

# **Virtex-4 Libraries Guide for Schematic Designs**

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## About this Guide

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This schematic guide is part of the ISE documentation collection. A separate version of this guide is available if you prefer to work with HDL.

This guide contains the following:

- Introduction.
- A list of design elements supported in this architecture, organized by functional categories.
- Individual descriptions of each available primitive.

## About Design Elements

This version of the Libraries Guide describes design elements available for this architecture. There are several categories of design elements:

- **Primitives** - The simplest design elements in the Xilinx libraries. Primitives are the design element "atoms." Examples of Xilinx primitives are the simple buffer, BUF, and the D flip-flop with clock enable and clear, FDCE.
- **Macros** - The design element "molecules" of the Xilinx libraries. Macros can be created from the design element primitives or macros. For example, the FD4CE flip-flop macro is a composite of 4 FDCE primitives.

Xilinx maintains software libraries with hundreds of functional design elements (macros and primitives) for different device architectures. New functional elements are assembled with each release of development system software. This guide is one in a series of architecture-specific libraries.

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## Functional Categories

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This section categorizes, by function, the circuit design elements described in detail later in this guide. The elements ( *primitives* and *macros*) are listed in alphanumeric order under each functional category.

Advanced	Flip Flop	Latch
Arithmetic	General	Logic
Buffer	GigaBit 11 IO	LUT
Carry Logic	GigaBit IO/Processor	Map
Clocking Resources	Input/Output Functions	Memory
Comparator	IO	Mux
Counter	IO FlipFlop	Shift Register
Decoder	IO Latch	Shifter

### Advanced

Design Element	Description
EMAC	Primitive: Fully integrated 10/100/1000 Mb/s Ethernet Media Access Controller (Ethernet MAC)
FIFO16	Primitive: Virtex-4 Block RAM Based, Built-In FIFO

### Arithmetic

Design Element	Description
ACC16	Macro: 16-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset
ACC4	Macro: 4-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset
ACC8	Macro: 8-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset
ADD16	Macro: 16-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow

Design Element	Description
<a href="#">ADD4</a>	Macro: 4-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow
<a href="#">ADD8</a>	Macro: 8-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow
<a href="#">ADSU16</a>	Macro: 16-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow
<a href="#">ADSU4</a>	Macro: 4-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow
<a href="#">ADSU8</a>	Macro: 8-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow
<a href="#">DSP48</a>	Primitive: 18x18 Signed Multiplier Followed by a Three-Input Adder with Optional Pipeline Registers
<a href="#">MULT18X18</a>	Primitive: 18 x 18 Signed Multiplier
<a href="#">MULT18X18S</a>	Primitive: 18 x 18 Signed Multiplier -- Registered Version

### Buffer

Design Element	Description
<a href="#">BUF</a>	Primitive: General Purpose Buffer
<a href="#">BUFCF</a>	Primitive: Fast Connect Buffer
<a href="#">BUFG</a>	Primitive: Global Clock Buffer
<a href="#">BUFGCE</a>	Primitive: Global Clock Buffer with Clock Enable
<a href="#">BUFGCE_1</a>	Primitive: Global Clock Buffer with Clock Enable and Output State 1
<a href="#">BUFGMUX</a>	Primitive: Global Clock MUX Buffer
<a href="#">BUFGMUX_1</a>	Primitive: Global Clock MUX Buffer with Output State 1

### Carry Logic

Design Element	Description
<a href="#">MUXCY</a>	Primitive: 2-to-1 Multiplexer for Carry Logic with General Output
<a href="#">MUXCY_D</a>	Primitive: 2-to-1 Multiplexer for Carry Logic with Dual Output
<a href="#">MUXCY_L</a>	Primitive: 2-to-1 Multiplexer for Carry Logic with Local Output
<a href="#">XORCY</a>	Primitive: XOR for Carry Logic with General Output
<a href="#">XORCY_D</a>	Primitive: XOR for Carry Logic with Dual Output
<a href="#">XORCY_L</a>	Primitive: XOR for Carry Logic with Local Output

## Clocking Resources

Design Element	Description
BUFGCTRL	Primitive: Global Clock MUX Buffer
BUFGMUX_VIRTEX4	Primitive: Global Clock MUX Buffer
BUFIO	Primitive: Local Clock Buffer for I/O
BUFR	Primitive: Regional Clock Buffer for I/O and Logic Resources
DCM_ADV	Primitive: Advanced Digital Clock Manager Circuit
DCM_BASE	Primitive: Base Digital Clock Manager Circuit
DCM_PS	Primitive: Digital Clock Manager with Basic and Phase Shift Features
GT11CLK	Primitive: A MUX That Can Select From Differential Package Input Clock, refclk From the Fabric, or rxblck to Drive the Two Vertical Reference Clock Buses for the Column of MGTs
GT11CLK_MGT	Primitive: Allows Differential Package Input to Drive the Two Vertical Reference Clock Buses for the Column of MGTs
PMCD	Primitive: Phase-Matched Clock Divider

## Comparator

Design Element	Description
COMP16	Macro: 16-Bit Identity Comparator
COMP2	Macro: 2-Bit Identity Comparator
COMP4	Macro: 4-Bit Identity Comparator
COMP8	Macro: 8-Bit Identity Comparator
COMPM16	Macro: 16-Bit Magnitude Comparator
COMPM2	Macro: 2-Bit Magnitude Comparator
COMPM4	Macro: 4-Bit Magnitude Comparator
COMPM8	Macro: 8-Bit Magnitude Comparator
COMPMC16	Macro: 16-Bit Magnitude Comparator
COMPMC8	Macro: 8-Bit Magnitude Comparator

## Counter

Design Element	Description
CB16CE	Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CB16CLE	Macro: 16-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear
CB16CLED	Macro: 16-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear

Design Element	Description
CB16RE	Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CB2CE	Macro: 2-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CB2CLE	Macro: 2-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear
CB2CLED	Macro: 2-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear
CB2RE	Macro: 2-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CB4CE	Macro: 4-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CB4CLE	Macro: 4-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear
CB4CLED	Macro: 4-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear
CB4RE	Macro: 4-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CB8CE	Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CB8CLE	Macro: 8-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear
CB8CLED	Macro: 8-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear
CB8RE	Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CC16CE	Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CC16CLE	Macro: 16-Bit Loadable Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CC16CLED	Macro: 16-Bit Loadable Cascadable Bidirectional Binary Counter with Clock Enable and Asynchronous Clear
CC16RE	Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CC8CE	Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CC8CLE	Macro: 8-Bit Loadable Cascadable Binary Counter with Clock Enable and Asynchronous Clear
CC8CLED	Macro: 8-Bit Loadable Cascadable Bidirectional Binary Counter with Clock Enable and Asynchronous Clear
CC8RE	Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset
CD4CE	Macro: 4-Bit Cascadable BCD Counter with Clock Enable and Asynchronous Clear
CD4CLE	Macro: 4-Bit Loadable Cascadable BCD Counter with Clock Enable and Asynchronous Clear
CD4RE	Macro: 4-Bit Cascadable BCD Counter with Clock Enable and Synchronous Reset



Design Element	Description
CD4RLE	Macro: 4-Bit Loadable Cascadable BCD Counter with Clock Enable and Synchronous Reset
CJ4CE	4-Bit Johnson Counter with Clock Enable and Asynchronous Clear
CJ4RE	Macro: 4-Bit Johnson Counter with Clock Enable and Synchronous Reset
CJ5CE	Macro: 5-Bit Johnson Counter with Clock Enable and Asynchronous Clear
CJ5RE	Macro: 5-Bit Johnson Counter with Clock Enable and Synchronous Reset
CJ8CE	Macro: 8-Bit Johnson Counter with Clock Enable and Asynchronous Clear
CJ8RE	Macro: 8-Bit Johnson Counter with Clock Enable and Synchronous Reset
CR16CE	Macro: 16-Bit Negative-Edge Binary Ripple Counter with Clock Enable and Asynchronous Clear
CR8CE	Macro: 8-Bit Negative-Edge Binary Ripple Counter with Clock Enable and Asynchronous Clear

### Decoder

Design Element	Description
D2_4E	Macro: 2- to 4-Line Decoder/Demultiplexer with Enable
D3_8E	Macro: 3- to 8-Line Decoder/Demultiplexer with Enable
D4_16E	Macro: 4- to 16-Line Decoder/Demultiplexer with Enable
DEC_CC16	Macro: 16-Bit Active Low Decoder
DEC_CC4	Macro: 4-Bit Active Low Decoder
DEC_CC8	Macro: 8-Bit Active Low Decoder
DECODE16	Macro: 16-Bit Active-Low Decoder
DECODE32	Macro: 32-Bit Active-Low Decoder
DECODE4	Macro: 4-Bit Active-Low Decoder
DECODE64	Macro: 64-Bit Active-Low Decoder
DECODE8	Macro: 8-Bit Active-Low Decoder

### Flip Flop

Design Element	Description
FD	Primitive: D Flip-Flop
FD_1	Primitive: D Flip-Flop with Negative-Edge Clock
FD16CE	Macro: 16-Bit Data Register with Clock Enable and Asynchronous Clear
FD16RE	Macro: 16-Bit Data Register with Clock Enable and Synchronous Reset

Design Element	Description
FD4CE	Macro: 4-Bit Data Register with Clock Enable and Asynchronous Clear
FD4RE	Macro: 4-Bit Data Register with Clock Enable and Synchronous Reset
FD8CE	Macro: 8-Bit Data Register with Clock Enable and Asynchronous Clear
FD8RE	Macro: 8-Bit Data Register with Clock Enable and Synchronous Reset
FDC	Primitive: D Flip-Flop with Asynchronous Clear
FDC_1	Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Clear
FDCE	Primitive: D Flip-Flop with Clock Enable and Asynchronous Clear
FDCE_1	Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Clear
FDCP	Primitive: D Flip-Flop with Asynchronous Preset and Clear
FDCP_1	Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Preset and Clear
FDCPE	Primitive: D Flip-Flop with Clock Enable and Asynchronous Preset and Clear
FDCPE_1	Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Preset and Clear
FDE	Primitive: D Flip-Flop with Clock Enable
FDE_1	Primitive: D Flip-Flop with Negative-Edge Clock and Clock Enable
FDP	Primitive: D Flip-Flop with Asynchronous Preset
FDP_1	Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Preset
FDPE	Primitive: D Flip-Flop with Clock Enable and Asynchronous Preset
FDPE_1	Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Preset
FDR	Primitive: D Flip-Flop with Synchronous Reset
FDR_1	Primitive: D Flip-Flop with Negative-Edge Clock and Synchronous Reset
FDRE	Primitive: D Flip-Flop with Clock Enable and Synchronous Reset
FDRE_1	Primitive: D Flip-Flop with Negative-Clock Edge, Clock Enable, and Synchronous Reset
FDRS	Primitive: D Flip-Flop with Synchronous Reset and Set
FDRS_1	Primitive: D Flip-Flop with Negative-Clock Edge and Synchronous Reset and Set
FDRSE	Primitive: D Flip-Flop with Synchronous Reset and Set and Clock Enable
FDRSE_1	Primitive: D Flip-Flop with Negative-Clock Edge, Synchronous Reset and Set, and Clock Enable

Design Element	Description
FDS	Primitive: D Flip-Flop with Synchronous Set
FDS_1	Primitive: D Flip-Flop with Negative-Edge Clock and Synchronous Set
FDSE	Primitive: D Flip-Flop with Clock Enable and Synchronous Set
FDSE_1	Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Synchronous Set
FJKC	Macro: J-K Flip-Flop with Asynchronous Clear
FJKCE	Macro: J-K Flip-Flop with Clock Enable and Asynchronous Clear
FJKP	Macro: J-K Flip-Flop with Asynchronous Preset
FJKPE	Macro: J-K Flip-Flop with Clock Enable and Asynchronous Preset
FJKRSE	Macro: J-K Flip-Flop with Clock Enable and Synchronous Reset and Set
FJKSRE	Macro: J-K Flip-Flop with Clock Enable and Synchronous Set and Reset
FTC	Macro: Toggle Flip-Flop with Asynchronous Clear
FTCE	Macro: Toggle Flip-Flop with Clock Enable and Asynchronous Clear
FTCLE	Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Clear
FTCLEX	Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Clear
FTP	Macro: Toggle Flip-Flop with Asynchronous Preset
FTPE	Macro: Toggle Flip-Flop with Clock Enable and Asynchronous Preset
FTPLE	Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Preset
FTRSE	Macro: Toggle Flip-Flop with Clock Enable and Synchronous Reset and Set
FTRSLE	Macro: Toggle/Loadable Flip-Flop with Clock Enable and Synchronous Reset and Set
FTSRE	Macro: Toggle Flip-Flop with Clock Enable and Synchronous Set and Reset
FTSRLE	Macro: Toggle/Loadable Flip-Flop with Clock Enable and Synchronous Set and Reset

### General

Design Element	Description
BSCAN_VIRTEX4	Primitive: Virtex®-4 JTAG Boundary-Scan Logic Access Circuit
CAPTURE_VIRTEX4	Primitive: Virtex®-4 Boundary Scan Logic Control Circuit
FRAME_ECC_VIRTEX4	Primitive: Reads a Single, Virtex®-4 Configuration Frame and Computes a Hamming, Single-Error Correction, Double-Error Detection Syndrome
GND	Primitive: Ground-Connection Signal Tag
ICAP_VIRTEX4	Primitive: Virtex-4 Internal Configuration Access Port
KEEPER	Primitive: KEEPER Symbol
PULLDOWN	Primitive: Resistor to GND for Input Pads, Open-Drain, and 3-State Outputs
PULLUP	Primitive: Resistor to VCC for Input PADS, Open-Drain, and 3-State Outputs
STARTUP_VIRTEX4	Primitive: Virtex®-4 User Interface to Configuration Clock, Global Reset, Global 3-State Controls, and Other Configuration Signals
USR_ACCESS_VIRTEX4	Primitive: 32-Bit Register with a 32-Bit DATA Bus and a DATAVALID Port
VCC	Primitive: VCC-Connection Signal Tag

### GigaBit 11 IO

Design Element	Description
GT11_CUSTOM	Primitive: RocketIO MGTs with 622 Mb/s to 11.1 Gb/s Data Rates, 8 to 24 Transceivers per FPGA, and 2.5 GHz 5.55 GHz VCO, Less Than 1ns RMS Jitter
GT11_DUAL	Primitive: RocketIO MGT Tile (contains 2 GT11_CUSTOM) with 622 Mb/s to 11.1 Gb/s data rates, 8 to 24 transceivers per FPGA, and 2.5 GHz 5.55 GHz VCO, less than 1ns RMS jitter

### GigaBit IO/Processor

Design Element	Description
PPC405_ADV	Primitive: Primitive for the Power PC Core
JTAGPPC	Primitive: JTAG Primitive for the Power PC

## Input/Output Functions

Design Element	Description
DCIRESET	Primitive: DCI State Machine Reset (After Configuration Has Been Completed)
IDELAY	Primitive: Input Delay Element
IDELAYCTRL	Primitive: IDELAY Tap Delay Value Control
IDDR	Primitive: Input Dual Data-Rate Register
ISERDES	Primitive: Dedicated I/O Buffer Input Deserializer
ODDR	Primitive: Dedicated Dual Data Rate (DDR) Output Register
OSERDES	Primitive: Dedicated IOB Output Serializer

## IO

Design Element	Description
IBUF	Primitive: Input Buffer
IBUFDS	Primitive: Differential Signaling Input Buffer
IBUFDS_DIFF_OUT	Primitive: Signaling Input Buffer with Differential Output
IBUF16	Macro: 16-Bit Input Buffer
IBUF4	Macro: 4-Bit Input Buffer
IBUF8	Macro: 8-Bit Input Buffer
IBUFG	Primitive: Dedicated Input Clock Buffer
IBUFGDS	Primitive: Differential Signaling Dedicated Input Clock Buffer and Optional Delay
IOBUF	Primitive: Bi-Directional Buffer
IOBUFDS	Primitive: 3-State Differential Signaling I/O Buffer with Active Low Output Enable
OBUF	Primitive: Output Buffer
OBUFDS	Primitive: Differential Signaling Output Buffer
OBUF16	Macro: 16-Bit Output Buffer
OBUF4	Macro: 4-Bit Output Buffer
OBUF8	Macro: 8-Bit Output Buffer
OBUFT	Primitive: 3-State Output Buffer with Active Low Output Enable
OBUFTDS	Primitive: 3-State Output Buffer with Differential Signaling, Active-Low Output Enable
OBUFT16	Macro: 16-Bit 3-State Output Buffer with Active Low Output Enable
OBUFT4	Macro: 4-Bit 3-State Output Buffers with Active-Low Output Enable
OBUFT8	Macro: 8-Bit 3-State Output Buffers with Active-Low Output Enable

## IO FlipFlop

Design Element	Description
IFD	Macro: Input D Flip-Flop
IFD_1	Macro: Input D Flip-Flop with Inverted Clock (Asynchronous Preset)
IFD16	Macro: 16-Bit Input D Flip-Flop
IFD4	Macro: 4-Bit Input D Flip-Flop
IFD8	Macro: 8-Bit Input D Flip-Flop
IFDI	Macro: Input D Flip-Flop (Asynchronous Preset)
IFDI_1	Macro: Input D Flip-Flop with Inverted Clock (Asynchronous Preset)
IFDX	Macro: Input D Flip-Flop with Clock Enable
IFDX_1	Macro: Input D Flip-Flop with Inverted Clock and Clock Enable
IFDX16	Macro: 16-Bit Input D Flip-Flops with Clock Enable
IFDX4	Macro: 4-Bit Input D Flip-Flop with Clock Enable
IFDX8	Macro: 8-Bit Input D Flip-Flop with Clock Enable
IFDXI	Macro: Input D Flip-Flop with Clock Enable (Asynchronous Preset)
IFDXI_1	Macro: Input D Flip-Flop with Inverted Clock and Clock Enable (Asynchronous Preset)
OFD	Macro: Output D Flip-Flop
OFD_1	Macro: Output D Flip-Flop with Inverted Clock
OFD16	Macro: 16-Bit Output D Flip-Flop
OFD4	Macro: 4-Bit Output D Flip-Flop
OFD8	Macro: 8-Bit Output D Flip-Flop
OFDE	Macro: D Flip-Flop with Active-High Enable Output Buffers
OFDE_1	Macro: D Flip-Flop with Active-High Enable Output Buffer and Inverted Clock
OFDE4	Macro: 4-Bit D Flip-Flop with Active-High Enable Output Buffers
OFDE8	Macro: 8-Bit D Flip-Flop with Active-High Enable Output Buffers
OFDE16	Macro: 16-Bit D Flip-Flop with Active-High Enable Output Buffers
OFDI	Macro: Output D Flip-Flop (Asynchronous Preset)
OFDI_1	Macro: Output D Flip-Flop with Inverted Clock (Asynchronous Preset)
OFDT	Macro: D Flip-Flop with Active-Low 3-State Output Buffer
OFDT_1	Macro: D Flip-Flop with Active-Low 3-State Output Buffer and Inverted Clock
OFDT16	Macro: 16-Bit D Flip-Flop with Active-Low 3-State Output Buffers

Design Element	Description
OFDT4	Macro: 4-Bit D Flip-Flop with Active-Low 3-State Output Buffers
OFDT8	Macro: 8-Bit D Flip-Flop with Active-Low 3-State Output Buffers
OFDX	Macro: Output D Flip-Flop with Clock Enable
OFDX_1	Macro: Output D Flip-Flop with Inverted Clock and Clock Enable
OFDX16	Macro: 16-Bit Output D Flip-Flop with Clock Enable
OFDX4	Macro: 4-Bit Output D Flip-Flop with Clock Enable
OFDX8	Macro: 8-Bit Output D Flip-Flop with Clock Enable
OFDXI	Macro: Output D Flip-Flop with Clock Enable (Asynchronous Preset)
OFDXI_1	Macro: Output D Flip-Flop with Inverted Clock and Clock Enable (Asynchronous Preset)

### IO Latch

Design Element	Description
ILD	Macro: Transparent Input Data Latch
ILD_1	Macro: Transparent Input Data Latch with Inverted Gate
ILD16	Macro: Transparent Input Data Latch
ILD4	Macro: Transparent Input Data Latch
ILD8	Macro: Transparent Input Data Latch
ILDI	Macro: Transparent Input Data Latch (Asynchronous Preset)
ILDI_1	Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)
ILDX	Macro: Transparent Input Data Latch
ILDX_1	Macro: Transparent Input Data Latch with Inverted Gate
ILDX16	Macro: Transparent Input Data Latch
ILDX4	Macro: Transparent Input Data Latch
ILDX8	Macro: Transparent Input Data Latch
ILDXI	Macro: Transparent Input Data Latch (Asynchronous Preset)
ILDXI_1	Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)

## Latch

Design Element	Description
ILD	Macro: Transparent Input Data Latch
ILD_1	Macro: Transparent Input Data Latch with Inverted Gate
ILD16	Macro: Transparent Input Data Latch
ILD4	Macro: Transparent Input Data Latch
ILD8	Macro: Transparent Input Data Latch
ILDI	Macro: Transparent Input Data Latch (Asynchronous Preset)
ILDI_1	Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)
ILDX	Macro: Transparent Input Data Latch
ILDX_1	Macro: Transparent Input Data Latch with Inverted Gate
ILDX16	Macro: Transparent Input Data Latch
ILDX4	Macro: Transparent Input Data Latch
ILDX8	Macro: Transparent Input Data Latch
ILDXI	Macro: Transparent Input Data Latch (Asynchronous Preset)
ILDXI_1	Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)

## Logic

Design Element	Description
MUXCY	Primitive: 2-to-1 Multiplexer for Carry Logic with General Output
MUXCY_D	Primitive: 2-to-1 Multiplexer for Carry Logic with Dual Output
MUXCY_L	Primitive: 2-to-1 Multiplexer for Carry Logic with Local Output
XORCY	Primitive: XOR for Carry Logic with General Output
XORCY_D	Primitive: XOR for Carry Logic with Dual Output
XORCY_L	Primitive: XOR for Carry Logic with Local Output



## LUT

Design Element	Description
<a href="#">LUT1</a>	Primitive: 1-Bit Look-Up Table with General Output
<a href="#">LUT1_D</a>	Primitive: 1-Bit Look-Up Table with Dual Output
<a href="#">LUT1_L</a>	Primitive: 1-Bit Look-Up Table with Local Output
<a href="#">LUT2</a>	Primitive: 2-Bit Look-Up Table with General Output
<a href="#">LUT2_D</a>	Primitive: 2-Bit Look-Up Table with Dual Output
<a href="#">LUT2_L</a>	Primitive: 2-Bit Look-Up Table with Local Output
<a href="#">LUT3</a>	Primitive: 3-Bit Look-Up Table with General Output
<a href="#">LUT3_D</a>	Primitive: 3-Bit Look-Up Table with Dual Output
<a href="#">LUT3_L</a>	Primitive: 3-Bit Look-Up Table with Local Output
<a href="#">LUT4</a>	Primitive: 4-Bit Look-Up-Table with General Output
<a href="#">LUT4_D</a>	Primitive: 4-Bit Look-Up Table with Dual Output
<a href="#">LUT4_L</a>	Primitive: 4-Bit Look-Up Table with Local Output

## Map

Design Element	Description
<a href="#">FMAP</a>	Primitive: F Function Generator Partitioning Control Symbol

## Memory

Design Element	Description
<a href="#">RAMB16</a>	Primitive: 16K-bit Data and 2K-bit Parity Single-Port Synchronous Block RAM with Configurable Port Widths
<a href="#">RAMB32_S64_ECC</a>	Primitive: 512 Deep by 64-Bit Wide Synchronous, Two-Port Block RAM with Built-In Error Correction
<a href="#">RAM16X1D</a>	Primitive: 16-Deep by 1-Wide Static Dual Port Synchronous RAM
<a href="#">RAM16X1D_1</a>	Primitive: 16-Deep by 1-Wide Static Dual Port Synchronous RAM with Negative-Edge Clock
<a href="#">RAM16X1S</a>	Primitive: 16-Deep by 1-Wide Static Synchronous RAM
<a href="#">RAM16X1S_1</a>	Primitive: 16-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock
<a href="#">RAM16X2S</a>	Primitive: 16-Deep by 2-Wide Static Synchronous RAM
<a href="#">RAM16X4S</a>	Primitive: 16-Deep by 4-Wide Static Synchronous RAM
<a href="#">RAM16X8S</a>	Primitive: 16-Deep by 8-Wide Static Synchronous RAM
<a href="#">RAM32X1S</a>	Primitive: 32-Deep by 1-Wide Static Synchronous RAM
<a href="#">RAM32X1S_1</a>	Primitive: 32-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock
<a href="#">RAM32X2S</a>	Primitive: 32-Deep by 2-Wide Static Synchronous RAM
<a href="#">RAM32X4S</a>	Primitive: 32-Deep by 4-Wide Static Synchronous RAM
<a href="#">RAM32X8S</a>	Primitive: 32-Deep by 8-Wide Static Synchronous RAM
<a href="#">RAM64X1S</a>	Primitive: 64-Deep by 1-Wide Static Synchronous RAM
<a href="#">RAM64X1S_1</a>	Primitive: 64-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock
<a href="#">RAM64X2S</a>	Primitive: 64-Deep by 2-Wide Static Synchronous RAM
<a href="#">ROM16X1</a>	Primitive: 16-Deep by 1-Wide ROM
<a href="#">ROM32X1</a>	Primitive: 32-Deep by 1-Wide ROM
<a href="#">ROM64X1</a>	Primitive: 64-Deep by 1-Wide ROM
<a href="#">ROM128X1</a>	Primitive: 128-Deep by 1-Wide ROM
<a href="#">ROM256X1</a>	Primitive: 256-Deep by 1-Wide ROM

## Mux

Design Element	Description
M16_1E	Macro: 16-to-1 Multiplexer with Enable
M2_1	Macro: 2-to-1 Multiplexer
M2_1B1	Macro: 2-to-1 Multiplexer with D0 Inverted
M2_1B2	Macro: 2-to-1 Multiplexer with D0 and D1 Inverted
M2_1E	Macro: 2-to-1 Multiplexer with Enable
M4_1E	Macro: 4-to-1 Multiplexer with Enable
M8_1E	Macro: 8-to-1 Multiplexer with Enable
MUXF5	Primitive: 2-to-1 Look-Up Table Multiplexer with General Output
MUXF5_D	Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output
MUXF5_L	Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output
MUXF6	Primitive: 2-to-1 Look-Up Table Multiplexer with General Output
MUXF6_D	Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output
MUXF6_L	Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output
MUXF7	Primitive: 2-to-1 Look-Up Table Multiplexer with General Output
MUXF7_D	Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output
MUXF7_L	Primitive: 2-to-1 look-up table Multiplexer with Local Output
MUXF8	Primitive: 2-to-1 Look-Up Table Multiplexer with General Output
MUXF8_D	Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output
MUXF8_L	Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output

## Shift Register

Design Element	Description
SR16CE	Macro: 16-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR16CLE	Macro: 16-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR16CLED	Macro: 16-Bit Shift Register with Clock Enable and Asynchronous Clear
SR16RE	Macro: 16-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset

Design Element	Description
SR16RLE	Macro: 16-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset
SR16RLED	Macro: 16-Bit Shift Register with Clock Enable and Synchronous Reset
SR4CE	Macro: 4-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR4CLE	Macro: 4-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR4CLED	Macro: 4-Bit Shift Register with Clock Enable and Asynchronous Clear
SR4RE	Macro: 4-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset
SR4RLE	Macro: 4-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset
SR4RLED	Macro: 4-Bit Shift Register with Clock Enable and Synchronous Reset
SR8CE	Macro: 8-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR8CLE	Macro: 8-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear
SR8CLED	Macro: 8-Bit Shift Register with Clock Enable and Asynchronous Clear
SR8RE	Macro: 8-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset
SR8RLE	Macro: 8-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset
SR8RLED	Macro: 8-Bit Shift Register with Clock Enable and Synchronous Reset
SRL16	Primitive: 16-Bit Shift Register Look-Up Table (LUT)
SRL16_1	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Negative-Edge Clock
SRL16E	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Clock Enable
SRL16E_1	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Negative-Edge Clock and Clock Enable
SRLC16	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry
SRLC16_1	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry and Negative-Edge Clock
SRLC16E	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry and Clock Enable
SRLC16E_1	Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry, Negative-Edge Clock, and Clock Enable

**Shifter**

Design Element	Description
<a href="#">BRLSHFT4</a>	Macro: 4-Bit Barrel Shifter
<a href="#">BRLSHFT8</a>	Macro: 8-Bit Barrel Shifter



## About Design Elements

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This section describes the design elements that can be used with this architecture. The design elements are organized alphabetically.

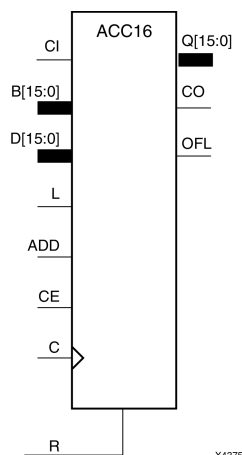
The following information is provided for each design element, where applicable:

- Name of element
- Brief description
- Schematic symbol (if any)
- Logic Table (if any)
- Port Descriptions (if any)
- Design Entry Method
- Available Attributes (if any)
- For more information

You can find examples of VHDL and Verilog instantiation code in the ISE software (in the main menu, select **Edit > Language Templates** or in the *Libraries Guide for HDL Designs* for this architecture.

## ACC16

### Macro: 16-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset



## Introduction

This design element can add or subtract a 16-bit unsigned-binary, respectively or two's-complement word to or from the contents of a 16-bit data register and store the results in the register. The register can be loaded with the 16-bit word.

When the load input (L) is High, CE is ignored and the data on the D inputs is loaded into the register during the Low-to-High clock (C) transition. ACC16 loads the data on inputs D15 : D0 into the 16-bit register.

This design element operates on either 16-bit unsigned binary numbers or 16-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is how they determine when "overflow" occurs. Unsigned binary uses carry-out (CO), while two's complement uses OFL to determine when "overflow" occurs.

- For unsigned binary operation, ACC16 can represent numbers between 0 and 15, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds. The carry-out (CO) is not registered synchronously with the data outputs. CO always reflects the accumulation of the B inputs (B15 : B0 for ACC16). This allows the cascading of ACC16s by connecting CO of one stage to CI of the next stage. An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

$\text{unsigned overflow} = \text{CO} \text{ XOR } \text{ADD}$

Ignore OFL in unsigned binary operation.

- For two's-complement operation, ACC16 represents numbers between -8 and +7, inclusive. If an addition or subtraction operation result exceeds this range, the OFL output goes High. The overflow (OFL) is not registered synchronously with the data outputs. OFL always reflects the accumulation of the B inputs (B15 : B0 for ACC16) and the contents of the register, which allows cascading of ACC16s by connecting OFL of one stage to CI of the next stage.

Ignore CO in two's-complement operation.

The synchronous reset (R) has priority over all other inputs, and when set to High, causes all outputs to go to logic level zero during the Low-to-High clock (C) transition. Clock (C) transitions are ignored when clock enable (CE) is Low.



This design element is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_*architecture* symbol.

## Logic Table

Input						Output
R	L	CE	ADD	D	C	Q
1	x	x	x	x	↑	0
0	1	x	x	Dn	↑	Dn
0	0	1	1	x	↑	Q0+Bn+CI
0	0	1	0	x	↑	Q0-Bn-CI
0	0	0	x	x	↑	No Change
Q0: Previous value of Q Bn: Value of Data input B CI: Value of input CI						

## Design Entry Method

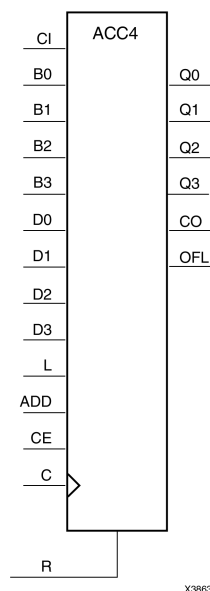
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ACC4

### Macro: 4-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset



## Introduction

This design element can add or subtract a 4-bit unsigned-binary, respectively or two's-complement word to or from the contents of a 4-bit data register and store the results in the register. The register can be loaded with the 4-bit word.

When the load input (L) is High, CE is ignored and the data on the D inputs is loaded into the register during the Low-to-High clock (C) transition. ACC4 loads the data on inputs D3 : D0 into the 4-bit register.

This design element operates on either 4-bit unsigned binary numbers or 4-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is how they determine when "overflow" occurs. Unsigned binary uses carry-out (CO), while two's complement uses OFL to determine when "overflow" occurs.

- For unsigned binary operation, ACC4 can represent numbers between 0 and 15, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds. The carry-out (CO) is not registered synchronously with the data outputs. CO always reflects the accumulation of the B inputs (B3 : B0 for ACC4). This allows the cascading of ACC4s by connecting CO of one stage to CI of the next stage. An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

`unsigned overflow = CO XOR ADD`

Ignore OFL in unsigned binary operation.

- For two's-complement operation, ACC4 represents numbers between -8 and +7, inclusive. If an addition or subtraction operation result exceeds this range, the OFL output goes High. The overflow (OFL) is not registered synchronously with the data outputs. OFL always reflects the accumulation of the B inputs (B3 : B0 for ACC4) and the contents of the register, which allows cascading of ACC4s by connecting OFL of one stage to CI of the next stage.

Ignore CO in two's-complement operation.

The synchronous reset (R) has priority over all other inputs, and when set to High, causes all outputs to go to logic level zero during the Low-to-High clock (C) transition. Clock (C) transitions are ignored when clock enable (CE) is Low.

This design element is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_*architecture* symbol.

## Logic Table

Input						Output
R	L	CE	ADD	D	C	Q
1	x	x	x	x	↑	0
0	1	x	x	Dn	↑	Dn
0	0	1	1	x	↑	Q0+Bn+CI
0	0	1	0	x	↑	Q0-Bn-CI
0	0	0	x	x	↑	No Change
Q0: Previous value of Q Bn: Value of Data input B CI: Value of input CI						

## Design Entry Method

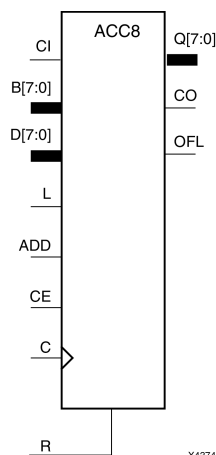
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ACC8

### Macro: 8-Bit Loadable Cascadable Accumulator with Carry-In, Carry-Out, and Synchronous Reset



## Introduction

This design element can add or subtract a 8-bit unsigned-binary, respectively or two's-complement word to or from the contents of a 8-bit data register and store the results in the register. The register can be loaded with the 8-bit word.

When the load input (L) is High, CE is ignored and the data on the D inputs is loaded into the register during the Low-to-High clock (C) transition. ACC8 loads the data on inputs D7 : D0 into the 8-bit register.

This design element operates on either 8-bit unsigned binary numbers or 8-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is how they determine when "overflow" occurs. Unsigned binary uses carry-out (CO), while two's complement uses OFL to determine when "overflow" occurs.

- For unsigned binary operation, ACC8 can represent numbers between 0 and 255, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds. The carry-out (CO) is not registered synchronously with the data outputs. CO always reflects the accumulation of the B inputs (B3 : B0 for ACC4). This allows the cascading of ACC8s by connecting CO of one stage to CI of the next stage. An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

`unsigned overflow = CO XOR ADD`

Ignore OFL in unsigned binary operation.

- For two's-complement operation, ACC8 represents numbers between -128 and +127, inclusive. If an addition or subtraction operation result exceeds this range, the OFL output goes High. The overflow (OFL) is not registered synchronously with the data outputs. OFL always reflects the accumulation of the B inputs (B3 : B0 for ACC8) and the contents of the register, which allows cascading of ACC8s by connecting OFL of one stage to CI of the next stage.

Ignore CO in two's-complement operation.

The synchronous reset (R) has priority over all other inputs, and when set to High, causes all outputs to go to logic level zero during the Low-to-High clock (C) transition. Clock (C) transitions are ignored when clock enable (CE) is Low.

This design element is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Input						Output
R	L	CE	ADD	D	C	Q
1	x	x	x	x	↑	0
0	1	x	x	Dn	↑	Dn
0	0	1	1	x	↑	Q0+Bn+CI
0	0	1	0	x	↑	Q0-Bn-CI
0	0	0	x	x	↑	No Change
Q0: Previous value of Q Bn: Value of Data input B CI: Value of input CI						

## Design Entry Method

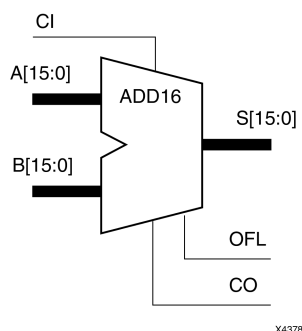
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ADD16

### Macro: 16-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow



## Introduction

This design element adds two words and a carry-in (CI), producing a sum output and carry-out (CO) or overflow (OFL). The factors added are A15:A0, B15:B0 and CI, producing the sum output S15:S0 and CO (or OFL).

## Logic Table

Input		Output
A	B	S
A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI
CI: Value of input CI.		

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 16-bit unsigned binary numbers or 16-bit two's-complement numbers, respectively. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's-complement uses OFL to determine when "overflow" occurs. To interpret the inputs as unsigned binary, follow the CO output. To interpret the inputs as two's complement, follow the OFL output.

**Unsigned Binary Operation** -For unsigned binary operation, this element represents numbers between 0 and 65535, inclusive. OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -32768 and +32767, inclusive. OFL is active (High) when the sum exceeds the bounds of the adder. CO is ignored in two's-complement operation.

## Design Entry Method

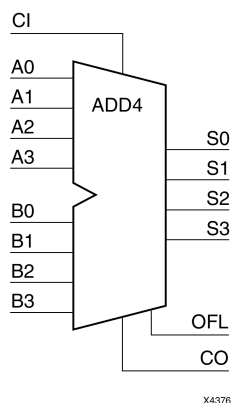
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ADD4

Macro: 4-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow



## Introduction

This design element adds two words and a carry-in (CI), producing a sum output and carry-out (CO) or overflow (OFL). The factors added are A3:A0, B3:B0, and CI producing the sum output S3:S0 and CO (or OFL).

## Logic Table

Input		Output
A	B	S
A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI
CI: Value of input CI.		

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 4-bit unsigned binary numbers or 4-bit two's-complement numbers, respectively. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's-complement uses OFL to determine when "overflow" occurs. To interpret the inputs as unsigned binary, follow the CO output. To interpret the inputs as two's complement, follow the OFL output.

**Unsigned Binary Operation** -For unsigned binary operation, this element represents numbers from 0 to 15, inclusive. OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -8 and +7, inclusive. OFL is active (High) when the sum exceeds the bounds of the adder. CO is ignored in two's-complement operation.

## Design Entry Method

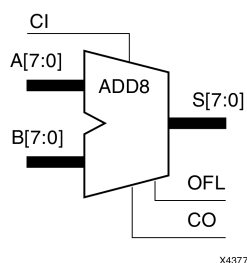
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ADD8

### Macro: 8-Bit Cascadable Full Adder with Carry-In, Carry-Out, and Overflow



## Introduction

This design element adds two words and a carry-in (CI), producing a sum output and carry-out (CO) or overflow (OFL). The factors added are A7:A0, B7:B0, and CI, producing the sum output S7:S0 and CO (or OFL).

## Logic Table

Input		Output
A	B	S
A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI
CI: Value of input CI.		

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 8-bit unsigned binary numbers or 8-bit two's-complement numbers, respectively. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's-complement uses OFL to determine when "overflow" occurs. To interpret the inputs as unsigned binary, follow the CO output. To interpret the inputs as two's complement, follow the OFL output.

**Unsigned Binary Operation** -For unsigned binary operation, this element represents numbers between 0 and 255, inclusive. OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -128 and +127, inclusive. OFL is active (High) when the sum exceeds the bounds of the adder. CO is ignored in two's-complement operation.

## Design Entry Method

This design element is only for use in schematics.

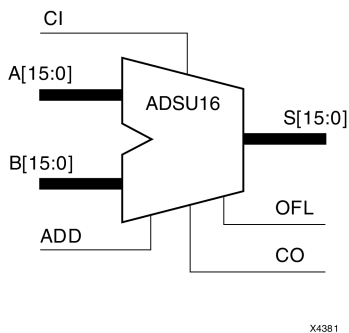
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## ADSU16

### Macro: 16-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow



### Introduction

When the ADD input is High, this element adds two 16-bit words (A15:A0 and B15:B0) and a carry-in (CI), producing a 16-bit sum output (S15:S0) and carry-out (CO) or overflow (OFL).

When the ADD input is Low, this element subtracts B15:B0 from A15:A0, producing a difference output and a carry-out (CO) or an overflow (OFL).

In add mode, CO and CI are active-High. In subtract mode, CO and CI are active-Low. OFL is active-High in add and subtract modes.

### Logic Table

Input			Output
ADD	A	B	S
1	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI*
0	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> -B <sub>n</sub> -CI*
CI*: ADD = 0, CI, CO active LOW			
CI*: ADD = 1, CI, CO active HIGH			

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 16-bit unsigned binary numbers or 16-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's complement uses OFL to determine when "overflow" occurs.

With adder/subtractors, either unsigned binary or two's-complement operations cause an overflow. If the result crosses the overflow boundary, an overflow is generated. Similarly, when the result crosses the carry-out boundary, a carry-out is generated.

**Unsigned Binary Operation** -For unsigned binary operation, this element can represent numbers between 0 and 65535, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds.

An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

unsigned overflow = CO XOR ADD

OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -32768 and +32767, inclusive.

If an addition or subtraction operation result exceeds this range, the OFL output goes High. CO is ignored in two's-complement operation.

## Design Entry Method

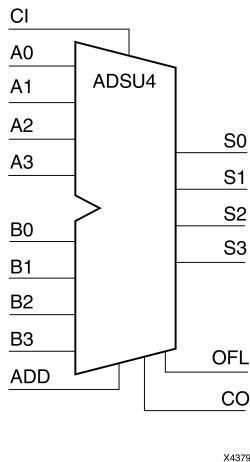
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ADSU4

### Macro: 4-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow



## Introduction

When the ADD input is High, this element adds two 4-bit words (A3:A0 and B3:B0) and a carry-in (CI), producing a 4-bit sum output (S3:S0) and a carry-out (CO) or an overflow (OFL).

When the ADD input is Low, this element subtracts B3:B0 from A3:A0, producing a 4-bit difference output (S3:S0) and a carry-out (CO) or an overflow (OFL).

In add mode, CO and CI are active-High. In subtract mode, CO and CI are active-Low. OFL is active-High in add and subtract modes.

## Logic Table

Input			Output
ADD	A	B	S
1	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI*
0	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> -B <sub>n</sub> -CI*
CI*: ADD = 0, CI, CO active LOW			
CI*: ADD = 1, CI, CO active HIGH			

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 4-bit unsigned binary numbers or 4-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's complement uses OFL to determine when "overflow" occurs.

With adder/subtractors, either unsigned binary or two's-complement operations cause an overflow. If the result crosses the overflow boundary, an overflow is generated. Similarly, when the result crosses the carry-out boundary, a carry-out is generated.

**Unsigned Binary Operation** -For unsigned binary operation, ADSU4 can represent numbers between 0 and 15, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds.

An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

`unsigned overflow = CO XOR ADD`

OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -8 and +7, inclusive.

If an addition or subtraction operation result exceeds this range, the OFL output goes High. CO is ignored in two's-complement operation.

## Design Entry Method

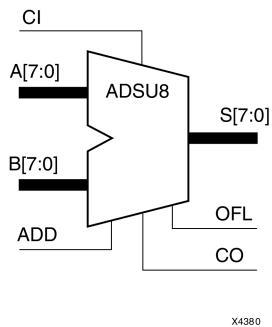
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ADSU8

### Macro: 8-Bit Cascadable Adder/Subtractor with Carry-In, Carry-Out, and Overflow



## Introduction

When the ADD input is High, this element adds two 8-bit words (A7:A0 and B7:B0) and a carry-in (CI), producing an 8-bit sum output (S7:S0) and carry-out (CO) or an overflow (OFL).

When the ADD input is Low, this element subtracts B7:B0 from A7:A0, producing an 8-bit difference output (S7:S0) and a carry-out (CO) or an overflow (OFL).

In add mode, CO and CI are active-High. In subtract mode, CO and CI are active-Low. OFL is active-High in add and subtract modes.

## Logic Table

Input			Output
ADD	A	B	S
1	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> +B <sub>n</sub> +CI*
0	A <sub>n</sub>	B <sub>n</sub>	A <sub>n</sub> -B <sub>n</sub> -CI*
CI*: ADD = 0, CI, CO active LOW			
CI*: ADD = 1, CI, CO active HIGH			

**Unsigned Binary Versus Two's Complement** -This design element can operate on either 8-bit unsigned binary numbers or 8-bit two's-complement numbers. If the inputs are interpreted as unsigned binary, the result can be interpreted as unsigned binary. If the inputs are interpreted as two's complement, the output can be interpreted as two's complement. The only functional difference between an unsigned binary operation and a two's-complement operation is the way they determine when "overflow" occurs. Unsigned binary uses CO, while two's complement uses OFL to determine when "overflow" occurs.

With adder/subtractors, either unsigned binary or two's-complement operations cause an overflow. If the result crosses the overflow boundary, an overflow is generated. Similarly, when the result crosses the carry-out boundary, a carry-out is generated.

**Unsigned Binary Operation** -For unsigned binary operation, this element can represent numbers between 0 and 255, inclusive. In add mode, CO is active (High) when the sum exceeds the bounds of the adder/subtractor. In subtract mode, CO is an active-Low borrow-out and goes Low when the difference exceeds the bounds.

An unsigned binary "overflow" that is always active-High can be generated by gating the ADD signal and CO as follows:

$$\text{unsigned overflow} = \text{CO XOR ADD}$$

OFL is ignored in unsigned binary operation.

**Two's-Complement Operation** -For two's-complement operation, this element can represent numbers between -128 and +127, inclusive.

If an addition or subtraction operation result exceeds this range, the OFL output goes High. CO is ignored in two's-complement operation.

## Design Entry Method

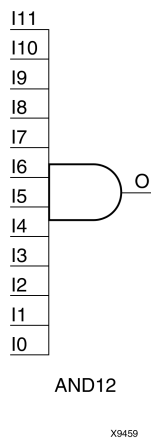
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND12

### Macro: 12- Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

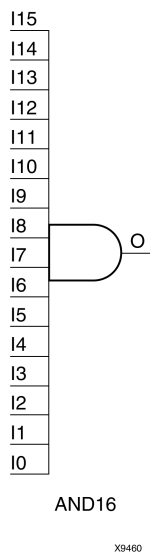
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND16

### Macro: 16- Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

This design element is only for use in schematics.

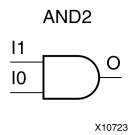
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## AND2

### Primitive: 2-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

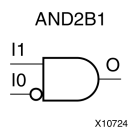
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND2B1

Primitive: 2-Input AND Gate with 1 Inverted and 1 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

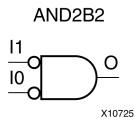
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND2B2

### Primitive: 2-Input AND Gate with Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

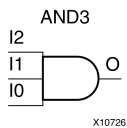
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND3

### Primitive: 3-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

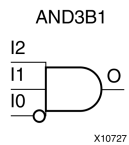
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND3B1

Primitive: 3-Input AND Gate with 1 Inverted and 2 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

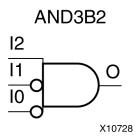
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND3B2

Primitive: 3-Input AND Gate with 2 Inverted and 1 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

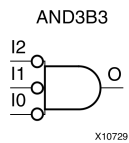
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND3B3

### Primitive: 3-Input AND Gate with Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

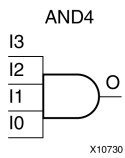
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND4

### Primitive: 4-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

This design element is only for use in schematics.

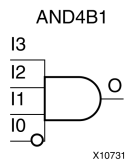
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## AND4B1

Primitive: 4-Input AND Gate with 1 Inverted and 3 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

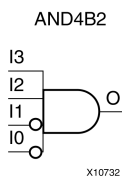
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND4B2

Primitive: 4-Input AND Gate with 2 Inverted and 2 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

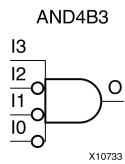
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND4B3

Primitive: 4-Input AND Gate with 3 Inverted and 1 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

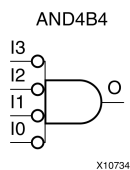
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND4B4

### Primitive: 4-Input AND Gate with Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

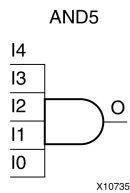
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND5

### Primitive: 5-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

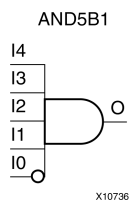
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND5B1

Primitive: 5-Input AND Gate with 1 Inverted and 4 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

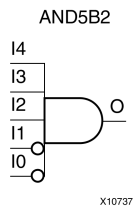
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND5B2

Primitive: 5-Input AND Gate with 2 Inverted and 3 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

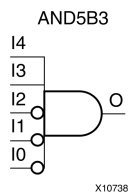
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND5B3

Primitive: 5-Input AND Gate with 3 Inverted and 2 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

This design element is only for use in schematics.

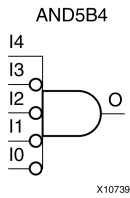
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## AND5B4

Primitive: 5-Input AND Gate with 4 Inverted and 1 Non-Inverted Inputs



### Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

### Design Entry Method

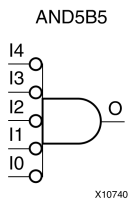
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND5B5

### Primitive: 5-Input AND Gate with Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

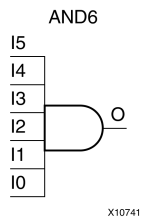
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND6

### Macro: 6-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

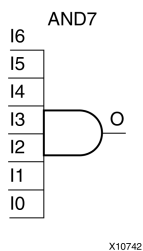
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND7

### Macro: 7-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

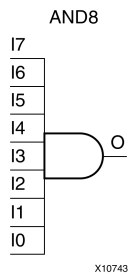
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND8

### Macro: 8-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

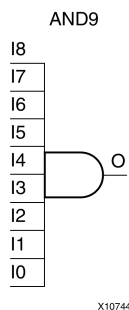
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## AND9

### Macro: 9-Input AND Gate with Non-Inverted Inputs



## Introduction

AND functions of up to five inputs are available in any combination of inverting and non-inverting inputs. AND functions of six to nine inputs, 12 inputs, and 16 inputs are available with noninverting inputs. To make some or all inputs inverting, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the appropriate number of inputs.

## Design Entry Method

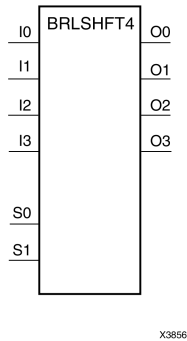
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BRLSHFT4

### Macro: 4-Bit Barrel Shifter



## Introduction

This design element is a 4-bit barrel shifter that can rotate four inputs (I3 : I0) up to four places. The control inputs (S1 and S0) determine the number of positions, from one to four, that the data is rotated. The four outputs (O3 : O0) reflect the shifted data inputs.

## Logic Table

Inputs						Outputs			
S1	S0	I0	I1	I2	I3	O0	O1	O2	O3
0	0	a	b	c	d	a	b	c	d
0	1	a	b	c	d	b	c	d	a
1	0	a	b	c	d	c	d	a	b
1	1	a	b	c	d	d	a	b	c

## Design Entry Method

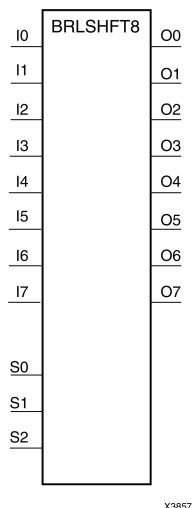
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BRLSHFT8

### Macro: 8-Bit Barrel Shifter



## Introduction

This design element is an 8-bit barrel shifter, can rotate the eight inputs (I7 : I0) up to eight places. The control inputs (S2 : S0) determine the number of positions, from one to eight, that the data is rotated. The eight outputs (O7 : O0) reflect the shifted data inputs.

## Logic Table

Inputs											Outputs							
S2	S1	S0	I0	I1	I2	I3	I4	I5	I6	I7	O0	O1	O2	O3	O4	O5	O6	O7
0	0	0	a	b	c	d	e	f	g	h	a	b	c	d	e	f	g	h
0	0	1	a	b	c	d	e	f	g	h	b	c	d	e	f	g	h	a
0	1	0	a	b	c	d	e	f	g	h	c	d	e	f	g	h	a	b
0	1	1	a	b	c	d	e	f	g	h	d	e	f	g	h	a	b	c
1	0	0	a	b	c	d	e	f	g	h	e	f	g	h	a	b	c	d
1	0	1	a	b	c	d	e	f	g	h	f	g	h	a	b	c	d	e
1	1	0	a	b	c	d	e	f	g	h	g	h	a	b	c	d	e	f
1	1	1	a	b	c	d	e	f	g	h	h	a	b	c	d	e	f	g

## Design Entry Method

This design element is only for use in schematics.

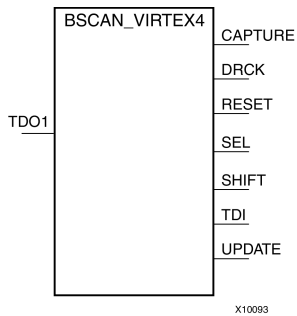
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## BSCAN\_VIRTEX4

### Primitive: Virtex®-4 JTAG Boundary-Scan Logic Access Circuit



## Introduction

This design element allows access to and from internal logic by the JTAG Boundary Scan logic controller. This allows for communication between the internal running design and the dedicated JTAG pins of the FPGA.

Each instance of this design element will handle one JTAG USER instruction (USER1 through USER4) as set with the JTAG\_CHAIN attribute. To handle all four USER instructions, instantiate four of these elements and set the JTAG\_CHAIN attribute appropriately.

**Note** For specific information on boundary scan for an architecture, see the Programmable Logic Data Sheet for this element.

## Port Descriptions

Port	Type	Width	Function
CAPTURE	Output	1	Active upon the loading of the USER instruction. Asserts High when the JTAG TAP controller is in the CAPTURE-DR state.
DRCK	Output	1	A mirror of the TCK input pin to the FPGA when the JTAG USER instruction assigned by JTAG_CHAIN is loaded and the JTAG TAP controller is in the SHIFT-DR state or in the CAPTURE-DR state.
RESET	Output	1	Active upon the loading of the USER instruction. It asserts High when the JTAG TAP controller is in the TEST-LOGIC-RESET state.
SEL	Output	1	Indicates when the USER instruction has been loaded into the JTAG Instruction Register. Becomes active in the UPDATE-IR state, and stays active until a new instruction is loaded.
SHIFT	Output	1	Active upon the loading of the USER instruction. It asserts High when the JTAG TAP controller is in the SHIFT-DR state.
TDI	Output	1	A mirror of the TDI pin.
UPDATE	Output	1	Active upon the loading of the USER instruction. It asserts High when the JTAG TAP controller is in the UPDATE-DR state.
TDO	Input	1	Active upon the loading of the USER instruction. External JTAG TDO pin will reflect data input to the macro's TDO1 pin.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

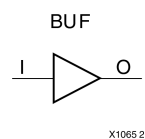
Attribute	Type	Allowed Values	Default	Description
JTAG_CHAIN	Integer	1, 2, 3, 4	1	Sets the JTAG USER instruction number that this instance of the element will handle.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUF

Primitive: General Purpose Buffer



### Introduction

This is a general-purpose, non-inverting buffer.

This element is not necessary and is removed by the partitioning software (MAP).

### Design Entry Method

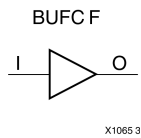
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFCF

### Primitive: Fast Connect Buffer



## Introduction

This design element is a single fast connect buffer used to connect the outputs of the LUTs and some dedicated logic directly to the input of another LUT. Using this buffer implies CLB packing. No more than four LUTs may be connected together as a group.

## Design Entry Method

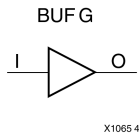
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFG

Primitive: Global Clock Buffer



### Introduction

This design element is a high-fanout buffer that connects signals to the global routing resources for low skew distribution of the signal. BUFs are typically used on clock nets as well other high fanout nets like sets/resets and clock enables.

### Port Descriptions

Port	Type	Width	Function
I	Input	1	Clock buffer input
O	Output	1	Clock buffer output

### Design Entry Method

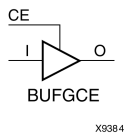
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGCE

### Primitive: Global Clock Buffer with Clock Enable



## Introduction

This design element is a global clock buffer with a single gated input. Its O output is "0" when clock enable (CE) is Low (inactive). When clock enable (CE) is High, the I input is transferred to the O output.

## Logic Table

Inputs		Outputs
I	CE	O
X	0	0
I	1	I

## Port Descriptions

Port	Type	Width	Function
I	Input	1	Clock buffer input
CE	Input	1	Clock enable input
O	Output	1	Clock buffer output

## Design Entry Method

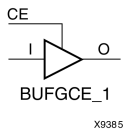
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGCE\_1

Primitive: Global Clock Buffer with Clock Enable and Output State 1



### Introduction

This design element is a multiplexed global clock buffer with a single gated input. Its O output is High (1) when clock enable (CE) is Low (inactive). When clock enable (CE) is High, the I input is transferred to the O output.

### Logic Table

Inputs		Outputs
I	CE	O
X	0	1
I	1	I

### Port Descriptions

Port	Type	Width	Function
I	Input	1	Clock buffer input
CE	Input	1	Clock enable input
O	Output	1	Clock buffer output

### Design Entry Method

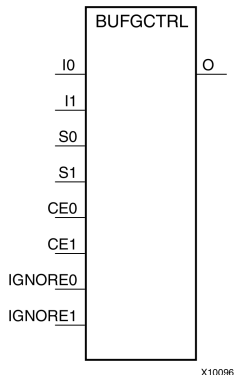
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGCTRL

### Primitive: Global Clock MUX Buffer



## Introduction

BUFGCTRL primitive is global clock buffer that is designed as a synchronous/asynchronous "glitch free" 2:1 multiplexer with two clock inputs. Unlike global clock buffers that are found in previous generation of FPGAs, these clock buffers are designed with more control pins to provide a wider range of functionality and more robust input switching. BUFGCTRL is not limited to clocking applications.

## Port Descriptions

Port	Type	Width	Function
O	Output	1	Clock Output pin
I0, I1	Input	1 (each)	Clock Input: I0 - Clock Input Pin I1 - Clock Input Pin
CE0, CE1	Input	1 (each)	Clock Enable Input. The CE pins represent the clock enable pin for each clock inputs and are used to select the clock inputs. A setup/hold time must be specified when you are using the CE pin to select inputs. Failure to meet this requirement could result in a clock glitch.
S0, S1	Input	1 (each)	Clock Select Input. The S pins represent the clock select pin for each clock inputs. When using the S pin as input select, there is a setup/hold time requirement. Unlike CE pins, failure to meet this requirement won't result in a clock glitch. However, it can cause the output clock to appear one clock cycle later.
IGNORE0, IGNORE1	Input	1 (each)	Clock Ignore Input. IGNORE pins are used whenever a designer wants to bypass the switching algorithm executed by the BUFGCTRL.

## Design Entry Method

This design element can be used in schematics.



## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT_OUT	Integer	0, 1	0	Initializes the BUFGCTRL output to the specified value after configuration.
PRESELECT_I0	Boolean	FALSE, TRUE	FALSE	If TRUE, BUFGCTRL output uses I0 input after configuration.
PRESELECT_I1	Boolean	FALSE, TRUE	FALSE	If TRUE, BUFGCTRL output uses I1 input after configuration.

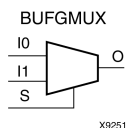
**Note** Both PRESELECT attributes might not be TRUE at the same time.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGMUX

### Primitive: Global Clock MUX Buffer



## Introduction

BUFGMUX is a multiplexed global clock buffer that can select between two input clocks: I0 and I1. When the select input (S) is Low, the signal on I0 is selected for output (O). When the select input (S) is High, the signal on I1 is selected for output.

BUFGMUX and BUFGMUX\_1 are distinguished by the state the output assumes when that output switches between clocks in response to a change in its select input. BUFGMUX assumes output state 0 and BUFGMUX\_1 assumes output state 1.

**Note** BUFGMUX guarantees that when S is toggled, the state of the output remains in the inactive state until the next active clock edge (either I0 or I1) occurs.

## Logic Table

Inputs			Outputs
I0	I1	S	O
I0	X	0	I0
X	I1	1	I1
X	X	↑	0
X	X	↓	0

## Port Descriptions

Port	Type	Width	Function
I0	Input	1	Clock0 input
I1	Input	1	Clock1 input
O	Output	1	Clock MUX output
S	Input	1	Clock select input

## Design Entry Method

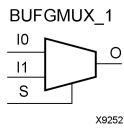
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGMUX\_1

### Primitive: Global Clock MUX Buffer with Output State 1



## Introduction

This design element is a multiplexed global clock buffer that can select between two input clocks: I0 and I1. When the select input (S) is Low, the signal on I0 is selected for output (O). When the select input (S) is High, the signal on I1 is selected for output.

This design element is distinguished from BUFGMUX by the state the output assumes when that output switches between clocks in response to a change in its select input. BUFGMUX assumes output state 0 and BUFGMUX\_1 assumes output state 1.

## Logic Table

Inputs			Outputs
I0	I1	S	O
I0	X	0	I0
X	I1	1	I1
X	X	↑	1
X	X	↓	1

## Port Descriptions

Port	Type	Width	Function
I0	Input	1	Clock0 input
I1	Input	1	Clock1 input
O	Output	1	Clock MUX output
S	Input	1	Clock select input

## Design Entry Method

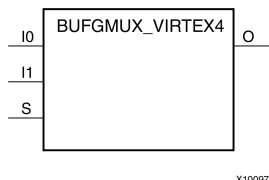
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFGMUX\_VIRTEX4

### Primitive: Global Clock MUX Buffer



## Introduction

This design element is a global clock buffer with two clock inputs, one clock output, and a select line. This primitive is based on BUFGCTRL, with some pins connected to logic High or Low.

This element uses the S pins as select pins. S can switch anytime without causing a glitch. The Setup/Hold time on S is for determining whether the output will pass an extra pulse of the previously selected clock before switching to the new clock. If S changes prior to the setup time TBCCCK\_S, and before I/O transitions from High to Low, then the output will not pass an extra pulse of I/O. If S changes following the hold time for S, then the output will pass an extra pulse, but it will not glitch. In any case the output will change to the new clock within three clock cycles of the slower clock.

The Setup/Hold requirements for S0 and S1 are with respect to the falling clock edge (assuming INIT\_OUT = 0), not the rising edge, as for CE0 and CE1.

Switching conditions for this element are the same as the S pin of BUFGCTRL.

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Clock Output
I1 : I0	Input	1	Clock Input
S0 : S1	Input	1	Clock Select Input

## Design Entry Method

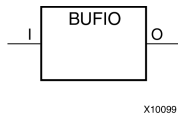
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFIO

Primitive: Local Clock Buffer for I/O



### Introduction

This design element is a clock buffer. It is simply a clock-in, clock-out buffer. It drives a dedicated clock net within the I/O column, independent of the global clock resources. Thus, these elements are ideally suited for source-synchronous data capture (forwarded/receiver clock distribution). They can only be driven by clock capable I/Os located in the same clock region. They drive the two adjacent I/O clock nets (for a total of up to three clock regions), as well as the regional clock buffers (BUFR). These elements cannot drive logic resources (CLB, block RAM, etc.) because the I/O clock network only reaches the I/O column.

### Port Descriptions

Port	Type	Width	Function
O	Output	1	Clock output
I	Input	1	Clock input

### Design Entry Method

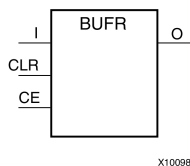
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## BUFR

### Primitive: Regional Clock Buffer for I/O and Logic Resources



## Introduction

The BUFR is a clock buffer. BUFRs drive clock signals to a dedicated clock net within a clock region, independent from the global clock tree. Each BUFR can drive the two regional clock nets in the region in which it is located, and the two clock nets in the adjacent clock regions (up to three clock regions). Unlike BUFIOs, BUFRs can drive the I/O logic and logic resources (CLB, block RAM, etc.) in the existing and adjacent clock regions. BUFRs can be driven by either the output from BUFIOs or local interconnect. In addition, BUFRs are capable of generating divided clock outputs with respect to the clock input. The divide value is an integer between one and eight. BUFRs are ideal for source-synchronous applications requiring clock domain crossing or serial-to-parallel conversion. There are two BUFRs in a typical clock region (two regional clock networks). The center column does not have BUFRs.

## Port Descriptions

Port	Type	Width	Function
CE	Input	1	Clock enable port. When asserted Low, this port disables the output clock at port O. When asserted High, this port resets the counter used to produce the divided clock output.
CLR	Input	1	Counter reset for divided clock output. When asserted High, this port resets the counter used to produce the divided clock output.
I	Input	1	Clock input port. This port is the clock source port for BUFR. It can be driven by BUFIO output or local interconnect.
O	Output	1	Clock output port. This port drives the clock tracks in the clock region of the BUFR and the two adjacent clock regions. This port drives FPGA fabric, and IOBs.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

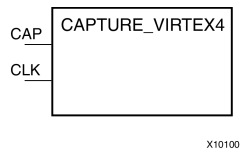
Attribute	Type	Allowed Values	Default	Description
BUFR_DIVIDE	String	"BYPASS", "1", "2", "3", "4", "5", "6", "7", "8"	"BYPASS"	Defines whether the output clock is a divided version of input clock.
SIM_DEVICE	String	VIRTEX4, VIRTEX5, VIRTEX6	VIRTEX4	Determine the CE latency for BUFR.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CAPTURE\_VIRTEX4

Primitive: Virtex®-4 Boundary Scan Logic Control Circuit



### Introduction

This element provides user control and synchronization over when and how the capture register (flip-flop and latch) information task is requested. The readback function is provided through dedicated configuration port instructions. However, without this element, the readback data is synchronized to the configuration clock. Only register (flip-flop and latch) states can be captured. Although LUT RAM, SRL, and block RAM states are readback, they cannot be captured.

An asserted high CAP signal indicates that the registers in the device are to be captured at the next Low-to-High clock transition. By default, data is captured after every trigger when transition on CLK while CAP is asserted. To limit the readback operation to a single data capture, add the ONESHOT=TRUE attribute to this element.

### Port Descriptions

Port	Direction	Width	Function
CAP	Input	1	Readback capture trigger
CLK	Input	1	Readback capture clock

### Design Entry Method

This design element can be used in schematics.

Connect all inputs and outputs to the design in order to ensure proper operation.

### Available Attributes

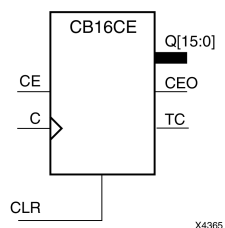
Attribute	Type	Allowed Values	Default	Description
ONESHOT	Boolean	TRUE, FALSE	TRUE	Specifies the procedure for performing single readback per CAP trigger.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB16CE

### Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
$z = \text{bit width} - 1$ $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

This design element is only for use in schematics.

## For More Information

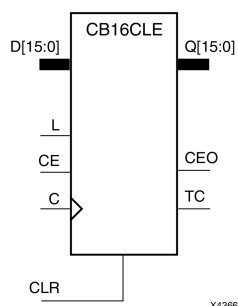
- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).





## CB16CLE

**Macro: 16-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear**



## Introduction

This element is a synchronously loadable, asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	Dn	Dn	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$							

## Design Entry Method

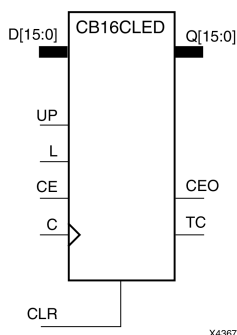
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB16CLED

**Macro: 16-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

For CPLD parts, see “CB2X1”, “CB4X1”, “CB8X1”, “CB16X1” for high-performance cascadable, bidirectional counters.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot UP) + (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot \overline{UP})$ $CEO = TC \cdot CE$								

## Design Entry Method

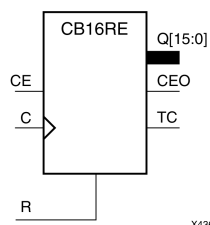
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB16RE

### Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous, resettable, cascadable binary counter. The synchronous reset (R), when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to zero on the Low-to-High clock transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when both Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

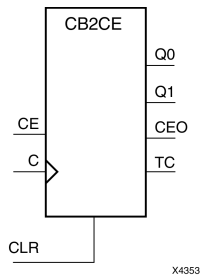
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB2CE

Macro: 2-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



### Introduction

This design element is an asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

### Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

### Design Entry Method

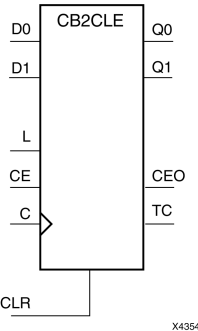
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# CB2CLE

## Macro: 2-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear



## Introduction

This element is a synchronously loadable, asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	Dn	Dn	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$							

## Design Entry Method

This design element is only for use in schematics.

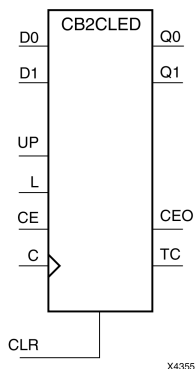


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB2CLED

**Macro: 2-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

For CPLD parts, see "CB2X1", "CB4X1", "CB8X1", "CB16X1" for high-performance cascadable, bidirectional counters.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot UP) + (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot \overline{UP})$ $CEO = TC \cdot CE$								

## Design Entry Method

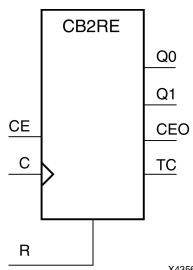
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB2RE

### Macro: 2-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous, resettable, cascadable binary counter. The synchronous reset (R), when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to zero on the Low-to-High clock (C) transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when both Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
$z = \text{bit width} - 1$ $TC = Q_z \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

## Design Entry Method

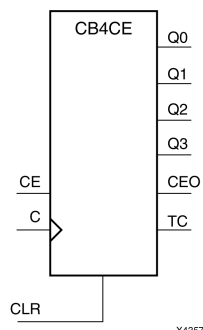
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB4CE

### Macro: 4-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q_{(z-1)} \cdot Q_{(z-2)} \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

## Design Entry Method

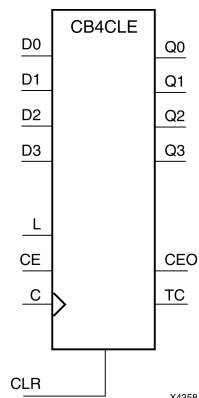
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB4CLE

### Macro: 4-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear



## Introduction

This element is a synchronously loadable, asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	D <sub>n</sub>	D <sub>n</sub>	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q_{(z-1)} \cdot Q_{(z-2)} \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$							

## Design Entry Method

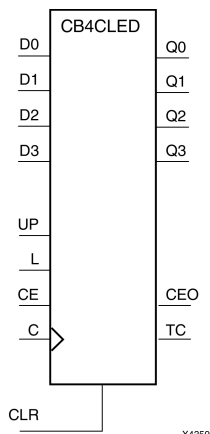
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB4CLED

**Macro: 4-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

For CPLD parts, see “CB2X1”, “CB4X1”, “CB8X1”, “CB16X1” for high-performance cascadable, bidirectional counters.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.



## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot UP) + (Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0 \cdot \overline{UP})$ $CEO = TC \cdot CE$								

## Design Entry Method

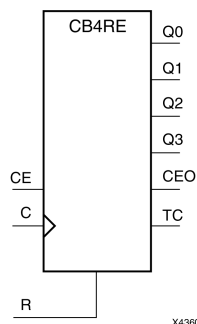
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB4RE

### Macro: 4-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous, resettable, cascadable binary counter. The synchronous reset (R), when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to zero on the Low-to-High clock transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when both Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

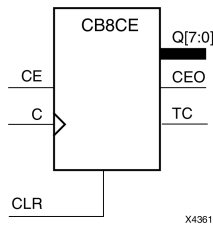
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB8CE

### Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

This design element is only for use in schematics.

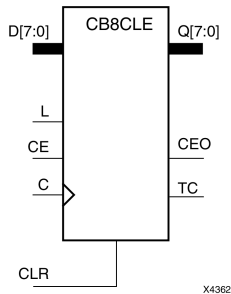
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## CB8CLE

### Macro: 8-Bit Loadable Cascadable Binary Counters with Clock Enable and Asynchronous Clear



## Introduction

This element is a synchronously loadable, asynchronously clearable, cascadable binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	Dn	Dn	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$							

## Design Entry Method

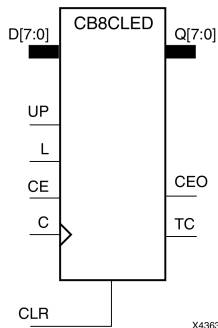
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CB8CLED

**Macro: 8-Bit Loadable Cascadable Bidirectional Binary Counters with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

For CPLD parts, see “CB2X1”, “CB4X1”, “CB8X1”, “CB16X1” for high-performance cascadable, bidirectional counters.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet UP) + (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet \overline{UP})$ $CEO = TC \bullet CE$								

## Design Entry Method

This design element is only for use in schematics.

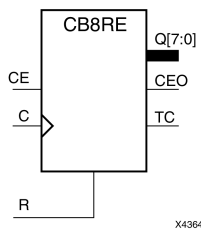
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## CB8RE

### Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous, resettable, cascadable binary counter. The synchronous reset (R), when High, overrides all other inputs and forces the Q outputs, terminal count (TC), and clock enable out (CEO) to zero on the Low-to-High clock transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when both Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
$z = \text{bit width} - 1$ $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

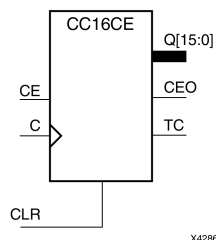
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC16CE

### Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an asynchronously clearable, cascadable binary counter. It is implemented using carry logic with relative location constraints to ensure efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q_{(z-1)} \cdot Q_{(z-2)} \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

## Design Entry Method

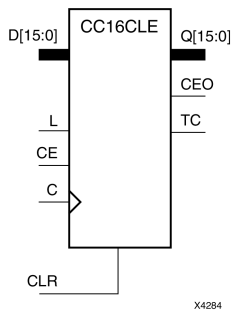
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC16CLE

**Macro: 16-Bit Loadable Cascadable Binary Counter with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable binary counter. It is implemented using carry logic with relative location constraints to ensure efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

### Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	Dn	Dn	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$							

### Design Entry Method

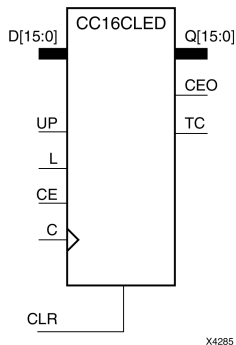
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC16CLED

**Macro: 16-Bit Loadable Cascadable Bidirectional Binary Counter with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. It is implemented using carry logic with relative location constraints, which assures most efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet UP) + (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet \overline{UP})$ $CEO = TC \bullet CE$								

## Design Entry Method

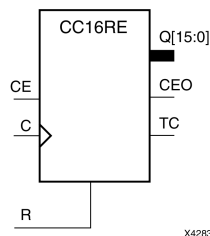
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC16RE

### Macro: 16-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous resettable, cascadable binary counter. These counters are implemented using carry logic with relative location constraints to ensure efficient logic placement. The synchronous reset (R) is the highest priority input. When R is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero on the Low-to-High clock (C) transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs and CE are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n (t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q_{(z-1)} \cdot Q_{(z-2)} \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

## Design Entry Method

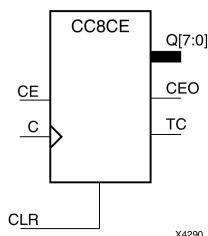
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC8CE

### Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an asynchronously clearable, cascadable binary counter. It is implemented using carry logic with relative location constraints to ensure efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs		
CLR	CE	C	Qz-Q0	TC	CEO
1	X	X	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
$z = \text{bit width} - 1$ $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$					

## Design Entry Method

This design element is only for use in schematics.

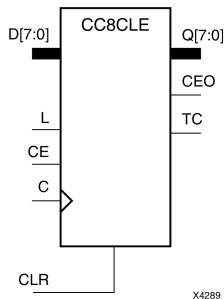
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## CC8CLE

**Macro: 8-Bit Loadable Cascadable Binary Counter with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable binary counter. It is implemented using carry logic with relative location constraints to ensure efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs increment when CE is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

### Logic Table

Inputs					Outputs		
CLR	L	CE	C	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	0	0	0
0	1	X	↑	Dn	Dn	TC	CEO
0	0	0	X	X	No change	No change	0
0	0	1	↑	X	Inc	TC	CEO
z = bit width - 1 $TC = Qz \cdot Q(z-1) \cdot Q(z-2) \cdot \dots \cdot Q0$ $CEO = TC \cdot CE$							

### Design Entry Method

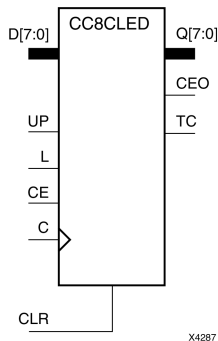
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC8CLED

**Macro: 8-Bit Loadable Cascadable Bidirectional Binary Counter with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a synchronously loadable, asynchronously clearable, cascadable, bidirectional binary counter. It is implemented using carry logic with relative location constraints, which assures most efficient logic placement. The asynchronous clear (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition, independent of the state of clock enable (CE). The Q outputs decrement when CE is High and UP is Low during the Low-to-High clock transition. The Q outputs increment when CE and UP are High. The counter ignores clock transitions when CE is Low.

For counting up, the TC output is High when all Q outputs and UP are High. For counting down, the TC output is High when all Q outputs and UP are Low.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, UP, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_*architecture* symbol.

## Logic Table

Inputs						Outputs		
CLR	L	CE	C	UP	Dz-D0	Qz-Q0	TC	CEO
1	X	X	X	X	X	0	0	0
0	1	X	↑	X	Dn	Dn	TC	CEO
0	0	0	X	X	X	No change	No change	0
0	0	1	↑	1	X	Inc	TC	CEO
0	0	1	↑	0	X	Dec	TC	CEO
z = bit width - 1 $TC = (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet UP) + (Qz \bullet Q(z-1) \bullet Q(z-2) \bullet \dots \bullet Q0 \bullet \overline{UP})$ $CEO = TC \bullet CE$								

## Design Entry Method

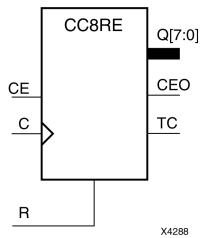
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CC8RE

### Macro: 8-Bit Cascadable Binary Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a synchronous resettable, cascadable binary counter. These counters are implemented using carry logic with relative location constraints to ensure efficient logic placement. The synchronous reset (R) is the highest priority input. When R is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero on the Low-to-High clock (C) transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when all Q outputs and CE are High.

Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n (t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs		
R	CE	C	Qz-Q0	TC	CEO
1	X	↑	0	0	0
0	0	X	No change	No change	0
0	1	↑	Inc	TC	CEO
z = bit width - 1 $TC = Q_z \cdot Q_{(z-1)} \cdot Q_{(z-2)} \cdot \dots \cdot Q_0$ $CEO = TC \cdot CE$					

## Design Entry Method

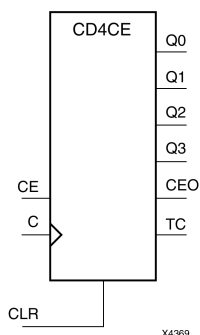
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CD4CE

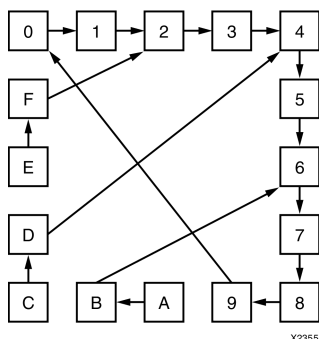
### Macro: 4-Bit Cascadable BCD Counter with Clock Enable and Asynchronous Clear



## Introduction

CD4CE is a 4-bit (stage), asynchronous clearable, cascadable binary-coded-decimal (BCD) counter. The asynchronous clear input (CLR) is the highest priority input. When CLR is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The Q outputs increment when clock enable (CE) is High during the Low-to-High clock (C) transition. The counter ignores clock transitions when CE is Low. The TC output is High when Q3 and Q0 are High and Q2 and Q1 are Low.

The counter recovers from any of six possible illegal states and returns to a normal count sequence within two clock cycles for Xilinx® devices, as shown in the following state diagram:



Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs					
CLR	CE	C	Q3	Q2	Q1	Q0	TC	CEO
1	X	X	0	0	0	0	0	0
0	1	↑	Inc	Inc	Inc	Inc	TC	CEO
0	0	X	No Change	No Change	No Change	No Change	TC	0
0	1	X	1	0	0	1	1	1
TC = $Q3 \cdot \neg Q2 \cdot \neg Q1 \cdot Q0$								
CEO = $TC \cdot CE$								

## Design Entry Method

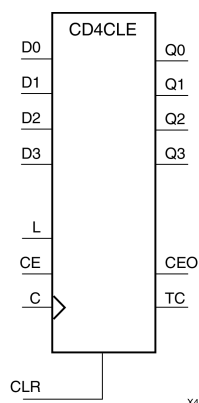
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CD4CLE

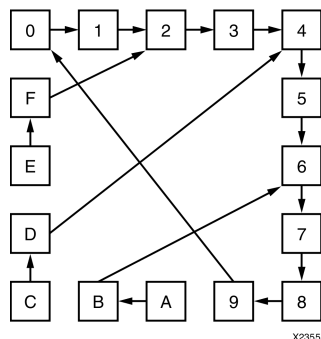
**Macro: 4-Bit Loadable Cascadable BCD Counter with Clock Enable and Asynchronous Clear**



## Introduction

CD4CLE is a 4-bit (stage), synchronously loadable, asynchronously clearable, binary-coded-decimal (BCD) counter. The asynchronous clear input (CLR) is the highest priority input. When (CLR) is High, all other inputs are ignored; the (Q) outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero, independent of clock transitions. The data on the (D) inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition. The (Q) outputs increment when clock enable input (CE) is High during the Low-to-High clock transition. The counter ignores clock transitions when (CE) is Low. The (TC) output is High when Q3 and Q0 are High and Q2 and Q1 are Low.

The counter recovers from any of six possible illegal states and returns to a normal count sequence within two clock cycles for Xilinx® devices, as shown in the following state diagram:



Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and CLR inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.



## Logic Table

Inputs					Outputs					
CLR	L	CE	D3 : D0	C	Q3	Q2	Q1	Q0	TC	CEO
1	X	X	X	X	0	0	0	0	0	0
0	1	X	D3 : D0	↑	D3	D2	D1	D0	TC	CEO
0	0	1	X	↑	Inc	Inc	Inc	Inc	TC	CEO
0	0	0	X	X	No Change	No Change	No Change	No Change	TC	0
0	0	1	X	X	1	0	0	1	1	1
$TC = Q3 \cdot !Q2 \cdot !Q1 \cdot Q0$ $CEO = TC \cdot CE$										

## Design Entry Method

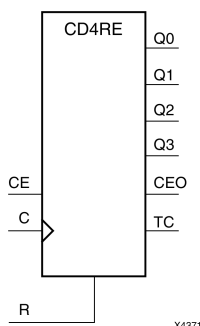
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CD4RE

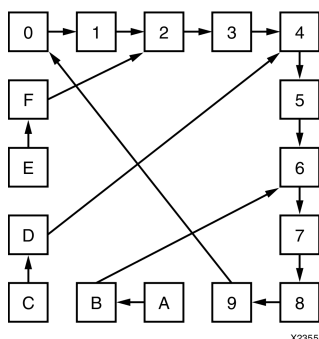
### Macro: 4-Bit Cascadable BCD Counter with Clock Enable and Synchronous Reset



## Introduction

CD4RE is a 4-bit (stage), synchronous resettable, cascadable binary-coded-decimal (BCD) counter. The synchronous reset input (R) is the highest priority input. When (R) is High, all other inputs are ignored; the (Q) outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero on the Low-to-High clock (C) transition. The (Q) outputs increment when the clock enable input (CE) is High during the Low-to-High clock transition. The counter ignores clock transitions when (CE) is Low. The (TC) output is High when Q3 and Q0 are High and Q2 and Q1 are Low.

The counter recovers from any of six possible illegal states and returns to a normal count sequence within two clock cycles for Xilinx® devices, as shown in the following state diagram:



Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs					
R	CE	C	Q3	Q2	Q1	Q0	TC	CEO
1	X	↑	0	0	0	0	0	0
0	1	↑	Inc	Inc	Inc	Inc	TC	CEO
0	0	X	No Change	No Change	No Change	No Change	TC	0
0	1	X	1	0	0	1	1	1
TC = $Q3 \bullet !Q2 \bullet !Q1 \bullet Q0$								
CEO = $TC \bullet CE$								

## Design Entry Method

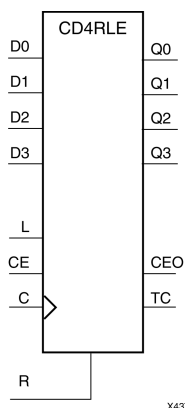
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CD4RLE

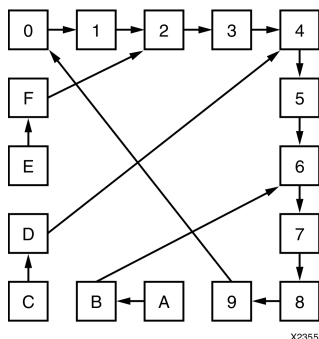
### Macro: 4-Bit Loadable Cascadable BCD Counter with Clock Enable and Synchronous Reset



## Introduction

CD4RLE is a 4-bit (stage), synchronous loadable, resettable, binary-coded-decimal (BCD) counter. The synchronous reset input (R) is the highest priority input. When R is High, all other inputs are ignored; the Q outputs, terminal count (TC), and clock enable out (CEO) go to logic level zero on the Low-to-High clock transitions. The data on the D inputs is loaded into the counter when the load enable input (L) is High during the Low-to-High clock (C) transition. The Q outputs increment when the clock enable input (CE) is High during the Low-to-High clock transition. The counter ignores clock transitions when CE is Low. The TC output is High when Q3 and Q0 are High and Q2 and Q1 are Low.

The counter recovers from any of six possible illegal states and returns to a normal count sequence within two clock cycles for Xilinx® devices, as shown in the following state diagram:



Create larger counters by connecting the CEO output of each stage to the CE input of the next stage and connecting the C, L, and R inputs in parallel. CEO is active (High) when TC and CE are High. The maximum length of the counter is determined by the accumulated CE-to-TC propagation delays versus the clock period. The clock period must be greater than  $n(t_{CE-TC})$ , where  $n$  is the number of stages and the time  $t_{CE-TC}$  is the CE-to-TC propagation delay of each stage. When cascading counters, use the CEO output if the counter uses the CE input or use the TC output if it does not.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs					Outputs					
R	L	CE	D3 : D0	C	Q3	Q2	Q1	Q0	TC	CEO
1	X	X	X	↑	0	0	0	0	0	0
0	1	X	D3 : D0	↑	D3	D	D	D0	TC	CEO
0	0	1	X	↑	Inc	Inc	Inc	Inc	TC	CEO
0	0	0	X	X	No Change	No Change	No Change	No Change	TC	0
0	0	1	X	X	1	0	0	1	1	1
TC = Q3•!Q2•!Q1•Q0										
CEO = TC•CE										

## Design Entry Method

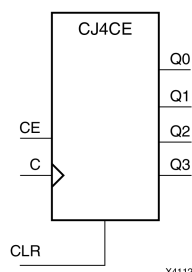
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CJ4CE

### 4-Bit Johnson Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is a clearable Johnson/shift counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero, independent of clock (C) transitions. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when (CE) is Low.

The Q3 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs	
CLR	CE	C	Q0	Q1 through Q3
1	X	X	0	0
0	0	X	No change	No change
0	1	↑	!q3	q0 through q2

q = state of referenced output one setup time prior to active clock transition

## Design Entry Method

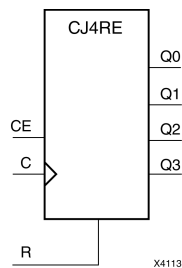
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CJ4RE

### Macro: 4-Bit Johnson Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a resettable Johnson/shift counter. The synchronous reset (R) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero during the Low-to-High clock (C) transition. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when CE is Low.

The Q3 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs	
R	CE	C	Q0	Q1 through Q3
1	X	↑	0	0
0	0	X	No change	No change
0	1	↑	!q3	q0 through q2
q = state of referenced output one setup time prior to active clock transition				

## Design Entry Method

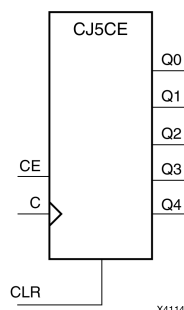
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CJ5CE

### Macro: 5-Bit Johnson Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is a clearable Johnson/shift counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero, independent of clock (C) transitions. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when (CE) is Low.

The Q4 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs	
CLR	CE	C	Q0	Q1 through Q4
1	X	X	0	0
0	0	X	No change	No change
0	1	↑	!q4	q0 through q3
q = state of referenced output one setup time prior to active clock transition				

## Design Entry Method

This design element is only for use in schematics.

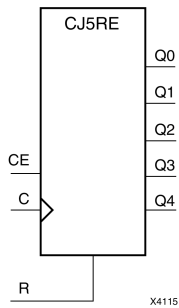
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## CJ5RE

### Macro: 5-Bit Johnson Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a resettable Johnson/shift counter. The synchronous reset (R) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero during the Low-to-High clock (C) transition. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when CE is Low.

The Q4 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs	
R	CE	C	Q0	Q1 through Q4
1	X	↑	0	0
0	0	X	No change	No change
0	1	↑	!q4	q0 through q3
q = state of referenced output one setup time prior to active clock transition				

## Design Entry Method

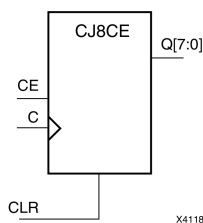
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CJ8CE

### Macro: 8-Bit Johnson Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is a clearable Johnson/shift counter. The asynchronous clear (CLR) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero, independent of clock (C) transitions. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when (CE) is Low.

The Q7 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs	
CLR	CE	C	Q0	Q1 through Q8
1	X	X	0	0
0	0	X	No change	No change
0	1	↑	!q7	q0 through q7
q = state of referenced output one setup time prior to active clock transition				

## Design Entry Method

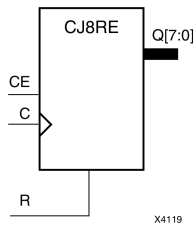
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CJ8RE

### Macro: 8-Bit Johnson Counter with Clock Enable and Synchronous Reset



## Introduction

This design element is a resettable Johnson/shift counter. The synchronous reset (R) input, when High, overrides all other inputs and forces the data (Q) outputs to logic level zero during the Low-to-High clock (C) transition. The counter increments (shifts Q0 to Q1, Q1 to Q2, and so forth) when the clock enable input (CE) is High during the Low-to-High clock transition. Clock transitions are ignored when CE is Low.

The Q7 output is inverted and fed back to input Q0 to provide continuous counting operation.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs	
R	CE	C	Q0	Q1 through Q7
1	X	↑	0	0
0	0	X	No change	No change
0	1	↑	!q7	q0 through q6
q = state of referenced output one setup time prior to active clock transition				

## Design Entry Method

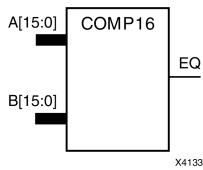
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMP16

### Macro: 16-Bit Identity Comparator



## Introduction

This design element is a 16-bit identity comparator. The equal output (EQ) is high when A15 : A0 and B15 : B0 are equal.

Equality is determined by a bit comparison of the two words. When any two of the corresponding bits from each word are not the same, the EQ output is Low.

## Design Entry Method

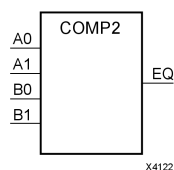
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMP2

### Macro: 2-Bit Identity Comparator



## Introduction

This design element is a 2-bit identity comparator. The equal output (EQ) is High when the two words A1 : A0 and B1 : B0 are equal.

Equality is determined by a bit comparison of the two words. When any two of the corresponding bits from each word are not the same, the EQ output is Low.

## Design Entry Method

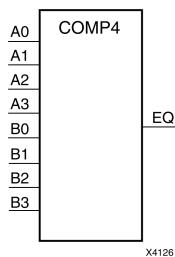
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMP4

### Macro: 4-Bit Identity Comparator



## Introduction

This design element is a 4-bit identity comparator. The equal output (EQ) is high when A3 : A0 and B3 : B0 are equal.

Equality is determined by a bit comparison of the two words. When any two of the corresponding bits from each word are not the same, the EQ output is Low.

## Design Entry Method

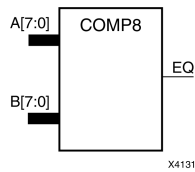
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMP8

### Macro: 8-Bit Identity Comparator



## Introduction

This design element is an 8-bit identity comparator. The equal output (EQ) is high when A7 : A0 and B7 : B0 are equal.

Equality is determined by a bit comparison of the two words. When any two of the corresponding bits from each word are not the same, the EQ output is Low.

## Design Entry Method

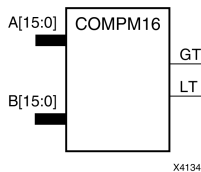
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# COMPM16

## Macro: 16-Bit Magnitude Comparator



## Introduction

This design element is a 16-bit magnitude comparator that compare two positive Binary-weighted words. It compares A15 : A0 and B15 : B0, where A15 and B15 are the most significant bits.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be measured with this macro by comparing both outputs with a NOR gate.

## Logic Table

Inputs								Outputs	
A7, B7	A6, B6	A5, B5	A4, B4	A3, B3	A2, B2	A1, B1	A0, B0	GT	LT
A7>B7	X	X	X	X	X	X	X	1	0
A7<B7	X	X	X	X	X	X	X	0	1
A7=B7	A6>B6	X	X	X	X	X	X	1	0
A7=B7	A6<B6	X	X	X	X	X	X	0	1
A7=B7	A6=B6	A5>B5	X	X	X	X	X	1	0
A7=B7	A6=B6	A5<B5	X	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4>B4	X	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4<B4	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3>B3	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3<B3	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2>B2	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2<B2	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1>B1	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1<B1	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0>B0	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0<B0	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0=B0	0	0

## Design Entry Method

This design element is only for use in schematics.

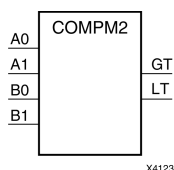


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMPM2

### Macro: 2-Bit Magnitude Comparator



## Introduction

This design element is a 2-bit magnitude comparator that compare two positive binary-weighted words. It compares A1 : A0 and B1 : B0, where A1 and B1 are the most significant bits.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be measured with this macro by comparing both outputs with a NOR gate.

## Logic Table

Inputs				Outputs	
A1	B1	A0	B0	GT	LT
0	0	0	0	0	0
0	0	1	0	1	0
0	0	0	1	0	1
0	0	1	1	0	0
1	1	0	0	0	0
1	1	1	0	1	0
1	1	0	1	0	1
1	1	1	1	0	0
1	0	X	X	1	0
0	1	X	X	0	1

## Design Entry Method

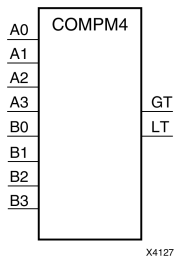
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMPM4

### Macro: 4-Bit Magnitude Comparator



### Introduction

This design element is a 4-bit magnitude comparator that compare two positive Binary-weighted words. It compares A3 : A0 and B3 : B0, where A3 and B3 are the most significant bits.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be measured with this macro by comparing both outputs with a NOR gate.

### Logic Table

Inputs				Outputs	
A3, B3	A2, B2	A1, B1	A0, B0	GT	LT
A3>B3	X	X	X	1	0
A3<B3	X	X	X	0	1
A3=B3	A2>B2	X	X	1	0
A3=B3	A2<B2	X	X	0	1
A3=B3	A2=B2	A1>B1	X	1	0
A3=B3	A2=B2	A1<B1	X	0	1
A3=B3	A2=A2	A1=B1	A0>B0	1	0
A3=B3	A2=B2	A1=B1	A0<B0	0	1
A3=B3	A2=B2	A1=B1	A0=B0	0	0

### Design Entry Method

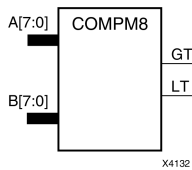
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMPM8

### Macro: 8-Bit Magnitude Comparator



## Introduction

This design element is an 8-bit magnitude comparator that compare two positive Binary-weighted words. It compares A7 : A0 and B7 : B0, where A7 and B7 are the most significant bits.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be measured with this macro by comparing both outputs with a NOR gate.

## Logic Table

Inputs								Outputs	
A7, B7	A6, B6	A5, B5	A4, B4	A3, B3	A2, B2	A1, B1	A0, B0	GT	LT
A7>B7	X	X	X	X	X	X	X	1	0
A7<B7	X	X	X	X	X	X	X	0	1
A7=B7	A6>B6	X	X	X	X	X	X	1	0
A7=B7	A6<B6	X	X	X	X	X	X	0	1
A7=B7	A6=B6	A5>B5	X	X	X	X	X	1	0
A7=B7	A6=B6	A5<B5	X	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4>B4	X	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4<B4	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3>B3	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3<B3	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2>B2	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2<B2	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1>B1	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1<B1	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0>B0	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0<B0	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0=B0	0	0

## Design Entry Method

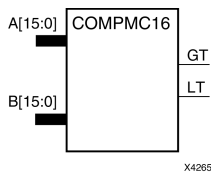
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# COMPMC16

## Macro: 16-Bit Magnitude Comparator



## Introduction

This design element is a 16-bit, magnitude comparator that compares two positive Binary weighted words A15 : A0 and B15 : B0, where A15 and B15 are the most significant bits.

This comparator is implemented using carry logic with relative location constraints to ensure efficient logic placement.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be flagged with this macro by connecting both outputs to a NOR gate.

## Logic Table

Inputs								Outputs	
A7, B7	A6, B6	A5, B5	A4, B4	A3, B3	A2, B2	A1, B1	A0, B0	GT	LT
A7>B7	X	X	X	X	X	X	X	1	0
A7<B7	X	X	X	X	X	X	X	0	1
A7=B7	A6>B6	X	X	X	X	X	X	1	0
A7=B7	A6<B6	X	X	X	X	X	X	0	1
A7=B7	A6=B6	A5>B5	X	X	X	X	X	1	0
A7=B7	A6=B6	A5<B5	X	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4>B4	X	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4<B4	X	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3>B3	X	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3<B3	X	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2>B2	X	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2<B2	X	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1>B1	X	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1<B1	X	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0>B0	1	0
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0<B0	0	1
A7=B7	A6=B6	A5=B5	A4=B4	A3=B3	A2=B2	A1=B1	A0=B0	0	0

## Design Entry Method

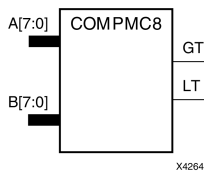
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## COMPMC8

### Macro: 8-Bit Magnitude Comparator



### Introduction

This design element is an 8-bit, magnitude comparator that compares two positive Binaryweighted words A7 : A0 and B7 : B0, where A7 and B7 are the most significant bits.

This comparator is implemented using carry logic with relative location constraints to ensure efficient logic placement.

The greater-than output (GT) is High when  $A > B$ , and the less-than output (LT) is High when  $A < B$ . When the two words are equal, both GT and LT are Low. Equality can be flagged with this macro by connecting both outputs to a NOR gate.

### Logic Table

Inputs								Outputs	
A7, B7	A6, B6	A5, B5	A4, B4	A3, B3	A2, B2	A1, B1	A0, B0	GT	LT
$A7 > B7$	X	X	X	X	X	X	X	1	0
$A7 < B7$	X	X	X	X	X	X	X	0	1
$A7 = B7$	$A6 > B6$	X	X	X	X	X	X	1	0
$A7 = B7$	$A6 < B6$	X	X	X	X	X	X	0	1
$A7 = B7$	$A6 = B6$	$A5 > B5$	X	X	X	X	X	1	0
$A7 = B7$	$A6 = B6$	$A5 < B5$	X	X	X	X	X	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 > B4$	X	X	X	X	1	0
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 < B4$	X	X	X	X	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 > B3$	X	X	X	1	0
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 < B3$	X	X	X	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 > B2$	X	X	1	0
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 < B2$	X	X	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 = B2$	$A1 > B1$	X	1	0
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 = B2$	$A1 < B1$	X	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 = B2$	$A1 = B1$	$A0 > B0$	1	0
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 = B2$	$A1 = B1$	$A0 < B0$	0	1
$A7 = B7$	$A6 = B6$	$A5 = B5$	$A4 = B4$	$A3 = B3$	$A2 = B2$	$A1 = B1$	$A0 = B0$	0	0

### Design Entry Method

This design element is only for use in schematics.

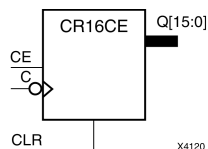


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CR16CE

**Macro: 16-Bit Negative-Edge Binary Ripple Counter with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a 16-bit cascadable, clearable, binary ripple counter with clock enable and asynchronous clear.

Larger counters can be created by connecting the last Q output of the first stage to the clock input of the next stage. CLR and CE inputs are connected in parallel. The clock period is not affected by the overall length of a ripple counter. The overall clock-to-output propagation is  $n(t_{C-Q})$ , where  $n$  is the number of stages and the time  $t_{C-Q}$  is the C-to-Qz propagation delay of each stage.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CLR	CE	C	Qz : Q0
1	X	X	0
0	0	X	No Change
0	1	↓	Inc
z = bit width - 1			

## Design Entry Method

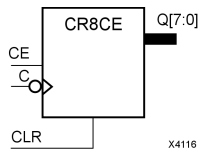
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## CR8CE

### Macro: 8-Bit Negative-Edge Binary Ripple Counter with Clock Enable and Asynchronous Clear



## Introduction

This design element is an 8-bit cascadable, clearable, binary, ripple counter with clock enable and asynchronous clear.

The asynchronous clear (CLR), when High, overrides all other inputs and causes the Q outputs to go to logic level zero. The counter increments when the clock enable input (CE) is High during the High-to-Low clock (C) transition. The counter ignores clock transitions when CE is Low.

Larger counters can be created by connecting the last Q output of the first stage to the clock input of the next stage. CLR and CE inputs are connected in parallel. The clock period is not affected by the overall length of a ripple counter. The overall clock-to-output propagation is  $n(t_{C-Q})$ , where  $n$  is the number of stages and the time  $t_{C-Q}$  is the C-to-Qz propagation delay of each stage.

This counter is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CLR	CE	C	Qz : Q0
1	X	X	0
0	0	X	No Change
0	1	↓	Inc
z = bit width - 1			

## Design Entry Method

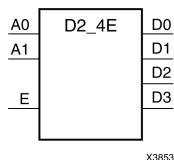
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## D2\_4E

### Macro: 2- to 4-Line Decoder/Demultiplexer with Enable



## Introduction

This design element is a decoder/demultiplexer. When the enable (E) input of this element is High, one of four active-High outputs (D3 : D0) is selected with a 2-bit binary address (A1 : A0) input. The non-selected outputs are Low. Also, when the E input is Low, all outputs are Low. In demultiplexer applications, the E input is the data input.

## Logic Table

Inputs			Outputs			
A1	A0	E	D3	D2	D1	D0
X	X	0	0	0	0	0
0	0	1	0	0	0	1
0	1	1	0	0	1	0
1	0	1	0	1	0	0
1	1	1	1	0	0	0

## Design Entry Method

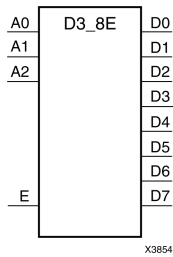
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## D3\_8E

### Macro: 3- to 8-Line Decoder/Demultiplexer with Enable



## Introduction

When the enable (E) input of the D3\_8E decoder/demultiplexer is High, one of eight active-High outputs (D7 : D0) is selected with a 3-bit binary address (A2 : A0) input. The non-selected outputs are Low. Also, when the E input is Low, all outputs are Low. In demultiplexer applications, the E input is the data input.

## Logic Table

Inputs				Outputs							
A2	A1	A0	E	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	1
0	0	1	1	0	0	0	0	0	0	1	0
0	1	0	1	0	0	0	0	0	1	0	0
0	1	1	1	0	0	0	0	1	0	0	0
1	0	0	1	0	0	0	1	0	0	0	0
1	0	1	1	0	0	1	0	0	0	0	0
1	1	0	1	0	1	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0

## Design Entry Method

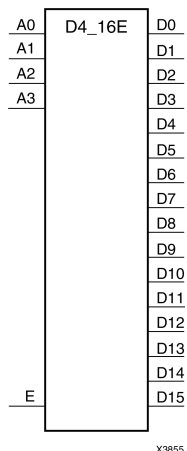
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## D4\_16E

### Macro: 4- to 16-Line Decoder/Demultiplexer with Enable



## Introduction

This design element is a decoder/demultiplexer. When the enable (E) input of this design element is High, one of 16 active-High outputs (D15 : D0) is selected with a 4-bit binary address (A3 : A0) input. The non-selected outputs are Low. Also, when the E input is Low, all outputs are Low. In demultiplexer applications, the E input is the data input.

## Design Entry Method

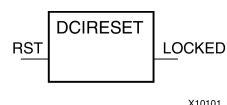
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DCIRESET

Primitive: DCI State Machine Reset (After Configuration Has Been Completed)



### Introduction

This design element is used to reset the DCI state machine after configuration has been completed.

### Port Descriptions

Port	Type	Width	Function
LOCKED	Output	1	DCIRESET LOCK status output.
RST	Input	1	DCIRESET asynchronous reset input.

### Design Entry Method

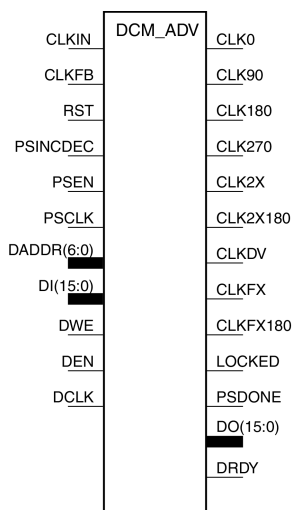
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DCM\_ADV

### Primitive: Advanced Digital Clock Manager Circuit



X10102

## Introduction

This design element is a configurable/reconfigurable DLL with additional phase and frequency synthesis control capabilities. This component is commonly used for many FPGA applications in order to derive and control the various clocks needed within the system. If dynamic reconfiguration is not necessary, use either the DCM\_BASE or DCM\_PS components.

## Port Descriptions

Port	Direction	Width	Function
Clock Outputs/Inputs			
CLK0	Output	1	The CLK0 output clock provides a clock with the same frequency as the DCM's effective CLKIN frequency. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE. When CLKFB is connected, CLK0 is phase aligned to CLKIN.
CLK90	Output	1	The CLK90 output clock provides a clock with the same frequency as the DCM's CLK0, only phase-shifted by 90°.
CLK180	Output	1	The CLK180 output clock provides a clock with the same frequency as the DCM's CLK0, only phase-shifted by 180°.
CLK270	Output	1	The CLK270 output clock provides a clock with the same frequency as the DCM's CLK0, only phase-shifted by 270°.
CLK2X	Output	1	The CLK2X output clock provides a clock that is phase aligned to CLK0, with twice the CLK0 frequency, and with an automatic 50/50 duty-cycle correction. Until the DCM is locked, the CLK2X output appears as a 1x version of the input clock with a 25/75 duty cycle. This behavior allows the DCM to lock on the correct edge with respect to the source clock.
CLK2X180	Output	1	The CLK2X180 output clock provides a clock with the same frequency as the DCM's CLK2X, only phase-shifted by 180°.



Port	Direction	Width	Function
CLKDV	Output	1	The frequency divide (CLKDV) output clock provides a clock that is phase aligned to CLK0 with a frequency that is a fraction of the effective CLKIN frequency. The fraction is determined by the CLKDV_DIVIDE attribute. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.
CLKFX	Output	1	The frequency (CLKFX) output clock provides a clock with the following frequency definition:  $\text{CLKFX Frequency} = (M/D) \times (\text{Effective CLKIN Frequency})$ <p>In this equation, M is the multiplier (numerator), with a value defined by the CLKFX_MULTIPLY attribute. D is the divisor (denominator), with a value defined by the CLKFX_DIVIDE attribute. Specifications for M and D, as well as input and output frequency ranges for the frequency synthesizer, are provided in the Data Sheet for this architecture. The rising edge of CLKFX output is phase aligned to the rising edges of CLK0, CLK2X, and CLKDV when the feedback path (CLKFB) is used. When M and D do have no common factor, the alignment occurs only once every D cycles of CLK0. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.</p>
CLKFX180	Output	1	The CLKFX180 output clock provides a clock with the same frequency as the DCM's CLKFX only phase-shifted by 180°.
CLKIN	Input	1	The source clock (CLKIN) input pin provides the source clock to the DCM. The CLKIN frequency must fall in the ranges specified in the Data Sheet for this architecture. The clock input signal comes from one of the following buffers: <ul style="list-style-type: none"> <li>• IBUFG - Global Clock Input Buffer. The DCM compensates for the clock input path when an IBUFG, on the same edge (top or bottom) of the device, such as the DCM, is used.</li> <li>• BUFG/BUFGCTRL - Internal Global Clock Buffer. Any BUFGCTRL can drive any DCM in the device using the dedicated global routing. A BUFGCTRL can drive the DCM CLKIN pin when used to connect two DCM in series.</li> <li>• IBUF - Input Buffer. When IBUF drives CLKIN input, the PAD to DCM input skew is not compensated and increased jitter can occur. This configuration is generally not recommended.</li> </ul>
CLKFB	Input	1	The feedback clock (CLKFB) input pin provides a reference or feedback signal to the DCM to delay-compensate the clock outputs and align it with the clock input. To provide the necessary feedback to the DCM, connect only the CLK0 output to the CLKFB input via a BUFG component in the case of internal feedback or an OBUF ' IBUFG to the case of external feedback. Set the CLK_FEEDBACK attribute to 1X. When the CLKFB pin is connected, CLK0, CLKDV, and CLKFX are phase aligned to CLKIN. When the CLKFB pin is not connected, set CLK_FEEDBACK to NONE and only the CLKFX and CLKFX180 outputs are valid, however, not phase aligned to CLKIN.
Status Outputs/Control Inputs			
LOCKED	Output	1	Synchronous output from the PLL that provides you with an indication that the PLL has achieved phase alignment and is ready for operation.
PSDONE	Output	1	Dynamic CLKIN select input. When high, '1' CLKIN1 is selected and while low, '0' CLKIN2 is selected. If dual clock selection is not necessary, connect this input to a logic 1.

Port	Direction	Width	Function
RST	Input	1	The reset (RST) input pin resets the DCM circuitry. The RST signal is an active High asynchronous reset. Asserting the RST signal asynchronously forces all DCM outputs Low (the LOCKED signal, all status signals, and all output clocks within four source clock cycles). Because the reset is asynchronous, the last cycle of the clocks can exhibit an unintended short pulse, severely distorted duty-cycle, and no longer phase adjust with respect to one another while deasserting. The RST pin must be used when reconfiguring the device or changing the input frequency. Deasserting the RST signal synchronously starts the locking process at the next CLKIN cycle. To ensure a proper DCM reset and locking process, the RST signal must be deasserted after the CLKIN signal has been present and stable for at least three clock cycles. In all designs, the DCM must be held in reset until the clock is stable. During configuration, the DCM is automatically held in reset until GSR is released. If the clock is stable when GSR is released.
PSCLK	Input	1	The phase-shift clock (PSCLK) input pin provides the source clock for the DCM phase shift. The phase-shift clock signal can be driven by any clock source (external or internal).  The frequency range of PSCLK is defined by PSCLK_FREQ_LF/HF (see the Data Sheet for this architecture). This input must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.
PSINCDEC	Input	1	The PSINCDEC input signal is synchronous with PSCLK. The PSINCDEC input signal is used to increment or decrement the phase-shift factor when CLKOUT_PHASE_SHIFT is set to one of the variable modes. As a result, the output clock is phase shifted. the PSINCDEC signal is asserted High for increment, or deasserted Low for decrement. This input must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.
PSEN	Input	1	The PSEN input signal is synchronous with PSCLK. A variable phase-shift operation is initiated by the PSEN input signal when CLKOUT_PHASE_SHIFT is set to a variable mode. It must be activated for one period of PSCLK. After PSEN is initiated, the phase change is effective for up to 100 CLKIN pulse cycles, plus three PSCLK cycles, and is indicated by a High pulse on PSDONE. There are no sporadic changes or glitches on any output during the phase transition. From the time PSEN is enabled until PSDONE is flagged, the DCM output clock moves bit-by-bit from its original phase shift to the target phase shift. The phase-shift is complete when PSDONE is flagged. PSEN must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.
Dynamic Reconfiguration/DCM Status			
For more information on Dynamic Configuration, please see the Configuration User Guide.			
DO	Output	16	The DO output bus provides DCM status when not using the dynamic reconfiguration feature, and a data output when using the dynamic reconfiguration. When showing DCM status, the following mapping applies: <ul style="list-style-type: none"> <li>DO[0] - Phase-shift overflow</li> <li>DO[1] - CLKIN stopped</li> <li>DO[2] - CLKFX stopped</li> <li>DO[3] - CLKFB stopped</li> <li>DO[15:4] - Not assigned</li> </ul>
DRDY	Output	1	The DRDY output pin provides ready status for the DCM's dynamic reconfiguration feature
DI	Input	16	The DI input bus provides reconfiguration data for dynamic reconfiguration. When not used, all bits must be assigned zeros.
DADDR	Input	7	The DADDR input bus provides a reconfiguration address for dynamic reconfiguration. When not used, all bits must be assigned zeros.

Port	Direction	Width	Function
DWE	Input	1	The DWE input pin provides the write enable control signal to write the DI data into the DADDR address. When not used, it must be tied Low.
DEN	Input	1	The DEN input pin provides the enable control signal to access the dynamic reconfiguration feature. To reflect the DCM status signals on the DO output bus when the dynamic reconfiguration feature is not used, DEN should be tied low.
DCLK	Input	1	The DCLK input pin provides the source clock for the DCM's dynamic reconfiguration circuit. The frequency of DCLK can be asynchronous (in phase and frequency) to CLKIN. The dynamic reconfiguration clock signal is driven by any clock source. The frequency range of DCLK is described in the Data Sheet for this architecture. When dynamic reconfiguration is not used, this input must be tied to ground.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CLK_FEEDBACK	String	"1X" , or "NONE"	"1X"	Specifies the clock feedback of the allowed value.
CLKDV_DIVIDE	Float	1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0	2.0	Specifies the extent to which the CLKDLL, CLKDLLE, CLKDLLHF, or DCM clock divider (CLKDV output) is to be frequency divided.
CLKFX_DIVIDE	Integer	1 to 32	1	Specifies the frequency divider value for the CLKFX output.
CLKFX_MULTIPLY	Integer	2 to 32	4	Specifies the frequency multiplier value for the CLKFX output.
CLKIN_DIVIDE_BY_2	Boolean	FALSE, TRUE	FALSE	Allows for the input clock frequency to be divided in half when such a reduction is necessary to meet the DCM input clock frequency requirements.
CLKIN_PERIOD	Float	1.25 to 1000.00	10.0	Specifies period of input clock in ns from 1.25 to 1000.00.
CLKOUT_PHASE_SHIFT	String	"NONE", "FIXED", "VARIABLE_POSITIVE", "VARIABLE_CENTER" or "DIRECT"	"NONE"	Specifies the phase shift mode of allowed value.
DCM_PERFORMANCE_MODE	String	"MAX_SPEED" or "MAX_RANGE"	"MAX_SPEED"	Allows selection between maximum frequency and minimum jitter for low frequency and maximum phase shift range.

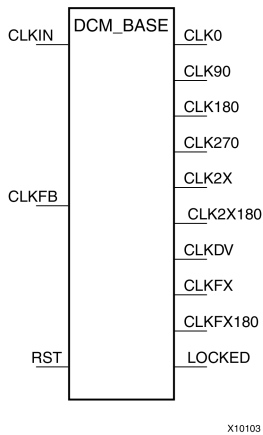
Attribute	Type	Allowed Values	Default	Description
DESKEW_ADJUST	String	"SOURCE_SYNCHRONOUS", "SYSTEM_SYNCHRONOUS" or "0" to "15"	"SYSTEM_SYNCHRONOUS"	Affects the amount of delay in the feedback path, and should be used for source-synchronous interfaces.
DFS_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	Specifies the frequency mode of the frequency synthesizer.
DLL_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	Specifies the DLL's frequency mode.
DUTY_CYCLE_CORRECTION	Boolean	TRUE, FALSE	TRUE	Corrects the duty cycle of the CLK0, CLK90, CLK180, and CLK270 outputs.
FACTORY_JF	Hexa-decimal	Any 16-Bit value.	F0F0	The FACTORY_JF attribute affects the DCMs jitter filter characteristic. The default value should not be modified unless otherwise instructed by Xilinx.
PHASE_SHIFT	Integer	-255 to 1023	0	Specifies the phase shift numerator. The range depends on CLKOUT_PHASE_SHIFT.
SIM_DEVICE	String	"VIRTEX4" or "VIRTEX5"	"VIRTEX5"	Device selection.
STARTUP_WAIT	Boolean	FALSE, TRUE	FALSE	When TRUE, the configuration startup sequence waits in the specified cycle until the DCM locks.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DCM\_BASE

### Primitive: Base Digital Clock Manager Circuit



## Introduction

This design element is a configurable DLL with additional phase and frequency synthesis control capabilities. This component is commonly used for many FPGA applications in order to derive and control the various clocks needed within the system. If dynamic reconfiguration is necessary, use the DCM\_ADV component. If dynamic phase shift is required, use the DCM\_PS component.

## Port Descriptions

Port	Direction	Width	Function
Clock Outputs/Inputs			
CLK0	Output	1	The CLK0 output clock provides a clock with the same frequency as the DCM's effective CLKIN frequency. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE. When CLKFB is connected, CLK0 is phase aligned to CLKIN.
CLK90	Output	1	The CLK90 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 90°.
CLK180	Output	1	The CLK180 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 180°.
CLK270	Output	1	The CLK270 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 270°.
CLK2X	Output	1	The CLK2X output clock provides a clock that is phase aligned to CLK0, with twice the CLK0 frequency, and with an automatic 50/50 duty-cycle correction. Until the DCM is locked, the CLK2X output appears as a 1x version of the input clock with a 25/75 duty cycle. This behavior allows the DCM to lock on the correct edge with respect to the source clock.
CLK2X180	Output	1	The CLK2X180 output clock provides a clock with the same frequency as the DCM's CLK2X only phase-shifted by 180°.
CLKDV	Output	1	The frequency divide (CLKDV) output clock provides a clock that is phase aligned to CLK0 with a frequency that is a fraction of the effective CLKIN frequency. The fraction is determined by the CLKDV_DIVIDE attribute. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.

Port	Direction	Width	Function
CLKFX	Output	1	<p>The frequency (CLKFX) output clock provides a clock with the following frequency definition:</p> $\text{CLKFX Frequency} = (M/D) \times (\text{Effective CLKIN Frequency})$ <p>In this equation, M is the multiplier (numerator) with a value defined by the CLKFX_MULTIPLY attribute. D is the divisor (denominator) with a value defined by the CLKFX_DIVIDE attribute. Specifications for M and D, as well as input and output frequency ranges for the frequency synthesizer, are provided in the Data Sheet for this architecture. The rising edge of CLKFX output is phase aligned to the rising edges of CLK0, CLK2X, and CLKDV when the feedback path (CLKFB) is used. When M and D to have no common factor, the alignment occurs only once every D cycles of CLK0. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.</p>
CLKFX180	Output	1	The CLKFX180 output clock provides a clock with the same frequency as the DCM's CLKFX only phase-shifted by 180°.
CLKIN	Input	1	<p>The source clock (CLKIN) input pin provides the source clock to the DCM. The CLKIN frequency must fall in the ranges specified in the Data Sheet for this architecture. The clock input signal comes from one of the following buffers:</p> <ul style="list-style-type: none"> <li>• IBUFG - Global Clock Input Buffer. The DCM compensates for the clock input path when an IBUFG on the same edge (top or bottom) of the device as the DCM is used.</li> <li>• BUFG/BUFGCTRL - Internal Global Clock Buffer. Any BUFGCTRL can drive any DCM in the device using the dedicated global routing. A BUFGCTRL can drive the DCM CLKIN pin when used to connect two DCM in series.</li> <li>• IBUF - Input Buffer. When IBUF drives CLKIN input, the PAD to DCM input skew is not compensated and increased jitter can occur. This configuration is generally not recommended.</li> </ul>
CLKFB	Input	1	<p>The feedback clock (CLKFB) input pin provides a reference or feedback signal to the DCM to delay-compensate the clock outputs, and align it with the clock input. To provide the necessary feedback to the DCM, connect only the CLK0 output to the CLKFB input via a BUFG component in the case of internal feedback or an OBUF ' IBUFG to the case of external feedback. Set the CLK_FEEDBACK attribute to 1X. When the CLKFB pin is connected, CLK0, CLKDV, and CLKFX are phase aligned to CLKIN. When the CLKFB pin is not connected, set CLK_FEEDBACK to NONE and only the CLKFX and CLKFX180 outputs are valid. However, they are not phase aligned to CLKIN.</p>
Status Outputs/Control Inputs			
LOCKED	Output	1	Synchronous output from the PLL that provides you with an indication the PLL has achieved phase alignment and is ready for operation.
RST	Input	1	<p>The reset (RST) input pin resets the DCM circuitry. The RST signal is an active High asynchronous reset. Asserting the RST signal asynchronously forces all DCM outputs Low (the LOCKED signal, all status signals, and all output clocks within four source clock cycles). Because the reset is asynchronous, the last cycle of the clocks can exhibit an unintended short pulse, severely distorted duty-cycle, and no longer phase adjust with respect to one another while deasserting. The RST pin must be used when reconfiguring the device or changing the input frequency. Deasserting the RST signal synchronously starts the locking process at the next CLKIN cycle. To ensure a proper DCM reset and locking process, the RST signal must be deasserted after the CLKIN signal has been present and stable for at least three clock cycles. In all designs, the DCM must be held in reset until the clock is stable. During configuration, the DCM is automatically held in reset until GSR is released. If the clock is stable when GSR is released.</p>

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

Attribute	Type	Allowed Values	Default	Description
CLK_FEEDBACK	String	"1X" , "2X", or "NONE"	"1X"	Specifies the feedback input to the DCM (CLK0, or CLK2X).
CLKDV_DIVIDE	Float	1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0	2.0	Specifies the extent to which the CLKDLL, CLKDLLE, CLKDLLHF, or DCM clock divider (CLKDV output) is to be frequency divided.
CLKFX_DIVIDE	Integer	1 to 32	1	Specifies the frequency divider value for the CLKFX output.
CLKFX_MULTIPLY	Integer	2 to 32	4	Specifies the frequency multiplier value for the CLKFX output.
CLKIN_DIVIDE_BY_2	Boolean	FALSE, TRUE	FALSE	Allows for the input clock frequency to be divided in half when such a reduction is necessary to meet the DCM input clock frequency requirements.
CLKIN_PERIOD	Float	1.25 to 1000.00	10.0	Specifies the period of input clock in ns from 1.25 to 1000.00.
CLKOUT_PHASE_SHIFT	String	"NONE", "FIXED", "VARIABLE_POSITIVE", "VARIABLE_CENTER" or "DIRECT"	"NONE"	Specifies the phase shift mode of allowed value.
DCM_PERFORMANCE_MODE	String	"MAX_SPEED" or "MAX_RANGE"	"MAX_SPEED"	Allows selection between maximum frequency and minimum jitter for low frequency and maximum phase shift range.
DESKEW_ADJUST	String	"SOURCE_SYNCHRONOUS", "SYSTEM_SYNCHRONOUS" or "0" to "15"	"SYSTEM_SYNCHRONOUS"	Affects the amount of delay in the feedback path, and should be used for source-synchronous interfaces.
DFS_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	Specifies the frequency mode of the frequency synthesizer.
DLL_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	This specifies the DLL's frequency mode
DUTY_CYCLE_CORRECTION	Boolean	TRUE, FALSE	TRUE	Corrects the duty cycle of the CLK0, CLK90, CLK180, and CLK270 outputs.
FACTORY_JF	Hexa-decimal	Any 16-Bit Value	F0F0	The FACTORY_JF attribute affects the DCMs jitter filter characteristic. This attribute is set the default value should not be modified unless otherwise instructed by Xilinx.
PHASE_SHIFT	Integer	-255 to 1023	0	Specifies the phase shift numerator. The range depends on CLKOUT_PHASE_SHIFT.



Attribute	Type	Allowed Values	Default	Description
STARTUP_WAIT	Boolean	FALSE, TRUE	FALSE	When set to TRUE, the configuration startup sequence waits in the specified cycle until the DCM locks.

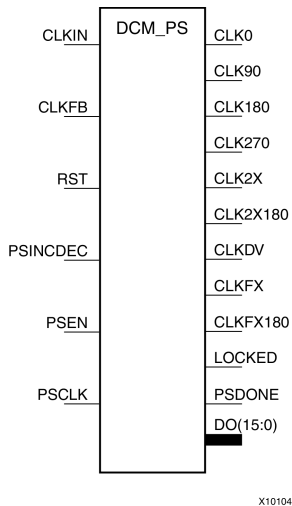
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## DCM\_PS

### Primitive: Digital Clock Manager with Basic and Phase Shift Features



## Introduction

This design element is a configurable DLL with additional phase and frequency synthesis control capabilities. This component is commonly used for many FPGA applications in order to derive and control the various clocks needed within the system. If dynamic reconfiguration is necessary, use the DCM\_ADV. If Dynamic Phase shift is not necessary, use the DCM\_BASE component.

## Port Descriptions

Port	Direction	Width	Function
Clock Outputs/Inputs			
CLK0	Output	1	The CLK0 output clock provides a clock with the same frequency as the DCM's effective CLKIN frequency. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE. When CLKFB is connected, CLK0 is phase aligned to CLKIN.
CLK90	Output	1	The CLK90 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 90°.
CLK180	Output	1	The CLK180 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 180°.
CLK270	Output	1	The CLK270 output clock provides a clock with the same frequency as the DCM's CLK0 only phase-shifted by 270°.
CLK2X	Output	1	The CLK2X output clock provides a clock that is phase aligned to CLK0, with twice the CLK0 frequency, and with an automatic 50/50 duty-cycle correction. Until the DCM is locked, the CLK2X output appears as a 1x version of the input clock with a 25/75 duty cycle. This behavior allows the DCM to lock on the correct edge with respect to the source clock.
CLK2X180	Output	1	The CLK2X180 output clock provides a clock with the same frequency as the DCM's CLK2X only phase-shifted by 180°.

Port	Direction	Width	Function
CLKDV	Output	1	The frequency divide (CLKDV) output clock provides a clock that is phase aligned to CLK0 with a frequency that is a fraction of the effective CLKIN frequency. The fraction is determined by the CLKDV_DIVIDE attribute. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.
CLKFX	Output	1	<p>The frequency (CLKFX) output clock provides a clock with the following frequency definition:</p> $\text{CLKFX Frequency} = (M/D) \times (\text{Effective CLKIN Frequency})$ <p>In this equation, M is the multiplier (numerator) with a value defined by the CLKFX_MULTIPLY attribute. D is the divisor (denominator) with a value defined by the CLKFX_DIVIDE attribute. Specifications for M and D, as well as input and output frequency ranges for the frequency synthesizer, are provided in the Data Sheet. The rising edge of CLKFX output is phase aligned to the rising edges of CLK0, CLK2X, and CLKDV when the feedback path (CLKFB) is used. When M and D do not have a common factor, the alignment occurs only once every D cycles of CLK0. By default, the effective CLKIN frequency is equal to the CLKIN frequency, except when the CLKIN_DIVIDE_BY_2 attribute is set to TRUE.</p>
CLKFX180	Output	1	The CLKFX180 output clock provides a clock with the same frequency as the DCM's CLKFX only phase-shifted by 180°.
CLKIN	Input	1	<p>The source clock (CLKIN) input pin provides the source clock to the DCM. The CLKIN frequency must fall in the ranges specified in the Data Sheet. The clock input signal comes from one of the following buffers:</p> <ul style="list-style-type: none"> <li>• IBUFG - Global Clock Input Buffer. The DCM compensates for the clock input path when an IBUFG on the same edge (top or bottom) of the device as the DCM is used.</li> <li>• BUFG/BUFGCTRL - Internal Global Clock Buffer. Any BUFGCTRL can drive any DCM in the device using the dedicated global routing. A BUFGCTRL can drive the DCM CLKIN pin when used to connect two DCM in series.</li> <li>• IBUF - Input Buffer. When IBUF drives CLKIN input, the PAD to DCM input skew is not compensated and increased jitter can occur. This configuration is generally not recommended.</li> </ul>
CLKFB	Input	1	The feedback clock (CLKFB) input pin provides a reference or feedback signal to the DCM to delay-compensate the clock outputs, and align it with the clock input. To provide the necessary feedback to the DCM, connect only the CLK0 output to the CLKFB input via a BUFG component in the case of internal feedback or an OBUF ' IBUFG to the case of external feedback. Set the CLK_FEEDBACK attribute to 1X. When the CLKFB pin is connected, CLK0, CLKDV, and CLKFX are phase aligned to CLKIN. When the CLKFB pin is not connected, set CLK_FEEDBACK to NONE and only the CLKFX and CLKFX180 outputs are valid. However, they are not phase aligned to CLKIN.
Status Outputs/Control Inputs			
LOCKED	Output	1	Synchronous output from the PLL that provides you with an indication the PLL has achieved phase alignment and is ready for operation.
PSDONE	Output	1	Dynamic CLKIN select input. When high, '1' CLKIN1 is selected and while low, '0' CLKIN2 is selected. If dual clock selection is not necessary, connect this input to a logic 1.

Port	Direction	Width	Function
RST	Input	1	The reset (RST) input pin resets the DCM circuitry. The RST signal is an active High asynchronous reset. Asserting the RST signal asynchronously forces all DCM outputs Low (the LOCKED signal, all status signals, and all output clocks within four source clock cycles). Because the reset is asynchronous, the last cycle of the clocks can exhibit an unintended short pulse, severely distorted duty-cycle, and no longer phase adjust with respect to one another while deasserting. The RST pin must be used when reconfiguring the device or changing the input frequency. Deasserting the RST signal synchronously starts the locking process at the next CLKIN cycle. To ensure a proper DCM reset and locking process, the RST signal must be deasserted after the CLKIN signal has been present and stable for at least three clock cycles. In all designs, the DCM must be held in reset until the clock is stable. During configuration, the DCM is automatically held in reset until GSR is released. If the clock is stable when GSR is released.
PSCLK	Input	1	The phase-shift clock (PSCLK) input pin provides the source clock for the DCM phase shift. The phase-shift clock signal can be driven by any clock source (external or internal).  The frequency range of PSCLK is defined by PSCLK_FREQ_LF/HF (see the Data Sheet). This input must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.
PSINCDEC	Input	1	The PSINCDEC input signal is synchronous with PSCLK. The PSINCDEC input signal is used to increment or decrement the phase-shift factor when CLKOUT_PHASE_SHIFT is set to one of the variable modes. As a result, the output clock is phase shifted. the PSINCDEC signal is asserted High for increment, or deasserted Low for decrement. This input must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.
PSEN	Input	1	The PSEN input signal is synchronous with PSCLK. A variable phase-shift operation is initiated by the PSEN input signal when CLKOUT_PHASE_SHIFT is set to a variable mode. It must be activated for one period of PSCLK. After PSEN is initiated, the phase change is effective for up to 100 CLKIN pulse cycles, plus three PSCLK cycles, and is indicated by a High pulse on PSDONE. There are no sporadic changes or glitches on any output during the phase transition. From the time PSEN is enabled until PSDONE is flagged, the DCM output clock moves bit-by-bit from its original phase shift to the target phase shift. The phase-shift is complete when PSDONE is flagged. PSEN must be tied to ground when the CLKOUT_PHASE_SHIFT attribute is set to NONE or FIXED.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CLK_FEEDBACK	String	"1X", "2X", or "NONE"	"1X"	Specifies the clock feedback of allowed value.
CLKDV_DIVIDE	FLOAT	1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0	2.0	Specifies the extent to which the CLKDLL, CLKDLLE, CLKDLLHF, or DCM clock divider (CLKDV output) is to be frequency divided.
CLKFX_DIVIDE	Integer	1 to 32	1	Specifies the frequency divider value for the CLKFX output.

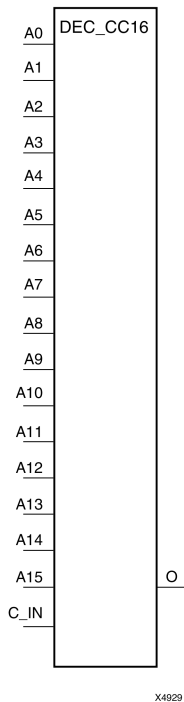
Attribute	Type	Allowed Values	Default	Description
CLKFX_MULTIPLY	Integer	2 to 32	4	Specifies the frequency multiplier value for the CLKFX output.
CLKIN_DIVIDE_BY_2	Boolean	FALSE, TRUE	FALSE	Allows for the input clock frequency to be divided in half when such a reduction is necessary to meet the DCM input clock frequency requirements.
CLKIN_PERIOD	FLOAT	1.25 to 1000.00	10.0	Specifies the period of input clock in ns from 1.25 to 1000.00.
CLKOUT_PHASE_SHIFT	String	"NONE", "FIXED", "VARIABLE_POSITIVE", "VARIABLE_CENTER" or "DIRECT"	"NONE"	Specifies the phase shift mode of allowed value.
DESKEW_ADJUST	String	"SOURCE_SYNCHRONOUS", "SYSTEM_SYNCHRONOUS" or "0" to "15"	"SYSTEM_SYNCHRONOUS"	Affects the amount of delay in the feedback path, and should be used for source-synchronous interfaces.
DFS_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	Specifies the frequency mode of the frequency synthesizer.
DLL_FREQUENCY_MODE	String	"LOW" or "HIGH"	"LOW"	This specifies the DLL's frequency mode.
DUTY_CYCLE_CORRECTION	Boolean	TRUE, FALSE	TRUE	Corrects the duty cycle of the CLK0, CLK90, CLK180, and CLK270 outputs.
FACTORY_JF	Hexa-decimal	Any 16-Bit Value	F0F0	The FACTORY_JF attribute affects the DCM's jitter filter characteristic. This attribute is set and the default value should not be modified unless otherwise instructed by Xilinx.
PHASE_SHIFT	Integer	-255 to 1023	0	Specifies the phase shift numerator. The range depends on CLKOUT_PHASE_SHIFT.
STARTUP_WAIT	Boolean	FALSE, TRUE	FALSE	When set to TRUE, the configuration startup sequence waits in the specified cycle until the DCM locks.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DEC\_CC16

### Macro: 16-Bit Active Low Decoder



## Introduction

This design element is a 16-bit decoder that is used to build wide-decoder functions. It is implemented by cascading CY\_MUX elements driven by look-up tables (LUTs). The C\_IN pin can only be driven by the output (O) of a previous decode stage. When one or more of the inputs (A) are Low, the output is Low. When all the inputs are High and the C\_IN input is High, the output is High. You can decode patterns by adding inverters to inputs.

## Logic Table

Inputs					Outputs
A0	A1	...	Az	C_IN	O
1	1	1	1	1	1
X	X	X	X	0	0
0	X	X	X	X	0
X	0	X	X	X	0
X	X	X	0	X	0

$z = 3$  for DEC\_CC4;  $z = 7$  for DEC\_CC8;  $z = 15$  for DEC\_CC16

## Design Entry Method

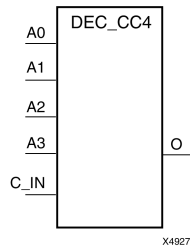
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DEC\_CC4

### Macro: 4-Bit Active Low Decoder



## Introduction

This design element is a 4-bit decoder that is used to build wide-decoder functions. It is implemented by cascading CY\_MUX elements driven by look-up tables (LUTs). The C\_IN pin can only be driven by the output (O) of a previous decode stage. When one or more of the inputs (A) are Low, the output is Low. When all the inputs are High and the C\_IN input is High, the output is High. You can decode patterns by adding inverters to inputs.

## Logic Table

Inputs					Outputs
A0	A1	...	Az	C_IN	O
1	1	1	1	1	1
X	X	X	X	0	0
0	X	X	X	X	0
X	0	X	X	X	0
X	X	X	0	X	0
z = 3 for DEC_CC4; z = 7 for DEC_CC8; z = 15 for DEC_CC16					

## Design Entry Method

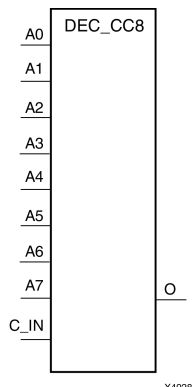
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DEC\_CC8

### Macro: 8-Bit Active Low Decoder



## Introduction

This design element is a 8-bit decoder that is used to build wide-decoder functions. It is implemented by cascading CY\_MUX elements driven by look-up tables (LUTs). The C\_IN pin can only be driven by the output (O) of a previous decode stage. When one or more of the inputs (A) are Low, the output is Low. When all the inputs are High and the C\_IN input is High, the output is High. You can decode patterns by adding inverters to inputs.

## Logic Table

Inputs					Outputs
A0	A1	...	Az	C_IN	O
1	1	1	1	1	1
X	X	X	X	0	0
0	X	X	X	X	0
X	0	X	X	X	0
X	X	X	0	X	0
z = 3 for DEC_CC4; z = 7 for DEC_CC8; z = 15 for DEC_CC16					

## Design Entry Method

This design element is only for use in schematics.

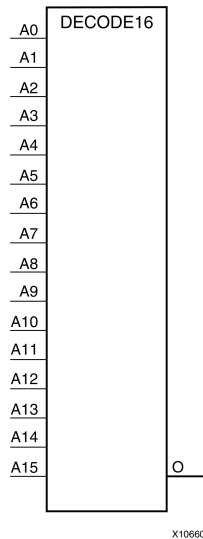
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## DECODE16

### Macro: 16-Bit Active-Low Decoder



## Introduction

This design element is a 4-bit, active-low decoder that is implemented using combinations of LUTs and MUXCYs.

## Logic Table

Inputs				Outputs*
A0	A1	...	Az	O
1	1	1	1	1
0	X	X	X	0
X	0	X	X	0
X	X	X	0	0

z = bitwidth -1

\*A pull-up resistor must be connected to the output to establish High-level drive current.

## Design Entry Method

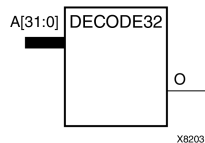
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DECODE32

### Macro: 32-Bit Active-Low Decoder



## Introduction

This design element is a 32-bit active-low decoder that is implemented using combinations of LUTs and MUXCYs.

## Logic Table

Inputs				Outputs
A0	A1	...	Az	O
1	1	1	1	1
0	X	X	X	0
X	0	X	X	0
X	X	X	0	0
z = 31 for DECODE32, z = 63 for DECODE64				

## Design Entry Method

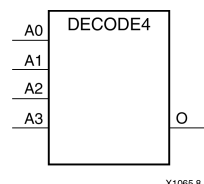
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DECODE4

### Macro: 4-Bit Active-Low Decoder



## Introduction

This design element is a 4-bit, active-low decoder that is implemented using combinations of LUTs and MUXCYs.

## Logic Table

Inputs				Outputs*
A0	A1	...	Az	O
1	1	1	1	1
0	X	X	X	0
X	0	X	X	0
X	X	X	0	0

z = bitwidth -1

\*A pull-up resistor must be connected to the output to establish High-level drive current.

## Design Entry Method

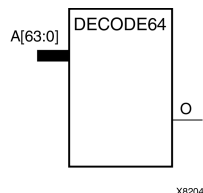
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DECODE64

### Macro: 64-Bit Active-Low Decoder



## Introduction

This design element is a 64-bit active-low decoder that is implemented using combinations of LUTs and MUXCYs.

## Logic Table

Inputs				Outputs
A0	A1	...	Az	O
1	1	1	1	1
0	X	X	X	0
X	0	X	X	0
X	X	X	0	0

*z = 31 for DECODE32, z = 63 for DECODE64*

## Design Entry Method

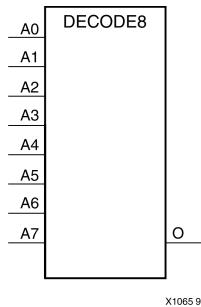
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DECODE8

### Macro: 8-Bit Active-Low Decoder



## Introduction

This design element is a 8-bit, active-low decoder that is implemented using combinations of LUTs and MUXCY's.

## Logic Table

Inputs				Outputs*
A0	A1	...	Az	O
1	1	1	1	1
0	X	X	X	0
X	0	X	X	0
X	X	X	0	0

z = bitwidth -1

\*A pull-up resistor must be connected to the output to establish High-level drive current.

## Design Entry Method

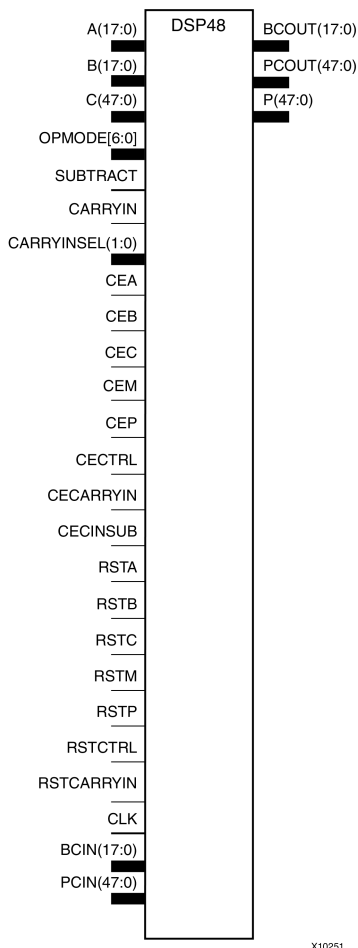
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## DSP48

**Primitive: 18x18 Signed Multiplier Followed by a Three-Input Adder with Optional Pipeline Registers**



## Introduction

A slice for this design element has a 48-bit output and is primarily intended for use in digital-signal processing applications. However, the flexibility of this component means that it can be applied to many more applications than a typical MACC unit. A basic DSP48 slice consists of a multiplier followed by an adder. The multiplier accepts two, 18-bit, signed, two's complement operands producing a 36-bit, signed, two's complement result. The result is sign extended to 48 bits. The adder accepts three, 48-bit, signed, two's complement operands producing a 48-bit, signed, two's complement result.

Possible operands for the adder include the multiplier output and external source or the registered output of the adder providing an accumulate function. The 48-bit output allows for 4096 accumulations of 36-bit operands before overflow occurs.

## Port Descriptions

Port	Direction	Width	Function
CLK	I	1	The DSP48 clock
A	I	18	The multiplier's A input, can also be used as adder's MSW input
B	I	18	The multiplier's B input, can also be used as adder's LSW input
BCIN	I	18	The multiplier's cascaded B input, can also be used as adder's LSW input
C	I	48	The adder's C input
PCIN	I	48	Cascaded adder's C Input from previous DSP slice
CARRYIN	I	1	The adders carry input
SUBTRACT	I	1	0= add, 1= (C, PCIN)-(mult,A:B)
OPMODE	I	7	Controls input to adder in DSP48 slices - see OPMODE table
CARRYINSEL	I	2	Selects carry source - see CARRYINSEL table
CEA	I	1	Clock enable - 0=hold 1=enable AREG
CEB	I	1	Clock enable - 0=hold 1=enable BREG
CEC	I	1	Clock enable - 0=hold 1=enable CREG
CEP	I	1	Clock enable - 0=hold 1=enable PREG

### *Synthesis Attributes Used to Define Pipeline Registers*

The following table describes the synthesis attributes used to define the pipeline registers.

Attribute	Function
AREG	0=bypass, 1=single, 2=dual
BREG	0=bypass, 1=single, 2=dual
CREG	0=bypass, 1=single
PREG	0=bypass, 1=single
MREG	0=bypass, 1=single
SUBTRACTREG	0=bypass, 1=single
OPMODEREG	0=bypass, 1=single
CARRYINSELREG	0=bypass, 1=single

### *Two's complement Signed Multiplier*

The multiplier inside the DSP48 slice is an 18-bit x 18-bit two's complement multiplier with a 36-bit signed two's complement result. Cascading of multipliers to achieve larger products is supported. Applications such as signed-signed, signed-unsigned, and unsigned-unsigned multiplication, logical, arithmetic, barrel-shifter, two's complement and magnitude return are easily implemented. There are two independent dynamic data input ports. The input ports can represent 18-bit signed or 17-bit unsigned data.

### *X, Y, and Z Multiplexers*

The Operational Mode (OpMode) inputs provide a way for the design to change its functionality on the fly. For example, the loading of an accumulator to restart an accumulation process. The OpMode bits can be optionally registered under the control of the configuration RAM.

The following tables list the possible values of OpMode and resulting function at the outputs of the three multiplexers supplying data to the adder/subtractor. The 7-bit OpMode control can be further broken down into multiplexer select bits. Not all possible combinations for the multiplexer select bits are allowed. If the multiplier output is selected then both the X and Y multiplexer are consumed with the multiplier output.

*OpMode Control Bit Select X, Y, and Z Multiplexer Outputs*

OPMODE Binary			X Multiplexer Output Fed to Add/Subtract
Z	Y	X	
XXX	XX	0	ZERO (Default)
XXX	1	1	Multiplier Output
XXX	XX	10	P
XXX	XX	11	A concatenated B

*OpMode Control Bit Select X, Y, and Z Multiplexer Outputs*

OPMODE Binary			Y Multiplexer Output Fed to Add/Subtract
Z	Y	X	
XXX	0	XX	ZERO (Default)
XXX	1	1	Multiplier Output
XXX	10	XX	Illegal selection
XXX	11	XX	C

*OpMode Controls X, Y, and Z Multiplexer Outputs*

OPMODE Binary			Y Multiplexer Output Fed to Add/Subtract
Z	Y	X	
XXX	0	XX	ZERO (Default)
XXX	1	1	Multiplier Output
XXX	10	XX	Illegal selection
XXX	11	XX	C

*Three Input Adder/Subtractor Control Logic*

The adder/subtractor output is a function of control and data inputs. The OpMode, as shown in the previous section, selects the inputs to the X, Y, Z multiplexer that are directed to the three adder/subtractor inputs. It also described that when the multiplier output is selected, both X and Y multiplexers are occupied. With the inputs to the adder/subtractor specified the function of the adder/subtractor itself must be examined. As with the input multiplexers, the OpMode bits specify a portion of this function. The table below shows this function. The symbol  $\pm$  in the table means either add or subtract and is specified by the state of the subtract control.

Hex OpMode	Binary OpMode	Output of Adder/Subtractor	Operation Description
<b>[6:0]</b>	<b>Z Y X</b>		
0x00	000 00 00	$\pm$ CIN	Zero
0x02	000 00 10	$\pm(P + \text{CIN})$	Hold P
0x03	000 00 11	$\pm(A:B + \text{CIN})$	A:B select
0x05	000 01 01	$\pm (A \times B + \text{CIN})$	Multiply
0x0c	000 11 00	$\pm (C + \text{CIN})$	C select
0x0e	000 11 10	$\pm (C + P + \text{CIN})$	Feedback add



Hex OpMode	Binary OpMode	Output of Adder/Subtractor	Operation Description
[6:0]	Z Y X		
0x0f	000 11 11	$\pm (A:B + C + CIN)$	36-bit adder
0x10	001 00 00	$PCIN \pm CIN$	P cascade select
0x12	001 00 10	$PCIN \pm (P + CIN)$	P cascade feedback add
0x13	001 00 11	$PCIN \pm (A:B + CIN)$	P cascade add
0x15	001 01 01	$PCIN \pm (A \times B + CIN)$	P cascade multiply add
0x1c	001 11 00	$PCIN \pm (C + CIN)$	P cascade add
0x1e	001 11 10	$PCIN \pm (C + P + CIN)$	P cascade feedback add add
0x1c	001 11 11	$PCIN \pm (A:B + C + CIN)$	P cascade add add
0x20	010 00 00	$P \pm CIN$	Hold P
0x22	010 00 10	$P \pm (P + CIN)$	Double feedback add
0x23	010 00 11	$P \pm (A:B + CIN)$	Feedback add
0x25	010 01 01	$P \pm (A \times B + CIN)$	Multiply-accumulate
0x2c	010 11 00	$P \pm (C + CIN)$	Feedback add
0x2e	010 11 10	$P \pm (C + P + CIN)$	Double feedback add
0x2f	010 11 11	$P \pm (A:B + C + CIN)$	Feedback add add
0x30	011 00 00	$C \pm CIN$	C Select
0x32	011 00 10	$C \pm (P + CIN)$	Feedback add
0x33	011 00 11	$C \pm (A:B + CIN)$	36-bit adder
0x35	011 01 01	$C \pm (A \times B + CIN)$	Multiply add
0x3c	011 11 00	$C \pm (C + CIN)$	Double
0x3e	011 11 10	$C \pm (C + P + CIN)$	Double add feedback add
0x3f	011 11 11	$C \pm (A:B + C + CIN)$	Double add
0x50	101 00 00	$Shift(PCIN) \pm CIN$	17-bit shift P cascade select
0x52	101 00 10	$Shift(PCIN) \pm (P + CIN)$	17-bit shift P cascade feedback add
0x53	101 00 11	$Shift(PCIN) \pm (A:B + CIN)$	17-bit shift P cascade add
0x55	101 01 01	$Shift(PCIN) \pm (A \times B + CIN)$	17-bit shift P cascade multiply add
0x5c	101 11 00	$Shift(PCIN) \pm (C + CIN)$	17-bit shift P cascade add
0x5e	101 11 10	$Shift(PCIN) \pm (C + P + CIN)$	17-bit shift P cascade feedback add add
0x5c	101 11 11	$Shift(PCIN) \pm (A:B + C + CIN)$	17-bit shift P cascade add add
0x60	110 00 00	$Shift(P) \pm CIN$	17-bit shift feedback
0x62	110 00 10	$Shift(P) \pm (P + CIN)$	17-bit shift feedback feedback add
0x63	110 00 11	$Shift(P) \pm (A:B + CIN)$	17-bit shift feedback add
0x65	110 01 01	$Shift(P) \pm (A \times B + CIN)$	17-bit shift feedback multiply add
0x6c	110 11 00	$Shift(P) \pm (C + CIN)$	17-bit shift feedback add
0x6e	110 11 10	$Shift(P) \pm (C + P + CIN)$	17-bit shift feedback feedback add add
0x6f	110 11 11	$Shift(P) \pm (A:B + C + CIN)$	17-bit shift feedback add add

### *Rounding Modes Supported by Carry Logic*

In addition to the OpMode inputs, the data inputs to the three input adder/subtractor, and the subtract control bit, the adder/subtractor output is a result of the carry-input logic.

CarryInSel signals, the Subtract control signal, and the OpMode control signals can be optionally registered under the control of the configuration RAM (denoted by the grey colored multiplexer symbol). This allows the control signals pipeline delay to match the pipeline delay for data in the design. The CarryInSel signals, the Subtract control signal, and the OpMode control signals share a common reset signal (RSTCTRL) and the Subtract control signal, and the OpMode control signals share a common clock enable signal. The clock enable allows control signals to stall along with data when needed.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
AREG	Integer	0, 1, 2	1	Selects whether to register the A input to the DSP48.
B_INPUT	String	"DIRECT" or "CASCADE"	"DIRECT"	"DIRECT"= multiplicand is B; "CASCADE"= multiplicand is BCIN.
BREG	Integer	0, 1, 2	1	Selects whether to register the B input to the DSP48.
CARRYINREG	Integer	0,1	1	Number of pipeline registers for the CARRYIN input.
CARRYINSELREG	Integer	0, 1	1	Number of pipeline registers for the CARRYINSEL.
CREG	Integer	0, 1, 2	1	Selects whether to register the C input to the DSP48.
LEGACY_MODE	String	"NONE," "MULT18X18", or "MULT18X18S"	"MULT18X18S"	An internal attribute setting for the DCM. It should not be modified from the default value.
MREG	Integer	0, 1	1	Selects whether to register the multiplier stage of the DSP48. Enable=1/disable=0.
OPMODEREG	Integer	0, 1	1	Number of pipeline registers on OPMODE input, 0 or 1.
PREG	Integer	0, 1	1	Selects whether to register the C input to the DSP48.
SUBTRACTREG	Integer	0, 1	1	Number of pipeline registers on the SUBTRACT input, 0 or 1.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## EMAC

**Primitive: Fully integrated 10/100/1000 Mb/s Ethernet Media Access Controller (Ethernet MAC)**

### Introduction

This design element provides Ethernet connectivity to the Virtex®-4 PowerPC® Processor. The Ethernet MAC (EMAC) supports the following feature:

- Fully integrated 10/100/1000 Mb/s Ethernet MAC
- Complies with the IEEE 802.3-2002 specification
- Configurable full- or half-duplex operation
- Media Independent Interface (MII) Management (MDIO) interface to manage objects in the Physical (PHY) layer
- User-accessable raw statistics vector outputs
- Supports VLAN frames
- Configurable inter-frame gap adjustment
- Configurable in-band Frame Check Sequence (FCS) field passing on both transmit and receive paths
- Provides auto pad on transmit and FCS field stripping on receive
- Configured and monitored through a host interface
- Hardware selectable Device Control Register (DCR) bus or 1G Ethernet MAC bus host interface
- Configurable flow control through Ethernet MAC Control PAUSE frames; symmetrically or asymmetrically enabled
- Configurable support for jumbo frames of any length
- Configurable receive address filter for unicast, multicast, and broadcast addresses
- Media Independent Interface (MII), Gigabit Media Independent Interface (GMII), and Reduced Gigabit Media Independent Interface (RGMII)
- Includes a 1000BASE-X Physical Coding Sublayer (PCS) and a Physical Medium Attachment (PMA) sublayer for use with the Multi-gigabit Transceiver (MGT) to provide a complete on-chip 1000BASE-X implementation
- Serial Gigabit Media Independent Interface (SGMII) supported through MGT interface to external copper PHY layer

### Port Descriptions

Inputs	Outputs
RESET	
TIEEMAC0CONFIGVEC [79:0]	
TIEEMAC1CONFIGVEC [79:0]	
TIEEMAC0UNICASTADDR [47:0]	
TIEEMAC1UNICASTADDR [47:0]	
PHYEMAC0GTCLK	
PHYEMAC1GTCLK	
CLIENTEMAC0DCMLOCKED	EMAC0CLIENTANINTERRUPT
CLIENTEMAC1DCMLOCKED	EMAC1CLIENTANINTERRUPT
CLIENTEMAC0RXCLIENTCLKIN	EMAC0CLIENTRXCLIENTCLKOUT
	EMAC0CLIENTRXD [15:0]

Inputs	Outputs
	EMAC0CLIENTRXDVLD
	EMAC0CLIENTRXDVLDMSW
	EMAC0CLIENTRXGOODFRAME
	EMAC0CLIENTRXBADFRAME
	EMAC0CLIENTRXFRAMEDROP
	EMAC0CLIENTRXDVREG6
	EMAC0CLIENTRXSTATS [6:0]
	EMAC0CLIENTRXSTATSBYTEVLD
	EMAC0CLIENTRXSTATSVLD
CLIENTEMAC1RXCLIENTCLKIN	EMAC1CLIENTRXCLIENTCLKOUT
	EMAC1CLIENTRXD [15:0]
	EMAC1CLIENTRXDVLD
	EMAC1CLIENTRXDVLDMSW
	EMAC1CLIENTRXGOODFRAME
	EMAC1CLIENTRXBADFRAME
	EMAC1CLIENTRXFRAMEDROP
	EMAC1CLIENTRXDVREG6
	EMAC1CLIENTRXSTATS [6:0]
	EMAC1CLIENTRXSTATSBYTEVLD
	EMAC1CLIENTRXSTATSVLD
CLIENTEMAC0TXGMIIMIICKIN	EMAC0CLIENTTXGMIIMIICKOUT
CLIENTEMAC0TXCLIENTCLKIN	EMAC0CLIENTTXCLIENTCLKOUT
CLIENTEMAC0TXD [15:0]	EMAC0CLIENTTXACK
CLIENTEMAC0TXDVLD	EMAC0CLIENTTXCOLLISION
CLIENTEMAC0TXDVLDMSW	EMAC0CLIENTTXRETRANSMIT
CLIENTEMAC0TXUNDERRUN	EMAC0CLIENTTXSTATS
CLIENTEMAC0TXIFGDELAY [7:0]	EMAC0CLIENTTXSTATSBYTEVLD
CLIENTEMAC0TXFIRSTBYTE	EMAC0CLIENTTXSTATSVLD
CLIENTEMAC1TXGMIIMIICKIN	EMAC1CLIENTTXGMIIMIICKOUT
CLIENTEMAC1TXCLIENTCLKIN	EMAC1CLIENTTXCLIENTCLKOUT
CLIENTEMAC1TXD [15:0]	EMAC1CLIENTTXACK
CLIENTEMAC1TXDVLD	EMAC1CLIENTTXCOLLISION
CLIENTEMAC1TXDVLDMSW	EMAC1CLIENTTXRETRANSMIT
CLIENTEMAC1TXUNDERRUN	EMAC1CLIENTTXSTATS
CLIENTEMAC1TXIFGDELAY [7:0]	EMAC1CLIENTTXSTATSBYTEVLD
CLIENTEMAC1TXFIRSTBYTE	EMAC1CLIENTTXSTATSVLD
CLIENTEMAC0PAUSEREQ	
CLIENTEMAC0PAUSEVAL [15:0]	

Inputs	Outputs
CLIENTEMAC1PAUSEREQ	
CLIENTEMAC1PAUSEVAL [15:0]	
HOSTADDR [9:0]	HOSTMIIMRDY
HOSTCLK	HOSTRDDATA [31:0]
HOSTMIIMSEL	
HOSTOPCODE [1:0]	
HOSTREQ	
HOSTWRDATA [31:0]	
HOSTEMAC1SEL	
DCREMACCLK	DCRHOSTDONEIR
DCREMACENABLE	EMACDCRACK
DCREMACDBUS [0:31]	EMACDCRDBUS [0:31]
DCREMACABUS [8:9]	
DCREMACREAD	
DCREMACWRITE	
PHYEMAC0RXCLK	EMAC0PHYTXCLK
PHYEMAC0RXD [7:0]	EMAC0PHYTXD [7:0]
PHYEMAC0RXDV	EMAC0PHYTXEN
PHYEMAC0RXER	EMAC0PHYTXER
PHYEMAC0MIITXCLK	
PHYEMAC0COL	
PHYEMAC0CRS	
PHYEMAC1RXCLK	EMAC1PHYTXCLK
PHYEMAC1RXD [7:0]	EMAC1PHYTXD [7:0]
PHYEMAC1RXDV	EMAC1PHYTXEN
PHYEMAC1RXER	EMAC1PHYTXER
PHYEMAC1MIITXCLK	
PHYEMAC1COL	
PHYEMAC1CRS	
PHYEMAC0SIGNALDET	EMAC0PHYENCOMMAALIGN
PHYEMAC0PHYAD [4:0]	EMAC0PHYLOOPBACKMSB
PHYEMAC0RXCLKCORCNT [2:0]	EMAC0PHYMGTRXRESET
PHYEMAC0RXBUFSTATUS [1:0]	EMAC0PHYMGTTXRESET
PHYEMAC0RXCHARISCOMMA	EMAC0PHYPOWERDOWN
PHYEMAC0RXCHARISK	EMAC0PHYSYNCAcqSTATUS
PHYEMAC0RXCHECKINGCRC	EMAC0PHYTXCHARDISPMODE
PHYEMAC0RXCOMMADET	EMAC0PHYTXCHARDISPVAL
PHYEMAC0RXDISPERR	EMAC0PHYTXCHARISK

Inputs	Outputs
PHYEMAC0RXLOSSOFSYNC [1:0]	
PHYEMAC0RXNOTINTABLE	
PHYEMAC0RXRUNDISP	
PHYEMAC0RXBUFERR	
PHYEMAC0TXBUFERR	
PHYEMAC1SIGNALDET	EMAC1PHYENCOMMAALIGN
PHYEMAC1PHYAD [4:0]	EMAC1PHYLOOPBACKMSB
PHYEMAC1RXCLKCORCNT [2:0]	EMAC1PHYMGTRXRESET
PHYEMAC1RXBUFSTATUS [1:0]	EMAC1PHYMGTTXRESET
PHYEMAC1RXCHARISCOMMA	EMAC1PHYPOWERDOWN
PHYEMAC1RXCHARISK	EMAC1PHYSYNCCACQSTATUS
PHYEMAC1RXCHECKINGCRC	EMAC1PHYTXCHARDISPMODE
PHYEMAC1RXCOMMADET	EMAC1PHYTXCHARDISPVAL
PHYEMAC1RXDISPERR	EMAC1PHYTXCHARISK
PHYEMAC1RXLOSSOFSYNC [1:0]	
PHYEMAC1RXNOTINTABLE	
PHYEMAC1RXRUNDISP	
PHYEMAC1RXBUFERR	
PHYEMAC1TXBUFERR	
PHYEMAC0MCLKIN	EMAC0PHYMCLKOUT
PHYEMAC0MDIN	EMAC0PHYMDOUT
	EMAC0PHYMDTRI
PHYEMAC1MCLKIN	EMAC1PHYMCLKOUT
PHYEMAC1MDIN	EMAC1PHYMDOUT
	EMAC1PHYMDTRI

## Design Entry Method

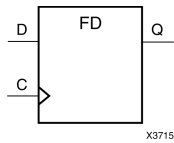
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD

### Primitive: D Flip-Flop



## Introduction

This design element is a D-type flip-flop with data input (D) and data output (Q). The data on the D inputs is loaded into the flip-flop during the Low-to-High clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
0	↑	0
1	↑	1

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

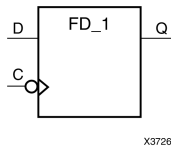
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD\_1

### Primitive: D Flip-Flop with Negative-Edge Clock



## Introduction

This design element is a single D-type flip-flop with data input (D) and data output (Q). The data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
0	↓	0
1	↓	1

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

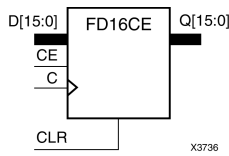
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FD16CE

### Macro: 16-Bit Data Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a 16-bit data register with clock enable and asynchronous clear. When clock enable (CE) is High and asynchronous clear (CLR) is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q) during the Low-to-High clock (C) transition. When CLR is High, it overrides all other inputs and resets the data outputs (Q) Low. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	CE	Dz : D0	C	Qz : Q0
1	X	X	X	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

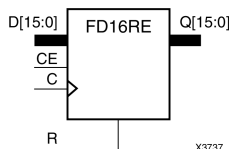
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 16-bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD16RE

### Macro: 16-Bit Data Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a 16-bit data registers. When the clock enable (CE) input is High, and the synchronous reset (R) input is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q0) during the Low-to-High clock (C) transition. When R is High, it overrides all other inputs and resets the data outputs (Q) Low on the Low-to-High clock transition. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
R	CE	Dz : D0	C	Qz : Q0
1	X	X	↑	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

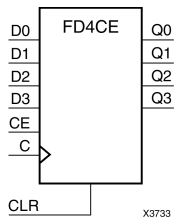
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 16-bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD4CE

### Macro: 4-Bit Data Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a 4-bit data register with clock enable and asynchronous clear. When clock enable (CE) is High and asynchronous clear (CLR) is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q) during the Low-to-High clock (C) transition. When CLR is High, it overrides all other inputs and resets the data outputs (Q) Low. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	CE	Dz : D0	C	Qz : Q0
1	X	X	X	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

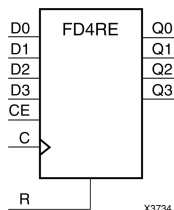
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 4-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD4RE

### Macro: 4-Bit Data Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a 4-bit data registers. When the clock enable (CE) input is High, and the synchronous reset (R) input is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q0) during the Low-to-High clock (C) transition. When R is High, it overrides all other inputs and resets the data outputs (Q) Low on the Low-to-High clock transition. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
R	CE	Dz : D0	C	Qz : Q0
1	X	X	↑	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

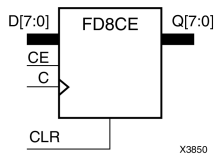
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 4-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD8CE

### Macro: 8-Bit Data Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a 8-bit data register with clock enable and asynchronous clear. When clock enable (CE) is High and asynchronous clear (CLR) is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q) during the Low-to-High clock (C) transition. When CLR is High, it overrides all other inputs and resets the data outputs (Q) Low. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
CLR	CE	Dz : D0	C	Qz : Q0
1	X	X	X	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

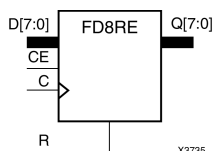
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 8-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FD8RE

### Macro: 8-Bit Data Register with Clock Enable and Synchronous Reset



## Introduction

This design element is an 8-bit data register. When the clock enable (CE) input is High, and the synchronous reset (R) input is Low, the data on the data inputs (D) is transferred to the corresponding data outputs (Q0) during the Low-to-High clock (C) transition. When R is High, it overrides all other inputs and resets the data outputs (Q) Low on the Low-to-High clock transition. When CE is Low, clock transitions are ignored.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
R	CE	Dz : D0	C	Qz : Q0
1	X	X	↑	0
0	0	X	X	No Change
0	1	Dn	↑	Dn
z = bit-width - 1				

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

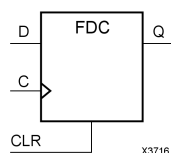
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 8-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDC

### Primitive: D Flip-Flop with Asynchronous Clear



## Introduction

This design element is a single D-type flip-flop with data (D) and asynchronous clear (CLR) inputs and data output (Q). The asynchronous CLR, when High, overrides all other inputs and sets the (Q) output Low. The data on the (D) input is loaded into the flip-flop when CLR is Low on the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CLR	D	C	Q
1	X	X	0
0	D	↑	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

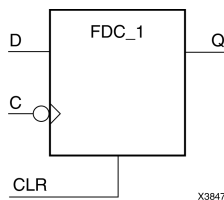
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDC\_1

### Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Clear



## Introduction

FDC\_1 is a single D-type flip-flop with data input (D), asynchronous clear input (CLR), and data output (Q). The asynchronous CLR, when active, overrides all other inputs and sets the (Q) output Low. The data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CLR	D	C	Q
1	X	X	0
0	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

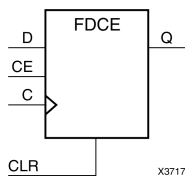
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FDCE

### Primitive: D Flip-Flop with Clock Enable and Asynchronous Clear



## Introduction

This design element is a single D-type flip-flop with clock enable and asynchronous clear. When clock enable (CE) is High and asynchronous clear (CLR) is Low, the data on the data input (D) of this design element is transferred to the corresponding data output (Q) during the Low-to-High clock (C) transition. When CLR is High, it overrides all other inputs and resets the data output (Q) Low. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	CE	D	C	Q
1	X	X	X	0
0	0	X	X	No Change
0	1	D	↑	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

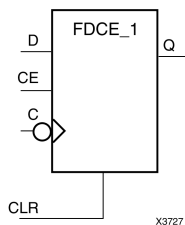
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDCE\_1

Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Clear



## Introduction

This design element is a single D-type flip-flop with data (D), clock enable (CE), asynchronous clear (CLR) inputs, and data output (Q). The asynchronous CLR input, when High, overrides all other inputs and sets the Q output Low. The data on the (D) input is loaded into the flip-flop when CLR is Low and CE is High on the High-to-Low clock (C) transition. When CE is Low, the clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
CLR	CE	D	C	Q
1	X	X	X	0
0	0	X	X	No Change
0	1	D	↓	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

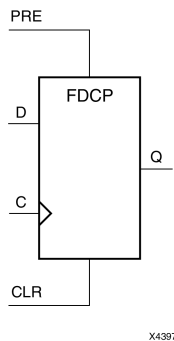
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDCP

### Primitive: D Flip-Flop with Asynchronous Preset and Clear



## Introduction

This design element is a single D-type flip-flop with data (D), asynchronous preset (PRE) and clear (CLR) inputs, and data output (Q). The asynchronous PRE, when High, sets the (Q) output High; CLR, when High, resets the output Low. Data on the (D) input is loaded into the flip-flop when PRE and CLR are Low on the Low-to-High clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	PRE	D	C	Q
1	X	X	X	0
0	1	X	X	1
0	0	D	↑	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

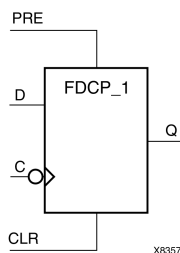
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDCP\_1

Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Preset and Clear



## Introduction

This design element is a single D-type flip-flop with data (D), asynchronous preset (PRE) and clear (CLR) inputs, and data output (Q). The asynchronous PRE, when High, sets the (Q) output High; CLR, when High, resets the output Low. Data on the (D) input is loaded into the flip-flop when PRE and CLR are Low on the High-to-Low clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
CLR	PRE	D	C	Q
1	X	X	X	0
0	1	X	X	1
0	0	0	↓	0
0	0	1	↓	1

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

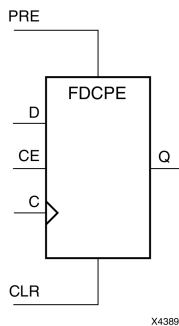
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDCPE

### Primitive: D Flip-Flop with Clock Enable and Asynchronous Preset and Clear



## Introduction

This design element is a single D-type flip-flop with data (D), clock enable (CE), asynchronous preset (PRE), and asynchronous clear (CLR) inputs. The asynchronous active high PRE sets the Q output High; that active high CLR resets the output Low and has precedence over the PRE input. Data on the D input is loaded into the flip-flop when PRE and CLR are Low and CE is High on the Low-to-High clock (C) transition. When CE is Low, the clock transitions are ignored and the previous value is retained. The FDCPE is generally implemented as a slice or IOB register within the device.

For FPGA devices, upon power-up, the initial value of this component is specified by the INIT attribute. If a subsequent GSR (Global Set/Reset) is asserted, the flop is asynchronously set to the INIT value.

**Note** While this device supports the use of asynchronous set and reset, it is not generally recommended to be used for in most cases. Use of asynchronous signals pose timing issues within the design that are difficult to detect and control and also have an adverse affect on logic optimization causing a larger design that can consume more power than if a synchronous set or reset is used.

## Logic Table

Inputs					Outputs
CLR	PRE	CE	D	C	Q
1	X	X	X	X	0
0	1	X	X	X	1
0	0	0	X	X	No Change
0	0	1	D	↑	D

## Port Descriptions

Port	Direction	Width	Function
Q	Output	1	Data output
C	Input	1	Clock input
CE	Input	1	Clock enable input
CLR	Input	1	Asynchronous clear input
D	Input	1	Data input
PRE	Input	1	Asynchronous set input

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

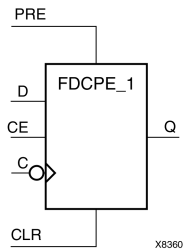
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0,1	0	Sets the initial value of Q output after configuration and on GSR.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDCPE\_1

**Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Preset and Clear**



### Introduction

FDCPE\_1 is a single D-type flip-flop with data (D), clock enable (CE), asynchronous preset (PRE), and asynchronous clear (CLR) inputs and data output (Q). The asynchronous PRE, when High, sets the (Q) output High; CLR, when High, resets the output Low. Data on the (D) input is loaded into the flip-flop when PRE and CLR are Low and CE is High on the High-to-Low clock (C) transition. When CE is Low, the clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

### Logic Table

Inputs					Outputs
CLR	PRE	CE	D	C	Q
1	X	X	X	X	0
0	1	X	X	X	1
0	0	0	X	X	No Change
0	0	1	D	↓	D

### Port Descriptions

Port	Direction	Width	Function
Q	Output	1	Data output
C	Input	1	Clock input
CE	Input	1	Clock enable input
CLR	Input	1	Asynchronous clear input
D	Input	1	Data input
PRE	Input	1	Asynchronous set input

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0,1	0	Sets the initial value of Q output after configuration and on GSR.

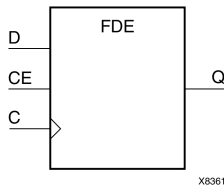
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FDE

### Primitive: D Flip-Flop with Clock Enable



## Introduction

This design element is a single D-type flip-flop with data input (D), clock enable (CE), and data output (Q). When clock enable is High, the data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
0	X	X	No Change
1	0	↑	0
1	1	↑	1

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

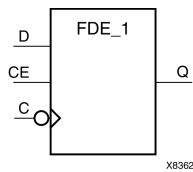
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDE\_1

### Primitive: D Flip-Flop with Negative-Edge Clock and Clock Enable



## Introduction

This design element is a single D-type flip-flop with data input (D), clock enable (CE), and data output (Q). When clock enable is High, the data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
0	X	X	No Change
1	0	↓	0
1	1	↓	1

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

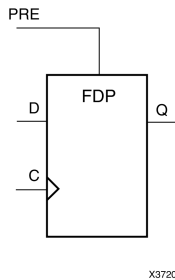
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDP

### Primitive: D Flip-Flop with Asynchronous Preset



## Introduction

This design element is a single D-type flip-flop with data (D) and asynchronous preset (PRE) inputs and data output (Q). The asynchronous PRE, when High, overrides all other inputs and presets the (Q) output High. The data on the (D) input is loaded into the flip-flop when PRE is Low on the Low-to-High clock (C) transition.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
PRE	C	D	Q
1	X	X	1
0	↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

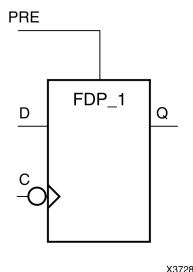
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDP\_1

### Primitive: D Flip-Flop with Negative-Edge Clock and Asynchronous Preset



## Introduction

This design element is a single D-type flip-flop with data (D) and asynchronous preset (PRE) inputs and data output (Q). The asynchronous PRE, when High, overrides all other inputs and presets the Q output High. The data on the D input is loaded into the flip-flop when PRE is Low on the High-to-Low clock (C) transition.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
PRE	C	D	Q
1	X	X	1
0	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

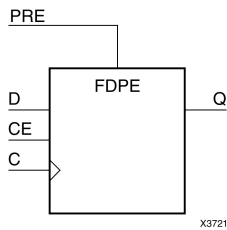
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDPE

### Primitive: D Flip-Flop with Clock Enable and Asynchronous Preset



## Introduction

This design element is a single D-type flip-flop with data (D), clock enable (CE), and asynchronous preset (PRE) inputs and data output (Q). The asynchronous PRE, when High, overrides all other inputs and sets the (Q) output High. Data on the (D) input is loaded into the flip-flop when PRE is Low and CE is High on the Low-to-High clock (C) transition. When CE is Low, the clock transitions are ignored.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
PRE	CE	D	C	Q
1	X	X	X	1
0	0	X	X	No Change
0	1	D	↑	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

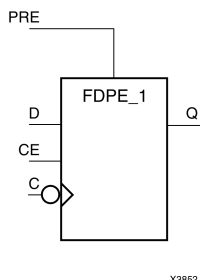
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDPE\_1

Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Asynchronous Preset



### Introduction

This design element is a single D-type flip-flop with data (D), clock enable (CE), and asynchronous preset (PRE) inputs and data output (Q). The asynchronous PRE, when High, overrides all other inputs and sets the (Q) output High. Data on the (D) input is loaded into the flip-flop when PRE is Low and CE is High on the High-to-Low clock (C) transition. When CE is Low, the clock transitions are ignored.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

### Logic Table

Inputs				Outputs
PRE	CE	D	C	Q
1	X	X	X	1
0	0	X	X	No Change
0	1	D	↓	D

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

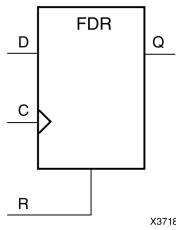
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDR

### Primitive: D Flip-Flop with Synchronous Reset



## Introduction

This design element is a single D-type flip-flop with data (D) and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low on the Low-to-High clock (C) transition. The data on the (D) input is loaded into the flip-flop when R is Low during the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
R	D	C	Q
1	X	↑	0
0	D	↑	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

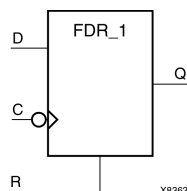
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDR\_1

### Primitive: D Flip-Flop with Negative-Edge Clock and Synchronous Reset



## Introduction

This design element is a single D-type flip-flop with data (D) and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low on the High-to-Low clock (C) transition. The data on the (D) input is loaded into the flip-flop when R is Low during the High-to-Low clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
R	D	C	Q
1	X	↓	0
0	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

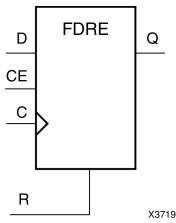
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FDRE

### Primitive: D Flip-Flop with Clock Enable and Synchronous Reset



## Introduction

This design element is a single D-type flip-flop with data (D), clock enable (CE), and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low on the Low-to-High clock (C) transition. The data on the (D) input is loaded into the flip-flop when R is Low and CE is High during the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
R	CE	D	C	Q
1	X	X	↑	0
0	0	X	X	No Change
0	1	D	↑	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

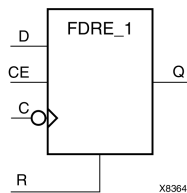
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDRE\_1

Primitive: D Flip-Flop with Negative-Clock Edge, Clock Enable, and Synchronous Reset



## Introduction

FDRE\_1 is a single D-type flip-flop with data (D), clock enable (CE), and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low on the High-to-Low clock (C) transition. The data on the (D) input is loaded into the flip-flop when R is Low and CE is High during the High-to-Low clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs				Outputs
R	CE	D	C	Q
1	X	X	↓	0
0	0	X	X	No Change
0	1	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

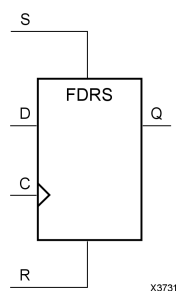
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDRS

### Primitive: D Flip-Flop with Synchronous Reset and Set



## Introduction

FDRS is a single D-type flip-flop with data (D), synchronous set (S), and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low during the Low-to-High clock (C) transition. (Reset has precedence over Set.) When S is High and R is Low, the flip-flop is set, output High, during the Low-to-High clock transition. When R and S are Low, data on the (D) input is loaded into the flip-flop during the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
R	S	D	C	Q
1	X	X	↓	0
0	1	X	↓	1
0	0	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

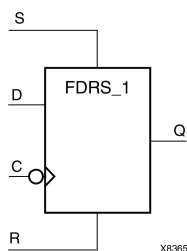
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDRS\_1

Primitive: D Flip-Flop with Negative-Clock Edge and Synchronous Reset and Set



## Introduction

FDRS\_1 is a single D-type flip-flop with data (D), synchronous set (S), and synchronous reset (R) inputs and data output (Q). The synchronous reset (R) input, when High, overrides all other inputs and resets the (Q) output Low during the High-to-Low clock (C) transition. (Reset has precedence over Set.) When S is High and R is Low, the flip-flop is set, output High, during the High-to-Low clock transition. When R and S are Low, data on the (D) input is loaded into the flip-flop during the High-to-Low clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
R	S	D	C	Q
1	X	X	↓	0
0	1	X	↓	1
0	0	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

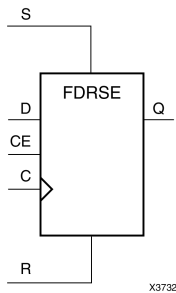
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDRSE

### Primitive: D Flip-Flop with Synchronous Reset and Set and Clock Enable



## Introduction

FDRSE is a single D-type flip-flop with synchronous reset (R), synchronous set (S), clock enable (CE) inputs. The reset (R) input, when High, overrides all other inputs and resets the Q output Low during the Low-to-High clock transition. (Reset has precedence over Set.) When the set (S) input is High and R is Low, the flip-flop is set, output High, during the Low-to-High clock (C) transition. Data on the D input is loaded into the flip-flop when R and S are Low and CE is High during the Low-to-High clock transition.

Upon power-up, the initial value of this component is specified by the INIT attribute. If a subsequent GSR (Global Set/Reset) is asserted, the flop is asynchronously set to the INIT value.

## Logic Table

Inputs					Outputs
R	S	CE	D	C	Q
1	X	X	X	↑	0
0	1	X	X	↑	1
0	0	0	X	X	No Change
0	0	1	1	↑	1
0	0	1	0	↑	0

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

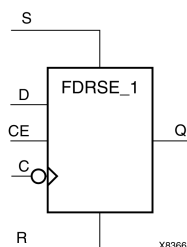
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0,1	0	Sets the initial value of Q output after configuration and on GSR.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDRSE\_1

**Primitive: D Flip-Flop with Negative-Clock Edge, Synchronous Reset and Set, and Clock Enable**



## Introduction

FDRSE\_1 is a single D-type flip-flop with synchronous reset (R), synchronous set (S), and clock enable (CE) inputs and data output (Q). The reset (R) input, when High, overrides all other inputs and resets the (Q) output Low during the High-to-Low clock transition. (Reset has precedence over Set.) When the set (S) input is High and R is Low, the flip-flop is set, output High, during the High-to-Low clock (C) transition. Data on the (D) input is loaded into the flip-flop when (R) and (S) are Low and (CE) is High during the High-to-Low clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs					Outputs
R	S	CE	D	C	Q
1	X	X	X	↓	0
0	1	X	X	↓	1
0	0	0	X	X	No Change
0	0	1	D	↓	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

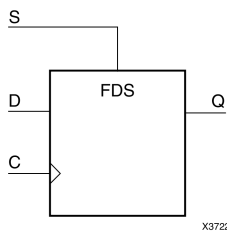
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0,1	0	Sets the initial value of Q output after configuration and on GSR.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDS

### Primitive: D Flip-Flop with Synchronous Set



## Introduction

FDS is a single D-type flip-flop with data (D) and synchronous set (S) inputs and data output (Q). The synchronous set input, when High, sets the Q output High on the Low-to-High clock (C) transition. The data on the D input is loaded into the flip-flop when S is Low during the Low-to-High clock (C) transition.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
S	D	C	Q
1	X	↑	1
0	D	↑	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

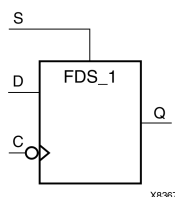
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDS\_1

### Primitive: D Flip-Flop with Negative-Edge Clock and Synchronous Set



## Introduction

FDS is a single D-type flip-flop with data (D) and synchronous set (S) inputs and data output (Q). The synchronous set input, when High, sets the Q output High on the Low-to-High clock (C) transition. The data on the D input is loaded into the flip-flop when S is Low during the Low-to-High clock (C) transition.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
S	D	C	Q
1	X	↓	1
0	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration.

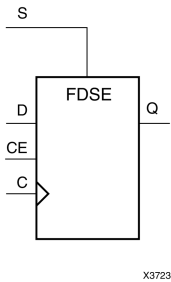
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FDSE

### Primitive: D Flip-Flop with Clock Enable and Synchronous Set



## Introduction

FDSE is a single D-type flip-flop with data (D), clock enable (CE), and synchronous set (S) inputs and data output (Q). The synchronous set (S) input, when High, overrides the clock enable (CE) input and sets the Q output High during the Low-to-High clock (C) transition. The data on the D input is loaded into the flip-flop when S is Low and CE is High during the Low-to-High clock (C) transition.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
S	CE	D	C	Q
1	X	X	↑	1
0	0	X	X	No Change
0	1	D	↑	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

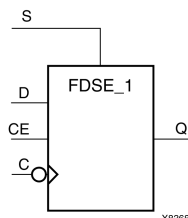
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FDSE\_1

### Primitive: D Flip-Flop with Negative-Edge Clock, Clock Enable, and Synchronous Set



## Introduction

FDSE\_1 is a single D-type flip-flop with data (D), clock enable (CE), and synchronous set (S) inputs and data output (Q). The synchronous set (S) input, when High, overrides the clock enable (CE) input and sets the Q output High during the High-to-Low clock (C) transition. The data on the D input is loaded into the flip-flop when S is Low and CE is High during the High-to-Low clock (C) transition.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs				Outputs
S	CE	D	C	Q
1	X	X	↓	1
0	0	X	X	No Change
0	1	D	↓	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

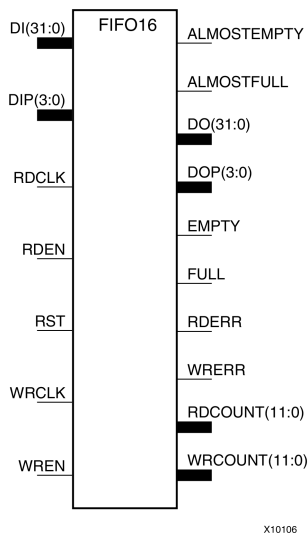
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FIFO16

### Primitive: Virtex-4 Block RAM Based, Built-In FIFO



X10106

## Introduction

A large percentage of FPGA designs implement FIFOs using block RAMs. In the Virtex®-4 architecture, additional dedicated logic in the block RAM enables you to easily implement synchronous or asynchronous FIFOs. This eliminates the need to use additional CLB logic for counter, comparator, or status flag generation and uses just one block RAM resource per FIFO. Both standard and first-word fall-through (FWFT) modes are supported.

**Standard Mode** -After the first word is written into an empty FIFO, the Empty flag deasserts synchronously with RDCLK. After Empty is deasserted Low and RDEN is asserted, the first word appears at DOUT on the rising edge of RDCLK.

**First Word Fall Through Mode** -After the first word is written into an empty FIFO, it automatically appears at DOUT after a few RDCLK cycles without asserting RDEN. Subsequent Read operations require Empty to be Low and RDEN to be High.

**Note** When using the dual-clock mode with independent clocks, depending on the offset between read and write clock edges, the Empty, Almost Empty, Full and Almost Full flags can deassert one cycle later. Due to the asynchronous nature of the clocks the simulation model only reflects the deassertion latency cycles listed in the architecture user guide.

The following table shows the FIFO capacity in the two modes:

FIFO Capacity Standard Mode	FWFT Mode
4k+1 entries by 4 bits	4k+2 entries by 4 bits
2k+1 entries by 9 bits	2k+2 entries by 9 bits
1k+1 entries by 18 bits	1k+2 entries by 18 bits
512+1 entries by 36 bits	512+2 entries by 36 bits

The block RAM can be configured as an asynchronous first-in/first-out (FIFO) memory with independent read and write clocks for either synchronous or asynchronous operation. Port A of the block RAM is used as a FIFO read port, and Port B is a FIFO write port. Data is read from the FIFO on the rising edge of read clock and written to the FIFO on the rising edge of write clock. Independent read and write port width selection is not supported in FIFO mode.

The available status flags are:

- **Full (FULL)** - Synchronous to WRCLK. The Full flag is asserted when there are no more available entries in the FIFO queue. When the FIFO is full, the write pointer will be frozen. This ensures the read and write pointers point to the same entry and no overflow will occur. The Full flag is registered at the output and takes one write cycle to assert. The Full flag is deasserted three clock cycles after the last entry is read, and it is synchronous to WRCLK.
- **Empty (EMPTY)** - Synchronous to RDCLK.
- **Almost Full (AFULL)** - Synchronous to WRCLK. The Almost Full flag is set when the FIFO has fewer than the number of available empty spaces specified by the ALMOST\_FULL\_OFFSET value. The Almost Full flag warns you to stop writing. It deasserts when the number of empty spaces in the FIFO is greater than the ALMOST\_FULL\_OFFSET value, and is synchronous to WRCLK.
- **Almost Empty (AEMPTY)** - Synchronous to RDCLK.
- **Write Count (WRCOUNT)** - Synchronous to WRCLK.
- **Write Error (WRERR)** - Synchronous to WRCLK. Once the Full flag has been asserted, any further write attempts will trigger the Write Error flag. The Write Error flag is deasserted when Write Enable or Full is deasserted Low. This signal is synchronous to WRCLK.
- **Read Count (RDCOUNT)** - Synchronous to RDCLK.
- **Read Error (RDERR)** - Synchronous to RDCLK.

## Port Descriptions

Port	Direction	Function
DI	Input	Data input
DIP	Input	Parity-bit input
WREN	Input	Write enable. When WREN = 1, data will be written to memory. When WREN = 0, write is disabled.
WRCLK	Input	Clock for write domain operation.
RDEN	Input	Read enable. When RDEN = 1, data will be read to output register. When RDEN = 0, read is disabled.
RDCLK	Input	Clock for read domain operation.
RESET	Input	Asynchronous reset of all FIFO functions, flags, and pointers.
DO	Output	Data output, synchronous to RDCLK
DOP	Output	Parity-bit output, synchronous to RDCLK
FULL	Output	All entries in FIFO memory are filled.
ALMOSTFULL	Output	Almost all entries in FIFO memory have been filled. Synchronous to WRCLK. The value is configurable by you.
EMPTY	Output	FIFO is empty. No additional read can be performed. Synchronous to RDCLK.
ALMOSTEMPTY	Output	Almost all valid entries in FIFO are read. Synchronous with RDCLK. The value is configurable by you.
RDCOUNT	Output	The FIFO data read pointer. It is synchronous with RDCLK. The value will wrap around if the maximum read pointer value has been reached.
WRCOUNT	Output	The FIFO data write pointer. It is synchronous with WRCLK. The value will wrap around if the maximum write pointer value has been reached.
WRERR	Output	When the FIFO is full, any additional write operation generates an error flag. Synchronous with WRCLK.
RDERR	Output	When the FIFO is empty, any additional read operation generates an error flag. Synchronous with RDCLK.

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

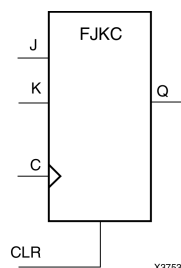
Attribute	Type	Allowed Values	Default	Description
ALMOST_EMPTY_OFFSET	Hexadecimal	Any 12-Bit Value	All zeros	Sets the almost empty threshold.
ALMOST_FULL_OFFSET	Hexadecimal	Any 12-Bit Value	All zeros	Sets almost full threshold.
DATA_WIDTH	Integer	4, 9, 18, 36	36	Sets data width to allowed value.
FIRST_WORD_FALL_THROUGH	Boolean	FALSE, TRUE	FALSE	Sets the FIFO FWFT to TRUE or FALSE.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKC

### Macro: J-K Flip-Flop with Asynchronous Clear



## Introduction

This design element is a single J-K-type flip-flop with J, K, and asynchronous clear (CLR) inputs and data output (Q). The asynchronous clear (CLR) input, when High, overrides all other inputs and resets the Q output Low. When CLR is Low, the output responds to the state of the J and K inputs, as shown in the following logic table, during the Low-to-High clock (C) transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	J	K	C	Q
1	X	X	X	0
0	0	0	↑	No Change
0	0	1	↑	0
0	1	0	↑	1
0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

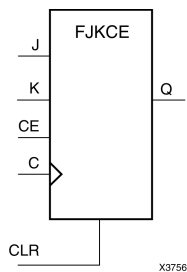
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKCE

### Macro: J-K Flip-Flop with Clock Enable and Asynchronous Clear



## Introduction

This design element is a single J-K-type flip-flop with J, K, clock enable (CE), and asynchronous clear (CLR) inputs and data output (Q). The asynchronous clear (CLR), when High, overrides all other inputs and resets the Q output Low. When CLR is Low and CE is High, Q responds to the state of the J and K inputs, as shown in the following logic table, during the Low-to-High clock transition. When CE is Low, the clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs					Outputs
CLR	CE	J	K	C	Q
1	X	X	X	X	0
0	0	X	X	X	No Change
0	1	0	0	X	No Change
0	1	0	1	↑	0
0	1	1	0	↑	1
0	1	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

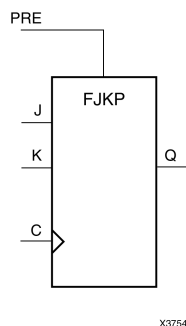


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKP

### Macro: J-K Flip-Flop with Asynchronous Preset



## Introduction

This design element is a single J-K-type flip-flop with J, K, and asynchronous preset (PRE) inputs and data output (Q). The asynchronous preset (PRE) input, when High, overrides all other inputs and sets the (Q) output High. When (PRE) is Low, the (Q) output responds to the state of the J and K inputs, as shown in the following logic table, during the Low-to-High clock transition.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
PRE	J	K	C	Q
1	X	X	X	1
0	0	0	X	No Change
0	0	1	↑	0
0	1	0	↑	1
0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

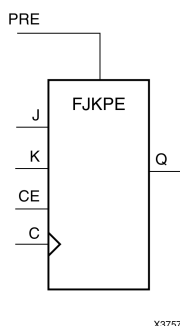
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKPE

### Macro: J-K Flip-Flop with Clock Enable and Asynchronous Preset



## Introduction

This design element is a single J-K-type flip-flop with J, K, clock enable (CE), and asynchronous preset (PRE) inputs and data output (Q). The asynchronous preset (PRE), when High, overrides all other inputs and sets the (Q) output High. When (PRE) is Low and (CE) is High, the (Q) output responds to the state of the J and K inputs, as shown in the logic table, during the Low-to-High clock (C) transition. When (CE) is Low, clock transitions are ignored.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs					Outputs
PRE	CE	J	K	C	Q
1	X	X	X	X	1
0	0	X	X	X	No Change
0	1	0	0	X	No Change
0	1	0	1	↑	0
0	1	1	0	↑	1
0	1	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

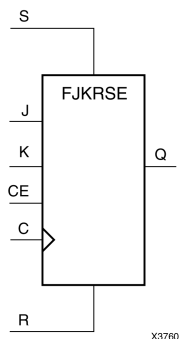
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKRSE

### Macro: J-K Flip-Flop with Clock Enable and Synchronous Reset and Set



## Introduction

This design element is a single J-K-type flip-flop with J, K, synchronous reset (R), synchronous set (S), and clock enable (CE) inputs and data output (Q). When synchronous reset (R) is High during the Low-to-High clock (C) transition, all other inputs are ignored and output (Q) is reset Low. When synchronous set (S) is High and (R) is Low, output (Q) is set High. When (R) and (S) are Low and (CE) is High, output (Q) responds to the state of the J and K inputs, according to the following logic table, during the Low-to-High clock (C) transition. When (CE) is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs						Outputs
R	S	CE	J	K	C	Q
1	X	X	X	X	↑	0
0	1	X	X	X	↑	1
0	0	0	X	X	X	No Change
0	0	1	0	0	X	No Change
0	0	1	0	1	↑	0
0	0	1	1	0	↑	1
0	0	1	1	0	↑	1
0	0	1	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

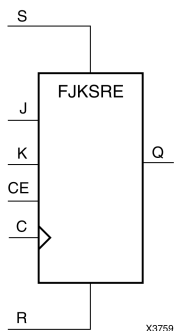
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FJKSRE

### Macro: J-K Flip-Flop with Clock Enable and Synchronous Set and Reset



## Introduction

This design element is a single J-K-type flip-flop with J, K, synchronous set (S), synchronous reset (R), and clock enable (CE) inputs and data output (Q). When synchronous set (S) is High during the Low-to-High clock (C) transition, all other inputs are ignored and output (Q) is set High. When synchronous reset (R) is High and (S) is Low, output (Q) is reset Low. When (S) and (R) are Low and (CE) is High, output (Q) responds to the state of the J and K inputs, as shown in the following logic table, during the Low-to-High clock (C) transition. When (CE) is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs						Outputs
S	R	CE	J	K	C	Q
1	X	X	X	X	↑	1
0	1	X	X	X	↑	0
0	0	0	X	X	X	No Change
0	0	1	0	0	X	No Change
0	0	1	0	1	↑	0
0	0	1	1	0	↑	1
0	0	1	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration.

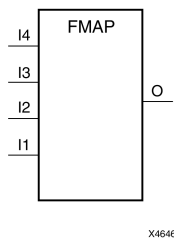


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FMAP

### Primitive: F Function Generator Partitioning Control Symbol



## Introduction

The FMAP symbol is used to map logic to the function generator of a slice. See the appropriate CAE tool interface user guide for information about specifying this attribute in your schematic design editor.

The MAP= *type* parameter can be used with the FMAP symbol to further define how much latitude you want to give the mapping program. The following table shows MAP option characters and their meanings

MAP Option Character	Function
P	Pins.
C	Closed — Adding logic to or removing logic from the CLB is not allowed.
L	Locked — Locking CLB pins.
O	Open — Adding logic to or removing logic from the CLB is allowed.
U	Unlocked — No locking on CLB pins.

Possible types of MAP parameters for FMAP are MAP=PUC, MAP=PLC, MAP=PLO, and MAP=PUO. The default parameter is PUO. If one of the “open” parameters is used (PLO or PUO), only the output signals must be specified.

**Note** Currently, only PUC and PUO are observed. PLC and PLO are translated into PUC and PUO, respectively.

The FMAP symbol can be assigned to specific CLB locations using LOC attributes.

## Design Entry Method

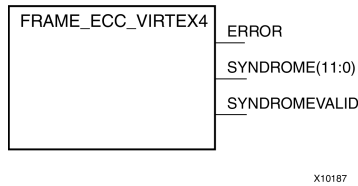
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FRAME\_ECC\_VIRTEX4

**Primitive:** Reads a Single, Virtex®-4 Configuration Frame and Computes a Hamming, Single-Error Correction, Double-Error Detection Syndrome



### Introduction

This design element reads a single Virtex®-4 configuration frame of 1312-bits, 32-bits at a time. It will then compute a Hamming single error correction, double error detection "syndrome." This identifies the single frame bit (if any), which is in error and should be corrected. It also indicates the presence of two bit errors, which cannot be corrected. Note that the FRAME\_ECC\_VIRTEX4 primitive does not repair changed bits.

### Port Descriptions

Port	Direction	Width	Function
ERROR	Output	1	Error Output. Indicates whether or not an error exists.
SYNDROME	Output	12	Indicates the location of the erroneous bit. Provides the bit location of the error and whether zero, one, or two erroneous bits are present.
SYNDROMEVALID	Output	1	When value is High, indicates the presence of zero, one or two bit errors in the frame. When asserted HIGH, SYNDROMEVALID indicates that the end of a frame readback.

### Design Entry Method

This design element can be used in schematics.

### Syndrome Value and Corresponding Error Status

Syndrome bit 11	Syndrome bit 10 to 0	Error Status
0	All 0s	No bit errors
0	Not equal to 0	One bit error, and syndrome value identifies the position of the erroneous bit
1	All 0s	Two bit errors, not correctable

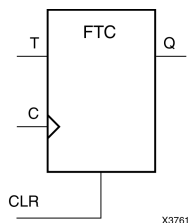
**Note** SYNDROME\_VALID must be HIGH for the values on the table above to be useful.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTC

### Macro: Toggle Flip-Flop with Asynchronous Clear



## Introduction

This design element is a synchronous, resettable toggle flip-flop. The asynchronous clear (CLR) input, when High, overrides all other inputs and resets the data output (Q) Low. The (Q) output toggles, or changes state, when the toggle enable (T) input is High and (CLR) is Low during the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CLR	T	C	Q
1	X	X	0
0	0	X	No Change
0	1	↑	Toggle

## Design Entry Method

You can instantiate this element when targeting a CPLD, but not when you are targeting an FPGA.

## Available Attributes

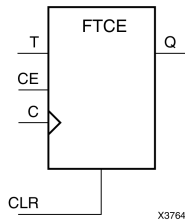
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTCE

### Macro: Toggle Flip-Flop with Clock Enable and Asynchronous Clear



## Introduction

This design element is a toggle flip-flop with toggle and clock enable and asynchronous clear. When the asynchronous clear (CLR) input is High, all other inputs are ignored and the data output (Q) is reset Low. When CLR is Low and toggle enable (T) and clock enable (CE) are High, Q output toggles, or changes state, during the Low-to-High clock (C) transition. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	CE	T	C	Q
1	X	X	X	0
0	0	X	X	No Change
0	1	0	X	No Change
0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

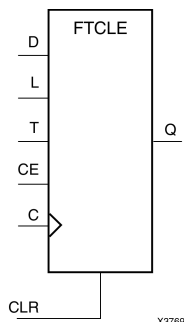
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTCLE

### Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Clear



## Introduction

This design element is a toggle/loadable flip-flop with toggle and clock enable and asynchronous clear. When the asynchronous clear input (CLR) is High, all other inputs are ignored and output Q is reset Low. When load enable input (L) is High and CLR is Low, clock enable (CE) is overridden and the data on data input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition. When toggle enable (T) and CE are High and L and CLR are Low, output Q toggles, or changes state, during the Low- to-High clock transition. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs						Outputs
CLR	L	CE	T	D	C	Q
1	X	X	X	X	X	0
0	1	X	X	D	↑	D
0	0	0	X	X	X	No Change
0	0	1	0	X	X	No Change
0	0	1	1	X	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

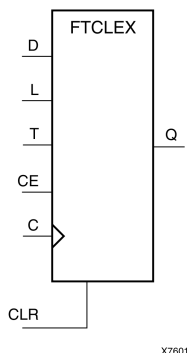
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTCLEX

### Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Clear



## Introduction

This design element is a toggle/loadable flip-flop with toggle and clock enable and asynchronous clear. When the asynchronous clear input (CLR) is High, all other inputs are ignored and output Q is reset Low. When load enable input (L) is High, CLR is Low, and CE is High, the data on data input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition. When toggle enable (T) and CE are High and L and CLR are Low, output Q toggles, or changes state, during the Low- to-High clock transition. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs						Outputs
CLR	L	CE	T	D	C	Q
1	X	X	X	X	X	0
0	1	X	X	D	↑	D
0	0	0	X	X	X	No Change
0	0	1	0	X	X	No Change
0	0	1	1	X	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration  For Spartan®-6, the INIT value should always match the polarity of the set or reset. For this element, the INIT should be 0. If set to 1, an asynchronous circuit must be created to exhibit this behavior, which Xilinx does not recommend.

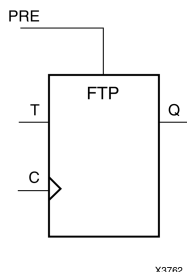


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTP

### Macro: Toggle Flip-Flop with Asynchronous Preset



## Introduction

This design element is a toggle flip-flop with toggle enable and asynchronous preset. When the asynchronous preset (PRE) input is High, all other inputs are ignored and output (Q) is set High. When toggle-enable input (T) is High and (PRE) is Low, output (Q) toggles, or changes state, during the Low-to-High clock (C) transition.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
PRE	T	C	Q
1	X	X	1
0	0	X	No Change
0	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

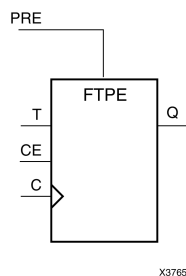
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	<p>Sets the initial value of Q output after configuration</p> <p>For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.</p>

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTPE

### Macro: Toggle Flip-Flop with Clock Enable and Asynchronous Preset



## Introduction

This design element is a toggle flip-flop with toggle and clock enable and asynchronous preset. When the asynchronous preset (PRE) input is High, all other inputs are ignored and output (Q) is set High. When the toggle enable input (T) is High, clock enable (CE) is High, and (PRE) is Low, output (Q) toggles, or changes state, during the Low-to-High clock transition. When (CE) is Low, clock transitions are ignored.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
PRE	CE	T	C	Q
1	X	X	X	1
0	0	X	X	No Change
0	1	0	X	No Change
0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

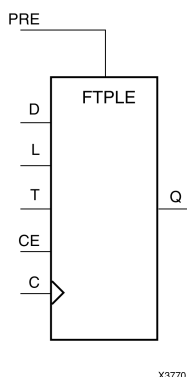
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTPLE

Macro: Toggle/Loadable Flip-Flop with Clock Enable and Asynchronous Preset



## Introduction

This design element is a toggle/loadable flip-flop with toggle and clock enable and asynchronous preset. When the asynchronous preset input (PRE) is High, all other inputs are ignored and output (Q) is set High. When the load enable input (L) is High and (PRE) is Low, the clock enable (CE) is overridden and the data (D) is loaded into the flip-flop during the Low-to-High clock transition. When L and PRE are Low and toggle-enable input (T) and (CE) are High, output (Q) toggles, or changes state, during the Low-to-High clock transition. When (CE) is Low, clock transitions are ignored.

For FPGA devices, this flip-flop is asynchronously preset, output High, when power is applied. Power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs						Outputs
PRE	L	CE	T	D	C	Q
1	X	X	X	X	X	1
0	1	X	X	D	↑	D
0	0	0	X	X	X	No Change
0	0	1	0	X	X	No Change
0	0	1	1	X	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

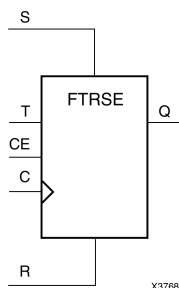
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration  For Spartan®-6, Xilinx recommends that the INIT value always matches the polarity of the set or reset. For this element, the INIT should be 1. If set to 0, additional asynchronous circuitry will be created to correctly model the behavior.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTRSE

### Macro: Toggle Flip-Flop with Clock Enable and Synchronous Reset and Set



## Introduction

This design element is a toggle flip-flop with toggle and clock enable and synchronous reset and set. When the synchronous reset input (R) is High, it overrides all other inputs and the data output (Q) is reset Low. When the synchronous set input (S) is High and (R) is Low, clock enable input (CE) is overridden and output (Q) is set High. (Reset has precedence over Set.) When toggle enable input (T) and (CE) are High and (R) and (S) are Low, output (Q) toggles, or changes state, during the Low-to-High clock transition.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs					Outputs
R	S	CE	T	C	Q
1	X	X	X	↑	0
0	1	X	X	↑	1
0	0	0	X	X	No Change
0	0	1	0	X	No Change
0	0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

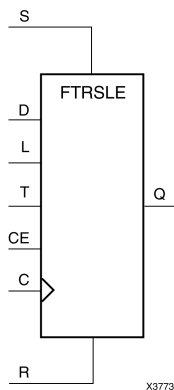
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTRSLE

**Macro: Toggle/Loadable Flip-Flop with Clock Enable and Synchronous Reset and Set**



## Introduction

This design element is a toggle/loadable flip-flop with toggle and clock enable and synchronous reset and set. The synchronous reset input (R), when High, overrides all other inputs and resets the data output (Q) Low. (Reset has precedence over Set.) When R is Low and synchronous set input (S) is High, the clock enable input (CE) is overridden and output Q is set High. When R and S are Low and load enable input (L) is High, CE is overridden and data on data input (D) is loaded into the flip-flop during the Low-to-High clock transition. When R, S, and L are Low, CE is High and T is High, output Q toggles, or changes state, during the Low-to-High clock transition. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs							Outputs
R	S	L	CE	T	D	C	Q
1	0	X	X	X	X	↑	0
0	1	X	X	X	X	↑	1
0	0	1	X	X	1	↑	1
0	0	1	X	X	0	↑	0
0	0	0	0	X	X	X	No Change
0	0	0	1	0	X	X	No Change
0	0	0	1	1	X	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

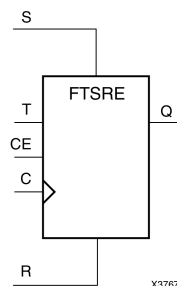
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## FTSRE

### Macro: Toggle Flip-Flop with Clock Enable and Synchronous Set and Reset



## Introduction

This design element is a toggle flip-flop with toggle and clock enable and synchronous set and reset. The synchronous set input, when High, overrides all other inputs and sets data output (Q) High. (Set has precedence over Reset.) When synchronous reset input (R) is High and S is Low, clock enable input (CE) is overridden and output Q is reset Low. When toggle enable input (T) and CE are High and S and R are Low, output Q toggles, or changes state, during the Low-to-High clock transition. When CE is Low, clock transitions are ignored.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs					Outputs
S	R	CE	T	C	Q
1	X	X	X	↑	1
0	1	X	X	↑	0
0	0	0	X	X	No Change
0	0	1	0	X	No Change
0	0	1	1	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

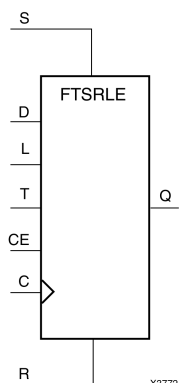
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## FTSRLE

### Macro: Toggle/Loadable Flip-Flop with Clock Enable and Synchronous Set and Reset



## Introduction

This design element is a toggle/loadable flip-flop with toggle and clock enable and synchronous set and reset. The synchronous set input (S), when High, overrides all other inputs and sets data output (Q) High. (Set has precedence over Reset.) When synchronous reset (R) is High and (S) is Low, clock enable input (CE) is overridden and output (Q) is reset Low. When load enable input (L) is High and S and R are Low, CE is overridden and data on data input (D) is loaded into the flip-flop during the Low-to-High clock transition. When the toggle enable input (T) and (CE) are High and (S), (R), and (L) are Low, output (Q) toggles, or changes state, during the Low-to-High clock transition. When (CE) is Low, clock transitions are ignored.

For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs							Outputs
S	R	L	CE	T	D	C	Q
1	X	X	X	X	X	↑	1
0	1	X	X	X	X	↑	0
0	0	1	X	X	1	↑	1
0	0	1	X	X	0	↑	0
0	0	0	0	X	X	X	No Change
0	0	0	1	0	X	X	No Change
0	0	0	1	1	X	↑	Toggle

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

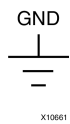
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# GND

## Primitive: Ground-Connection Signal Tag



## Introduction

The GND signal tag, or parameter, forces a net or input function to a Low logic level. A net tied to GND cannot have any other source.

When the logic-trimming software or fitter encounters a net or input function tied to GND, it removes any logic that is disabled by the GND signal. The GND signal is only implemented when the disabled logic cannot be removed.

## Design Entry Method

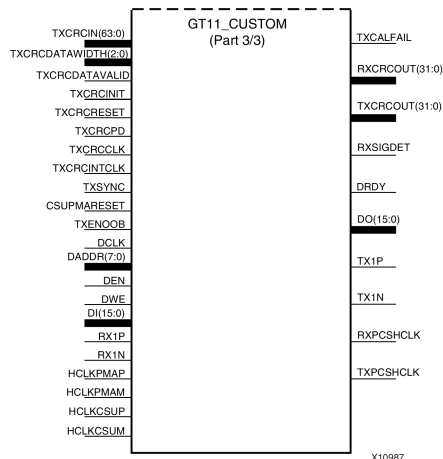
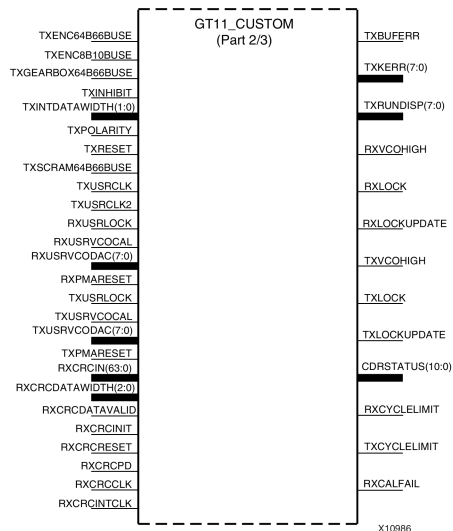
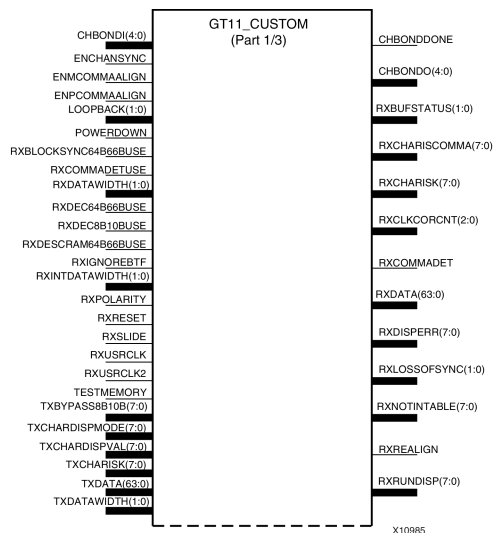
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## GT11\_CUSTOM

Primitive: RocketIO MGTs with 622 Mb/s to 11.1 Gb/s Data Rates, 8 to 24 Transceivers per FPGA, and 2.5 GHz 5.55 GHz VCO, Less Than 1ns RMS Jitter



## Introduction

This design element is a RocketIO™ MGT. RocketIO MGTs have flexible, programmable features that allow a multi-gigabit serial transceiver to be easily integrated into any Virtex®-4 design. These elements support the following features:

- 10.3 Gb/s data rates
- 8 to 24 transceivers per FPGA
- 2.5 GHz - 5.55 GHz VCO, less than 1ns RMS jitter
- Transmitter pre-emphasis
- Receiver continuous time equalization
- On-chip AC coupled receiver, with optional by-pass
- Receiver signal detect and loss of signal indicator, out of band signal receiver
- Transmit driver idle state for out of band signaling-both outputs at Vcm
- 8B/10B or 64B/66B encoding, or no data encoding (pass through mode)
- Channel bonding
- Flexible Cyclic Redundancy Check (CRC) generation and checking
- Pins for transmitter and receiver termination voltage
- You can reconfigure, using the secondary (dynamic) configuration bus
- Multiple loopback paths including PMA RX-TX path

RocketIO MGTs are only available in FX devices.

## Logic Table

Inputs	Outputs
CHBONDI [4:0]	DRDY
CSUPMARESET	RXBUFERR
DADDR [7:0]	RXCALFAIL
DCLK	RXCOMMADET
DEN	RXCYLELIMIT
DI [15:0]	RXLOCK
DWE	RXRealIGN
ENCHANSYNC	RXRECCLK1
ENMCOMMAALIGN	RXBCLK
ENPCOMMAALIGN	RXRECCLK2
GREFCLK	RXSIGDET
LOOPBACK [1:0]	TX1N
POWERDOWN	TX1P
REFCLK1	TXBUFERR
REFCLK2	TXCALFAIL
RX1N	TXCYCLELIMIT
RX1P	TXLOCK
RXBLOCKSYNC64B66BUSE	DO [15:0]
RXCLKSTABLE	RXLOSSOFSYNC [1:0]

Inputs	Outputs
RXCOMMADETUSE	RXCRCOUT [31:0]
RXCRCCLK	TXCRCOUT [31:0]
RXCRCDATAVALID	CHBONDO [4:0]
RXCRCDATAWIDTH [2:0]	RXSTATUS [5:0]
RXCRCIN [63:0]	RXDATA [63:0]
RXCRCINIT	RXCHARISCOMMA [7:0]
RXCRCINTCLK	RXCHARISK [7:0]
RXCRCPD	RXDISPERR [7:0]
RXCRCRESET	RXNOTINTABLE [7:0]
RXDATAWIDTH [1:0]	RXRUNDISP [7:0]
RXDEC64B66BUSE	TXRUNDISP [7:0]
RXDEC8B10BUSE	TXKERR [7:0]
RXDESCRAM64B66BUSE	
RXIGNOREBTF	
RXINTDATAWIDTH [1:0]	
RXPMARESET	
RXPOLARITY	
RXRESET	
RXSLIDE	
RXUSRCLK	
RXUSRCLK2	
TXBYPASS8B10B [7:0]	
TXCHARDISPMODE [7:0]	
TXCHARDISPVAL [7:0]	
TXCHARISK [7:0]	
TXCLKSTABLE	
TXCRCCLK	
TXCRCDATAVALID	
TXCRCDATAWIDTH [2:0]	
TXCRCIN [63:0]	
TXCRCINIT	
TXCRCINTCLK	
TXCRCPD	
TXCRCRESET	
TXDATA [63:0]	
TXDATAWIDTH [1:0]	
TXENC64B66BUSE	
TXENC8B10BUSE	

Inputs	Outputs
TXENOOB	
TXGEARBOX64B66BUSE	
TXINHIBIT	
TXINTDATAWIDTH [1:0]	
TXPMARESET	
TXPOLARITY	
TXRESET	
TXSCRAM64B66BUSE	
TXSYNC	
TXUSRCLK	
TXUSRCLK2	

## Design Entry Method

This design element can be used in schematics.

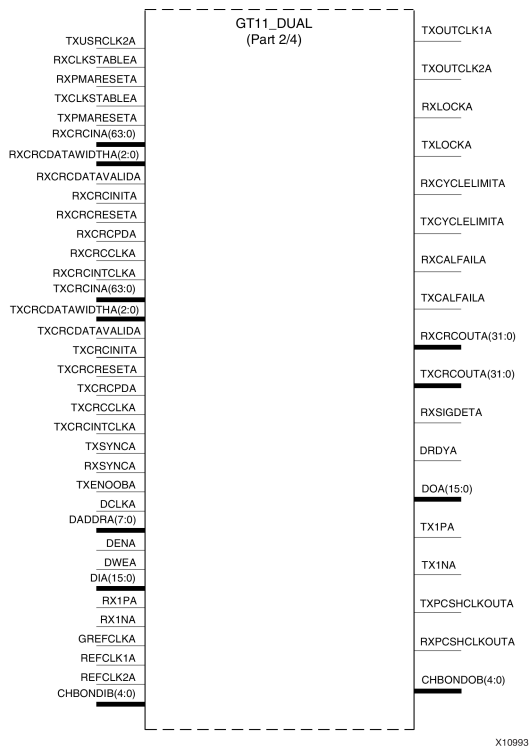
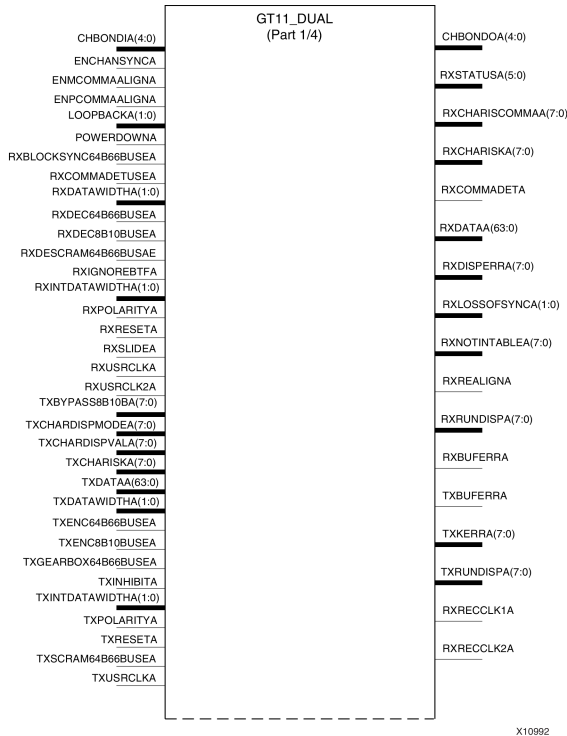
## For More Information

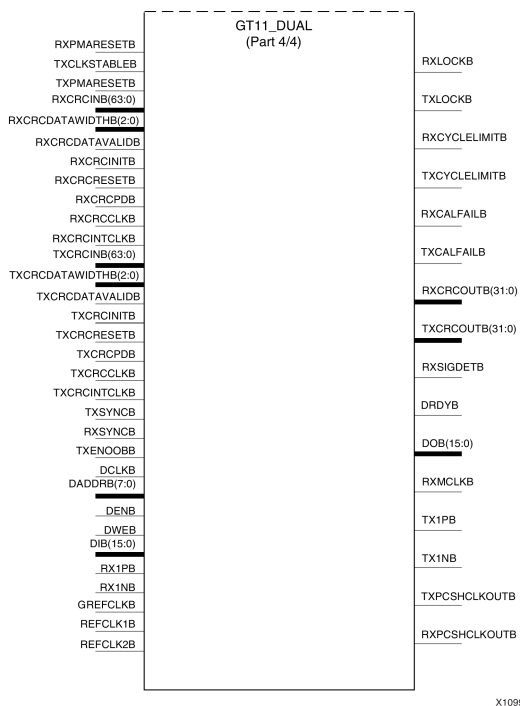
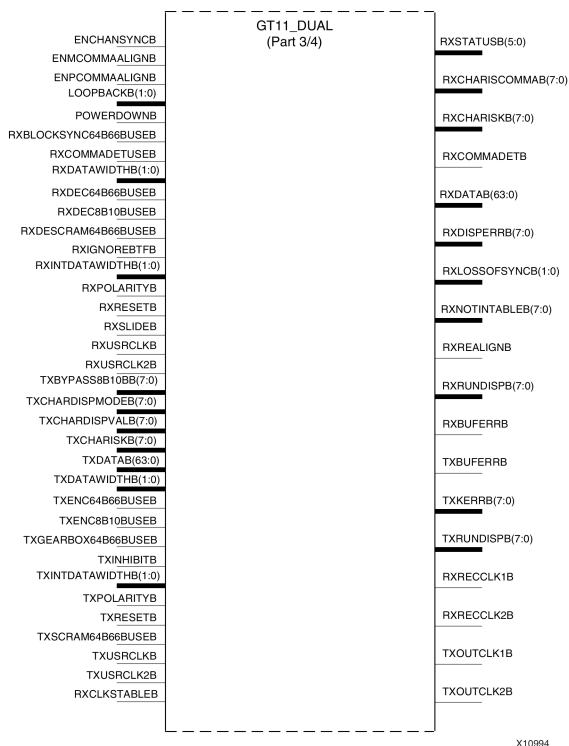
- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



# GT11\_DUAL

Primitive: RocketIO MGT Tile (contains 2 GT11\_CUSTOM) with 622 Mb/s to 11.1 Gb/s data rates, 8 to 24 transceivers per FPGA, and 2.5 GHz 5.55 GHz VCO, less than 1ns RMS jitter





## Introduction

RocketIO™ MGTs have flexible, programmable features that allow a multi-gigabit serial transceiver to be easily integrated into any Virtex®-4 design. The RocketIO MGTs support the following features:

- 622 Mb/s to 11.1 Gb/s data rates
- 8 to 24 transceivers per FPGA
- 2.5 GHz - 5.55 GHz VCO, less than 1ns RMS jitter
- Transmitter pre-emphasis (pre-equalization)
- Receiver continuous time equalization
- On-chip AC coupled receiver
- Digital oversampled receiver for data rates up to 2.5 Gb/s
- Receiver signal detect and loss of signal indicator, out-of-band signal receiver
- Transmit driver idle state for out-of-band signaling, both outputs at Vcm
- 8B/10B or 64B/66B encoding, or no data encoding (pass through mode)
- Channel bonding
- Flexible Cyclic Redundancy Check (CRC) generation and checking
- Pins for transmitter and receiver termination voltage
- You can reconfigure, using the secondary (dynamic) configuration bus
- Multiple loopback paths including PMA RX-TX path

## Logic Table

Inputs	Outputs
[1:0] LOOPBACK_A;	[1:0] RXLOSSOFSYNC_A;
[1:0] LOOPBACK_B;	[1:0] RXLOSSOFSYNC_B;
[1:0] RXDATAWIDTH_A;	[15:0] DO_A;
[1:0] RXDATAWIDTH_B;	[15:0] DO_B;
[1:0] RXINTDATAWIDTH_A;	[31:0] RXCRCOUT_A;
[1:0] RXINTDATAWIDTH_B;	[31:0] RXCRCOUT_B;
[1:0] TXDATAWIDTH_A;	[31:0] TXCRCOUT_A;
[1:0] TXDATAWIDTH_B;	[31:0] TXCRCOUT_B;
[1:0] TXINTDATAWIDTH_A;	[4:0] CHBONDO_A;
[1:0] TXINTDATAWIDTH_B;	[4:0] CHBONDO_B;
[15:0] DI_A;	[5:0] RXSTATUS_A;
[15:0] DI_B;	[5:0] RXSTATUS_B;
[2:0] RXCRCDATAWIDTH_A;	[63:0] RXDATA_A;
[2:0] RXCRCDATAWIDTH_B;	[63:0] RXDATA_B;
[2:0] TXCRCDATAWIDTH_A;	[7:0] RXCHARISCOMMA_A;
[2:0] TXCRCDATAWIDTH_B;	[7:0] RXCHARISCOMMA_B;
[4:0] CHBONDI_A;	[7:0] RXCHARISK_A;
[4:0] CHBONDI_B;	[7:0] RXCHARISK_B;
[63:0] RXCRCIN_A;	[7:0] RXDISPERR_A;
[63:0] RXCRCIN_B;	[7:0] RXDISPERR_B;

Inputs	Outputs
[63:0] TXCRCIN_A;	[7:0] RXNOTINTABLE_A;
[63:0] TXCRCIN_B;	[7:0] RXNOTINTABLE_B;
[63:0] TXDATA_A;	[7:0] RXRUNDISP_A;
[63:0] TXDATA_B;	[7:0] RXRUNDISP_B;
[7:0] DADDR_A;	[7:0] TXKERR_A;
[7:0] DADDR_B;	[7:0] TXKERR_B;
[7:0] TXBYPASS8B10B_A;	[7:0] TXRUNDISP_A;
[7:0] TXBYPASS8B10B_B;	[7:0] TXRUNDISP_B;
[7:0] TXCHARDISPMODE_A;	DRDY_A;
[7:0] TXCHARDISPMODE_B;	DRDY_B;
[7:0] TXCHARDISPVAL_A;	RXBUFERR_A;
[7:0] TXCHARDISPVAL_B;	RXBUFERR_B;
[7:0] TXCHARISK_A;	RXCALFAIL_A;
[7:0] TXCHARISK_B;	RXCALFAIL_B;
DCLK_A;	RXCOMMADET_A;
DCLK_B;	RXCOMMADET_B;
DEN_A;	RXCYLELIMIT_A;
DEN_B;	RXCYLELIMIT_B;
DWE_A;	RXLOCK_A;
DWE_B;	RXLOCK_B;
ENCHANSYNC_A;	RXMCLK_A;
ENCHANSYNC_B;	RXMCLK_B;
ENMCOMMAALIGN_A;	RXPCSHCLKOUT_A;
ENMCOMMAALIGN_B;	RXPCSHCLKOUT_B;
ENPCOMMAALIGN_A;	RXRealIGN_A;
ENPCOMMAALIGN_B;	RXRealIGN_B;
GREFCLK_A;	RXRECCLK1_A;
GREFCLK_B;	RXRECCLK1_B;
POWERDOWN_A;	RXRECCLK2_A;
POWERDOWN_B;	RXRECCLK2_B;
REFCLK1_A;	RXSIGDET_A;
REFCLK1_B;	RXSIGDET_B;
REFCLK2_A;	TX1N_A;
REFCLK2_B;	TX1N_B;
RX1N_A;	TX1P_A;
RX1N_B;	TX1P_B;
RX1P_A;	TXBUFERR_A;
RX1P_B;	TXBUFERR_B;

Inputs	Outputs
RXBLOCKSYNC64B66BUSE_A;	TXCALFAIL_A;
RXBLOCKSYNC64B66BUSE_B;	TXCALFAIL_B;
RXCLKSTABLE_A;	TXCYCLELIMIT_A;
RXCLKSTABLE_B;	TXCYCLELIMIT_B;
RXCOMMADETUSE_A;	TXLOCK_A;
RXCOMMADETUSE_B;	TXLOCK_B;
RXCRCCLK_A;	TXOUTCLK1_A;
RXCRCCLK_B;	TXOUTCLK1_B;
RXCRCDATAVALID_A;	TXOUTCLK2_A;
RXCRCDATAVALID_B;	TXOUTCLK2_B;
RXCRCINIT_A;	TXPCSHCLKOUT_A;
RXCRCINIT_B;	TXPCSHCLKOUT_B;
RXCRCINTCLK_A;	
RXCRCINTCLK_B;	
RXCRCPD_A;	
RXCRCPD_B;	
RXCRCRESET_A;	
RXCRCRESET_B;	
RXDEC64B66BUSE_A;	
RXDEC64B66BUSE_B;	
RXDEC8B10BUSE_A;	
RXDEC8B10BUSE_B;	
RXDESCRAM64B66BUSE_A;	
RXDESCRAM64B66BUSE_B;	
RXIGNOREBTF_A;	
RXIGNOREBTF_B;	
RXPMARESET_A;	
RXPMARESET_B;	
RXPOLARITY_A;	
RXPOLARITY_B;	
RXRESET_A;	
RXRESET_B;	
RXSLIDE_A;	
RXSLIDE_B;	
RXSYNC_A;	
RXSYNC_B;	
RXUSRCLK_A;	
RXUSRCLK_B;	

Inputs	Outputs
RXUSRCLK2_A;	
RXUSRCLK2_B;	
TXCLKSTABLE_A;	
TXCLKSTABLE_B;	
TXCRCCLK_A;	
TXCRCCLK_B;	
TXCRCDATAVALID_A;	
TXCRCDATAVALID_B;	
TXCRCINIT_A;	
TXCRCINIT_B;	
TXCRCINTCLK_A;	
TXCRCINTCLK_B;	
TXCRCPD_A;	
TXCRCPD_B;	
TXCRCRESET_A;	
TXCRCRESET_B;	
TXENC64B66BUSE_A;	
TXENC64B66BUSE_B;	
TXENC8B10BUSE_A;	
TXENC8B10BUSE_B;	
TXENOOB_A;	
TXENOOB_B;	
TXGEARBOX64B66BUSE_A;	
TXGEARBOX64B66BUSE_B;	
TXINHIBIT_A;	
TXINHIBIT_B;	
TXPMARESET_A;	
TXPMARESET_B;	
TXPOLARITY_A;	
TXPOLARITY_B;	
TXRESET_A;	
TXRESET_B;	
TXSCRAM64B66BUSE_A;	
TXSCRAM64B66BUSE_B;	
TXSYNC_A;	
TXSYNC_B;	
TXUSRCLK_A;	
TXUSRCLK_B;	

Inputs	Outputs
TXUSRCLK2_A;	
TXUSRCLK2_B;	

## Design Entry Method

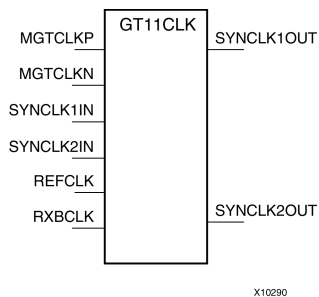
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## GT11CLK

**Primitive:** A MUX That Can Select From Differential Package Input Clock, refclk From the Fabric, or rxbclk to Drive the Two Vertical Reference Clock Buses for the Column of MGTs



### Introduction

This block needs to be instantiated when using the dedicated package pins for RocketIO™ clocks. There are two available per MGT column. The attributes allow this package input to drive one or both SYNCLK clock trees. Please see the *Virtex®-4 RocketIO MGT User Guide* for more details.

The attribute REFCLKSEL allows more clocking options. These options include: MGTCLK, SYNCLK1IN, SYNCLK2IN, REFCLK, RXBCLK.

### Port Descriptions

Inputs are MGTCLKP, MGTCLKN

Outputs are SYNCLK1OUT, SYNCLK2OUT

### Design Entry Method

This design element can be used in schematics.

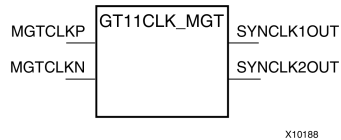
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## GT11CLK\_MGT

**Primitive:** Allows Differential Package Input to Drive the Two Vertical Reference Clock Buses for the Column of MGTs



### Introduction

This block needs to be instantiated when using the dedicated package pins for RocketIO™ clocks. There are two available per MGT column. The attributes allow this package input to drive one or both SYNCLK clock trees. Please see the *Virtex®-4RocketIO MGT User Guide* for more details.

### Port Description

Inputs are MGTCLKP, MGTCLKN.

Outputs are SYNCLK1OUT, SYNCLK2OUT.

### Design Entry Method

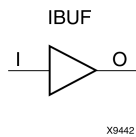
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUF

### Primitive: Input Buffer



## Introduction

This design element is automatically inserted (inferred) by the synthesis tool to any signal directly connected to a top-level input or in-out port of the design. You should generally let the synthesis tool infer this buffer. However, it can be instantiated into the design if required. In order to do so, connect the input port (I) directly to the associated top-level input or in-out port, and connect the output port (O) to the logic sourced by that port. Modify any necessary generic maps (VHDL) or named parameter value assignment (Verilog) in order to change the default behavior of the component.

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Buffer output
I	Input	1	Buffer input

## Design Entry Method

This design element can be used in schematics.

This element is usually inferred by the synthesis tool for any specified top-level input port to the design, and therefore it is generally not necessary to specify the element in source code. However, if desired, this element may be manually instantiated by copying the instantiation code from below and pasting it into the top-level entity/module of your code. Xilinx recommends that you put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level input port of the design and the O port to the logic in which this input is to source. Specify the desired generic/default values in order to configure the proper behavior of the buffer.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

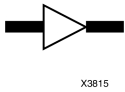
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUF16

### Macro: 16-Bit Input Buffer

IBUF16



## Introduction

Input Buffers isolate the internal circuit from the signals coming into the chip. This design element is contained in input/output blocks (IOBs) and allows the specification of the particular I/O Standard to configure the I/O. In general, an this element should be used for all single-ended data input or bidirectional pins.

## Design Entry Method

This design element can be used in schematics.

This element is usually inferred by the synthesis tool for any specified top-level input port to the design, and therefore it is generally not necessary to specify the element in source code. However, if desired, this element may be manually instantiated by copying the instantiation code from below and pasting it into the top-level entity/module of your code. Xilinx recommends that you put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level input port of the design and the O port to the logic in which this input is to source. Specify the desired generic/default values in order to configure the proper behavior of the buffer.

## Available Attributes

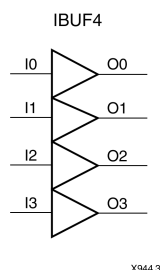
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUF4

### Macro: 4-Bit Input Buffer



## Introduction

Input Buffers isolate the internal circuit from the signals coming into the chip. This design element is contained in input/output blocks (IOBs) and allows the specification of the particular I/O Standard to configure the I/O. In general, an this element should be used for all single-ended data input or bidirectional pins.

## Design Entry Method

This design element can be used in schematics.

This element is usually inferred by the synthesis tool for any specified top-level input port to the design, and therefore it is generally not necessary to specify the element in source code. However, if desired, this element may be manually instantiated by copying the instantiation code from below and pasting it into the top-level entity/module of your code. Xilinx recommends that you put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level input port of the design and the O port to the logic in which this input is to source. Specify the desired generic/defparam values in order to configure the proper behavior of the buffer.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

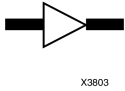
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUF8

### Macro: 8-Bit Input Buffer

IBUF8



## Introduction

Input Buffers isolate the internal circuit from the signals coming into the chip. This design element is contained in input/output blocks (IOBs) and allows the specification of the particular I/O Standard to configure the I/O. In general, an this element should be used for all single-ended data input or bidirectional pins.

## Design Entry Method

This design element can be used in schematics.

This element is usually inferred by the synthesis tool for any specified top-level input port to the design, and therefore it is generally not necessary to specify the element in source code. However, if desired, this element may be manually instantiated by copying the instantiation code from below and pasting it into the top-level entity/module of your code. Xilinx recommends that you put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level input port of the design and the O port to the logic in which this input is to source. Specify the desired generic/defparam values in order to configure the proper behavior of the buffer.

## Available Attributes

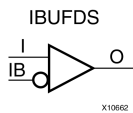
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUFDS

### Primitive: Differential Signaling Input Buffer



### Introduction

This design element is an input buffer that supports low-voltage, differential signaling. In IBUFDS, a design level interface signal is represented as two distinct ports (I and IB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET\_P and MYNET\_N). Optionally, a programmable differential termination feature is available to help improve signal integrity and reduce external components.

### Logic Table

Inputs		Outputs
I	IB	O
0	0	No Change
0	1	0
1	0	1
1	1	No Change

### Port Descriptions

Port	Type	Width	Function
I	Input	1	Diff_p Buffer Input
IB	Input	1	Diff_n Buffer Input
O	Output	1	Buffer Output

### Design Entry Method

This design element can be used in schematics.

Put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level "master" input port of the design, the IB port to the top-level "slave" input port, and the O port to the logic in which this input is to source. Specify the desired generic/defparam values in order to configure the proper behavior of the buffer.

### Available Attributes

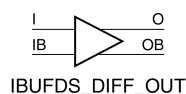
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DIFF_TERM	Boolean	TRUE or FALSE	FALSE	Enables the built-in differential termination resistor.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUFDS\_DIFF\_OUT

Primitive: Signaling Input Buffer with Differential Output



X10107

### Introduction

This design element is an input buffer that supports differential signaling. In IBUFDS\_DIFF\_OUT, a design level interface signal is represented as two distinct ports (I and IB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET\_P and MYNET\_N). The IBUFDS\_DIFF\_OUT differs from the IBUFDS in that it allows internal access to both phases of the differential signal. Optionally, a programmable differential termination feature is available to help improve signal integrity and reduce external components.

### Logic Table

Inputs		Outputs	
I	IB	O	OB
0	0	No Change	No Change
0	1	0	1
1	0	1	0
1	1	No Change	No Change

### Design Entry Method

This design element is only for use in schematics.

It is suggested to put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level "master" input port of the design, the IB port to the top-level "slave" input port, and the O and OB ports to the logic in which this input is to source. Specify the desired generic/parameter values in order to configure the proper behavior of the buffer.

### Available Attributes

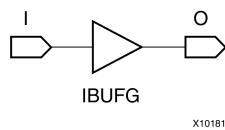
Attribute	Type	Allowed Values	Default	Description
DIFF_TERM	Boolean	TRUE, FALSE	FALSE	Specifies the use of the internal differential termination resistance.
IOSTANDARD	String	See Data Sheet.	"DEFAULT"	Assigns an I/O standard to the element.

### For More Information



## IBUFG

Primitive: Dedicated Input Clock Buffer



### Introduction

The IBUFG is a dedicated input to the device which should be used to connect incoming clocks to the FPGA's global clock routing resources. The IBUFG provides dedicated connections to the DCM\_SP and BUFG providing the minimum amount of clock delay and jitter to the device. The IBUFG input can only be driven by the global clock pins. The IBUFG output can drive CLKIN of a DCM\_SP, BUFG, or your choice of logic.

### Port Descriptions

Port	Direction	Width	Function
O	Output	1	Clock Buffer output
I	Input	1	Clock Buffer input

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

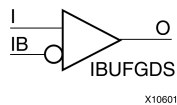
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IBUFGDS

### Primitive: Differential Signaling Dedicated Input Clock Buffer and Optional Delay



## Introduction

This design element is a dedicated differential signaling input buffer for connection to the clock buffer (BUFG) or DCM. In IBUFGDS, a design-level interface signal is represented as two distinct ports (I and IB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET\_P and MYNET\_N). Optionally, a programmable differential termination feature is available to help improve signal integrity and reduce external components. Also available is a programmable delay to assist in the capturing of incoming data to the device.

## Logic Table

Inputs		Outputs
I	IB	O
0	0	No Change
0	1	0
1	0	1
1	1	No Change

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Clock Buffer output
IB	Input	1	Diff_n Clock Buffer Input
I	Input	1	Diff_p Clock Buffer Input

## Design Entry Method

This design element can be used in schematics.

Put all I/O components on the top-level of the design to help facilitate hierarchical design methods. Connect the I port directly to the top-level "master" input port of the design, the IB port to the top-level "slave" input port and the O port to a DCM, BUFG or logic in which this input is to source. Some synthesis tools infer the BUFG automatically if necessary, when connecting an IBUFG to the clock resources of the FPGA. Specify the desired generic/defparam values in order to configure the proper behavior of the buffer.

## Available Attributes

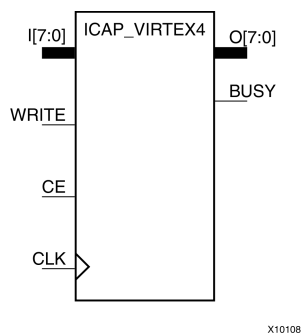
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DIFF_TERM	Boolean	TRUE or FALSE	FALSE	Enables the built-in differential termination resistor.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ICAP\_VIRTEX4

Primitive: Virtex-4 Internal Configuration Access Port



### Introduction

This design element provides user access to the Virtex®-4 internal configuration access port (ICAP).

### Port Descriptions

Port	Direction	Width	Function
BUSY	Output	1	Busy signal
O	Output	32	32-bit data bus output
CE	Input	1	Clock enable pin
CLK	Input	1	Clock input
WRITE	Input	1	Write signal
I	Input	32	32-bit data bus input

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

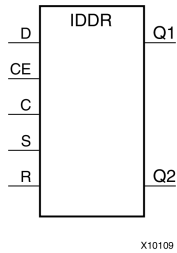
Attribute	Type	Allowed Values	Default	Description
ICAP_WIDTH	String	"X8" or "X32"	"X8"	Specifies the data width for the ICAP component.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IDDR

### Primitive: Input Dual Data-Rate Register



### Introduction

This design element is a dedicated input register designed to receive external dual data rate (DDR) signals into Xilinx® FPGAs. The IDDR is available with modes that present the data to the FPGA fabric at the time and clock edge they are captured, or on the same clock edge. This feature allows you to avoid additional timing complexities and resource usage.

- **OPPOSITE\_EDGE mode** - Data is recovered in the classic DDR methodology. Given a DDR data and clock at pin D and C respectively, Q1 changes after every positive edge of clock C, and Q2 changes after every negative edge of clock C.
- **SAME\_EDGE mode** - Data is still recovered by opposite edges of clock C. However, an extra register has been placed in front of the negative edge data register. This extra register is clocked with positive clock edge of clock signal C. As a result, DDR data is now presented into the FPGA fabric at the same clock edge. However, because of this feature, the data pair appears to be "separated." Q1 and Q2 no longer have pair 1 and 2. Instead, the first pair presented is Pair 1 and DONT\_CARE, followed by Pair 2 and 3 at the next clock cycle.
- **SAME\_EDGE\_PIPELINED mode** - Recovers data in a similar fashion as the SAME\_EDGE mode. In order to avoid the "separated" effect of the SAME\_EDGE mode, an extra register has been placed in front of the positive edge data register. A data pair now appears at the Q1 and Q2 pin at the same time. However, using this mode costs you an additional cycle of latency for Q1 and Q2 signals to change.

IDDR also works with the SelectIO™ features, such as the IODELAY.

**Note** For high speed interfaces, the IDDR\_2CLK component can be used to specify two independent clocks to capture the data. Use this component when the performance requirements of the IDDR are not adequate, since the IDDR\_2CLK requires more clocking resources and can imply placement restrictions that are not necessary when using the IDDR component.

### Port Descriptions

Port	Direction	Width	Function
Q1 - Q2	Output	1	These pins are the IDDR output that connects to the FPGA fabric. Q1 is the first data pair and Q2 is the second data pair.
C	Input	1	Clock input pin.
CE	Input	1	When asserted Low, this port disables the output clock at port O.
D	Input	1	This pin is where the DDR data is presented into the IDDR module.  This pin connects to a top-level input or bi-directional port, and IODELAY configured for an input delay or to an appropriate input or bidirectional buffer.
R	Input	1	Active high reset forcing Q1 and Q2 to a logic zero. Can be synchronous or asynchronous based on the SRTYPE attribute.
S	Input	1	Active high reset forcing Q1 and Q2 to a logic one. Can be synchronous or asynchronous based on the SRTYPE attribute.

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

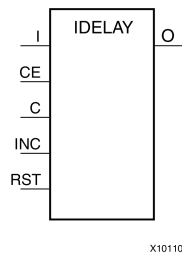
Attribute	Type	Allowed Values	Default	Description
DDR_CLK_EDGE	String	"OPPOSITE_EDGE", "SAME_EDGE", "SAME_EDGE_PIPELINED"	"OPPOSITE_EDGE"	Sets the IDDR mode of operation with respect to clock edge.
INIT_Q1	Binary	0, 1	0	Initial value on the Q1 pin after configuration startup or when GSR is asserted.
INIT_Q2	Binary	0, 1	0	Initial value on the Q2 pin after configuration startup or when GSR is asserted.
SRTYPE	String	"SYNC" or "ASYN"	"SYNC"	Set/reset type selection. "SYNC" specifies the behavior of the reset (R) and set (S) pins to be synchronous to the positive edge of the C clock pin. "ASYN" specifies an asynchronous set/reset function.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IDELAY

### Primitive: Input Delay Element



## Introduction

Virtex® devices have an IDELAY module in the input path of every user I/O. IDELAY allows the implementation of deskew algorithms to correctly capture incoming data. IDELAY can be applied to data signals, clock signals, or both. IDELAY features a fully-controllable, 64-tap delay line. When used in conjunction with the IDELAYCTRL component circuitry, the IDELAY can provide precise time increments of delay independent of process, voltage, and temperature (PVT) variations. Three modes of operation are available:

- **Zero hold time delay mode** - This mode of operation allows backward compatibility for designs using the zero-hold time delay feature. When used in this mode, the IDELAYCTRL primitive does not need to be instantiated.
- **Fixed tap-delay mode** - In the fixed tap-delay mode, the delay value is set to the number determined by the attribute IOBDELAY\_VALUE. This value cannot be changed during run-time. When used in this mode, the IDELAYCTRL primitive must be instantiated.
- **Variable tap-delay mode** - In the variable tap-delay mode, the delay value can be changed at run-time by manipulating the control signals CE and INC. When used in this mode, the IDELAYCTRL primitive must be instantiated.

## Port Descriptions

Ports	Direction	Width	Function
I	Input	1	Serial input data from IOB
C	Input	1	Clock input
INC	Input	1	Increment/decrement number of tap delays
CE	Input	1	Enable increment/decrement function
RST	Input	1	Reset delay chain to pre-programmed value. If no value programmed, reset to 0
O	Output	1	Combinatorial output

### Data Input and Output - I and O

IDELAY primitives are located in three different types of general purpose IOB locations. The input and output connectivity differs for each type of IOB location.

- **General Purpose IOBs** - The input of IDELAY in a general-purpose IOB comes directly from the input buffer, IBUF. The output of IDELAY (O) is connected directly to your logic. The input and output datapath is combinatorial and is not affected by the clock signal (C). However, you can choose to register the output signal (O) in the IOB.
- **Regional Clock-Capable IOBs** - Regional clock-capable IOBs are located in one I/O pair directly above and below an HCLK IOB. The input of IDELAY in a regional clock-capable IOB comes directly from the input buffer, IBUF. The output of IDELAY in a regional clock-capable IOB can go to one of the following locations:
  - Directly to your logic
  - BUFIO (in the case of a regional clock signal)

The regional clock buffer, BUFIO, connects the incoming regional clock signal to the regional I/O clock tree, IOCLK. BUFIO also connects to the regional clock buffer, BUFR to connect to the regional clock tree, rclk. The input and output datapath is combinatorial and is not affected by the clock signal (C). However, you can choose to register the output signal (O) in the IOB.

- **Global clock-capable IOBs** - Global clock-capable IOBs are located in the center I/O column. The input of the IDELAY module in a global clock-capable IOB comes directly from the input global clock buffer, IBUFG. The output of the IDELAY module in a global clock-capable IOB can go to one of the following locations:
  - Directly to your logic
  - BUFG (in the case of a global clock signal)

The global clock buffer, BUFG, connects the incoming regional clock signal to the global clock tree, gclk. The input and output datapath is combinatorial and is not affected by the clock signal (C). However, you can choose to register the output signal (O) in the IOB.

### Clock Input - C

All control inputs to IDELAY (RST, CE and INC) are synchronous to the clock input (C). The data input and output (I and O) of IDELAY is not affected by this clock signal. This clock input is identical to the CLKDIV input for the ISERDES. All the clock sources used to drive CLKDIV can therefore drive the IDELAY clock input (C). The clock sources that can drive the clock input (C) are:

- Eight gclk (global clock tree)
- Two rclk (regional clock tree)

### Module Reset - RST

The IDELAY reset signal, RST, resets the tap-delay line to a value set by the IOBDELAY\_VALUE attribute. If the IOBDELAY\_VALUE attribute is not specified, the tap-delay line is reset to 0.

### Increment/Decrement Signals - CE, INC

The increment/decrement enable signal (CE) determines when the increment/decrement signal (INC) is activated. INC determines whether to increment or decrement the tap-delay line. When CE = 0, the tap delay remains constant no matter what the value of INC. When CE = 1, the tap-delay value increments or decrements depending on the value of INC. The tap delay is incremented or decremented synchronously with respect to the input clock (C). As long as CE = 1, the tap-delay increments or decrements by one every clock cycle. The increment/decrement operation is summarized in the following table:

Operation	RST	CE	INC
Reset to configured value of tap count	1	x	x
Increment tap count	0	1	1
Decrement tap count	0	1	0
No change	0	0	x



**Note**

1. RST resets delay chain to tap count specified by attribute IOBDELAY\_VALUE. If IOBDELAY\_VALUE is not specified, tap count reset to 0.
2. RST, CE, and INC are synchronous to the input clock signal (C).

When CE is raised, the increment/decrement operation begins on the next positive clock cycle. When CE is lowered, the increment/decrement operation ceases on the next positive clock cycle.

**Design Entry Method**

This design element can be used in schematics.

**Available Attributes**

Attribute	Type	Allowed Values	Default	Description
IOBDELAY_TYPE	String	"DEFAULT", "FIXED", "VARIABLE"	"DEFAULT"	This attribute sets the type of tap delay.
IOBDELAY_VALUE	Integer	0 to 63	0	This attribute specifies the initial number of tap delays.

*IOBDELAY\_TYPE Attribute*

The IOBDELAY\_TYPE attribute sets the type of delay used. The attribute values are DEFAULT, FIXED, and VARIABLE. The default value is DEFAULT. When set to DEFAULT, the zero-hold time delay element is selected. This delay element eliminates pad-to-pad hold time. The delay is matched to the internal clock-distribution delay of the device. When used, it guarantees a pad-to-pad hold time of zero.

When set to FIXED, the tap-delay value is fixed at the number of taps determined by the IOBDELAY\_VALUE attribute. This value is preset and cannot be changed dynamically.

When set to VARIABLE, the variable tap delay is selected. The tap delay can be incremented by setting CE = 1 and INC = 1 or decremented by setting CE = 1 and INC = 0. The increment/decrement operation is synchronous to C, the input clock signal.

*IOBDELAY\_VALUE Attribute*

The IOBDELAY\_VALUE attribute specifies the initial number of tap delays. The possible values are any Integers from 0 to 63. The default value is 0. When set to 0, the total delay becomes the delay of the output MUX which is approximately 400 ps.

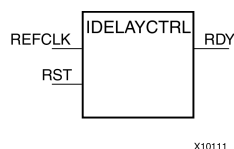
The value of the tap delay reverts to IOBDELAY\_VALUE when the tap delay is reset (RST = 1), or the IOBDELAY\_TYPE is set to FIXED.

**For More Information**

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IDELAYCTRL

### Primitive: IDELAY Tap Delay Value Control



## Introduction

This design element must be instantiated when using the IODELAYE1. This occurs when the IDELAY or ISERDES primitive is instantiated with the IOBDelay\_TYPE attribute set to Fixed or Variable. The IDELAYCTRL module provides a voltage bias, independent of process, voltage, and temperature variations to the tap-delay line using a fixed-frequency reference clock, REFCLK. This enables very accurate delay tuning.

## Port Descriptions

Port	Type	Width	Function
RDY	Output	1	Indicates the validity of the reference clock input, REFCLK. When REFCLK disappears (i.e., REFCLK is held High or Low for one clock period or more), the RDY signal is deasserted.
REFCLK	Input	1	Provides a voltage bias, independent of process, voltage, and temperature variations, to the tap-delay lines in the IOBs. The frequency of REFCLK must be 200 MHz to guarantee the tap-delay value specified in the applicable data sheet.
RST	Input	1	Resets the IDELAYCTRL circuitry. The RST signal is an active-high asynchronous reset. To reset the IDELAYCTRL, assert it High for at least 50 ns.

**RST (Module reset)** - Resets the IDELAYCTRL circuitry. The RST signal is an active-high asynchronous reset. To reset the IDELAYCTRL, assert it High for at least 50 ns.

**REFCLK (Reference Clock)** - Provides a voltage bias, independent of process, voltage, and temperature variations, to the tap-delay lines in the IOBs. The frequency of REFCLK must be 200 MHz to guarantee the tap-delay value specified in the applicable data sheet.

**RDY (Ready Output)** - Indicates the validity of the reference clock input, REFCLK. When REFCLK disappears (i.e., REFCLK is held High or Low for one clock period or more), the RDY signal is deasserted.

## Design Entry Method

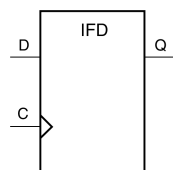
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFD

### Macro: Input D Flip-Flop



X3776

## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. The data on input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

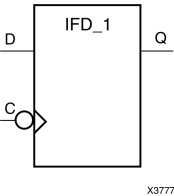
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# IFD\_1

## Macro: Input D Flip-Flop with Inverted Clock (Asynchronous Preset)



## Introduction

This design element is a D-type flip flop which is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The D input also provides data input for the flip-flop, which synchronizes data entering the chip. The D input data is loaded into the flip-flop during the High-to-Low clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
0	↓	0
1	↓	1

## Design Entry Method

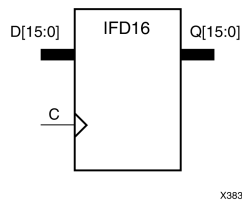
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFD16

### Macro: 16-Bit Input D Flip-Flop



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. The data on input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

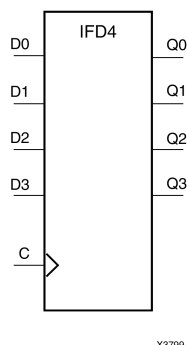
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFD4

### Macro: 4-Bit Input D Flip-Flop



X3799

## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. The data on input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

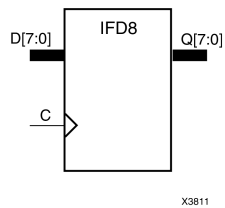
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFD8

### Macro: 8-Bit Input D Flip-Flop



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. The data on input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

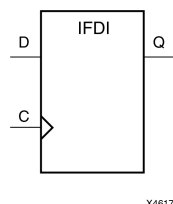
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDI

### Macro: Input D Flip-Flop (Asynchronous Preset)



## Introduction

This design element is a D-type flip-flop which is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The D input provides data input for the flip-flop, which synchronizes data entering the chip. The D input data is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

This design element is only for use in schematics.

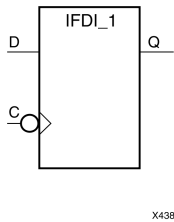
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## IFDI\_1

### Macro: Input D Flip-Flop with Inverted Clock (Asynchronous Preset)



## Introduction

The design element is a D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. The data on input (D) is loaded into the flip-flop during the High-to-Low clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
0	↓	0
1	↓	1

## Design Entry Method

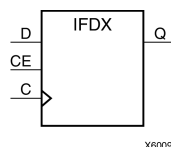
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDX

### Macro: Input D Flip-Flop with Clock Enable



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The D input provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When CE is Low, flip-flop outputs do not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

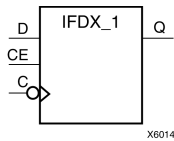
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDX\_1

### Macro: Input D Flip-Flop with Inverted Clock and Clock Enable



## Introduction

This design element is a D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The D input also provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the High-to-Low clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When the CE pin is Low, the output (Q) does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↓	D
0	X	X	No Change

## Design Entry Method

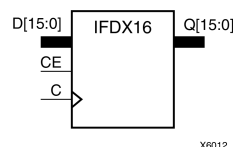
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDX16

### Macro: 16-Bit Input D Flip-Flops with Clock Enable



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The D input provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When CE is Low, flip-flop outputs do not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

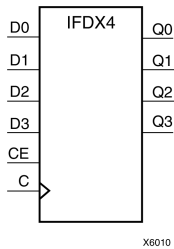
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDX4

### Macro: 4-Bit Input D Flip-Flop with Clock Enable



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The D input provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When CE is Low, flip-flop outputs do not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

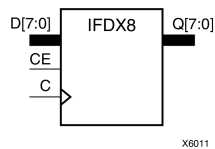
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDX8

### Macro: 8-Bit Input D Flip-Flop with Clock Enable



## Introduction

This D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD (without using an IBUF). The D input provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When CE is Low, flip-flop outputs do not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

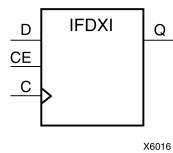
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDXI

### Macro: Input D Flip-Flop with Clock Enable (Asynchronous Preset)



## Introduction

The design element is a D-type flip-flop is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The D input provides data input for the flip-flop, which synchronizes data entering the chip. When CE is High, the data on input D is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When the CE pin is Low, the output (Q) does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

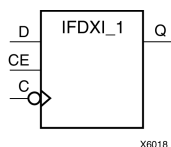
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IFDXI\_1

Macro: Input D Flip-Flop with Inverted Clock and Clock Enable (Asynchronous Preset)



## Introduction

The design element is a D-type flip-flop that is contained in an input/output block (IOB). The input (D) of the flip-flop is connected to an IPAD or an IOPAD. The (D) input provides data input for the flip-flop, which synchronizes data entering the chip. When (CE) is High, the data on input (D) is loaded into the flip-flop during the High-to-Low clock (C) transition and appears at the output (Q). The clock input can be driven by internal logic or through another external pin. When the (CE) pin is Low, the output (Q) does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↓	D
0	X	X	No Change

## Design Entry Method

This design element is only for use in schematics.

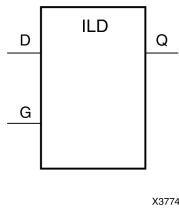
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## ILD

### Macro: Transparent Input Data Latch



## Introduction

This design element is a single, transparent data latch that holds transient data entering a chip. This latch is contained in an input/output block (IOB). The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF). When the gate input (G) is High, data on the input (D) appears on the output (Q). Data on the D input during the High-to-Low G transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Output
G	D	Q
1	D	D
0	X	No Change
↓	D	D

## Design Entry Method

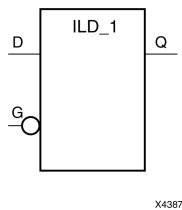
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILD\_1

### Macro: Transparent Input Data Latch with Inverted Gate



## Introduction

This design element is a transparent data latch that holds transient data entering a chip. When the gate input (G) is Low, data on the data input (D) appears on the data output (Q). Data on (D) during the Low-to-High (G) transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs		Outputs
G	D	Q
0	D	D
1	X	No Change
↑	D	D

## Design Entry Method

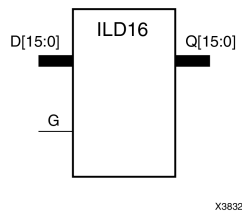
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILD16

### Macro: Transparent Input Data Latch



## Introduction

These design elements are multiple transparent data latches that hold transient data entering a chip. The ILD latch is contained in an input/output block (IOB). The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF). When the gate input (G) is High, data on the inputs (D) appears on the outputs (Q). Data on the D inputs during the High-to-Low G transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

## Design Entry Method

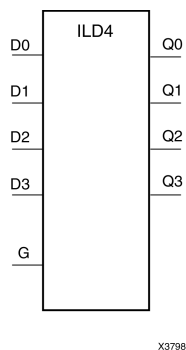
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILD4

### Macro: Transparent Input Data Latch



## Introduction

These design elements are multiple transparent data latches that hold transient data entering a chip. The ILD latch is contained in an input/output block (IOB). The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF). When the gate input (G) is High, data on the inputs (D) appears on the outputs (Q). Data on the D inputs during the High-to-Low G transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

## Design Entry Method

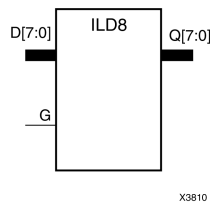
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILD8

### Macro: Transparent Input Data Latch



## Introduction

These design elements are multiple transparent data latches that hold transient data entering a chip. The ILD latch is contained in an input/output block (IOB). The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF). When the gate input (G) is High, data on the inputs (D) appears on the outputs (Q). Data on the D inputs during the High-to-Low G transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

## Design Entry Method

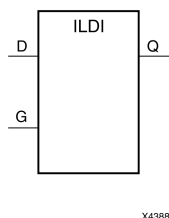
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDI

### Macro: Transparent Input Data Latch (Asynchronous Preset)



## Introduction

This design element is a transparent data latch that holds transient data entering a chip. When the gate input (G) is High, data on the input (D) appears on the output (Q). Data on the D input during the High-to-Low G transition is stored in the latch.

The ILDI is the input flip-flop master latch. It is possible to access two different outputs from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDI) corresponds to a falling edge-triggered flip-flop (IFDI\_1). Similarly, a transparent Low latch (ILDI\_1) corresponds to a rising edge-triggered flip-flop (IFDI).

The latch is asynchronously preset, output High, when power is applied.

For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	D	D
0	X	No Change
↓	D	D

## Design Entry Method

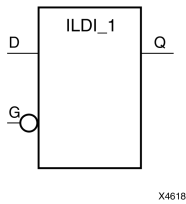
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDI\_1

### Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)



## Introduction

This design element is a transparent data latch that holds transient data entering a chip. When the gate input (G) is Low, data on the data input (D) appears on the data output (Q). Data on D during the Low-to-High G transition is stored in the latch.

The latch is asynchronously preset, output High, when power is applied.

For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs		Outputs
G	D	Q
0	1	1
0	0	0
1	X	No Change
↑	D	D

## Design Entry Method

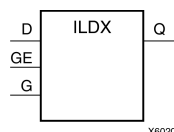
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDX

### Macro: Transparent Input Data Latch



## Introduction

This design element is single or multiple transparent data latches that holds transient data entering a chip. The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF).

The ILDX is the input flip-flop master latch. Two outputs can be accessed from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDX) corresponds to a falling edge-triggered flip-flop (IFDX\_1). Similarly, a transparent Low latch (ILDX\_1) corresponds to a rising edge-triggered flip-flop (IFDX)

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	0	X	No Change
1	1	1	1
1	1	0	0
1	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

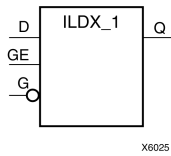
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## ILDX\_1

### Macro: Transparent Input Data Latch with Inverted Gate



## Introduction

This design element is a transparent data latch that holds transient data entering a chip. When the gate input (G) is Low, data on the data input (D) appears on the data output (Q). Data on D during the Low-to-High G transition is stored in the latch.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	1	X	No Change
1	0	1	1
1	0	0	0
1	↑	D	D

## Design Entry Method

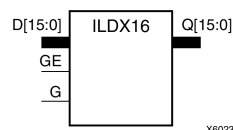
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDX16

### Macro: Transparent Input Data Latch



## Introduction

This design element is single or multiple transparent data latches that holds transient data entering a chip. The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF).

The ILDX is the input flip-flop master latch. Two outputs can be accessed from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDX) corresponds to a falling edge-triggered flip-flop (IFDX\_1). Similarly, a transparent Low latch (ILDX\_1) corresponds to a rising edge-triggered flip-flop (IFDX)

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	0	X	No Change
1	1	Dn	Dn

## Design Entry Method

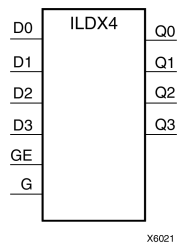
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDX4

### Macro: Transparent Input Data Latch



## Introduction

This design element is single or multiple transparent data latches that holds transient data entering a chip. The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF).

The ILDX is the input flip-flop master latch. Two outputs can be accessed from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDX) corresponds to a falling edge-triggered flip-flop (IFDX\_1). Similarly, a transparent Low latch (ILDX\_1) corresponds to a rising edge-triggered flip-flop (IFDX)

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	1	X	No Change
1	0	1	1
1	0	0	0
1	↑	Dn	Dn

## Design Entry Method

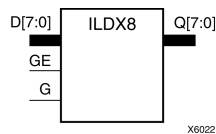
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDX8

### Macro: Transparent Input Data Latch



## Introduction

This design element is single or multiple transparent data latches that holds transient data entering a chip. The latch input (D) is connected to an IPAD or an IOPAD (without using an IBUF).

The ILDX is the input flip-flop master latch. Two outputs can be accessed from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDX) corresponds to a falling edge-triggered flip-flop (IFDX\_1). Similarly, a transparent Low latch (ILDX\_1) corresponds to a rising edge-triggered flip-flop (IFDX)

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	0	X	No Change
1	1	Dn	Dn

## Design Entry Method

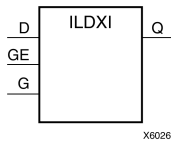
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDXI

### Macro: Transparent Input Data Latch (Asynchronous Preset)



## Introduction

This design element is a transparent data latch that holds transient data entering a chip. When the gate input (G) is High, data on the input (D) appears on the output (Q). Data on the (D) input during the High-to-Low (G) transition is stored in the latch.

The ILDXI is the input flip-flop master latch. Two outputs can be accessed from the input flip-flop: one that responds to the level of the clock signal and another that responds to an edge of the clock signal. When using both outputs from the same input flip-flop, a transparent High latch (ILDXI) corresponds to a falling edge-triggered flip-flop (IFDXI\_1). Similarly, a transparent Low latch (ILDXI\_1) corresponds to a rising edge-triggered flip-flop (IFDXI).

The latch is asynchronously preset, output High, when power is applied.

For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	0	X	No Change
1	1	D	D
1	↓	D	D

## Design Entry Method

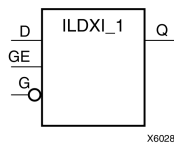
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ILDXI\_1

### Macro: Transparent Input Data Latch with Inverted Gate (Asynchronous Preset)



## Introduction

This design element is a transparent data latch that holds transient data entering a chip.

The latch is asynchronously preset, output High, when power is applied.

For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	1	X	No Change
1	0	D	D
1	↑	D	D

## Design Entry Method

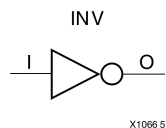
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# INV

## Primitive: Inverter



## Introduction

This design element is a single inverter that identifies signal inversions in a schematic.

## Design Entry Method

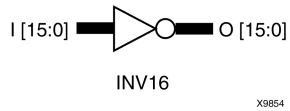
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## INV16

### Macro: 16 Inverters



## Introduction

This design element is a multiple inverter that identifies signal inversions in a schematic.

## Design Entry Method

This design element is only for use in schematics.

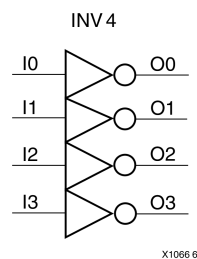
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## INV4

### Macro: Four Inverters



## Introduction

This design element is a multiple inverter that identifies signal inversions in a schematic.

## Design Entry Method

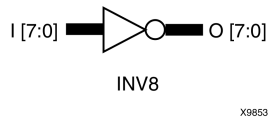
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## INV8

### Macro: Eight Inverters



## Introduction

This design element is a multiple inverter that identifies signal inversions in a schematic.

## Design Entry Method

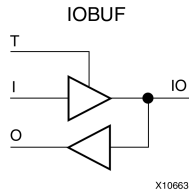
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IOBUF

### Primitive: Bi-Directional Buffer



## Introduction

The design element is a bidirectional single-ended I/O Buffer used to connect internal logic to an external bidirectional pin.

## Logic Table

Inputs		Bidirectional	Outputs
T	I	IO	O
1	X	Z	IO
0	1	1	1
0	0	0	0

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Buffer output
IO	Inout	1	Buffer inout
I	Input	1	Buffer input
T	Input	1	3-State enable input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

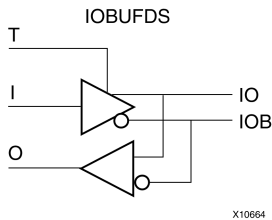
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Selects output drive strength (mA) for the SelectIO™ buffers that use the LVTTTL, LVCMOS12, LVCMOS15, LVCMOS18, LVCMOS25, or LVCMOS33 interface I/O standard.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW", "FAST", "QUIETIO"	"SLOW"	Sets the output rise and fall time. See the Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## IOBUFDS

Primitive: 3-State Differential Signaling I/O Buffer with Active Low Output Enable



## Introduction

The design element is a bidirectional buffer that supports low-voltage, differential signaling. For the IOBUFDS, a design level interface signal is represented as two distinct ports (IO and IOB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET\_P and MYNET\_N). Optionally, a programmable differential termination feature is available to help improve signal integrity and reduce external components. Also available is a programmable delay to assist in the capturing of incoming data to the device.

## Logic Table

Inputs		Bidirectional		Outputs
I	T	IO	IOB	O
X	1	Z	Z	No Change
0	0	0	1	0
1	0	1	0	1

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Buffer output
IO	Inout	1	Diff_p inout
IOB	Inout	1	Diff_n inout
I	Input	1	Buffer input
T	Input	1	3-state enable input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

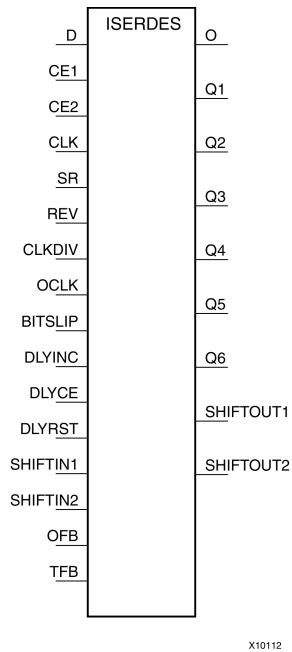
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# ISERDES

## Primitive: Dedicated I/O Buffer Input Deserializer



## Introduction

The ISERDES module provides a way for you to easily implement source synchronous solutions. ISERDES is a dedicated source synchronous I/O architecture. This module helps you by saving logic resources in the FPGA fabric for source synchronous applications. Furthermore, ISERDES also avoids additional timing complexities that can be encountered when designing such a solution in the FPGA fabric.

The ISERDES module contains or works in conjunction with the following modules: serial-to-parallel converters, serial delay chains, a word alignment unit (BITSLIP), and a clock enable (CE) module. In addition, ISERDES contains multiple clock inputs to accommodate various applications and works in conjunction with the SelectIO™ features. Following are descriptions of the ISERDES submodules.

## Delay Chains Module

The Delay Chains module is a dedicated architecture that provides an adjustable or fixed timing relationship between input data and forwarded clock. This solution is achieved by placing delays in the ISERDES module that deskew the inputs. The input delay chains can be preprogrammed (fixed) or dynamically changed (variable). In addition this module works in conjunction with the IDELAYCTRL primitive.

A number of attributes are required in order to use the Delay Chains module. The attributes are as follows.

- IOBDELAY\_VALUE
- IOBDELAY
- IOBDELAY\_TYPE

IOBDELAY\_VALUE can take values between 0 and 63. This attribute defines the number of delay taps used. Default value for this attribute is 0.

Setting the IOBDELAY attribute to "IBUF," "IFD," and "BOTH" allows the Delay Chains to be used in the combinatorial output (O output), registered output (Q1-Q6 output), and both respectively. Setting the IOBDELAY attribute to "NONE" bypasses the delay chains module.

The IOBDELAY\_TYPE can take three different values: "DEFAULT," "FIXED," or "VARIABLE." The "DEFAULT" allows you to use the 0 hold time value. Using the "FIXED" mode, the delay taps equal to value defined by IOBDELAY\_VALUE. In this mode, the value can't be changed after the device is programmed. In the last mode, "VARIABLE," the delay value is set to an initial value defined by IOBDELAY\_VALUE and adjustable after the device is programmed.

The Delay Chains module is controlled by DLYRST, DLYCE, and DLYINC pins. Each of the operations performed with these pins are synchronous to the CLKDIV clock signal. Asserting DLYRST to logic High configures the delay tap to the value defined in IOBDELAY\_VALUE. To increment/decrement the delay tap value, you must use both DLYCE and DLYINC. For this operation to proceed, the DLYCE must be asserted to logic High. Setting DLYINC to 1 increments and setting DLYINC to 0 decrements the delay tap value.

The following table identifies the Delay Chains Controls.

Operation	DLYRST	DLYCE	DLYINC
Reset to IOBDELAY_VALUE	1	X	X
Increment tap value	0	1	1
Decrement tap value	0	1	0
No change	0	0	X

**Note** All Delay Chains operations are synchronous to CLKDIV.

## Serial-to-Parallel Converter

The serial-to-parallel converter in the ISERDES module takes in serial data and convert them into data width choices from 2 to 6. Data widths larger than 6 (7,8, and 10) is achievable by cascading two ISERDES modules for data width expansion. In order to do this, one ISERDES must be set into a MASTER mode, while another is set into SLAVE mode. Connect the SHIFTIN of "slave" and SHIFTOUT of "master" ports together. The "slave" uses Q3 to Q6 ports as its output. The serial-to-parallel converter is available for both SDR and DDR modes.

This module is primarily controlled by CLK and CLKDIV clocks. The following table describes the relationship between CLK and CLKDIV for both SDR and DDR mode.

The following table illustrates the CLK/CLKDIV relationship of the serial-to-parallel converter:

SDR Data Width	DDR Data Width	CLK	CLKDIV
2	4	2X	X



SDR Data Width	DDR Data Width	CLK	CLKDIV
3	6	3X	X
4	8	4X	X
5	10	5X	X
6	-	6X	X
7	-	7X	X
8	-	8X	X

### CE Module

CE Module is essentially a 2:1 parallel-to-serial converter. This module is controlled by CLKDIV clock input and is used to control the clock enable port of the Serial-to-Parallel Converter module.

### BITSLIP Module

The BITSLIP module is a "Barrel Shifter" type function that reorders an output sequence. An output pattern only changes whenever the BITSLIP is invoked. The maximum number of BITSLIP reordering is always equal to the number of bits in the pattern length minus one (DATA\_WIDTH - 1). BITSLIP is supported for both SDR and DDR operations. However, note that the output reordering for SDR and DDR greatly differs.

To use the BITSLIP, set the "BITSLIP\_ENABLE" attribute to "ON." Setting this attribute to "OFF" allows you to bypass the BITSLIP module.

The BITSLIP operation is synchronous to the CLKDIV clock input. To invoke the BITSLIP module, the BITSLIP port must be asserted High for one and only one CLKDIV cycle. After one CLKDIV cycle the BITSLIP port is asserted High, the BITSLIP operation is complete. For DDR mode, a BITSLIP operation can not be stable until after two CLKDIV cycles. All outputs of the BITSLIP appear in one of the registered output ports (Q1 to Q6) BITSLIP operations are synchronous to CLKDIV.

### Additional Features

#### Width Expansion

It is possible to use the ISERDES modules to recover data widths larger than 6 bits. To use this feature, two ISERDES modules need to be instantiated. Both the ISERDES must be an adjacent master and slave pair. The attribute SERDES\_MODE must be set to either "MASTER" or "SLAVE" in order to differentiate the modes of the ISERDES pair. In addition, you must connect the SHIFOUT ports of the MASTER to the SHIFTIN ports of the SLAVE. This feature supports data widths of 7, 8, and 10 for SDR and DDR mode. The table below lists the data width availability for SDR and DDR mode.

Mode	Widths
SDR Data Widths	2,3,4,5,6,7,8
DDR Data Widths	4,6,8,10

### Port Descriptions

Port	Direction	Width	Function
O	Output	1	Combinatorial Output - This port is an unregistered output of the ISERDES module. It is the unregistered output of the delay chain. In addition, this output port can also be configured to bypass all the submodules within ISERDES module. This output can be used to drive the BUFIOs.

Port	Direction	Width	Function
Q1:6	Output	1 (each)	<p>Registered Outputs - This port is a registered output of the ISERDES module. Using these outputs, you have a selection of the following combination of ISERDES submodules path as the inputs:</p> <ul style="list-style-type: none"> <li>• Delay chain to serial-to-parallel converter to BITSLIP module.</li> <li>• Delay chain to serial-to-parallel converter.</li> </ul> <p>These ports can be programmed from 2 to 6 bits. In the extended width mode, this port can be expanded up to 10 bits.</p>
SHIFTOUT 1:2	Output	1 (each)	Carry out for data input expansion. Connect to SHIFTIN1/2 of slave.
BITSLIP	Input	1	Invokes the ISERDES to perform a BITSLIP operation when logic High is given and the BITSLIP module is enabled.
CE 1:2	Input	1 (each)	Clock enables input that feeds into the CE module.
CLK	Input	1	<p>High Speed Forwarded Clock Input - This clock input is used to drive the Serial to Parallel Converter and the BITSLIP module. The possible source for the CLK port is from one of the following clock resources:</p> <ul style="list-style-type: none"> <li>• Eight global clock lines in a clock region</li> <li>• Two regional clock lines</li> <li>• Six clock capable I/Os (within adjacent clock region)</li> <li>• Fabric (through bypass)</li> </ul>
CLKDIV	Input	1	<p>Divided High Speed Forward Clock Input - This clock input is used to drive the Serial to Parallel Converter, Delay Chain, the BITSLIP module, and CE module. This clock has to have slower frequency than the clock connected to the CLK port. The possible source for the CLKDIV port is from one of the following clock resources:</p> <ul style="list-style-type: none"> <li>• Eight global clock lines in a clock region</li> <li>• Two regional clock lines</li> </ul>
D	Input	1	Serial Input Data From IOB - The D is where all the incoming data enters the ISERDES module. This port works in conjunction with SelectIO to accommodate the desired I/O standards.
DLYCE	Input	1	Enable delay chain to be incremented or decremented
DLYINC	Input	1	Delay Chain Increment/Decrement Pin - When the DLYCE pin is asserted High, the value at DLYINC pin increments/decrements the delay chain value. Logic High increments the tap value, while logic LOW decrements the tap value.
DLYRST	Input	1	Delay Chain Reset Pin - Resets delay line to programmed value of IOBDELAY_VALUE (=Tap Count). If no value programmed, resets delay line to 0 taps.

Port	Direction	Width	Function
OCLK	Input	1	<p>High Speed Clock for Memory Interfaces Applications - This clock input is used to drive the serial-to-parallel converter in the ISERDES module. The possible source for the OCLK port is from one of the following clock resources:</p> <ul style="list-style-type: none"> <li>• Eight global clock lines in a clock region</li> <li>• Two regional clock lines</li> <li>• Six clock capable I/Os (within adjacent clock region)</li> <li>• Fabric (through bypass)</li> </ul> <p>This clock is an ideal solution for memory interfaces in which strobe signals are required.</p>
REV	Input	1	Reverse SR. For internal testing purposes. When SR is used, a second input, REV forces the storage element into the opposite state. The reset condition predominates over the set condition. The REV pin is not supported in ISERDES.
SR	Input	1	Set/Reset Input - The set/reset pin, SR forces the storage element into the state specified by the SRVAL attribute, set through your constraints file (UCF). SRVAL = "1" forces a logic 1. SRVAL = "0" forces a logic "0." When SR is used, a second input (REV) forces the storage element into the opposite state. The reset condition predominates over the set condition. The SR pin active high asynchronous reset for all registers in the ISERDES component.
SHIFTIN 1:2	Input	1 (each)	Carry input for data input expansion. Connect to SHIFTOUT1/2 of master.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
BITSLIP_ENABLE	Boolean	FALSE, TRUE	FALSE	Allows you to enable the bitflip controller.
DATA_RATE	String	"SDR" or "DDR"	"DDR"	Specify data rate of either allowed value.
DATA_WIDTH	String	If DATA_RATE = "DDR", value is limited to 4, 6, 8, or 10. If DATA_RATE = "SDR", value is limited to 2, 3, 4, 5, 6, 7, or 8.	4	Defines the serial-to-parallel converter width. This value also depends on the SDR vs. DDR and the Mode of the ISERDES.
INTERFACE_TYPE	String	"MEMORY" or "NETWORKING"	"MEMORY"	Determines which ISERDES use model is used.
IOBDelay	String	"NONE", "IBUF", "IFD", "BOTH"	"NONE"	Defines where the ISERDES outputs the Delay Chains.
IOBDelay_TYPE	String	"DEFAULT", "FIXED", or "VARIABLE"	"DEFAULT"	Defines whether the Delay Chains are in fixed or variable mode.
IOBDelay_VALUE	Integer	0 to 63	0	Set initial tap delay to an Integer from 0 to 63.

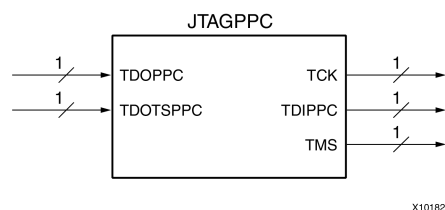
Attribute	Type	Allowed Values	Default	Description
NUM_CE	Integer	1 or 2	2	Define number or clock enables to an Integer of 1 or 2.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## JTAGPPC

### Primitive: JTAG Primitive for the Power PC



## Introduction

This design element connects the JTAG logic in the PPC405 core to the JTAG logic of the FPGA device in which the core resides. The connections are made through programmable routing, so the connection only exists after configuration.

## Port Descriptions

Inputs	Outputs
TDOTSPPC	TDIPPC
TDOPPC	TCK
	TMS

## Design Entry Method

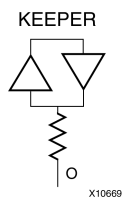
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## KEEPER

### Primitive: KEEPER Symbol



## Introduction

The design element is a weak keeper element that retains the value of the net connected to its bidirectional O pin. For example, if a logic 1 is being driven onto the net, KEEPER drives a weak/resistive 1 onto the net. If the net driver is then 3-stated, KEEPER continues to drive a weak/resistive 1 onto the net.

## Port Descriptions

Name	Direction	Width	Function
O	Output	1-Bit	Keeper output

## Design Entry Method

This design element can be used in schematics or instantiated in HDL code. Instantiation templates for VHDL and Verilog are available below.

This element can be connected to a net in the following locations on a top-level schematic file:

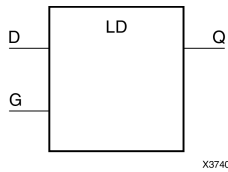
- A net connected to an input IO Marker
- A net connected to both an output IO Marker and 3-statable IO element, such as an OBUFT.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD

### Primitive: Transparent Data Latch



## Introduction

LD is a transparent data latch. The data output (Q) of the latch reflects the data (D) input while the gate enable (G) input is High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	D	D
0	X	No Change
↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

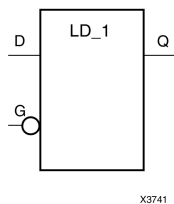
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD\_1

### Primitive: Transparent Data Latch with Inverted Gate



## Introduction

This design element is a transparent data latch with an inverted gate. The data output (Q) of the latch reflects the data (D) input while the gate enable (G) input is Low. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
0	D	D
1	X	No Change
↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration.

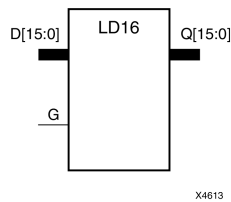
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## LD16

### Macro: Multiple Transparent Data Latch



### Introduction

This design element has 16 transparent data latches with a common gate enable (G). The data output (Q) of the latch reflects the data (D) input while the gate enable (G) input is High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

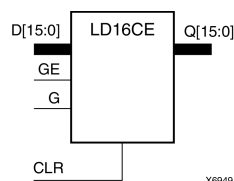
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 16-Bit Value	All zeros	Sets the initial value of Q output after configuration

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD16CE

### Macro: Transparent Data Latch with Asynchronous Clear and Gate Enable



## Introduction

This design element has 16 transparent data latches with asynchronous clear and gate enable. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) outputs Low. (Q) reflects the data (D) inputs while the gate (G) and gate enable (GE) are High, and (CLR) is Low. If (GE) is Low, data on (D) cannot be latched. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	GE	G	Dn	Qn
1	X	X	X	0
0	0	X	X	No Change
0	1	1	Dn	Dn
0	1	0	X	No Change
0	1	↓	Dn	Dn

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

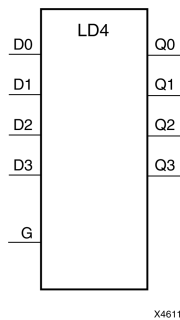
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 16-Bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD4

### Macro: Multiple Transparent Data Latch



## Introduction

This design element has four transparent data latches with a common gate enable (G). The data output (Q) of the latch reflects the data (D) input while the gate enable (G) input is High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

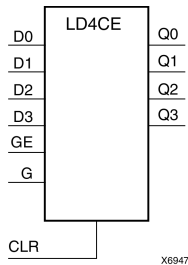
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 4-Bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD4CE

### Macro: Transparent Data Latch with Asynchronous Clear and Gate Enable



## Introduction

This design element has 4 transparent data latches with asynchronous clear and gate enable. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) outputs Low. (Q) reflects the data (D) inputs while the gate (G) and gate enable (GE) are High, and (CLR) is Low. If (GE) is Low, data on (D) cannot be latched. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	GE	G	Dn	Qn
1	X	X	X	0
0	0	X	X	No Change
0	1	1	Dn	Dn
0	1	0	X	No Change
0	1	↓	Dn	Dn

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

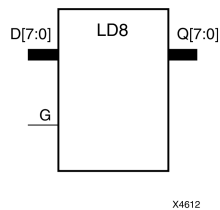
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 4-Bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD8

### Macro: Multiple Transparent Data Latch



## Introduction

This design element has 8 transparent data latches with a common gate enable (G). The data output (Q) of the latch reflects the data (D) input while the gate enable (G) input is High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
G	D	Q
1	Dn	Dn
0	X	No Change
↓	Dn	Dn

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

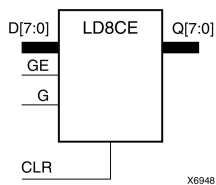
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 8-Bit Value	All zeros	Sets the initial value of Q output after configuration

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LD8CE

### Macro: Transparent Data Latch with Asynchronous Clear and Gate Enable



## Introduction

This design element has 8 transparent data latches with asynchronous clear and gate enable. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) outputs Low. (Q) reflects the data (D) inputs while the gate (G) and gate enable (GE) are High, and (CLR) is Low. If (GE) is Low, data on (D) cannot be latched. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
CLR	GE	G	Dn	Qn
1	X	X	X	0
0	0	X	X	No Change
0	1	1	Dn	Dn
0	1	0	X	No Change
0	1	↓	Dn	Dn

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

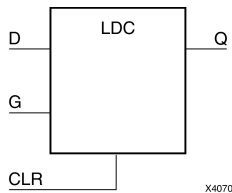
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	Any 8-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDC

### Primitive: Transparent Data Latch with Asynchronous Clear



## Introduction

This design element is a transparent data latch with asynchronous clear. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. (Q) reflects the data (D) input while the gate enable (G) input is High and (CLR) is Low. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
CLR	G	D	Q
1	X	X	0
0	1	D	D
0	0	X	No Change
0	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

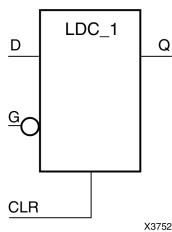
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDC\_1

### Primitive: Transparent Data Latch with Asynchronous Clear and Inverted Gate



## Introduction

This design element is a transparent data latch with asynchronous clear and inverted gate. When the asynchronous clear input (CLR) is High, it overrides the other inputs (D and G) and resets the data (Q) output Low. (Q) reflects the data (D) input while the gate enable (G) input and CLR are Low. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
CLR	G	D	Q
1	X	X	0
0	0	D	D
0	1	X	No Change
0	↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration.

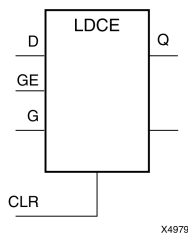
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## LDCE

### Primitive: Transparent Data Latch with Asynchronous Clear and Gate Enable



## Introduction

This design element is a transparent data latch with asynchronous clear and gate enable. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. Q reflects the data (D) input while the gate (G) input and gate enable (GE) are High and CLR is Low. If (GE) is Low, data on (D) cannot be latched. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs				Outputs
CLR	GE	G	D	Q
1	X	X	X	0
0	0	X	X	No Change
0	1	1	D	D
0	1	0	X	No Change
0	1	↓	D	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

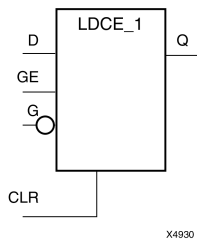
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDCE\_1

**Primitive: Transparent Data Latch with Asynchronous Clear, Gate Enable, and Inverted Gate**



### Introduction

This design element is a transparent data latch with asynchronous clear, gate enable, and inverted gate. When the asynchronous clear input (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. (Q) reflects the data (D) input while the gate (G) input and (CLR) are Low and gate enable (GE) is High. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs				Outputs
CLR	GE	G	D	Q
1	X	X	X	0
0	0	X	X	No Change
0	1	0	D	D
0	1	1	X	No Change
0	1	↑	D	D

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

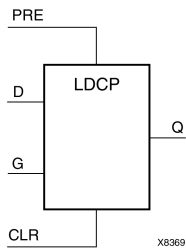
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Sets the initial value of Q output after configuration.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDCP

### Primitive: Transparent Data Latch with Asynchronous Clear and Preset



## Introduction

The design element is a transparent data latch with data (D), asynchronous clear (CLR) and preset (PRE) inputs. When CLR is High, it overrides the other inputs and resets the data (Q) output Low. When PRE is High and CLR is low, it presets the data (Q) output High. Q reflects the data (D) input while the gate (G) input is High and CLR and PRE are Low. The data on the D input during the High-to-Low gate transition is stored in the latch. The data on the Q output remains unchanged as long as G remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	PRE	G	D	Q
1	X	X	X	0
0	1	X	X	1
0	0	1	D	D
0	0	0	X	No Change
0	0	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

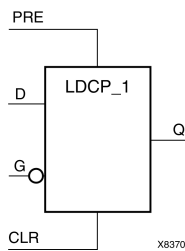
Attribute	Type	Allowed Values	Default	Description
INIT	Integer	0, 1	0	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDCP\_1

Primitive: Transparent Data Latch with Asynchronous Clear and Preset and Inverted Gate



## Introduction

This design element is a transparent data latch with data (D), asynchronous clear (CLR), preset (PRE) inputs, and inverted gate (G). When (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. When (PRE) is High and (CLR) is Low, it presets the data (Q) output High. (Q) reflects the data (D) input while gate (G) input, (CLR), and (PRE) are Low. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs
CLR	PRE	G	D	Q
1	X	X	X	0
0	1	X	X	1
0	0	0	D	D
0	0	1	X	No Change
0	0	↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

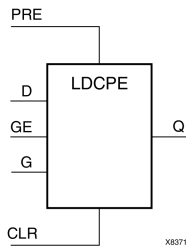
Attribute	Type	Allowed Values	Default	Description
INIT	Integer	0, 1	0	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDCPE

### Primitive: Transparent Data Latch with Asynchronous Clear and Preset and Gate Enable



## Introduction

This design element is a transparent data latch with data (D), asynchronous clear (CLR), asynchronous preset (PRE), and gate enable (GE). When (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. When (PRE) is High and (CLR) is Low, it presets the data (Q) output High. Q reflects the data (D) input while the gate (G) input and gate enable (GE) are High and (CLR) and PRE are Low. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the Q output remains unchanged as long as (G) or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs					Outputs
CLR	PRE	GE	G	D	Q
1	X	X	X	X	0
0	1	X	X	X	1
0	0	0	X	X	No Change
0	0	1	1	0	0
0	0	1	1	1	1
0	0	1	0	X	No Change
0	0	1	↓	D	D

## Port Descriptions

Port	Direction	Width	Function
Q	Output	1	Data Output
CLR	Input	1	Asynchronous clear/reset input
D	Input	1	Data Input
G	Input	1	Gate Input
GE	Input	1	Gate Enable Input
PRE	Input	1	Asynchronous preset/set input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

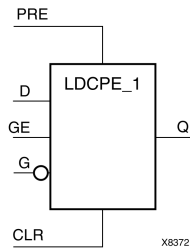
Attribute	Type	Allowed Values	Default	Description
INIT	Integer	0, 1	0	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDCPE\_1

**Primitive: Transparent Data Latch with Asynchronous Clear and Preset, Gate Enable, and Inverted Gate**



### Introduction

This design element is a transparent data latch with data (D), asynchronous clear (CLR), asynchronous preset (PRE), gate enable (GE), and inverted gate (G). When (CLR) is High, it overrides the other inputs and resets the data (Q) output Low. When PRE is High and (CLR) is Low, it presets the data (Q) output High. (Q) reflects the data (D) input while gate enable (GE) is High and gate (G), (CLR), and (PRE) are Low. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) is High or (GE) is Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

### Logic Table

Inputs					Outputs
CLR	PRE	GE	G	D	Q
1	X	X	X	X	0
0	1	X	X	X	1
0	0	0	X	X	No Change
0	0	1	0	D	D
0	0	1	1	X	No Change
0	0	1	↑	D	D

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

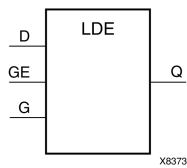
Attribute	Type	Allowed Values	Default	Description
INIT	Integer	0, 1	0	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDE

### Primitive: Transparent Data Latch with Gate Enable



## Introduction

This design element is a transparent data latch with data (D) and gate enable (GE) inputs. Output (Q) reflects the data (D) while the gate (G) input and gate enable (GE) are High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	1	D	D
1	0	X	No Change
1	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

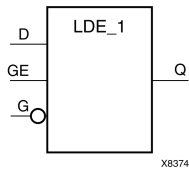
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## LDE\_1

### Primitive: Transparent Data Latch with Gate Enable and Inverted Gate



## Introduction

This design element is a transparent data latch with data (D), gate enable (GE), and inverted gate (G). Output (Q) reflects the data (D) while the gate (G) input is Low and gate enable (GE) is High. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) is High or (GE) is Low.

This latch is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
GE	G	D	Q
0	X	X	No Change
1	0	D	D
1	1	X	No Change
1	↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

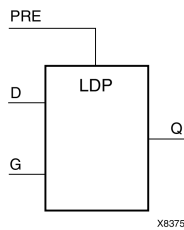
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	0	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDP

### Primitive: Transparent Data Latch with Asynchronous Preset



## Introduction

This design element is a transparent data latch with asynchronous preset (PRE). When PRE is High it overrides the other inputs and presets the data (Q) output High. Q reflects the data (D) input while gate (G) input is High and PRE is Low. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the Q output remains unchanged as long as G remains Low.

The latch is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
PRE	G	D	Q
1	X	X	1
0	1	0	0
0	1	1	1
0	0	X	No Change
0	↓	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

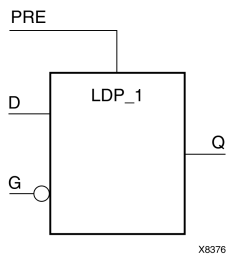
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Specifies the initial value upon power-up or the assertion of GSR for the Q port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDP\_1

### Primitive: Transparent Data Latch with Asynchronous Preset and Inverted Gate



## Introduction

This design element is a transparent data latch with asynchronous preset (PRE) and inverted gate (G). When the (PRE) input is High, it overrides the other inputs and presets the data (Q) output High. (Q) reflects the data (D) input while gate (G) input and (PRE) are Low. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High.

The latch is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
PRE	G	D	Q
1	X	X	1
0	0	D	D
0	1	X	No Change
0	↑	D	D

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

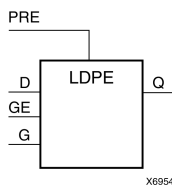
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDPE

### Primitive: Transparent Data Latch with Asynchronous Preset and Gate Enable



## Introduction

This design element is a transparent data latch with asynchronous preset and gate enable. When the asynchronous preset (PRE) is High, it overrides the other input and presets the data (Q) output High. Q reflects the data (D) input while the gate (G) input and gate enable (GE) are High. The data on the (D) input during the High-to-Low gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) or (GE) remains Low.

The latch is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs
PRE	GE	G	D	Q
1	X	X	X	1
0	0	X	X	No Change
0	1	1	D	D
0	1	0	X	No Change
0	1	↓	D	D

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

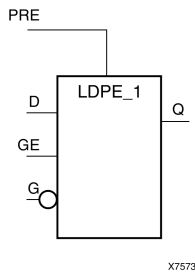
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LDPE\_1

**Primitive: Transparent Data Latch with Asynchronous Preset, Gate Enable, and Inverted Gate**



### Introduction

This design element is a transparent data latch with asynchronous preset, gate enable, and inverted gate. When the asynchronous preset (PRE) is High, it overrides the other input and presets the data (Q) output High. (Q) reflects the data (D) input while the gate (G) and (PRE) are Low and gate enable (GE) is High. The data on the (D) input during the Low-to-High gate transition is stored in the latch. The data on the (Q) output remains unchanged as long as (G) remains High or (GE) remains Low.

The latch is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs				Outputs
PRE	GE	G	D	Q
1	X	X	X	1
0	0	X	X	No Change
0	1	0	D	D
0	1	1	X	No Change
0	1	↑	D	D

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

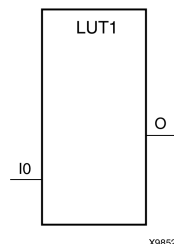
Attribute	Type	Allowed Values	Default	Description
INIT	Binary	0, 1	1	Specifies the initial value upon power-up or the assertion of GSR for the (Q) port.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT1

### Primitive: 1-Bit Look-Up Table with General Output



## Introduction

This design element is a 1-bit look-up table (LUT) with general output (O).

An INIT attribute with an appropriate number of hexadecimal digits for the number of inputs must be attached to the LUT to specify its function. This element provides a look-up table version of a buffer or inverter. These elements are the basic building blocks. Two LUTs are available in each CLB slice; four LUTs are available in each CLB. Multiple variants of LUTs accommodate additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs	Outputs
I0	O
0	INIT[0]
1	INIT[1]
INIT = Binary number assigned to the INIT attribute	

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

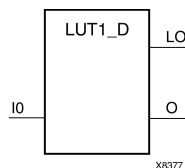
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 2-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT1\_D

### Primitive: 1-Bit Look-Up Table with Dual Output



## Introduction

This design element is a 1-bit look-up table (LUT) with two functionally identical outputs, O and LO. It provides a look-up table version of a buffer or inverter.

The O output is a general interconnect. The LO output is used to connect to another output within the same CLB slice and to the fast connect buffer. A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs	Outputs	
I0	O	LO
0	INIT[0]	INIT[0]
1	INIT[1]	INIT[1]
INIT = Binary number assigned to the INIT attribute		

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 2-Bit Value	All zeros	Initializes look-up tables.

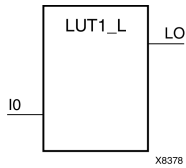
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## LUT1\_L

### Primitive: 1-Bit Look-Up Table with Local Output



## Introduction

This design element is a 1-bit look-up table (LUT) with a local output (LO) that is used to connect to another output within the same CLB slice and to the fast connect buffer. It provides a look-up table version of a buffer or inverter.

A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs	Outputs
I0	LO
0	INIT[0]
1	INIT[1]
INIT = Binary number assigned to the INIT attribute	

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

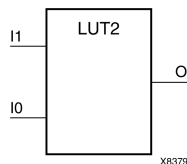
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 2-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT2

### Primitive: 2-Bit Look-Up Table with General Output



## Introduction

This design element is a 2-bit look-up table (LUT) with general output (O).

An INIT attribute with an appropriate number of hexadecimal digits for the number of inputs must be attached to the LUT to specify its function. This element provides a look-up table version of a buffer or inverter. These elements are the basic building blocks. Two LUTs are available in each CLB slice; four LUTs are available in each CLB. Multiple variants of LUTs accommodate additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs		Outputs
I1	I0	O
0	0	INIT[0]
0	1	INIT[1]
1	0	INIT[2]
1	1	INIT[3]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute		

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

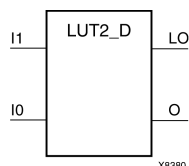
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 4-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT2\_D

### Primitive: 2-Bit Look-Up Table with Dual Output



## Introduction

This design element is a 2-bit look-up table (LUT) with two functionally identical outputs, O and LO.

The O output is a general interconnect. The LO output is used to connect to another output within the same CLB slice and to the fast connect buffer. A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The LogicTable Method** - A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** - Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs		Outputs	
I1	I0	O	LO
0	0	INIT[0]	INIT[0]
0	1	INIT[1]	INIT[1]
1	0	INIT[2]	INIT[2]
1	1	INIT[3]	INIT[3]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

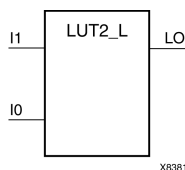
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 4-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT2\_L

### Primitive: 2-Bit Look-Up Table with Local Output



## Introduction

This design element is a 2-bit look-up table (LUT) with a local output (LO) that is used to connect to another output within the same CLB slice and to the fast connect buffer. It provides a look-up table version of a buffer or inverter.

A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs		Outputs
I1	I0	LO
0	0	INIT[0]
0	1	INIT[1]
1	0	INIT[2]
1	1	INIT[3]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute		

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

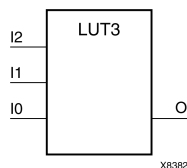
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 4-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT3

### Primitive: 3-Bit Look-Up Table with General Output



## Introduction

This design element is a 3-bit look-up table (LUT) with general output (O). A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

An INIT attribute with an appropriate number of hexadecimal digits for the number of inputs must be attached to the LUT to specify its function. This element provides a look-up table version of a buffer or inverter. These elements are the basic building blocks. Two LUTs are available in each CLB slice; four LUTs are available in each CLB. Multiple variants of LUTs accommodate additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs			Outputs
I2	I1	I0	O
0	0	0	INIT[0]
0	0	1	INIT[1]
0	1	0	INIT[2]
0	1	1	INIT[3]
1	0	0	INIT[4]
1	0	1	INIT[5]
1	1	0	INIT[6]
1	1	1	INIT[7]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute			

## Design Entry Method

This design element can be used in schematics.



## Available Attributes

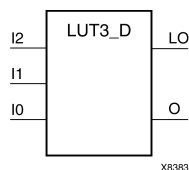
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 8-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT3\_D

### Primitive: 3-Bit Look-Up Table with Dual Output



## Introduction

This design element is a 3-bit look-up table (LUT) with two functionally identical outputs, O and LO.

The O output is a general interconnect. The LO output is used to connect to another output within the same CLB slice and to the fast connect buffer. A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs			Outputs	
I2	I1	I0	O	LO
0	0	0	INIT[0]	INIT[0]
0	0	1	INIT[1]	INIT[1]
0	1	0	INIT[2]	INIT[2]
0	1	1	INIT[3]	INIT[3]
1	0	0	INIT[4]	INIT[4]
1	0	1	INIT[5]	INIT[5]
1	1	0	INIT[6]	INIT[6]
1	1	1	INIT[7]	INIT[7]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute				

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

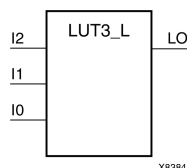
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 8-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT3\_L

### Primitive: 3-Bit Look-Up Table with Local Output



## Introduction

This design element is a 3-bit look-up table (LUT) with a local output (LO) that is used to connect to another output within the same CLB slice and to the fast connect buffer. It provides a look-up table version of a buffer or inverter.

A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs			Outputs
I2	I1	I0	LO
0	0	0	INIT[0]
0	0	1	INIT[1]
0	1	0	INIT[2]
0	1	1	INIT[3]
1	0	0	INIT[4]
1	0	1	INIT[5]
1	1	0	INIT[6]
1	1	1	INIT[7]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

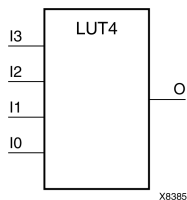
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 8-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# LUT4

## Primitive: 4-Bit Look-Up-Table with General Output



## Introduction

This design element is a 4-bit look-up table (LUT) with general output (O).

An INIT attribute with an appropriate number of hexadecimal digits for the number of inputs must be attached to the LUT to specify its function. This element provides a look-up table version of a buffer or inverter. These elements are the basic building blocks. Two LUTs are available in each CLB slice; four LUTs are available in each CLB. Multiple variants of LUTs accommodate additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs				Outputs
I3	I2	I1	I0	O
0	0	0	0	INIT[0]
0	0	0	1	INIT[1]
0	0	1	0	INIT[2]
0	0	1	1	INIT[3]
0	1	0	0	INIT[4]
0	1	0	1	INIT[5]
0	1	1	0	INIT[6]
0	1	1	1	INIT[7]
1	0	0	0	INIT[8]
1	0	0	1	INIT[9]
1	0	1	0	INIT[10]
1	0	1	1	INIT[11]
1	1	0	0	INIT[12]
1	1	0	1	INIT[13]
1	1	1	0	INIT[14]
1	1	1	1	INIT[15]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute				

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

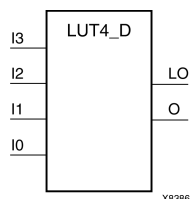
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT4\_D

### Primitive: 4-Bit Look-Up Table with Dual Output



## Introduction

This design element is a 4-bit look-up table (LUT) with two functionally identical outputs, O and LO

The O output is a general interconnect. The LO output is used to connect to another output within the same CLB slice and to the fast connect buffer. A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and is more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.



## Logic Table

Inputs				Outputs	
I3	I2	I1	I0	O	LO
0	0	0	0	INIT[0]	INIT[0]
0	0	0	1	INIT[1]	INIT[1]
0	0	1	0	INIT[2]	INIT[2]
0	0	1	1	INIT[3]	INIT[3]
0	1	0	0	INIT[4]	INIT[4]
0	1	0	1	INIT[5]	INIT[5]
0	1	1	0	INIT[6]	INIT[6]
0	1	1	1	INIT[7]	INIT[7]
1	0	0	0	INIT[8]	INIT[8]
1	0	0	1	INIT[9]	INIT[9]
1	0	1	0	INIT[10]	INIT[10]
1	0	1	1	INIT[11]	INIT[11]
1	1	0	0	INIT[12]	INIT[12]
1	1	0	1	INIT[13]	INIT[13]
1	1	1	0	INIT[14]	INIT[14]
1	1	1	1	INIT[15]	INIT[15]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute					

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

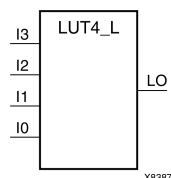
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## LUT4\_L

### Primitive: 4-Bit Look-Up Table with Local Output



## Introduction

This design element is a 4-bit look-up table (LUT) with a local output (LO) that is used to connect to another output within the same CLB slice and to the fast connect buffer. It provides a look-up table version of a buffer or inverter.

A mandatory INIT attribute, with an appropriate number of hexadecimal digits for the number of inputs, must be attached to the LUT to specify its function.

The INIT parameter for the FPGA LUT primitive is what gives the LUT its logical value. By default, this value is zero, thus driving the output to a zero regardless of the input values (acting as a ground). However, in most cases a new INIT value must be determined in order to specify the logic function for the LUT primitive. There are at least two methods by which the LUT value can be determined:

**The Logic Table Method** -A common method to determine the desired INIT value for a LUT is using a logic table. To do so, simply create a binary logic table of all possible inputs, specify the desired logic value of the output and then create the INIT string from those output values.

**The Equation Method** -Another method to determine the LUT value is to define parameters for each input to the LUT that correspond to their listed truth value and use those to build the logic equation you are after. This method is easier to understand once you have grasped the concept and more self-documenting than the above method. However, this method does require the code to first specify the appropriate parameters.

## Logic Table

Inputs				Outputs
I3	I2	I1	I0	LO
0	0	0	0	INIT[0]
0	0	0	1	INIT[1]
0	0	1	0	INIT[2]
0	0	1	1	INIT[3]
0	1	0	0	INIT[4]
0	1	0	1	INIT[5]
0	1	1	0	INIT[6]
0	1	1	1	INIT[7]
1	0	0	0	INIT[8]
1	0	0	1	INIT[9]
1	0	1	0	INIT[10]
1	0	1	1	INIT[11]
1	1	0	0	INIT[12]
1	1	0	1	INIT[13]
1	1	1	0	INIT[14]
1	1	1	1	INIT[15]
INIT = Binary equivalent of the hexadecimal number assigned to the INIT attribute				

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

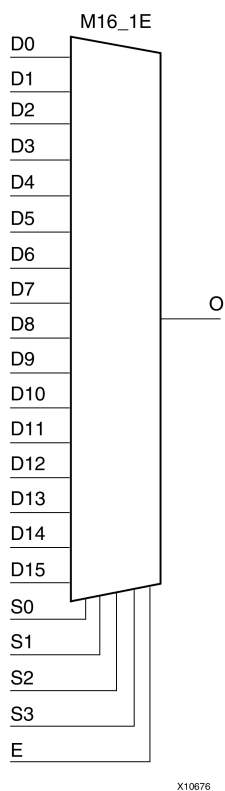
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Initializes look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M16\_1E

### Macro: 16-to-1 Multiplexer with Enable



## Introduction

This design element is a 16-to-1 multiplexer with enable. When the enable input (E) is High, the M16\_1E multiplexer chooses one data bit from 16 sources (D15 : D0) under the control of the select inputs (S3 : S0). The output (O) reflects the state of the selected input as shown in the logic table. When (E) is Low, the output is Low.

## Logic Table

Inputs						Outputs
E	S3	S2	S1	S0	D15-D0	O
0	X	X	X	X	X	0
1	0	0	0	0	D0	D0
1	0	0	0	1	D1	D1
1	0	0	1	0	D2	D2
1	0	0	1	1	D3	D3
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
1	1	1	0	0	D12	D12
1	1	1	0	1	D13	D13
1	1	1	1	0	D14	D14
1	1	1	1	1	D15	D15

## Design Entry Method

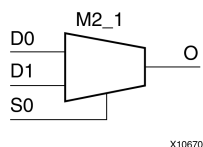
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M2\_1

### Macro: 2-to-1 Multiplexer



## Introduction

This design element chooses one data bit from two sources (D1 or D0) under the control of the select input (S0). The output (O) reflects the state of the selected data input. When Low, S0 selects D0 and when High, S0 selects D1.

## Logic Table

Inputs			Outputs
S0	D1	D0	O
1	D1	X	D1
0	X	D0	D0

## Design Entry Method

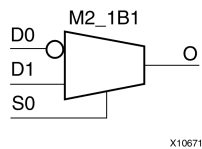
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M2\_1B1

### Macro: 2-to-1 Multiplexer with D0 Inverted



## Introduction

This design element chooses one data bit from two sources (D1 or D0) under the control of select input (S0). When S0 is Low, the output (O) reflects the inverted value of (D0). When S0 is High, (O) reflects the state of D1.

## Logic Table

Inputs			Outputs
S0	D1	D0	O
1	1	X	1
1	0	X	0
0	X	1	0
0	X	0	1

## Design Entry Method

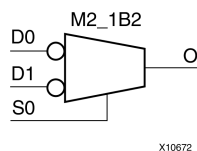
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M2\_1B2

### Macro: 2-to-1 Multiplexer with D0 and D1 Inverted



## Introduction

This design element chooses one data bit from two sources (D1 or D0) under the control of select input (S0). When S0 is Low, the output (O) reflects the inverted value of D0. When S0 is High, O reflects the inverted value of D1.

## Logic Table

Inputs			Outputs
S0	D1	D0	O
1	1	X	0
1	0	X	1
0	X	1	0
0	X	0	1

## Design Entry Method

This design element is only for use in schematics.

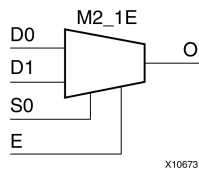
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## M2\_1E

### Macro: 2-to-1 Multiplexer with Enable



## Introduction

This design element is a 2-to-1 multiplexer with enable. When the enable input (E) is High, the M2\_1E chooses one data bit from two sources (D1 or D0) under the control of select input (S0). When Low, S0 selects D0 and when High, S0 selects D1. When (E) is Low, the output is Low.

## Logic Table

Inputs				Outputs
E	S0	D1	D0	O
0	X	X	X	0
1	0	X	1	1
1	0	X	0	0
1	1	1	X	1
1	1	0	X	0

## Design Entry Method

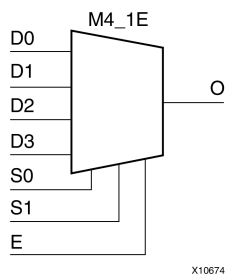
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M4\_1E

### Macro: 4-to-1 Multiplexer with Enable



### Introduction

This design element is a 4-to-1 multiplexer with enable. When the enable input (E) is High, the M4\_1E multiplexer chooses one data bit from four sources (D3, D2, D1, or D0) under the control of the select inputs (S1 : S0). The output (O) reflects the state of the selected input as shown in the logic table. When (E) is Low, the output is Low.

### Logic Table

Inputs							Outputs
E	S1	S0	D0	D1	D2	D3	O
0	X	X	X	X	X	X	0
1	0	0	D0	X	X	X	D0
1	0	1	X	D1	X	X	D1
1	1	0	X	X	D2	X	D2
1	1	1	X	X	X	D3	D3

### Design Entry Method

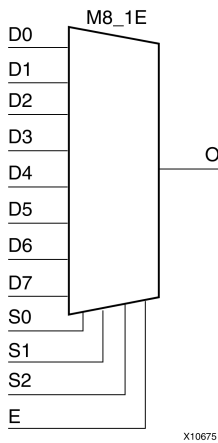
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## M8\_1E

### Macro: 8-to-1 Multiplexer with Enable



## Introduction

This design element is an 8-to-1 multiplexer with enable. When the enable input (E) is High, the M8\_1E multiplexer chooses one data bit from eight sources (D7 : D0) under the control of the select inputs (S2 : S0). The output (O) reflects the state of the selected input as shown in the logic table. When (E) is Low, the output is Low.

## Logic Table

Inputs					Outputs
E	S2	S1	S0	D7-D0	O
0	X	X	X	X	0
1	0	0	0	D0	D0
1	0	0	1	D1	D1
1	0	1	0	D2	D2
1	0	1	1	D3	D3
1	1	0	0	D4	D4
1	1	0	1	D5	D5
1	1	1	0	D6	D6
1	1	1	1	D7	D7

## Design Entry Method

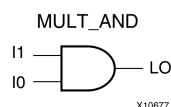
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MULT\_AND

### Primitive: Fast Multiplier AND



## Introduction

The design element is an AND component located within the slice where the two inputs are shared with the 4-input LUT and the output drives into the carry logic. This added logic is especially useful for building fast and smaller multipliers. However, it can be used for other purposes as well. The I1 and I0 inputs must be connected to the I1 and I0 inputs of the associated LUT. The LO output must be connected to the DI input of the associated MUXCY, MUXCY\_D, or MUXCY\_L.

## Logic Table

Inputs		Outputs
I1	I0	LO
0	0	0
0	1	0
1	0	0
1	1	1

## Design Entry Method

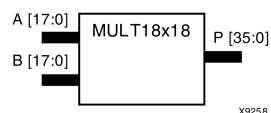
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# MULT18X18

Primitive: 18 x 18 Signed Multiplier



## Introduction

MULT18X18 is a combinational signed 18-bit by 18-bit multiplier. The value represented in the 18-bit input A is multiplied by the value represented in the 18-bit input B. Output P is the 36-bit product of A and B.

## Logic Table

Inputs		Output
A	B	P
A	B	A x B
A, B, and P are two's complement.		

## Design Entry Method

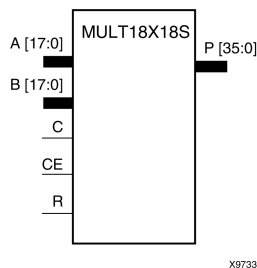
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MULT18X18S

Primitive: 18 x 18 Signed Multiplier Registered Version



### Introduction

MULT18X18S is the registered version of the 18 x 18 signed multiplier with output P and inputs A, B, C, CE, and R. The registers are initialized to 0 after the GSR pulse.

The value represented in the 18-bit input A is multiplied by the value represented in the 18-bit input B. Output P is the 36-bit product of A and B.

### Logic Table

Inputs					Output
C	CE	Am	Bn	R	P
↑	X	X	X	1	0
↑	1	Am	Bn	0	A x B
X	0	X	X	0	No Change
A, B, and P are two's complement.					

### Design Entry Method

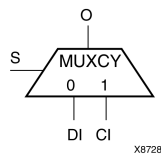
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXCY

### Primitive: 2-to-1 Multiplexer for Carry Logic with General Output



## Introduction

The direct input (DI) of a slice is connected to the (DI) input of the MUXCY. The carry in (CI) input of an LC is connected to the CI input of the MUXCY. The select input (S) of the MUXCY is driven by the output of the look-up table (LUT) and configured as a MUX function. The carry out (O) of the MUXCY reflects the state of the selected input and implements the carry out function of each LC. When Low, S selects DI; when High, S selects CI.

The variants “MUXCY\_D” and “MUXCY\_L” provide additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

## Logic Table

Inputs			Outputs
S	DI	CI	O
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

## Design Entry Method

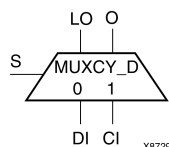
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXCY\_D

### Primitive: 2-to-1 Multiplexer for Carry Logic with Dual Output



## Introduction

This design element implements a 1-bit, high-speed carry propagate function. One such function can be implemented per logic cell (LC), for a total of 4-bits per configurable logic block (CLB). The direct input (DI) of an LC is connected to the DI input of the MUXCY\_D. The carry in (CI) input of an LC is connected to the CI input of the MUXCY\_D. The select input (S) of the MUX is driven by the output of the look-up table (LUT) and configured as an XOR function. The carry out (O and LO) of the MUXCY\_D reflects the state of the selected input and implements the carry out function of each LC. When Low, S selects DI; when High, S selects CI.

Outputs O and LO are functionally identical. The O output is a general interconnect. See also “MUXCY” and “MUXCY\_L”.

## Logic Table

Inputs			Outputs	
S	DI	CI	O	LO
0	1	X	1	1
0	0	X	0	0
1	X	1	1	1
1	X	0	0	0

## Design Entry Method

This design element can be used in schematics.

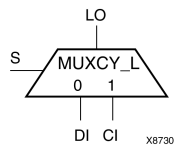
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## MUXCY\_L

Primitive: 2-to-1 Multiplexer for Carry Logic with Local Output



### Introduction

This design element implements a 1-bit high-speed carry propagate function. One such function is implemented per logic cell (LC), for a total of 4-bits per configurable logic block (CLB). The direct input (DI) of an LC is connected to the DI input of the MUXCY\_L. The carry in (CI) input of an LC is connected to the CI input of the MUXCY\_L. The select input (S) of the MUXCY\_L is driven by the output of the look-up table (LUT) and configured as an XOR function. The carry out (LO) of the MUXCY\_L reflects the state of the selected input and implements the carry out function of each (LC). When Low, (S) selects DI; when High, (S) selects (CI).

See also “MUXCY” and “MUXCY\_D.”

### Logic Table

Inputs			Outputs
S	DI	CI	LO
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

### Design Entry Method

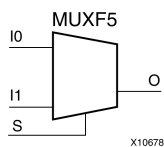
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF5

### Primitive: 2-to-1 Look-Up Table Multiplexer with General Output



## Introduction

This design element provides a multiplexer function in a CLB slice for creating a function-of-5 look-up table or a 4-to-1 multiplexer in combination with the associated look-up tables. The local outputs (LO) from the two look-up tables are connected to the I0 and I1 inputs of the MUXF5. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The variants, “MUXF5\_D” and “MUXF5\_L”, provide additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

## Logic Table

Inputs			Outputs
S	I0	I1	O
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

## Design Entry Method

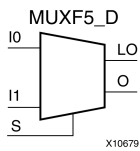
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF5\_D

### Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output



## Introduction

This design element provides a multiplexer function in a CLB slice for creating a function-of-5 look-up table or a 4-to-1 multiplexer in combination with the associated look-up tables. The local outputs (LO) from the two look-up tables are connected to the I0 and I1 inputs of the MUXF5. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

Outputs O and LO are functionally identical. The O output is a general interconnect. The LO output connects to other inputs in the same CLB slice. See also “MUXF5” and “MUXF5\_L”.

## Logic Table

Inputs			Outputs	
S	I0	I1	O	LO
0	1	X	1	1
0	0	X	0	0
1	X	1	1	1
1	X	0	0	0

## Design Entry Method

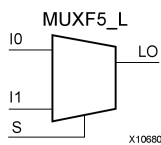
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF5\_L

### Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output



## Introduction

This design element provides a multiplexer function in a CLB slice for creating a function-of-5 look-up table or a 4-to-1 multiplexer in combination with the associated look-up tables. The local outputs (LO) from the two look-up tables are connected to the I0 and I1 inputs of the MUXF5. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The LO output connects to other inputs in the same CLB slice.

See also “MUXF5” and “MUXF5\_D”.

## Logic Table

Inputs			Output
S	I0	I1	LO
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

## Design Entry Method

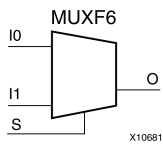
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF6

### Primitive: 2-to-1 Look-Up Table Multiplexer with General Output



## Introduction

This design element provides a multiplexer function in two slices for creating a function-of-6 look-up table or an 8-to-1 multiplexer in combination with the associated four look-up tables and two MUXF5s. The local outputs (LO) from the two MUXF5s in the CLB are connected to the I0 and I1 inputs of the MUXF6. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The variants, “MUXF6\_D” and “MUXF6\_L”, provide additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

## Logic Table

Inputs			Outputs
S	I0	I1	O
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

## Design Entry Method

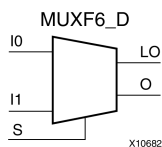
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF6\_D

### Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output



## Introduction

This design element provides a multiplexer function in a two slices for creating a function-of-6 look-up table or an 8-to-1 multiplexer in combination with the associated four look-up tables and two MUXF5s. The local outputs (LO) from the two MUXF5s in the CLB are connected to the I0 and I1 inputs of the MUXF6. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

Outputs O and LO are functionally identical. The O output is a general interconnect. The LO output connects to other inputs in the same CLB slice.

## Logic Table

Inputs			Outputs	
S	I0	I1	O	LO
0	1	X	1	1
0	0	X	0	0
1	X	1	1	1
1	X	0	0	0

## Design Entry Method

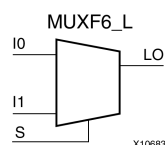
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF6\_L

Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output



### Introduction

This design element provides a multiplexer function for use in creating a function-of-6 look-up table or an 8-to-1 multiplexer in combination with the associated four look-up tables and two MUXF5s. The local outputs (LO) from the two MUXF5s in the CLB are connected to the I0 and I1 inputs of the MUXF6. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The LO output connects to other inputs in the same CLB slice.

### Logic Table

Inputs			Output
S	I0	I1	LO
0	1	X	1
0	0	X	0
1	X	1	1
1	X	0	0

### Design Entry Method

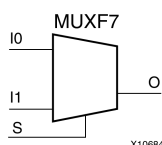
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF7

### Primitive: 2-to-1 Look-Up Table Multiplexer with General Output



## Introduction

This design element provides a multiplexer function for use in creating a function-of-7 look-up table or an 8-to-1 multiplexer in combination with the associated look-up tables. Local outputs (LO) of MUXF6 are connected to the I0 and I1 inputs of the MUXF7. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The variants, “MUXF7\_D” and “MUXF7\_L”, provide additional types of outputs that can be used by different timing models for more accurate pre-layout timing estimation.

## Logic Table

Inputs			Outputs
S	I0	I1	O
0	I0	X	I0
1	X	I1	I1
X	0	0	0
X	1	1	1

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Output of MUX to general routing
I0	Input	1	Input (tie to MUXF6 LO out)
I1	Input	1	Input (tie to MUXF6 LO out)
S	Input	1	Input select to MUX

## Design Entry Method

This design element can be used in schematics.

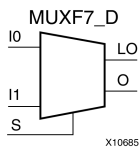
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## MUXF7\_D

### Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output



## Introduction

This design element provides a multiplexer function for use in creating a function-of-7 look-up table or a 16-to-1 multiplexer in combination with the associated look-up tables. Local outputs (LO) of MUXF6 are connected to the I0 and I1 inputs of the MUXF7. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

Outputs O and LO are functionally identical. The O output is a general interconnect. The LO output connects to other inputs in the same CLB slice.

## Logic Table

Inputs			Outputs	
S	I0	I1	O	LO
0	I0	X	I0	I0
1	X	I1	I1	I1
X	0	0	0	0
X	1	1	1	1

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Output of MUX to general routing
LO	Output	1	Output of MUX to local routing
I0	Input	1	Input (tie to MUXF6 LO out)
I1	Input	1	Input (tie to MUXF6 LO out)
S	Input	1	Input select to MUX

## Design Entry Method

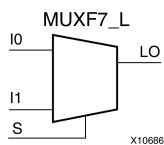
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF7\_L

Primitive: 2-to-1 look-up table Multiplexer with Local Output



### Introduction

This design element provides a multiplexer function for use in creating a function-of-7 look-up table or a 16-to-1 multiplexer in combination with the associated look-up tables. Local outputs (LO) of MUXF6 are connected to the I0 and I1 inputs of the MUXF7. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The LO output connects to other inputs in the same CLB slice.

### Logic Table

Inputs			Output
S	I0	I1	LO
0	I0	X	I0
1	X	I1	I1
X	0	0	0
X	1	1	1

### Port Descriptions

Port	Direction	Width	Function
LO	Output	1	Output of MUX to local routing
I0	Input	1	Input
I1	Input	1	Input
S	Input	1	Input select to MUX

### Design Entry Method

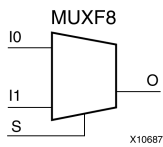
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF8

### Primitive: 2-to-1 Look-Up Table Multiplexer with General Output



## Introduction

This design element provides a multiplexer function in eight slices for creating a function-of-8 look-up table or a 16-to-1 multiplexer in combination with the associated look-up tables, MUXF5s, MUXF6s, and MUXF7s. Local outputs (LO) of MUXF7 are connected to the I0 and I1 inputs of the MUXF8. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

## Logic Table

Inputs			Outputs
S	I0	I1	O
0	I0	X	I0
1	X	I1	I1
X	0	0	0
X	1	1	1

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Output of MUX to general routing
I0	Input	1	Input (tie to MUXF7 LO out)
I1	Input	1	Input (tie to MUXF7 LO out)
S	Input	1	Input select to MUX

## Design Entry Method

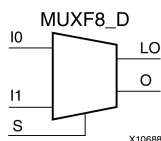
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF8\_D

### Primitive: 2-to-1 Look-Up Table Multiplexer with Dual Output



## Introduction

This design element provides a multiplexer function in eight slices for creating a function-of-8 look-up table or a 32-to-1 multiplexer in combination with the associated four look-up tables and two MUXF8s. Local outputs (LO) of MUXF7 are connected to the I0 and I1 inputs of the MUXF8. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

Outputs O and LO are functionally identical. The O output is a general interconnect. The LO output connects to other inputs in the same CLB slice.

## Logic Table

Inputs			Outputs	
S	I0	I1	O	LO
0	I0	X	I0	I0
1	X	I1	I1	I1
X	0	0	0	0
X	1	1	1	1

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Output of MUX to general routing
LO	Output	1	Output of MUX to local routing
I0	Input	1	Input (tie to MUXF7 LO out)
I1	Input	1	Input (tie to MUXF7 LO out)
S	Input	1	Input select to MUX

## Design Entry Method

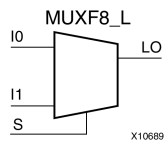
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## MUXF8\_L

Primitive: 2-to-1 Look-Up Table Multiplexer with Local Output



### Introduction

This design element provides a multiplexer function in eight slices for creating a function-of-8 look-up table or a 32-to-1 multiplexer in combination with the associated four look-up tables and two MUXF8s. Local outputs (LO) of MUXF7 are connected to the I0 and I1 inputs of the MUXF8. The S input is driven from any internal net. When Low, S selects I0. When High, S selects I1.

The LO output connects to other inputs in the same CLB slice.

### Logic Table

Inputs			Output
S	I0	I1	LO
0	I0	X	I0
1	X	I1	I1
X	0	0	0
X	1	1	1

### Port Descriptions

Port	Direction	Width	Function
LO	Output	1	Output of MUX to local routing
I0	Input	1	Input (tie to MUXF7 LO out)
I1	Input	1	Input (tie to MUXF7 LO out)
S	Input	1	Input select to MUX

### Design Entry Method

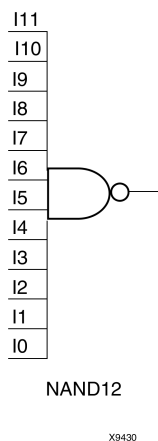
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND12

### Macro: 12- Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

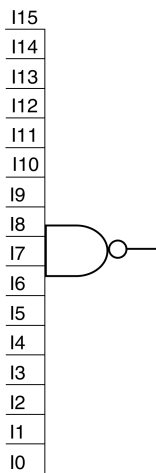
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND16

### Macro: 16- Input NAND Gate with Non-Inverted Inputs



NAND16

X9431

## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

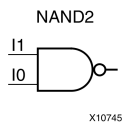
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND2

### Primitive: 2-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

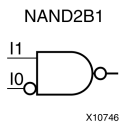
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NAND2B1

Primitive: 2-Input NAND Gate with 1 Inverted and 1 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

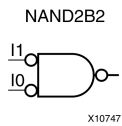
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND2B2

### Primitive: 2-Input NAND Gate with Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

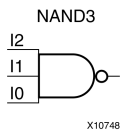
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND3

### Primitive: 3-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

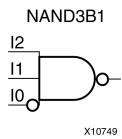
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND3B1

Primitive: 3-Input NAND Gate with 1 Inverted and 2 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

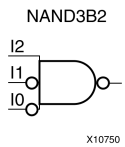
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND3B2

Primitive: 3-Input NAND Gate with 2 Inverted and 1 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

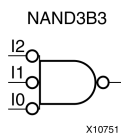
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND3B3

### Primitive: 3-Input NAND Gate with Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

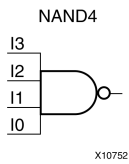
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND4

### Primitive: 4-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

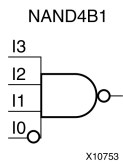
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND4B1

Primitive: 4-Input NAND Gate with 1 Inverted and 3 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

This design element is only for use in schematics.

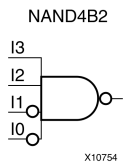
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NAND4B2

Primitive: 4-Input NAND Gate with 2 Inverted and 2 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

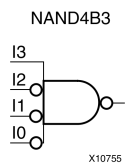
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND4B3

Primitive: 4-Input NAND Gate with 3 Inverted and 1 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

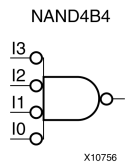
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND4B4

### Primitive: 4-Input NAND Gate with Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

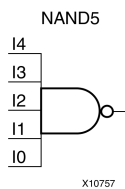
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND5

### Primitive: 5-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

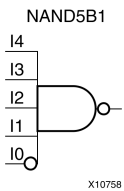
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND5B1

Primitive: 5-Input NAND Gate with 1 Inverted and 4 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

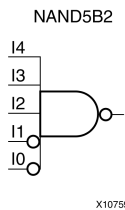
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND5B2

Primitive: 5-Input NAND Gate with 2 Inverted and 3 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

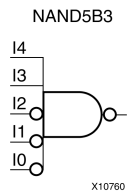
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND5B3

Primitive: 5-Input NAND Gate with 3 Inverted and 2 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

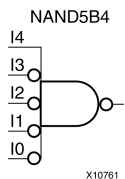
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND5B4

Primitive: 5-Input NAND Gate with 4 Inverted and 1 Non-Inverted Inputs



### Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

This design element is only for use in schematics.

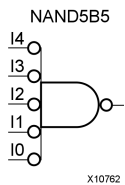
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NAND5B5

### Primitive: 5-Input NAND Gate with Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

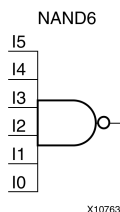
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND6

### Macro: 6-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

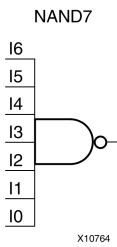
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND7

### Macro: 7-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

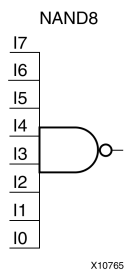
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND8

### Macro: 8-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

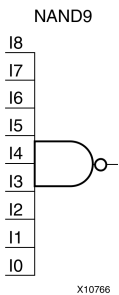
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NAND9

### Macro: 9-Input NAND Gate with Non-Inverted Inputs



## Introduction

NAND gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NAND gates of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

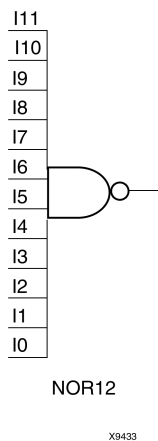
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR12

### Macro: 12-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

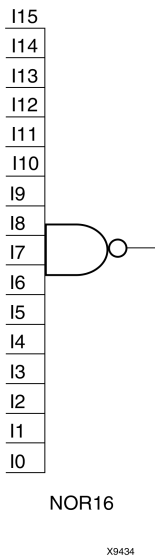
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR16

### Macro: 16-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

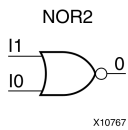
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR2

### Primitive: 2-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

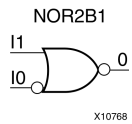
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NOR2B1

Primitive: 2-Input NOR Gate with 1 Inverted and 1 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

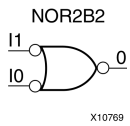
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR2B2

### Primitive: 2-Input NOR Gate with Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

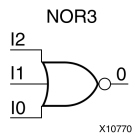
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR3

### Primitive: 3-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

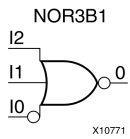
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR3B1

Primitive: 3-Input NOR Gate with 1 Inverted and 2 Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

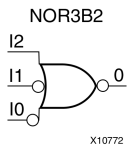
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR3B2

Primitive: 3-Input NOR Gate with 2 Inverted and 1 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

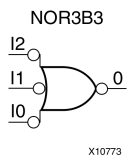
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR3B3

### Primitive: 3-Input NOR Gate with Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

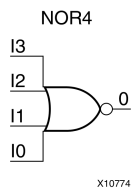
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR4

### Primitive: 4-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

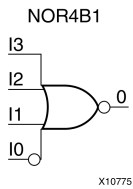
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR4B1

Primitive: 4-Input NOR Gate with 1 Inverted and 3 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

This design element is only for use in schematics.

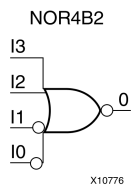
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NOR4B2

Primitive: 4-Input NOR Gate with 2 Inverted and 2 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

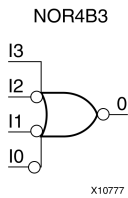
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR4B3

Primitive: 4-Input NOR Gate with 3 Inverted and 1 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

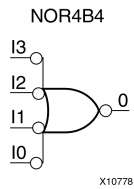
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR4B4

### Primitive: 4-Input NOR Gate with Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

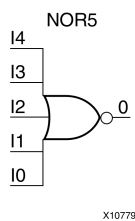
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR5

### Primitive: 5-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

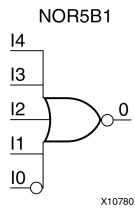
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR5B1

Primitive: 5-Input NOR Gate with 1 Inverted and 4 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

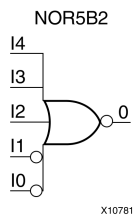
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR5B2

Primitive: 5-Input NOR Gate with 2 Inverted and 3 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

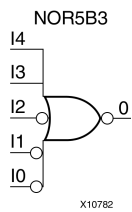
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR5B3

Primitive: 5-Input NOR Gate with 3 Inverted and 2 Non-Inverted Inputs



### Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

### Design Entry Method

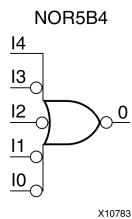
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR5B4

Primitive: 5-Input NOR Gate with 4 Inverted and 1 Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

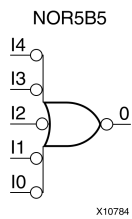
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## NOR5B5

### Primitive: 5-Input NOR Gate with Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

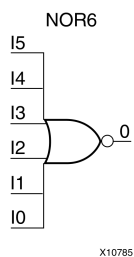
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR6

### Macro: 6-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

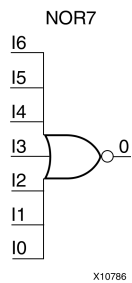
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR7

### Macro: 7-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

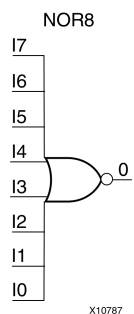
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR8

### Macro: 8-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

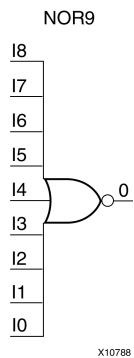
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## NOR9

### Macro: 9-Input NOR Gate with Non-Inverted Inputs



## Introduction

NOR gates of up to five inputs are available in any combination of inverting and non-inverting inputs. NOR gates of six to nine inputs, 12 inputs, and 16 inputs are available only with non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace gates with unused inputs with gates having the necessary number of inputs.

## Design Entry Method

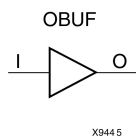
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUF

### Primitive: Output Buffer



## Introduction

This design element is a simple output buffer used to drive output signals to the FPGA device pins that do not need to be 3-stated (constantly driven). Either an OBUF, OBUFT, OBUFDS, or OBUFTDS must be connected to every output port in the design.

This element isolates the internal circuit and provides drive current for signals leaving a chip. It exists in input/output blocks (IOB). Its output (O) is connected to an OPAD or an IOPAD. The interface standard used by this element is LVTTTL. Also, this element has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Output of OBUF to be connected directly to top-level output port.
I	Input	1	Input of OBUF. Connect to the logic driving the output port.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

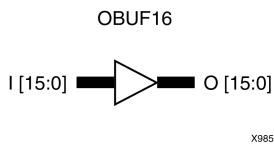
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. Consult the product Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUF16

### Macro: 16-Bit Output Buffer



## Introduction

This design element is a multiple output buffer.

This element isolates the internal circuit and provides drive current for signals leaving a chip. It exists in input/output blocks (IOB). Its output (O) is connected to an OPAD or an IOPAD. The interface standard used by this element is LVTTTL. Also, this element has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

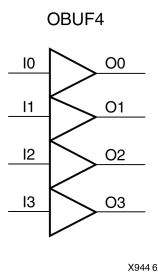
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. Consult the product Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUF4

### Macro: 4-Bit Output Buffer



## Introduction

This design element is a multiple output buffer.

This element isolates the internal circuit and provides drive current for signals leaving a chip. It exists in input/output blocks (IOB). Its output (O) is connected to an OPAD or an IOPAD. The interface standard used by this element is LVTTTL. Also, this element has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. Consult the product Data Sheet for recommendations of the best setting for this attribute.

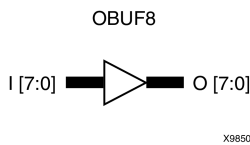
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OBUF8

### Macro: 8-Bit Output Buffer



## Introduction

This design element is a multiple output buffer.

This element isolates the internal circuit and provides drive current for signals leaving a chip. It exists in input/output blocks (IOB). Its output (O) is connected to an OPAD or an IOPAD. The interface standard used by this element is LVTTTL. Also, this element has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

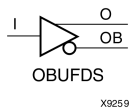
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. Consult the product Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUFDS

### Primitive: Differential Signaling Output Buffer



## Introduction

This design element is a single output buffer that supports low-voltage, differential signaling (1.8 v CMOS). OBUFDS isolates the internal circuit and provides drive current for signals leaving the chip. Its output is represented as two distinct ports (O and OB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET and MYNETB).

## Logic Table

Inputs	Outputs	
I	O	OB
0	0	1
1	1	0

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Diff_p output (connect directly to top level port)
OB	Output	1	Diff_n output (connect directly to top level port)
I	Input	1	Buffer input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

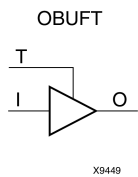
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUFT

### Primitive: 3-State Output Buffer with Active Low Output Enable



## Introduction

This design element is a single, 3-state output buffer with input I, output O, and active-Low output enables (T). This element uses the LVTTL standard and has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

When T is Low, data on the inputs of the buffers is transferred to the corresponding outputs. When T is High, the output is high impedance (off or Z state). OBUFTs are generally used when a single-ended output is needed with a 3-state capability, such as the case when building bidirectional I/O.

## Logic Table

Inputs		Outputs
T	I	O
1	X	Z
0	1	1
0	0	0

## Port Descriptions

Port	Direction	Width	Function
O	Output	1	Buffer output (connect directly to top-level port)
I	Input	1	Buffer input
T	Input	1	3-state enable input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

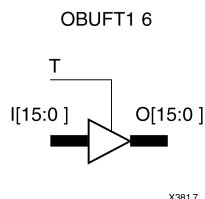
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. See the Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUFT16

Macro: 16-Bit 3-State Output Buffer with Active Low Output Enable



### Introduction

This design element is a multiple, 3-state output buffer with input I, output O, and active-Low output enables (T). This element uses the LVTTL standard and has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

When T is Low, data on the inputs of the buffers is transferred to the corresponding outputs. When T is High, the output is high impedance (off or Z state). OBUFTs are generally used when a single-ended output is needed with a 3-state capability, such as the case when building bidirectional I/O.

### Logic Table

Inputs		Outputs
T	I	O
1	X	Z
0	1	1
0	0	0

### Design Entry Method

This design element is only for use in schematics.

### Available Attributes

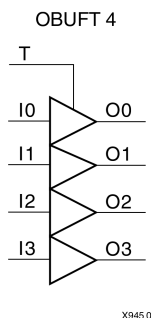
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. See the Data Sheet for recommendations of the best setting for this attribute.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUFT4

### Macro: 4-Bit 3-State Output Buffers with Active-Low Output Enable



## Introduction

This design element is a multiple, 3-state output buffer with input I, output O, and active-Low output enables (T). This element uses the LVTTTL standard and has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

When T is Low, data on the inputs of the buffers is transferred to the corresponding outputs. When T is High, the output is high impedance (off or Z state). OBUFTs are generally used when a single-ended output is needed with a 3-state capability, such as the case when building bidirectional I/O.

## Logic Table

Inputs		Outputs
T	I	O
1	X	Z
0	1	1
0	0	0

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

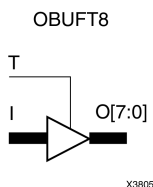
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. See the Data Sheet for recommendations of the best setting for this attribute.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OBUFT8

### Macro: 8-Bit 3-State Output Buffers with Active-Low Output Enable



## Introduction

This design element is a multiple, 3-state output buffer with input I, output O, and active-Low output enables (T). This element uses the LVTTTL standard and has selectable drive and slew rates using the DRIVE and SLOW or FAST constraints. The defaults are DRIVE=12 mA and SLOW slew.

When T is Low, data on the inputs of the buffers is transferred to the corresponding outputs. When T is High, the output is high impedance (off or Z state). OBUFTs are generally used when a single-ended output is needed with a 3-state capability, such as the case when building bidirectional I/O.

## Logic Table

Inputs		Outputs
T	I	O
1	X	Z
0	1	1
0	0	0

## Design Entry Method

This design element is only for use in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
DRIVE	Integer	2, 4, 6, 8, 12, 16, 24	12	Specifies the output current drive strength of the I/O. It is suggested that you set this to the lowest setting tolerable for the design drive and timing requirements.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.
SLEW	String	"SLOW" or "FAST"	"SLOW"	Specifies the slew rate of the output driver. See the Data Sheet for recommendations of the best setting for this attribute.

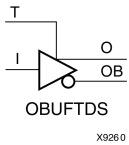
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OBUFTDS

Primitive: 3-State Output Buffer with Differential Signaling, Active-Low Output Enable



### Introduction

This design element is an output buffer that supports low-voltage, differential signaling. For the OBUFTDS, a design level interface signal is represented as two distinct ports (O and OB), one deemed the "master" and the other the "slave." The master and the slave are opposite phases of the same logical signal (for example, MYNET\_P and MYNET\_N).

### Logic Table

Inputs		Outputs	
I	T	O	OB
X	1	Z	Z
0	0	0	1
1	0	1	0

### Port Descriptions

Port	Direction	Width	Function
O	Output	1	Diff_p output (connect directly to top level port)
OB	Output	1	Diff_n output (connect directly to top level port)
I	Input	1	Buffer input
T	Input	1	3-state enable input

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

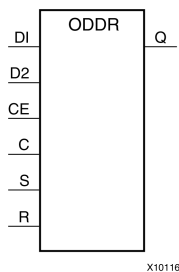
Attribute	Type	Allowed Values	Default	Description
CAPACITANCE	String	"LOW", "NORMAL", "DONT_CARE"	"DONT_CARE"	Specified whether the I/O should be used with lower or normal intrinsic capacitance.
IOSTANDARD	String	See Data Sheet	"DEFAULT"	Assigns an I/O standard to the element.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ODDR

### Primitive: Dedicated Dual Data Rate (DDR) Output Register



## Introduction

This design element is a dedicated output register for use in transmitting dual data rate (DDR) signals from FPGA devices. The ODDR primitive's interface with the FPGA fabric are not limited to opposite edges. The ODDR is available with modes that allow data to be presented from the FPGA fabric at the same clock edge. This feature allows designers to avoid additional timing complexities and CLB usage. In addition, the ODDR works in conjunction with SelectIO™ features.

### ODDR Modes

This element has two modes of operation. These modes are set by the `DDR_CLK_EDGE` attribute.

- **OPPOSITE\_EDGE mode** - The data transmit interface uses the classic DDR methodology. Given a data and clock at pin D1-2 and C respectively, D1 is sampled at every positive edge of clock C, and D2 is sampled at every negative edge of clock C. Q changes every clock edge.
- **SAME\_EDGE mode** - Data is still transmitted at the output of the ODDR by opposite edges of clock C. However, the two inputs to the ODDR are clocked with a positive clock edge of clock signal C and an extra register is clocked with a negative clock edge of clock signal C. Using this feature, DDR data can now be presented into the ODDR at the same clock edge.

## Port Descriptions

Port	Type	Width	Function
Q	Output	1	Data Output (DDR) - The ODDR output that connects to the IOB pad.
C	Input	1	Clock Input - The C pin represents the clock input pin.
CE	Input	1	Clock Enable Input - When asserted High, this port enables the clock input on port C.
D1 : D2	Input	1 (each)	Data Input - This pin is where the DDR data is presented into the ODDR module.
R	Input	1	Reset - Depends on how SRTYPE is set.
S	Input	1	Set - Active High asynchronous set pin. This pin can also be Synchronous depending on the SRTYPE attribute.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

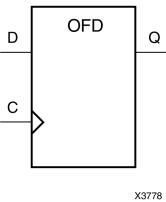
Attribute	Type	Allowed Values	Default	Description
DDR_CLK_EDGE	String	"OPPOSITE_EDGE", "SAME_EDGE"	"OPPOSITE_EDGE"	DDR clock mode recovery mode selection.
INIT	Integer	0, 1	1	Q initialization value.
SRTYPE	String	"SYNC", "ASYNC"	"SYNC"	Set/Reset type selection.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFD

## Macro: Output D Flip-Flop



## Introduction

This design element is a single output D flip-flop.

The outputs are connected to OPADs or IOPADs. The data on the (D) inputs is loaded into the flip-flops during the Low-to-High clock (C) transition and appears on the (Q) outputs.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

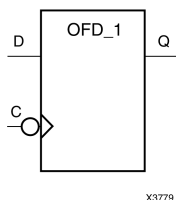
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFD\_1

### Macro: Output D Flip-Flop with Inverted Clock



## Introduction

The design element is located in an input/output block (IOB). The output (Q) of the D flip-flop is connected to an OPAD or an IOPAD. The data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition and appears on the (Q) output.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↓	D

## Design Entry Method

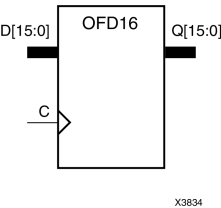
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFD16

## Macro: 16-Bit Output D Flip-Flop



## Introduction

This design element is a multiple output D flip-flop.

The outputs are connected to OPADs or IOPADs. The data on the (D) inputs is loaded into the flip-flops during the Low-to-High clock (C) transition and appears on the (Q) outputs.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

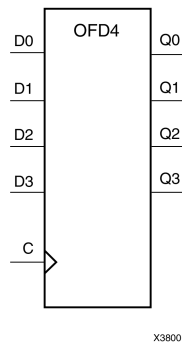
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFD4

### Macro: 4-Bit Output D Flip-Flop



## Introduction

This design element is a multiple output D flip-flop.

The outputs are connected to OPADs or IOPADs. The data on the (D) inputs is loaded into the flip-flops during the Low-to-High clock (C) transition and appears on the (Q) outputs.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

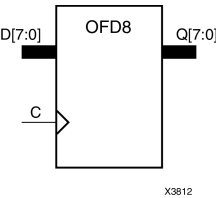
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFD8

## Macro: 8-Bit Output D Flip-Flop



## Introduction

This design element is a multiple output D flip-flop.

The outputs are connected to OPADs or IOPADs. The data on the (D) inputs is loaded into the flip-flops during the Low-to-High clock (C) transition and appears on the (Q) outputs.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

This design element is only for use in schematics.

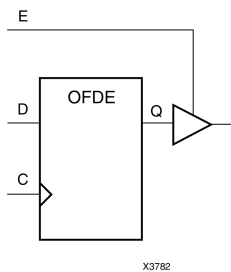
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OFDE

### Macro: D Flip-Flop with Active-High Enable Output Buffers



## Introduction

This is a single D flip-flop whose output is enabled by a 3-state buffer. The flip-flop data output (Q) is connected to the input of output buffer (OBUFE). The OBUFE output (O) is connected to an OPAD or IOPAD. The data on the data input (D) is loaded into the flip-flop during the Low-to-High clock (C) transition. When the active-High enable input (E) is High, the data on the flip-flop output (Q) appears on the OBUFE (O) output. When (E) is Low, the output is high impedance (Z state or Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Output
E	D	C	O
0	X	X	Z
1	Dn	↑	Dn

## Design Entry Method

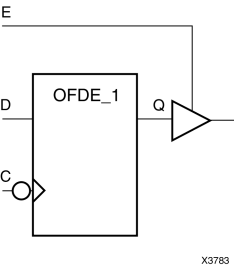
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFDE\_1

## Macro: D Flip-Flop with Active-High Enable Output Buffer and Inverted Clock



## Introduction

This design element and its output buffer are located in an input/output block (IOB). The data output of the flip-flop (Q) is connected to the input of an output buffer or OBUFE. The output of the OBUFE is connected to an OPAD or an IOPAD. The data on the data input (D) is loaded into the flip-flop on the High-to-Low clock (C) transition. When the active-High enable input (E) is High, the data on the flip-flop output (Q) appears on the (O) output. When (E) is Low, the output is high impedance (Z state or Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
E	D	C	O
0	X	X	Z
1	D	↓	D

## Design Entry Method

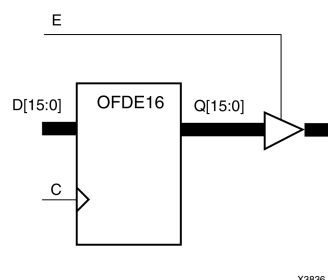
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDE16

### Macro: 16-Bit D Flip-Flop with Active-High Enable Output Buffers



## Introduction

This is a multiple D flip-flop whose outputs are enabled by 3-state buffers. The flip-flop data outputs (Q) are connected to the inputs of output buffers (OBUFE). The OBUFE outputs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-High enable inputs (E) are High, the data on the flip-flop outputs (Q) appears on the OBUFE outputs (O). When (E) is Low, outputs are high impedance (Z state or Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
E	D	C	O
0	X	X	Z
1	Dn	↑	Dn

## Design Entry Method

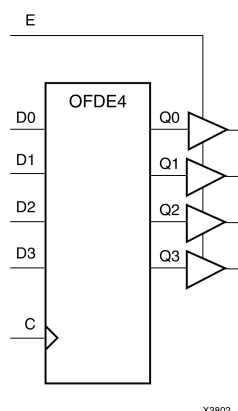
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDE4

### Macro: 4-Bit D Flip-Flop with Active-High Enable Output Buffers



## Introduction

This is a multiple D flip-flop whose outputs are enabled by 3-state buffers. The flip-flop data outputs (Q) are connected to the inputs of output buffers (OBUFE). The OBUFE outputs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-High enable inputs (E) are High, the data on the flip-flop outputs (Q) appears on the OBUFE outputs (O). When (E) is Low, outputs are high impedance (Z state or Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
E	D	C	O
0	X	X	Z
1	Dn	↑	Dn

## Design Entry Method

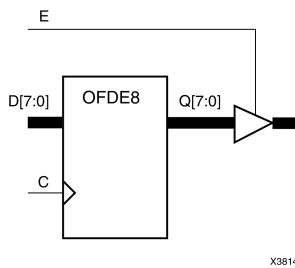
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDE8

### Macro: 8-Bit D Flip-Flop with Active-High Enable Output Buffers



## Introduction

This is a multiple D flip-flop whose outputs are enabled by 3-state buffers. The flip-flop data outputs (Q) are connected to the inputs of output buffers (OBUFE). The OBUFE outputs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-High enable inputs (E) are High, the data on the flip-flop outputs (Q) appears on the OBUFE outputs (O). When (E) is Low, outputs are high impedance (Z state or Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
E	D	C	O
0	X	X	Z
1	Dn	↑	Dn

## Design Entry Method

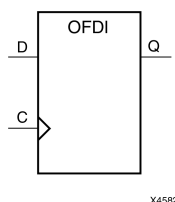
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDI

### Macro: Output D Flip-Flop (Asynchronous Preset)



## Introduction

The design element is contained in an input/output block (IOB). The output (Q) of the (D) flip-flop is connected to an OPAD or an IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q).

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↑	D

## Design Entry Method

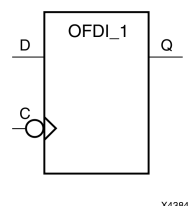
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFDI\_1

## Macro: Output D Flip-Flop with Inverted Clock (Asynchronous Preset)



## Introduction

This design element exists in an input/output block (IOB). The (D) flip-flop output (Q) is connected to an OPAD or an IOPAD. The data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition and appears on the (Q) output.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs		Outputs
D	C	Q
D	↓	D

## Design Entry Method

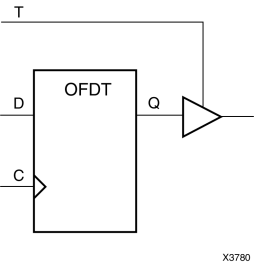
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFDT

## Macro: D Flip-Flop with Active-Low 3-State Output Buffer



## Introduction

This design element is a single D flip-flops whose output is enabled by a 3-state buffer.

The data outputs (Q) of the flip-flops are connected to the inputs of output buffers (OBUFT). The outputs of the OBUFTs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-Low enable inputs (T) are Low, the data on the flip-flop outputs (Q) appears on the (O) outputs. When (T) is High, outputs are high impedance (Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
T	D	C	O
1	X	X	Z
0	D	↑	D

## Design Entry Method

This design element is only for use in schematics.

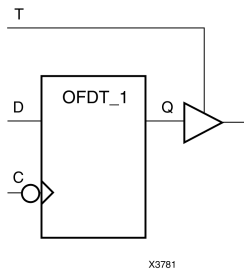
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OFDT\_1

### Macro: D Flip-Flop with Active-Low 3-State Output Buffer and Inverted Clock



## Introduction

The design element and its output buffer are located in an input/output block (IOB). The flip-flop data output (Q) is connected to the input of an output buffer (OBUFT). The OBUFT output is connected to an OPAD or an IOPAD. The data on the data input (D) is loaded into the flip-flop on the High-to-Low clock (C) transition. When the active-Low enable input (T) is Low, the data on the flip-flop output (Q) appears on the (O) output. When (T) is High, the output is high impedance (Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
T	D	C	O
1	X	X	Z
0	D	↓	D

## Design Entry Method

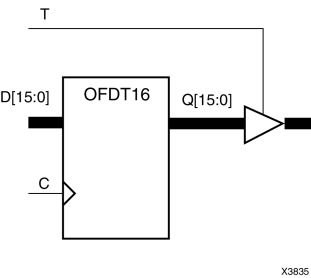
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFDT16

## Macro: 16-Bit D Flip-Flop with Active-Low 3-State Output Buffers



### Introduction

This design element is a multiple D flip-flop whose output are enabled by 3-state buffers.

The data outputs (Q) of the flip-flops are connected to the inputs of output buffers (OBUFT). The outputs of the OBUFTs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-Low enable inputs (T) are Low, the data on the flip-flop outputs (Q) appears on the (O) outputs. When (T) is High, outputs are high impedance (Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs			Outputs
T	D	C	O
1	X	X	Z
0	D	↑	D

### Design Entry Method

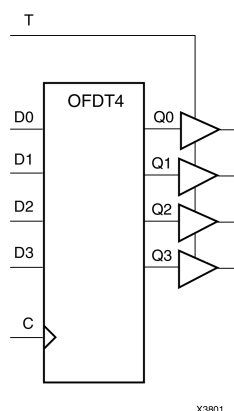
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDT4

### Macro: 4-Bit D Flip-Flop with Active-Low 3-State Output Buffers



## Introduction

This design element is a multiple D flip-flop whose output are enabled by 3-state buffers.

The data outputs (Q) of the flip-flops are connected to the inputs of output buffers (OBUFT). The outputs of the OBUFTs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-Low enable inputs (T) are Low, the data on the flip-flop outputs (Q) appears on the (O) outputs. When (T) is High, outputs are high impedance (Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
T	D	C	O
1	X	X	Z
0	D	↑	D

## Design Entry Method

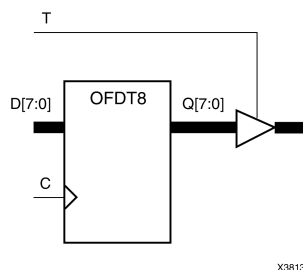
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDT8

### Macro: 8-Bit D Flip-Flop with Active-Low 3-State Output Buffers



## Introduction

This design element is a multiple D flip-flop whose output are enabled by 3-state buffers.

The data outputs (Q) of the flip-flops are connected to the inputs of output buffers (OBUFT). The outputs of the OBUFTs (O) are connected to OPADs or IOPADs. The data on the data inputs (D) is loaded into the flip-flops during the Low-to-High clock (C) transition. When the active-Low enable inputs (T) are Low, the data on the flip-flop outputs (Q) appears on the (O) outputs. When (T) is High, outputs are high impedance (Off).

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs			Outputs
T	D	C	O
1	X	X	Z
0	D	↑	D

## Design Entry Method

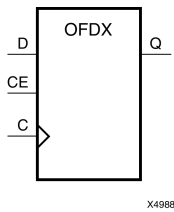
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDX

### Macro: Output D Flip-Flop with Clock Enable



## Introduction

This design element is a single output D flip-flop. The (Q) output is connected to OPAD or IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears on the (Q) output. When (CE) is Low, the flip-flop output does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	Dn	↑	Dn
0	X	X	No change

## Design Entry Method

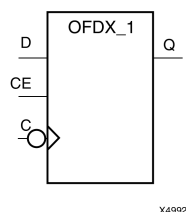
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDX\_1

### Macro: Output D Flip-Flop with Inverted Clock and Clock Enable



## Introduction

The design element is located in an input/output block (IOB). The output (Q) of the (D) flip-flop is connected to an OPAD or an IOPAD. The data on the (D) input is loaded into the flip-flop during the High-to-Low clock (C) transition and appears on the (Q) output. When the (CE) pin is Low, the output (Q) does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↓	D
0	X	X	No Change

## Design Entry Method

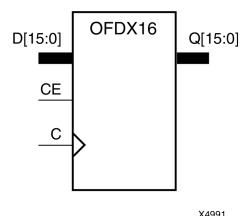
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDX16

### Macro: 16-Bit Output D Flip-Flop with Clock Enable



## Introduction

This design element is a multiple output D flip-flop. The (Q) output is connected to OPAD or IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears on the (Q) output. When (CE) is Low, the flip-flop output does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	Dn	↑	Dn
0	X	X	No change

## Design Entry Method

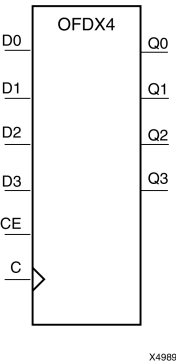
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# OFDX4

## Macro: 4-Bit Output D Flip-Flop with Clock Enable



## Introduction

This design element is a multiple output D flip-flop. The (Q) output is connected to OPAD or IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears on the (Q) output. When (CE) is Low, the flip-flop output does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	Dn	↑	Dn
0	X	X	No change

## Design Entry Method

This design element is only for use in schematics.

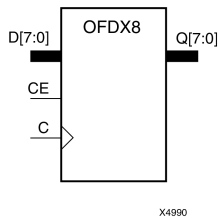
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OFDX8

### Macro: 8-Bit Output D Flip-Flop with Clock Enable



## Introduction

This design element is a multiple output D flip-flop. The (Q) output is connected to OPAD or IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears on the (Q) output. When (CE) is Low, the flip-flop output does not change.

This flip-flop is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	Dn	↑	Dn
0	X	X	No change

## Design Entry Method

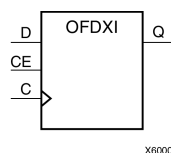
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDXI

### Macro: Output D Flip-Flop with Clock Enable (Asynchronous Preset)



## Introduction

The design element is contained in an input/output block (IOB). The output (Q) of the D flip-flop is connected to an OPAD or an IOPAD. The data on the (D) input is loaded into the flip-flop during the Low-to-High clock (C) transition and appears at the output (Q). When (CE) is Low, the output does not change.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↑	D
0	X	X	No Change

## Design Entry Method

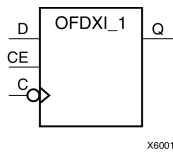
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OFDXI\_1

Macro: Output D Flip-Flop with Inverted Clock and Clock Enable (Asynchronous Preset)



### Introduction

The design element is located in an input/output block (IOB). The D flip-flop output (Q) is connected to an OPAD or an IOPAD. The data on the D input is loaded into the flip-flop during the High-to-Low clock (C) transition and appears on the Q output. When CE is Low, the output (Q) does not change.

This flip-flop is asynchronously preset, output High, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs			Outputs
CE	D	C	Q
1	D	↓	D
0	X	X	No Change

### Design Entry Method

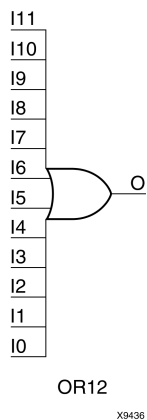
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR12

### Macro: 12-Input OR Gate with Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

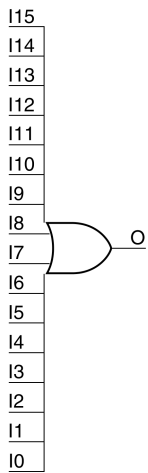
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR16

### Macro: 16-Input OR Gate with Non-Inverted Inputs



OR16

X9437

## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

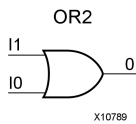
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR2

### Primitive: 2-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

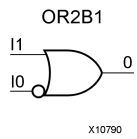
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR2B1

Primitive: 2-Input OR Gate with 1 Inverted and 1 Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

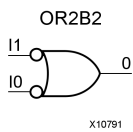
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR2B2

### Primitive: 2-Input OR Gate with Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

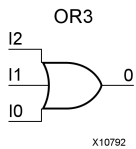
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OR3

### Primitive: 3-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

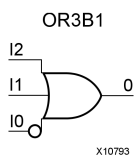
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR3B1

Primitive: 3-Input OR Gate with 1 Inverted and 2 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

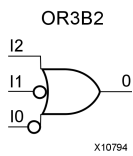
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR3B2

Primitive: 3-Input OR Gate with 2 Inverted and 1 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

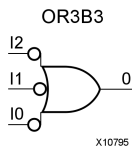
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR3B3

### Primitive: 3-Input OR Gate with Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

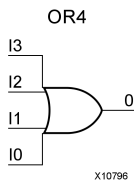
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR4

### Primitive: 4-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

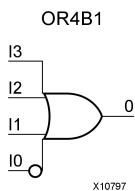
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR4B1

Primitive: 4-Input OR Gate with 1 Inverted and 3 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

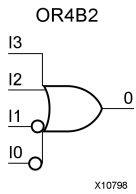
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR4B2

Primitive: 4-Input OR Gate with 2 Inverted and 2 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

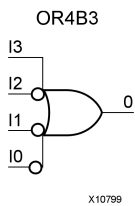
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR4B3

Primitive: 4-Input OR Gate with 3 Inverted and 1 Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

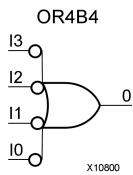
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OR4B4

### Primitive: 4-Input OR Gate with Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

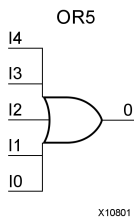
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5

### Primitive: 5-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

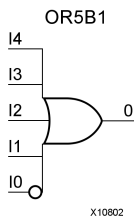
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5B1

Primitive: 5-Input OR Gate with 1 Inverted and 4 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

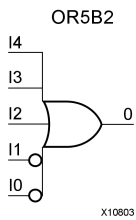
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5B2

### Primitive: 5-Input OR Gate with 2 Inverted and 3 Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

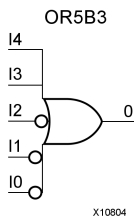
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5B3

Primitive: 5-Input OR Gate with 3 Inverted and 2 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

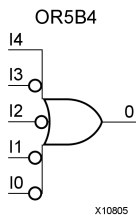
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5B4

Primitive: 5-Input OR Gate with 4 Inverted and 1 Non-Inverted Inputs



### Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

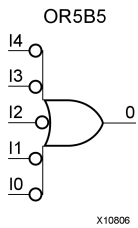
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR5B5

### Primitive: 5-Input OR Gate with Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

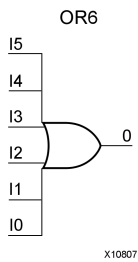
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR6

### Macro: 6-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

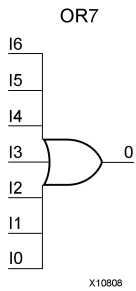
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## OR7

### Macro: 7-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

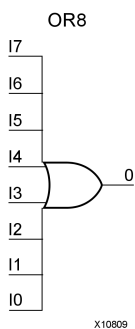
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR8

### Macro: 8-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

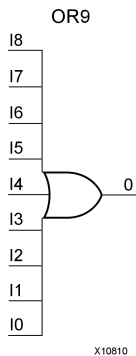
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OR9

### Macro: 9-Input OR Gate with Non-Inverted Inputs



## Introduction

OR functions of up to five inputs are available in any combination of inverting and non-inverting inputs. OR functions of six to nine inputs, 12 inputs, and 16 inputs are available with only non-inverting inputs. To invert some or all inputs, use external inverters. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

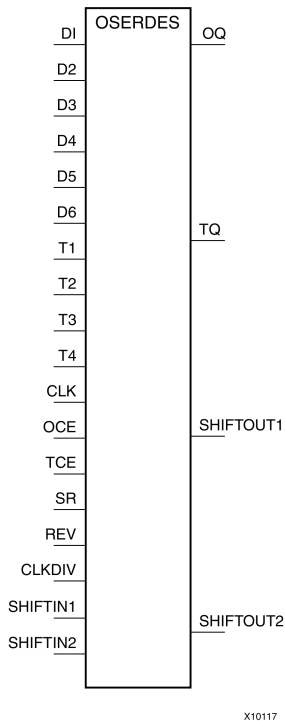
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## OSERDES

### Primitive: Dedicated IOB Output Serializer



## Introduction

Use the OSERDES primitive to easily implement a source synchronous interface. This device helps you by saving logic resources that would otherwise be implemented in the FPGA fabric. It also avoids additional timing complexities that you might encounter when you are designing circuitry in the FPGA fabric. This element contains multiple clock inputs to accommodate various applications, and will work in conjunction with SelectIO™ features.

## Port Descriptions

Port	Type	Width	Function
OQ	Output	1	Data Path Output - This port is the data output of the OSERDES module. This port connects the output of the data parallel-to-serial converter to the data input of the IOB pad. In addition, this output port can also be configured to bypass all the submodules within the OSERDES module.
SHIFTOUT1-2	Output	1 (each)	Carry Out for data input expansion. Connect to SHIFTIN1/2 of master.
TQ	Output	1	3-State Path Output - This port is the 3-state output of the OSERDES module. This port connects the output of the 3-state parallel-to-serial converter to the control input of the IOB pad.
CLK	Input	1	High Speed Clock Input - This clock input is used to drive the parallel-to-serial converters. The possible source for the CLK port is from one of the following clock resources: <ul style="list-style-type: none"> <li>Ten global clock lines in a clock region</li> <li>Four regional clock lines</li> </ul>

Port	Type	Width	Function
			<ul style="list-style-type: none"> <li>Four clock capable I/Os (within adjacent clock region)</li> <li>Fabric (through bypass)</li> </ul>
CLKDIV	Input	1	Divided High Speed Clock Input - This clock input is used to drive the parallel-to-serial converter. This clock must be a divided down version of the clock connected to the CLK port. One of the following clock resources can be used as a source for CLKDIV: <ul style="list-style-type: none"> <li>Ten global clock lines in a clock region</li> <li>Four regional clock lines</li> </ul>
D1-D6	Input	1	Parallel Data Inputs - Ports D1 to D6 are the location in which all incoming parallel data enters the OSERDES module. This port is connected to the FPGA fabric, and can be configured from 2 to 6 bits. In the extended width mode, this port can be expanded up to 10 bits.
OCE	Input	1	Parallel to serial converter (data) clock enable - This port is used to enable the output of the data parallel-to-serial converter when asserted High.
SR	Input	1	Set/Reset Input - The set/reset (SR) pin forces the storage element into the state specified by the SRVAL attribute. SRVAL = "1" forces a logic 1. SRVAL = "0" forces a logic "0." The reset condition predominates over the set condition.
SHIFTIN1-2	Input	1 (each)	Carry Input for Data Input Expansion. Connect to SHIFTOUT1/2 of slave.
T1 - T4	Input	1 (each)	Parallel 3-State Inputs - Ports T1 to T4 are the location in which all parallel 3-state signals enters the OSERDES module. This port is connected to the FPGA fabric, and can be configured from 1 to 4 bits. This feature is not supported in the extended width mode.
TCE	Input	1	Parallel to serial converter (3-state) clock enable - This port is used to enable the output of the 3-state signal parallel-to-serial converter when asserted High.

## Design Entry Method

This design element can be used in schematics.

The data parallel-to-serial converter in the OSERDES module takes in 2 to 6 bits of parallel data and converts them into serial data. Data input widths larger than 6 (7, 8, and 10) are achievable by cascading two OSERDES modules for data width expansion. In order to do this, one OSERDES must be set into a MASTER mode, while another is set into SLAVE mode. You must connect the SHIFTOUT of "slave" and SHIFTIN of "master" ports together. The "slave" only uses D3 to D6 ports as its input. The parallel-to-serial converter is available for both SDR and DDR modes.

This module is designed such that the data input at D1 port is the first output bit. This module is controlled by CLK and CLKDIV clocks. The following table describes the relationship between CLK and CLKDIV for both SDR and DDR mode.

SDR Data Width	DDR Data Width	CLK	CLKDIV
2	4	2X	X
3	6	3X	X
4	8	4X	X
5	10	5X	X
6	-	6X	X
7	-	7X	X
8	-	8X	X

Output of this block is connected to the data input of an IOB pad of the FPGA. This IOB pad can be configured to a desired standard using SelectIO.

#### *Parallel-to-Serial Converter (3-state)*

The 3-state parallel-to-serial converter in the OSERDES module takes in up to 4 bits of parallel 3-state signals and converts them into serial 3-state signal. Unlike the data parallel-to-serial converter, the 3-state parallel-to-serial converter is not extendable to more than 4-bit, 3-state signals. This module is primarily controlled by CLK and CLKDIV clocks. In order to use this module, the following attributes must be declared: DATA\_RATE\_TQ and TRISTATE\_WIDTH. In certain cases, you can also need to declare DATA\_RATE\_OQ and DATA\_WIDTH. The following table lists the attributes needed for the desired functionality.

Mode of Operation	DATA_RATE_TQ	TRISTATE_WIDTH
4-bit DDR*	DDR	4
1-bit SDR	SDR	1
Buffer	BUF	1

Output of this block is connected to the 3-state input of an IOB pad of the FPGA. This IOB pad can be configured to a desired standard using SelectIO.

#### *Width Expansion*

It is possible to use this element to transmit parallel data widths larger than six. However, the 3-state output is not expandable. In order to use this feature, *two* of these elements need to be instantiated, and the two must be an adjacent master and slave pair. The attribute MODE must be set to either "MASTER" or "SLAVE" in order to differentiate the modes of the OSERDES pair. In addition, you must connect the SHIFTIN ports of the MASTER to the SHIFTOUT ports of the SLAVE. This feature supports data widths of 7, 8, and 10 for SDR and DDR mode. The table below lists the data width availability for SDR and DDR mode.

Mode	Widths
SDR Data Widths	2,3,4,5,6,7,8
DDR Data Widths	4,6,8,10

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
DATA_RATE_OQ	String	"SDR", "DDR"	"DDR"	Defines whether the data changes at every clock edge or every positive clock edge with respect to CLK.
DATA_RATE_TQ	String	"BUF", "SDR", "DDR"	"DDR"	Defines whether the 3-state changes at every clock edge, every positive clock edge, or buffer configuration with respect to CLK.

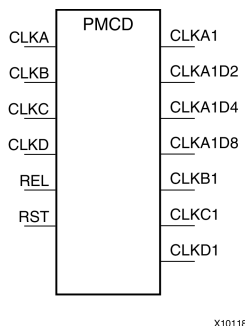
Attribute	Type	Allowed Values	Default	Description
DATA_WIDTH	Integer	2, 3, 4, 5, 6, 7, 8, or 10	4	If DATA_RATE_OQ = DDR, value is limited to 4, 6, 8, or 10. If DATA_RATE_OQ = SDR, value is limited to 2, 3, 4, 5, 6, 7, or 8.
INIT_OQ	Binary	0, 1	0	Defines the initial value of OQ output
INIT_TQ	Binary	0, 1	0	Defines the initial value of TQ output
SERDES_MODE	String	"MASTER", "SLAVE"	"MASTER"	Defines whether the OSERDES module is a master or slave when width expansion is used.
SRVAL_OQ	Binary	0, 1	0	Defines the value of OQ output when reset is invoked.
SRVAL_TQ	Binary	0, 1	0	Defines the value of TQ output when reset is invoked.
TRISTATE_WIDTH	Integer	1, 2, 4	4	If DATA_RATE_TQ = DDR, value is limited to 2 or 4. The value can only be set to 1 when DATA_RATE_TQ = SDR or BUF.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## PMCD

### Primitive: Phase-Matched Clock Divider



## Introduction

This design element is one of the clock resources available in the Virtex®-4 architecture. It provides the following clock management features:

### *Phase-Aligned Divided Clocks*

The phase-aligned divided clocks create up to four frequency-divided and phase-aligned versions of an input clock, CLKA. The output clocks are a function of the input clock frequency: divided-by-1 (CLKA1), divided-by-2 (CLKAD2), divided-by-4 (CLKA1D4), and divided-by-8 (CLKA1D8). CLKA1, CLKA1D2, CLKA1D4, CLKA1D8 output clocks are rising-edge aligned.

### *Matched-Clock Phase*

The matched-clock phase preserves edge alignments, phase relations, or skews between the input clock CLKA and other PMCD input clocks. Three additional input clocks (CLKB, CLKC, and CLKD) and three corresponding delayed output clocks (CLKB1, CLKC1, and CLKD1) are available. The same delay is inserted to CLKA, CLKB, CLKC, and CLKD; thus, the delayed CLKA1, CLKB1, CLKC1, and CLKD1 clock outputs maintain edge alignments, phase relations, and the skews of the respective inputs.

This design element can be used with other clock resources, including global buffers and the digital clock management feature. Together, these clock resources provide flexibility in managing complex clock networks in designs

## Port Descriptions

Port	Direction	Function
CLKA	Input	CLKA is a clock input to the PMCD. The CLKA frequency can be divided by 1, 2, 4, and 8.
CLKB CLKC CLKD	Input	CLKB, CLKC, and CLKD are clock inputs to the PMCD. These clock are not divided by PMCD, however, they are delayed by the PMCD to maintain the phase alignment and phase relationship to CLKA.
RST	Input	RST is the reset input to the PMCD. Asserting the RST signal asynchronously forces all outputs Low. Deasserting RST synchronously allows all outputs to toggle.
REL	Input	REL is the release input to the PMCD. Asserting the REL signal releases the divided output synchronous to CLKA.
CLKA1	Output	The CLKA1 output has the same frequency as the CLKA input. It is a delayed version of CLKA.
CLKA1D2	Output	The CLKA1D2 output has the frequency of CLKA divided by two. CLKA1D2 is rising-edge aligned to CLKA1.



Port	Direction	Function
CLKA1D4	Output	The CLKA1D4 output has the frequency of CLKA divided by four. CLKA1D4 is rising-edge aligned to CLKA1.
CLKA1D8	Output	The CLKA1D8 output has the frequency of CLKA divided by eight, CLKA1D8 is rising-edge aligned to CLKA1.
CLKB1 CLKC1 CLKD1	Output	The CLKB1 output is has the same frequency as the CLKB input, a delayed version of CLKB. The skew between CLKB1 and CLKA1 is the same as the skew between CLKB and CLKA inputs. Similarly, CLKC1 is a delayed version of CLKC, and CLKD1 is a delayed version of CLKD.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

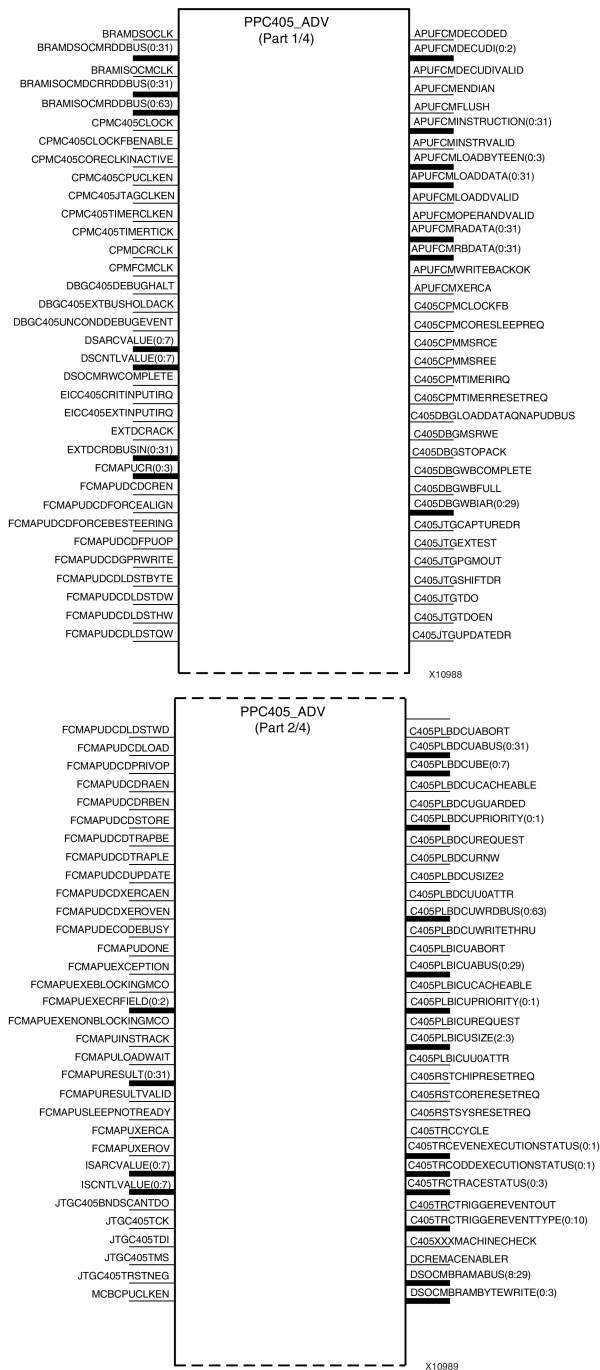
Attribute	Type	Allowed Values	Default	Description
EN_REL	Boolean	FALSE, TRUE	FALSE	This attribute allows for CLKA1D2, CLKA1D4, and CLKA1D8 outputs to be released at REL signal assertion. <b>Note</b> REL is synchronous to CLKA input.
RST_DEASSERT_ CLK	String	"CLKA," "CLKB", "CLKC", "CLKD"	"CLKA"	This attribute allows the deassertion of the RST signal to be synchronous to a selected PMCD input clock.

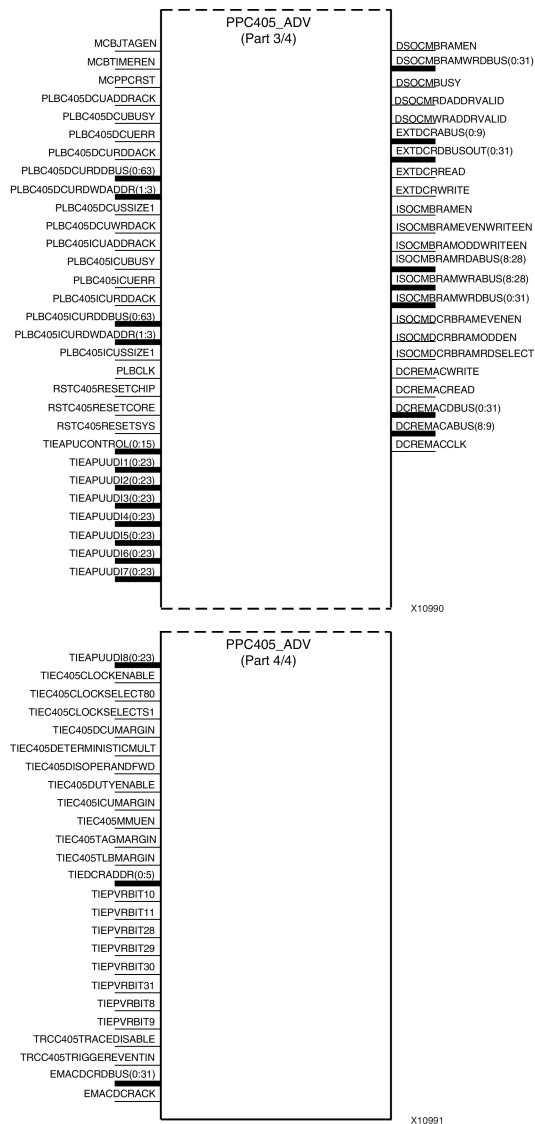
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# PPC405\_ADV

## Primitive: Primitive for the Power PC Core





## Introduction

This design element is a 32-bit implementation of the PowerPC® embedded environment architecture that is derived from the PowerPC architecture. Specifically, the PowerPC 405 is an embedded PowerPC 405F6, for Virtex®-4 devices, processor core. The processor core also contains on-chip memory logic (OCM), an APU controller (Virtex-4 devices only), and the gasket logic and interface.

The PowerPC architecture provides a software model that ensures compatibility between implementations of the PowerPC family of microprocessors. The PowerPC architecture defines parameters that guarantee compatible processor implementations at the application-program level, allowing broad flexibility in the development derivative PowerPC implementations that meet specific market requirements.

## Design Entry Method

This design element can be used in schematics.

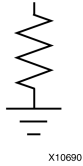
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## PULLDOWN

Primitive: Resistor to GND for Input Pads, Open-Drain, and 3-State Outputs

PULLDOWN



### Introduction

This resistor element is connected to input, output, or bidirectional pads to guarantee a logic Low level for nodes that might float.

### Port Descriptions

Port	Direction	Width	Function
O	Output	1	Pulldown output (connect directly to top level port)

### Design Entry Method

This design element can be used in schematics.

This element can be connected to a net in the following locations on a top-level schematic file:

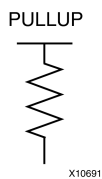
- A net connected to an input IO Marker.
- A net connected to both an output IO Marker and 3-statable IO element, such as an OBUFT.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## PULLUP

Primitive: Resistor to VCC for Input PADs, Open-Drain, and 3-State Outputs



### Introduction

This design element allows for an input, 3-state output or bi-directional port to be driven to a weak high value when not being driven by an internal or external source. This element establishes a High logic level for open-drain elements and macros when all the drivers are off.

### Port Descriptions

Port	Direction	Width	Function
O	Output	1	Pullup output (connect directly to top level port)

### Design Entry Method

This design element can be used in schematics.

This element can be connected to a net in the following locations on a top-level schematic file:

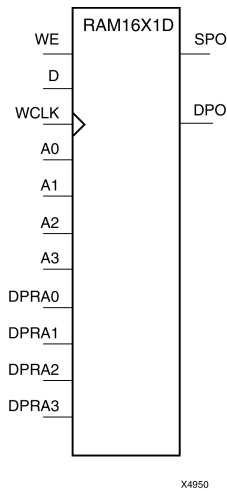
- A net connected to an input IO Marker
- A net connected to both an output IO Marker and 3-statable IO element, such as an OBUFT.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM16X1D

Primitive: 16-Deep by 1-Wide Static Dual Port Synchronous RAM



### Introduction

This element is a 16-word by 1-bit static dual port random access memory with synchronous write capability. The device has two address ports: the read address (DPRA3:DPRA0) and the write address (A3:A0). These two address ports are asynchronous. The read address controls the location of the data driven out of the output pin (DPO), and the write address controls the destination of a valid write transaction. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected.

When WE is High, any positive transition on (WCLK) loads the data on the data input (D) into the word selected by the 4-bit write address. For predictable performance, write address and data inputs must be stable before a Low-to-High (WCLK) transition. This RAM block assumes an active-High (WCLK). (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

The SPO output reflects the data in the memory cell addressed by A3:A0. The DPO output reflects the data in the memory cell addressed by DPRA3:DPRA0.

**Note** The write process is not affected by the address on the read address port.

You can use the INIT attribute to directly specify an initial value. The value must be a hexadecimal number, for example, INIT=ABAC. If the INIT attribute is not specified, the RAM is initialized with all zeros.

### Logic Table

Mode selection is shown in the following logic table:

Inputs			Outputs	
WE (mode)	WCLK	D	SPO	DPO
0 (read)	X	X	data_a	data_d
1 (read)	0	X	data_a	data_d
1 (read)	1	X	data_a	data_d
1 (write)	↑	D	D	data_d
1 (read)	↓	X	data_a	data_d
data_a = word addressed by bits A3-A0				
data_d = word addressed by bits DPRA3-DPRA0				

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros.	Initializes RAMs, registers, and look-up tables.

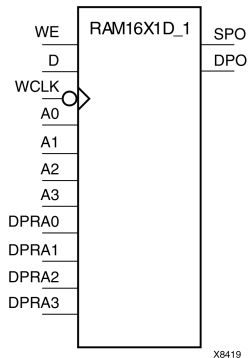
### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## RAM16X1D\_1

**Primitive: 16-Deep by 1-Wide Static Dual Port Synchronous RAM with Negative-Edge Clock**



### Introduction

This is a 16-word by 1-bit static dual port random access memory with synchronous write capability and negative-edge clock. The device has two separate address ports: the read address (DPRA3:DPRA0) and the write address (A3:A0). These two address ports are asynchronous. The read address controls the location of the data driven out of the output pin (DPO), and the write address controls the destination of a valid write transaction.

When the write enable (WE) is set to Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any negative transition on (WCLK) loads the data on the data input (D) into the word selected by the 4-bit write address. For predictable performance, write address and data inputs must be stable before a High-to-Low WCLK transition. This RAM block assumes an active-High (WCLK). (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

You can initialize RAM16X1D\_1 during configuration using the INIT attribute.

The SPO output reflects the data in the memory cell addressed by A3:A0. The DPO output reflects the data in the memory cell addressed by DPRA3:DPRA0.

**Note** The write process is not affected by the address on the read address port.

### Logic Table

Mode selection is shown in the following logic table:

Inputs			Outputs	
WE (mode)	WCLK	D	SPO	DPO
0 (read)	X	X	data_a	data_d
1 (read)	0	X	data_a	data_d
1 (read)	1	X	data_a	data_d
1 (write)	↓	D	D	data_d
1 (read)	↑	X	data_a	data_d
data_a = word addressed by bits A3:A0				
data_d = word addressed by bits DPRA3:DPRA0				

## Port Descriptions

Port	Direction	Width	Function
DPO	Output	1	Read-only 1-Bit data output
SPO	Output	1	R/W 1-Bit data output
A0	Input	1	R/W address[0] input
A1	Input	1	R/W address[1] input
A2	Input	1	R/W address[2] input
A3	Input	1	R/W address[3] input
D	Input	1	Write 1-Bit data input
DPRA0	Input	1	Read-only address[0] input
DPRA1	Input	1	Read-only address[1] input
DPRA2	Input	1	Read-only address[2] input
DPRA3	Input	1	Read-only address[3] input
WCLK	Input	1	Write clock input
WE	Input	1	Write enable input

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

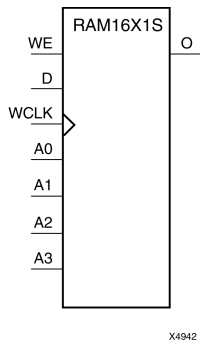
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Initializes RAMs, registers, and look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM16X1S

Primitive: 16-Deep by 1-Wide Static Synchronous RAM



### Introduction

This element is a 16-word by 1-bit static random access memory with synchronous write capability. When the write enable (WE) is set Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is set High, any positive transition on WCLK loads the data on the data input (D) into the word selected by the 4-bit address (A3:A0). This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins. You can initialize RAM16X1S during configuration using the INIT attribute.

### Logic Table

Inputs			Outputs
WE(mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D	D
1 (read)	↓	X	Data
Data = word addressed by bits A3:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

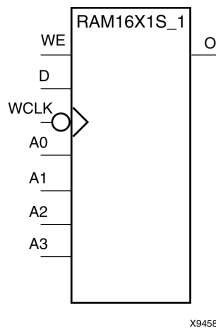
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Specifies initial contents of the RAM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM16X1S\_1

Primitive: 16-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock



### Introduction

This element is a 16-word by 1-bit static random access memory with synchronous write capability and negative-edge clock. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any negative transition on (WCLK) loads the data on the data input (D) into the word selected by the 4-bit address (A3:A0). For predictable performance, address and data inputs must be stable before a High-to-Low WCLK transition. This RAM block assumes an active-Low (WCLK). However, (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins.

You can initialize this element during configuration using the INIT attribute.

### Logic Table

Inputs			Outputs
WE(mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↓	D	D
1 (read)	↑	X	Data
Data = word addressed by bits A3:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

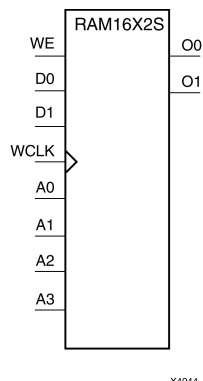
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Specifies initial contents of the RAM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM16X2S

### Primitive: 16-Deep by 2-Wide Static Synchronous RAM



## Introduction

This element is a 16-word by 2-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on the data input (D1:D0) into the word selected by the 4-bit address (A3:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O1:O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

You can use the INIT\_xx properties to specify the initial contents of a wide RAM. INIT\_00 initializes the RAM cells corresponding to the O0 output, INIT\_01 initializes the cells corresponding to the O1 output, etc. For example, a RAM16X2S instance is initialized by INIT\_00 and INIT\_01 containing 4 hex characters each. A RAM16X8S instance is initialized by eight properties INIT\_00 through INIT\_07 containing 4 hex characters each. A RAM64x2S instance is completely initialized by two properties INIT\_00 and INIT\_01 containing 16 hex characters each.

Except for Virtex-4 devices, the initial contents of this element cannot be specified directly.

## Logic Table

Inputs			Outputs
WE (mode)	WCLK	D1:D0	O1:O0
0 (read)	X	X	Data
1(read)	0	X	Data
1(read)	1	X	Data
1(write)	↑	D1:D0	D1:D0
1(read)	↓	X	Data
Data = word addressed by bits A3:A0			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT_00 to INIT_01	Hexadecimal	Any 16-Bit Value	All zeros	Initializes RAMs, registers, and look-up tables.

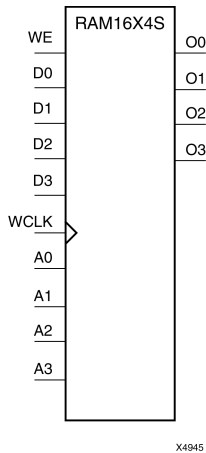
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## RAM16X4S

Primitive: 16-Deep by 4-Wide Static Synchronous RAM



### Introduction

This element is a 16-word by 4-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on the data input (D3:D0) into the word selected by the 4-bit address (A3:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O3:O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

### Logic Table

Inputs			Outputs
WE (mode)	WCLK	D3:D0	O3:O0
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D3:D0	D3:D0
1 (read)	↓	X	Data
Data = word addressed by bits A3:A0.			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

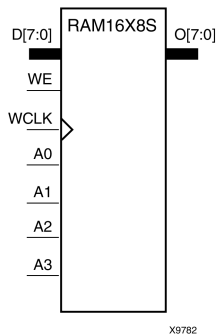
Attribute	Type	Allowed Values	Default	Description
INIT_00 to INIT_03	Hexadecimal	Any 16-Bit Value	All zeros	INIT of RAM

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM16X8S

Primitive: 16-Deep by 8-Wide Static Synchronous RAM



### Introduction

This element is a 16-word by 8-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on data inputs (D7:D0) into the word selected by the 4-bit address (A3:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O7:O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

### Logic Table

Inputs			Outputs
WE (mode)	WCLK	D7:D0	O7:O0
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D7:D0	D7:D0
1 (read)	↓	X	Data
Data = word addressed by bits A3–A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

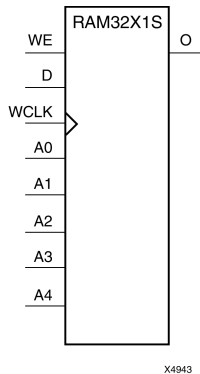
Attribute	Type	Allowed Values	Default	Description
INIT_00 to INIT_07	Hexadecimal	Any 16-Bit Value	All zeros	Initializes RAMs, registers, and look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM32X1S

Primitive: 32-Deep by 1-Wide Static Synchronous RAM



### Introduction

The design element is a 32-word by 1-bit static random access memory with synchronous write capability. When the write enable is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any positive transition on (WCLK) loads the data on the data input (D) into the word selected by the 5-bit address (A4-A0). For predictable performance, address and data inputs must be stable before a Low-to-High (WCLK) transition. This RAM block assumes an active-High (WCLK). However, (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins. You can initialize RAM32X1S during configuration using the INIT attribute.

### Logic Table

Inputs			Outputs
WE (Mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↓	D	D
1 (read)	↑	X	Data

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

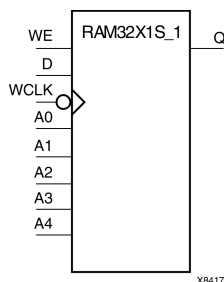
Attribute	Type	Allowed Values	Default	Descriptions
INIT	Hexadecimal	Any 32-Bit Value	All zeros	Specifies initial contents of the RAM.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM32X1S\_1

Primitive: 32-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock



## Introduction

The design element is a 32-word by 1-bit static random access memory with synchronous write capability. When the write enable is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any negative transition on (WCLK) loads the data on the data input (D) into the word selected by the 5-bit address (A4:A0). For predictable performance, address and data inputs must be stable before a High-to-Low (WCLK) transition. This RAM block assumes an active-Low (WCLK). However, (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins. You can initialize RAM32X1S\_1 during configuration using the INIT attribute.

## Logic Table

Inputs			Outputs
WE (Mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↓	D	D
1 (read)	↑	X	Data
Data = word addressed by bits A4:A0			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

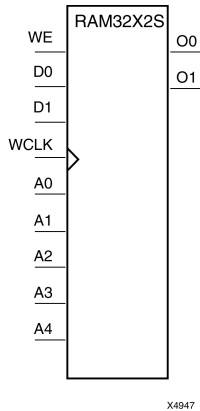
Attribute	Type	Allowed Values	Default	Descriptions
INIT	Hexadecimal	Any 32-Bit Value	0	Initializes RAMs, registers, and look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM32X2S

Primitive: 32-Deep by 2-Wide Static Synchronous RAM



### Introduction

The design element is a 32-word by 2-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any positive transition on (WCLK) loads the data on the data input (D1-D0) into the word selected by the 5-bit address (A4-A0). For predictable performance, address and data inputs must be stable before a Low-to-High (WCLK) transition. This RAM block assumes an active-High (WCLK). However, (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block. The signal output on the data output pins (O1-O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

You can use the INIT\_00 and INIT\_01 properties to specify the initial contents of RAM32X2S.

### Logic Table

Inputs			Outputs
WE (Mode)	WCLK	D	O0-O1
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D1:D0	D1:D0
1 (read)	↓	X	Data
Data = word addressed by bits A4:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

Attribute	Type	Allowed Values	Default	Descriptions
INIT_00	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 0 of RAM.
INIT_01	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 1 of RAM.

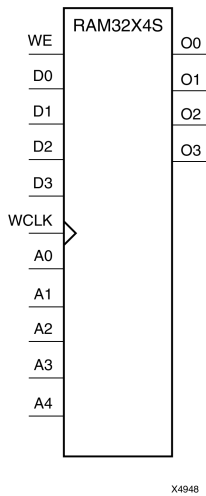
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## RAM32X4S

### Primitive: 32-Deep by 4-Wide Static Synchronous RAM



## Introduction

This design element is a 32-word by 4-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on the data inputs (D3-D0) into the word selected by the 5-bit address (A4:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O3-O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

## Logic Table

Inputs			Outputs
WE	WCLK	D3-D0	O3-O0
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D3:D0	D3:D0
1 (read)	↓	X	Data
Data = word addressed by bits A4:A0			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

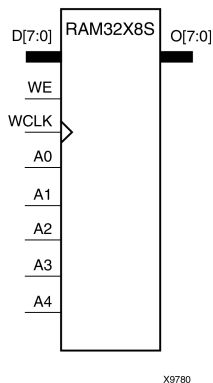
Attribute	Type	Allowed Values	Default	Description
INIT_00	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 0 of RAM.
INIT_01	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 1 of RAM.
INIT_02	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 2 of RAM.
INIT_03	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 3 of RAM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM32X8S

Primitive: 32-Deep by 8-Wide Static Synchronous RAM



### Introduction

This design element is a 32-word by 8-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on the data inputs (D7:D0) into the word selected by the 5-bit address (A4:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O7:O0) is the data that is stored in the RAM at the location defined by the values on the address pins.

### Logic Table

Inputs			Outputs
WE (mode)	WCLK	D7:D0	O7:O0
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D7:D0	D7:D0
1 (read)	↓	X	Data
Data = word addressed by bits A4:A0			

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

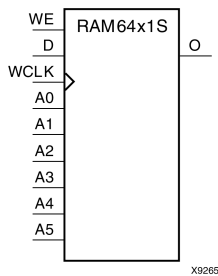
Attribute	Type	Allowed Values	Default	Description
INIT_00	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 0 of RAM.
INIT_01	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 1 of RAM.
INIT_02	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 2 of RAM.
INIT_03	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 3 of RAM.
INIT_04	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 4 of RAM.
INIT_05	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 5 of RAM.
INIT_06	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 6 of RAM.
INIT_07	Hexadecimal	Any 32-Bit Value	All zeros	INIT for bit 7 of RAM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM64X1S

### Primitive: 64-Deep by 1-Wide Static Synchronous RAM



### Introduction

This design element is a 64-word by 1-bit static random access memory (RAM) with synchronous write capability. When the write enable is set Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is set High, any positive transition on WCLK loads the data on the data input (D) into the word selected by the 6-bit address (A5:A0). This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins.

You can initialize this element during configuration using the INIT attribute.

### Logic Table

Mode selection is shown in the following logic table

Inputs			Outputs
WE (mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D	D
1 (read)	↓	X	Data
Data = word addressed by bits A5:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

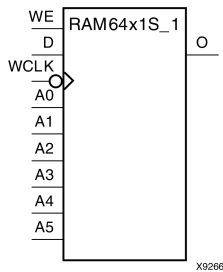
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 64-Bit Value	All zeros	Initializes ROMs, RAMs, registers, and look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAM64X1S\_1

Primitive: 64-Deep by 1-Wide Static Synchronous RAM with Negative-Edge Clock



### Introduction

This design element is a 64-word by 1-bit static random access memory with synchronous write capability. When the write enable is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When (WE) is High, any negative transition on (WCLK) loads the data on the data input (D) into the word selected by the 6-bit address (A5:A0). For predictable performance, address and data inputs must be stable before a High-to-Low (WCLK) transition. This RAM block assumes an active-Low (WCLK). However, (WCLK) can be active-High or active-Low. Any inverter placed on the (WCLK) input net is absorbed into the block.

The signal output on the data output pin (O) is the data that is stored in the RAM at the location defined by the values on the address pins.

You can initialize this element during configuration using the INIT attribute.

### Logic Table

Inputs			Outputs
WE (mode)	WCLK	D	O
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↓	D	D
1 (read)	↑	X	Data
Data = word addressed by bits A5:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 64-Bit Value	All zeros	Initializes ROMs, RAMs, registers, and look-up tables.

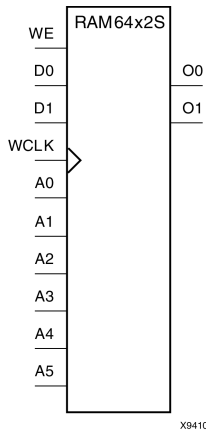
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## RAM64X2S

Primitive: 64-Deep by 2-Wide Static Synchronous RAM



### Introduction

This design element is a 64-word by 2-bit static random access memory with synchronous write capability. When the write enable (WE) is Low, transitions on the write clock (WCLK) are ignored and data stored in the RAM is not affected. When WE is High, any positive transition on WCLK loads the data on the data input (D1:D0) into the word selected by the 6-bit address (A5:A0). For predictable performance, address and data inputs must be stable before a Low-to-High WCLK transition. This RAM block assumes an active-High WCLK. However, WCLK can be active-High or active-Low. Any inverter placed on the WCLK input net is absorbed into the block.

The signal output on the data output pins (O1:O0) is the data that is stored in the RAM at the location defined by the values on the address pins. You can use the INIT\_00 and INIT\_01 properties to specify the initial contents of this design element.

### Logic Table

Inputs			Outputs
WE (mode)	WCLK	D0:D1	O0:O1
0 (read)	X	X	Data
1 (read)	0	X	Data
1 (read)	1	X	Data
1 (write)	↑	D1:D0	D1:D0
1 (read)	↓	X	Data
Data = word addressed by bits A5:A0			

### Design Entry Method

This design element can be used in schematics.

### Available Attributes

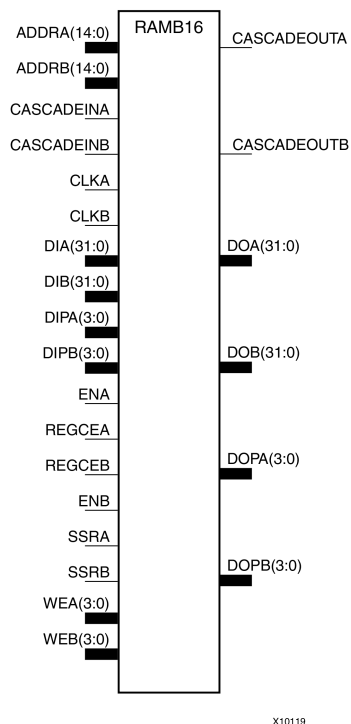
Attribute	Type	Allowed Values	Default	Description
INIT_00	Hexadecimal	Any 64-Bit Value	All zeros	Initializes RAMs, registers, and look-up tables.
INIT_01	Hexadecimal	Any 64-Bit Value	All zeros	Initializes RAMs, registers, and look-up tables.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAMB16

**Primitive: 16K-bit Data and 2K-bit Parity Single-Port Synchronous Block RAM with Configurable Port Widths**



## Introduction

In addition to distributed RAM memory, Virtex®-4 and above devices feature a large number of 18 kB block RAM memories. This block RAM memory is a True Dual-Port RAM, offering fast, discrete, and large blocks of memory in the device. The memory is organized in columns, and the total amount of block RAM memory depends on the size of the device. The 18 kB blocks are cascadable to enable a deeper and wider memory implementation, with a minimal timing penalty incurred through specialized routing resources.

Read Operation	The read operation uses one clock edge. The read address is registered on the read port, and the stored data is loaded into the output latches after the RAM access interval passes.
Write Operation	A write operation is a single clock-edge operation. The write address is registered on the write port, and the data input is stored in memory.

### Write Operating Modes

There are three options for the behavior of the data output during a write operation on its port. The "read during write" mode offers the flexibility of using the data output bus during a write operation on the same port. Output behavior is determined by the configuration. This choice increases the efficiency of block RAM memory at each clock cycle and allows designs that use maximum bandwidth.

Three different modes are used to determine data available on the output latches after a write clock edge.

WRITE_FIRST or Transparent Mode (Default)	The input data is simultaneously written into memory and stored in the data output (transparent write).
READ_FIRST or Read-Before-Write Mode	Data previously stored at the write address appears on the output latches, while the input data is being stored in memory (read before write).
NO_CHANGE Mode	The output latches remain unchanged during a write operation.

Mode selection is set by configuration. One of these three modes is set individually for each port by an attribute. The default mode is WRITE\_FIRST.

## Port Descriptions

### *Output Latches Synchronous Set/Reset - SRVAL (SRVAL\_A & SRVAL\_B)*

The SRVAL\_A and SRVAL\_B (dual-port) attributes define output latch values when the SSR input is asserted. The width of the SRVAL (SRVAL\_A and SRVAL\_B) attribute is the port width, as shown in the following table:

Port Width Values and Data Width	DOP Bus	DO Bus	SRVAL
1	NA	<0>	1
2	NA	<1:0>	2
4	NA	<3:0>	4
9	<0>	<7:0>	(1+8) = 9
18	<1:0>	<15:0>	(2+16) = 18
36	<3:0>	<31:0>	(4 + 32) = 36

### *Optional Output Register On/Off Switch - DO[A/B]\_REG*

This attribute sets the number of pipeline register at A/B output of RAMB16. The valid values are 0 (default) or 1.

### *Clock Inversion at Output Register Switch - INVERT\_CLK\_DO[A/B]\_REG*

When set to TRUE, the clock input to the pipeline register at A/B output of RAMB16 is inverted. The default value is FALSE.

### *Extended Mode Address Determinant - RAM\_EXTENSION\_[A/B]*

This attribute determines whether the block RAM of interest has its A/B port as UPPER/LOWER address when using the cascade mode. In the cascading mode, READ\_WIDTH\_[A/B] and WRITE\_WIDTH\_[A/B] should be set to 1. When the block RAM is not used in cascade mode, the default value is NONE.

### *Read Width - READ\_WIDTH\_[A/B]*

This attribute determines the A/B read port width of the block RAM. The valid values are: 0 (default), 1, 2, 4, 9, 18, and 36. The READ\_WIDTH\_[A/B] for both the ports should not be set to zero at the same time.

### *Write Width - WRITE\_WIDTH\_[A/B]*

This attribute determines the A/B write port width of the block RAM. The valid values are: 0 (default), 1, 2, 4, 9, 18, and 36.

### *Write Mode - WRITE\_MODE\_[A/B]*

This attribute determines the write mode of the A/B input ports. The possible values are WRITE\_FIRST (default), READ\_FIRST, and NO\_CHANGE.

### *RAMB16 Location Constraints*

Block RAM instances can have LOC properties attached to them to constrain placement. Block RAM placement locations differ from the convention used for naming CLB locations, allowing LOC properties to transfer easily from array to array. The LOC properties use the following form: LOC = RAMB16\_X#Y#

The RAMB16\_X0Y0 is the bottom-left block RAM location on the device.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
DOA_REG	Integer	0, 1	0	Optional output registers on A port
DOB_REG	Integer	0, 1	0	Optional output registers on B port.
INIT_00 to INIT_39	Hexa-decimal	Any 256-Bit Value	All zeros	To change the initial contents of the RAM to anything other than all zero's.
INIT_0A to INIT_0F	Hexa-decimal	Any 256-Bit Value	All zeros	To change the initial contents of the RAM to anything other than all zero's.
INIT_1A to INIT_1F	Hexa-decimal	Any 256-Bit Value	All zeros	To change the initial contents of the RAM to anything other than all zero's.
INIT_2A to INIT_2F	Hexa-decimal	Any 256-Bit Value	All zeros	To change the initial contents of the RAM to anything other than all zero's.
INIT_3A to INIT_3F	Hexa-decimal	Any 256-Bit Value	All zeros	To change the initial contents of the RAM to anything other than all zeros.
INIT_A	Hexa-decimal	Any 36-Bit Value	All zeros	Initial values on A output port.
INIT_B	Hexa-decimal	Any 36-Bit Value	All zeros	Initial values on B output port.
INITP_00 to INITP_07	Hexa-decimal	Any 256-Bit Value	All zeros	Applied for the parity bits.
INVERT_CLK_DOA_REG	Boolean	FALSE, TRUE	FALSE	Invert clock on A port output registers.
INVERT_CLK DOB_REG	Boolean	FALSE, TRUE	FALSE	Invert clock on B port output registers.
RAM_EXTENSION_A	String	"LOWER", "NONE" or "UPPER"	"NONE"	Allowed value when cascaded.
RAM_EXTENSION_B	String	"LOWER", "NONE" or "UPPER"	"NONE"	Allowed value when cascaded.
READ_WIDTH_A	Integer	0, 1, 2, 4, 9, 18 or 36	0	Determines the A read port width of the block RAM.
READ_WIDTH_B	Integer	0, 1, 2, 4, 9, 18 or 36	0	Determines the B read port width of the block RAM.

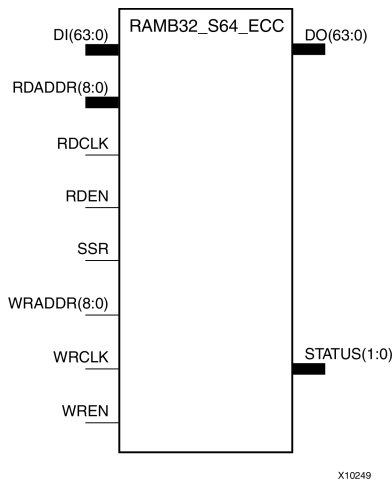
SIM_COLLISION_CHECK	String	"ALL", "WARNING_ONLY", "GENERATE_X_ONLY", or "NONE"	"ALL"	<p>Allows modification of the simulation behavior if a memory collision occurs. The output is affected as follows:</p> <ul style="list-style-type: none"> <li>"ALL" - Warning produced and affected outputs/memory location go unknown (X).</li> <li>"WARNING_ONLY" - Warning produced and affected outputs/memory retain last value.</li> <li>"GENERATE_X_ONLY" - No warning. However, affected outputs/memory go unknown (X).</li> <li>"NONE" - No warning and affected outputs/memory retain last value.</li> </ul> <p><b>Note</b> Setting this to a value other than "ALL" can allow problems in the design go unnoticed during simulation. Care should be taken when changing the value of this attribute. Please see the <i>Synthesis and Simulation Design Guide</i> for more information.</p>
SRVAL_A	Hexa-decimal	Any 36-Bit Value.	All zeros	Use to set/reset value for A port output.
SRVAL_B	Hexa-decimal	Any 36-Bit Value.	All zeros	Use to set/reset value for B port output.
WRITE_MODE_A	String	"WRITE_FIRST", "READ_FIRST" or "NO_CHANGE"	"WRITE_FIRST"	Configures Port A (Sn) of a dual-port RAMB16 to support one of three write modes.
WRITE_MODE_B	String	"WRITE_FIRST", "READ_FIRST" or "NO_CHANGE"	"WRITE_FIRST"	Configures Port B (Sn) of a dual-port RAMB16 to support one of three write modes.
WRITE_WIDTH_A	Integer	0, 1, 2, 4, 9, 18 or 36	0	Determines the A write port width of the block RAM.
WRITE_WIDTH_B	Integer	0, 1, 2, 4, 9, 18 or 36	0	Determines the A write port width of the block RAM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## RAMB32\_S64\_ECC

**Primitive: 512 Deep by 64-Bit Wide Synchronous, Two-Port Block RAM with Built-In Error Correction**



### Introduction

Two vertically adjacent block RAMs can be configured as a single 512 x 64 RAM with built in Hamming error correction, using the extra eight bits in the 72-bit wide RAM. The operation is transparent to you. The eight protection bits are generated during each write operation, and are used during each read operation to correct any single error, or to detect (but not correct) any double error. Two status outputs indicate the three possible read results: No error, single error corrected, double error detected. The read operation does not correct the error in the memory array, it only presents corrected data on DOUT.

This error correction code (ECC) configuration option is available with any block RAM pair, but cannot use the one block RAM immediately above or below the Virtex®-4 PowerPC®™ blocks.

### Port Descriptions

Port	Direction	Function
DIN<63:0>	Input	Data input bus
WRADDR<8:0>	Input	Write address bus
RDADDR<8:0>	Input	Read address bus
WREN	Input	Write enable. When WREN = 1, data will be written into memory. When WREN = 0, write is disabled.
RDEN	Input	Read enable. When RDEN = 1, data will be read from memory. When RDEN = 0, read is disabled.
SSR	Input	Set/Reset output registers (not the memory content)
WRCLK	Input	Clock for write operations
RDCLK	Input	Clock for read operations
DOUT<63:0>	Output	Data output bus
STATUS<1:0>(1)	Output	Error status bus

**Note** Hamming code implemented in the block RAM ECC logic detects one of three conditions: no detectable error, single-bit error detected and corrected on DOUT (but not corrected in the memory), and double-bit error detected without correction. The result of STATUS<1:0> indicates these three conditions.

STATUS[1:0]	Function
0	No bit error.
1	Single-bit error. The block RAM ECC macro detects and automatically corrects a single-bit error.
10	Double-bit error. The block RAM ECC macro detects a double-bit error.
11	Indeterminate state. The Hamming code implemented in the block RAM ECC cannot generate a predictable status if STATUS<1:0> is equal to three. Designers must ensure that the data has at most double-bit errors for the STATUS<1:0> to generate the proper indicator.

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
DO_REG	Integer	0, 1	0	Optional output registers on A port .
SIM_COLLISION_CHECK	String	"ALL", "NONE", "WARNING_ONLY" or "GENERATE_X_ONLY"	"ALL"	<p>Allows modification of the simulation behavior if a memory collision occurs. The output is affected as follows:</p> <ul style="list-style-type: none"> <li>"ALL" - Warning produced and affected outputs/memory location go unknown (X).</li> <li>"WARNING_ONLY" - Warning produced and affected outputs/memory retain last value.</li> <li>"GENERATE_X_ONLY" - No warning. However, affected outputs/memory go unknown (X).</li> <li>"NONE" - No warning and affected outputs/memory retain last value.</li> </ul> <p><b>Note</b> Setting this to a value other than "ALL" can allow problems in the design go unnoticed during simulation. Care should be taken when changing the value of this attribute. Please see the <i>Synthesis and Simulation Design Guide</i> for more information.</p>

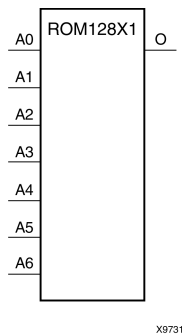
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## ROM128X1

Primitive: 128-Deep by 1-Wide ROM



### Introduction

This design element is a 128-word by 1-bit read-only memory. The data output (O) reflects the word selected by the 7-bit address (A6:A0). The ROM is initialized to a known value during configuration with the INIT=value parameter. The value consists of 32 hexadecimal digits that are written into the ROM from the most-significant digit A=FH to the least-significant digit A=0H. An error occurs if the INIT=value is not specified.

### Logic Table

Input				Output
I0	I1	I2	I3	O
0	0	0	0	INIT(0)
0	0	0	1	INIT(1)
0	0	1	0	INIT(2)
0	0	1	1	INIT(3)
0	1	0	0	INIT(4)
0	1	0	1	INIT(5)
0	1	1	0	INIT(6)
0	1	1	1	INIT(7)
1	0	0	0	INIT(8)
1	0	0	1	INIT(9)
1	0	1	0	INIT(10)
1	0	1	1	INIT(11)
1	1	0	0	INIT(12)
1	1	0	1	INIT(13)
1	1	1	0	INIT(14)
1	1	1	1	INIT(15)

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

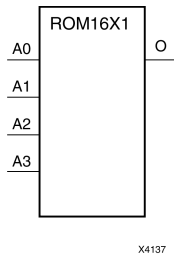
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 128-Bit Value	All zeros	Specifies the contents of the ROM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ROM16X1

Primitive: 16-Deep by 1-Wide ROM



### Introduction

This design element is a 16-word by 1-bit read-only memory. The data output (O) reflects the word selected by the 4-bit address (A3:A0). The ROM is initialized to a known value during configuration with the INIT=value parameter. The value consists of four hexadecimal digits that are written into the ROM from the most-significant digit A=FH to the least-significant digit A=0H. For example, the INIT=10A7 parameter produces the data stream: 0001 0000 1010 0111. An error occurs if the INIT=value is not specified.

### Logic Table

Input				Output
I0	I1	I2	I3	O
0	0	0	0	INIT(0)
0	0	0	1	INIT(1)
0	0	1	0	INIT(2)
0	0	1	1	INIT(3)
0	1	0	0	INIT(4)
0	1	0	1	INIT(5)
0	1	1	0	INIT(6)
0	1	1	1	INIT(7)
1	0	0	0	INIT(8)
1	0	0	1	INIT(9)
1	0	1	0	INIT(10)
1	0	1	1	INIT(11)
1	1	0	0	INIT(12)
1	1	0	1	INIT(13)
1	1	1	0	INIT(14)
1	1	1	1	INIT(15)

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

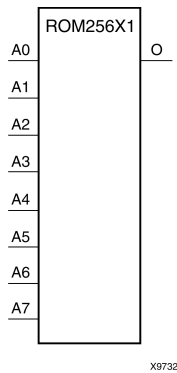
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Specifies the contents of the ROM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ROM256X1

Primitive: 256-Deep by 1-Wide ROM



### Introduction

This design element is a 256-word by 1-bit read-only memory. The data output (O) reflects the word selected by the 8-bit address (A7:A0). The ROM is initialized to a known value during configuration with the INIT=value parameter. The value consists of 64 hexadecimal digits that are written into the ROM from the most-significant digit A=FH to the least-significant digit A=0H.

An error occurs if the INIT=value is not specified.

### Logic Table

Input				Output
I0	I1	I2	I3	O
0	0	0	0	INIT(0)
0	0	0	1	INIT(1)
0	0	1	0	INIT(2)
0	0	1	1	INIT(3)
0	1	0	0	INIT(4)
0	1	0	1	INIT(5)
0	1	1	0	INIT(6)
0	1	1	1	INIT(7)
1	0	0	0	INIT(8)
1	0	0	1	INIT(9)
1	0	1	0	INIT(10)
1	0	1	1	INIT(11)
1	1	0	0	INIT(12)
1	1	0	1	INIT(13)
1	1	1	0	INIT(14)
1	1	1	1	INIT(15)

## Design Entry Method

This design element can be used in schematics.

### Available Attributes

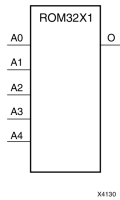
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 256-Bit Value	All zeros	Specifies the contents of the ROM.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## ROM32X1

Primitive: 32-Deep by 1-Wide ROM



### Introduction

This design element is a 32-word by 1-bit read-only memory. The data output (O) reflects the word selected by the 5-bit address (A4:A0). The ROM is initialized to a known value during configuration with the INIT=value parameter. The value consists of eight hexadecimal digits that are written into the ROM from the most-significant digit A=1FH to the least-significant digit A=00H.

For example, the INIT=10A78F39 parameter produces the data stream: 0001 0000 1010 0111 1000 1111 0011 1001. An error occurs if the INIT=value is not specified.

### Logic Table

Input				Output
I0	I1	I2	I3	O
0	0	0	0	INIT(0)
0	0	0	1	INIT(1)
0	0	1	0	INIT(2)
0	0	1	1	INIT(3)
0	1	0	0	INIT(4)
0	1	0	1	INIT(5)
0	1	1	0	INIT(6)
0	1	1	1	INIT(7)
1	0	0	0	INIT(8)
1	0	0	1	INIT(9)
1	0	1	0	INIT(10)
1	0	1	1	INIT(11)
1	1	0	0	INIT(12)
1	1	0	1	INIT(13)
1	1	1	0	INIT(14)
1	1	1	1	INIT(15)

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 32-Bit Value	All zeros	Specifies the contents of the ROM.

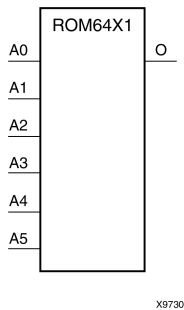
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## ROM64X1

Primitive: 64-Deep by 1-Wide ROM



### Introduction

This design element is a 64-word by 1-bit read-only memory. The data output (O) reflects the word selected by the 6-bit address (A5:A0). The ROM is initialized to a known value during configuration with the INIT=value parameter. The value consists of 16 hexadecimal digits that are written into the ROM from the most-significant digit A=FH to the least-significant digit A=0H. An error occurs if the INIT=value is not specified.

### Logic Table

Input				Output
I0	I1	I2	I3	O
0	0	0	0	INIT(0)
0	0	0	1	INIT(1)
0	0	1	0	INIT(2)
0	0	1	1	INIT(3)
0	1	0	0	INIT(4)
0	1	0	1	INIT(5)
0	1	1	0	INIT(6)
0	1	1	1	INIT(7)
1	0	0	0	INIT(8)
1	0	0	1	INIT(9)
1	0	1	0	INIT(10)
1	0	1	1	INIT(11)
1	1	0	0	INIT(12)
1	1	0	1	INIT(13)
1	1	1	0	INIT(14)
1	1	1	1	INIT(15)

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

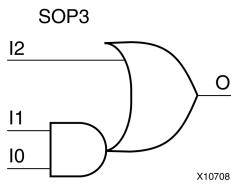
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 64-Bit Value	All zeros	Specifies the contents of the ROM.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3

### Macro: 3-Input Sum of Products



## Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

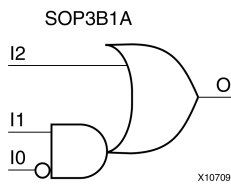
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3B1A

### Macro: 3–Input Sum of Products with One Inverted Input (Option A)



## Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

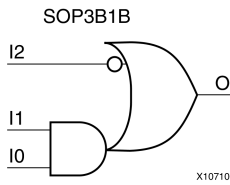
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3B1B

Macro: 3–Input Sum of Products with One Inverted Input (Option B)



### Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

### Design Entry Method

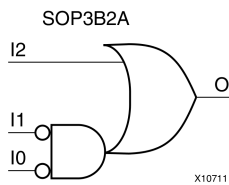
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3B2A

### Macro: 3–Input Sum of Products with Two Inverted Inputs (Option A)



## Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

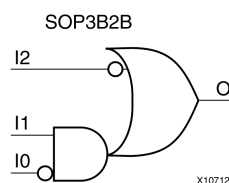
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3B2B

Macro: 3–Input Sum of Products with Two Inverted Inputs (Option B)



### Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

### Design Entry Method

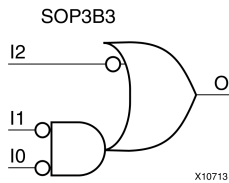
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP3B3

### Macro: 3-Input Sum of Products with Inverted Inputs



## Introduction

Three input Sum of Products (SOP) macros provide common logic functions by OR gating the output of one AND function with one direct input. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

This design element is only for use in schematics.

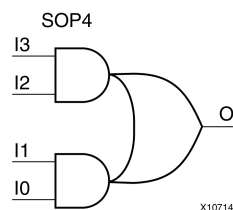
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SOP4

### Macro: 4–Input Sum of Products



## Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

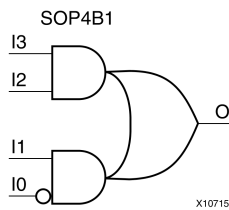
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP4B1

Macro: 4–Input Sum of Products with One Inverted Input



### Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

### Design Entry Method

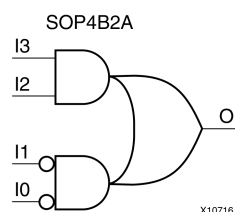
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP4B2A

Macro: 4–Input Sum of Products with Two Inverted Inputs (Option A)



### Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

### Design Entry Method

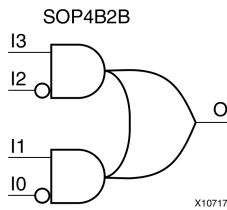
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP4B2B

### Macro: 4–Input Sum of Products with Two Inverted Inputs (Option B)



## Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

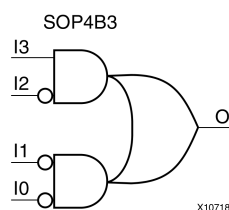
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP4B3

Macro: 4–Input Sum of Products with Three Inverted Inputs



## Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

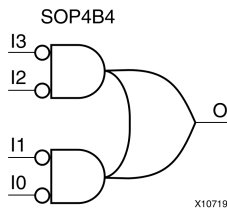
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SOP4B4

### Macro: 4–Input Sum of Products with Inverted Inputs



## Introduction

Four input Sum of Products (SOP) macros provide common logic functions by OR gating the outputs of two AND functions. Variations of inverting and non-inverting inputs are available.

## Design Entry Method

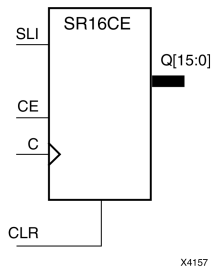
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR16CE

**Macro: 16-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel outputs (Q), and clock enable (CE) and asynchronous clear (CLR) inputs. The (CLR) input, when High, overrides all other inputs and resets the data outputs (Q) Low. When (CE) is High and (CLR) is Low, the data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and (CLR) is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (SLI→Q0, Q0→Q1, Q1→Q2, and so forth). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (CLR) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs	
CLR	CE	SLI	C	Q0	Qz : Q1
1	X	X	X	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1
z = bit width - 1					
qn-1 = state of referenced output one setup time prior to active clock transition					

## Design Entry Method

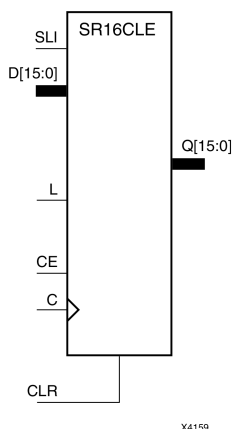
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR16CLE

**Macro: 16-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



### Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and asynchronous clear (CLR). The register ignores clock transitions when (L) and (CE) are Low. The asynchronous (CLR), when High, overrides all other inputs and resets the data outputs (Q) Low. When (L) is High and (CLR) is Low, data on the Dn -D0 inputs is loaded into the corresponding Qn -(Q0) bits of the register.

When (CE) is High and (L) and (CLR) are Low, data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent clock transitions, when (CE) is High and (L) and (CLR) are Low, the data shifts to the next highest bit position as new data is loaded into (Q)0 (for example, SLI→Q0, Q0→Q1, and Q1→Q2).

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (CLR) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_*architecture* symbol.

### Logic Table

Inputs						Outputs	
CLR	L	CE	SLI	Dn : D0	C	Q0	Qz : Q1
1	X	X	X	X	X	0	0
0	1	X	X	Dn : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

### Design Entry Method

This design element is only for use in schematics.

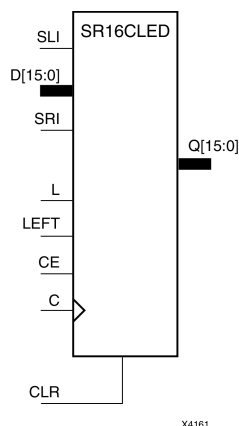


## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR16CLED

### Macro: 16-Bit Shift Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q), and four control inputs: clock enable (CE), load enable (L), shift left/right (LEFT), and asynchronous clear (CLR). The register ignores clock transitions when (CE) and (L) are Low. The asynchronous clear, when High, overrides all other inputs and resets the data outputs (Qn) Low.

When (L) is High and (CLR) is Low, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register. When (CE) is High and (L) and (CLR) are Low, data is shifted right or left, depending on the state of the LEFT input. If LEFT is High, data on the SLI is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 or Q2) during subsequent clock transitions. If LEFT is Low, data on the SRI is loaded into the last (Q) output during the Low-to-High clock transition and shifted right during subsequent clock transitions. The logic tables indicate the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs								Outputs		
CLR	L	CE	LEFT	SLI	SRI	D15 : D0	C	Q0	Q15	Q14 : Q1
1	X	X	X	X	X	X	X	0	0	0
0	1	X	X	X	X	D15 : D0	↑	D0	D15	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q14	qn-1
0	0	1	0	X	SRI	X	↑	q1	SRI	qn+1
qn-1 or qn+1 = state of referenced output one setup time prior to active clock transition.										

## Design Entry Method

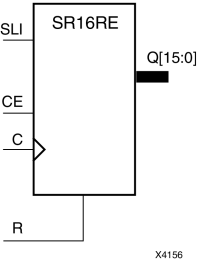
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# SR16RE

## Macro: 16-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset



### Introduction

This design element is a shift register with shift-left serial input (SLI), parallel outputs (Qn), clock enable (CE), and synchronous reset (R) inputs. The R input, when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low.

When (CE) is High and (R) is Low, the data on the (SLI) is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and R is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (for example, SLI→Q0, Q0→Q1, and Q1→Q2). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (R) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

### Logic Table

Inputs				Outputs	
R	CE	SLI	C	Q0	Qz : Q1
1	X	X	↑	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1
z = bitwidth -1					
qn-1 = state of referenced output one setup time prior to active clock transition					

### Design Entry Method

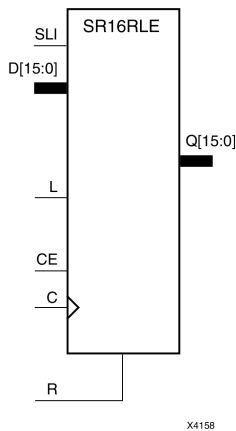
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR16RLE

**Macro: 16-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset**



### Introduction

This design element is a shift register with shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and synchronous reset (R). The register ignores clock transitions when (L) and (CE) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, data on the (D) inputs is loaded into the corresponding Q bits of the register.

When (CE) is High and (L) and (R) are Low, data on the (SLI) input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the Q0 output. During subsequent clock transitions, when (CE) is High and (L) and (R) are Low, the data shifts to the next highest bit position as new data is loaded into Q0.

Registers can be cascaded by connecting the last Q output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (R) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs						Outputs	
R	L	CE	SLI	Dz : D0	C	Q0	Qz : Q1
1	X	X	X	X	↑	0	0
0	1	X	X	Dz : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

### Design Entry Method

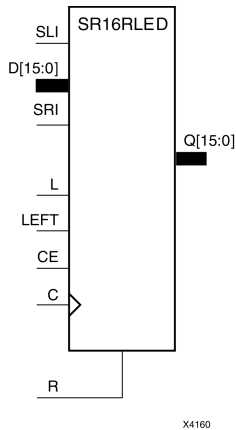
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR16RLED

### Macro: 16-Bit Shift Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q) and four control inputs — clock enable (CE), load enable (L), shift left/right (LEFT), and synchronous reset (R). The register ignores clock transitions when (CE) and (L) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register.

When (CE) is High and (L) and (R) are Low, data shifts right or left, depending on the state of the LEFT input. If LEFT is High, data on (SLI) is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 and Q2) during subsequent clock transitions. If LEFT is Low, data on the (SRI) is loaded into the last (Q) output during the Low-to-High clock transition and shifted right ) during subsequent clock transitions. The logic tables below indicates the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs								Outputs		
R	L	CE	LEFT	SLI	SRI	D15:D0	C	Q0	Q15	Q14:Q1
1	X	X	X	X	X	X	↑	0	0	0
0	1	X	X	X	X	D15:D0	↓	D0	D15	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q14	qn-1
0	0	1	0	X	SRI	X	↓	q1	SRI	qn+1
qn-1 or qn+1 = state of referenced output one setup time prior to active clock transition										

## Design Entry Method

This design element is only for use in schematics.

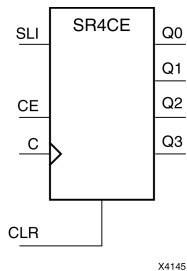
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SR4CE

**Macro: 4-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel outputs (Q), and clock enable (CE) and asynchronous clear (CLR) inputs. The (CLR) input, when High, overrides all other inputs and resets the data outputs (Q) Low. When (CE) is High and (CLR) is Low, the data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and (CLR) is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (SLI→Q0, Q0→Q1, Q1→Q2, and so forth). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (CLR) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs				Outputs	
CLR	CE	SLI	C	Q0	Qz : Q1
1	X	X	X	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1

z = bit width - 1  
qn-1 = state of referenced output one setup time prior to active clock transition

## Design Entry Method

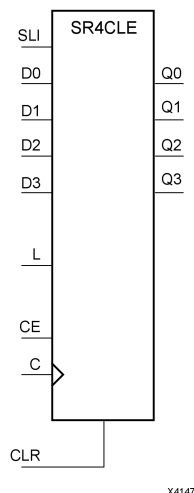
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR4CLE

**Macro: 4-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



X4147

## Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and asynchronous clear (CLR). The register ignores clock transitions when (L) and (CE) are Low. The asynchronous (CLR), when High, overrides all other inputs and resets the data outputs (Q) Low. When (L) is High and (CLR) is Low, data on the Dn -D0 inputs is loaded into the corresponding Qn -(Q0) bits of the register.

When (CE) is High and (L) and (CLR) are Low, data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent clock transitions, when (CE) is High and (L) and (CLR) are Low, the data shifts to the next highest bit position as new data is loaded into (Q)0 (for example, SLI→Q0, Q0→Q1, and Q1→Q2).

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (CLR) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs						Outputs	
CLR	L	CE	SLI	Dn : D0	C	Q0	Qz : Q1
1	X	X	X	X	X	0	0
0	1	X	X	Dn : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

## Design Entry Method

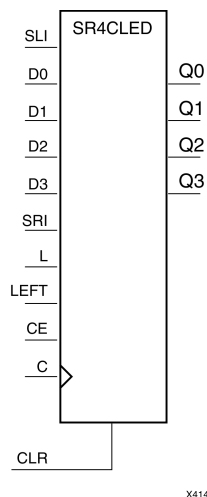
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR4CLED

### Macro: 4-Bit Shift Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q), and four control inputs: clock enable (CE), load enable (L), shift left/right (LEFT), and asynchronous clear (CLR). The register ignores clock transitions when (CE) and (L) are Low. The asynchronous clear, when High, overrides all other inputs and resets the data outputs (Qn) Low.

When (L) is High and (CLR) is Low, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register. When (CE) is High and (L) and (CLR) are Low, data is shifted right or left, depending on the state of the LEFT input. If LEFT is High, data on the SLI is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 or Q2) during subsequent clock transitions. If LEFT is Low, data on the SRI is loaded into the last (Q) output during the Low-to-High clock transition and shifted right during subsequent clock transitions. The logic tables indicate the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

## Logic Table

Inputs								Outputs		
CLR	L	CE	LEFT	SLI	SRI	D3 : D0	C	Q0	Q3	Q2 : Q1
1	X	X	X	X	X	X	X	0	0	0
0	1	X	X	X	X	D3– D0	↑	D0	D3	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q2	qn-1
0	0	1	0	X	SRI	X	↑	q1	SRI	qn+1

qn-1 and qn+1 = state of referenced output one setup time prior to active clock transition.

## Design Entry Method

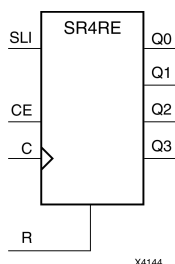
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR4RE

### Macro: 4-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a shift register with shift-left serial input (SLI), parallel outputs (Qn), clock enable (CE), and synchronous reset (R) inputs. The R input, when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low.

When (CE) is High and (R) is Low, the data on the (SLI) is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and R is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (for example, SLI→Q0, Q0→Q1, and Q1→Q2). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (R) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs				Outputs	
R	CE	SLI	C	Q0	Qz : Q1
1	X	X	↑	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1
z = bitwidth -1					
qn-1 = state of referenced output one setup time prior to active clock transition					

## Design Entry Method

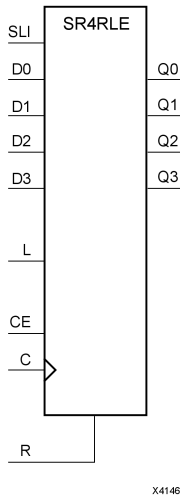
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR4RLE

**Macro: 4-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset**



### Introduction

This design element is a shift register with shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and synchronous reset (R). The register ignores clock transitions when (L) and (CE) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, data on the (D) inputs is loaded into the corresponding Q bits of the register.

When (CE) is High and (L) and (R) are Low, data on the (SLI) input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the Q0 output. During subsequent clock transitions, when (CE) is High and (L) and (R) are Low, the data shifts to the next highest bit position as new data is loaded into Q0.

Registers can be cascaded by connecting the last Q output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (R) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs						Outputs	
R	L	CE	SLI	Dz : D0	C	Q0	Qz : Q1
1	X	X	X	X	↑	0	0
0	1	X	X	Dz : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

## Design Entry Method

This design element is only for use in schematics.

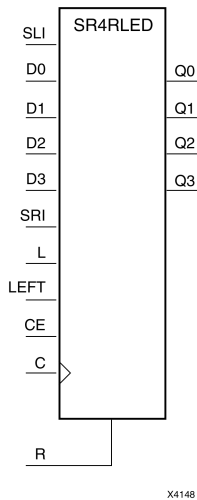
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SR4RLED

### Macro: 4-Bit Shift Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q) and four control inputs — clock enable (CE), load enable (L), shift left/right (LEFT), and synchronous reset (R). The register ignores clock transitions when (CE) and (L) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register.

When (CE) is High and (L) and (R) are Low, data shifts right or left, depending on the state of the LEFT input. If LEFT is High, data on (SLI) is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 and Q2) during subsequent clock transitions. If LEFT is Low, data on the (SRI) is loaded into the last (Q) output during the Low-to-High clock transition and shifted right ) during subsequent clock transitions. The logic tables below indicates the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs								Outputs		
R	L	CE	LEFT	SLI	SRI	D3 : D0	C	Q0	Q3	Q2 : Q1
1	X	X	X	X	X	X	↑	0	0	0
0	1	X	X	X	X	D3 : D0	↑	D0	D3	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q2	qn-1
0	0	1	0	X	SRI	X	↑	q1	SRI	qn+1
qn-1 or qn+1 = state of referenced output one setup time prior to active clock transition										

## Design Entry Method

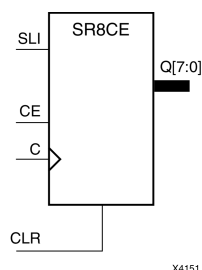
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR8CE

**Macro: 8-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel outputs (Q), and clock enable (CE) and asynchronous clear (CLR) inputs. The (CLR) input, when High, overrides all other inputs and resets the data outputs (Q) Low. When (CE) is High and (CLR) is Low, the data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and (CLR) is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (SLI→Q0, Q0→Q1, Q1→Q2, and so forth). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (CLR) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate `STARTUP_architecture` symbol.

## Logic Table

Inputs				Outputs	
CLR	CE	SLI	C	Q0	Qz : Q1
1	X	X	X	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1
z = bit width - 1					
qn-1 = state of referenced output one setup time prior to active clock transition					

## Design Entry Method

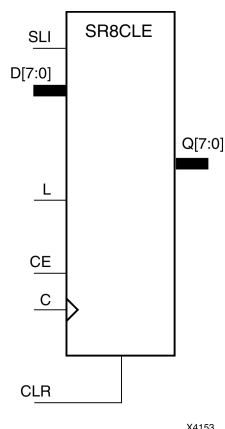
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR8CLE

**Macro: 8-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Asynchronous Clear**



## Introduction

This design element is a shift register with a shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and asynchronous clear (CLR). The register ignores clock transitions when (L) and (CE) are Low. The asynchronous (CLR), when High, overrides all other inputs and resets the data outputs (Q) Low. When (L) is High and (CLR) is Low, data on the Dn -D0 inputs is loaded into the corresponding Qn -(Q0) bits of the register.

When (CE) is High and (L) and (CLR) are Low, data on the SLI input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent clock transitions, when (CE) is High and (L) and (CLR) are Low, the data shifts to the next highest bit position as new data is loaded into (Q)0 (for example, SLI→Q0, Q0→Q1, and Q1→Q2).

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (CLR) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs						Outputs	
CLR	L	CE	SLI	Dn : D0	C	Q0	Qz : Q1
1	X	X	X	X	X	0	0
0	1	X	X	Dn : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

## Design Entry Method

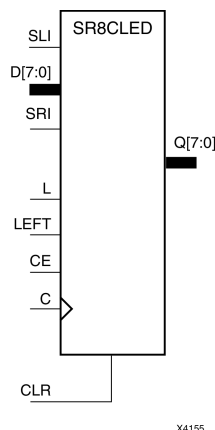
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR8CLED

### Macro: 8-Bit Shift Register with Clock Enable and Asynchronous Clear



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q), and four control inputs: clock enable (CE), load enable (L), shift left/right (LEFT), and asynchronous clear (CLR). The register ignores clock transitions when (CE) and (L) are Low. The asynchronous clear, when High, overrides all other inputs and resets the data outputs (Qn) Low.

When (L) is High and (CLR) is Low, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register. When (CE) is High and (L) and (CLR) are Low, data is shifted right or left, depending on the state of the LEFT input. If LEFT is High, data on the SLI is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 or Q2) during subsequent clock transitions. If LEFT is Low, data on the SRI is loaded into the last (Q) output during the Low-to-High clock transition and shifted right during subsequent clock transitions. The logic tables indicate the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs								Outputs		
CLR	L	CE	LEFT	SLI	SRI	D7 : D0	C	Q0	Q7	Q6 : Q1
1	X	X	X	X	X	X	X	0	0	0
0	1	X	X	X	X	D7 : D0	↑	D0	D7	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q6	qn-1
0	0	1	0	X	SRI	X	↑	q1	SRI	qn+1
qn-1 or qn+1 = state of referenced output one setup time prior to active clock transition.										

## Design Entry Method

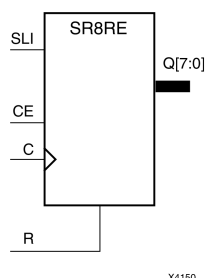
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR8RE

### Macro: 8-Bit Serial-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a shift register with shift-left serial input (SLI), parallel outputs (Qn), clock enable (CE), and synchronous reset (R) inputs. The R input, when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low.

When (CE) is High and (R) is Low, the data on the (SLI) is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the (Q0) output. During subsequent Low-to-High clock transitions, when (CE) is High and R is Low, data shifts to the next highest bit position as new data is loaded into (Q0) (for example, SLI→Q0, Q0→Q1, and Q1→Q2). The register ignores clock transitions when (CE) is Low.

Registers can be cascaded by connecting the last (Q) output of one stage to the SLI input of the next stage and connecting clock, (CE), and (R) in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs				Outputs	
R	CE	SLI	C	Q0	Qz : Q1
1	X	X	↑	0	0
0	0	X	X	No Change	No Change
0	1	SLI	↑	SLI	qn-1
z = bitwidth -1					
qn-1 = state of referenced output one setup time prior to active clock transition					

## Design Entry Method

This design element is only for use in schematics.

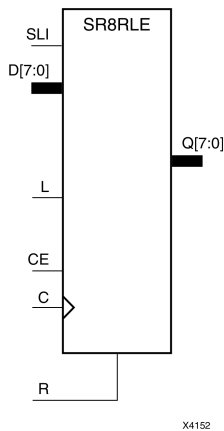
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SR8RLE

**Macro: 8-Bit Loadable Serial/Parallel-In Parallel-Out Shift Register with Clock Enable and Synchronous Reset**



### Introduction

This design element is a shift register with shift-left serial input (SLI), parallel inputs (D), parallel outputs (Q), and three control inputs: clock enable (CE), load enable (L), and synchronous reset (R). The register ignores clock transitions when (L) and (CE) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, data on the (D) inputs is loaded into the corresponding Q bits of the register.

When (CE) is High and (L) and (R) are Low, data on the (SLI) input is loaded into the first bit of the shift register during the Low-to-High clock (C) transition and appears on the Q0 output. During subsequent clock transitions, when (CE) is High and (L) and (R) are Low, the data shifts to the next highest bit position as new data is loaded into Q0.

Registers can be cascaded by connecting the last Q output of one stage to the SLI input of the next stage and connecting clock, (CE), (L), and (R) inputs in parallel.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate *STARTUP\_architecture* symbol.

### Logic Table

Inputs						Outputs	
R	L	CE	SLI	Dz : D0	C	Q0	Qz : Q1
1	X	X	X	X	↑	0	0
0	1	X	X	Dz : D0	↑	D0	Dn
0	0	1	SLI	X	↑	SLI	qn-1
0	0	0	X	X	X	No Change	No Change
z = bitwidth -1							
qn-1 = state of referenced output one setup time prior to active clock transition							

### Design Entry Method

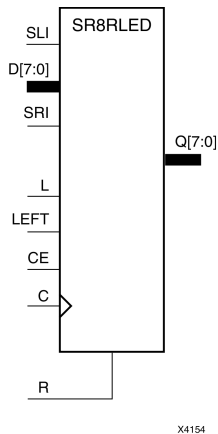
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SR8RLED

### Macro: 8-Bit Shift Register with Clock Enable and Synchronous Reset



## Introduction

This design element is a shift register with shift-left (SLI) and shift-right (SRI) serial inputs, parallel inputs (D), parallel outputs (Q) and four control inputs — clock enable (CE), load enable (L), shift left/right (LEFT), and synchronous reset (R). The register ignores clock transitions when (CE) and (L) are Low. The synchronous (R), when High, overrides all other inputs during the Low-to-High clock (C) transition and resets the data outputs (Q) Low. When (L) is High and (R) is Low during the Low-to-High clock transition, the data on the (D) inputs is loaded into the corresponding (Q) bits of the register.

When (CE) is High and (L) and (R) are Low, data shifts right or left, depending on the state of the LEFT input. If LEFT is High, data on (SLI) is loaded into (Q0) during the Low-to-High clock transition and shifted left (for example, to Q1 and Q2) during subsequent clock transitions. If LEFT is Low, data on the (SRI) is loaded into the last (Q) output during the Low-to-High clock transition and shifted right ) during subsequent clock transitions. The logic tables below indicates the state of the (Q) outputs under all input conditions.

This register is asynchronously cleared, outputs Low, when power is applied. For FPGA devices, power-on conditions are simulated when global set/reset (GSR) is active. GSR defaults to active-High but can be inverted by adding an inverter in front of the GSR input of the appropriate STARTUP\_architecture symbol.

## Logic Table

Inputs								Outputs		
R	L	CE	LEFT	SLI	SRI	D7 : D0	C	Q0	Q7	Q6 : Q1
1	X	X	X	X	X	X	↑	0	0	0
0	1	X	X	X	X	D7 : D0	↓	D0	D7	Dn
0	0	0	X	X	X	X	X	No Change	No Change	No Change
0	0	1	1	SLI	X	X	↑	SLI	q6	qn-1
0	0	1	0	X	SRI	X	↓	q1	SRI	qn+1
qn-1 or qn+1 = state of referenced output one setup time prior to active clock transition										

## Design Entry Method

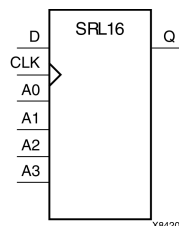
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRL16

### Primitive: 16-Bit Shift Register Look-Up Table (LUT)



## Introduction

This design element is a shift register look-up table (LUT). The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

The data (D) is loaded into the first bit of the shift register during the Low-to-High clock (CLK) transition. During subsequent Low-to-High clock transitions data shifts to the next highest bit position while new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached.

## Logic Table

Inputs			Output
Am	CLK	D	Q
Am	X	X	Q(Am)
Am	↑	D	Q(Am - 1)
m = 0, 1, 2, 3			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

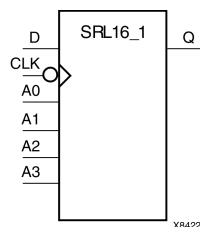
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of Q output after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRL16\_1

### Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Negative-Edge Clock



## Introduction

This design element is a shift register look-up table (LUT). The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

The data (D) is loaded into the first bit of the shift register during the High-to-Low clock (CLK) transition. During subsequent High-to-Low clock transitions data shifts to the next highest bit position as new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached.

## Logic Table

Inputs			Output
A <sub>m</sub>	CLK	D	Q
A <sub>m</sub>	X	X	Q(A <sub>m</sub> )
A <sub>m</sub>	↓	D	Q(A <sub>m</sub> - 1)
m = 0, 1, 2, 3			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of Q output after configuration

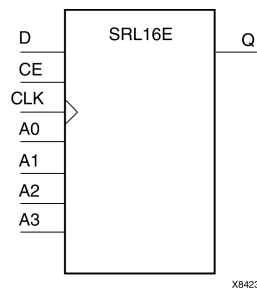
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SRL16E

### Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Clock Enable



## Introduction

This design element is a shift register look-up table (LUT). The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

When CE is High, the data (D) is loaded into the first bit of the shift register during the Low-to-High clock (CLK) transition. During subsequent Low-to-High clock transitions, when CE is High, data shifts to the next highest bit position as new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached. When CE is Low, the register ignores clock transitions.

## Logic Table

Inputs				Output
A <sub>m</sub>	CE	CLK	D	Q
A <sub>m</sub>	0	X	X	Q(A <sub>m</sub> )
A <sub>m</sub>	1	↑	D	Q(A <sub>m</sub> - 1)
m = 0, 1, 2, 3				

## Port Descriptions

Port	Direction	Width	Function
Q	Output	1	Shift register data output
D	Input	1	Shift register data input
CLK	Input	1	Clock
CE	Input	1	Active high clock enable
A	Input	4	Dynamic depth selection of the SRL <ul style="list-style-type: none"><li>A=0000 ==&gt; 1-bit shift length</li><li>A=1111 ==&gt; 16-bit shift length</li></ul>

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

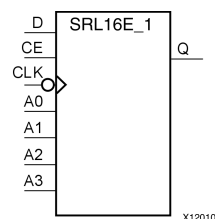
Attribute	Type	Allowed Values	Default	Description
INIT	Hexa-decimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRL16E\_1

Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Negative-Edge Clock and Clock Enable



## Introduction

This design element is a shift register look-up table (LUT) with clock enable (CE). The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

When CE is High, the data (D) is loaded into the first bit of the shift register during the High-to-Low clock (CLK) transition. During subsequent High-to-Low clock transitions, when CE is High, data is shifted to the next highest bit position as new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached. When CE is Low, the register ignores clock transitions.

## Logic Table

Inputs				Output
Am	CE	CLK	D	Q
Am	0	X	X	Q(Am)
Am	1	↓	D	Q(Am - 1)
m = 0, 1, 2, 3				

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

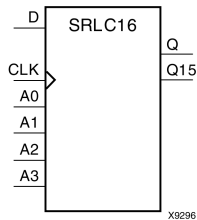
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRLC16

### Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry



## Introduction

This design element is a shift register look-up table (LUT) with Carry. The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

The data (D) is loaded into the first bit of the shift register during the Low-to-High clock (CLK) transition. During subsequent Low-to-High clock transitions data shifts to the next highest bit position as new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached.

**Note** The Q15 output is available for you in cascading to multiple shift register LUTs to create larger shift registers.

## Logic Table

Inputs			Output
A <sub>m</sub>	CLK	D	Q
A <sub>m</sub>	X	X	Q(A <sub>m</sub> )
A <sub>m</sub>	↑	D	Q(A <sub>m</sub> - 1)
m = 0, 1, 2, 3			

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

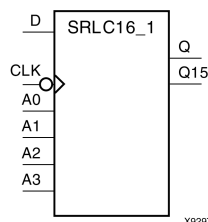
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRLC16\_1

### Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry and Negative-Edge Clock



## Introduction

This design element is a shift register look-up table (LUT) with carry and a negative-edge clock. The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

**Note** The Q15 output is available for your use in cascading multiple shift register LUTs to create larger shift registers.

## Logic Table

Inputs			Output	
Am	CLK	D	Q	Q15
Am	X	X	Q(Am)	No Change
Am	↓	D	Q(Am - 1)	Q14
m = 0, 1, 2, 3				

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

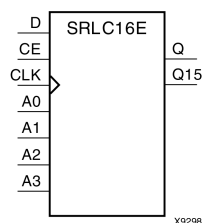
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## SRLC16E

### Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry and Clock Enable



## Introduction

This design element is a shift register look-up table (LUT) with carry and clock enable. The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

The data (D) is loaded into the first bit of the shift register during the Low-to-High clock (CLK) transition. When CE is High, during subsequent Low-to-High clock transitions, data shifts to the next highest bit position as new data is loaded. The data appears on the Q output when the shift register length determined by the address inputs is reached.

**Note** The Q15 output is available for you in cascading to multiple shift register LUTs to create larger shift registers.

## Logic Table

Inputs				Output	
Am	CLK	CE	D	Q	Q15
Am	X	0	X	Q(Am)	Q(15)
Am	X	1	X	Q(Am)	Q(15)
Am	↑	1	D	Q(Am - 1)	Q15
m = 0, 1, 2, 3					

## Design Entry Method

This design element can be used in schematics.

## Available Attributes

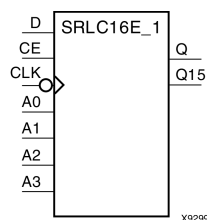
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## SRLC16E\_1

Primitive: 16-Bit Shift Register Look-Up Table (LUT) with Carry, Negative-Edge Clock, and Clock Enable



### Introduction

This design element is a shift register look-up table (LUT) with carry, clock enable, and negative-edge clock. The inputs A3, A2, A1, and A0 select the output length of the shift register.

The shift register can be of a fixed, static length or it can be dynamically adjusted.

- **To create a fixed-length shift register** -Drive the A3 through A0 inputs with static values. The length of the shift register can vary from 1 bit to 16 bits, as determined by the following formula:  $\text{Length} = (8 \times A3) + (4 \times A2) + (2 \times A1) + A0 + 1$ . If A3, A2, A1, and A0 are all zeros (0000), the shift register is one bit long. If they are all ones (1111), it is 16 bits long.
- **To change the length of the shift register dynamically** -Change the values driving the A3 through A0 inputs. For example, if A2, A1, and A0 are all ones (111) and A3 toggles between a one (1) and a zero (0), the length of the shift register changes from 16 bits to 8 bits. Internally, the length of the shift register is always 16 bits and the input lines A3 through A0 select which of the 16 bits reach the output.

The shift register LUT contents are initialized by assigning a four-digit hexadecimal number to an INIT attribute. The first, or the left-most, hexadecimal digit is the most significant bit. If an INIT value is not specified, it defaults to a value of four zeros (0000) so that the shift register LUT is cleared during configuration.

When CE is High, the data (D) is loaded into the first bit of the shift register during the High-to-Low clock (CLK) transition. During subsequent High-to-Low clock transitions data shifts to the next highest bit position as new data is loaded when CE is High. The data appears on the Q output when the shift register length determined by the address inputs is reached.

**Note** The Q15 output is available for your use in cascading multiple shift register LUTs to create larger shift registers.

### Logic Table

Inputs				Output	
Am	CE	CLK	D	Q	Q15
Am	0	X	X	Q(Am)	No Change
Am	1	X	X	Q(Am)	No Change
Am	1	↓	D	Q(Am -1 )	Q14
m= 0, 1, 2, 3					

### Design Entry Method

This design element can be used in schematics.

## Available Attributes

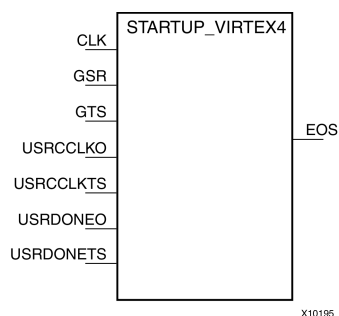
Attribute	Type	Allowed Values	Default	Description
INIT	Hexadecimal	Any 16-Bit Value	All zeros	Sets the initial value of content and output of shift register after configuration.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## STARTUP\_VIRTEX4

**Primitive: Virtex®-4 User Interface to Configuration Clock, Global Reset, Global 3-State Controls, and Other Configuration Signals**



### Introduction

This design element lets you activate Global Set/Reset (GSR), Global Tristate (GTS) control, and your configuration clock. It also allows you to control the DONE and CLK pins after configuration.

### Port Descriptions

Port	Direction	Width	Function
EOS	Output	1	EOS signal
CLK	Input	1	Clock input
GTS	Input	1	Global Tristate (GTS) control
GSR	Input	1	Global Set/Reset (GSR)
USRCCLKO	Input	1	Allows you to drive external CCLK pin.
USRCCLKTS	Input	1	Tristates CCLK pin when asserted
USRDONEO	Input	1	Allows you to drive external DONE pin.
USRDONETS	Input	1	Tristates DONE pin when asserted.

### Design Entry Method

This design element can be used in schematics.

**Note** Block RAM content, LUT RAMs, the Digital Clock Manager (DCM), and shift register LUTs (SRL16, SRL16\_1, SRL16E, SRL16E\_1, SRLC16, SRLC16\_1, SRLC16E, and SRLC16E\_1) are not set/reset.

Following configuration, the Global Tristate (GTS), when High--and when BSCAN, is not enabled and executing an EXTEST instruction--forces all the IOB outputs into high-impedance mode, which isolates the device outputs from the circuit but leaves the inputs active.

CLK input allows you to clock through configuration startup sequence with a user-specified IO, rather than having to provide clock on JTAGs TCK or CCCLK pin. To enable this, Bitgen must also have the startup clk set to userclk when generating your bitstream.

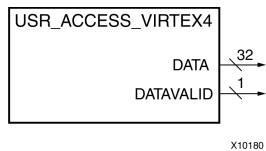
USRCCLKO/TS and USRDONEO/TS are used to control the external DONE and CCLK pins. Using the STARTUP\_VIRTEX4 in combination with the USR\_ACCESS\_VIRTEX4 primitive supports a variety of applications, such as loading PROM data into the FPGA for various uses. Refer to USR\_ACCESS\_VIRTEX4 for more information.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## USR\_ACCESS\_VIRTEX4

Primitive: 32-Bit Register with a 32-Bit DATA Bus and a DATAVALID Port



### Introduction

This design element is a 32-bit register that allows data from the bitstream to be directly accessible by the FPGA fabric. This module has two outputs: the 32-bit DATA bus and DATAVALID. The configuration data source clock can be CCLK or TCK.

The use model for this block is that it allows data from a bitstream data storage source (e.g., PROM) to be accessed by the fabric after the FPGA has been configured. To accomplish this the STARTUP\_VIRTEX4 block should also be instantiated. The STARTUP\_VIRTEX4 block has inputs that allow you to take over the CCLK and DONE pins after the EOS (End-Of-Startup) signal has been asserted. These pins are USR\_CCLK\_O, USR\_CCLK\_TS, USR\_DONE\_O, and USR\_DONE\_TS. The Bitgen option -g DONE\_cycle: 7 should be used to prevent the DONE pin from going high since that would reset the PROM. The USR\_CCLK\_O pin should be connected to a controlled clock in the fabric. The PROM should contain a packet of data with the USR\_ACCESS register as the target. After EOS has been asserted, the data packet can be loaded by clocking the USR\_CCLK\_O pin while keeping USR\_CCLK\_TS low (it can be tied low in this usage).

Alternatively, the USR\_ACCESS register can be used to provide a single 32-bit constant value to the fabric as an alternative to using a BRAM or LUTRAM to hold the constant.

### Port Descriptions

Port	Direction	Width	Function
DATA	Output	32	The 32-bit register that allows the FPGA fabric to access data from bitstream data storage source.
DATAVALID	Output	1	Indicates whether the value in the DATA bus is new or valid. When this condition is true, this port is asserted HIGH for one cycle of the configuration data source clock.

### Design Entry Method

This design element can be used in schematics.

When using this module to access data from bitstream data storage source (e.g., PROM) to FPGA fabric after configuration, the STARTUP\_VIRTEX4 block should also be instantiated. This element contains inputs that allow the designer to utilize the CCLK and DONE pins after the EOS (End-Of-Startup) signal have been asserted. These pins are USR\_CCLK\_O, USR\_CCLK\_TS, USR\_DONE\_O, and USR\_DONE\_TS.

The USR\_CCLK\_O pin should be connected to a controlled clock in the fabric. The data storage source should contain a packet of data with the USR\_ACCESS\_VIRTEX4 register as the target. After EOS has been asserted, the data packet can be loaded by clocking the USR\_CCLK\_O pin while keeping USR\_CCLK\_TS to logic Low. The USR\_CCLK\_TS can be tied to logic Low when using this application.

In addition, when using this module, the bitgen option -g DONE\_cycle: 7 should be used to prevent the High assertion of DONE pin. Should the DONE pin be asserted High, the PROM will be reset.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



# VCC

## Primitive: VCC-Connection Signal Tag



## Introduction

This design element serves as a signal tag, or parameter, that forces a net or input function to a logic High level. A net tied to this element cannot have any other source.

When the placement and routing software encounters a net or input function tied to this element, it removes any logic that is disabled by the Vcc signal, which is only implemented when the disabled logic cannot be removed.

## Design Entry Method

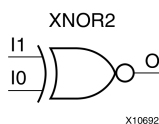
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR2

### Primitive: 2-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

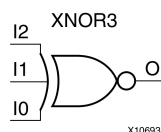
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR3

### Primitive: 3-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

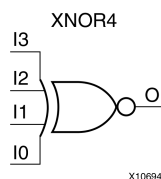
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR4

### Primitive: 4-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

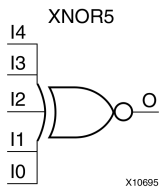
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR5

### Primitive: 5-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

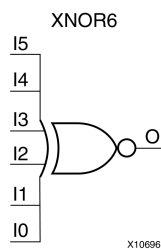
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR6

### Macro: 6-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

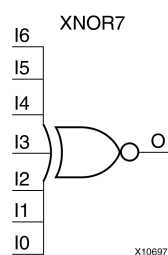
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR7

### Macro: 7-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

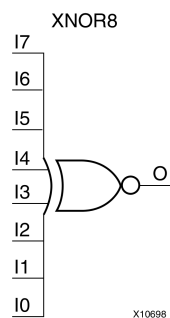
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XNOR8

### Macro: 8-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

This design element is only for use in schematics.

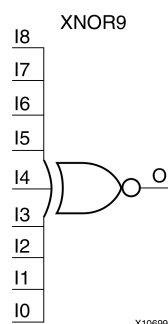
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## XNOR9

### Macro: 9-Input XNOR Gate with Non-Inverted Inputs



## Introduction

XNOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Logic Table

Input	Output
I0 ... Iz	O
Odd number of 1	0
Even number of 1	1

## Design Entry Method

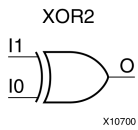
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR2

### Primitive: 2-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

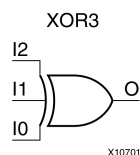
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR3

### Primitive: 3-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

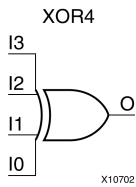
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR4

### Primitive: 4-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

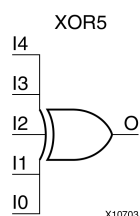
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR5

Primitive: 5-Input XOR Gate with Non-Inverted Inputs



### Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

### Design Entry Method

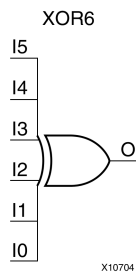
This design element is only for use in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR6

### Macro: 6-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

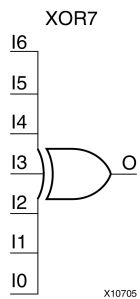
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR7

### Macro: 7-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

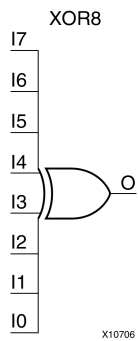
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XOR8

### Macro: 8-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

This design element is only for use in schematics.

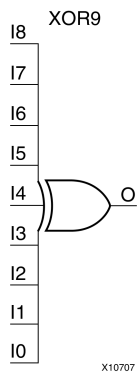
## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).



## XOR9

### Macro: 9-Input XOR Gate with Non-Inverted Inputs



## Introduction

XOR functions of up to nine inputs are available. All inputs are non-inverting. Because each input uses a CLB resource, replace functions with unused inputs with functions having the necessary number of inputs.

## Design Entry Method

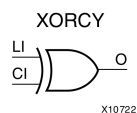
This design element is only for use in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XORCY

### Primitive: XOR for Carry Logic with General Output



## Introduction

This design element is a special XOR with general O output that generates faster and smaller arithmetic functions. The XORCY primitive is a dedicated XOR function within the carry-chain logic of the slice. It allows for fast and efficient creation of arithmetic (add/subtract) or wide logic functions (large AND/OR gate).

## Logic Table

Input		Output
LI	CI	O
0	0	0
0	1	1
1	0	1
1	1	0

## Design Entry Method

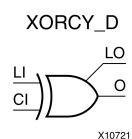
This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

## XORCY\_D

Primitive: XOR for Carry Logic with Dual Output



### Introduction

This design element is a special XOR that generates faster and smaller arithmetic functions.

### Logic Table

Input		Output
LI	CI	O and LO
0	0	0
0	1	1
1	0	1
1	1	0

### Design Entry Method

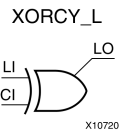
This design element can be used in schematics.

### For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).

# XORCY\_L

Primitive: XOR for Carry Logic with Local Output



## Introduction

This design element is a special XOR with local LO output that generates faster and smaller arithmetic functions.

## Logic Table

Input		Output
LI	CI	LO
0	0	0
0	1	1
1	0	1
1	1	0

## Design Entry Method

This design element can be used in schematics.

## For More Information

- See the [Virtex-4 FPGA User Guide](#).
- See the [Virtex-4 FPGA Data Sheet DC and Switching Characteristics](#).