Avalon-Stream BFM – Quick Reference

For general information see UVVM Essential Mechanisms located in uvvm_vvc_framework/doc.

NOTE: As of UVVM v3.x, all shared variables have been made protected. This means that any access to shared variables must be done using get- and set-methods. This documentation has not yet been updated with the methods for accessing these variables, but will be very soon.

BFM

avalon_st_bfm_pkg.vhd

Avalon-Stream Master

avalon_st_transmit ([channel_value], data_array, msg, clk, avalon_st_if, [scope, [msg_id_panel, [config]]])

Example: avalon_st_transmit(v_channel, v_data_array(0 to v_numBytes-1), "Send v_numBytes bytes on v_channel", clk, avalon_st_if, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
Example: avalon_st_transmit(v_data_array(0 to v_numWords-1), "Send v_numWords words", clk, avalon_st_if, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
Example: avalon_st_transmit((x"01", x"02", x"03", x"04"), "Send 4 bytes", clk, avalon_st_if);

init_avalon_st_if_signals (is_master, channel_width, data_width, data_error_width, empty_width)

Example: avalon_st_if <= init_avalon_st_if_signals(true, avalon_st_if.channel'length, avalon_st_if.data'length, avalon_st_if.data_error'length, avalon_st_if.empty'length);

Avalon-Stream Slave

avalon_st_receive ([channel_value], data_array, msg, clk, avalon_st_if, [scope, [msg_id_panel, [config, [ext_proc_call]]]])

Example: avalon_st_receive(v_channel, v_rx_data_array, "Receive packet", clk, avalon_st_if, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
Example: avalon_st_receive(v_rx_data_array, "Receive packet", clk, avalon_st_if);

avalon_st_expect ([channel_exp], data_exp, msg, clk, avalon_st_if, [alert_level, [scope, [msg_id_panel, [config]]]])

Example: avalon_st_expect(v_channel, v_data_array(0 to v_numBytes-1), "Expect v_numBytes bytes on v_channel", clk, avalon_st_if, ERROR, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
Example: avalon_st_expect(v_data_array(0 to v_numWords-1), "Expect v_numWords words", clk, avalon_st_if, ERROR, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
Example: avalon_st_expect((x"01", x"02", x"03", x"04"), "Expect 4 bytes", clk, avalon_st_if)

init_avalon_st_if_signals (is_master, channel_width, data_width, data_error_width, empty_width)

Example: avalon_st_if <= init_avalon_st_if_signals(false, avalon_st_if.channel'length, avalon_st_if.data'length, avalon_st_if.data_error'length, avalon_st_if.empty'length);

VHDL 2008 only

UVVM™

BFM Configuration record '**t_avalon_st_bfm_config**'

Record element	Type	C_AVALON_ST_BFM_CONFIG_DEFAULT
max_wait_cycles	natural	100
max_wait_cycles_severity	t_alert_level	ERROR
clock_period	time	-1 ns
clock_period_margin	time	0 ns
clock_margin_severity	t_alert_level	TB_ERROR
setup_time	time	-1 ns
hold_time	time	-1 ns
bfm_sync	t_bfm_sync	SYNC_ON_CLOCK_ONLY
match_strictness	t_match_strictness	MATCH_EXACT
symbol_width	natural	8
first_symbol_in_msb	boolean	true
max_channel	natural	0
use_packet_transfer	boolean	true
valid_low_at_word_idx	integer	0
valid_low_multiple_random_prob	real	0.5
valid_low_duration	integer	0
valid_low_max_random_duration	integer	5
ready_low_at_word_idx	integer	0
ready_low_multiple_random_prob	real	0.5
ready_low_duration	integer	0
ready_low_max_random_duration	integer	5
ready_default_value	std_logic	'0'
id_for_bfm	t_msg_id	ID_BFM
id_for_bfm_pkt_initiate	t_msg_id	ID_PACKET_INITIATE
id_for_bfm_pkt_complete	t_msg_id	ID_PACKET_COMPLETE
id_for_bfm_pkt_data	t_msg_id	ID_PACKET_DATA

Signal record **'t_avalon_st_if'**

Record element	Type
channel	std_logic_vector
data	std_logic_vector
data_error	std_logic_vector
ready	std_logic
valid	std_logic
empty	std_logic_vector
end_of_packet	std_logic
start_of_packet	std_logic

BFM signal parameters

Name	Type	Description
clk	std_logic	The clock signal used to read and write data in/out of the Avalon-Stream BFM.
avalon_st_if	t_avalon_st_if	See table "Signal record 't_avalon_st_if'" above. Note: All supported signals, including `channel` and `data_error` are included in the record type, even when not used or connected to DUT.

For more information on the Avalon-Stream signals, refer to "Avalon® Interface Specifications, Chapter: Avalon Streaming Interfaces", document number MNL-AVABUSREF, available from Intel.

BFM non-signal parameters

Name	Type	Example(s)	Description
channel_value channel_exp	std_logic_vector	x"01"	Channel number for the data being transferred or expected. The value is limited by max_channel in the BFM config.

data_array
data_exp
	t_slv_array	(x"D0D1", x"D2D3")	An array of SLVs containing the data to be sent/received.
			
			data_array(0) is sent/received first, while data_array(data_array'high) is sent/received last.
			For clarity, data_array is required to be ascending, for example defined by the test sequencer as follows:
			`variable v_data_array : t_slv_array(0 to C_MAX_WORDS-1)(C_MAX_WORD_LENGTH-1 downto 0);`
			For simplicity, the word_length can only be the size of the configured symbol or the size of the data bus.
			`variable v_data_array : t_slv_array(0 to C_MAX_WORDS-1)(C_SYMBOL_WIDTH-1 downto 0);`
			`variable v_data_array : t_slv_array(0 to C_MAX_WORDS-1)(C_DATA_BUS_LENGTH-1 downto 0);`

alert_level	t_alert_level	ERROR or TB_WARNING	Set the severity for the alert that may be asserted by the procedure.
msg	string	"Send packet"	A custom message to be appended in the log/alert.
scope	string	"AVALON_ST_BFM"	A string describing the scope from which the log/alert originates. In a simple single sequencer typically "AVALON_ST_BFM". In a verification component typically "AVALON_ST_VVC ".
msg_id_panel	t_msg_id_panel	shared_msg_id_panel	Optional msg_id_panel, controlling verbosity within a specified scope. Defaults to a common message ID panel defined in the UVVM-Util adaptations package.
config	t_avalon_st_bfm_config	C_AVALON_ST_BFM_ CONFIG_DEFAULT	Configuration of BFM behaviour and restrictions. See section 0 for details.

BFM features

The following signals are supported:

Signal	Source	Width	Supported by BFM	Description
associatedClock	Clock	1	Yes	Sample on the rising edge.
associatedReset	Reset	-	No	BFM doesn't control the reset.
channel	Master	1-128	Yes	Channel number for the data being transferred on the current cycle.
data	Master	1-4096	Yes	Data word. It can consist of several symbols.
error	Master	1-256	No	Bit mask to mark errors affecting the data being transferred on the current cycle. The error_descriptor in the BFM config defines the error signal properties.
ready	Slave	1	Yes	Indicates that the slave can accept data. A transfer takes place when both valid and ready are asserted.
valid	Master	1	Yes	This signal qualifies all other master to slave signals. A transfer takes place when both valid and ready are asserted.
empty	Master	1-5	Yes	Number of symbols that are empty during the end_of_packet cycle. The signal width in bits is ceil[$\log_2$(symbols_per_cycle)]. Only required when the data signal carries more than one symbol of data per cycle and has a variable packet length.
end_of_packet	Master	1	Yes	When '1', it indicates that the data is the last word of the packet.
start_of_packet	Master	1	Yes	When '1', it indicates that the data is the first word of the packet.

BFM details

1 BFM procedure details

Procedure	Description
avalon_st_transmit()	**avalon_st_transmit ([channel_value], data_array, msg, clk, avalon_st_if, [scope, [msg_id_panel, [config]]])** The avalon_st_transmit() procedure transmits a stream/packet on the Avalon interface. The length and data are defined by the “data_array” argument, which is a t_slv_array. data_array(0) is sent first. data_array(data_array’high) is sent last. When the config use_packet_transfer is enabled: During the first word, the BFM asserts the start_of_packet signal. During the last word, the BFM asserts the end_of_packet signal and it sets the number of invalid symbols in the word on the empty signal.
avalon_st_receive()	**avalon_st_receive ([channel_value], data_array, msg, clk, avalon_st_if, [scope, [msg_id_panel, [config, [ext_proc_call]]]])** The avalon_st_receive() procedure receives a stream/packet on the Avalon interface. The received data is stored in the data_array output, which is a t_slv_array. When the config use_packet_transfer is enabled: The signal start_of_packet is expected to be set during the first word. The signal end_of_packet is expected to be set during the last word. Also during this word the empty signal is used to determine the number of invalid symbols.
avalon_st_expect()	**avalon_st_expect ([channel_exp], data_exp, msg, clk, avalon_st_if, [alert_level, [scope, [msg_id_panel, [config]]]])** Calls the avalon_st_receive() procedure, then compares the received data with data_exp and the optional channel with channel_exp.
init_avalon_st_if_signals()	**init_avalon_st_if_signals(is_master, channel_width, data_width, data_error_width, empty_width)** This function initializes the Avalon-Stream interface. All the BFM outputs are set to zeros ('0')

2 BFM Configuration record

Type name: t_avalon_st_bfm_config

Record element	Type	C_AVALON_ST_BFM_CONFIG_DEFAULT	Description
max_wait_cycles	natural	100	Used for setting the maximum cycles to wait before an alert is issued when waiting for ready or valid signals from the DUT.
max_wait_cycles_severity	t_alert_level	ERROR	Severity if max_wait_cycles expires.
clock_period	time	-1 ns	Period of the clock signal.
clock_period_margin	time	0 ns	Input clock period margin to specified clock_period.
clock_margin_severity	t_alert_level	TB_ERROR	The above margin will have this severity.
setup_time	time	-1 ns	Setup time for generated signals. Suggested value is clock_period/4. An alert is reported if setup_time exceed clock_period/2.
hold_time	time	-1 ns	Hold time for generated signals. Suggested value is clock_period/4. An alert is reported if hold_time exceed clock_period/2.
bfm_sync	t_bfm_sync	SYNC_ON_CLOCK_ONLY	When set to SYNC_ON_CLOCK_ONLY the BFM will enter on the first falling edge, estimate the clock period, synchronise the output signals and exit ¼ clock period after a succeeding rising edge. When set to SYNC_WITH_SETUP_AND_HOLD the BFM will use the configured setup_time, hold_time and clock_period to synchronise output signals with clock edges.
match_strictness	t_match_strictness	MATCH_EXACT	Matching strictness for std_logic values in check procedures. MATCH_EXACT requires both values to be the same. Note that the expected value can contain the don't care operator '-'. MATCH_STD allows comparisons between 'H' and '1', 'L' and '0' and '-' in both values.
symbol_width	natural	8	Number of data bits per symbol.
first_symbol_in_msb	boolean	true	Symbol ordering. When true, first-order symbol is in most significant bits.
max_channel	natural	0	Maximum number of channels that the interface supports.
use_packet_transfer	boolean	true	When true, packet signals are enabled: start_of_packet, end_of_packet & empty.
valid_low_at_word_idx	integer	0	Word index during which the master BFM shall de-assert valid while sending a packet. Can be set to multiple random indices using C_MULTIPLE_RANDOM.
valid_low_multiple_random_prob	real	0.5	Probability, between 0.0 and 1.0, of how often valid shall be de-asserted when using C_MULTIPLE_RANDOM.
valid_low_duration	integer	0	Number of clock cycles to de-assert valid. To disable this feature set to 0. Can be set to random using C_RANDOM.
valid_low_max_random_duration	integer	5	Maximum number of clock cycles to de-assert valid when using C_RANDOM.
ready_low_at_word_idx	integer	0	Word index during which the slave BFM shall de-assert ready while receiving the packet. Can be set to multiple random indices using C_MULTIPLE_RANDOM.
ready_low_multiple_random_prob	real	0.5	Probability, between 0.0 and 1.0, of how often ready shall be de-asserted when using C_MULTIPLE_RANDOM.

ready_low_duration	integer	0	Number of clock cycles to de-assert ready. To disable this feature set to 0. Can be set to random using C_RANDOM.
ready_low_max_random_duration	integer	5	Maximum number of clock cycles to de-assert ready when using C_RANDOM.
ready_default_value	std_logic	'0'	Determines the ready output value while the slave BFM is idle.
id_for_bfm	t_msg_id	ID_BFM	The message ID used as a general message ID in the BFM.
id_for_bfm_pkt_initiate	t_msg_id	ID_PACKET_INITIATE	The message ID used for logging packet initiates in the BFM.
id_for_bfm_pkt_complete	t_msg_id	ID_PACKET_COMPLETE	The message ID used for logging packet completes in the BFM.
id_for_bfm_pkt_data	t_msg_id	ID_PACKET_DATA	The message ID used for logging packet data in the BFM.

3 Additional Documentation

For additional documentation on the Avalon-Stream standard, refer to "Avalon® Interface Specifications, Chapter: Avalon Streaming Interfaces", document number MNL-AVABUSREF, available from Intel.

4 Compilation

The Avalon-Stream BFM may only be compiled with VHDL 2008. It is dependent on the UVVM Utility Library (UVVM-Util), which is only compatible with VHDL 2008.
See the separate UVVM-Util documentation for more info. After UVVM-Util has been compiled, the avalon_st_bfm_pkg.vhd BFM can be compiled into any desired library.
See UVVM Essential Mechanisms located in uvvm_vvc_framework/doc for information about compile scripts.

4.1 Simulator compatibility and setup

See README.md for a list of supported simulators.

For required simulator setup see UVVM-Util Quick reference.

5 Local BFM overloads

A good approach for better readability and maintainability is to make simple, local overloads for the BFM procedures in the TB process.
This allows calling the BFM procedures with the key parameters only
e.g.

```
avalon_st_transmit(v_data_array(0 to 1), "msg");
```

rather than

```
avalon_st_transmit(v_data_array(0 to 1), "msg", clk, avalon_st_if, C_SCOPE, shared_msg_id_panel, avalon_st_bfm_config);
```

By defining the local overload as e.g.:

```
procedure avalon_st_transmit(
  constant data_array : in t_slv_array;
  constant msg        : in string) is
begin
    avalon_st_transmit(data_array,                          -- keep as is
                       msg,                                 -- keep as is
                       clk,                                 -- Clock signal
                       avalon_st_if,                        -- Signal must be visible in local process scope
                       C_SCOPE,                             -- Just use the default
                       shared_msg_id_panel,                 -- Use global, shared msg_id_panel
                       C_AVALON_ST_BFM_CONFIG_LOCAL);       -- Use locally defined configuration or C_AVALON_ST_BFM_CONFIG_DEFAULT
end;
```

Using a local overload like this also allows the following – if wanted:

- Set up defaults for constants. May be different for two overloads of the same BFM
- Apply dedicated message_id_panel to allow dedicated verbosity control

IMPORTANT
This is a simplified Bus Functional Model (BFM) for Avalon-Stream. The given BFM complies with the basic Avalon-Stream protocol and thus allows a normal access towards an Avalon-Stream interface. This BFM is not Avalon-Stream protocol checker. For a more advanced BFM please contact Bitvis AS at support@bitvis.no