**GPIO BFM** –Quick Reference

**BFM**

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| gpio\_set (data\_value, msg, data\_port, [scope, [msg\_id\_panel, [config]]]) |
| Example: gpio\_set(C\_BAUD\_RATE, “Setting Baudrate to 9600”, data\_port, C\_SCOPE, shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_set(C\_BAUD\_RATE, “Setting Baudrate to 9600”, data\_port); |

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| gpio\_get (data\_value, msg, data\_port, [scope, [msg\_id\_panel, [config]]]) |
| Example: gpio\_get(v\_baudrate, “Read baudrate”, data\_port, C\_SCOPE, shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_get(v\_baudrate, “Read baudrate”, data\_port); |

*gpio\_bfm\_pkg.vhd*

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| gpio\_check (data\_exp, msg, data\_port, [alert\_level, [scope, [msg\_id\_panel, [config]]]]) |
| Example: gpio\_check(x”3B”, “Check data from UART RX”, data\_port, ERROR, C\_SCOPE, shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_check(x”3B”, “Check data from UART RX”, data\_port); |

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| gpio\_check\_stable (data\_exp, stable\_req, msg, data\_port, [alert\_level, [scope, [msg\_id\_panel, [config]]]]) |
| Example: gpio\_check\_stable(x”3B”, 100 us, “Check data from UART RX has been stable for 100 us”, data\_port, ERROR, C\_SCOPE, shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_check\_stable(x”3B”, 100 us, “Check data from UART RX has been stable for 100 us”, data\_port); |

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| gpio\_expect (data\_exp, msg, data\_port, [timeout, [alert\_level, [scope, [msg\_id\_panel, [config]]]]]) |
| Example: gpio\_expect(x”0D”, “Read UART RX until CR is found”, data\_port, 10 ms, ERROR, C\_SCOPE, shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_expect(x”0D”, “Read UART RX until CR is found”, data\_port); |

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| gpio\_expect\_stable (data\_exp, stable\_req, stable\_req\_from, msg, data\_port, [timeout, [alert\_level, [scope, [msg\_id\_panel, [config]]]]]) |
| Example: gpio\_expect\_stable(x”0D”, 100 us, FROM\_NOW, “Read UART RX until CR is found and check it remains stable for 100 us”, data\_port, 10 ms, ERROR, C\_SCOPE,  shared\_msg\_id\_panel, gpio\_bfm\_config);  Example: gpio\_expect\_stable(x”0D”, 100 us, FROM\_LAST\_EVENT, “Read UART RX and check it has been stable for 100 us since the last event”, data\_port); |



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| BFM Configuration record ´**t\_gpio\_bfm\_config´** | | |
| **Record element** | **Type** | **C\_GPIO\_BFM\_CONFIG\_DEFAULT** |
| clock\_period | time | -1 ns |
| match\_strictness | t\_match\_strictness | MATCH\_STD |
| id\_for\_bfm | t\_msg\_id | ID\_BFM |
| id\_for\_bfm\_wait | t\_msg\_id | ID\_BFM\_WAIT |
| timeout | time | -1 ns |
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| BFM non-signal parameters | | | |
| **Name** | **Type** | **Example(s)** | **Description** |
| data\_value | std\_logic\_vector | x”D3” | The data value to be written to the register. |
| data\_exp | std\_logic\_vector | x”0D” or C\_UART\_CR | The data value expected when reading the register. A mismatch results in an alert ‘alert\_level’. |
| stable\_req | time | 1 ms | The time that the expected data value should remain stable in the register. |
| stable\_req\_from | t\_from\_point\_in\_time | FROM NOW or FROM\_LAST\_EVENT | The point in time where stable\_req starts. |
| timeout | time | 10 ms or C\_CLK\_PERIOD | The maximum time to pass before the expected data must be found.  A timeout result in an alert ‘alert\_level’. |
| alert\_level | string | ERROR or TB\_WARNING | Set the severity for the alert that may be asserted by the method. |
| msg | string | “Set baudrate to 1MHz” | A custom message to be appended in the log/alert. |
| scope | string | “GPIO\_BFM” or C\_SCOPE | A string describing the scope from which the log/alert originates. In a simple single sequencer typically “GPIO\_BFM”. In a verification component, typically “GPIO\_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 ID panel defined in the adaptations package. |
| config | t\_gpio\_bfm\_config | C\_GPIO\_BFM\_CONFIG\_DEFAULT | Configuration of BFM behaviour and restrictions. See section 0 for details. |

BFM details

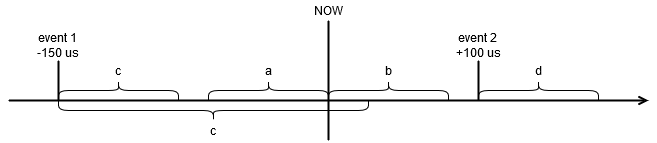
# BFM procedure details and examples

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| **Procedure** | **Description** |
| **gpio\_set()** | **gpio\_set (data\_value, msg, data\_port, [scope, [msg\_id\_panel, [config]]])**  The gpio\_set() procedure will write the given data in ‘data\_value’ to the DUT.  When called, the gpio\_set() procedure will write to the DUT register immediately, except bits set to “don’t care” (‘-‘).   * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM is enabled for the specified message ID panel. * Data\_value is normalised to data\_port direction.     Example:  gpio\_set(C\_BAUDRATE\_9600, “Set baudrate to 9600”, data\_port, C\_SCOPE, shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_set(C\_BAUDRATE\_9600, “Set baudrate to 9600”, data\_port); |
| **gpio\_get()** | **gpio\_get (data\_value, msg, data\_port, [scope, [msg\_id\_panel, [config]]])**  The gpio\_get() procedure reads the DUT register and returns it in the ‘data\_value’ parameter.   * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM is enabled for the specified message ID panel.   Example:  gpio\_get(v\_baudrate, “Read baudrate”, data\_port, C\_SCOPE, shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_get(v\_baudrate, “Read baudrate”, data\_port); |
| **gpio\_check()** | **gpio\_check (data\_exp, msg, data\_port, [alert\_level, [scope, [msg\_id\_panel, [config]]]])**  The gpio\_check() procedure reads the DUT register and compares the data with the expected data in ‘data\_exp’. If the DUT data does not match ‘data\_exp’, an alert with severity ‘alert\_level’ will be triggered. If the DUT data matches ‘data\_exp’, a message with ID config.id\_for\_bfm will be logged.   * The default value of alert\_level is ERROR. * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM is enabled for the specified message ID panel. * Data\_exp is normalised to data\_port direction.   Example:  gpio\_check(x"3B", “Check data from UART RX”, data\_port, ERROR, C\_SCOPE, shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_check(x”3B”, “Check data from UART RX”, data\_port); |
| **gpio\_check\_stable()** | **gpio\_check\_stable (data\_exp, stable\_req, msg, data\_port, [alert\_level, [scope, [msg\_id\_panel, [config]]]])**  The gpio\_check\_stable() procedure reads the DUT register and compares the data with the expected data in ‘data\_exp’, it also checks that the DUT register has been stable for the ‘stable\_req’ time (see section 1.1). If the DUT data does not match ‘data\_exp’ or is not stable, an alert with severity ‘alert\_level’ will be triggered. If the DUT data matches ‘data\_exp’ and is stable, a message with ID config.id\_for\_bfm will be logged.   * The default value of alert\_level is ERROR. * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM is enabled for the specified message ID panel. * Data\_exp is normalised to data\_port direction.   Example:  gpio\_check\_stable(x"3B", 100 us, “Check data from UART RX has been stable for 100 us”, data\_port, ERROR, C\_SCOPE,  shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_check\_stable(x”3B”, 100 us, “Check data from UART RX has been stable for 100 us”, data\_port); |
| **gpio\_expect()** | **gpio\_expect (data\_exp, msg, data\_port, [timeout, [alert\_level, [scope, [msg\_id\_panel, [config]]]]])**  The gpio\_expect() procedure reads a register until the expected data, ‘data\_exp’, is matched or until a timeout value is reached.  If the received data does not match ‘data\_exp’ within the timeout delay, an alert with severity ‘alert\_level’ will be triggered. If the DUT data matches ‘data\_exp’, a message with ID config.id\_for\_bfm will be logged.   * The default timeout is -1 ns. * The default value of alert\_level is ERROR. * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM ID is enabled for the specified message ID panel. * Data\_exp is normalised to data\_port direction.   Example:  gpio\_expect(x"0B", “Read UART RX until CR is found”, data\_port, 10 ms, ERROR, C\_SCOPE, shared\_msg\_id\_panel,  C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_expect(x”0B”, “Read UART RX until CR is found”, data\_port, 10 ms); |
| **gpio\_expect\_stable()** | **gpio\_expect\_stable (data\_exp, stable\_req, stable\_req\_from, msg, data\_port, [timeout, [alert\_level, [scope, [msg\_id\_panel, [config]]]]])**  The gpio\_expect\_stable() procedure reads a register until the expected data, ‘data\_exp’, is matched or until a timeout value is reached. It also checks that the register remains stable for the ‘stable\_req’ time, sampled after the ‘stable\_req\_from’ point in time (see section 1.1).  If the received data does not match ‘data\_exp’ within the timeout delay or it doesn’t remain stable, an alert with severity ‘alert\_level’ will be triggered. If the DUT data matches ‘data\_exp’ and is stable, a message with ID config.id\_for\_bfm will be logged.   * The default timeout is -1 ns. * The default value of alert\_level is ERROR. * The default value of scope is C\_SCOPE (“GPIO BFM”) * The default value of msg\_id\_panel is shared\_msg\_id\_panel, defined in UVVM\_Util. * The default value of config is C\_GPIO\_BFM\_CONFIG\_DEFAULT. * A log message is written if ID\_BFM ID is enabled for the specified message ID panel. * Data\_exp is normalised to data\_port direction.   Example:  gpio\_expect\_stable(x"0B", 100 us, FROM\_NOW, “Read UART RX until CR is found and check it remains stable for 100 us”,  data\_port, 10 ms, ERROR, C\_SCOPE, shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);  Suggested usage (requires local overload, see section 4):  gpio\_expect\_stable(x”0B”, 100 us, FROM\_LAST\_EVENT, “Read UART RX and check it has been stable for 100 us since the last  event”, data\_port); |

## Checking stability

The procedures gpio\_check\_stable and gpio\_expect\_stable can check if the DUT data port is stable for a certain time. There are different scenarios where we could check stability:

1. To check that data has been stable for a certain time before now, use gpio\_check\_stable().
2. To check that data, which is already same as expected, remains stable for a certain time from now, use gpio\_expect\_stable(FROM\_NOW).
3. To check that data, which is already same as expected, remains stable for a certain time from the last change, use gpio\_expect\_stable(FROM\_LAST\_EVENT).
4. To check that data remains stable after it is equal than expected, use gpio\_expect\_stable(FROM\_NOW). Note that in this case the ‘stable\_req\_from’ parameter does not have any influence since the event has not occurred.



# BFM Configuration record

Type name: t\_gpio\_bfm\_config

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| **Record element** | **Type** | **C\_GPIO\_BFM\_CONFIG\_DEFAULT** | **Description** |
| clock\_period | time | -1 ns | Specifies the clock period |
| match\_strictness | t\_match\_strictness | MATCH\_STD | 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. |
| id\_for\_bfm | t\_msg\_id | ID\_BFM | The message ID used as a general message ID in the GPIO BFM |
| id\_for\_bfm\_wait | t\_msg\_id | ID\_BFM\_WAIT | The message ID used for logging waits in the GPIO BFM |
| timeout | time | -1 ns | Timeout value for the expect procedures. This is only used if no timeout parameter is given in the procedures. |

# Compilation

The GPIO 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 gpio\_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.

## Simulator compatibility and setup

See README.md for a list of supported simulators.

For required simulator setup see UVVM-Util Quick reference.

# 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.

gpio\_expect(x”F5”, “Read UART RX until 0xF5 is found”, data\_port, 2 ms);

rather than

gpio\_expect(x”F5”, “Read UART RX until 0xF5 is found”, data\_port, 2 ms, ERROR,

C\_SCOPE, shared\_msg\_id\_panel, C\_GPIO\_BFM\_CONFIG\_DEFAULT);

By defining the local overload as e.g.:

procedure gpio\_check(

constant data\_exp : in std\_logic\_vector;

constant msg : in string;

constant data\_port : in std\_logic\_vector;

constant timeout : in time) is

begin

gpio\_check(data\_exp, -- keep as is

msg, -- keep as is

data\_port, -- keep as is

timeout, -- keep as is

error, -- Just use the default

C\_SCOPE, -- Just use the default

shared\_msg\_id\_panel, -- Use global, shared msg id panel

C\_GPIO\_CONFIG\_LOCAL); -- Use locally defined configuration or C\_GPIO\_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

**INTELLECTUAL**

**PROPERTY**

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