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## Features

- Drop-in module for Virtex, Virtex™-E and Spartan™-II FPGAs
- Generates comparison logic for  $A = B$ ,  $A <> B$ ,  $A <= B$ ,  $A < B$ ,  $A >= B$  or  $A > B$
- Operates on signed or unsigned data
- Supports inputs from 1 to 64 bits wide
- Optional compare to constant capability
- Optional clock enable and asynchronous and

synchronous controls

- Incorporates Xilinx Smart-IP technology for maximum performance
- To be used with version 2.1i and later of the Xilinx CORE Generator System

## Functional Description

- The comparator is used to create comparison logic that performs one of the following functions:  $A = B$ ,  $A <> B$ ,  $A <= B$ ,  $A < B$ ,  $A >= B$  or  $A > B$ . A and B are external ports of up to 64 bits wide and B can optionally be set to a constant value. The module can handle signed or unsigned data. Options are provided for **Clock Enable**, **Asynchronous Set and Clear**, and **Synchronous Set and Clear**. The module can optionally be generated as a Relationally Placed Macro (RPM) or as unplaced logic. When an RPM is generated the logic is placed in a column.

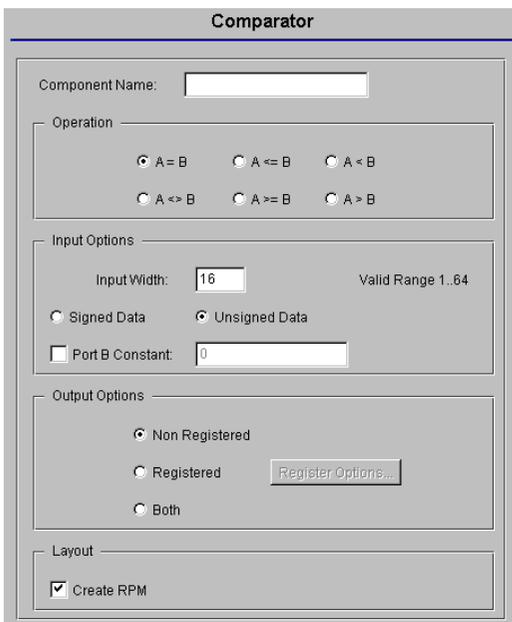


Figure 1: Main Comparator Parameterization Screen

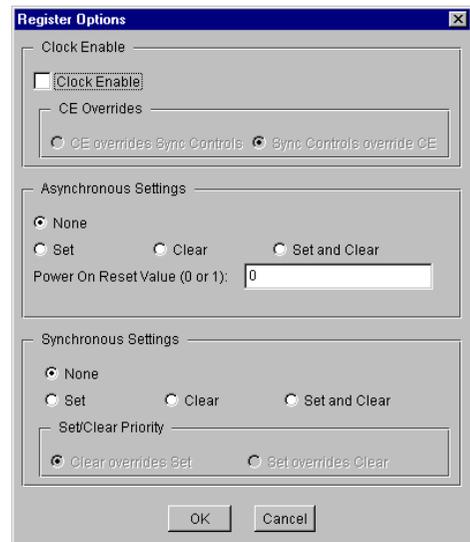
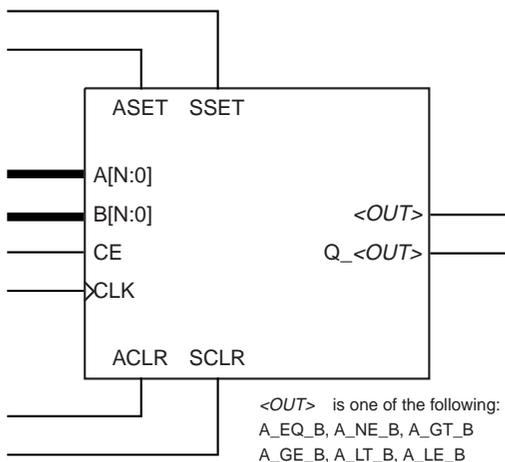


Figure 2: Comparator Register Options Parameterization Screen



X9081

Figure 3: Core Schematic Symbol

### Pinout

Signal names for the schematic symbol are shown in Figure 3 and described in Table 1. Note that Figure 3 shows the C\_OUT and Q\_C\_OUT pins which appear on adders and adder/subtractors. For a subtractor these pins will be named B\_OUT and Q\_B\_OUT, respectively.

### CORE Generator Parameters

The main CORE Generator parameterization screen for this module is shown in Figure 1. The parameters are as follows:

- **Component Name:** The component name is used as the base name of the output files generated for this module. Names must begin with a letter and must be composed from the following characters: a to z, 0 to 9 and “\_”.
- **Operation:** Select the appropriate radio button for the operation required. The default setting is **A = B**.
- **Input Options:**
  - **input Width:** Enter the width of ports A and B. The valid range is 1 to 64. The default value is 16.
  - **Input Sign:** Enter the sign of the input data. The default setting is **Unsigned**.
  - **Port B Constant:** When this check box is checked the Port B value will be set to the value specified in the **Port B Constant Value** text box. The default is for the Port B value to come from Port B.

Table 1: Core Signal Pinout

Signal	Signal Direction	Description
A[N:0]	Input	Comparator Input
B[N:0]	Input	Comparator Input
A_EQ_B	Output	A Equals B Asynchronous Output
Q_A_EQ_B	Output	A Equals B Registered Output
A_NE_B	Output	A Not Equal to B Asynchronous Output
Q_A_NE_B	Output	A Not Equal to B Registered Output
A_LE_B	Output	A Less Than or Equal to B Asynchronous Output
Q_A_LE_B	Output	A Less Than or Equal to B Registered Output
A_LT_B	Output	A Less Than B Asynchronous Output
Q_A_LT_B	Output	A Less Than B Registered Output
A_GE_B	Output	A Greater Than or Equal to B Asynchronous Output
Q_A_GE_B	Output	A Greater Than or Equal to B Registered Output
A_GT_B	Output	A Greater Than B Asynchronous Output
Q_A_GT_B	Output	A Greater Than B Registered Output
CE	Input	Clock Enable
CLK	Input	Clock - rising edge clock signal
ASET	Input	Asynchronous Set - forces the registered output to a high state when driven
ACLR	Input	Asynchronous Clear - forces outputs to a low state when driven
SSET	Input	Synchronous Set - forces the registered output to a high state on next concurrent clock edge
SCLR	Input	Synchronous Clear - forces the registered output to a low state on next concurrent clock edge

Note:  
All control inputs are Active High. Should an Active Low input be required for a particular control pin an inverter must be placed in the path to the pin. The inverter will be absorbed appropriately during mapping.

- **Port B Constant Value:** Enter the value for the Port B constant. The Constant Value must be provided in hex and must not exceed the specified **Input Width**. This text box is only enabled when the **Port B Constant** check box is checked. The default value is 0.
- **Output Options:** Select the appropriate radio button for the types of outputs required. The default setting is **Non Registered**.
  - **Register Options:** This button is only enabled when a registered output has been requested via the **Output Options**. Clicking on this button brings up the Register Options parameterization screen (see figure 2).
- **Create RPM:** When this box is checked the module is generated with relative location attributes attached. The resulting placement of the module is in a column with two bits per slice. The default operation is to create an RPM.  
Note that when a module is created as an RPM it is possible that one or more of the module dimensions may exceed those of the device being targeted. If this is the case mapping errors will occur and the compilation process will fail. In this case the module should be re-generated with the **Create RPM** checkbox unchecked.

The Register Options parameterization screen for this module is shown in Figure 2. The parameters are as follows:

- **Clock Enable:** When this box is checked the module is generated with a clock enable input. The default setting is unchecked.
- **CE Overrides:** This parameter controls whether or not the SSET and SCLR inputs are qualified by CE. This parameter is only enabled when a **Clock Enable** input has been requested.

When **CE Overrides Sync Controls** is selected an active level on any of the synchronous control inputs will only be acted upon when the CE pin is also Active. Note that this is not the way that the dedicated inputs on the flip-flop primitives work, and so setting the **CE Overrides** parameter to **CE Overrides Sync Controls** will force any synchronous control functionality to be implemented using logic in the Look Up Tables (LUTs) preceding the output register. This results in increased resource utilization.

When **Sync Controls Override CE** is selected an active level on any of the synchronous control inputs is acted upon irrespective of the state of the CE pin. This setting allows the dedicated inputs on the flip-flop primitives to be used for the synchronous control functions provided that asynchronous controls are not requested. If both asynchronous and synchronous controls are requested, the synchronous control functionality must be implemented using logic in the LUTs preceding the output register. In this case, the CE input has to be gated with the synchronous control inputs so that each synchronous

control input and the CE input can generate a CE signal to the flip-flops. This results in a performance degradation for the module due to the additional gating in the CE path.

The default setting is **Sync Controls Override CE** so that a more efficient implementation can be generated.

- **Asynchronous Settings:** All asynchronous controls are implemented using the dedicated inputs on the flip-flop primitives. The module can be generated with the following asynchronous control inputs by clicking on the appropriate button:
  - **None:** No asynchronous control inputs. This is the default setting.
  - **Set:** An ASET control pin is generated.
  - **Clear:** An ACLR control pin is generated.
  - **Set and Clear:** Both ASET and ACLR control pins are generated. ACLR has priority over ASET when both are asserted at the same time.
- **Power On Reset Value:** This text box accepts a value of 0 or 1 and defines the power on value for the output register. The default value is 0.
- **Synchronous Settings:** When no asynchronous controls are requested (i.e. the **Asynchronous Setting** is **None**) the synchronous controls can be implemented using the dedicated inputs on the flip-flop primitives. There are exceptions to this which are described in the sections for the **Set/Clear Priority** and **CE Overrides** parameters.  
When asynchronous controls are present any synchronous control functionality must be implemented using logic in the Look Up Tables (LUTs) preceding the output register. With modules where a non-registered output is not required there are combinations of parameters that allow this logic to be absorbed into the same LUTs used to implement the function. In cases where this absorption is not possible the synchronous control logic will require an additional LUT per output bit.  
The module can be generated with the following synchronous control inputs by clicking on the appropriate button:
  - **None:** No synchronous control inputs. This is the default setting.
  - **Set:** An SSET control pin is generated.
  - **Clear:** An SCLR control pin is generated.
  - **Set and Clear:** Both SSET and SCLR control pins are generated. SCLR/SSET priority is defined by the setting of the **Set/Clear Priority** parameter.
- **Set/Clear Priority:** By selecting the appropriate radio button the relative priority of SCLR and SSET can be controlled. This parameter is only enabled when **Set and Clear** is selected for **Synchronous Settings**.

A setting of **Clear Overrides Set** corresponds to the native operation of the flip-flop primitive. This setting will result in a more efficient implementation when asynchronous controls are not requested. A setting of **Set Over-**

**rides Clear** can only be implemented using logic in the LUTs preceding the output register.

The default setting is **Clear Overrides Set** so that the dedicated inputs on the flip-flops can be used if available.

CSET power\_on\_reset\_value = 0  
 CSET synchronous\_settings = none  
 CSET set\_clear\_priority = clear\_overrides\_set

## Parameter Values in the XCO File

Names of XCO file parameters and their parameter values are identical to the names and values shown in the GUI, except that underscore characters ( `_` ) are used instead of spaces. The text in an XCO file is case insensitive.

Table 2 shows the XCO file parameters and values, and summarizes the GUI defaults. The following is an example of the CSET parameters in an XCO file:

```
CSET component_name = abc123
CSET operation = a_eq_b
CSET input_width = 16
CSET input_sign = unsigned
CSET port_b_constant = FALSE
CSET port_b_constant_value = 0
CSET output_options = non_registered
CSET create_rpm = TRUE
CSET clock_enable = FALSE
CSET ce_overrides = sync_controls_override_ce
CSET asynchronous_settings = none
```

## Core Resource Utilization

A=B and A<>B comparisons are implemented using AND gates. In the case where the B input is variable, carry chains are also used. For A<B, A<=B, A>B, A>=B comparisons, subtractor logic is used.

Resource utilization follows these guidelines when default Register Options are specified.

**Table 2: XCO File Values and Default Values**

Parameter	XCO File Values	Default GUI Setting
component_name	ASCII text starting with a letter and based upon the following character set: a..z, 0..9 and <code>_</code>	blank
operation	One of the following keywords: a_eq_b, a_le_b, a_lt_b, a_ne_b, a_ge_b or a_gt_b	a_eq_b
input_width	Integer in the range 1 to 64	16
input_sign	One of the following keywords: unsigned or signed	unsigned
port_b_constant	One of the following keywords: true, false	false
port_b_constant_value	Hex value whose value does not exceed $2^{\text{input\_width}} - 1$	0
output_options	One of the following keywords: non_registered, registered or both	non_registered
create_rpm	One of the following keywords: true, false	true
clock_enable	One of the following keywords: true, false	false
ce_overrides	One of the following keywords: sync_controls_override_ce, ce_overrides_sync_controls	sync_controls_override_ce
asynchronous_settings	One of the following keywords: none, set, clear, set_and_clear, init	none
power_on_reset_value	One of the following values: 0, 1	0
synchronous_settings	One of the following keywords: none, set, clear, set_and_clear, init	none
set_clear_priority	One of the following keywords: clear_overrides_set or set_overrides_clear	clear_overrides_set

**Table 3: Comparator Resource Utilization**

Operation	Variable B Input (LUTs)	Constant B Input (LUTs)
A=B, A<>B	2 bits of compare per LUT: $((N+1)/2)^1$	4 bits per LUT for 1- to 4-bit compares, then 3 bits per LUT for inputs greater than 4 bits
A<B, A>B, A<=B, A>=B	$(N+1)^1$	

Note:

1. **N** = input data width

## Ordering Information

This core is downloadable free of charge from the Xilinx IP Center ([www.xilinx.com/ipcenter](http://www.xilinx.com/ipcenter)), for use with the 2.1i and later versions of the Xilinx Core Generator System. The Core Generator System is bundled with the Alliance and Foundation implementation tools.

To order Xilinx software contact your local Xilinx sales representative. For information on the Xilinx sales office nearest you, please refer to <http://www.xilinx.com/company/sales.htm>.