**Ethernet HVVC** –Quick Reference

This ethernet VVC is based on IEEE 802.3. It does not support optional fields or EtherType, only length is supported.

**HVVC**

For general information see UVVM Essential Mechanisms located in uvvm\_vvc\_framework/doc.

|  |
| --- |
| ethernet\_send (VVCT, vvc\_instance\_idx, channel, [mac\_dest], [mac\_src], payload, msg, [scope, [use\_provided\_msg\_id\_panel, [msg\_id\_panel]]]) |
| Example: ethernet\_send(ETHERNET\_VVCT, 1, TX, v\_mac\_dest, v\_mac\_src, v\_payload, “Send ethernet packet”); |

*ethernet\_hvvc.vhd*

|  |
| --- |
| ethernet\_receive (VVCT, vvc\_instance\_idx, channel, msg, [scope, [use\_provided\_msg\_id\_panel, [msg\_id\_panel]]]) |
| Example: ethernet\_receive(ETHERNET\_VVCT, 1, RX, “Receive ethernet packet”); |

|  |
| --- |
| ethernet\_expect (VVCT, vvc\_instance\_idx, channel, [mac\_dest], [mac\_src], payload, msg, [alert\_level]) |
| Example: ethernet\_expect(ETHERNET\_VVCT, 1, RX, v\_mac\_dest, v\_mac\_src, v\_payload, “Expect ethernet packet”, ERROR); |

|  |  |
| --- | --- |
| Record ´**t\_ethernet\_frame´** | |
| **Record element** | **Type** |
| mac\_destination | unsigned(47 downto 0) |
| mac\_source | unsigned(47 downto 0) |
| length | integer |
| payload | t\_byte\_array |
| fcs | std\_logic\_vector(31 downto 0) |

Ethernet VVC Configuration record **´vvc\_config´ --** accessible via **shared\_ethernet\_vvc\_config**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Record element** | | **Type** | **C\_ETHERNET\_VVC\_CONFIG\_DEFAULT** | |
| inter\_bfm\_delay | | t\_inter\_bfm\_delay | C\_ETHERNET\_INTER\_BFM\_DELAY\_DEFAULT | |
| cmd\_queue\_count\_max | | natural | C\_CMD\_QUEUE\_COUNT\_MAX | |
| cmd\_queue\_count\_threshold | | natural | C\_CMD\_QUEUE\_COUNT\_THRESHOLD | |
| cmd\_queue\_count\_threshold\_severity | | t\_alert\_level | C\_CMD\_QUEUE\_COUNT\_THRESHOLD\_SEVERITY | |
| result\_queue\_count\_max | | natural | C\_RESULT\_QUEUE\_COUNT\_MAX | |
| result\_queue\_count\_threshold | | natural | C\_RESULT\_QUEUE\_COUNT\_THRESHOLD | |
| result\_queue\_count\_threshold\_severity | | t\_alert\_level | C\_RESULT\_QUEUE\_COUNT\_THERSHOLD\_SEVERITY | |
| bfm\_config1 | | t\_ethernet\_bfm\_config | C\_ETHERNET\_BFM\_CONFIG\_DEFAULT | |
| msg\_id\_panel | | t\_msg\_id\_panel | C\_ETHERNET\_HVVC\_MSG\_ID\_PANEL\_DEFAULT | |
|  | |  |  | |
| BFM Configuration record ´**t\_ethernet\_bfm\_config´** | | | | | |
| **Record element** | | **Type** | | | **C\_ETHERNET\_BFM\_CONFIG\_DEFAULT** |
| mac\_destination | | unsigned(47 downto 0) | | | x”000000000000” |
| mac\_source | | unsigned(47 downto 0) | | | x”000000000000” |
| fcs\_error\_severity | | t\_alert\_level | | | TB\_ERROR |
| interpacket\_gap\_time2 | | time | | | 96 ns |

1 Not strictly a bus functional model (BFM), but holds BFM-like configuration data.

2 Interpacket gap is implemented as a wait statement after the ethernet packet has been

sent. Check of interpacket gap on receive is not implemented.

**Common VVC procedures applicable for this VVC**  
- See UVVM Methods QuickRef for details.

**await\_completion**() **enable\_log\_msg**() **disable\_log\_msg**()

**fetch\_result**()

**flush\_command\_queue**()  
**terminate\_current\_command**() **terminate\_all\_commands**() **insert\_delay**()

**get\_last\_received\_cmd\_idx()**



Ethernet VVC Status record signal **´vvc\_status´ --** accessible via **shared\_ethernet\_vvc\_status**

|  |  |  |
| --- | --- | --- |
| **Record element** | **Type** |  |
| current\_cmd\_idx | natural |  | |
| previous\_cmd\_idx | natural |  |
| pending\_cmd\_cnt | natural |  |

VVC target parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Example(s)** | **Description** |
| VVCT | t\_vvc\_target\_record | ETHERNET\_VVCT | VVC target type compiled into each VVC in order to differentiate between VVCs. |
| vvc\_instance\_idx | integer | 1 | Instance number of the VVC. |
| channel | t\_channel | TX, RX | The VVC channel of the VVC instance. |

VVC functional parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Example(s)** | **Description** |
| mac\_dest | unsigned | x”00\_00\_00\_00\_00\_02” | The MAC address of destination. |
| mac\_src | unsigned | x”00\_00\_00\_00\_00\_01” | The MAC address of source. |
| payload | t\_byte\_array | (x”01”, x”23”, x”45”, x”AB”, x”CD”) | The payload containing data. |

VVC transaction info

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| operation | t\_operation | Command operation type. |
| msg | string | Command message. |
| ethernet\_frame | t\_ethernet\_frame | Ethernet frame. |

VVC entity generic constants

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Default** | **Description** |
| GC\_INSTANCE\_IDX | natural | - | Instance number to assign the VVC |
| GC\_INTERFACE | t\_interface | - | VVC interface type, e.g. GMII. |
| GC\_VVC\_INSTANCE\_IDX | natural |  | Instance number of the sub-VVC. |
| GC\_DUT\_IF\_FIELD\_CONFIG | t\_dut\_if\_field\_config\_channel\_array | C\_DUT\_IF\_FIELD\_CONFIG\_CHANNEL\_ARRAY\_DEFAULT | Array of configurations for address-based VVC interfaces. See chapter 4 for details. |
| GC\_ETHERNET\_BFM\_CONFIG | t\_ethernet\_bfm\_config | C\_ETHERNET\_BFM\_CONFIG\_DEFAULT | Configuration of Ethernet. |
| GC\_CMD\_QUEUE\_COUNT\_MAX | natural | 1000 | Absolute maximum number of commands in the HVVC command queue |
| GC\_CMD\_QUEUE\_COUNT\_THRESHOLD | natural | 950 | An alert will be generated when reaching this threshold to indicate that the command queue is almost full. The queue will still accept new commands until it reaches C\_CMD\_QUEUE\_COUNT\_MAX. |
| GC\_CMD\_QUEUE\_COUNT\_THRESHOLD\_SEVERITY | t\_alert\_level | WARNING | Alert severity which will be used when command queue reaches GC\_CMD\_QUEUE\_COUNT\_THRESHOLD. |
| GC\_RESULT\_QUEUE\_COUNT\_MAX | natural | 1000 | Maximum number of unfetched results before result\_queue is full. |
| GC\_RESULT\_QUEUE\_COUNT\_THRESHOLD | natural | 950 | An alert with severity 'result\_queue\_count\_threshold\_severity' will be issued if result queue exceeds this count. Used for early warning if result queue is almost full. Will be ignored if set to 0. |
| GC\_RESULT\_QUEUE\_COUNT\_THRESHOLD\_SEVERITY | t\_alert\_level | WARNING | Severity of alert to be initiated if exceeding result\_queue\_count\_threshold |

VVC details

All VVC procedures are defined in vvc\_methods\_pkg (dedicated to this VVC), and uvvm\_vvc\_framework.uvvm\_methods\_pkg and uvvm\_vvc\_framework.uvvm\_support\_pkg (common VVC procedures).

It is also possible to send a multicast to all instances of a VVC with ALL\_INSTANCES as parameter for vvc\_instance\_idx.

# VVC procedure details and examples

|  |  |
| --- | --- |
| **Procedure** | **Description** |
| **ethernet\_send()** | **ethernet\_send (VVCT, vvc\_instance\_idx, channel, [mac\_dest], [mac\_src], payload, msg)**  The ethernet\_send() VVC procedure adds a send command to the Ethernet VVC executor queue, which will run as soon as all preceding commands have completed.  Example:  ethernet\_send(ETHERNET\_VVCT, 1, TX, v\_mac\_dest, v\_mac\_src, v\_payload, “Send ethernet packet”);  ethernet\_send(ETHERNET\_VVCT, 1, TX, v\_payload, “Send ethernet packet”); |
| **ethernet\_receive()** | **ethernet\_receive (VVCT, vvc\_instance\_idx, channel, msg)**  The ethernet\_receive() VVC procedure adds a receive command to the Ethernet VVC executor queue, which will run as soon as all preceding commands have completed.  The value read from the DUT will not be returned in this procedure call since it is non-blocking for the sequencer/caller, but the read data will be stored in the VVC for a potential future fetch (see example with *fetch\_result* below).  Example:  ethernet\_receive(ETHERNET\_VVCT, 1, RX, “Receive ethernet packet”);  **Example with fetch\_result() call**: Result is placed in **v\_data**  variable v\_cmd\_idx : natural; -- Command index for the last read  variable v\_data : bitvis\_vip\_ethernet.vvc\_cmd\_pkg.t\_vvc\_result; -- Result from read.  (…)  ethernet\_receive(ETHERNET\_VVCT, 1, RX, “Receive ethernet package”);  v\_cmd\_idx := get\_last\_received\_cmd\_idx(ETHERNET\_VVCT, 1, RX);  await\_completion(ETHERNET\_VVCT,1, RX, v\_cmd\_idx, 1 us, "Wait for receive to finish");  fetch\_result(ETHERNET\_VVCT, 1, RX, v\_cmd\_idx, **v\_data**, "Fetching result from receive operation"); |
| **ethernet\_expect()** | **ethernet\_expect (VVCT, vvc\_instance\_idx, channel, [mac\_dest], [mac\_src], payload, msg, [alert\_level])**  The ethernet\_expect() VVC procedure adds an expect command to the Ethernet VVC executor queue, which will run as soon as all preceding commands have completed. The ethernet\_expect() procedure will perform a read operation, then check if the read data is equal to the expected data. If the read data is not equal to the expected data, an alert with severity ‘alert\_level’ will be issued. The read data will not be stored in this procedure.  Examples:  ethernet\_expect(ETHERNET\_VVCT, 1, RX, v\_mac\_dest, v\_mac\_src, v\_payload”, “Expect data from ethernet”); |

# VVC Configuration

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Record element** | **Type** | **C\_ETHERNET\_BFM\_CONFIG\_DEFAULT** | | **Description** | |
| inter\_bfm\_delay | t\_inter\_bfm\_delay | C\_ETHERNET\_INTER\_BFM\_DELAY\_DEFAULT | Delay between any requested BFM accesses towards the DUT. - TIME\_START2START: Time from a BFM start to the next BFM start   (A TB\_WARNING will be issued if access takes   longer than TIME\_START2START).  - TIME\_FINISH2START: Time from a BFM end to the next BFM start. Any insert\_delay() command will add to the above minimum delays, giving for instance the ability to skew the BFM starting time. | |
| cmd\_queue\_count\_max | natural | C\_CMD\_QUEUE\_COUNT\_MAX | Maximum pending number in command queue before queue is full. Adding additional commands will result in an ERROR. | |
| cmd\_queue\_count\_threshold | natural | C\_CMD\_QUEUE\_COUNT\_THRESHOLD | An alert with severity “cmd\_queue\_count\_threshold\_severity” will be issued if command queue exceeds this count. Used for early warning if command queue is almost full. Will be ignored if set to 0. | |
| cmd\_queue\_count\_threshold\_severity | t\_alert\_level | C\_CMD\_QUEUE\_COUNT\_THRESHOLD\_SEVERITY | Severity of alert to be initiated if exceeding cmd\_queue\_count\_threshold | |
| result\_queue\_count\_max | natural | C\_RESULT\_QUEUE\_COUNT\_MAX | Maximum number of unfetched results before result\_queue is full. | | | |
| result\_queue\_count\_threshold | natural | C\_RESULT\_QUEUE\_COUNT\_THRESHOLD | An alert with severity 'result\_queue\_count\_threshold\_severity' will be issued if result queue exceeds this count. Used for early warning if result queue is almost full. Will be ignored if set to 0. | | | |
| result\_queue\_count\_threshold\_severity | t\_alert\_level | C\_ RESULT\_QUEUE\_COUNT\_THRESHOLD\_SEVERITY | Severity of alert to be initiated if exceeding result\_queue\_count\_threshold | | | |
| bfm\_config | t\_ethernet\_bfm\_config | C\_ETHERNET\_BFM\_CONFIG\_DEFAULT | Configuration for Ethernet BFM. | |
| msg\_id\_panel | t\_msg\_id\_panel | C\_ETHERNET\_HVVC\_MSG\_ID\_PANEL\_DEFAULT | VVC dedicated message ID panel | |

# The configuration record can be accessed from the Central Testbench Sequencer through the shared variable array, e.g.:

shared\_ethernet\_vvc\_config(1).inter\_bfm\_delay.delay\_in\_time := 50 ns;

shared\_ethernet\_vvc\_config(1).bfm\_config.id\_for\_bfm := ID\_BFM;

The index in shared\_ethernet\_vvc\_config corresponds with the instance number of the VVC.

# VVC Status

The current status of the VVC can be retrieved during simulation. This is achieved by reading from the shared variable shared\_ethernet\_vvc\_status record from the test sequencer. The record contents can be seen below:

|  |  |  |
| --- | --- | --- |
| **Record element** | **Type** | **Description** |
| current\_cmd\_idx | natural | Command index currently running |
| previous\_cmd\_idx | natural | Previous command index to run |
| pending\_cmd\_cnt | natural | Pending number of commands in the command queue |

# Activity watchdog

The VVCs support an activity watchdog which monitors VVC activity and will alert if no VVC activity is registered within a selected timeout value. The VVCs will register their presence to the activity watchdog at start-up, and report when busy and not, using dedicated activity watchdog methods and triggering the global\_trigger\_testcase\_inactivity\_watchdog signal, during simulations.

Include activity\_watchdog(timeout, num\_exp\_vvc, alert\_level, msg) in the testbench to start using the activity watchdog.

Note that each channel is counted in the number of registered VVCs in the activity watchdog register, thus the Ethernet VVC is counted as two VVCs.  
More information can be found in UVVM Essential Mechanisms PDF in the UVVM VVC Framework doc folder.

# DUT interface field configuration

The table below shows which index in the DUT IF field configuration array the Ethernet fields are associated with. These configurations are only necessary when the lower level VVC is address-based. The DUT IF field configuration array is a two-dimensional array, dimensions channel and index. If the same configuration is used for all fields, only one configuration per channel is needed. The highest indexed configuration is used for indexes higher than those supplied. E.g. if the array consists of two configurations the first configuration, index 0, is used for the field preamble & SFD and the other fields use the last configuration, index 1. Each index holds an element of type t\_dut\_if\_config, see table below.

|  |  |  |
| --- | --- | --- |
| **Record** ´**t\_dut\_if\_field\_config´** | | |
| **Record element** | **Type** | **Description** |
| dut\_address | unsigned | Address of the DUT IF field. |
| dut\_address\_increment | integer | Incrementation of the address on each access. |
| data\_width | positive | The width of the data per transfer, must be <= bus width. |
| field\_description | string | Description of the DUT IF field. |

**The Ethernet interface fields are associated with the following indexes**

|  |  |  |
| --- | --- | --- |
| **Ethernet field** | **Name** | **Index** |
| Preamble & SFD | C\_IF\_FIELD\_NUM\_ETHERNET\_PREAMBLE\_SFD | 0 |
| MAC destination | C\_IF\_FIELD\_NUM\_ETHERNET\_MAC\_DESTINATION | 1 |
| MAC source | C\_IF\_FIELD\_NUM\_ETHERNET\_SOURCE | 2 |
| Length | C\_IF\_FIELD\_NUM\_ETHERNET\_LENGTH | 3 |
| Payload | C\_IF\_FIELD\_NUM\_ETHERNET\_PAYLOAD | 4 |
| FCS | C\_IF\_FIELD\_NUM\_ETHERNET\_FCS | 5 |

# Additional Documentation

Additional documentation about UVVM and its features can be found under “/uvvm\_vvc\_framework/doc/”.

# Compilation

The Ethernet HVVC must be compiled with VHDL 2008.   
It is dependent on the following libraries

* ***UVVM Utility Library***
* ***UVVM VVC Framework***
* ***HVVC-to-VVC Bridge***

See UVVM Essential Mechanisms located in uvvm\_vvc\_framework/doc for information about compile scripts.

**Compile order for the Ethernet HVVC:**

|  |  |  |
| --- | --- | --- |
| **Compile to library** | **File** | **Comment** |
| bitvis\_vip\_ethernet | ethernet\_bfm\_pkg.vhd | Ethernet BFM |
| bitvis\_vip\_ethernet | hvvc\_cmd\_pkg.vhd | Ethernet HVVC command types and operations |
| bitvis\_vip\_ethernet | ../uvvm\_vvc\_framework/src\_target\_dependent/td\_target\_support\_pkg.vhd | UVVM VVC target support package, compiled into bitvis\_vip\_ethernet library. |
| bitvis\_vip\_ethernet | ../uvvm\_vvc\_framework/src\_target\_dependent/td\_vvc\_framework\_common\_methods\_pkg.vhd | Common UVVM framework methods compiled into bitvis\_vip\_ethernet library |
| bitvis\_vip\_ethernet | hvvc\_methods\_pkg.vhd | Ethernet HVVC methods |
| bitvis\_vip\_ethernet | ../uvvm\_vvc\_framework/src\_target\_dependent/td\_queue\_pkg.vhd | UVVM queue package for the HVVC |
| bitvis\_vip\_ethernet | ../uvvm\_vvc\_framework/src\_target\_dependent/td\_vvc\_entity\_support\_pkg.vhd | UVVM VVC entity support compiled into bitvis\_vip\_ethernet library |
| bitvis\_vip\_ethernet | ethernet\_transmit\_hvvc.vhd | Ethernet transmit HVVC |
| bitvis\_vip\_ethernet | ethernet\_receive\_hvvc.vhd | Ethernet receive HVVC |
| bitvis\_vip\_ethernet | ethernet\_hvvc.vhd | Ethernet HVVC |

# Simulator compatibility and setup

This VVC has been compiled and tested with Modelsim version 10.5b and Riviera-PRO version 2018.02.111.6909.

For required simulator setup see ***UVVM-Util*** Quick reference.

IMPORTANT

This is a simplified Verification IP (VIP) for Ethernet.

This Ethernet VVC is based on IEEE 802.3. It does not support optional fields or EtherType, only length is supported. This VIP is not an Ethernet protocol checker.

For a more advanced VIP please contact Bitvis AS at [support@bitvis.no](mailto:support@bitvis.no)

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