back-door access path is used, the effect of writing the register through a physical access is mimicked. For example, a read-only memory will not be written.

**burst_read**

```plaintext
define uvm_reg_data_t
#define UVM_DEFAULT_PATH
#define null

virtual task burst_read(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    ref uvm_reg_data_t value[],
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0)
)
```

Read values from memory locations

Burst-read into values the data the memory locations beginning at the specified offset. If the memory is mapped in more than one address map, an address map must be specified if not using the backdoor. If a back-door access path is used, the effect of writing the register through a physical access is mimicked. For example, a read-only memory will not be written.

**poke**

```plaintext
virtual task poke(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input string kind = "",
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0)
)
```

Deposit the specified value in a memory location

Deposit the value in the DUT memory location corresponding to this abstraction class instance at the specified offset, as-is, using a back-door access.

Uses the HDL path for the design abstraction specified by *kind*.

**peek**
virtual task peek(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    output uvm_reg_data_t value,
    input String kind = "", 
    input uvm_sequence_base parent = null, 
    input uvm_object extension = null,
    input String fname = "", 
    input int lineno = 0
)

Read the current value from a memory location

Sample the value in the DUT memory location corresponding to this abstraction class instance at the specified offset using a back-door access. The memory location value is sampled, not modified.

Uses the HDL path for the design abstraction specified by kind.

FRONTDOOR

set_frontdoor

function void set_frontdoor(
    uvm_reg_frontdoor ftdr,
    uvm_reg_map map = null,
    String fname = "", 
    int lineno = 0
)

Set a user-defined frontdoor for this memory

By default, memories are mapped linearly into the address space of the address maps that instantiate them. If memories are accessed using a different mechanism, a user-defined access mechanism must be defined and associated with the corresponding memory abstraction class.

If the memory is mapped in multiple address maps, an address map must be specified.

get_frontdoor

function uvm_reg_frontdoor get_frontdoor(

    uvm_reg_map map = null
)

Returns the user-defined frontdoor for this memory

If null, no user-defined frontdoor has been defined. A user-defined frontdoor is defined by using the uvm_mem::set_frontdoor() method.

If the memory is mapped in multiple address maps, an address map must be specified.

BACKDOOR

set_backdoor
function void set_backdoor ( uvm_reg_backdoor bkdr, 
    string fname = "", 
    int lineno = 0 
)

Set a user-defined backdoor for this memory

By default, memories are accessed via the built-in string-based DPI routines if an HDL path has been specified using the uvm_mem::configure() or uvm_mem::add_hdl_path() method. If this default mechanism is not suitable (e.g. because the memory is not implemented in pure SystemVerilog) a user-defined access mechanism must be defined and associated with the corresponding memory abstraction class.

**get_backdoor**

function uvm_reg_backdoor get_backdoor( 
    bit inherited = 1 
)

Returns the user-defined backdoor for this memory

If null, no user-defined backdoor has been defined. A user-defined backdoor is defined by using the uvm_reg::set_backdoor() method.

If inherit is TRUE, returns the backdoor of the parent block if none have been specified for this memory.

**clear_hdl_path**

function void clear_hdl_path ( 
    string kind = "RTL" 
)

Delete HDL paths

Remove any previously specified HDL path to the memory instance for the specified design abstraction.

**add_hdl_path**

function void add_hdl_path ( 
    uvm_hdl_path_slice slices[], 
    string kind = "RTL" 
)

Add an HDL path

Add the specified HDL path to the memory instance for the specified design abstraction. This method may be called more than once for the same design abstraction if the memory is physically duplicated in the design abstraction.

**add_hdl_path_slice**

function void add_hdl_path_slice( 
    string name, int offset, 
)
Add the specified HDL slice to the HDL path for the specified design abstraction. If `first` is TRUE, starts the specification of a duplicate HDL implementation of the memory.

**has_hdl_path**

```plaintext
function bit has_hdl_path (  
    string kind = ""
)
```

Check if a HDL path is specified

Returns TRUE if the memory instance has a HDL path defined for the specified design abstraction. If no design abstraction is specified, uses the default design abstraction specified for the parent block.

get_hdl_path

```plaintext
function void get_hdl_path (  
    ref uvm_hdl_path_concat paths[],  
    input string kind = ""
)
```

Get the incremental HDL path(s)

Returns the HDL path(s) defined for the specified design abstraction in the memory instance. Returns only the component of the HDL paths that corresponds to the memory, not a full hierarchical path.

If no design abstraction is specified, the default design abstraction for the parent block is used.

get_full_hdl_path

```plaintext
function void get_full_hdl_path (  
    ref uvm_hdl_path_concat paths[],  
    input string kind = "",  
    input string separator = "."
)
```

Get the full hierarchical HDL path(s)

Returns the full hierarchical HDL path(s) defined for the specified design abstraction in the memory instance. There may be more than one path returned even if only one path was defined for the memory instance, if any of the parent components have more than one path defined for the same design abstraction.

If no design abstraction is specified, the default design abstraction for each ancestor block is used to get each incremental path.

get_hdl_path_kinds

```plaintext
function void get_hdl_path_kinds (  
    ref string kinds[]
)
```
Get design abstractions for which HDL paths have been defined

**backdoor_read**

```
virtual protected task backdoor_read(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access read for this memory type. By default calls `uvm_mem::backdoor_read_func()`.

**backdoor_write**

```
virtual task backdoor_write(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access write for this memory type.

**backdoor_read_func**

```
virtual function uvm_status_e backdoor_read_func(
    uvm_reg_item rw
)
```

User-defined backdoor read access

Override the default string-based DPI backdoor access read for this memory type.

**CALLBACKS**

**pre_write**

```
virtual task pre_write(
    uvm_reg_item rw
)
```

Called before memory write.

If the `offset`, `value`, `access path`, or `address map` are modified, the updated offset, data value, access path or address map will be used to perform the memory operation. If the `status` is modified to anything other than `UVM_IS_OK`, the operation is aborted.

The registered callback methods are invoked after the invocation of this method.

**post_write**
Called after memory write.

If the status is modified, the updated status will be returned by the memory operation.

The registered callback methods are invoked before the invocation of this method.

**pre_read**

```virtual task pre_read(
  uvm_reg_item rw
)
```

Called before memory read.

If the offset, access path or address map are modified, the updated offset, access path or address map will be used to perform the memory operation. If the status is modified to anything other than UVM_IS_OK, the operation is aborted.

The registered callback methods are invoked after the invocation of this method.

**post_read**

```virtual task post_read(
  uvm_reg_item rw
)
```

Called after memory read.

If the readback data or status is modified, the updated readback //data or status will be returned by the memory operation.

The registered callback methods are invoked before the invocation of this method.

**Coverage**

**build_coverage**

```protected function uvm_reg_cvr_t build_coverage(
  uvm_reg_cvr_t models
)
```

Check if all of the specified coverage model must be built.

Check which of the specified coverage model must be built in this instance of the memory abstraction class, as specified by calls to uvm_reg::include_coverage().

Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e. Returns the sum of all coverage models to be built in the memory model.
add_coverage

virtual protected function void add_coverage(
    uvm_reg_cvr_t models
)

Specify that additional coverage models are available.

Add the specified coverage model to the coverage models available in this class. Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e.

This method shall be called only in the constructor of subsequently derived classes.

has_coverage

virtual function bit has_coverage(
    uvm_reg_cvr_t models
)

Check if memory has coverage model(s)

Returns TRUE if the memory abstraction class contains a coverage model for all of the models specified. Models are specified by adding the symbolic value of individual coverage model as defined in uvm_coverage_model_e.

set_coverage

virtual function uvm_reg_cvr_t set_coverage(
    uvm_reg_cvr_t is_on
)

Turns on coverage measurement.

Turns the collection of functional coverage measurements on or off for this memory. The functional coverage measurement is turned on for every coverage model specified using uvm_coverage_model_e symbolic identifiers. Multiple functional coverage models can be specified by adding the functional coverage model identifiers. All other functional coverage models are turned off. Returns the sum of all functional coverage models whose measurements were previously on.

This method can only control the measurement of functional coverage models that are present in the memory abstraction classes, then enabled during construction. See the uvm_mem::has_coverage() method to identify the available functional coverage models.

get_coverage

virtual function bit get_coverage(
    uvm_reg_cvr_t is_on
)

Check if coverage measurement is on.

Returns TRUE if measurement for all of the specified functional coverage models are currently on. Multiple functional coverage models can be specified by adding the functional coverage model identifiers.

See uvm_mem::set_coverage() for more details.
Functional coverage measurement method

This method is invoked by the memory abstraction class whenever an address within one of its address map is successfully read or written. The specified offset is the offset within the memory, not an absolute address.

Empty by default, this method may be extended by the abstraction class generator to perform the required sampling in any provided functional coverage model.
25.7 uvm_reg_indirect_data

Indirect data access abstraction class

Models the behavior of a register used to indirectly access a register array, indexed by a second address register.

This class should not be instantiated directly. A type-specific class extension should be used to provide a factory-enabled constructor and specify the n_bits and coverage models.

Summary

uvm_reg_indirect_data
Indirect data access abstraction class

CLASS HIERARCHY

uvm_void
uvm_object
uvm_reg
uvm_reg_indirect_data

CLASS DECLARATION

class uvm_reg_indirect_data extends uvm_reg

METHODS

new

function new(
    string name = "uvm_reg_indirect",
    int unsigned n_bits,
    int has_cover
)

Create an instance of this class

Should not be called directly, other than via super.new(). The value of n_bits must match the number of bits in the indirect register array.

configure

function void configure (uvm_reg idx, uvm_reg reg_a[], uvm_reg_block blk_parent)
Configure the indirect data register.

The \textit{idx} register specifies the index, in the \textit{reg_a} register array, of the register to access. The \textit{idx} must be written to first. A read or write operation to this register will subsequently read or write the indexed register in the register array.

The number of bits in each register in the register array must be equal to \textit{n_bits} of this register.

See \texttt{uvm_reg::configure()} for the remaining arguments.
This special register models a DUT FIFO accessed via write/read, where writes push to the FIFO and reads pop from it.

Backdoor access is not enabled, as it is not yet possible to force complete FIFO state, i.e. the write and read indexes used to access the FIFO data.

**Summary**

### uvm_reg_fifo

This special register models a DUT FIFO accessed via write/read, where writes push to the FIFO and reads pop from it.

#### Class Hierarchy

```
uvm_void
uvm_object
uvm_reg
uvm_reg_fifo
```

#### Class Declaration

```
class uvm_reg_fifo extends uvm_reg
```

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#### fifo

```
rand uvm_reg_data_t fifo[]
```

The abstract representation of the FIFO. Constrained to be no larger than the size
parameter. It is public to enable subtypes to add constraints on it and randomize.

**INITIALIZATION**

**new**

```plaintext
function new(  
    string name = "reg_fifo",
    int unsigned size,
    int unsigned n_bits,
    int has_cover
)
```

Creates an instance of a FIFO register having size elements of n_bits each.

**set_compare**

```plaintext
function void set_compare(  
    uvm_check_e check = UVM_CHECK
)
```

Sets the compare policy during a mirror (read) of the DUT FIFO. The DUT read value is checked against its mirror only when both the check argument in the mirror() call and the compare policy for the field is UVM_CHECK.

**INTROSPECTION**

**size**

```plaintext
function int unsigned size()
```

The number of entries currently in the FIFO.

**capacity**

```plaintext
function int unsigned capacity()
```

The maximum number of entries, or depth, of the FIFO.

**Access**

**write**

Pushes the given value to the DUT FIFO. If auto-prediction is enabled, the written value is also pushed to the abstract FIFO before the call returns. If auto-prediction is not enabled (via uvm_reg_map::set_auto_predict), the value is pushed to abstract FIFO only when the write operation is observed on the target bus. This mode requires using the
**uvm_reg_predictor** class. If the write is via an `update()` operation, the abstract FIFO already contains the written value and is thus not affected by either prediction mode.

### read

Reads the next value out of the DUT FIFO. If auto-prediction is enabled, the frontmost value in abstract FIFO is popped.

### set

```c
virtual function void set(
    uvm_reg_data_t value,
    string   fname = ",
    int      lineno = 0
)
```

Pushes the given value to the abstract FIFO. You may call this method several times before an `update()` as a means of preloading the DUT FIFO. Calls to `set()` to a full FIFO are ignored. You must call `update()` to update the DUT FIFO with your set values.

### update

```c
virtual task update(
    output uvm_status_e status,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = ",
    input int lineno = 0
)
```

Pushes (writes) all values preloaded using `set()` to the DUT. You must `update` after `set` before any blocking statements, else other reads/writes to the DUT FIFO may cause the mirror to become out of sync with the DUT.

### mirror

Reads the next value out of the DUT FIFO. If auto-prediction is enabled, the frontmost value in abstract FIFO is popped. If the `check` argument is set and comparison is enabled with `set_compare()`.

### get

```c
virtual function uvm_reg_data_t get(
    string   fname = ",
    int      lineno = 0
)
```

Returns the next value from the abstract FIFO, but does not pop it. Used to get the expected value in a `mirror()` operation.

### do_predict
virtual function void do_predict(
    uvm_reg_item rw,
    uvm_predict_e kind = UVM_PREDICT_DIRECT,
    uvm_reg_byte_en_t be = -1
)

Updates the abstract (mirror) FIFO based on write() and read() operations. When auto-prediction is on, this method is called before each read, write, peek, or poke operation returns. When auto-prediction is off, this method is called by a uvm_reg_predictor upon receipt and conversion of an observed bus operation to this register.

If a write prediction, the observed write value is pushed to the abstract FIFO as long as it is not full and the operation did not originate from an update(). If a read prediction, the observed read value is compared with the frontmost value in the abstract FIFO if set_compare() enabled comparison and the FIFO is not empty.

**SPECIAL OVERRIDES**

**pre_write**

```plaintext
virtual task pre_write(
    uvm_reg_item rw
)
```

Special pre-processing for a write() or update(). Called as a result of a write() or update(). It is an error to attempt a write to a full FIFO or a write while an update is still pending. An update is pending after one or more calls to set(). If in your application the DUT allows writes to a full FIFO, you must override pre_write as appropriate.

**pre_read**

```plaintext
virtual task pre_read(
    uvm_reg_item rw
)
```

Special post-processing for a write() or update(). Aborts the operation if the internal FIFO is empty. If in your application the DUT does not behave this way, you must override pre_write as appropriate.
25.9 Virtual Registers

A virtual register is a collection of fields, overlaid on top of a memory, usually in an array. The semantics and layout of virtual registers comes from an agreement between the software and the hardware, not any physical structures in the DUT.

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**uvm_vreg**

Virtual register abstraction base class

A virtual register represents a set of fields that are logically implemented in consecutive memory locations.

All virtual register accesses eventually turn into memory accesses.

A virtual register array may be implemented on top of any memory abstraction class and possibly dynamically resized and/or relocated.

**Summary**

**uvm_vreg**

Virtual register abstraction base class

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**Initialization**

### new

```plaintext
function new(
    string     name,
    int unsigned n_bits
)
```

Create a new instance and type-specific configuration

Create an instance of a virtual register abstraction class with the specified name.

*n_bits* specifies the total number of bits in a virtual register. Not all bits need to be mapped to a virtual field. This value is usually a multiple of 8.

### configure

```plaintext
function void configure(
    uvm_reg_block parent,
)
```
Instance-specific configuration

Specify the parent block of this virtual register array. If one of the other parameters are specified, the virtual register is assumed to be dynamic and can be later (re-)implemented using the uvm_vreg::implement() method.

If mem is specified, then the virtual register array is assumed to be statically implemented in the memory corresponding to the specified memory abstraction class and size, offset and incr must also be specified. Static virtual register arrays cannot be re-implemented.

**implement**

```cpp
virtual function bit implement(
  longint unsigned n,
  uvm_mem mem = null,
  uvm_reg_addr_t offset = 0,
  int unsigned incr = 0
)
```

Dynamically implement, resize or relocate a virtual register array

Implement an array of virtual registers of the specified size, in the specified memory and offset. If an offset increment is specified, each virtual register is implemented at the specified offset increment from the previous one. If an offset increment of 0 is specified, virtual registers are packed as closely as possible in the memory.

If no memory is specified, the virtual register array is in the same memory, at the same base offset using the same offset increment as originally implemented. Only the number of virtual registers in the virtual register array is modified.

The initial value of the newly-implemented or relocated set of virtual registers is whatever values are currently stored in the memory now implementing them.

Returns TRUE if the memory can implement the number of virtual registers at the specified base offset and offset increment. Returns FALSE otherwise.

The memory region used to implement a virtual register array is reserved in the memory allocation manager associated with the memory to prevent it from being allocated for another purpose.

**allocate**

```cpp
virtual function uvm_mem_region allocate(
  longint unsigned n,
  uvm_mem_mam mam,
  uvm_mem_mam_policy alloc = null
)
```

Randomly implement, resize or relocate a virtual register array

Implement a virtual register array of the specified size in a randomly allocated region of the appropriate size in the address space managed by the specified memory allocation manager. If a memory allocation policy is specified, it is passed to the uvm_mem_mam::request_region() method.
The initial value of the newly-implemented or relocated set of virtual registers is whatever values are currently stored in the memory region now implementing them.

Returns a reference to a `uvm_mem_region` memory region descriptor if the memory allocation manager was able to allocate a region that can implement the virtual register array with the specified allocation policy. Returns `null` otherwise.

A region implementing a virtual register array must not be released using the `uvm_mem_mam::release_region()` method. It must be released using the `uvm_vreg::release_region()` method.

**get_region**

```
virtual function uvm_mem_region get_region()
```

Get the region where the virtual register array is implemented

Returns a reference to the `uvm_mem_region` memory region descriptor that implements the virtual register array.

Returns `null` if the virtual registers array is not currently implemented. A region implementing a virtual register array must not be released using the `uvm_mem_mam::release_region()` method. It must be released using the `uvm_vreg::release_region()` method.

**release_region**

```
virtual function void release_region()
```

Dynamically un-implement a virtual register array

Release the memory region used to implement a virtual register array and return it to the pool of available memory that can be allocated by the memory’s default allocation manager. The virtual register array is subsequently considered as unimplemented and can no longer be accessed.

Statically-implemented virtual registers cannot be released.

**INTROSPECTION**

**get_name**

Get the simple name

Return the simple object name of this register.

**get_full_name**

```
virtual function string get_full_name()
```

Get the hierarchical name
Return the hierarchical name of this register. The base of the hierarchical name is the root block.

`get_parent`

```cpp
virtual function uvm_reg_block get_parent()
```

Get the parent block

`get_memory`

```cpp
virtual function uvm_mem get_memory()
```

Get the memory where the virtual register array is implemented

`get_n_maps`

```cpp
virtual function int get_n_maps ()
```

Returns the number of address maps this virtual register array is mapped in

`is_in_map`

```cpp
function bit is_in_map ( uvm_reg_map map )
```

Return TRUE if this virtual register array is in the specified address `map`

`get_maps`

```cpp
virtual function void get_maps ( ref uvm_reg_map maps[] )
```

Returns all of the address `maps` where this virtual register array is mapped

`get_rights`

```cpp
virtual function string get_rights( uvm_reg_map map = null )
```

Returns the access rights of this virtual register array

Returns “RW”, “RO” or “WO”. The access rights of a virtual register array is always “RW”, unless it is implemented in a shared memory with access restriction in a particular address map.

If no address map is specified and the memory is mapped in only one address map, that address map is used. If the memory is mapped in more than one address map, the default address map of the parent block is used.
If an address map is specified and the memory is not mapped in the specified address map, an error message is issued and “RW” is returned.

**get_access**

```
virtual function string get_access(
    uvm_reg_map map = null
)
```

Returns the access policy of the virtual register array when written and read via an address map.

If the memory implementing the virtual register array is mapped in more than one address map, an address map must be specified. If access restrictions are present when accessing a memory through the specified address map, the access mode returned takes the access restrictions into account. For example, a read-write memory accessed through an address map with read-only restrictions would return ”RO”.

**get_size**

```
virtual function int unsigned get_size()
```

Returns the size of the virtual register array.

**get_n_bytes**

```
virtual function int unsigned get_n_bytes()
```

Returns the width, in bytes, of a virtual register.

The width of a virtual register is always a multiple of the width of the memory locations used to implement it. For example, a virtual register containing two 1-byte fields implemented in a memory with 4-bytes memory locations is 4-byte wide.

**get_n_memlocs**

```
virtual function int unsigned get_n_memlocs()
```

Returns the number of memory locations used by a single virtual register.

**get_incr**

```
virtual function int unsigned get_incr()
```

Returns the number of memory locations between two individual virtual registers in the same array.

**get_fields**

```
virtual function void get_fields(
    ref uvm_vreg_field field[]
)
```
Return the virtual fields in this virtual register

Fills the specified array with the abstraction class for all of the virtual fields contained in this virtual register. Fields are ordered from least-significant position to most-significant position within the register.

**get_field_by_name**

```plaintext
virtual function uvm_vreg_field get_field_by_name(
    string name
)
```

Return the named virtual field in this virtual register

Finds a virtual field with the specified name in this virtual register and returns its abstraction class. If no fields are found, returns *null*.

**get_offset_in_memory**

```plaintext
virtual function uvm_reg_addr_t get_offset_in_memory(
    longint unsigned idx
)
```

Returns the offset of a virtual register

Returns the base offset of the specified virtual register, in the overall address space of the memory that implements the virtual register array.

**get_address**

```plaintext
virtual function uvm_reg_addr_t get_address(
    longint unsigned idx,
    uvm_reg_map map = null
)
```

Returns the base external physical address of a virtual register

Returns the base external physical address of the specified virtual register if accessed through the specified address *map*.

If no address map is specified and the memory implementing the virtual register array is mapped in only one address map, that address map is used. If the memory is mapped in more than one address map, the default address map of the parent block is used.

If an address map is specified and the memory is not mapped in the specified address map, an error message is issued.

**HDL Access**

**write**

```plaintext
virtual task write(
```

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Write the specified value in a virtual register

Write value in the DUT memory location(s) that implements the virtual register array that corresponds to this abstraction class instance using the specified access path.

If the memory implementing the virtual register array is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

The operation is eventually mapped into set of memory-write operations at the location where the virtual register specified by idx in the virtual register array is implemented.

**read**

```plaintext
virtual task read(
   input longint unsigned idx,
   output uvm_status_e status,
   output uvm_reg_data_t value,
   input uvm_path_e path = UVM_DEFAULT_PATH,
   input uvm_reg_map map = null,
   input uvm_sequence_base parent = null,
   input string fname = "",
   input int lineno = 0
)
```

Read the current value from a virtual register

Read from the DUT memory location(s) that implements the virtual register array that corresponds to this abstraction class instance using the specified access path and return the readback value.

If the memory implementing the virtual register array is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

The operation is eventually mapped into set of memory-read operations at the location where the virtual register specified by idx in the virtual register array is implemented.

**poke**

```plaintext
virtual task poke(
   input longint unsigned idx,
   output uvm_status_e status,
   output uvm_reg_data_t value,
   input uvm_path_e path = UVM_DEFAULT_PATH,
   input uvm_reg_map map = null,
   input uvm_sequence_base parent = null,
   input string fname = "",
   input int lineno = 0
)
```

Deposit the specified value in a virtual register

Deposit value in the DUT memory location(s) that implements the virtual register array
that corresponds to this abstraction class instance using the memory backdoor access.

The operation is eventually mapped into set of memory-poke operations at the location where the virtual register specified by \( idx \) in the virtual register array is implemented.

**peek**

```verilog
define virtual task peek(
    input longint unsigned idx,
    output uvm_status_e status,
    output uvm_reg_data_t value,
    input uvm_sequence_base parent = null, 
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0 
)
```

Sample the current value in a virtual register

Sample the DUT memory location(s) that implements the virtual register array that corresponds to this abstraction class instance using the memory backdoor access, and return the sampled value.

The operation is eventually mapped into set of memory-peek operations at the location where the virtual register specified by \( idx \) in the virtual register array is implemented.

**reset**

```verilog
function void reset(
    string kind = "HARD"
)
```

Reset the access semaphore

Reset the semaphore that prevents concurrent access to the virtual register. This semaphore must be explicitly reset if a thread accessing this virtual register array was killed in before the access was completed.

**callbacks**

**pre_write**

```verilog
define virtual task pre_write(
    longint unsigned idx,
    ref uvm_reg_data_t wdat,
    ref uvm_path_e path,
    ref uvm_reg_map map 
)
```

Called before virtual register write.

If the specified data value, access path or address map are modified, the updated data value, access path or address map will be used to perform the virtual register operation.

The registered callback methods are invoked after the invocation of this method. All register callbacks are executed after the corresponding field callbacks. The pre-write virtual register and field callbacks are executed before the corresponding pre-write memory callbacks.
### post_write

```plaintext
virtual task post_write(
    longint unsigned idx,
    uvm_reg_data_t wdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after virtual register write.

If the specified status is modified, the updated status will be returned by the virtual register operation.

The registered callback methods are invoked before the invocation of this method. All register callbacks are executed before the corresponding field callbacks The post-write virtual register and field callbacks are executed after the corresponding post-write memory callbacks

### pre_read

```plaintext
virtual task pre_read(
    longint unsigned idx,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Called before virtual register read.

If the specified access path or address map are modified, the updated access path or address map will be used to perform the register operation.

The registered callback methods are invoked after the invocation of this method. All register callbacks are executed after the corresponding field callbacks The pre-read virtual register and field callbacks are executed before the corresponding pre-read memory callbacks

### post_read

```plaintext
virtual task post_read(
    longint unsigned idx,
    ref uvm_reg_data_t rdat,
    input uvm_path_e path,
    input uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after virtual register read.

If the specified readback data or status is modified, the updated readback data or status will be returned by the register operation.

The registered callback methods are invoked before the invocation of this method. All register callbacks are executed before the corresponding field callbacks The post-read virtual register and field callbacks are executed after the corresponding post-read memory callbacks
uvm_vreg_cbs

Pre/post read/write callback facade class

Summary

**uvm_vreg_cbs**

Pre/post read/write callback facade class

**CLASS HIERARCHY**

```
    uvm_void
    uvm_object
    uvm_callback
    uvm_vreg_cbs
```

**CLASS DECLEARATION**

```
class uvm_vreg_cbs extends uvm_callback
```

**METHODS**

**pre_write**

```
virtual task pre_write(
    uvm_vreg rg,
    longint unsigned idx,
    ref uvm_reg_data_t wdat,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Callback called before a write operation.

The registered callback methods are invoked after the invocation of the `uvm_vreg::pre_write()` method. All virtual register callbacks are executed after the corresponding virtual field callbacks. The pre-write virtual register and field callbacks are executed before the corresponding pre-write memory callbacks.

The written value `wdat`, access `path` and address `map`, if modified, modifies the actual value, access path or address map used in the virtual register operation.
**post_write**

```
virtual task post_write(
    uvm_vreg rg,
    longint unsigned idx,
    uvm_reg_data_t wdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after register write.

The registered callback methods are invoked before the invocation of the `uvm_reg::post_write()` method. All register callbacks are executed before the corresponding virtual field callbacks. The post-write virtual register and field callbacks are executed after the corresponding post-write memory callbacks.

The `status` of the operation, if modified, modifies the actual returned status.

**pre_read**

```
virtual task pre_read(
    uvm_vreg rg,
    longint unsigned idx,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Called before register read.

The registered callback methods are invoked after the invocation of the `uvm_reg::pre_read()` method. All register callbacks are executed after the corresponding virtual field callbacks. The pre-read virtual register and field callbacks are executed before the corresponding pre-read memory callbacks.

The access `path` and address `map`, if modified, modifies the actual access path or address map used in the register operation.

**post_read**

```
virtual task post_read(
    uvm_vreg rg,
    longint unsigned idx,
    ref uvm_reg_data_t rdat,
    input uvm_path_e path,
    input uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after register read.

The registered callback methods are invoked before the invocation of the `uvm_reg::post_read()` method. All register callbacks are executed before the corresponding virtual field callbacks. The post-read virtual register and field callbacks are executed after the corresponding post-read memory callbacks.

The readback value `rdat` and the `status` of the operation, if modified, modifies the actual returned readback value and status.
**Types**

**uvm_vreg_cb**

Convenience callback type declaration

Use this declaration to register virtual register callbacks rather than the more verbose parameterized class

**uvm_vreg_cb_iter**

Convenience callback iterator type declaration

Use this declaration to iterate over registered virtual register callbacks rather than the more verbose parameterized class
25.10 Virtual Register Field Classes

This section defines the virtual field and callback classes.

A virtual field is set of contiguous bits in one or more memory locations. The semantics and layout of virtual fields comes from an agreement between the software and the hardware, not any physical structures in the DUT.

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uvm_vreg_field

Virtual field abstraction class

A virtual field represents a set of adjacent bits that are logically implemented in consecutive memory locations.

Summary

uvm_vreg_field

Virtual field abstraction class

**Class Hierarchy**

```
| uvm_void |
| uvm_object |
| uvm_vreg_field |
```

**Class Declaration**

```
class uvm_vreg_field extends uvm_object
```

**Initialization**

```
| new | Create a new virtual field instance |
| configure | Instance-specific configuration |
```

**Introspection**

```
| get_name | Get the simple name |
| get_full_name | Get the hierarchical name |
| get_parent | Get the parent virtual register |
| get_lsb_pos_in_register | Return the position of the virtual field / Returns the index of the least significant bit of the virtual field in the virtual register that instantiates it. |
| get_n_bits | Returns the width, in bits, of the virtual field. |
| get_access | Returns the access policy of the virtual field register when written and read via an address map. |
```

**HDL Access**
**INITIALIZATION**

**new**

```cpp
function new(
    string name = "uvm_vreg_field"
)
```

Create a new virtual field instance

This method should not be used directly. The uvm_vreg_field::type_id::create() method should be used instead.

**configure**

```cpp
function void configure(
    uvm_vreg parent,
    int unsigned size,
    int unsigned lsb_pos
)
```

Instance-specific configuration

Specify the `parent` virtual register of this virtual field, its `size` in bits, and the position of its least-significant bit within the virtual register relative to the least-significant bit of the virtual register.

**INTROSPECTION**

**get_name**

Get the simple name

Return the simple object name of this virtual field

**get_full_name**

```cpp
virtual function string get_full_name()
```

Get the hierarchical name
Return the hierarchical name of this virtual field. The base of the hierarchical name is the root block.

get_parent

virtual function uvm_vreg get_parent()

Get the parent virtual register.

get_lsb_pos_in_register

virtual function int unsigned get_lsb_pos_in_register()

Return the position of the virtual field. Returns the index of the least significant bit of the virtual field in the virtual register that instantiates it. An offset of 0 indicates a field that is aligned with the least-significant bit of the register.

get_n_bits

virtual function int unsigned get_n_bits()

Returns the width, in bits, of the virtual field.

get_access

virtual function string get_access(
    uvm_reg_map map = null
)

Returns the access policy of the virtual field register when written and read via an address map.

If the memory implementing the virtual field is mapped in more than one address map, an address map must be specified. If access restrictions are present when accessing a memory through the specified address map, the access mode returned takes the access restrictions into account. For example, a read-write memory accessed through an address map with read-only restrictions would return "RO".

HDL Access

write

virtual task write(
    input longint unsigned idx,
    output uvm_status_e status,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
Write the specified value in a virtual field

Write value in the DUT memory location(s) that implements the virtual field that corresponds to this abstraction class instance using the specified access path.

If the memory implementing the virtual register array containing this virtual field is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

The operation is eventually mapped into memory read-modify-write operations at the location where the virtual register specified by idx in the virtual register array is implemented. If a backdoor is available for the memory implementing the virtual field, it will be used for the memory-read operation.

\[\text{read} \]

```plaintext
virtual task read(
    input longint unsigned idx,
    output uvm_status_e status,
    output uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Read the current value from a virtual field

Read from the DUT memory location(s) that implements the virtual field that corresponds to this abstraction class instance using the specified access path, and return the readback value.

If the memory implementing the virtual register array containing this virtual field is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

The operation is eventually mapped into memory read operations at the location(s) where the virtual register specified by idx in the virtual register array is implemented.

\[\text{poke} \]

```plaintext
virtual task poke(
    input longint unsigned idx,
    output uvm_status_e status,
    input uvm_reg_data_t value,
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Deposit the specified value in a virtual field

Deposit value in the DUT memory location(s) that implements the virtual field that corresponds to this abstraction class instance using the specified access path.

The operation is eventually mapped into memory peek-modify-poke operations at the location where the virtual register specified by idx in the virtual register array is implemented.
peek

```plaintext
virtual task peek(
    input longint unsigned idx,
    output uvm_status_e status,
    output uvm_reg_data_t value,
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input int lineno = 0
)
```

Sample the current value from a virtual field

Sample from the DUT memory location(s) that implements the virtual field that corresponds to this abstraction class instance using the specified access path, and return the readback value.

If the memory implementing the virtual register array containing this virtual field is mapped in more than one address map, an address map must be specified if a physical access is used (front-door access).

The operation is eventually mapped into memory peek operations at the location(s) where the virtual register specified by idx in the virtual register array is implemented.

CALLBACKS

pre_write

```plaintext
virtual task pre_write(
    longint unsigned idx,
    ref uvm_reg_data_t wdat,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Called before virtual field write.

If the specified data value, access path or address map are modified, the updated data value, access path or address map will be used to perform the virtual register operation.

The virtual field callback methods are invoked before the callback methods on the containing virtual register. The registered callback methods are invoked after the invocation of this method. The pre-write virtual register and field callbacks are executed before the corresponding pre-write memory callbacks.

post_write

```plaintext
virtual task post_write(
    longint unsigned idx,
    uvm_reg_data_t wdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after virtual field write

If the specified status is modified, the updated status will be returned by the virtual
register operation.

The virtual field callback methods are invoked after the callback methods on the containing virtual register. The registered callback methods are invoked before the invocation of this method. The post-write virtual register and field callbacks are executed after the corresponding post-write memory callbacks.

**pre_read**

```plaintext
virtual task pre_read(
    longint unsigned idx,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Called before virtual field read.

If the specified access path or address map are modified, the updated access path or address map will be used to perform the virtual register operation.

The virtual field callback methods are invoked after the callback methods on the containing virtual register. The registered callback methods are invoked after the invocation of this method. The pre-read virtual register and field callbacks are executed before the corresponding pre-read memory callbacks.

**post_read**

```plaintext
virtual task post_read(
    longint unsigned idx,
    ref uvm_reg_data_t rdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after virtual field read.

If the specified readback data rdat or status is modified, the updated readback data or status will be returned by the virtual register operation.

The virtual field callback methods are invoked after the callback methods on the containing virtual register. The registered callback methods are invoked before the invocation of this method. The post-read virtual register and field callbacks are executed after the corresponding post-read memory callbacks.

**uvm_vreg_field_cbs**

Pre/post read/write callback facade class

**Summary**

```
Summary

uvm_vreg_field_cbs

Pre/post read/write callback facade class

```
**Class Declaration**

```
class uvm_vreg_field_cbs extends uvm_callback
```

**Methods**

**pre_write**

```
virtual task pre_write(
    uvm_vreg_field field,
    longint unsigned idx,
    ref uvm_reg_data_t wdat,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Callback called before a write operation.

The registered callback methods are invoked before the invocation of the virtual register pre-write callbacks and after the invocation of the `uvm_vreg_field::pre_write()` method.

The written value `wdat`, access `path` and address `map`, if modified, modifies the actual value, access path or address map used in the register operation.

**post_write**

```
virtual task post_write(
    uvm_vreg_field field,
    longint unsigned idx,
    uvm_reg_data_t wdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after a write operation

The registered callback methods are invoked after the invocation of the virtual register post-write callbacks and before the invocation of the `uvm_vreg_field::post_write()` method.

The `status` of the operation, if modified, modifies the actual returned status.
**pre_read**

```verbatim
virtual task pre_read(
    uvm_vreg_field field,
    longint unsigned idx,
    ref uvm_path_e path,
    ref uvm_reg_map map
)
```

Called before a virtual field read.

The registered callback methods are invoked after the invocation of the virtual register pre-read callbacks and after the invocation of the `uvm_vreg_field::pre_read()` method.

The access `path` and address `map`, if modified, modifies the actual access path or address map used in the register operation.

**post_read**

```verbatim
virtual task post_read(
    uvm_vreg_field field,
    longint unsigned idx,
    ref uvm_reg_data_t rdat,
    uvm_path_e path,
    uvm_reg_map map,
    ref uvm_status_e status
)
```

Called after a virtual field read.

The registered callback methods are invoked after the invocation of the virtual register post-read callbacks and before the invocation of the `uvm_vreg_field::post_read()` method.

The readback value `rdat` and the `status` of the operation, if modified, modifies the actual returned readback value and status.

**Types**

**uvm_vreg_field_cb**

Convenience callback type declaration

Use this declaration to register virtual field callbacks rather than the more verbose parameterized class

**uvm_vreg_field_cb_iter**

Convenience callback iterator type declaration

Use this declaration to iterate over registered virtual field callbacks rather than the more verbose parameterized class
25.11 Register Callbacks

This section defines the base class used for all register callback extensions. It also includes pre-defined callback extensions for use on read-only and write-only registers.

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**Predefined Extensions**

- uvm_reg_read_only_cbs: Pre-defined register callback method for read-only registers that will issue an error if a write() operation is attempted.
- uvm_reg_write_only_cbs: Pre-defined register callback method for write-only registers that will issue an error if a read() operation is attempted.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_callback
  uvm_reg_cbs
```

**Class Declaration**

```
virtual class uvm_reg_cbs extends uvm_callback
```
**Methods**

**pre_write**

Called before a write operation.

All registered `pre_write` callback methods are invoked after the invocation of the `pre_write` method of associated object (`uvm_reg`, `uvm_reg_field`, `uvm_mem`, or `uvm_reg_backdoor`). If the element being written is a `uvm_reg`, all `pre_write` callback methods are invoked before the contained `uvm_reg_fields`.

- Backdoor: `uvm_reg_backdoor::pre_write`, `uvm_reg_cbs::pre_write` cbs for backdoor.
- Register: `uvm_reg::pre_write`, `uvm_reg_cbs::pre_write` cbs for reg, then foreach field: `uvm_reg_field::pre_write`, `uvm_reg_cbs::pre_write` cbs for field
- RegField: `uvm_reg_field::pre_write`, `uvm_reg_cbs::pre_write` cbs for field
- Memory: `uvm_mem::pre_write`, `uvm_reg_cbs::pre_write` cbs for mem

The `rw` argument holds information about the operation.

- Modifying the `value` modifies the actual value written.
- For memories, modifying the `offset` modifies the offset used in the operation.
- For non-backdoor operations, modifying the access `path` or address `map` modifies the actual path or map used in the operation.

If the `rw.status` is modified to anything other than `UVM_IS_OK`, the operation is aborted.

See `uvm_reg_item` for details on `rw` information.

**post_write**

Called after a write operation.

All registered `post_write` callback methods are invoked before the invocation of the `post_write` method of the associated object (`uvm_reg`, `uvm_reg_field`, `uvm_mem`, or...
uvm_reg_backdoor). If the element being written is a uvm_reg, all post_write callback methods are invoked before the contained uvm_reg_fields.

Summary of callback order

| Backdoor  | uvm_reg_cbs::post_write cbs for backdoor, uvm_backdoor::post_write |
| Register  | uvm_reg_cbs::post_write cbs for reg, uvm_reg::post_write, then foreach field: uvm_reg_cbs::post_write cbs for field, uvm_reg_field::post_read |
| RegField  | uvm_reg_cbs::post_write cbs for field, uvm_reg_field::post_write |
| Memory    | uvm_reg_cbs::post_write cbs for mem, uvm_mem::post_write |

The rw argument holds information about the operation.

- Modifying the status member modifies the returned status.
- Modifying the value or offset members has no effect, as the operation has already completed.

See uvm_reg_item for details on rw information.

### pre_read

```markdown
virtual task pre_read(
    uvm_reg_item rw
)
```

Callback called before a read operation.

All registered pre_read callback methods are invoked after the invocation of the pre_read method of associated object (uvm_reg, uvm_reg_field, uvm_mem, or uvm_reg_backdoor). If the element being read is a uvm_reg, all pre_read callback methods are invoked before the contained uvm_reg_fields.

| Backdoor  | uvm_reg_backdoor::pre_read, uvm_reg_cbs::pre_read cbs for backdoor |
| Register  | uvm_reg::pre_read, uvm_reg_cbs::pre_read cbs for reg, then foreach field: uvm_reg_field::pre_read, uvm_reg_cbs::pre_read cbs for field |
| RegField  | uvm_reg_field::pre_read, uvm_reg_cbs::pre_read cbs for field |
| Memory    | uvm_mem::pre_read, uvm_reg_cbs::pre_read cbs for mem |

The rw argument holds information about the operation.

- The value member of rw is not used has no effect if modified.
- For memories, modifying the offset modifies the offset used in the operation.
- For non-backdoor operations, modifying the access path or address map modifies the actual path or map used in the operation.

If the rw.status is modified to anything other than UVM_IS_OK, the operation is aborted.

See uvm_reg_item for details on rw information.

### post_read

```markdown
virtual task post_read(
)
```
Callback called after a read operation.

All registered post_read callback methods are invoked before the invocation of the post_read method of the associated object (uvm_reg, uvm_reg_field, uvm_mem, or uvm_reg_backdoor). If the element being read is a uvm_reg, all post_read callback methods are invoked before the contained uvm_reg_fields.

**Backdoor**
- uvm_reg_cbs::post_read cbs for backdoor,
- uvm_backdoor::post_read

**Register**
- uvm_reg_cbs::post_read cbs for reg, uvm_reg::post_read, then
- foreach field: uvm_reg_cbs::post_read cbs for field,
- uvm_reg_field::post_read

**RegField**
- uvm_reg_cbs::post_read cbs for field, uvm_reg_field::post_read

**Memory**
- uvm_reg_cbs::post_read cbs for mem, uvm_mem::post_read

The rw argument holds information about the operation.
- Modifying the readback value or status modifies the actual returned value and status.
- Modifying the value or offset members has no effect, as the operation has already completed.

See uvm_reg_item for details on rw information.

### post_predict

```vhdl
virtual function void post_predict(
  input uvm_reg_field fld,
  input uvm_reg_data_t previous,
  inout uvm_reg_data_t value,
  input uvm_predict_e kind,
  input uvm_path_e path,
  input uvm_reg_map map
)
```

Called by the uvm_reg_field::predict() method after a successful UVM_PREDICT_READ or UVM_PREDICT_WRITE prediction.

previous is the previous value in the mirror and value is the latest predicted value. Any change to value will modify the predicted mirror value.

### encode

```vhdl
virtual function void encode(
  ref uvm_reg_data_t data[]
)
```

Data encoder

The registered callback methods are invoked in order of registration after all the pre_write methods have been called. The encoded data is passed through each invocation in sequence. This allows the pre_write methods to deal with clear-text data.

By default, the data is not modified.
**decode**

```cpp
def decode(
    ref uvm_reg_data_t data[]
)
```

Data decode

The registered callback methods are invoked in reverse order of registration before all the `post_read` methods are called. The decoded data is passed through each invocation in sequence. This allows the `post_read` methods to deal with clear-text data.

The reversal of the invocation order is to allow the decoding of the data to be performed in the opposite order of the encoding with both operations specified in the same callback extension.

By default, the data is not modified.

**Typedefs**

**Summary**

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**Predefined Extensions**

- **uvm_reg_cb**
  Convenience callback type declaration for registers
  Use this declaration to register the register callbacks rather than the more verbose parameterized class

- **uvm_reg_cb_iter**
  Convenience callback iterator type declaration for registers
  Use this declaration to iterate over registered register callbacks rather than the more verbose parameterized class

- **uvm_reg_bd_cb**
Convenience callback type declaration for backdoor

Use this declaration to register register backdoor callbacks rather than the more verbose parameterized class

**uvm_reg_bd_cb_iter**

Convenience callback iterator type declaration for backdoor

Use this declaration to iterate over registered register backdoor callbacks rather than the more verbose parameterized class

**uvm_mem_cb**

Convenience callback type declaration for memories

Use this declaration to register memory callbacks rather than the more verbose parameterized class

**uvm_mem_cb_iter**

Convenience callback iterator type declaration for memories

Use this declaration to iterate over registered memory callbacks rather than the more verbose parameterized class

**uvm_reg_field_cb**

Convenience callback type declaration for fields

Use this declaration to register field callbacks rather than the more verbose parameterized class

**uvm_reg_field_cb_iter**

Convenience callback iterator type declaration for fields

Use this declaration to iterate over registered field callbacks rather than the more verbose parameterized class

**PREDEFINED EXTENSIONS**

**uvm_reg_read_only_cbs**

Pre-defined register callback method for read-only registers that will issue an error if a write() operation is attempted.
Summary

**uvm_reg_read_only_cbs**

Pre-defined register callback method for read-only registers that will issue an error if a write() operation is attempted.

**Class Hierarchy**

```
  uvm_void
  uvm_object
  uvm_callback
  uvm_reg_cbs
  uvm_reg_read_only_cbs
```

**Class Declaration**

```
class uvm_reg_read_only_cbs extends uvm_reg_cbs
```

**Methods**

**pre_write**

```
virtual task pre_write(
  uvm_reg_item Tw
)
```

Produces an error message and sets status to **UVM_NOT_OK**.

**add**

```
static function void add(
  uvm_reg rg
)
```

Add this callback to the specified register and its contained fields.

**remove**

```
static function void remove(
  uvm_reg rg
)
```

Remove this callback from the specified register and its contained fields.
### Summary

**uvm_reg_write_only_cbs**

Pre-defined register callback method for write-only registers that will issue an error if a read() operation is attempted.

#### Class Hierarchy

```
  uvm_void
  uvm_object
  uvm_callback
  uvm_reg_cbs
  uvm_reg_write_only_cbs
```

#### Class Declaration

```
class uvm_reg_write_only_cbs extends uvm_reg_cbs
```

#### Methods

**pre_read**

```
virtual task pre_read(
    uvm_reg_item rw
)
```

Produces an error message and sets status to **UVM_NOT_OK**.

**add**

```
static function void add(
    uvm_reg rg
)
```

Add this callback to the specified register and its contained fields.
Remove this callback from the specified register and its contained fields.

```c
static function void remove(
    uvm_reg rg
)
```
25.12 Memory Allocation Manager

Manages the exclusive allocation of consecutive memory locations called *regions*. The regions can subsequently be accessed like little memories of their own, without knowing in which memory or offset they are actually located.

The memory allocation manager should be used by any application-level process that requires reserved space in the memory, such as DMA buffers.

A region will remain reserved until it is explicitly released.

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**uvm_mem_mam**

Memory allocation manager

Memory allocation management utility class similar to C’s malloc() and free(). A single instance of this class is used to manage a single, contiguous address space.

Summary

**uvm_mem_mam**

Memory allocation manager

**Class Declaration**

```cpp
class uvm_mem_mam
```

**Initialization**

- alloc_mode_e: Memory allocation mode
- locality_e: Location of memory regions
- default_alloc: Region allocation policy
- new: Create a new manager instance
- reconfigure: Reconfigure the manager

**Memory Management**

- reserve_region: Reserve a specific memory region
- request_region: Request and reserve a memory region
- release_region: Release the specified region
- release_all_regions: Forcibly release all allocated memory regions.

**Introspection**

- convert2string: Image of the state of the manager
- for_each: Iterate over all currently allocated regions
- get_memory: Get the managed memory implementation
**INITIALIZATION**

**alloc_mode_e**
Memory allocation mode

Specifies how to allocate a memory region

- **GREEDY**  Consume new, previously unallocated memory
- **THRIFTY** Reused previously released memory as much as possible (not yet implemented)

**locality_e**
Location of memory regions

Specifies where to locate new memory regions

- **BROAD**  Locate new regions randomly throughout the address space
- **NEARBY** Locate new regions adjacent to existing regions

**default_alloc**
Region allocation policy

This object is repeatedly randomized when allocating new regions.

**new**

```plaintext
function new(
    string name,
    uvm_mem_mam_cfg cfg,
    uvm_mem mem = null
)
```
Create a new manager instance

Create an instance of a memory allocation manager with the specified name and configuration. This instance manages all memory region allocation within the address range specified in the configuration descriptor.

If a reference to a memory abstraction class is provided, the memory locations within the regions can be accessed through the region descriptor, using the `uvm_mem_region::read()` and `uvm_mem_region::write()` methods.

**reconfigure**

```plaintext
function uvm_mem_mam_cfg reconfigure{
```
Reconfigure the manager

Modify the maximum and minimum addresses of the address space managed by the allocation manager, allocation mode, or locality. The number of bytes per memory location cannot be modified once an allocation manager has been constructed. All currently allocated regions must fall within the new address space.

Returns the previous configuration.

if no new configuration is specified, simply returns the current configuration.

MEMORY MANAGEMENT

reserve_region

function uvm_mem_region reserve_region(
    bit [63:0] Start_offset,
    int unsigned n_bytes,
    string fname = "",
    int lineno = 0
)

Reserve a specific memory region

Reserve a memory region of the specified number of bytes starting at the specified offset. A descriptor of the reserved region is returned. If the specified region cannot be reserved, null is returned.

It may not be possible to reserve a region because it overlaps with an already-allocated region or it lies outside the address range managed by the memory manager.

Regions can be reserved to create "holes" in the managed address space.

request_region

function uvm_mem_region request_region(
    int unsigned n_bytes,
    uvm_mem_mam_policy alloc = null,
    string fname = "",
    int lineno = 0
)

Request and reserve a memory region

Request and reserve a memory region of the specified number of bytes starting at a random location. If an policy is specified, it is randomized to determine the start offset of the region. If no policy is specified, the policy found in the uvm_mem_mam::default_alloc class property is randomized.

A descriptor of the allocated region is returned. If no region can be allocated, null is returned.

It may not be possible to allocate a region because there is no area in the memory with enough consecutive locations to meet the size requirements or because there is another contradiction when randomizing the policy.
If the memory allocation is configured to *THRIFTY* or *NEARBY*, a suitable region is first sought procedurally.

**release_region**

```plaintext
function void release_region(
    uvm_mem_region region
)
```

Release the specified region

Release a previously allocated memory region. An error is issued if the specified region has not been previously allocated or is no longer allocated.

**release_all_regions**

```plaintext
function void release_all_regions()
```

Forcibly release all allocated memory regions.

**INTROSPECTION**

**convert2string**

```plaintext
function string convert2string()
```

Image of the state of the manager

Create a human-readable description of the state of the memory manager and the currently allocated regions.

**for_each**

```plaintext
function uvm_mem_region for_each(
    bit reset = 0
)
```

Iterate over all currently allocated regions

If reset is *TRUE*, reset the iterator and return the first allocated region. Returns *null* when there are no additional allocated regions to iterate on.

**get_memory**

```plaintext
function uvm_mem get_memory()
```

Get the managed memory implementation

Return the reference to the memory abstraction class for the memory implementing the locations managed by this instance of the allocation manager. Returns *null* if no memory abstraction class was specified at construction time.
Allocated memory region descriptor

Each instance of this class describes an allocated memory region. Instances of this class are created only by the memory manager, and returned by the `uvm_mem_mam::reserve_region()` and `uvm_mem_mam::request_region()` methods.

**Summary**

### uvm_mem_region

Allocated memory region descriptor

**Class Declaration**

```plaintext
class uvm_mem_region
```

**Methods**

- `function bit [63:0] get_start_offset()` Get the start offset of the region
- `function bit [63:0] get_end_offset()` Get the end offset of the region
- `function bit [63:0] get_len` Size of the memory region
- `function bit [63:0] get_n_bytes` Number of bytes in the region
- `function bit [63:0] release_region` Release this region
- `function bit [63:0] get_memory` Get the memory where the region resides
- `function bit [63:0] get_virtual_registers` Get the virtual register array in this region
- `function bit [63:0] write` Write to a memory location in the region.
- `function bit [63:0] read` Read from a memory location in the region.
- `function bit [63:0] burst_write` Write to a set of memory location in the region.
- `function bit [63:0] burst_read` Read from a set of memory location in the region.
- `function bit [63:0] poke` Deposit in a memory location in the region.
- `function bit [63:0] peek` Sample a memory location in the region.

**Methods**

**get_start_offset**

```plaintext
function bit [63:0] get_start_offset()
```

Get the start offset of the region

Return the address offset, within the memory, where this memory region starts.

**get_end_offset**

```plaintext
function bit [63:0] get_end_offset()
```

Get the end offset of the region

Return the address offset, within the memory, where this memory region ends.
**get_len**

function int unsigned get_len()

Size of the memory region

Return the number of consecutive memory locations (not necessarily bytes) in the allocated region.

**get_n_bytes**

function int unsigned get_n_bytes()

Number of bytes in the region

Return the number of consecutive bytes in the allocated region. If the managed memory contains more than one byte per address, the number of bytes in an allocated region may be greater than the number of requested or reserved bytes.

**release_region**

function void release_region()

Release this region

**get_memory**

function uvm_mem get_memory()

Get the memory where the region resides

Return a reference to the memory abstraction class for the memory implementing this allocated memory region. Returns null if no memory abstraction class was specified for the allocation manager that allocated this region.

**get_virtual_registers**

function uvm_vreg get_virtual_registers()

Get the virtual register array in this region

Return a reference to the virtual register array abstraction class implemented in this region. Returns null if the memory region is not known to implement virtual registers.

**write**

```plaintext
task write(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input uvm_sequence_base parent = null,
    input int prior = -1,
    input uvm_object extension = null,
)
```

UVM 1.2 Class Reference
Write to a memory location in the region.

Write to the memory location that corresponds to the specified \texttt{offset} within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See \texttt{uvm_mem::write()} for more details.

\textbf{read}

\begin{verbatim}
    task read(
      output uvm_status_e status,
      input uvm_reg_addr_t offset,
      input uvm_reg_data_t value,
      output uvm_path_e path = UVM_DEFAULT_PATH,
      input uvm_reg_map map = null,
      input uvm_sequence_base parent = null,
      input int prior = -1,
      input uvm_object extension = null,
      input string fname = "",
      input int lineno = 0
    )
\end{verbatim}

Read from a memory location in the region.

Read from the memory location that corresponds to the specified \texttt{offset} within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See \texttt{uvm_mem::read()} for more details.

\textbf{burst_write}

\begin{verbatim}
    task burst_write(
      output uvm_status_e status,
      input uvm_reg_addr_t offset,
      input uvm_reg_data_t value[],
      output uvm_path_e path = UVM_DEFAULT_PATH,
      input uvm_reg_map map = null,
      input uvm_sequence_base parent = null,
      input int prior = -1,
      input uvm_object extension = null,
      input string fname = "",
      input int lineno = 0
    )
\end{verbatim}

Write to a set of memory location in the region.

Write to the memory locations that corresponds to the specified \texttt{burst} within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See \texttt{uvm_mem::burst_write()} for more details.
Read from a set of memory location in the region.

Read from the memory locations that corresponds to the specified burst within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See uvm_mem::burst_read() for more details.

**poke**

```plaintext
task poke(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Deposit in a memory location in the region.

Deposit the specified value in the memory location that corresponds to the specified offset within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See uvm_mem::poke() for more details.

**peek**

```plaintext
task peek(
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    output uvm_sequence_base parent = null,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Sample a memory location in the region.

Sample the memory location that corresponds to the specified offset within this region. Requires that the memory abstraction class be associated with the memory allocation manager that allocated this region.

See uvm_mem::peek() for more details.
An instance of this class is randomized to determine the starting offset of a randomly allocated memory region. This class can be extended to provide additional constraints on the starting offset, such as word alignment or location of the region within a memory page. If a procedural region allocation policy is required, it can be implemented in the pre/post_randomize() method.

**Summary**

**uvm_mem_mam_policy**

An instance of this class is randomized to determine the starting offset of a randomly allocated memory region.

**Class Declaration**

```cpp
class uvm_mem_mam_policy
```

**Variables**

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</tbody>
</table>

**len**

```cpp
int unsigned len
```

Number of addresses required

**start_offset**

```cpp
rand bit [63:0] start_offset
```

The starting offset of the region

**min_offset**

```cpp
bit [63:0] min_offset
```

Minimum address offset in the managed address space

**max_offset**

```cpp
bit [63:0] max_offset
```

Maximum address offset in the managed address space
Regions already allocated in the managed address space

**uvm_mem_mam_cfg**

Specifies the memory managed by an instance of a `uvm_mem_mam` memory allocation manager class.

### Summary

**uvm_mem_mam_cfg**

Specifies the memory managed by an instance of a `uvm_mem_mam` memory allocation manager class.

**Class Declaration**

```plaintext
class uvm_mem_mam_cfg
```

**Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n_bytes</td>
<td>Number of bytes in each memory location</td>
</tr>
<tr>
<td>end_offset</td>
<td>Last address of managed space</td>
</tr>
<tr>
<td>mode</td>
<td>Region allocation mode</td>
</tr>
<tr>
<td>locality</td>
<td>Region location mode</td>
</tr>
</tbody>
</table>

**Variables**

- **n_bytes**
  
  `rand int unsigned n_bytes`
  
  Number of bytes in each memory location

- **end_offset**
  
  `rand bit [63:0] end_offset`
  
  Last address of managed space

- **mode**
  
  `rand uvm_mem_mam::alloc_mode_e mode`
  
  Region allocation mode
locality

rand uvm_mem_mam::locality_e locality

Region location mode
26.1 Generic Register Operation Descriptors

This section defines the abstract register transaction item. It also defines a descriptor for a physical bus operation that is used by uvm_reg_adapter subtypes to convert from a protocol-specific address/data/rw operation to a bus-independent, canonical r/w operation.

Contents

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<tr>
<th>Generic Register Operation Descriptors</th>
<th>This section defines the abstract register transaction item.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_reg_item</td>
<td>Defines an abstract register transaction item.</td>
</tr>
<tr>
<td>uvm_reg_bus_op</td>
<td>Struct that defines a generic bus transaction for register and memory accesses, having kind (read or write), address, data, and byte enable information.</td>
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</tbody>
</table>

uvm_reg_item

Defines an abstract register transaction item. No bus-specific information is present, although a handle to a uvm_reg_map is provided in case a user wishes to implement a custom address translation algorithm.

Summary

uvm_reg_item

Defines an abstract register transaction item.

**Class Hierarchy**

```
<table>
<thead>
<tr>
<th>uvm_void</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_transaction</td>
</tr>
<tr>
<td>uvm_sequence_item</td>
</tr>
<tr>
<td><strong>uvm_reg_item</strong></td>
</tr>
</tbody>
</table>
```

**Class Declaration**

```
class uvm_reg_item extends uvm_sequence_item
```

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>element_kind</td>
<td>Kind of element being accessed: REG, MEM, or FIELD.</td>
</tr>
<tr>
<td>element</td>
<td>A handle to the RegModel model element associated with this transaction.</td>
</tr>
<tr>
<td>kind</td>
<td>Kind of access: READ or WRITE.</td>
</tr>
<tr>
<td>value</td>
<td>The value to write to, or after completion, the value read from the DUT.</td>
</tr>
<tr>
<td>offset</td>
<td>For memory accesses, the offset address.</td>
</tr>
<tr>
<td>status</td>
<td>The result of the transaction: IS_OK, HAS_X, or ERROR.</td>
</tr>
<tr>
<td>local_map</td>
<td>The local map used to obtain addresses.</td>
</tr>
<tr>
<td><strong>map</strong></td>
<td>The original map specified for the operation.</td>
</tr>
<tr>
<td><strong>path</strong></td>
<td>The path being used: <strong>UVM_FRONTDOOR</strong> or <strong>UVM_BACKDOOR</strong>.</td>
</tr>
<tr>
<td><strong>parent</strong></td>
<td>The sequence from which the operation originated.</td>
</tr>
<tr>
<td><strong>prior</strong></td>
<td>The priority requested of this transfer, as defined by <strong>uvm_sequence_base::start_item</strong>.</td>
</tr>
<tr>
<td><strong>extension</strong></td>
<td>Handle to optional user data, as conveyed in the call to write(), read(), mirror(), or update() used to trigger the operation.</td>
</tr>
<tr>
<td><strong>bd_kind</strong></td>
<td>If path is <strong>UVM_BACKDOOR</strong>, this member specifies the abstraction kind for the backdoor access, e.g.</td>
</tr>
<tr>
<td><strong>fname</strong></td>
<td>The file name from where this transaction originated, if provided at the call site.</td>
</tr>
<tr>
<td><strong>lineno</strong></td>
<td>The file name from where this transaction originated, if provided at the call site.</td>
</tr>
</tbody>
</table>

**Methods**

- **new**
  Create a new instance of this type, giving it the optional name.
- **convert2string**
  Returns a string showing the contents of this transaction.
- **do_copy**
  Copy the rhs object into this object.

---

**Variables**

**element_kind**

```c
uvm_elem_kind_e element_kind
```

Kind of element being accessed: REG, MEM, or FIELD. See **uvm_elem_kind_e**.

**element**

```c
uvm_object element
```

A handle to the RegModel model element associated with this transaction. Use **element_kind** to determine the type to cast to: **uvm_reg**, **uvm_mem**, or **uvm_reg_field**.

**kind**

```c
rand uvm_access_e kind
```

Kind of access: READ or WRITE.

**value**

```c
rand uvm_reg_data_t value[]
```

The value to write to, or after completion, the value read from the DUT. Burst operations use the **values** property.

**offset**
For memory accesses, the offset address. For bursts, the *starting* offset address.

### status

```c
uvm_status_e status
```

The result of the transaction: IS_OK, HAS_X, or ERROR. See `uvm_status_e`.

### local_map

```c
uvm_reg_map local_map
```

The local map used to obtain addresses. Users may customize address-translation using this map. Access to the sequencer and bus adapter can be obtained by getting this map’s root map, then calling `uvm_reg_map::get_sequencer` and `uvm_reg_map::get_adapter`.

### map

```c
uvm_reg_map map
```

The original map specified for the operation. The actual `map` used may differ when a test or sequence written at the block level is reused at the system level.

### path

```c
uvm_path_e path
```

The path being used: `UVM_FRONTDOOR` or `UVM_BACKDOOR`.

### parent

```c
rand uvm_sequence_base parent
```

The sequence from which the operation originated.

### prior

```c
int prior = -1
```

The priority requested of this transfer, as defined by `uvm_sequence_base::start_item`.

### extension

```c
rand uvm_object extension
```

Handle to optional user data, as conveyed in the call to `write()`, `read()`, `mirror()`, or
update() used to trigger the operation.

**bd_kind**

```plaintext
string bd_kind
```

If path is UVM_BACKDOOR, this member specifies the abstraction kind for the backdoor access, e.g. “RTL” or “GATES”.

**fname**

```plaintext
string fname
```

The file name from where this transaction originated, if provided at the call site.

**lineno**

```plaintext
int lineno
```

The file name from where this transaction originated, if provided at the call site.

## Methods

### new

```plaintext
function new(string name = "")
```

Create a new instance of this type, giving it the optional name.

### convert2string

```plaintext
virtual function string convert2string()
```

Returns a string showing the contents of this transaction.

### do_copy

```plaintext
virtual function void do_copy(uvm_object rhs)
```

Copy the rhs object into this object. The rhs object must derive from uvm_reg_item.

**uvm_reg_bus_op**
Struct that defines a generic bus transaction for register and memory accesses, having kind (read or write), address, data, and byte enable information. If the bus is narrower than the register or memory location being accessed, there will be multiple of these bus operations for every abstract uvm_reg_item transaction. In this case, data represents the portion of uvm_reg_item::value being transferred during this bus cycle. If the bus is wide enough to perform the register or memory operation in a single cycle, data will be the same as uvm_reg_item::value.

**Summary**

```markdown
<table>
<thead>
<tr>
<th>VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>kind</td>
</tr>
<tr>
<td>addr</td>
</tr>
<tr>
<td>data</td>
</tr>
<tr>
<td>n_bits</td>
</tr>
<tr>
<td>byte_en</td>
</tr>
<tr>
<td>status</td>
</tr>
</tbody>
</table>
```

**VARIABLES**

**kind**

```c
uvm_access_e kind
```

Kind of access: READ or WRITE.

**addr**

```c
uvm_reg_addr_t addr
```

The bus address.

**data**

```c
uvm_reg_data_t data
```

The data to write. If the bus width is smaller than the register or memory width, data represents only the portion of value that is being transferred this bus cycle.

**n_bits**

```c
int n_bits
```
The number of bits of `uvm_reg_item::value` being transferred by this transaction.

**byte_en**

| uvm_reg_byte_en_t byte_en |

Enables for the byte lanes on the bus. Meaningful only when the bus supports byte enables and the operation originates from a field write/read.

**status**

| uvm_status_e status |

The result of the transaction: UVM_IS_OK, UVM_HAS_X, UVM_NOT_OK. See `uvm_status_e`. 
26.2 Classes for Adapting Between Register and Bus Operations

This section defines classes used to convert transaction streams between generic register address/data reads and writes and physical bus accesses.

Contents

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</thead>
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</tr>
<tr>
<td><strong>uvm_reg_tlm_adapter</strong></td>
</tr>
</tbody>
</table>

**uvm_reg_adapter**

This class defines an interface for converting between uvm_reg_bus_op and a specific bus transaction.

Summary

**uvm_reg_adapter**

This class defines an interface for converting between uvm_reg_bus_op and a specific bus transaction.

**Class Hierarchy**

- uvm_void
- uvm_object
- **uvm_reg_adapter**

**Class Declaration**

```
virtual class uvm_reg_adapter extends uvm_object
new
supports_byte_enable Set this bit in extensions of this class if the bus protocol supports byte enables.
provides_responses Set this bit in extensions of this class if the bus driver provides separate response items.
parent_sequence Set this member in extensions of this class if the bus driver requires bus items be executed via a particular sequence base type.
reg2bus Extensions of this class *must* implement this method to convert the specified uvm_reg_bus_op to a corresponding uvm_sequence_item subtype that defines the bus transaction.
bus2reg Extensions of this class *must* implement this method to copy members of the given bus-specific bus_item to corresponding members of the provided bus_rw
```
instance.

**get_item**

Returns the bus-independent read/write information that corresponds to the generic bus transaction currently translated to a bus-specific transaction.

**Example**

The following example illustrates how to implement a RegModel-BUS adapter class for the APB bus protocol.

```plaintext
new

function new(  
  string name = ""
  )

Create a new instance of this type, giving it the optional name.

supports_byte_enable

bit supports_byte_enable

Set this bit in extensions of this class if the bus protocol supports byte enables.

provides_responses

bit provides_responses

Set this bit in extensions of this class if the bus driver provides separate response items.

parent_sequence

uvm_sequence_base parent_sequence

Set this member in extensions of this class if the bus driver requires bus items be executed via a particular sequence base type. The sequence assigned to this member must implement do_clone().

reg2bus

pure virtual function uvm_sequence_item reg2bus(  
  const ref uvm_reg_bus_op rw
  )

Extensions of this class must implement this method to convert the specified uvm_reg_bus_op to a corresponding uvm_sequence_item subtype that defines the bus transaction.

The method must allocate a new bus-specific uvm_sequence_item, assign its members from the corresponding members from the given generic rw bus operation, then return it.

bus2reg
Extensions of this class must implement this method to copy members of the given bus-specific bus_item to corresponding members of the provided bus_rw instance. Unlike reg2bus, the resulting transaction is not allocated from scratch. This is to accommodate applications where the bus response must be returned in the original request.

**get_item**

```plaintext
virtual function uvm_reg_item get_item()
```

Returns the bus-independent read/write information that corresponds to the generic bus transaction currently translated to a bus-specific transaction. This function returns a value reference only when called in the uvm_reg_adapter::reg2bus() method. It returns null at all other times. The content of the return uvm_reg_item instance must not be modified and used strictly to obtain additional information about the operation.

**Example**

The following example illustrates how to implement a RegModel-BUS adapter class for the APB bus protocol.

```plaintext
class rreg2apb_adapter extends uvm_reg_adapter;
`uvm_object_utils(reg2apb_adapter)
function new(string name="reg2apb_adapter");
  super.new(name);
endfunction
virtual function uvm_sequence_item reg2bus(uvm_reg_bus_op rw);
  apb_item apb = apb_item::type_id::create("apb_item");
  apb.op   = (rw.kind == UVM_READ) ? apb::READ : apb::WRITE;
  apb.addr = rw.addr;
  apb.data = rw.data;
  return apb;
endfunction
virtual function void bus2reg(uvm_sequencer_item bus_item,
                              uvm_reg_bus_op rw);
  apb_item apb;
  if (!$cast(apb,bus_item)) begin
    `uvm_fatal("CONVERT_APB2REG","Bus item is not of type apb_item")
  end
  rw.kind  = apb.op==apb::READ ? UVM_READ : UVM_WRITE;
  rw.addr = apb.addr;
  rw.data = apb.data;
  rw.status = UVM_IS_OK;
endfunction
endclass
```

**Summary**

For converting between uvm_reg_bus_op and uvm_tlm_gp items.
**uvm_reg_tlm_adapter**

For converting between *uvm_reg_bus_op* and *uvm_tlm_gp* items.

**CLASS HIERARCHY**

```
+ uvm_void
|   + uvm_object
|     + uvm_reg_adapter
    + uvm_reg_tlm_adapter
```

**CLASS DECLARATION**

```
class uvm_reg_tlm_adapter extends uvm_reg_adapter
```

**METHODS**

**reg2bus**

```
virtual function uvm_sequence_item reg2bus(
    const ref uvm_reg_bus_op rw
)
```

Converts a *uvm_reg_bus_op* struct to a *uvm_tlm_gp* item.

**bus2reg**

```
virtual function void bus2reg(
    uvm_sequence_item bus_item,
    ref uvm_reg_bus_op rw
)
```

Converts a *uvm_tlm_gp* item to a *uvm_reg_bus_op*. into the provided *rw* transaction.
26.3 Explicit Register Predictor

The `uvm_reg_predictor` class defines a predictor component, which is used to update the register model’s mirror values based on transactions explicitly observed on a physical bus.

**Summary**

**Explicit Register Predictor**

The `uvm_reg_predictor` class defines a predictor component, which is used to update the register model’s mirror values based on transactions explicitly observed on a physical bus.

**uvm_reg_predictor**

Updates the register model mirror based on observed bus transactions

This class converts observed bus transactions of type `BUSTYPE` to generic registers transactions, determines the register being accessed based on the bus address, then updates the register’s mirror value with the observed bus data, subject to the register’s access mode. See `uvm_reg::predict` for details.

Memories can be large, so their accesses are not predicted.

**Summary**

**uvm_reg_predictor**

Updates the register model mirror based on observed bus transactions

**CLASS HIERARCHY**

- `uvm_void`
- `uvm_object`
- `uvm_report_object`
- `uvm_component`
- `uvm_reg_predictor`

**CLASS DECLARATION**

```cpp
class uvm_reg_predictor #(
    type BUSTYPE = int ) extends uvm_component
```

**VARIABLES**

- `bus_in` Observed bus transactions of type `BUSTYPE` are received from this port and processed.
- `reg_ap` Analysis output port that publishes `uvm_reg_item` transactions converted from bus transactions received on `bus_in`.
- `map` The map used to convert a bus address to the corresponding register or memory handle.
adapter

The adapter used to convey the parameters of a bus operation in terms of a canonical uvm_reg_bus_op datum.

**Methods**

- **new**
  Create a new instance of this type, giving it the optional *name* and *parent*.

- **pre_predict**
  Override this method to change the value or re-direct the target register.

- **check_phase**
  Checks that no pending register transactions are still queued.

**Variables**

### bus_in

```plaintext
uvm_analysis_imp #(BUSTYPE,
    uvm_reg_predictor #(BUSTYPE)) bus_in
```

Observed bus transactions of type *BUSTYPE* are received from this port and processed.

For each incoming transaction, the predictor will attempt to get the register or memory handle corresponding to the observed bus address.

If there is a match, the predictor calls the register or memory’s predict method, passing in the observed bus data. The register or memory mirror will be updated with this data, subject to its configured access behavior--RW, RO, WO, etc. The predictor will also convert the bus transaction to a generic uvm_reg_item and send it out the *reg_ap* analysis port.

If the register is wider than the bus, the predictor will collect the multiple bus transactions needed to determine the value being read or written.

### reg_ap

```plaintext
uvm_analysis_port #(uvm_reg_item
    ) reg_ap
```

Analysis output port that publishes uvm_reg_item transactions converted from bus transactions received on *bus_in*.

### map

```plaintext
uvm_reg_map map
```

The map used to convert a bus address to the corresponding register or memory handle. Must be configured before the run phase.

### adapter

```plaintext
uvm_reg_adapter adapter
```
The adapter used to convey the parameters of a bus operation in terms of a canonical uvm_reg_bus_op datum. The uvm_reg_adapter must be configured before the run phase.

**Methods**

### new

```plaintext
function new (string name, uvm_component parent)
```

Create a new instance of this type, giving it the optional name and parent.

### pre_predict

```plaintext
virtual function void pre_predict( uvm_reg_item rw)
```

Override this method to change the value or re-direct the target register.

### check_phase

```plaintext
virtual function void check_phase( uvm_phase phase)
```

Checks that no pending register transactions are still queued.
26.4 Register Sequence Classes

This section defines the base classes used for register stimulus generation.

Contents

<table>
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<th>Register Sequence Classes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>uvm_reg_sequence</td>
<td>This class provides base functionality for both user-defined RegModel test sequences and &quot;register translation sequences&quot;.</td>
</tr>
<tr>
<td>uvm_reg_frontdoor</td>
<td>Facade class for register and memory frontdoor access.</td>
</tr>
</tbody>
</table>

**uvm_reg_sequence**

This class provides base functionality for both user-defined RegModel test sequences and “register translation sequences”.

- When used as a base for user-defined RegModel test sequences, this class provides convenience methods for reading and writing registers and memories. Users implement the body() method to interact directly with the RegModel model (held in the model property) or indirectly via the delegation methods in this class.
- When used as a translation sequence, objects of this class are executed directly on a bus sequencer which are used in support of a layered sequencer use model, a pre-defined convert-and-execute algorithm is provided.

Register operations do not require extending this class if none of the above services are needed. Register test sequences can be extend from the base uvm_sequence #(REQ,RSP) base class or even from outside a sequence.

Note- The convenience API not yet implemented.

**Summary**

**uvm_reg_sequence**

This class provides base functionality for both user-defined RegModel test sequences and “register translation sequences”.

**Class Hierarchy**

```
BASE
uvm_reg_sequence
```

**Class Declaration**

```
class uvm_reg_sequence #(
    type BASE = uvm_sequence #(uvm_reg_item)
) extends BASE
```

- BASE: Specifies the sequence type to extend from.
- model: Block abstraction this sequence executes on, defined only when this sequence is a user-defined test sequence.
- adapter: Adapter to use for translating between abstract register
transactions and physical bus transactions, defined only when this sequence is a translation sequence.

reg_seqr defined only when this sequence is a translation sequence.

new Create a new instance, giving it the optional name.

body Continually gets a register transaction from the configured upstream sequencer, reg_seqr, and executes the corresponding bus transaction via do_reg_item.

do_reg_item Executes the given register transaction, rw, via the sequencer on which this sequence was started.

**Convenience Write/Read API**

write_reg Writes the given register rg using uvm_reg::write, supplying ‘this’ as the parent argument.

read_reg Reads the given register rg using uvm_reg::read, supplying ‘this’ as the parent argument.

poke_reg Pokes the given register rg using uvm_reg::poke, supplying ‘this’ as the parent argument.

peek_reg Peeks the given register rg using uvm_reg::peek, supplying ‘this’ as the parent argument.

update_reg Updates the given register rg using uvm_reg::update, supplying ‘this’ as the parent argument.

mirror_reg Mirrors the given register rg using uvm_reg::mirror, supplying ‘this’ as the parent argument.

write_mem Writes the given memory mem using uvm_mem::write, supplying ‘this’ as the parent argument.

read_mem Reads the given memory mem using uvm_mem::read, supplying ‘this’ as the parent argument.

poke_mem Pokes the given memory mem using uvm_mem::poke, supplying ‘this’ as the parent argument.

peek_mem Peeks the given memory mem using uvm_mem::peek, supplying ‘this’ as the parent argument.

**BASE**

Specifies the sequence type to extend from.

When used as a translation sequence running on a bus sequencer, BASE must be compatible with the sequence type expected by the bus sequencer.

When used as a test sequence running on a particular sequencer, BASE must be compatible with the sequence type expected by that sequencer.

When used as a virtual test sequence without a sequencer, BASE does not need to be specified, i.e. the default specialization is adequate.

To maximize opportunities for reuse, user-defined RegModel sequences should “promote” the BASE parameter.

```java
class my_reg_sequence #(type BASE=uvm_sequence #(uvm_reg_item))
    extends uvm_reg_sequence #(BASE);
```

This way, the RegModel sequence can be extended from user-defined base sequences.
Block abstraction this sequence executes on, defined only when this sequence is a user-defined test sequence.

adapter

// uvm_reg_adapter adapter

Adapter to use for translating between abstract register transactions and physical bus transactions, defined only when this sequence is a translation sequence.

reg_seqr

// uvm_sequencer #(uvm_reg_item) reg_seqr

Layered upstream “register” sequencer.

Specifies the upstream sequencer between abstract register transactions and physical bus transactions. Defined only when this sequence is a translation sequence, and we want to “pull” from an upstream sequencer.

new

// function new (string name = "uvm_reg_sequence_inst")

Create a new instance, giving it the optional name.

body

// virtual task body()

Continually gets a register transaction from the configured upstream sequencer, reg_seqr, and executes the corresponding bus transaction via do_reg_item.

User-defined RegModel test sequences must override body() and not call super.body(), else a warning will be issued and the calling process not return.

do_reg_item

// virtual task do_reg_item(uvm_reg_item rw)

Executes the given register transaction, rw, via the sequencer on which this sequence was started (i.e. m_sequencer). Uses the configured adapter to convert the register transaction into the type expected by this sequencer.

**Convenience Write/Read API**
The following methods delegate to the corresponding method in the register or memory element. They allow a sequence `body()` to do reads and writes without having to explicitly supply itself to `parent` sequence argument. Thus, a register write

```plaintext
model.regA.write(status, value, .parent(this));
```

can be written instead as

```plaintext
write_reg(model.regA, status, value);
```

### `write_reg`

```plaintext
virtual task write_reg(
    input uvm_reg rg,
    output uvm_status_e status,
    input uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Writes the given register `rg` using `uvm_reg::write`, supplying `‘this’` as the `parent` argument. Thus,

```plaintext
write_reg(model.regA, status, value);
```

is equivalent to

```plaintext
model.regA.write(status, value, .parent(this));
```

### `read_reg`

```plaintext
virtual task read_reg(
    input uvm_reg rg,
    output uvm_status_e status,
    output uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Reads the given register `rg` using `uvm_reg::read`, supplying `‘this’` as the `parent` argument. Thus,

```plaintext
read_reg(model.regA, status, value);
```
is equivalent to

```cpp
model.regA.read(status, value, .parent(this));
```

**poke_reg**

```cpp
virtual task poke_reg(
     input uvm_reg  rg,
     output uvm_status_e status,
     input uvm_reg_data_t value,
     input string  kind = "",
     input uvm_object  extension = null,
     input string  fname = "",
     input int  lineno = 0
)
```

Pokes the given register `rg` using `uvm_reg::poke`, supplying `‘this’` as the `parent` argument. Thus,

```cpp
poke_reg(model.regA, status, value);
```

is equivalent to

```cpp
model.regA.poke(status, value, .parent(this));
```

**peek_reg**

```cpp
virtual task peek_reg(
     input uvm_reg  rg,
     output uvm_status_e status,
     output uvm_reg_data_t value,
     input string  kind = "",
     input uvm_object  extension = null,
     input string  fname = "",
     input int  lineno = 0
)
```

Peeks the given register `rg` using `uvm_reg::peek`, supplying `‘this’` as the `parent` argument. Thus,

```cpp
peek_reg(model.regA, status, value);
```

is equivalent to

```cpp
model.regA.peek(status, value, .parent(this));
```
**update_reg**

```vhdl
class update_reg:
  virtual task update_reg(
    input uvm_reg   _rg,
    output uvm_status_e status,
    input uvm_path_e   path   = UVM_DEFAULT_PATH,
    input uvm_reg_map  map    = null,
    input int         prior   = -1,
    input uvm_object  extension = null,
    input strIng     fname   = "",
    input int        lineno  = 0
  )
```

Updates the given register \( rg \) using \u0060uvm_reg::update\u0060, supplying ‘this’ as the \textit{parent} argument. Thus,

```vhdl```
update_reg(model.regA, status, value);
```

is equivalent to

```vhdl```
model.regA.update(status, value, .parent(this));
```

**mirror_reg**

```vhdl
class mirror_reg:
  virtual task mirror_reg(
    input uvm_reg   _rg,
    output uvm_status_e status,
    input uvm_check_e check    = UVM_NO_CHECK,
    input uvm_path_e   path   = UVM_DEFAULT_PATH,
    input uvm_reg_map  map    = null,
    input int         prior   = -1,
    input uvm_object  extension = null,
    input strIng     fname   = "",
    input int        lineno  = 0
  )
```

Mirrors the given register \( rg \) using \u0060uvm_reg::mirror\u0060, supplying ‘this’ as the \textit{parent} argument. Thus,

```vhdl```
mirror_reg(model.regA, status, UVM_CHECK);
```

is equivalent to

```vhdl```
model.regA.mirror(status, UVM_CHECK, .parent(this));
```

**write_mem**

```vhdl
class write_mem:
  virtual task write_mem(
    input uvm_mem   _mem,
    output uvm_status_e status,
  )
```

UVM 1.2 Class Reference
Writes the given memory `mem` using `uvm_mem::write`, supplying `this` as the `parent` argument. Thus,

```verilog
write_mem(model.regA, status, offset, value);
```

is equivalent to

```verilog
model.regA.write(status, offset, value, .parent(this));
```

### read_mem

```verilog
virtual task read_mem(
    input uvm_mem mem,
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    output uvm_reg_data_t value,
    input uvm_path_e path = UVM_DEFAULT_PATH,
    input uvm_reg_map map = null,
    input int prior = -1,
    input uvm_object extension = null,
    input string fname = "",
    input int lineno = 0
)
```

Reads the given memory `mem` using `uvm_mem::read`, supplying `this` as the `parent` argument. Thus,

```verilog
read_mem(model.regA, status, offset, value);
```

is equivalent to

```verilog
model.regA.read(status, offset, value, .parent(this));
```

### poke_mem

```verilog
virtual task poke_mem(
    input uvm_mem mem,
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    input uvm_reg_data_t value,
    input string kind = "",
    input uvm_object extension = null,
    input string fname = "",
)
```
Pokes the given memory `mem` using `uvm_mem::poke`, supplying ‘this’ as the `parent` argument. Thus,

```cpp
poke_mem(model.regA, status, offset, value);
```

is equivalent to

```cpp
model.regA.poke(status, offset, value, .parent(this));
```

**peek_mem**

```cpp
virtual task peek_mem(
    input uvm_mem\*\* mem,
    output uvm_status_e status,
    input uvm_reg_addr_t offset,
    output uvm_reg_data_t value,
    input string\_kind = ",",
    input string\_extension = null,
    input string\_fname = ",",
    input int\_lineno = 0
)
```

Peeks the given memory `mem` using `uvm_mem::peek`, supplying ‘this’ as the `parent` argument. Thus,

```cpp
peek_mem(model.regA, status, offset, value);
```

is equivalent to

```cpp
model.regA.peek(status, offset, value, .parent(this));
```

**uvm_reg_frontdoor**

Facade class for register and memory frontdoor access.

User-defined frontdoor access sequence

Base class for user-defined access to register and memory reads and writes through a physical interface.

By default, different registers and memories are mapped to different addresses in the address space and are accessed via those exclusively through physical addresses.

The frontdoor allows access using a non-linear and/or non-mapped mechanism. Users can extend this class to provide the physical access to these registers.
Summary

**uvm_reg_frontdoor**

Facade class for register and memory frontdoor access.

### CLASS HIERARCHY

```
uvm_reg_sequence#(uvm_sequence#(uvm_sequence_item))
```

### CLASS DECLARATION

```
virtual class uvm_reg_frontdoor extends uvm_reg_sequence

#(  
uvm_sequence #(uvm_sequence_item)
)
```

### VARIABLES

- **rw_info**
  - Holds information about the register being read or written
  - `uvm_reg_item rw_info`

- **sequencer**
  - Sequencer executing the operation
  - `uvm_sequencer_base sequencer`

### METHODS

- **new**
  - Constructor, new object given optional `name`.
  - `function new(
    string name = ""
  )`

---

**UVM 1.2 Class Reference**

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26.5 uvm_reg_backdoor

Base class for user-defined back-door register and memory access.

This class can be extended by users to provide user-specific back-door access to
registers and memories that are not implemented in pure SystemVerilog or that are not
accessible using the default DPI backdoor mechanism.

Summary

### uvm_reg_backdoor

Base class for user-defined back-door register and memory access.

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</table>

<table>
<thead>
<tr>
<th>Class Declaration</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

<table>
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<th>Methods</th>
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<td>write</td>
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<td>pre_write</td>
</tr>
<tr>
<td>post_write</td>
</tr>
</tbody>
</table>

Create an instance of this class

Create an instance of the user-defined backdoor class for the specified register or
memory

```plaintext
function new(
    string name = ""
)

Create an instance of this class
```

Create an instance of the user-defined backdoor class for the specified register or
memory

```plaintext
```
**do_pre_read**

```verbatim
protected task do_pre_read(
    uvm_reg_item rw
)
```

Execute the pre-read callbacks

This method *must* be called as the first statement in a user extension of the `read()` method.

**do_post_read**

```verbatim
protected task do_post_read(
    uvm_reg_item rw
)
```

Execute the post-read callbacks

This method *must* be called as the last statement in a user extension of the `read()` method.

**do_pre_write**

```verbatim
protected task do_pre_write(
    uvm_reg_item rw
)
```

Execute the pre-write callbacks

This method *must* be called as the first statement in a user extension of the `write()` method.

**do_post_write**

```verbatim
protected task do_post_write(
    uvm_reg_item rw
)
```

Execute the post-write callbacks

This method *must* be called as the last statement in a user extension of the `write()` method.

**write**

```verbatim
virtual task write(
    uvm_reg_item rw
)
```

User-defined backdoor write operation.

Call `do_pre_write()`. Deposit the specified value in the specified register HDL implementation. Call `do_post_write()`. Returns an indication of the success of the operation.
read

```cpp
virtual task read(uvm_reg_item rw)
```

User-defined backdoor read operation.

Overload this method only if the backdoor requires the use of task.

Call `do_pre_read()`. Peek the current value of the specified HDL implementation. Call `do_post_read()`. Returns the current value and an indication of the success of the operation.

By default, calls `read_func()`.

read_func

```cpp
virtual function void read_func(uvm_reg_item rw)
```

User-defined backdoor read operation.

Peek the current value in the HDL implementation. Returns the current value and an indication of the success of the operation.

is_auto_updated

```cpp
virtual function bit is_auto_updated(uvm_reg_field field)
```

Indicates if wait_for_change() method is implemented

Implement to return TRUE if and only if `wait_for_change()` is implemented to watch for changes in the HDL implementation of the specified field

wait_for_change

```cpp
virtual local task wait_for_change(uvm_object element)
```

Wait for a change in the value of the register or memory element in the DUT.

When this method returns, the mirror value for the register corresponding to this instance of the backdoor class will be updated via a backdoor read operation.

pre_read

```cpp
virtual task pre_read(uvm_reg_item rw)
```

Called before user-defined backdoor register read.
The registered callback methods are invoked after the invocation of this method.

**post_read**

```plaintext
virtual task post_read(
    uvm_reg_item rw
)
```

Called after user-defined backdoor register read.

The registered callback methods are invoked before the invocation of this method.

**pre_write**

```plaintext
virtual task pre_write(
    uvm_reg_item rw
)
```

Called before user-defined backdoor register write.

The registered callback methods are invoked after the invocation of this method.

The written value, if modified, modifies the actual value that will be written.

**post_write**

```plaintext
virtual task post_write(
    uvm_reg_item rw
)
```

Called after user-defined backdoor register write.

The registered callback methods are invoked before the invocation of this method.
26.6 UVM HDL Backdoor Access support routines

These routines provide an interface to the DPI/PLI implementation of backdoor access used by registers.

If you DON’T want to use the DPI HDL API, then compile your SystemVerilog code with the vlog switch

```
vlog ... +define+UVM_HDL_NO_DPI ...
```

Summary

**UVM HDL Backdoor Access support routines.**

These routines provide an interface to the DPI/PLI implementation of backdoor access used by registers.

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<td>Sets the maximum size bit vector for backdoor access.</td>
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<td>uvm_hdl_check_path</td>
<td>Checks that the given HDL path exists.</td>
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<td>uvm_hdl_deposit</td>
<td>Sets the given HDL path to the specified value.</td>
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<td>uvm_hdl_force</td>
<td>Forces the value on the given path.</td>
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<td>uvm_hdl_force_time</td>
<td>Forces the value on the given path for the specified amount of force_time.</td>
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<tr>
<td>uvm_hdl_release_and_read</td>
<td>Releases a value previously set with uvm_hdl_force.</td>
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<tr>
<td>uvm_hdl_release</td>
<td>Releases a value previously set with uvm_hdl_force.</td>
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<tr>
<td>uvm_hdl_read()</td>
<td>Gets the value at the given path.</td>
</tr>
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</table>

**VARIABLES**

**UVM_HDL_MAX_WIDTH**

```
parameter int UVM_HDL_MAX_WIDTH = `UVM_HDL_MAX_WIDTH
```

Sets the maximum size bit vector for backdoor access. This parameter will be looked up by the DPI-C code using: vpi_handle_by_name( “uvm_pkg::UVM_HDL_MAX_WIDTH”, 0);
Checks that the given HDL path exists. Returns 0 if NOT found, 1 otherwise.

**uvm_hdl_deposit**

```c
import "DPI-C" context function int uvm_hdl_deposit(
    string path,
    uvm_hdl_data_t value
)
```

Sets the given HDL path to the specified value. Returns 1 if the call succeeded, 0 otherwise.

**uvm_hdl_force**

```c
import "DPI-C" context function int uvm_hdl_force(
    string path,
    uvm_hdl_data_t value
)
```

Forces the value on the given path. Returns 1 if the call succeeded, 0 otherwise.

**uvm_hdl_force_time**

```c
task uvm_hdl_force_time(
    string path,
    uvm_hdl_data_t value,
    time force_time = 0
)
```

Forces the value on the given path for the specified amount of force_time. If force_time is 0, uvm_hdl_deposit is called. Returns 1 if the call succeeded, 0 otherwise.

**uvm_hdl_release_and_read**

```c
import "DPI-C" context function int uvm_hdl_release_and_read(
    string path,
    inout uvm_hdl_data_t value
)
```

Releases a value previously set with uvm_hdl_force. Returns 1 if the call succeeded, 0 otherwise. value is set to the HDL value after the release. For 'reg', the value will still be the forced value until it has been procedurally reassigned. For 'wire', the value will change immediately to the resolved value of its continuous drivers, if any. If none, its value remains as forced until the next direct assignment.

**uvm_hdl_release**

```c
import "DPI-C" context function int uvm_hdl_release(
    string path
)
```

Releases a value previously set with uvm_hdl_force. Returns 1 if the call succeeded, 0 otherwise.
uvm_hdl_read()

```c
import "DPI-C" context function int uvm_hdl_read(
  string  path,
  output uvm_hdl_data_t value
)
```

Gets the value at the given `path`. Returns 1 if the call succeeded, 0 otherwise.
27.1 uvm_reg_mem_built_in_seq

Sequence that executes a user-defined selection of pre-defined register and memory test sequences.

Summary

uvm_reg_mem_built_in_seq

Sequence that executes a user-defined selection of pre-defined register and memory test sequences.

Class Hierarchy

uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))

uvm_reg_mem_built_in_seq

Class Declaration

class uvm_reg_mem_built_in_seq extends uvm_reg_sequence
#
(uvm_sequence #(uvm_reg_item))

Variables

model The block to be tested.

tests The pre-defined test sequences to be executed.

Methods

body Executes any or all the built-in register and memory sequences.

Variables

model

The block to be tested. Declared in the base class.

```
uvm_reg_block model;
```

tests

```
bit [63:0] tests = UVM_DO_ALL_REG_MEM_TESTS
```

The pre-defined test sequences to be executed.

Methods
body

virtual task body()

Executes any or all the built-in register and memory sequences. Do not call directly. Use seq.start() instead.
27.2 uvm_reg_hw_reset_seq

Test the hard reset values of registers

The test sequence performs the following steps

1. resets the DUT and the block abstraction class associated with this sequence.
2. reads all of the registers in the block, via all of the available address maps, comparing the value read with the expected reset value.

If bit-type resource named “NO_REG_TESTS” or “NO_REG_HW_RESET_TEST” in the “REG::” namespace matches the full name of the block or register, the block or register is not tested.

```plaintext
uvm_resource_db#(bit)::set({"REG::",regmodel.blk.get_full_name(),".*"},
  "NO_REG_TESTS", 1, this);
```

This is usually the first test executed on any DUT.

Summary

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<tr>
<td>Test the hard reset values of registers</td>
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**CLASS HIERARCHY**

```plaintext
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
```

**CLASS DECLARATION**

```plaintext
class uvm_reg_hw_reset_seq extends uvm_reg_sequence #(
  uvm_sequence #(uvm_reg_item)
)
```

**VARIABLES**

- **model**
  - The block to be tested.
  - Declared in the base class.

- **body**
  - Executes the Hardware Reset sequence.

**METHODS**

- **do_block**
  - Test all of the registers in a given block

- **reset_blk**
  - Reset the DUT that corresponds to the specified block abstraction class.
**body**

```
virtual task body()
```

Executes the Hardware Reset sequence. Do not call directly. Use seq.start() instead.

**Methods**

**do_block**

```
protected virtual task do_block(uvm_reg_block blk)
```

Test all of the registers in a given block

**reset_blk**

```
virtual task reset_blk(uvm_reg_block blk)
```

Reset the DUT that corresponds to the specified block abstraction class.

Currently empty. Will rollback the environment’s phase to the reset phase once the new phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.
27.3 Bit Bashing Test Sequences

This section defines classes that test individual bits of the registers defined in a register model.

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<th>Bit Bashing Test Sequences</th>
<th>This section defines classes that test individual bits of the registers defined in a register model.</th>
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<td>Verify the implementation of a single register by attempting to write 1’s and 0’s to every bit in it, via every address map in which the register is mapped, making sure that the resulting value matches the mirrored value.</td>
</tr>
<tr>
<td>uvm_reg_bit_bash_seq</td>
<td>Verify the implementation of all registers in a block by executing the uvm_reg_single_bit_bash_seq sequence on it.</td>
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uvm_reg_single_bit_bash_seq

Verify the implementation of a single register by attempting to write 1’s and 0’s to every bit in it, via every address map in which the register is mapped, making sure that the resulting value matches the mirrored value.

If bit-type resource named "NO_REG_TESTS" or "NO_REG_BIT_BASH_TEST" in the "REG:" namespace matches the full name of the register, the register is not tested.

```
uvm_resource_db#(bit)::set("REG::",regmodel.blk.r0.get_full_name(), "NO_REG_TESTS", 1, this);
```

Registers that contain fields with unknown access policies cannot be tested.

The DUT should be idle and not modify any register during this test.

Summary

uvm_reg_single_bit_bash_seq

Verify the implementation of a single register by attempting to write 1’s and 0’s to every bit in it, via every address map in which the register is mapped, making sure that the resulting value matches the mirrored value.

**Class Hierarchy**

```
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
uvm_reg_sequence#(uvm_reg_item)
uvm_reg_single_bit_bash_seq
```

**Class Declaration**

```
class uvm_reg_single_bit_bash_seq extends uvm_reg_sequence {
  Uvm_sequence #(uvm_reg_item)
}
**Variables**

- **rg**
  - `uvm_reg rg`
  - The register to be tested

---

**uvm_reg_bit_bash_seq**

Verify the implementation of all registers in a block by executing the `uvm_reg_single_bit_bash_seq` sequence on it.

If bit-type resource named "NO_REG_TESTS" or "NO_REG_BIT_BASH_TEST" in the "REG:" namespace matches the full name of the block, the block is not tested.

```
uvm_resource_db#(bit)::set("REG::",regmodel.blk.get_full_name(),".*", "NO_REG_TESTS", 1, this);
```

---

**Summary**

**uvm_reg_bit_bash_seq**

Verify the implementation of all registers in a block by executing the `uvm_reg_single_bit_bash_seq` sequence on it.

**Class Hierarchy**

```
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
uvm_reg_bit_bash_seq
```

**Class Declaration**

```
class uvm_reg_bit_bash_seq extends uvm_reg_sequence #(
  uvm_sequence #(uvm_reg_item)
)
```

**Variables**

- **model**
  - The block to be tested.
- **reg_seq**
  - The sequence used to test one register

**Methods**

- **body**
  - Executes the Register Bit Bash sequence.
- **do_block**
  - Test all of the registers in a given block
- **reset_blk**
  - Reset the DUT that corresponds to the specified block abstraction class.
**VARIABLES**

**model**
The block to be tested. Declared in the base class.

```vhdl
uvm_reg_block model;
```

**reg_seq**
The sequence used to test one register

```vhdl
protected uvm_reg_single_bit_bash_seq reg_seq
```

**METHODS**

**body**

```vhdl
virtual task body()
```

Executes the Register Bit Bash sequence. Do not call directly. Use seq.start() instead.

**do_block**

```vhdl
protected virtual task do_block(
    uvm_reg_block blk
)
```

Test all of the registers in a given block

**reset_blk**

```vhdl
virtual task reset_blk(
    uvm_reg_block blk
)
```

Reset the DUT that corresponds to the specified block abstraction class.

Currently empty. Will rollback the environment’s phase to the reset phase once the new phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.
27.4 Register Access Test Sequences

This section defines sequences that test DUT register access via the available frontdoor and backdoor paths defined in the provided register model.

Contents

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<th>Register Access Test Sequences</th>
<th>Description</th>
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<td>Verify the accessibility of a register by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the mirrored value.</td>
</tr>
<tr>
<td><strong>uvm_reg_access_seq</strong></td>
<td>Verify the accessibility of all registers in a block by executing the <strong>uvm_reg_single_access_seq</strong> sequence on every register within it.</td>
</tr>
<tr>
<td><strong>uvm_reg_mem_access_seq</strong></td>
<td>Verify the accessibility of all registers and memories in a block by executing the <strong>uvm_reg_access_seq</strong> and <strong>uvm_mem_access_seq</strong> sequence respectively on every register and memory within it.</td>
</tr>
</tbody>
</table>

**uvm_reg_single_access_seq**

Verify the accessibility of a register by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the mirrored value.

If bit-type resource named "NO_REG_TESTS" or "NO_REG_ACCESS_TEST" in the "REG::" namespace matches the full name of the register, the register is not tested.

```
uvm_resource_db#(bit)::set({'REG::',regmodel.blk.r0.get_full_name(),'NO_REG_TESTS',1,this});
```

Registers without an available backdoor or that contain read-only fields only, or fields with unknown access policies cannot be tested.

The DUT should be idle and not modify any register during this test.

**Summary**

**uvm_reg_single_access_seq**

Verify the accessibility of a register by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the mirrored value.
uvm_reg_single_access_seq

**Class Declaration**

```plaintext
class uvm_reg_single_access_seq extends uvm_reg_sequence
#
  uvm_sequence #(uvm_reg_item)
)
```

**Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rg</td>
<td>The register to be tested</td>
</tr>
</tbody>
</table>

uvm_reg_access_seq

Verify the accessibility of all registers in a block by executing the `uvm_reg_single_access_seq` sequence on every register within it.

If bit-type resource named "NO_REG_TESTS" or "NO_REG_ACCESS_TEST" in the "REG::" namespace matches the full name of the block, the block is not tested.

```plaintext
uvm_resource_db#(bit)::set("REG::",regmodel.blk.get_full_name(),".*", "NO_REG_TESTS", 1, this);
```

**Summary**

**uvm_reg_access_seq**

Verify the accessibility of all registers in a block by executing the `uvm_reg_single_access_seq` sequence on every register within it.

**Class Hierarchy**

- uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
- uvm_reg_access_seq

**Class Declaration**

```plaintext
class uvm_reg_access_seq extends uvm_reg_sequence #(
  uvm_sequence #(uvm_reg_item)
)
```

**Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>model</td>
<td>The block to be tested.</td>
</tr>
<tr>
<td>reg_seq</td>
<td>The sequence used to test one register</td>
</tr>
</tbody>
</table>
**Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>body</td>
<td>Executes the Register Access sequence. Do not call directly. Use seq.start() instead.</td>
</tr>
<tr>
<td>do_block</td>
<td>Test all of the registers in a block</td>
</tr>
<tr>
<td>reset_blk</td>
<td>Reset the DUT that corresponds to the specified block abstraction class.</td>
</tr>
</tbody>
</table>

**Variables**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>model</td>
<td>The block to be tested. Declared in the base class.</td>
</tr>
<tr>
<td>reg_seq</td>
<td>The sequence used to test one register</td>
</tr>
</tbody>
</table>

```plaintext
uvm_reg_block model;
```

```plaintext
protected uvm_reg_single_access_seq reg_seq
```

**Methods**

- **body**

  ```plaintext
  virtual task body()
  ```

  Executes the Register Access sequence. Do not call directly. Use seq.start() instead.

- **do_block**

  ```plaintext
  protected virtual task do_block(
      uvm_reg_block blk
  )
  ```

  Test all of the registers in a block

- **reset_blk**

  ```plaintext
  virtual task reset_blk(
      uvm_reg_block blk
  )
  ```

  Reset the DUT that corresponds to the specified block abstraction class.

  Currently empty. Will rollback the environment’s phase to the reset phase once the new
phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.

**uvm_reg_mem_access_seq**

Verify the accessibility of all registers and memories in a block by executing the `uvm_reg_access_seq` and `uvm_mem_access_seq` sequence respectively on every register and memory within it.

Blocks and registers with the NO_REG_TESTS or the NO_REG_ACCESS_TEST attribute are not verified.

**Summary**

**uvm_reg_mem_access_seq**

Verify the accessibility of all registers and memories in a block by executing the `uvm_reg_access_seq` and `uvm_mem_access_seq` sequence respectively on every register and memory within it.

**Class Hierarchy**

```
| uvm_reg_sequence#(uvm_sequence#(uvm_reg_item)) |
| **uvm_reg_mem_access_seq**                    |
```

**Class Declaration**

```c
class uvm_reg_mem_access_seq extends uvm_reg_sequence #(
    uvm_sequence #(uvm_reg_item)
)
```

27.5 Shared Register and Memory Access Test Sequences

This section defines sequences for testing registers and memories that are shared between two or more physical interfaces, i.e. are associated with more than one `uvm_reg_map` instance.

Contents

<table>
<thead>
<tr>
<th>Shared Register and Memory Access Test Sequences</th>
<th>This section defines sequences for testing registers and memories that are shared between two or more physical interfaces.</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>uvm_reg_shared_access_seq</code></td>
<td>Verify the accessibility of a shared register by writing through each address map then reading it via every other address maps in which the register is readable and the backdoor, making sure that the resulting value matches the mirrored value.</td>
</tr>
<tr>
<td><code>uvm_mem_shared_access_seq</code></td>
<td>Verify the accessibility of a shared memory by writing through each address map then reading it via every other address maps in which the memory is readable and the backdoor, making sure that the resulting value matches the written value.</td>
</tr>
<tr>
<td><code>uvm_reg_mem_shared_access_seq</code></td>
<td>Verify the accessibility of all shared registers and memories in a block by executing the <code>uvm_reg_shared_access_seq</code> and <code>uvm_mem_shared_access_seq</code> sequence respectively on every register and memory within it.</td>
</tr>
</tbody>
</table>

**uvm_reg_shared_access_seq**

Verify the accessibility of a shared register by writing through each address map then reading it via every other address maps in which the register is readable and the backdoor, making sure that the resulting value matches the mirrored value.

If bit-type resource named "NO_REG_TESTS" or "NO_REG_SHARED_ACCESS_TEST" in the "REG::" namespace matches the full name of the register, the register is not tested.

```uvm
uvm_resource_db#(bit)::set("REG::",regmodel.blk.r0.get_full_name()), "NO_REG_TESTS", 1, this);
```

Registers that contain fields with unknown access policies cannot be tested.

The DUT should be idle and not modify any register during this test.

**Summary**

```uvm
uvm_reg_shared_access_seq
```
Verify the accessibility of a shared register by writing through each address map then reading it via every other address maps in which the register is readable and the backdoor, making sure that the resulting value matches the mirrored value.

**CLASS HIERARCHY**

```plaintext
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
uvm_reg_shared_access_seq
```

**CLASS DECLARATION**

```plaintext
class uvm_reg_shared_access_seq extends uvm_reg_sequence
#
  uvm_sequence #(uvm_reg_item)
)
```

**VARIABLES**

```plaintext
rg
```

The register to be tested

**uvm_mem_shared_access_seq**

Verify the accessibility of a shared memory by writing through each address map then reading it via every other address maps in which the memory is readable and the backdoor, making sure that the resulting value matches the written value.

If bit-type resource named “NO_REG_TESTS”, “NO_MEM_TESTS”, “NO_REG_SHARED_ACCESS_TEST” or “NO_MEM_SHARED_ACCESS_TEST” in the “REG::” namespace matches the full name of the memory, the memory is not tested.

```plaintext
uvm_resource_db#(bit)::set("REG::",regmodel.blk.mem0.get_full_name()),
  "NO_MEM_TESTS", 1, this);
```

The DUT should be idle and not modify the memory during this test.

**Summary**

**uvm_mem_shared_access_seq**

Verify the accessibility of a shared memory by writing through each address map then reading it via every other address maps in which the memory is readable and the backdoor, making sure that the resulting value matches the written value.

**CLASS HIERARCHY**
class uvm_mem_shared_access_seq extends uvm_reg_sequence
#
  uvm_sequence #(uvm_reg_item)
#
VARIABLES
  mem The memory to be tested

Verify the accessibility of all shared registers and memories in a block by executing the `uvm_reg_shared_access_seq` and `uvm_mem_shared_access_seq` sequence respectively on every register and memory within it.

If bit-type resource named "NO_REG_TESTS", "NO_MEM_TESTS", "NO_REG_SHARED_ACCESS_TEST" or "NO_MEM_SHARED_ACCESS_TEST" in the "REG::" namespace matches the full name of the block, the block is not tested.

```
uvm_resource_db#(bit)::set("REG:\", regmodel.blk.get_full_name(),"::", "NO_REG_TESTS", 1, this);
```

Summary

Verify the accessibility of all shared registers and memories in a block by executing the `uvm_reg_shared_access_seq` and `uvm_mem_shared_access_seq` sequence respectively on every register and memory within it.

**Class Hierarchy**

```
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
```

**Class Declaration**

```
class uvm_reg_mem_shared_access_seq extends uvm_reg_sequence
#
  uvm_sequence #((uvm_reg_item)
#
```
### VARIABLES

<table>
<thead>
<tr>
<th>model</th>
<th>The block to be tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>reg_seq</td>
<td>The sequence used to test one register</td>
</tr>
<tr>
<td>mem_seq</td>
<td>The sequence used to test one memory</td>
</tr>
</tbody>
</table>

### METHODS

<table>
<thead>
<tr>
<th>body</th>
<th>Executes the Shared Register and Memory sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>do_block</td>
<td>Test all of the registers and memories in a block</td>
</tr>
<tr>
<td>reset_blk</td>
<td>Reset the DUT that corresponds to the specified block abstraction class.</td>
</tr>
</tbody>
</table>

```verilog
uvm_reg_block model;

protected uvm_reg_shared_access_seq reg_seq

protected uvm_mem_shared_access_seq mem_seq
```

```verilog
virtual task body()
```
Test all of the registers and memories in a block

**reset_blk**

```cpp
virtual task reset_blk(
    uvm_reg_block blk
)
```

Reset the DUT that corresponds to the specified block abstraction class.

Currently empty. Will rollback the environment’s phase to the reset phase once the new phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.
27.6 Memory Access Test Sequence

Contents

**Memory Access Test Sequence**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_mem_single_access_seq</td>
<td>Verify the accessibility of a memory by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the written value.</td>
</tr>
<tr>
<td>uvm_mem_access_seq</td>
<td>Verify the accessibility of all memories in a block by executing the uvm_mem_single_access_seq sequence on every memory within it.</td>
</tr>
</tbody>
</table>

### uvm_mem_single_access_seq

Verify the accessibility of a memory by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the written value.

If bit-type resource named "NO_REG_TESTS", "NO_MEM_TESTS", or "NO_MEM_ACCESS_TEST" in the "REG::" namespace matches the full name of the memory, the memory is not tested.

```plaintext
uvm_resource_db#(bit)::set("REG::", regmodel.blk.mem0.get_full_name(), "NO_MEM_TESTS", 1, this);
```

Memories without an available backdoor cannot be tested.

The DUT should be idle and not modify the memory during this test.

**Summary**

 Verify the accessibility of a memory by writing through its default address map then reading it via the backdoor, then reversing the process, making sure that the resulting value matches the written value.

**Class Hierarchy**

```plaintext
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
uvm_mem_single_access_seq
```

**Class Declaration**

```plaintext
class uvm_mem_single_access_seq extends uvm_reg_sequence
#
  uvm_sequence #(uvm_reg_item)
```
**VARIABLES**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mem</td>
<td>The memory to be tested</td>
</tr>
</tbody>
</table>

---

**Summary**

**uvm_mem_access_seq**

Verify the accessibility of all memories in a block by executing the `uvm_mem_single_access_seq` sequence on every memory within it.

If bit-type resource named "NO_REG_TESTS", "NO_MEM_TESTS", or "NO_MEM_ACCESS_TEST" in the "REG::" namespace matches the full name of the block, the block is not tested.

```verilog
class uvm_mem_access_seq extends uvm_reg_sequence #(
    uvm_sequence #(uvm_reg_item)
)

UVM 1.2 Class Reference

<table>
<thead>
<tr>
<th>Class Hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class Declaration</th>
</tr>
</thead>
</table>
| class uvm_mem_access_seq extends uvm_reg_sequence #(
    uvm_sequence #(uvm_reg_item)
) |

<table>
<thead>
<tr>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>model</td>
</tr>
<tr>
<td>mem_seq</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>body</td>
</tr>
<tr>
<td>do_block</td>
</tr>
<tr>
<td>reset_blk</td>
</tr>
</tbody>
</table>
VARIABLES

**model**
The block to be tested.Declared in the base class.

```cpp
uvm_reg_block model;
```

**mem_seq**
The sequence used to test one memory

```cpp
protected uvm_mem_single_access_seq mem_seq
```

METHODS

**body**

```cpp
virtual task body()
```
Execute the Memory Access sequence. Do not call directly. Use seq.start() instead.

**do_block**

```cpp
protected virtual task do_block(
    uvm_reg_block blk
)
```
Test all of the memories in a given block

**reset_blk**

```cpp
virtual task reset_blk(
    uvm_reg_block blk
)
```
Reset the DUT that corresponds to the specified block abstraction class.

Currently empty. Will rollback the environment’s phase to the reset phase once the new phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.
27.7 Memory Walking-Ones Test Sequences

This section defines sequences for applying a “walking-ones” algorithm on one or more memories.

Contents

<table>
<thead>
<tr>
<th>Memory Walking-Ones Test Sequences</th>
<th>This section defines sequences for applying a “walking-ones” algorithm on one or more memories.</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_mem_single_walk_seq</td>
<td>Runs the walking-ones algorithm on the memory given by the mem property, which must be assigned prior to starting this sequence.</td>
</tr>
<tr>
<td>uvm_mem_walk_seq</td>
<td>Verifies the all memories in a block by executing the uvm_mem_single_walk_seq sequence on every memory within it.</td>
</tr>
</tbody>
</table>

uvm_mem_single_walk_seq

Runs the walking-ones algorithm on the memory given by the mem property, which must be assigned prior to starting this sequence.

If bit-type resource named “NO_REG_TESTS”, “NO_MEM_TESTS”, or “NO_MEM_WALK_TEST” in the “REG::” namespace matches the full name of the memory, the memory is not tested.

```uvm_resource_db#(bit)::set(\"REG::\",regmodel.blk.mem0.get_full_name()),\n"NO_MEM_TESTS", 1, this);```

The walking ones algorithm is performed for each map in which the memory is defined.

```for (k = 0 thru memsize-1)
write addr=k data=~k
if (k > 0) { 
  read addr=k-1, expect data=~(k-1)
  write addr=k-1 data=k-1
if (k == last addr)
  read addr=k, expect data=~k```

Summary

uvm_mem_single_walk_seq

Runs the walking-ones algorithm on the memory given by the mem property, which must be assigned prior to starting this sequence.

Class Hierarchy

```
UVM 1.2 Class Reference
730`
### VARIABLES

**mem**

```plaintext
class uvm_mem mem
```

The memory to test; must be assigned prior to starting sequence.

### METHODS

**new**

```plaintext
function new(
    string name = "uvm_mem_walk_seq"
)
```

Creates a new instance of the class with the given name.

**body**

```plaintext
virtual task body()
```

Performs the walking-ones algorithm on each map of the memory specified in `mem`.

---

**uvm_mem_walk_seq**

Verifies the all memories in a block by executing the `uvm_mem_single_walk_seq` sequence on every memory within it.

If bit-type resource named "NO_REG_TESTS", "NO_MEM_TESTS", or "NO_MEM_WALK_TEST" in the "REG::" namespace matches the full name of the block, the block is not tested.

```plaintext
uvm_resource_db#(bit)::set({"REG::", regmodel.blk.get_full_name(), ".", "NO_MEM_TESTS", 1, this});
```
Summary

**uvm_mem_walk_seq**

Verifies the all memories in a block by executing the `uvm_mem_single_walk_seq` sequence on every memory within it.

**CLASS HIERARCHY**

```
        uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
        uvm_mem_walk_seq
```

**CLASS DECLARATION**

```
class uvm_mem_walk_seq extends uvm_reg_sequence #(
    uvm_sequence #(uvm_reg_item)
)
```

**VARIABLES**

- **model**
  - The block to be tested. Declared in the base class.
  ```
  uvm_reg_block model;
  ```

- **mem_seq**
  - The sequence used to test one memory
  ```
  protected uvm_mem_single_walk_seq mem_seq
  ```

**METHODS**

- **body**
  ```
  virtual task body()
  ```

  Executes the mem walk sequence, one block at a time.

  Test all of the memories in a given block

  Reset the DUT that corresponds to the specified block abstraction class.
Executes the mem walk sequence, one block at a time. Do not call directly. Use seq.start() instead.

**do_block**

```cpp
protected virtual task do_block(
    uvm_reg_block blk
)
```

Test all of the memories in a given *block*

**reset_blk**

```cpp
virtual task reset_blk(
    uvm_reg_block blk
)
```

Reset the DUT that corresponds to the specified block abstraction class.

Currently empty. Will rollback the environment’s phase to the *reset* phase once the new phasing is available.

In the meantime, the DUT should be reset before executing this test sequence or this method should be implemented in an extension to reset the DUT.
27.8 HDL Paths Checking Test Sequence

Summary

HDL Paths Checking Test Sequence

uvm_reg_mem_hdl_paths_seq

Verify the correctness of HDL paths specified for registers and memories.

This sequence is be used to check that the specified backdoor paths are indeed accessible by the simulator. By default, the check is performed for the default design abstraction. If the simulation contains multiple models of the DUT, HDL paths for multiple design abstractions can be checked.

If a path is not accessible by the simulator, it cannot be used for read/write backdoor accesses. In that case a warning is produced. A simulator may have finer-grained access permissions such as separate read or write permissions. These extra access permissions are NOT checked.

The test is performed in zero time and does not require any reads/writes to/from the DUT.

Summary

uvm_reg_mem_hdl_paths_seq

Verify the correctness of HDL paths specified for registers and memories.

**CLASS HIERARCHY**

```
uvm_reg_sequence#(uvm_sequence#(uvm_reg_item))
uvm_reg_mem_hdl_paths_seq
```

**CLASS DECLARATION**

```
class uvm_reg_mem_hdl_paths_seq extends uvm_reg_sequence
#
  uvm_sequence #(uvm_reg_item)
)
```

**VARIABLES**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>abstractions</td>
<td>If set, check the HDL paths for the specified design abstractions.</td>
</tr>
</tbody>
</table>
string abstractions[$]

If set, check the HDL paths for the specified design abstractions. If empty, check the HDL path for the default design abstraction, as specified with `uvm_reg_block::set_default_hdl_path()`
28.1 Command Line Processor Class

This class provides a general interface to the command line arguments that were provided for the given simulation. Users can retrieve the complete arguments using methods such as `get_args()` and `get_arg_matches()` but also retrieve the suffixes of arguments using `get_arg_values()`.

The uvm_cmdline_processor class also provides support for setting various UVM variables from the command line such as components’ verbosities and configuration settings for integral types and strings. Command line arguments that are in uppercase should only have one setting to invocation. Command line arguments that in lowercase can have multiple settings per invocation.

All of these capabilities are described in the uvm_cmdline_processor section.

Summary

**Command Line Processor Class**

This class provides a general interface to the command line arguments that were provided for the given simulation.
28.2 uvm_cmdline_processor

This class provides an interface to the command line arguments that were provided for the given simulation. The class is intended to be used as a singleton, but that isn’t required. The generation of the data structures which hold the command line argument information happens during construction of the class object. A global variable called `uvm_cmdline_proc` is created at initialization time and may be used to access command line information.

The uvm_cmdline_processor class also provides support for setting various UVM variables from the command line such as components’ verbalities and configuration settings for integral types and strings. Each of these capabilities is described in the Built-in UVM Aware Command Line Arguments section.

Summary

### uvm_cmdline_processor

This class provides an interface to the command line arguments that were provided for the given simulation.

#### Class Hierarchy

<table>
<thead>
<tr>
<th>Class Hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td>uvm_void</td>
</tr>
<tr>
<td>uvm_object</td>
</tr>
<tr>
<td>uvm_report_object</td>
</tr>
<tr>
<td>uvm_cmdline_processor</td>
</tr>
</tbody>
</table>

#### Class Declaration

```class uvm_cmdline_processor extends uvm_report_object```

#### Singleton

get_inst

Returns the singleton instance of the UVM command line processor.

#### Basic Arguments

**get_args**

This function returns a queue with all of the command line arguments that were used to start the simulation.

**get_plusargs**

This function returns a queue with all of the plus arguments that were used to start the simulation.

**get_uvmargs**

This function returns a queue with all of the uvm arguments that were used to start the simulation.

**get_arg_matches**

This function loads a queue with all of the arguments that match the input expression and returns the number of items that matched.

#### Argument Values

**get_arg_value**

This function finds the first argument which matches the `match` arg and returns the suffix of the argument.

**get_arg_values**

This function finds all the arguments which matches the `match` arg and returns the suffix of the arguments in a list of values.

#### Tool Information

**get_tool_name**

Returns the simulation tool that is executing the simulation.

**get_tool_version**

Returns the version of the simulation tool that is executing the simulation.

#### Command Line Debug

**+UVM_DUMP.Cmdline_Args**

`+UVM_DUMP.Cmdline_Args` allows the user to dump all command line arguments to the reporting mechanism.

#### Built-in UVM Aware Command Line Arguments

**+UVM_TESTNAME**

`+UVM_TESTNAME=<class name>` allows the user to specify which uvm_test (or uvm_component) should be created via the factory and cycled through the UVM phases.

**+UVM_VERBOSITY**

`+UVM_VERBOSITY=<verbosity>` allows the user to specify the initial
verbosity for all components.

+uvm_set_verbosity
+uvm_set_verbosity=<comp>,<id>,<verbosity>,<phase> and
+uvm_set_verbosity=<comp>,<id>,<verbosity>,time,<time> allow the
users to manipulate the verbosity of specific components at specific
phases (and times during the "run" phases) of the simulation.

+uvm_set_action
+uvm_set_action=<comp>,<id>,<severity>,<action> provides the
equivalent of various uvm_report_object's set_report_*_action APIs.

+uvm_set_severity
+uvm_set_severity=<comp>,<id>,<current severity>,<new severity>
provides the equivalent of the various uvm_report_object's
set_report_*_severity_override APIs.

+UVM_TIMEOUT
+UVM_TIMEOUT=<timeout>,<overridable> allows users to change the
global timeout of the UVM framework.

+UVM_MAX.Quit.COUNT
+UVM_MAX.Quit.COUNT=<count>,<overridable> allows users to
change max quit count for the report server.

+UVM_PHASE_TRACE
+UVM_PHASE_TRACE turns on tracing of phase executions.

+UVM_OBJECTION_TRACE
+UVM_OBJECTION_TRACE turns on tracing of objection activity.

+UVMRESOURCE_DB_TRACE
+UVMRESOURCE_DB_TRACE turns on tracing of resource DB access.

+UVM_CONFIG_DB_TRACE
+UVM_CONFIG_DB_TRACE turns on tracing of configuration DB access.

+uvm_set_inst_override
+uvm_set_type_override
+uvm_set_inst_override=<req_type>,<override_type>,<full_inst_path>
and
+uvm_set_type_override=<req_type>,<override_type>[,<replace>]
work like the name based overrides in the factory--
factory.set_inst_override_by_name() and
factory.set_type_override_by_name().

+uvm_set_config_int
+uvm_set_config_string
+uvm_set_config_int=<comp>,<field>,<value> and
+uvm_set_config_string=<comp>,<field>,<value> work like their
procedural counterparts: set_config_int() and set_config_string().

+uvm_set_default_sequence
The +uvm_set_default_sequence=<seqr>,<phase>,<type> plusarg
allows the user to define a default sequence from the command line,
using the typename of that sequence.

---

**Singleton**

**get_inst**

```plaintext
static function uvm_cmdline_processor get_inst()
```

Returns the singleton instance of the UVM command line processor.

**Basic Arguments**

**get_args**

```plaintext
function void get_args (  
    output string args[$]
)
```

This function returns a queue with all of the command line arguments that were used to
start the simulation. Note that element 0 of the array will always be the name of the
executable which started the simulation.

**get_plusargs**

```plaintext
function void get_plusargs (  
)
```
This function returns a queue with all of the plus arguments that were used to start the simulation. Plus arguments may be used by the simulator vendor, or may be specific to a company or individual user. Plus args never have extra arguments (i.e. if there is a plusarg as the second argument on the command line, the third argument is unrelated); this is not necessarily the case with vendor specific dash arguments.

**get_uvmargs**

This function returns a queue with all of the uvm arguments that were used to start the simulation. A UVM argument is taken to be any argument that starts with a - or + and uses the keyword UVM (case insensitive) as the first three letters of the argument.

**get_arg_matches**

```plaintext
function int get_arg_matches (string match, ref string args[]) {
    // Implementation...
}
```

This function loads a queue with all of the arguments that match the input expression and returns the number of items that matched. If the input expression is bracketed with //, then it is taken as an extended regular expression otherwise, it is taken as the beginning of an argument to match. For example:

```plaintext
string myargs[]
initial begin
    void'(uvm_cmdline_proc.get_arg_matches("+foo",myargs)); //matches +foo,
    +foobar //doesn't match +barfoo
    void'(uvm_cmdline_proc.get_arg_matches("/\"foo\"",myargs)); //matches +foo,
    +foobarr, //foo.sv,
    barfoo, etc.
    void'(uvm_cmdline_proc.get_arg_matches("/^foo.*\.sv",myargs)); //matches foo.sv
    foo123.sv, //and
    barfoo.sv. //not
}
```

**Argument Values**

**get_arg_value**

```plaintext
function int get_arg_value (string match, ref string value) {
    // Implementation...
}
```

This function finds the first argument which matches the *match* arg and returns the suffix of the argument. This is similar to the $value$plusargs system task, but does not take a formatting string. The return value is the number of command line arguments that match the *match* string, and *value* is the value of the first match.
get_arg_values

```verbatim
def function int get_arg_values (string match, ref string values[$])

This function finds all the arguments which matches the match arg and returns the suffix
of the arguments in a list of values. The return value is the number of matches that
were found (it is the same as values.size() ). For example if ‘+foo=1,yes,on
+foo=5,no,off’ was provided on the command line and the following code was executed:

```verbatim
```

string foo_values[$]
initial begin
    void'(uvm_cmdline_proc.get_arg_values("+foo=",foo_values));
```

```verbatim

The foo_values queue would contain two entries. These entries are shown here:

0   “1,yes,on”
1   “5,no,off”

Splitting the resultant string is left to user but using the uvm_split_string() function is
recommended.

TOOL INFORMATION

get_tool_name

```verbatim

function string get_tool_name ()

Returns the simulation tool that is executing the simulation. This is a vendor specific
string.

get_tool_version

```verbatim

function string get_tool_version ()

Returns the version of the simulation tool that is executing the simulation. This is a
vendor specific string.

COMMAND LINE DEBUG

+UVM_DUMP_CMDLINEARGS

+UVM_DUMP_CMDLINE_ARGS allows the user to dump all command line arguments to
the reporting mechanism. The output is in tree format.

BUILT-IN UVM AWARE COMMAND LINE ARGUMENTS
+UVM_TESTNAME

+UVM_TESTNAME=<class name> allows the user to specify which uvm_test (or uvm_component) should be created via the factory and cycled through the UVM phases. If multiple of these settings are provided, the first occurrence is used and a warning is issued for subsequent settings. For example:

```
<sim command> +UVM_TESTNAME=read_modify_write_test
```

+UVM_VERBOSITY

+UVM_VERBOSITY=<verbosity> allows the user to specify the initial verbosity for all components. If multiple of these settings are provided, the first occurrence is used and a warning is issued for subsequent settings. For example:

```
<sim command> +UVM_VERBOSITY=UVM_HIGH
```

+uvm_set_verbosity

+uvm_set_verbosity=<comp>,<id>,<verbosity>,<phase> and +uvm_set_verbosity=<comp>,<id>,<verbosity>,time,<time> allow the users to manipulate the verbosity of specific components at specific phases (and times during the “run” phases) of the simulation. The id argument can be either ALL for all IDs or a specific message id. Wildcarding is not supported for id due to performance concerns. Settings for non-“run” phases are executed in order of occurrence on the command line. Settings for “run” phases (times) are sorted by time and then executed in order of occurrence for settings of the same time. For example:

```
<sim command>
+uvm_set_verbosity=uvm_test_top.env0.agent1.*,_ALL_,UVM_FULL,time,800
```

+uvm_set_action

+uvm_set_action=<comp>,<id>,<severity>,<action> provides the equivalent of various uvm_report_object’s set_report_*_action APIs. The special keyword, ALL, can be provided for both/either the id and/or severity arguments. The action can be UVM_NO_ACTION or a | separated list of the other UVM message actions. For example:

```
<sim command>
+uvm_set_action=uvm_test_top.env0.*,_ALL_,UVM_ERROR,UVM_NO_ACTION
```

+uvm_set_severity

+uvm_set_severity=<comp>,<id>,<current severity>,<new severity> provides the equivalent of the various uvm_report_object’s set_report_*_severity_override APIs. The
special keyword, **ALL**, can be provided for both/either the *id* and/or *current severity* arguments. For example:

```
<sim command>
+uvm_set_severity=uvm_test_top.env0.*,BAD_CRC,UVM_ERROR,UVM_WARNING
```

**+UVM_TIMEOUT**

**+UVM_TIMEOUT=<timeout>,<overridable>** allows users to change the global timeout of the UVM framework. The `<overridable>` argument ('YES' or 'NO') specifies whether user code can subsequently change this value. If set to 'NO' and the user code tries to change the global timeout value, a warning message will be generated.

```
<sim command> +UVM_TIMEOUT=200000,NO
```

**+UVM_MAX_QUIT_COUNT**

**+UVM_MAX_QUIT_COUNT=<count>,<overridable>** allows users to change max quit count for the report server. The `<overridable>` argument ('YES' or 'NO') specifies whether user code can subsequently change this value. If set to 'NO' and the user code tries to change the max quit count value, a warning message will be generated.

```
<sim command> +UVM_MAX_QUIT_COUNT=5,NO
```

**+UVM_PHASE_TRACE**

**+UVM_PHASE_TRACE** turns on tracing of phase executions. Users simply need to put the argument on the command line.

**+UVM_OBJECTION_TRACE**

**+UVM_OBJECTION_TRACE** turns on tracing of objection activity. Users simply need to put the argument on the command line.

**+UVM_RESOURCE_DB_TRACE**

**+UVM_RESOURCE_DB_TRACE** turns on tracing of resource DB access. Users simply need to put the argument on the command line.

**+UVM_CONFIG_DB_TRACE**

**+UVM_CONFIG_DB_TRACE** turns on tracing of configuration DB access. Users simply need to put the argument on the command line.
+uvm_set_inst_override

+uvm_set_type_override
+uvm_set_inst_override=<req_type>,<override_type>,<full_inst_path> and
+uvm_set_type_override=<req_type>,<override_type>[,<replace>] work like the name
based overrides in the factory--factory.set_inst_override_by_name() and
factory.set_type_override_by_name(). For uvm_set_type_override, the third argument is
0 or 1 (the default is 1 if this argument is left off); this argument specifies whether
previous type overrides for the type should be replaced. For example:

```
<sim command> +uvm_set_type_override=eth_packet,short_eth_packet
```

+uvm_set_config_int

+uvm_set_config_string
+uvm_set_config_int=<comp>,<field>,<value> and
+uvm_set_config_string=<comp>,<field>,<value> work like their procedural
counterparts: set_config_int() and set_config_string(). For the value of int config
settings, 'b (0b), 'o, 'd, 'h ('x or
0x) as the first two characters of the value are treated
as base specifiers for interpreting the base of the number. Size specifiers are not used
since SystemVerilog does not allow size specifiers in string to value conversions. For
example:

```
<sim command> +uvm_set_config_int=uvm_test_top.soc_env,mode,5
```

No equivalent of set_config_object() exists since no way exists to pass a uvm_object into
the simulation via the command line.

+uvm_set_default_sequence

The +uvm_set_default_sequence=<seqr>,<phase>,<type> plusarg allows the user to
define a default sequence from the command line, using the typename of that sequence.
For example:

```
<sim command> +uvm_set_default_sequence=path.to.sequencer,main_phase,seq_type
```

This is functionally equivalent to calling the following in your test:

```
uvm_coreservice_t cs = uvm_coreservice_t::get();
uvm_factory f = cs.get_factoy();
uvm_config_db#(uvm_object_wrapper)::set(this,
     "path.to.sequencer.main_phase",
     "default_sequence",
     f.find_wrapper_by_name("seq_type"));
```
29. Global Functionality

UVM provides other functionality at the package scope including methods, enums, defines, and classes. Some of these are targeted towards specific aspects of the functionality described in the UVM standard, and others are useful across multiple aspects.

Summary

**Global Functionality**

UVM provides other functionality at the package scope including methods, enums, defines, and classes.
### Types and Enumerations

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<th>Description</th>
</tr>
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<td>Defines the maximum bit vector size for integral types.</td>
</tr>
<tr>
<td><code>UVM_PACKER_MAX_BYTES</code></td>
<td>Defines the maximum bytes to allocate for packing an object using the <code>uvm_packer</code>.</td>
</tr>
<tr>
<td><code>UVM_DEFAULT_TIMEOUT</code></td>
<td>The default timeout for simulation, if not overridden by <code>uvm_root::set_timeout</code> or <code>uvm_cmdline_processor::+UVM_TIMEOUT</code></td>
</tr>
<tr>
<td><code>uvm_bitstream_t</code></td>
<td>The bitstream type is used as an argument type for passing integral values in such methods as <code>uvm_object::set_int_local</code>, <code>uvm_config_int</code>, <code>uvm_printer::print_field</code>, <code>uvm_recorder::record_field</code>, <code>uvm_packer::pack_field</code> and <code>uvm_packer::unpack_field</code>.</td>
</tr>
<tr>
<td><code>uvm_integral_t</code></td>
<td>The integral type is used as an argument type for passing integral values of 64 bits or less in such methods as <code>uvm_printer::print_field_int</code>, <code>uvm_recorder::record_field_int</code>, <code>uvm_packer::pack_field_int</code> and <code>uvm_packer::unpack_field_int</code>.</td>
</tr>
<tr>
<td><code>uvm_radix_enum</code></td>
<td>Specifies the radix to print or record in.</td>
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<tr>
<td><code>uvm_recursion_policy_enum</code></td>
<td>Specifies the policy for copying objects.</td>
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<td><code>uvm_active_passive_enum</code></td>
<td>Convenience value to define whether a component, usually an agent, is in &quot;active&quot; mode or &quot;passive&quot; mode.</td>
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<td>This is an attribute of a <code>uvm_phase</code> object which defines the phase type.</td>
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<td><code>uvm_phase_state</code></td>
<td>The set of possible states of a phase.</td>
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<td><code>uvm_wait_op</code></td>
<td>Specifies the operand when using methods like <code>uvm_phase::wait_for_state</code>.</td>
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<td>Objections</td>
<td></td>
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<tr>
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<td>Default Policy Classes</td>
<td></td>
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<tr>
<td><code>uvm_default_table_printer</code></td>
<td>Policy classes copying, comparing, packing, unpacking, and recording <code>uvm_object</code>-based objects.</td>
</tr>
<tr>
<td></td>
<td>The table printer is a global object that can be used with <code>uvm_object::do_print</code> to get</td>
</tr>
</tbody>
</table>
**Field Automation**

`\UVM_MAX_STREAMBITS`

Defines the maximum bit vector size for integral types.

`\UVM_PACKER_MAX_BYTES`

Defines the maximum bytes to allocate for packing an object using the `uvm_packer`. Default is `\UVM_MAX_STREAMBITS`, in bytes.

`\UVM_DEFAULT_TIMEOUT`

The default timeout for simulation, if not overridden by `uvm_root::set_timeout` or `uvm_cmdline_processor::+UVM_TIMEOUT`

`uvm_bitstream_t`

The bitstream type is used as an argument type for passing integral values in such methods as `uvm_object::set_int_local`, `uvm_config_int`, `uvm_printer::print_field`, `uvm_recorder::record_field`, `uvm_packer::pack_field` and `uvm_packer::unpack_field`.

`uvm_integral_t`

The integral type is used as an argument type for passing integral values of 64 bits or less in such methods as `uvm_printer::print_field_int`, `uvm_recorder::record_field_int`, `uvm_packer::pack_field_int` and `uvm_packer::unpack_field_int`.

`uvm_radix_enum`

Specifies the radix to print or record in.

- `UVM_BIN` Selects binary (%b) format
- `UVM_DEC` Selects decimal (%d) format
- `UVM_UNSIGNED` Selects unsigned decimal (%u) format
- `UVM_UNFORMAT2` Selects unformatted 2 value data (%u) format
UVM_UNFORMAT4  Selects unformatted 4 value data (%z) format
UVM_OCT        Selects octal (%o) format
UVM_HEX        Selects hexadecimal (%h) format
UVM_STRING     Selects string (%s) format
UVM_TIME       Selects time (%t) format
UVM_ENUM       Selects enumeration value (name) format
UVM_REAL       Selects real (%g) in exponential or decimal format, whichever format results in the shorter printed output
UVM_REAL_DEC   Selects real (%f) in decimal format
UVM_REAL_EXP   Selects real (%e) in exponential format

**uvm_recursion_policy_enum**

Specifies the policy for copying objects.

- **UVM_DEEP**: Objects are deep copied (object must implement `uvm_object::copy` method)
- **UVM_SHALLOW**: Objects are shallow copied using default SV copy.
- **UVM_REFERENCE**: Only object handles are copied.

**uvm_active_passive_enum**

Convenience value to define whether a component, usually an agent, is in “active” mode or “passive” mode.

- **UVM_PASSIVE**: “Passive” mode
- **UVM_ACTIVE**: “Active” mode

`uvm_field_*` macro flags

Defines what operations a given field should be involved in. Bitwise OR all that apply.

- **UVM_DEFAULT**: All field operations turned on
- **UVM_COPY**: Field will participate in `uvm_object::copy`
- **UVM_COMPARE**: Field will participate in `uvm_object::compare`
- **UVM_PRINT**: Field will participate in `uvm_object::print`
- **UVM_RECORD**: Field will participate in `uvm_object::record`
- **UVM_PACK**: Field will participate in `uvm_object::pack`
- **UVM_NOCOPY**: Field will not participate in `uvm_object::copy`
- **UVM_NOCOMPARE**: Field will not participate in `uvm_object::compare`
- **UVM_NOPRINT**: Field will not participate in `uvm_object::print`
- **UVM_NORECORD**: Field will not participate in `uvm_object::record`
- **UVM_NOPACK**: Field will not participate in `uvm_object::pack`
- **UVM_DEEP**: Object field will be deep copied
- **UVM_SHALLOW**: Object field will be shallow copied
- **UVM_REFERENCE**: Object field will copied by reference
**REPORTING**

**uvm_severity**

Defines all possible values for report severity.

- **UVM_INFO**  Informative message.
- **UVM_WARNING**  Indicates a potential problem.
- **UVM_ERROR**  Indicates a real problem. Simulation continues subject to the configured message action.
- **UVM_FATAL**  Indicates a problem from which simulation cannot recover. Simulation exits via $finish after a #0 delay.

**uvm_action**

Defines all possible values for report actions. Each report is configured to execute one or more actions, determined by the bitwise OR of any or all of the following enumeration constants.

- **UVM_NO_ACTION**  No action is taken
- **UVM_DISPLAY**  Sends the report to the standard output
- **UVM_LOG**  Sends the report to the file(s) for this (severity,id) pair
- **UVM_COUNT**  Counts the number of reports with the COUNT attribute. When this value reaches max_quit_count, the simulation terminates
- **UVM_EXIT**  Terminates the simulation immediately.
- **UVM_CALL_HOOK**  Callback the report hook methods
- **UVM_STOP**  Causes $stop to be executed, putting the simulation into interactive mode.
- **UVM_RM_RECORD**  Sends the report to the recorder

**uvm_verbosity**

Defines standard verbosity levels for reports.

- **UVM_NONE**  Report is always printed. Verbosity level setting cannot disable it.
- **UVM_LOW**  Report is issued if configured verbosity is set to UVM_LOW or above.
- **UVM_MEDIUM**  Report is issued if configured verbosity is set to UVM_MEDIUM or above.
- **UVM_HIGH**  Report is issued if configured verbosity is set to UVM_HIGH or above.
- **UVM_FULL**  Report is issued if configured verbosity is set to UVM_FULL or above.
**Port Type**

**uvm_port_type_e**

Specifies the type of port

- **UVM_PORT**
  The port requires the interface that is its type parameter.

- **UVM_EXPORT**
  The port provides the interface that is its type parameter via a connection to some other export or implementation.

- **UVM_IMPLEMENTATION**
  The port provides the interface that is its type parameter, and it is bound to the component that implements the interface.

**Sequences**

**uvm_sequencer_arb_mode**

Specifies a sequencer's arbitration mode

- **UVM_SEQ_ARB_FIFO**
  Requests are granted in FIFO order (default)

- **UVM_SEQ_ARB_WEIGHTED**
  Requests are granted randomly by weight

- **UVM_SEQ_ARB_RANDOM**
  Requests are granted randomly

- **UVM_SEQ_ARB_STRICT_FIFO**
  Requests at highest priority granted in fifo order

- **UVM_SEQ_ARB_STRICT_RANDOM**
  Requests at highest priority granted in randomly

- **UVM_SEQ_ARB_USER**
  Arbitration is delegated to the user-defined function, user_priority_arbitration. That function will specify the next sequence to grant.

**uvm_sequence_state_enum**

Defines current sequence state

- **UVM_CREATED**
  The sequence has been allocated.

- **UVM_PRE_START**
  The sequence is started and the uvm_sequence_base::pre_start() task is being executed.

- **UVM_PRE_BODY**
  The sequence is started and the uvm_sequence_base::pre_body() task is being executed.

- **UVM_BODY**
  The sequence is started and the uvm_sequence_base::body() task is being executed.

- **UVM_ENDED**
  The sequence has completed the execution of the uvm_sequence_base::body() task.
**UVM_POST_BODY**  The sequence is started and the `uvm_sequence_base::post_body()` task is being executed.

**UVM_POST_START**  The sequence is started and the `uvm_sequence_base::post_start()` task is being executed.

**UVM_STOPPED**  The sequence has been forcibly ended by issuing a `uvm_sequence_base::kill()` on the sequence.

**UVM_FINISHED**  The sequence is completely finished executing.

---

**uvm_sequence_lib_mode**

Specifies the random selection mode of a sequence library

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVM_SEQ_LIB_RAND</td>
<td>Random sequence selection</td>
</tr>
<tr>
<td>UVM_SEQ_LIB_RANDC</td>
<td>Random cyclic sequence selection</td>
</tr>
<tr>
<td>UVM_SEQ_LIB_ITEM</td>
<td>Emit only items, no sequence execution</td>
</tr>
<tr>
<td>UVM_SEQ_LIB_USER</td>
<td>Apply a user-defined random-selection algorithm</td>
</tr>
</tbody>
</table>

---

**PHASING**

---

**uvm_phase_type**

This is an attribute of a `uvm_phase` object which defines the phase type.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVM_PHASE_IMP</td>
<td>The phase object is used to traverse the component hierarchy and call the component phase method as well as the <code>phase_started</code> and <code>phase_ended</code> callbacks. These nodes are created by the phase macros, <code>uvm_builtin_task_phase</code>, <code>uvm_builtin_topdown_phase</code>, and <code>uvm_builtin_bottomup_phase</code>. These nodes represent the phase type, i.e. <code>uvm_run_phase</code>, <code>uvm_main_phase</code>.</td>
</tr>
<tr>
<td>UVM_PHASE_NODE</td>
<td>The object represents a simple node instance in the graph. These nodes will contain a reference to their corresponding IMP object.</td>
</tr>
<tr>
<td>UVM_PHASE_SCHEDULE</td>
<td>The object represents a portion of the phasing graph, typically consisting of several NODE types, in series, parallel, or both.</td>
</tr>
<tr>
<td>UVM_PHASE_TERMINAL</td>
<td>This internal object serves as the termination NODE for a SCHEDULE phase object.</td>
</tr>
<tr>
<td>UVM_PHASE_DOMAIN</td>
<td>This object represents an entire graph segment that executes in parallel with the <code>run</code> phase. Domains may define any network of NODEs and SCHEDULEs. The built-in domain, <code>uvm</code>, consists of a single schedule of all the run-time phases, starting with <code>pre_reset</code> and ending with <code>post_shutdown</code>.</td>
</tr>
</tbody>
</table>

---

**uvm_phase_state**
The set of possible states of a phase. This is an attribute of a schedule node in the graph, not of a phase, to maintain independent per-domain state.

- **UVM_PHASE_UNINITIALIZED**
  The state is uninitialized. This is the default state for phases, and for nodes which have not yet been added to a schedule.

- **UVM_PHASE_DORMANT**
  The schedule is not currently operating on the phase node, however it will be scheduled at some point in the future.

- **UVM_PHASE_SCHEDULED**
  At least one immediate predecessor has completed. Scheduled phases block until all predecessors complete or until a jump is executed.

- **UVM_PHASE_SYNCING**
  All predecessors complete, checking that all synced phases (e.g. across domains) are at or beyond this point.

- **UVM_PHASE_STARTED**
  Phase ready to execute, running phase_started() callback.

- **UVM_PHASE_EXECUTING**
  An executing phase is one where the phase callbacks are being executed. Its process is tracked by the phaser.

- **UVM_PHASE_READY_TO_END**
  No objections remain in this phase or in any predecessors of its successors or in any synced phases. This state indicates an opportunity for any phase that needs extra time for a clean exit to raise an objection, thereby causing a return to UVM_PHASE_EXECUTING. If no objection is raised, state will transition to UVM_PHASE_ENDED after a delta cycle. (An example of predecessors of successors: The successor to phase ‘run’ is ‘extract’, whose predecessors are ‘run’ and ‘post_shutdown’. Therefore, ‘run’ will go to this state when both its objections and those of ‘post_shutdown’ are all dropped.

- **UVM_PHASE_ENDED**
  Phase completed execution, now running phase Ended() callback.

- **UVM_PHASE_JUMPING**
  All processes related to phase are being killed and all predecessors are forced into the DONE state.

- **UVM_PHASE_CLEANUP**
  All processes related to phase are being killed.

- **UVM_PHASE_DONE**
  A phase is done after it terminated execution. Becoming done may enable a waiting successor phase to execute.

The state transitions occur as follows:

```
UNINITIALIZED  ->  DORMANT  ->  SCHED  ->  SYNC  ->  START  ->  EXEC  ->  READY  ->  END
                ^                      # jump_to
                |                      
                |                      
                JUMPING<  +
```

UVM 1.2 Class Reference

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**uvm_wait_op**

Specifies the operand when using methods like `uvm_phase::wait_for_state`.

- **UVM_EQ**: equal
- **UVM_NE**: not equal
- **UVM_LT**: less than
- **UVM_LTE**: less than or equal to
- **UVM_GT**: greater than
- **UVM_GTE**: greater than or equal to

**Objections**

**uvm_objection_event**

Enumerated the possible objection events one could wait on. See `uvm_objection::wait_for`.

- **UVM_RAISED**: an objection was raised
- **UVM_DROPPED**: an objection was raised
- **UVM_ALL_DROPPED**: all objections have been dropped

**Default Policy Classes**

Policy classes copying, comparing, packing, unpacking, and recording `uvm_object`-based objects.

**uvm_default_table_printer**

```plaintext
table_printer uvm_default_table_printer = new()
```

The table printer is a global object that can be used with `uvm_object::do_print` to get tabular style printing.

**uvm_default_tree_printer**

```plaintext
tree_printer uvm_default_tree_printer = new()
```

The tree printer is a global object that can be used with `uvm_object::do_print` to get multi-line tree style printing.

**uvm_default_line_printer**

```plaintext
line_printer uvm_default_line_printer = new()
```
The line printer is a global object that can be used with `uvm_object::do_print` to get single-line style printing.

**uvm_default_printer**

```plaintext
uvm_printer uvm_default_printer = uvm_default_table_printer
```

The default printer policy. Used when calls to `uvm_object::print` or `uvm_object::sprint` do not specify a printer policy.

The default printer may be set to any legal `uvm_printer` derived type, including the global line, tree, and table printers described above.

**uvm_default_packer**

```plaintext
uvm_packer uvm_default_packer = new()
```

The default packer policy. Used when calls to `uvm_object::pack` and `uvm_object::unpack` do not specify a packer policy.

**uvm_default_comparer**

```plaintext
uvm_comparer uvm_default_comparer = new()
```

The default compare policy. Used when calls to `uvm_object::compare` do not specify a comparer policy.
29.2 Globals

**Summary**

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**SIMULATION CONTROL**

**run_test**

```plaintext
task run_test (string test_name = "")
```

Convenience function for uvm_top.run_test(). See uvm_root for more information.

**REPORTING**
uvm_get_report_object

function uvm_report_object uvm_get_report_object()

Returns the nearest uvm_report_object when called. For the global version, it returns uvm_root.

uvm_report_enabled

function int uvm_report_enabled (
    int verbosity,
    uvm_severity severity = UVM_INFO,
    string id = ""
)

Returns 1 if the configured verbosity in uvm_top for this severity/id is greater than or equal to verbosity else returns 0.

See also uvm_report_object::uvm_report_enabled.

Static methods of an extension of uvm_report_object, e.g. uvm_component-based objects, cannot call uvm_report_enabled because the call will resolve to the uvm_report_object::uvm_report_enabled, which is non-static. Static methods cannot call non-static methods of the same class.

uvm_report

function void uvm_report(
    uvm_severity severity,
    string id,
    string message,
    int verbosity = (severity ==
        uvm_severity'(UVM_ERROR)) ?
    UVM_LOW : (severity ==
        uvm_severity'(UVM_FATAL)) ?
    UVM_NONE : UVM_MEDIUM,
    string filename = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)

uvm_report_info

function void uvm_report_info(
    string id,
    string message,
    int severity = UVM_MEDIUM,
    string filename = "",
    int line = 0,
    string context_name = "",
    bit report_enabled_checked = 0
)

uvm_report_warning

function void uvm_report_warning(
    string id,
These methods, defined in package scope, are convenience functions that delegate to the corresponding component methods in `uvm_top`. They can be used in module-based code to use the same reporting mechanism as class-based components. See `uvm_report_object` for details on the reporting mechanism.

**Note:** Verbosity is ignored for warnings, errors, and fatals to ensure users do not inadvertently filter them out. It remains in the methods for backward compatibility.

This method, defined in package scope, is a convenience function that delegate to the corresponding component method in `uvm_top`. It can be used in module-based code to use the same reporting mechanism as class-based components. See `uvm_report_object` for details on the reporting mechanism.

**MISCELLANEOUS**
Returns 1 if the two strings match, 0 otherwise.

The first string, \( expr \), is a string that may contain `*` and `?` characters. A * matches zero or more characters, and ? matches any single character. The 2nd argument, \( str \), is the string begin matched against. It must not contain any wildcards.

### uvm_string_to_bits

```plaintext
function logic[UVM_LARGE_STRING:0] uvm_string_to_bits(
    string str
)
```

Converts an input string to its bit-vector equivalent. Max bit-vector length is approximately 14000 characters.

### uvm_bits_to_string

```plaintext
function string uvm_bits_to_string(
    logic [UVM_LARGE_STRING:0] str
)
```

Converts an input bit-vector to its string equivalent. Max bit-vector length is approximately 14000 characters.

### uvm_wait_for_nba_region

```plaintext
task uvm_wait_for_nba_region
```

Callers of this task will not return until the NBA region, thus allowing other processes any number of delta cycles (#0) to settle out before continuing. See `uvm_sequencer_base::wait_for_sequences` for example usage.

### uvm_split_string

```plaintext
function automatic void uvm_split_string ( 
    string str,
    byte sep,
    ref string values[]
)
```

Returns a queue of strings, \( values \), that is the result of the \( str \) split based on the \( sep \). For example:

```plaintext
uvm_split_string("1, on, false", ",", splits);
```

Results in the `splits` queue containing the three elements: 1, on and false.
The *uvm_enum_wrapper*(T) class is a utility mechanism provided as a convenience to the end user. It provides a *from_name* method which is the logical inverse of the SystemVerilog *name* method which is built into all enumerations.

## Summary

**uvm_enum_wrapper#(T)**

The *uvm_enum_wrapper#(T)* class is a utility mechanism provided as a convenience to the end user.

**Class Declaration**

```
class uvm_enum_wrapper#(
    type T = uvm_active_passive_enum
)
```

**Methods**

- **from_name**

  Attempts to convert a string *name* to an enumerated value.

### Methods

**from_name**

```cpp
static function bit from_name(
    string name,
    ref T value
)
```

Attempts to convert a string *name* to an enumerated value.

If the conversion is successful, the method will return 1, otherwise 0.

Note that the *name* passed in to the method must exactly match the value which would be produced by *enum::name*, and is case sensitive.

### For example

```cpp
typedef uvm_enum_wrapper#(uvm_radix_enum) radix_wrapper;
uvm_radix_enum r_v;
// The following would return '0', as "foo" isn't a value
// in uvm_radix_enum:
radix_wrapper::from_name("foo", r_v);

// The following would return '0', as "uvm_bin" isn't a value
// in uvm_radix_enum (although the upper case "UVM_BIN" is):
radix_wrapper::from_name("uvm_bin", r_v);

// The following would return '1', and r_v would be set to
// the value of UVM_BIN
radix_wrapper::from_name("UVM_BIN", r_v);
```
29.3 uvm_coreservice_t

The singleton instance of uvm_coreservice_t provides a common point for all central uvm services such as uvm_factory, uvm_report_server, ... The service class provides a static ::get which returns an instance adhering to uvm_coreservice_t the rest of the set_facility get_facility pairs provide access to the internal uvm services.

Custom implementations of uvm_coreservice_t can be included in uvm_pkg::* and can selected via the define UVM_CORESERVICE_TYPE. They cannot reside in another package.

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<tr>
<td>uvm_default_coreservice_t</td>
<td>uvm_default_coreservice_t provides a default implementation of the uvm_coreservice_t API.</td>
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METHODS

get_factory

```cpp
pure virtual function uvm_factory get_factory()
```

intended to return the currently enabled uvm factory,

set_factory

```cpp
pure virtual function void set_factory(uvm_factory f)
```

intended to set the current uvm factory

get_report_server

```cpp
pure virtual function uvm_report_server get_report_server()
```

intended to return the current global report_server

set_report_server

```cpp
pure virtual function void set_report_server(uvm_report_server server)
```

intended to set the central report server to server
**get_default_tr_database**

```c
pure virtual function uvm_tr_database get_default_tr_database()
```

intended to return the current default record database

**set_default_tr_database**

```c
pure virtual function void set_default_tr_database(uvm_tr_database db)
```

intended to set the current default record database to `db`

**set_component_visitor**

```c
pure virtual function void set_component_visitor(uvm_visitor#(uvm_component) v)
```

intended to set the component visitor to `v` (this visitor is being used for the traversal at `end_of_elaboration_phase` for instance for name checking)

**get_component_visitor**

```c
pure virtual function uvm_visitor#(uvm_component) get_component_visitor()
```

intended to retrieve the current component visitor see `set_component_visitor`

**get_root**

```c
pure virtual function uvm_root get_root()
```

returns the `uvm_root` instance

**get**

```c
static function uvm_coreservice_t get()
```

Returns an instance providing the `uvm_coreservice_t` interface. The actual type of the instance is determined by the define `UVM_CORESERVICE_TYPE`.

```
#define UVM_CORESERVICE_TYPE uvm_blocking_coreservice
class uvm_blocking_coreservice extends uvm_default_coreservice_t;
  virtual function void set_factory(uvm_factory f);
  `uvm_error("FACTORY","you are not allowed to override the factory")
endfunction
endclass
```
**uvm_default_coreservice_t**

uvm_default_coreservice_t provides a default implementation of the uvm_coreservice_t API. It instantiates uvm_default_factory, uvm_default_report_server, uvm_root.

**Summary**

### uvm_default_coreservice_t

uvm_default_coreservice_t provides a default implementation of the uvm_coreservice_t API.

### Class Hierarchy

```
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<tr>
<td>uvm_default_coreservice_t</td>
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```

### Class Declaration

```
class uvm_default_coreservice_t extends uvm_coreservice_t
```

### Methods

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<td>Returns the currently enabled uvm factory.</td>
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<tr>
<td>set_factory</td>
<td>Sets the current uvm factory.</td>
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<tr>
<td>get_default_tr_database</td>
<td>Returns the current default record database</td>
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<tr>
<td>set_default_tr_database</td>
<td>Sets the current default record database to db</td>
</tr>
<tr>
<td>get_report_server</td>
<td>Returns the current global report_server if no report server has been set before, returns an instance of uvm_default_report_server</td>
</tr>
<tr>
<td>set_report_server</td>
<td>Sets the central report server to server</td>
</tr>
<tr>
<td>set_component_visitor</td>
<td>Sets the component visitor to v (this visitor is being used for the traversal at end_of_elaboration_phase for instance for name checking)</td>
</tr>
<tr>
<td>get_component_visitor</td>
<td>Retrieves the current component visitor if unset (or null) returns a uvm_component_name_check_visitor instance</td>
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**Methods**

### get_factory

```
virtual function uvm_factory get_factory()
```

Returns the currently enabled uvm factory. When no factory has been set before, instantiates a uvm_default_factory

### set_factory

```
virtual function void set_factory(
    uvm_factory f
)
```

Sets the current uvm factory. Please note: it is up to the user to preserve the contents
of the original factory or delegate calls to the original factory

**get_default_tr_database**

```cpp
virtual function uvm_tr_database get_default_tr_database()
```

returns the current default record database

If no default record database has been set before this method is called, returns an instance of `uvm_text_tr_database`

**set_default_tr_database**

```cpp
virtual function void set_default_tr_database(
    uvm_tr_database db
)
```

Sets the current default record database to `db`

**get_report_server**

```cpp
virtual function uvm_report_server get_report_server()
```

returns the current global report_server if no report server has been set before, returns an instance of `uvm_default_report_server`

**set_report_server**

```cpp
virtual function void set_report_server(
    uvm_report_server server
)
```

sets the central report server to `server`

**set_component_visitor**

```cpp
virtual function void set_component_visitor(
    uvm_visitor#(uvm_component) v
)
```

sets the component visitor to `v` (this visitor is being used for the traversal at end_of_elaboration_phase for instance for name checking)

**get_component_visitor**

```cpp
virtual function uvm_visitor#(uvm_component) get_component_visitor()
```

retrieves the current component visitor if unset(or null) returns a `uvm_component_name_check_visitor` instance
29.4 uvm_visitor #(NODE)

The uvm_visitor class provides an abstract base class for a visitor. The visitor visits instances of type NODE. For general information regarding the visitor pattern see
http://en.wikipedia.org/wiki/Visitor_pattern

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<td>The uvm_structure_proxy is a wrapper and provides a set of elements of the STRUCTURE to the caller on demand.</td>
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<td>uvm_visitor_adapter #(STRUCTURE,uvm_visitor#(STRUCTURE))</td>
<td>The visitor adaptor traverses all nodes of the STRUCTURE and will invoke visitor.visit() on every node.</td>
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<tr>
<td>uvm_top_down_visitor_adapter</td>
<td>This uvm_top_down_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion.</td>
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<tr>
<td>uvm_bottom_up_visitor_adapter</td>
<td>This uvm_bottom_up_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion.</td>
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<tr>
<td>uvm_by_level_visitor_adapter</td>
<td>This uvm_by_level_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion.</td>
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<td>This specialized visitor analyze the naming of the current component.</td>
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Methods

**begin_v**

virtual function void begin_v()

This method will be invoked by the visitor before the first NODE is visited

**end_v**

virtual function void end_v()

This method will be invoked by the visitor after the last NODE is visited

**visit**

pure virtual function void visit(NODE node)

This method will be invoked by the visitor for every visited node of the provided structure. The user is expected to provide the own functionality in this function.

```markdown
class count_nodes_visitor#(type T=uvm_component) extends uvm_visitor#(T);
    function new [string name = ""];
        super.new(name);
    endfunction
    local int cnt;
    virtual function void begin_v(); cnt = 0; endfunction
    virtual function void end_v(); `uvm_info("TEXT",$sformatf("%d elements",cnt),UVM_NONE) endfunction
    virtual function void visit(T node); cnt++; endfunction
endclass
```

### uvm_structure_proxy #(STRUCTURE)

The uvm_structure_proxy is a wrapper and provides a set of elements of the STRUCTURE to the caller on demand. This is to decouple the retrieval of the STRUCTUREs subelements from the actual function being invoked on STRUCTURE.

#### Summary

**uvm_structure_proxy #(STRUCTURE)**

The uvm_structure_proxy is a wrapper and provides a set of elements of the STRUCTURE to the caller on demand.

**Methods**

`get_immediate_children`  
This method will return in `children` a set of the direct subelements of `s`.

#### Methods

**get_immediate_children**

```markdown
pure virtual function void get_immediate_children(
    STRUCTURE s,
    ref STRUCTURE children[]
)
```

This method will return in `children` a set of the direct subelements of `s`.

### uvm_visitor_adapter #(STRUCTURE,uvm_visitor#(STRUCTURE))

The visitor adaptor traverses all nodes of the STRUCTURE and will invoke visitor.visit() on
every node.

Summary

`uvm_visitor_adapter
#(STRUCTURE,uvm_visitor#(STRUCTURE))`

The visitor adaptor traverses all nodes of the STRUCTURE and will invoke `visitor.visit()` on every node.

Methods

*accept()*

Calling this function will traverse through `s` (and every subnode of `s`).

**Methods**

`accept()`

```
pure virtual function void accept(
   STRUCTURE s,
   VISITOR v,
   uvm_structure_proxy#(STRUCTURE) p,
   bit invoke_begin_end = 1
)
```

Calling this function will traverse through `s` (and every subnode of `s`). For each node found `v.visit(node)` will be invoked. The children of `s` are recursively determined by invoking `p.get_immediate_children()`. `invoke_begin_end` determines whether the visitors begin/end functions should be invoked prior to traversal.

`uvm_top_down_visitor_adapter`

This `uvm_top_down_visitor_adapter` traverses the STRUCTURE `s` (and will invoke the visitor) in a hierarchical fashion. During traversal `s` will be visited before all subnodes of `s` will be visited.

Summary

`uvm_top_down_visitor_adapter`

This `uvm_top_down_visitor_adapter` traverses the STRUCTURE `s` (and will invoke the visitor) in a hierarchical fashion.

**Class Hierarchy**

```
   uvm_visitor_adapter#(STRUCTURE,VISITOR)
   uvm_top_down_visitor_adapter
```

**Class Declaration**

```
class uvm_top_down_visitor_adapter#(
   type structure = uvm_component,
   ..
)
```
This uvm_bottom_up_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion. During traversal all children of node s will be visited.

Summary

This uvm_bottom_up_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion.

CLASS HIERARCHY

uvm_visitor_adapter#(STRUCTURE, VISITOR)

uvm_bottom_up_visitor_adapter

CLASS DECLARATION

class uvm_bottom_up_visitor_adapter#(
    type STRUCTURE = uvm_component,
    VISITOR = uvm_visitor#(STRUCTURE)
) extends uvm_visitor_adapter#(STRUCTURE, VISITOR)

This uvm_by_level_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion. During traversal will visit all direct children of s before all grand-children are visited.

Summary

This uvm_by_level_visitor_adapter traverses the STRUCTURE s (and will invoke the visitor) in a hierarchical fashion.

CLASS HIERARCHY

uvm_visitor_adapter#(STRUCTURE, VISITOR)

uvm_by_level_visitor_adapter

CLASS DECLARATION

class uvm_by_level_visitor_adapter#(
    type STRUCTURE = uvm_component,
    VISITOR = uvm_visitor#(STRUCTURE)
) extends uvm_visitor_adapter#(STRUCTURE, VISITOR)
**uvm_component_proxy**

The class is providing the proxy to extract the direct subcomponents of s

**Summary**

**uvm_component_proxy**

The class is providing the proxy to extract the direct subcomponents of s

**CLASS HIERARCHY**

```
    uvm_structure_proxy#(uvm_component)
        uvm_component_proxy
```

**CLASS DECLARATION**

```
class uvm_component_proxy extends uvm_structure_proxy#
    uvm_component
```

---

**uvm_component_name_check_visitor**

This specialized visitor analyze the naming of the current component. The established rule set ensures that a component.get_full_name() is parsable, unique, printable to order to avoid any ambiguities when messages are being emitted.

ruleset a legal name is composed of

- allowed charset "A-z:_0-9[]{}()-:
- whitespace-as-is, no-balancing delimiter semantic, no escape sequences
- path delimiter not allowed anywhere in the name

the check is coded here as a function to complete it in a single function call otherwise save/restore issues with the used dpi could occur

**Summary**

**uvm_component_name_check_visitor**

This specialized visitor analyze the naming of the current component.

**CLASS HIERARCHY**

```
    uvm_visitor#(uvm_component)
        uvm_component_name_check_visitor
```

**CLASS DECLARATION**

```
class uvm_component_name_check_visitor extends uvm_visitor#
    uvm_component
```
get_name_constraint

This method should return a regex for what is being considered a valid/good component name. The visitor will check all component names using this regex and report failing names.
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\uvm_do_callbacks
\uvm_do_callbacks_exit_on
\uvm_do_obj_callbacks
\uvm_do_obj_callbacks_exit_on
\uvm_do_on
\uvm_do_on_pri
\uvm_do_on_pri_with
\uvm_do_on_with
\uvm_do_pri
\uvm_do_pri_with
\uvm_do_with
\uvm_error
\uvm_error_begin
\uvm_error_context
\uvm_error_context_begin
\uvm_error_context_end
\uvm_error_end
\uvm_fatal
\uvm_fatal_begin
\uvm_fatal_context
\uvm_fatal_context_begin
\uvm_fatal_context_end
\uvm_fatal_end
\uvm_field_aa_int_byte
\uvm_field_aa_int_byte_unsigned
\uvm_field_aa_int_enumkey
\uvm_field_aa_int_int
\uvm_field_aa_int_int_unsigned
\uvm_field_aa_int_integer
\uvm_field_aa_int_integer_unsigned
\uvm_field_aa_int_key
UVM_FIX_REV
UVM_MAJOR_REV
UVM_MAJOR_REV_1
UVM_MINOR_REV
UVM_MINOR_REV_2
UVM_NAME
UVM_POST_VERSION_1_1
uvm_sequence_library_utils
  uvm_sequence_library
UVM_VERSION_1_2
UVM_VERSION_STRING
accept
   uvm_visitor_adapter#(STRUCTURE,uvm_visitor#(STRUCTURE))
accept_tr
   uvm_component
   uvm_transaction
add
   uvm_callbacks#(T,CB)
   uvm_heartbeat
   uvm_phase
   uvm_pool#(KEY,T)
   uvm_reg_read_only_cbs
   uvm_reg_write_only_cbs
add_by_name
   uvm_callbacks#(T,CB)
add_callback
   uvm_event#(T)
add_coverage
   uvm_mem
   uvm_reg
   uvm_reg_block
add_hdl_path
   uvm_mem
   uvm_reg
   uvm_reg_block
   uvm_reg_file
add_hdl_path_slice
   uvm_mem
   uvm_reg
add_int
   uvm_report_catcher
   uvm_report_message
   uvm_report_message_element_container
add_mem
   uvm_reg_map
add_object
   uvm_report_catcher
   uvm_report_message
   uvm_report_message_element_container
add_path
   uvm_hdl_path_concat
add_reg
   uvm_reg_map
add_sequence
   uvm_sequence_library
add_sequences
uvm_sequence_library

add_slice
  uvm_hdl_path_concat

add_string
  uvm_report_catcher
  uvm_report_message
  uvm_report_message_element_container

add_submap
  uvm_reg_map

add_typewide_sequence
  uvm_sequence_library

add_typewide_sequences
  uvm_sequence_library

add_uvm_phases
  uvm_domain

adjust_name
  uvm_printer

all_dropped
  uvm_component
  uvm_object
  uvm_object_callback

allocate
  uvm_vreg

apply_config_settings
  uvm_component

b_transport
  uvm_tlm_if

backdoor
  uvm_reg_map

backdoor_read
  uvm_mem
  uvm_reg

backdoor_read_func
  uvm_mem
  uvm_reg

backdoor_watch
  uvm_reg

backdoor_write
  uvm_mem
  uvm_reg

begin_child_tr
  uvm_component
  uvm_transaction

begin_tr
  uvm_component
  uvm_transaction

begin_v
uvm_visitor#(NODE)

**body**
- uvm_mem_access_seq
- uvm_mem_single_walk_seq
- uvm_mem_walk_seq
- uvm_reg_access_seq
- uvm_reg_bit_bash_seq
- uvm_reg_mem_built_in_seq
- uvm_reg_mem_shared_access_seq
- uvm_reg_sequence
- uvm_sequence_base

**build_coverage**
- uvm_mem
- uvm_reg
- uvm_reg_block

**build_phase**
- uvm_component

**burst_read**
- uvm_mem
- uvm_mem_region

**burst_write**
- uvm_mem
- uvm_mem_region

**bus2reg**
- uvm_reg_adapter
- uvm_reg_tlm_adapter

**callback_mode**
- uvm_callback

**can_get**
- uvm_tlm_if_base#(T1,T2)

**can Peek**
- uvm_tlm_if_base#(T1,T2)

**can_put**
- uvm_tlm_if_base#(T1,T2)

**cancel**
- uvm_barrier
- uvm_event_base

**capacity**
- uvm_reg_fifo

**catch**
- uvm_report_catcher

**check_config_usage**
- uvm_component

**check_data_width**
- uvm_reg_block

**check_phase**
- uvm_component
- uvm_reg_predictor
clear
  uvm_object

clear_extension
  uvm_tlm_generic_payload

clear_extensions
  uvm_tlm_generic_payload

clear_hdl_path
  uvm_mem
  uvm_reg
  uvm_reg_block
  uvm_reg_file

clear_response_queue
  uvm_sequence_base

close
  uvm_object

close
  uvm_recorder
  uvm_tr_stream

close_db
  uvm_tr_database

compare
  uvm_object

compare_field
  uvm_comparer

compare_field_int
  uvm_comparer

compare_field_real
  uvm_comparer

compare_object
  uvm_comparer

compare_string
  uvm_comparer

compose_report_message
  uvm_default_report_server
  uvm_report_server

configure
  uvm_mem
  uvm_reg
  uvm_reg_block
  uvm_reg_field
  uvm_reg_file
  uvm_reg_indirect_data
  uvm_reg_map
  uvm_vreg
  uvm_vreg_field

configure_phase
  uvm_component

connect
  uvm_port_base#(IF)
  uvm_tlm_nb_passthrough_target_socket
  uvm_tlm_nb_target_socket

Connect
  uvm_tlm_b_initiator_socket
connect_phase
  uvm_component

convert2string
  uvm_mem_mam
  uvm_object
  uvm_reg_item

copy
  uvm_object

create
  uvm_component
  uvm_object
  create_component
    uvm_component
    uvm_component_registry#(T,Tname)
    uvm_object
    uvm_object_registry#(T,Tname)
    uvm_tlm_extension_base

create_component
  uvm_component
  uvm_object
  create_component_by_name
    uvm_default_factory
    uvm_factory

create_component_by_type
  uvm_default_factory
  uvm_factory

create_item
  uvm_sequence_base

create_map
  uvm_reg_block

create_object
  uvm_component
  create_object
    uvm_component
    uvm_object_registry#(T,Tname)
    uvm_object_wrapper

create_object_by_name
  uvm_default_factory
  uvm_factory

create_object_by_type
  uvm_default_factory
  uvm_factory

current_grabber
  uvm_sequencer_base
D

d debug_connected_to
   uvm_port_base#(IF)

d debug_create_by_name
   uvm_default_factory
   uvm_factory

d debug_create_by_type
   uvm_default_factory
   uvm_factory

d debug_provided_to
   uvm_port_base#(IF)

d decode
   uvm_reg_cbs

d decr
   uvm_tlm_time

d define_access
   uvm_reg_field

d define_domain
   uvm_component

d delete
   uvm_callbacks#(T,CB)
   uvm_object_string_pool#(T)
   uvm_pool#(KEY,T)
   uvm_queue#(T)
   uvm_report_message_element_container

d delete_by_name
   uvm_callbacks#(T,CB)

d delete_callback
   uvm_event#(T)

d delete_elements
   uvm_report_message_element_container

d die
   uvm_root

d disable_auto_item_recording
   uvm_sqr_if_base#(REQ,RSP)

d disable_recording
   uvm_transaction

d display
   uvm_callbacks#(T,CB)

d display_objections
   uvm_objection

do_accept_tr
   uvm_component
   uvm_transaction
do_begin_tr
  uvm_component
  uvm_transaction
do_block
  uvm_mem_access_seq
  uvm_mem_walk_seq
  uvm_reg_access_seq
  uvm_reg_bit_bash_seq
  uvm_reg_hw_reset_seq
  uvm_reg_mem_shared_access_seq
do_bus_read
  uvm_reg_map
do_bus_write
  uvm_reg_map
do_close
  uvm_recorder
  uvm_text_recorder
  uvm_text_tr_stream
  uvm_tr_stream
do_close_db
  uvm_text_tr_database
  uvm_tr_database
do_compare
  uvm_object
do_copy
  uvm_object
  uvm_reg_item
  uvm_report_server
do_end_tr
  uvm_component
  uvm_transaction
do_establish_link
  uvm_text_tr_database
  uvm_tr_database
do_free
  uvm_recorder
  uvm_text_recorder
  uvm_text_tr_stream
  uvm_tr_stream
do_get_lhs
  uvm_cause_effect_link
  uvm_link_base
  uvm_parent_child_link
  uvm_related_link
do_get_rhs
  uvm_cause_effect_link
  uvm_link_base
  uvm_parent_child_link
  uvm_related_link
do_kill
  uvm_sequence_base
do_open
  uvm_recorder
  uvm_text_recorder
uvm_text_tr_stream
uvm_tr_stream

do_open_db
    uvm_text_tr_database
    uvm_tr_database

do_open_recorder
    uvm_text_tr_stream
    uvm_tr_stream

do_open_stream
    uvm_text_tr_database
    uvm_tr_database

do_pack
    uvm_object

do_post_read
    uvm_reg_backdoor

do_post_write
    uvm_reg_backdoor

do_pre_read
    uvm_reg_backdoor

do_pre_write
    uvm_reg_backdoor

do_predict
    uvm_reg_fifo

do_print
    uvm_object
    uvm_resource_base

do_read
    uvm_reg_map

do_record
    uvm_object

do_record_field
    uvm_recorder
    uvm_text_recorder

do_record_field_int
    uvm_recorder
    uvm_text_recorder

do_record_field_real
    uvm_recorder
    uvm_text_recorder

do_record_generic
    uvm_recorder
    uvm_text_recorder

do_record_object
    uvm_recorder
    uvm_text_recorder

do_record_string
    uvm_recorder
    uvm_text_recorder

do_record_time
    uvm_recorder
    uvm_text_recorder

do_reg_item
uvm_reg_sequence

do_set_lhs
   uvm_cause_effect_link
   uvm_link_base
   uvm_parent_child_link
   uvm_related_link

do_set_rhs
   uvm_cause_effect_link
   uvm_link_base
   uvm_parent_child_link
   uvm_related_link

do_unpack
   uvm_object

do_write
   uvm_reg_map

drop_objection
   uvm_object
   uvm_phase

dropped
   uvm_component
   uvm_object
   uvm_objection_callback

dump
   uvm_resource_db
   uvm_resource_pool

emit
   uvm_printer
   uvm_table_printer
   uvm_tree_printer

enable_recording
   uvm_transaction

encode
   uvm_reg_cbs

end_of_elaboration_phase
   uvm_component

end_prematurely
   uvm_phase

dump
   uvm_component
   uvm_transaction

end_v
   uvm_visitor #(NODE)

establish_link
   uvm_tr_database

exec_func
   uvm_phase

exec_task
   uvm_phase
execute
  uvm_bottomup_phase
  uvm_task_phase
  uvm_topdown_phase
execute_item
  uvm_sequencer_base
execute_report_message
  uvm_default_report_server
  uvm_report_server
exists
  uvm_config_db
  uvm_pool#(KEY,T)
extract_phase
  uvm_component

final_phase
  uvm_component
find
  uvm_phase
  uvm_root
find_all
  uvm_root
  uvm_utils#(TYPE,FIELD)
find_block
  uvm_reg_block
find_blocks
  uvm_reg_block
find_by_name
  uvm_phase
find_override_by_name
  uvm_default_factory
  uvm_factory
find_override_by_type
  uvm_default_factory
  uvm_factory
find_unused_resources
  uvm_resource_pool
find_wrapper_by_name
  uvm_factory
finish_item
  uvm_sequence_base
first
  uvm_callback_iter
  uvm_pool#(KEY,T)
flush
  uvm_in_order_comparator#(T,comp_type,convert,pair_type)
  uvm_tlm_fifo#(T)
for_each
uvm_mem_mam

**format_action**
- uvm_report_handler

**format_header**
- uvm_printer

**format_row**
- uvm_printer

**free**
- uvm_recorder
- uvm_tr_stream

**free_tr_stream**
- uvm_component

**from_name**
- uvm_enum_wrapper#(T)
### Generate Stimulus
- `uvm_random_stimulus#(T)`

### Get
- `uvm_build_phase`
- `uvm_check_phase`
- `uvm_component_registry#(T,Tname)`
- `uvm_config_db`
- `uvm_configure_phase`
- `uvm_connect_phase`
- `uvm_coreservice_t`
- `uvm_end_of_elaboration_phase`
- `uvm_extract_phase`
- `uvm_factory`
- `uvm_final_phase`
- `uvm_get_to_lock_dap`
- `uvm_main_phase`
- `uvm_object_registry#(T,Tname)`
- `uvm_object_string_pool#(T)`
- `uvm_pool#(KEY,T)`
- `uvm_post_configure_phase`
- `uvm_post_main_phase`
- `uvm_post_reset_phase`
- `uvm_post_shutdown_phase`
- `uvm_pre_configure_phase`
- `uvm_pre_main_phase`
- `uvm_pre_reset_phase`
- `uvm_pre_shutdown_phase`
- `uvm_queue#(T)`
- `uvm_reg`
- `uvm_reg_field`
- `uvm_reg_fifo`
- `uvm_report_phase`
- `uvm_reset_phase`
- `uvm_resource_pool`
- `uvm_root`
- `uvm_run_phase`
- `uvm_sequencer#(REQ,RSP)`
- `uvm_set_before_get_dap`
- `uvm_set_get_dap_base`
- `uvm_shutdown_phase`
- `uvm_simple_lock_dap`
- `uvm_sqr_if_base#(REQ,RSP)`
- `uvm_start_of_simulation_phase`
- `uvm_tlm_if_base#(T1,T2)`

### Get Abstime
- `uvm_tlm_time`

### Get Accept Time
- `uvm_transaction`

### Get Access
uvm_mem
uvm_reg_field
uvm_vreg
uvm_vreg_field

get_action
  uvm_report_catcher
  uvm_report_message
  uvm_report_message_element_base

get_adapter
  uvm_reg_map

get_addr_unit_bytes
  uvm_reg_map

get_address
  uvm_mem
  uvm_reg
  uvm_tlm_generic_payload
  uvm_vreg

get_addresses
  uvm_mem
  uvm_reg

get_adjacent_predecessor_nodes
  uvm_phase

get_adjacent_successor_nodes
  uvm_phase

get_arbitration
  uvm_sequencer_base

get_arg_matches
  uvm_cmdline_processor

get_arg_value
  uvm_cmdline_processor

get_arg_values
  uvm_cmdline_processor

get_args
  uvm_cmdline_processor

get_auto_predict
  uvm_reg_map

get_automatic_phase_object
  uvm_sequence_base

get_backdoor
  uvm_mem
  uvm_reg
  uvm_reg_block

get_base_addr
  uvm_reg_map

get_begin_time
  uvm_transaction

get_block_by_name
  uvm_reg_block

get_blocks
  uvm_reg_block

get_by_name
  uvm_resource#(T)
uvm_resource_db
uvm_resource_pool

get_type
  uvm_resource#(T)
  uvm_resource_db
  uvm_resource_pool

get_byte_enable
  uvm_tlm_generic_payload

get_byte_enable_length
  uvm_tlm_generic_payload

get_cb
  uvm_callback_iter

get_check_on_read
  uvm_reg_map

get_child
  uvm_component

get_children
  uvm_component

get_client
  uvm_report_catcher

get_close_time
  uvm_recorder

get_command
  uvm_tlm_generic_payload

get_common_domain
  uvm_domain

get_comp
  uvm_port_base#(IF)

get_compare
  uvm_reg_field

get_component_visitor
  uvm_coreservice_t
  uvm_default_coreservice_t

get_config
  uvm_utils#(TYPE,FIELD)

get_connected_to
  uvm_port_component_base

get_context
  uvm_report_catcher
  uvm_report_message

get_coverage
  uvm_mem
  uvm_reg
  uvm_reg_block

get_current_item
  uvm_sequence#(REQ,RSP)
  uvm_sequencer_param_base#(REQ,RSP)

get_data
  uvm_tlm_generic_payload

get_data_length
  uvm_tlm_generic_payload
get_db
  uvm_tr_stream
get_default_hdl_path
  uvm_reg_block
  uvm_reg_file
get_default_path
  uvm_reg_block
get_default_tr_database
  uvm_coreservice_t
  uvm_default_coreservice_t
get_depth
  uvm_component
  uvm_sequence_item
get_domain
  uvm_component
  uvm_phase
get_domain_name
  uvm_phase
get_domains
  uvm_domain
get_drain_time
  uvm_objection
get_element_container
  uvm_report_catcher
  uvm_report_message
get_elements
  uvm_report_message_element_container
get_end_offset
  uvm_mem_region
get_end_time
  uvm_transaction
get_event_pool
  uvm_transaction
get_extension
  uvm_tlm_generic_payload
get_factory
  uvm_coreservice_t
  uvm_default_coreservice_t
get_field_by_name
  uvm_reg
  uvm_reg_block
  uvm_vreg
get_fields
  uvm_reg
  uvm_reg_block
  uvm_reg_map
  uvm_vreg
get_file
  uvm_report_message
get_filename
  uvm_report_message
get_first
uvm_callbacks#(T,CB)

get_first_child
  uvm_component

get_fname
  uvm_report_catcher

get_frontdoor
  uvm_mem
  uvm_reg

get_full_hdl_path
  uvm_mem
  uvm_reg
  uvm_reg_block
  uvm_reg_file

get_full_name
  uvm_component
  uvm_mem
  uvm_object
  uvm_phase
  uvm_port_base#(IF)
  uvm_reg
  uvm_reg_block
  uvm_reg_field
  uvm_reg_file
  uvm_reg_map
  uvm_vreg
  uvm_vreg_field

get_global
  uvm_object_string_pool#(T)
  uvm_pool#(KEY,T)
  uvm_queue#(T)

get_global_pool
  uvm_object_string_pool#(T)
  uvm_pool#(KEY,T)

get_global_queue
  uvm_queue#(T)

get_handle
  uvm_recorder
  uvm_tr_stream

get_hdl_path
  uvm_mem
  uvm_reg
  uvm_reg_block
  uvm_reg_file

get_hdl_path_kinds
  uvm_mem
  uvm_reg

get_highest_precedence
  uvm_resource#(T)
  uvm_resource_pool

get_id
  uvm_report_catcher
  uvm_report_message

get_id_count
  uvm_default_report_server
uvm_report_server
get_id_set
 uvm_report_server
get_if
 uvm_port_base#(IF)
get_immediate_children
 uvm_structure_proxy#(STRUCTURE)
get_imp
 uvm_phase
get_incr
 uvm_vreg
get_initiator
 uvm_transaction
get_inst
 uvm_cmdline_processor
get_inst_count
 uvm_object
get_inst_id
 uvm_object
get_is_active
 uvm_agent
get_item
 uvm_reg_adapter
get_jump_target
 uvm_phase
get_last
 uvm_callbacks#(T,CB)
get_len
 uvm_mem_region
get_lhs
 uvm_link_base
get_line
 uvm_report_catcher
 uvm_report_message
get_link
 uvm_cause_effect_link
 uvm_parent_child_link
 uvm_related_link
get_lsb_pos
 uvm_reg_field
get_lsb_pos_in_register
 uvm_vreg_field
get_map_by_name
 uvm_reg_block
get_maps
 uvm_mem
 uvm_reg
 uvm_reg_block
 uvm_vreg
get_max_quit_count
 uvm_default_report_server
get_max_size
    uvm_mem
    uvm_reg
    uvm_reg_field
get_mem_by_name
    uvm_reg_block
get_mem_by_offset
    uvm_reg_map
get_memories
    uvm_reg_block
get_memory
    uvm_mem_mam
    uvm_mem_region
    uvm_vreg
get_message
    uvm_report_catcher
    uvm_report_message
get_message_database
    uvm_default_report_server
    uvm_report_server
get_mirrored_value
    uvm_reg
    uvm_reg_field
get_n_bits
    uvm_mem
    uvm_reg
    uvm_reg_field
    uvm_vreg_field
get_n_bytes
    uvm_mem
    uvm_mem_region
    uvm_reg
    uvm_reg_map
    uvm_vreg
get_n_maps
    uvm_mem
    uvm_reg
    uvm_vreg
get_n_memlocs
    uvm_vreg
get_name
    uvm_mem
    uvm_object
    uvm_port_base#(IF)
    uvm_reg
    uvm_reg_block
    uvm_reg_field
    uvm_reg_file
    uvm_reg_map
    uvm_report_message_element_base
    uvm_tlm_time
    uvm_vreg
    uvm_vreg_field
get_name_constraint
  uvm_component_name_check_visitor

get_next
  uvm_callbacks#(T,CB)

get_next_child
  uvm_component

get_next_item
  uvm_sequencer#(REQ,RSP)
  uvm_sqr_if_base#(REQ,RSP)

get_num_children
  uvm_component

get_num_extensions
  uvm_tlm_generic_payload

get_num_last_reqs
  uvm_sequencer_param_base#(REQ,RSP)

get_num_last_rsps
  uvm_sequencer_param_base#(REQ,RSP)

get_num_reqs_sent
  uvm_sequencer_param_base#(REQ,RSP)

get_num_rsps_received
  uvm_sequencer_param_base#(REQ,RSP)

get_num_waiters
  uvm_barrier
  uvm_event_base

get_object_type
  uvm_object

get_objection
  uvm_phase

get_objection_count
  uvm_objection
  uvm_phase

get_objection_total
  uvm_objection

get_objectors
  uvm_objection

get_offset
  uvm_mem
  uvm_reg

get_offset_in_memory
  uvm_vreg

get_open_time
  uvm_recorder

get_packed_size
  uvm_packer

get_parent
  uvm_component
  uvm_mem
  uvm_phase
  uvm_port_base#(IF)
  uvm_reg
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