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### Understanding Embedded - FPGAs (Field Programmable Gate Array)

Embedded - FPGAs, or Field Programmable Gate Arrays, are advanced integrated circuits that offer unparalleled flexibility and performance for digital systems. Unlike traditional fixed-function logic devices, FPGAs can be programmed and reprogrammed to execute a wide array of logical operations, enabling customized functionality tailored to specific applications. This reprogrammability allows developers to iterate designs quickly and implement complex functions without the need for custom hardware.

### Applications of Embedded - FPGAs

The versatility of Embedded - FPGAs makes them indispensable in numerous fields. In telecommunications.

#### Details

Product Status	Obsolete
Number of LABs/CLBs	384
Number of Logic Elements/Cells	1728
Total RAM Bits	32768
Number of I/O	140
Number of Gates	50000
Voltage - Supply	2.375V ~ 2.625V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 85°C (TJ)
Package / Case	208-BFQFP
Supplier Device Package	208-PQFP (28x28)
Purchase URL	<a href="https://www.e-xfl.com/product-detail/xilinx/xc2s50-5pqg208c">https://www.e-xfl.com/product-detail/xilinx/xc2s50-5pqg208c</a>

## Introduction

The Spartan®-II Field-Programmable Gate Array family gives users high performance, abundant logic resources, and a rich feature set, all at an exceptionally low price. The six-member family offers densities ranging from 15,000 to 200,000 system gates, as shown in [Table 1](#). System performance is supported up to 200 MHz. Features include block RAM (to 56K bits), distributed RAM (to 75,264 bits), 16 selectable I/O standards, and four DLLs. Fast, predictable interconnect means that successive design iterations continue to meet timing requirements.

The Spartan-II family is a superior alternative to mask-programmed ASICs. The FPGA avoids the initial cost, lengthy development cycles, and inherent risk of conventional ASICs. Also, FPGA programmability permits design upgrades in the field with no hardware replacement necessary (impossible with ASICs).

## Features

- Second generation ASIC replacement technology
  - Densities as high as 5,292 logic cells with up to 200,000 system gates
  - Streamlined features based on Virtex® FPGA architecture
  - Unlimited reprogrammability
  - Very low cost
  - Cost-effective 0.18 micron process
- System level features
  - SelectRAM™ hierarchical memory:
    - 16 bits/LUT distributed RAM
    - Configurable 4K bit block RAM
    - Fast interfaces to external RAM
  - Fully PCI compliant
  - Low-power segmented routing architecture
  - Full readback ability for verification/observability
  - Dedicated carry logic for high-speed arithmetic
  - Efficient multiplier support
  - Cascade chain for wide-input functions
  - Abundant registers/latches with enable, set, reset
  - Four dedicated DLLs for advanced clock control
  - Four primary low-skew global clock distribution nets
  - IEEE 1149.1 compatible boundary scan logic
- Versatile I/O and packaging
  - Pb-free package options
  - Low-cost packages available in all densities
  - Family footprint compatibility in common packages
  - 16 high-performance interface standards
  - Hot swap Compact PCI friendly
  - Zero hold time simplifies system timing
- Core logic powered at 2.5V and I/Os powered at 1.5V, 2.5V, or 3.3V
- Fully supported by powerful Xilinx® ISE® development system
  - Fully automatic mapping, placement, and routing

Table 1: Spartan-II FPGA Family Members

Device	Logic Cells	System Gates (Logic and RAM)	CLB Array (R x C)	Total CLBs	Maximum Available User I/O <sup>(1)</sup>	Total Distributed RAM Bits	Total Block RAM Bits
XC2S15	432	15,000	8 x 12	96	86	6,144	16K
XC2S30	972	30,000	12 x 18	216	92	13,824	24K
XC2S50	1,728	50,000	16 x 24	384	176	24,576	32K
XC2S100	2,700	100,000	20 x 30	600	176	38,400	40K
XC2S150	3,888	150,000	24 x 36	864	260	55,296	48K
XC2S200	5,292	200,000	28 x 42	1,176	284	75,264	56K

### Notes:

1. All user I/O counts do not include the four global clock/user input pins. See details in [Table 2, page 4](#).

## Architectural Description

## Spartan-II FPGA Array

The Spartan®-II field-programmable gate array, shown in [Figure 2](#), is composed of five major configurable elements:

- IOBs provide the interface between the package pins and the internal logic
- CLBs provide the functional elements for constructing most logic
- Dedicated block RAM memories of 4096 bits each
- Clock DLLs for clock-distribution delay compensation and clock domain control
- Versatile multi-level interconnect structure

As can be seen in [Figure 2](#), the CLBs form the central logic structure with easy access to all support and routing structures. The IOBs are located around all the logic and

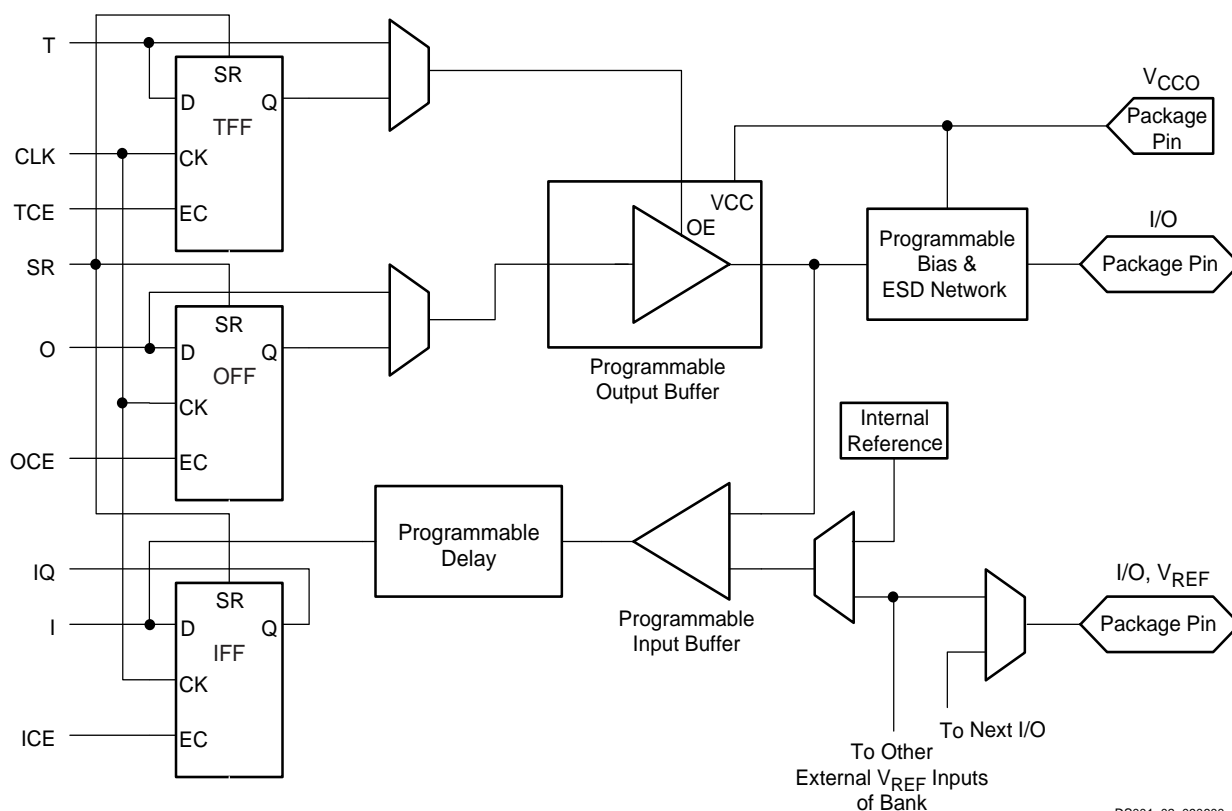
memory elements for easy and quick routing of signals on and off the chip.

Values stored in static memory cells control all the configurable logic elements and interconnect resources. These values load into the memory cells on power-up, and can reload if necessary to change the function of the device.

Each of these elements will be discussed in detail in the following sections.

## Input/Output Block

The Spartan-II FPGA IOB, as seen in [Figure 2](#), features inputs and outputs that support a wide variety of I/O signaling standards. These high-speed inputs and outputs are capable of supporting various state of the art memory and bus interfaces. [Table 3](#) lists several of the standards which are supported along with the required reference, output and termination voltages needed to meet the standard.



**Figure 2: Spartan-II FPGA Input/Output Block (IOB)**

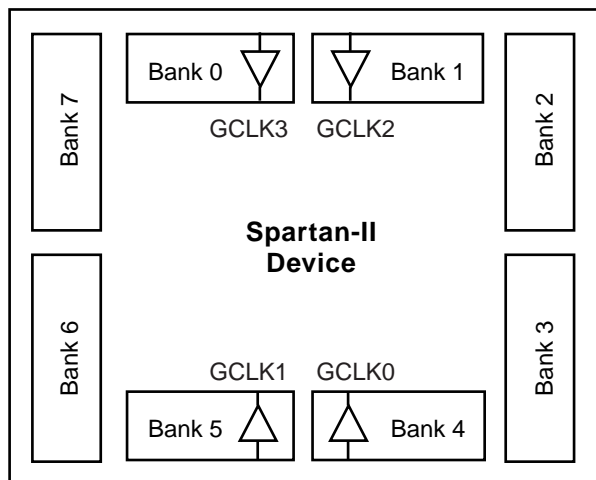
drivers are disabled. Maintaining a valid logic level in this way helps eliminate bus chatter.

Because the weak-keeper circuit uses the IOB input buffer to monitor the input level, an appropriate  $V_{REF}$  voltage must be provided if the signaling standard requires one. The provision of this voltage must comply with the I/O banking rules.

### I/O Banking

Some of the I/O standards described above require  $V_{CCO}$  and/or  $V_{REF}$  voltages. These voltages are externally connected to device pins that serve groups of IOBs, called banks. Consequently, restrictions exist about which I/O standards can be combined within a given bank.

Eight I/O banks result from separating each edge of the FPGA into two banks (see Figure 3). Each bank has multiple  $V_{CCO}$  pins which must be connected to the same voltage. Voltage is determined by the output standards in use.



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Figure 3: Spartan-II I/O Banks

Within a bank, output standards may be mixed only if they use the same  $V_{CCO}$ . Compatible standards are shown in Table 4. GTL and GTL+ appear under all voltages because their open-drain outputs do not depend on  $V_{CCO}$ .

Table 4: Compatible Output Standards

$V_{CCO}$	Compatible Standards
3.3V	PCI, LVTTTL, SSTL3 I, SSTL3 II, CTT, AGP, GTL, GTL+
2.5V	SSTL2 I, SSTL2 II, LVCMOS2, GTL, GTL+
1.5V	HSTL I, HSTL III, HSTL IV, GTL, GTL+

Some input standards require a user-supplied threshold voltage,  $V_{REF}$ . In this case, certain user-I/O pins are

automatically configured as inputs for the  $V_{REF}$  voltage. About one in six of the I/O pins in the bank assume this role.

$V_{REF}$  pins within a bank are interconnected internally and consequently only one  $V_{REF}$  voltage can be used within each bank. All  $V_{REF}$  pins in the bank, however, must be connected to the external voltage source for correct operation.

In a bank, inputs requiring  $V_{REF}$  can be mixed with those that do not but only one  $V_{REF}$  voltage may be used within a bank. Input buffers that use  $V_{REF}$  are not 5V tolerant. LVTTTL, LVCMOS2, and PCI are 5V tolerant. The  $V_{CCO}$  and  $V_{REF}$  pins for each bank appear in the device pinout tables.

Within a given package, the number of  $V_{REF}$  and  $V_{CCO}$  pins can vary depending on the size of device. In larger devices, more I/O pins convert to  $V_{REF}$  pins. Since these are always a superset of the  $V_{REF}$  pins used for smaller devices, it is possible to design a PCB that permits migration to a larger device. All  $V_{REF}$  pins for the largest device anticipated must be connected to the  $V_{REF}$  voltage, and not used for I/O.

### Independent Banks Available

Package	VQ100 PQ208	CS144 TQ144	FG256 FG456
Independent Banks	1	4	8

### Configurable Logic Block

The basic building block of the Spartan-II FPGA CLB is the logic cell (LC). An LC includes a 4-input function generator, carry logic, and storage element. Output from the function generator in each LC drives the CLB output and the D input of the flip-flop. Each Spartan-II FPGA CLB contains four LCs, organized in two similar slices; a single slice is shown in Figure 4.

In addition to the four basic LCs, the Spartan-II FPGA CLB contains logic that combines function generators to provide functions of five or six inputs.

### Look-Up Tables

Spartan-II FPGA function generators are implemented as 4-input look-up tables (LUTs). In addition to operating as a function generator, each LUT can provide a 16 x 1-bit synchronous RAM. Furthermore, the two LUTs within a slice can be combined to create a 16 x 2-bit or 32 x 1-bit synchronous RAM, or a 16 x 1-bit dual-port synchronous RAM.

The Spartan-II FPGA LUT can also provide a 16-bit shift register that is ideal for capturing high-speed or burst-mode data. This mode can also be used to store data in applications such as Digital Signal Processing.

Similarly, the F6 multiplexer combines the outputs of all four function generators in the CLB by selecting one of the F5-multiplexer outputs. This permits the implementation of any 6-input function, an 8:1 multiplexer, or selected functions of up to 19 inputs.

Each CLB has four direct feedthrough paths, one per LC. These paths provide extra data input lines or additional local routing that does not consume logic resources.

### Arithmetic Logic

Dedicated carry logic provides capability for high-speed arithmetic functions. The Spartan-II FPGA CLB supports two separate carry chains, one per slice. The height of the carry chains is two bits per CLB.

The arithmetic logic includes an XOR gate that allows a 1-bit full adder to be implemented within an LC. In addition, a dedicated AND gate improves the efficiency of multiplier implementation.

The dedicated carry path can also be used to cascade function generators for implementing wide logic functions.

### BUFTs

Each Spartan-II FPGA CLB contains two 3-state drivers (BUFTs) that can drive on-chip busses. See "Dedicated Routing," page 12. Each Spartan-II FPGA BUFT has an independent 3-state control pin and an independent input pin.

### Block RAM

Spartan-II FPGAs incorporate several large block RAM memories. These complement the distributed RAM Look-Up Tables (LUTs) that provide shallow memory structures implemented in CLBs.

Block RAM memory blocks are organized in columns. All Spartan-II devices contain two such columns, one along each vertical edge. These columns extend the full height of the chip. Each memory block is four CLBs high, and consequently, a Spartan-II device eight CLBs high will contain two memory blocks per column, and a total of four blocks.

Table 5: Spartan-II Block RAM Amounts

Spartan-II Device	# of Blocks	Total Block RAM Bits
XC2S15	4	16K
XC2S30	6	24K
XC2S50	8	32K
XC2S100	10	40K
XC2S150	12	48K
XC2S200	14	56K

Each block RAM cell, as illustrated in Figure 5, is a fully synchronous dual-ported 4096-bit RAM with independent control signals for each port. The data widths of the two ports can be configured independently, providing built-in bus-width conversion.

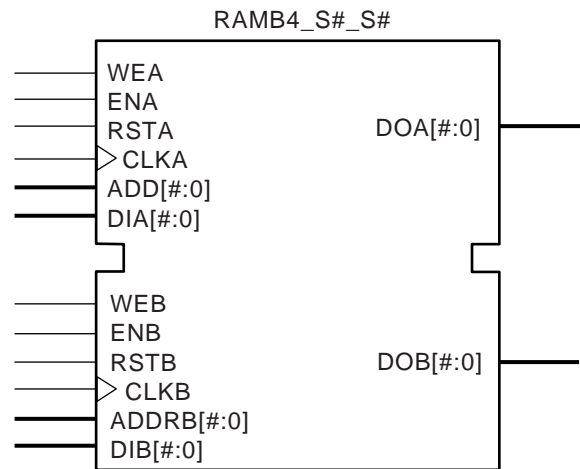


Figure 5: Dual-Port Block RAM

Table 6 shows the depth and width aspect ratios for the block RAM.

Table 6: Block RAM Port Aspect Ratios

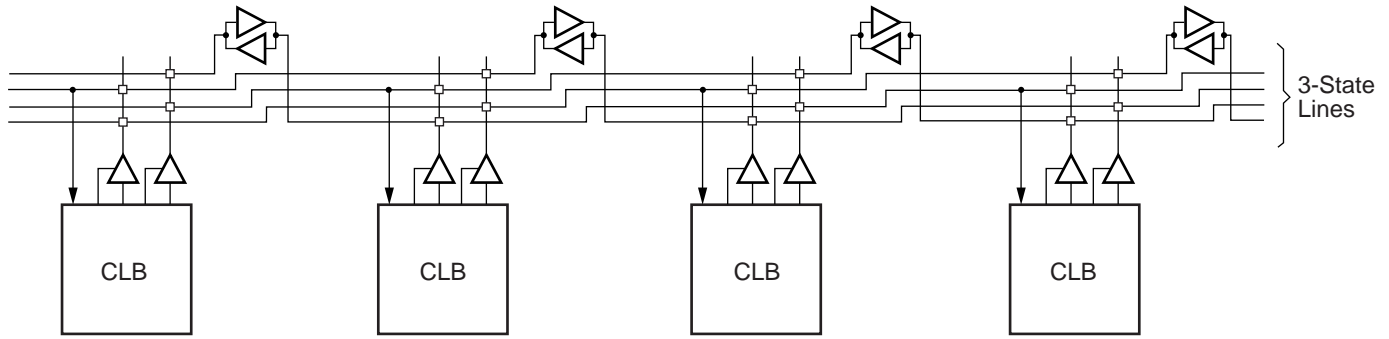
Width	Depth	ADDR Bus	Data Bus
1	4096	ADDR<11:0>	DATA<0>
2	2048	ADDR<10:0>	DATA<1:0>
4	1024	ADDR<9:0>	DATA<3:0>
8	512	ADDR<8:0>	DATA<7:0>
16	256	ADDR<7:0>	DATA<15:0>

The Spartan-II FPGA block RAM also includes dedicated routing to provide an efficient interface with both CLBs and other block RAMs.

### Programmable Routing Matrix

It is the longest delay path that limits the speed of any worst-case design. Consequently, the Spartan-II routing architecture and its place-and-route software were defined in a single optimization process. This joint optimization minimizes long-path delays, and consequently, yields the best system performance.

The joint optimization also reduces design compilation times because the architecture is software-friendly. Design cycles are correspondingly reduced due to shorter design iteration times.



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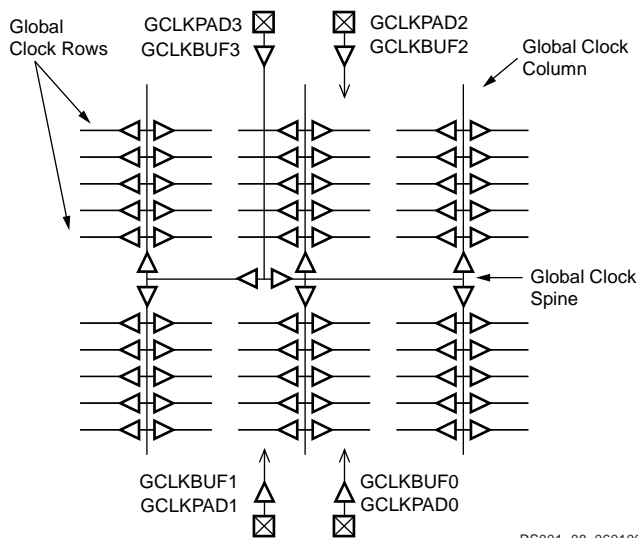
Figure 7: BUFT Connections to Dedicated Horizontal Bus Lines

## Clock Distribution

The Spartan-II family provides high-speed, low-skew clock distribution through the primary global routing resources described above. A typical clock distribution net is shown in Figure 8.

Four global buffers are provided, two at the top center of the device and two at the bottom center. These drive the four primary global nets that in turn drive any clock pin.

Four dedicated clock pads are provided, one adjacent to each of the global buffers. The input to the global buffer is selected either from these pads or from signals in the general purpose routing. Global clock pins do not have the option for internal, weak pull-up resistors.



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Figure 8: Global Clock Distribution Network

## Delay-Locked Loop (DLL)

Associated with each global clock input buffer is a fully digital Delay-Locked Loop (DLL) that can eliminate skew between the clock input pad and internal clock-input pins throughout the device. Each DLL can drive two global clock

networks. The DLL monitors the input clock and the distributed clock, and automatically adjusts a clock delay element. Additional delay is introduced such that clock edges reach internal flip-flops exactly one clock period after they arrive at the input. This closed-loop system effectively eliminates clock-distribution delay by ensuring that clock edges arrive at internal flip-flops in synchronism with clock edges arriving at the input.

In addition to eliminating clock-distribution delay, the DLL provides advanced control of multiple clock domains. The DLL provides four quadrature phases of the source clock, can double the clock, or divide the clock by 1.5, 2, 2.5, 3, 4, 5, 8, or 16. It has six outputs.

The DLL also operates as a clock mirror. By driving the output from a DLL off-chip and then back on again, the DLL can be used to deskew a board level clock among multiple Spartan-II devices.

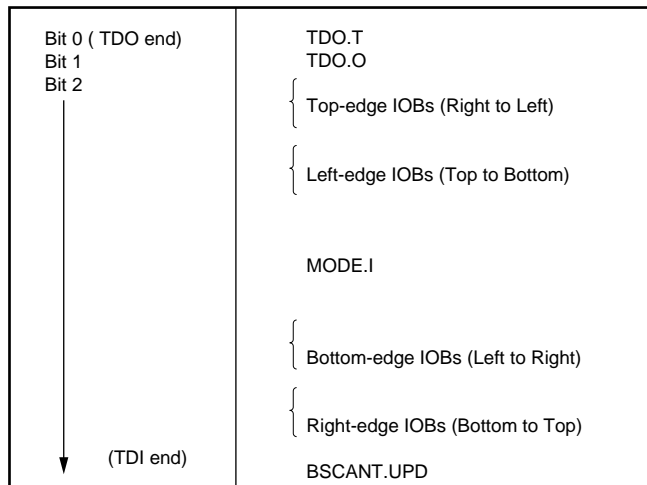
In order to guarantee that the system clock is operating correctly prior to the FPGA starting up after configuration, the DLL can delay the completion of the configuration process until after it has achieved lock.

## Boundary Scan

Spartan-II devices support all the mandatory boundary-scan instructions specified in the IEEE standard 1149.1. A Test Access Port (TAP) and registers are provided that implement the EXTEST, SAMPLE/PRELOAD, and BYPASS instructions. The TAP also supports two USERCODE instructions and internal scan chains.

The TAP uses dedicated package pins that always operate using LVTTTL. For TDO to operate using LVTTTL, the  $V_{CCO}$  for Bank 2 must be 3.3V. Otherwise, TDO switches rail-to-rail between ground and  $V_{CCO}$ . TDI, TMS, and TCK have a default internal weak pull-up resistor, and TDO has no default resistor. Bitstream options allow setting any of the four TAP pins to have an internal pull-up, pull-down, or neither.





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Figure 10: Boundary Scan Bit Sequence

## Development System

Spartan-II FPGAs are supported by the Xilinx ISE® development tools. The basic methodology for Spartan-II FPGA design consists of three interrelated steps: design entry, implementation, and verification. Industry-standard tools are used for design entry and simulation, while Xilinx provides proprietary architecture-specific tools for implementation.

The Xilinx development system is integrated under a single graphical interface, providing designers with a common user interface regardless of their choice of entry and verification tools. The software simplifies the selection of implementation options with pull-down menus and on-line help.

For HDL design entry, the Xilinx FPGA development system provides interfaces to several synthesis design environments.

A standard interface-file specification, Electronic Design Interchange Format (EDIF), simplifies file transfers into and out of the development system.

Spartan-II FPGAs supported by a unified library of standard functions. This library contains over 400 primitives and macros, ranging from 2-input AND gates to 16-bit accumulators, and includes arithmetic functions, comparators, counters, data registers, decoders, encoders, I/O functions, latches, Boolean functions, multiplexers, shift registers, and barrel shifters.

The design environment supports hierarchical design entry. These hierarchical design elements are automatically combined by the implementation tools. Different design entry tools can be combined within a hierarchical design, thus allowing the most convenient entry method to be used for each portion of the design.

## Design Implementation

The place-and-route tools (PAR) automatically provide the implementation flow described in this section. The partitioner takes the EDIF netlist for the design and maps the logic into the architectural resources of the FPGA (CLBs and IOBs, for example). The placer then determines the best locations for these blocks based on their interconnections and the desired performance. Finally, the router interconnects the blocks.

The PAR algorithms support fully automatic implementation of most designs. For demanding applications, however, the user can exercise various degrees of control over the process. User partitioning, placement, and routing information is optionally specified during the design-entry process. The implementation of highly structured designs can benefit greatly from basic floorplanning.

The implementation software incorporates timing-driven placement and routing. Designers specify timing requirements along entire paths during design entry. The timing path analysis routines in PAR then recognize these user-specified requirements and accommodate them.

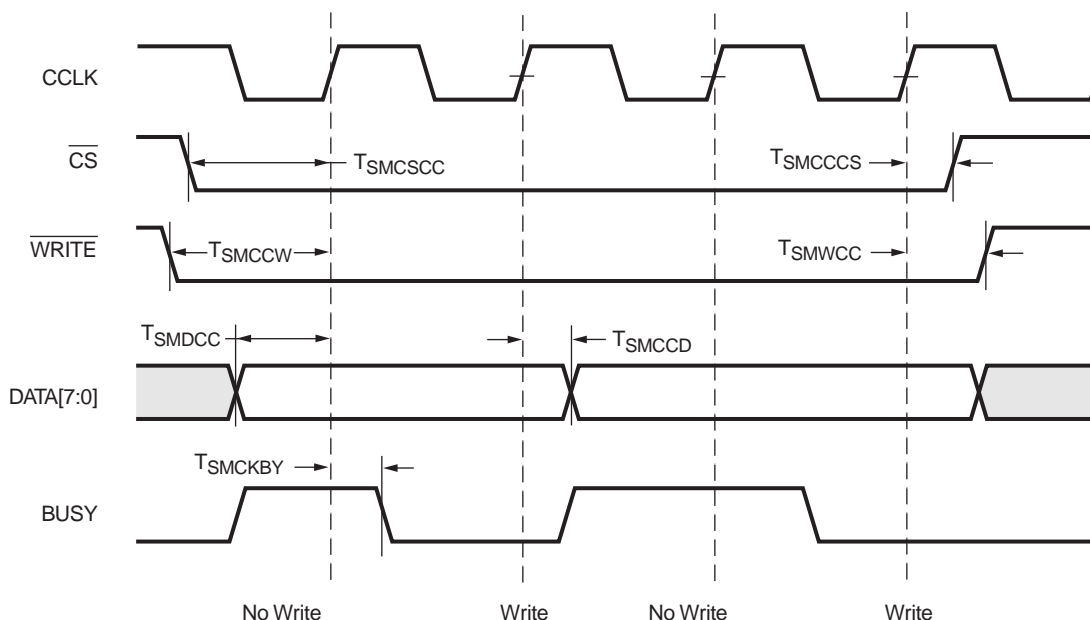
Timing requirements are entered in a form directly relating to the system requirements, such as the targeted clock frequency, or the maximum allowable delay between two registers. In this way, the overall performance of the system along entire signal paths is automatically tailored to user-generated specifications. Specific timing information for individual nets is unnecessary.

## Design Verification

In addition to conventional software simulation, FPGA users can use in-circuit debugging techniques. Because Xilinx devices are infinitely reprogrammable, designs can be verified in real time without the need for extensive sets of software simulation vectors.

The development system supports both software simulation and in-circuit debugging techniques. For simulation, the system extracts the post-layout timing information from the design database, and back-annotates this information into the netlist for use by the simulator. Alternatively, the user can verify timing-critical portions of the design using the static timing analyzer.

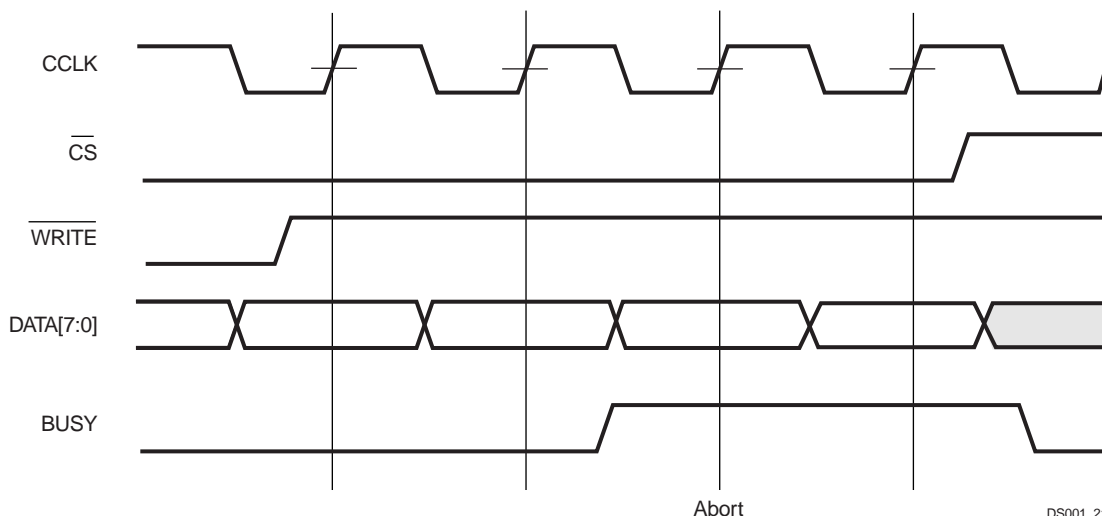
For in-circuit debugging, the development system includes a download cable, which connects the FPGA in the target system to a PC or workstation. After downloading the design into the FPGA, the designer can read back the contents of the flip-flops, and so observe the internal logic state. Simple modifications can be downloaded into the system in a matter of minutes.



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Symbol		Description		Units
$T_{SMDCC}$	CCLK	D0-D7 setup/hold	5	ns, min
$T_{SMCCD}$		D0-D7 hold	0	ns, min
$T_{SMCSCC}$		$\overline{CS}$ setup	7	ns, min
$T_{SMCCCS}$		$\overline{CS}$ hold	0	ns, min
$T_{SMCCW}$		$\overline{WRITE}$ setup	7	ns, min
$T_{SMWCC}$		$\overline{WRITE}$ hold	0	ns, min
$T_{SMCKBY}$		BUSY propagation delay	12	ns, max
$F_{CC}$		Maximum frequency	66	MHz, max
$F_{CCNH}$		Maximum frequency with no handshake	50	MHz, max

Figure 20: Slave Parallel Write Timing



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Figure 21: Slave Parallel Write Abort Waveforms



Table 11: Available Library Primitives

Primitive	Port A Width	Port B Width
RAMB4_S4	4	N/A
RAMB4_S4_S4		4
RAMB4_S4_S8		8
RAMB4_S4_S16		16
RAMB4_S8	8	N/A
RAMB4_S8_S8		8
RAMB4_S8_S16		16
RAMB4_S16	16	N/A
RAMB4_S16_S16		16

## Port Signals

Each block RAM port operates independently of the others while accessing the same set of 4096 memory cells.

Table 12 describes the depth and width aspect ratios for the block RAM memory.

Table 12: Block RAM Port Aspect Ratios

Width	Depth	ADDR Bus	Data Bus
1	4096	ADDR<11:0>	DATA<0>
2	2048	ADDR<10:0>	DATA<1:0>
4	1024	ADDR<9:0>	DATA<3:0>
8	512	ADDR<8:0>	DATA<7:0>
16	256	ADDR<7:0>	DATA<15:0>

## Clock—CLK[A/B]

Each port is fully synchronous with independent clock pins. All port input pins have setup time referenced to the port CLK pin. The data output bus has a clock-to-out time referenced to the CLK pin.

## Enable—EN[A/B]

The enable pin affects the read, write and reset functionality of the port. Ports with an inactive enable pin keep the output pins in the previous state and do not write data to the memory cells.

## Write Enable—WE[A/B]

Activating the write enable pin allows the port to write to the memory cells. When active, the contents of the data input bus are written to the RAM at the address pointed to by the address bus, and the new data also reflects on the data out bus. When inactive, a read operation occurs and the contents of the memory cells referenced by the address bus reflect on the data out bus.

## Reset—RST[A/B]

The reset pin forces the data output bus latches to zero synchronously. This does not affect the memory cells of the RAM and does not disturb a write operation on the other port.

## Address Bus—ADDR[A/B]<#:0>

The address bus selects the memory cells for read or write. The width of the port determines the required width of this bus as shown in Table 12.

## Data In Bus—DI[A/B]<#:0>

The data in bus provides the new data value to be written into the RAM. This bus and the port have the same width, as shown in Table 12.

## Data Output Bus—DO[A/B]<#:0>

The data out bus reflects the contents of the memory cells referenced by the address bus at the last active clock edge. During a write operation, the data out bus reflects the data in bus. The width of this bus equals the width of the port. The allowed widths appear in Table 12.

## Inverting Control Pins

The four control pins (CLK, EN, WE and RST) for each port have independent inversion control as a configuration option.

## Address Mapping

Each port accesses the same set of 4096 memory cells using an addressing scheme dependent on the width of the port. The physical RAM location addressed for a particular width are described in the following formula (of interest only when the two ports use different aspect ratios).

$$\text{Start} = ([\text{ADDR}_{\text{port}} + 1] * \text{Width}_{\text{port}}) - 1$$

$$\text{End} = \text{ADDR}_{\text{port}} * \text{Width}_{\text{port}}$$

Table 13 shows low order address mapping for each port width.

Table 13: Port Address Mapping

Port Width	Port Addresses																
1	4095...	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2	2047...	07		06		05		04		03		02		01		00	
4	1023...	03				02				01				00			
8	511...	01								00							
16	255...	00															

LVTTL output buffers have selectable drive strengths.

The format for LVTTL OBUF primitive names is as follows.

OBUF\_<slew\_rate>\_<drive\_strength>

<slew\_rate> is either F (Fast), or S (Slow) and <drive\_strength> is specified in milliamps (2, 4, 6, 8, 12, 16, or 24). The default is slew rate limited with 12 mA drive.

OBUF placement restrictions require that within a given  $V_{CCO}$  bank each OBUF share the same output source drive voltage. Input buffers of any type and output buffers that do not require  $V_{CCO}$  can be placed within any  $V_{CCO}$  bank.

Table 17 summarizes the output compatibility requirements. The LOC property can specify a location for the OBUF.

**Table 17: Output Standards Compatibility Requirements**

Rule 1	Only outputs with standards which share compatible $V_{CCO}$ may be used within the same bank.
Rule 2	There are no placement restrictions for outputs with standards that do not require a $V_{CCO}$ .
$V_{CCO}$	Compatible Standards
3.3	LVTTL, SSTL3_I, SSTL3_II, CTT, AGP, GTL, GTL+, PCI33_3, PCI66_3
2.5	SSTL2_I, SSTL2_II, LVCMOS2, GTL, GTL+
1.5	HSTL_I, HSTL_III, HSTL_IV, GTL, GTL+

## OBUFT

The generic 3-state output buffer OBUFT, shown in Figure 39, typically implements 3-state outputs or bidirectional I/O.

With no extension or property specified for the generic OBUFT primitive, the assumed standard is slew rate limited LVTTL with 12 mA drive strength.

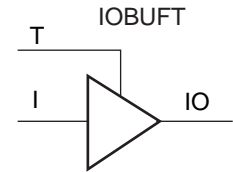
The LVTTL OBUFT can support one of two slew rate modes to minimize bus transients. By default, the slew rate for each output buffer is reduced to minimize power bus transients when switching non-critical signals.

LVTTL 3-state output buffers have selectable drive strengths.

The format for LVTTL OBUFT primitive names is as follows.

OBUFT\_<slew\_rate>\_<drive\_strength>

<slew\_rate> can be either F (Fast), or S (Slow) and <drive\_strength> is specified in milliamps (2, 4, 6, 8, 12, 16, or 24).



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**Figure 39: 3-State Output Buffer Primitive (OBUFT)**

The Versatile I/O OBUFT placement restrictions require that within a given  $V_{CCO}$  bank each OBUFT share the same output source drive voltage. Input buffers of any type and output buffers that do not require  $V_{CCO}$  can be placed within the same  $V_{CCO}$  bank.

The LOC property can specify a location for the OBUFT.

3-state output buffers and bidirectional buffers can have either a weak pull-up resistor, a weak pull-down resistor, or a weak "keeper" circuit. Control this feature by adding the appropriate primitive to the output net of the OBUFT (PULLUP, PULLDOWN, or KEEPER).

The weak "keeper" circuit requires the input buffer within the IOB to sample the I/O signal. So, OBUFTs programmed for an I/O standard that requires a  $V_{REF}$  have automatic placement of a  $V_{REF}$  in the bank with an OBUFT configured with a weak "keeper" circuit. This restriction does not affect most circuit design as applications using an OBUFT configured with a weak "keeper" typically implement a bidirectional I/O. In this case the IBUF (and the corresponding  $V_{REF}$ ) are explicitly placed.

The LOC property can specify a location for the OBUFT.

## IOBUF

Use the IOBUF primitive for bidirectional signals that require both an input buffer and a 3-state output buffer with an active high 3-state pin. The generic input/output buffer IOBUF appears in Figure 40.

With no extension or property specified for the generic IOBUF primitive, the assumed standard is LVTTL input buffer and slew rate limited LVTTL with 12 mA drive strength for the output buffer.

The LVTTL IOBUF can support one of two slew rate modes to minimize bus transients. By default, the slew rate for each output buffer is reduced to minimize power bus transients when switching non-critical signals.

LVTTL bidirectional buffers have selectable output drive strengths.

The format for LVTTL IOBUF primitive names is as follows:

### HSTL Class III

A sample circuit illustrating a valid termination technique for HSTL\_III appears in Figure 45. DC voltage specifications appear in Table 23 for the HSTL\_III standard. See "DC Specifications" in Module 3 for the actual FPGA characteristics.

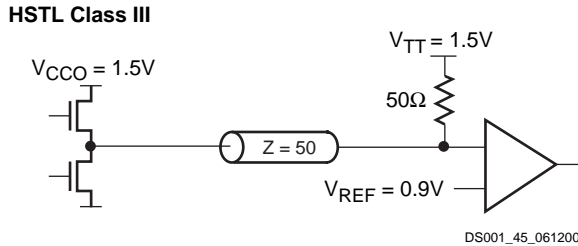


Figure 45: Terminated HSTL Class III

Table 23: HSTL Class III Voltage Specification

Parameter	Min	Typ	Max
$V_{CCO}$	1.40	1.50	1.60
$V_{REF}^{(1)}$	-	0.90	-
$V_{TT}$	-	$V_{CCO}$	-
$V_{IH}$	$V_{REF} + 0.1$	-	-
$V_{IL}$	-	-	$V_{REF} - 0.1$
$V_{OH}$	$V_{CCO} - 0.4$	-	-
$V_{OL}$	-	-	0.4
$I_{OH}$ at $V_{OH}$ (mA)	-8	-	-
$I_{OL}$ at $V_{OL}$ (mA)	24	-	-

**Notes:**

- Per EIA/JESD8-6, "The value of  $V_{REF}$  is to be selected by the user to provide optimum noise margin in the use conditions specified by the user."

### HSTL Class IV

A sample circuit illustrating a valid termination technique for HSTL\_IV appears in Figure 46. DC voltage specifications appear in Table 24 for the HSTL\_IV standard. See "DC Specifications" in Module 3 for the actual FPGA characteristics.

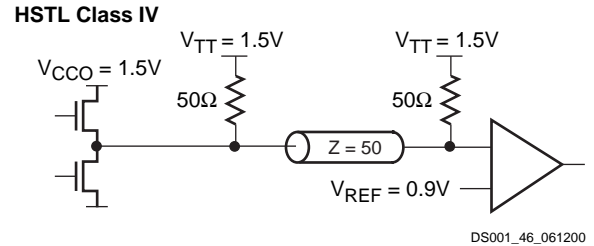


Figure 46: Terminated HSTL Class IV

Table 24: HSTL Class IV Voltage Specification

Parameter	Min	Typ	Max
$V_{CCO}$	1.40	1.50	1.60
$V_{REF}$	-	0.90	-
$V_{TT}$	-	$V_{CCO}$	-
$V_{IH}$	$V_{REF} + 0.1$	-	-
$V_{IL}$	-	-	$V_{REF} - 0.1$
$V_{OH}$	$V_{CCO} - 0.4$	-	-
$V_{OL}$	-	-	0.4
$I_{OH}$ at $V_{OH}$ (mA)	-8	-	-
$I_{OL}$ at $V_{OL}$ (mA)	48	-	-

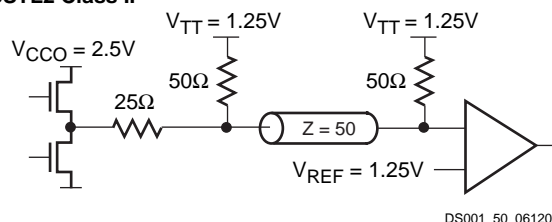
**Notes:**

- Per EIA/JESD8-6, "The value of  $V_{REF}$  is to be selected by the user to provide optimum noise margin in the use conditions specified by the user."

## SSTL2 Class II

A sample circuit illustrating a valid termination technique for SSTL2\_II appears in [Figure 50](#). DC voltage specifications appear in [Table 28](#) for the SSTL2\_II standard. See "[DC Specifications](#)" in Module 3 for the actual FPGA characteristics.

## SSTL2 Class II



**Figure 50: Terminated SSTL2 Class II**

**Table 28: SSTL2\_II Voltage Specifications**

Parameter	Min	Typ	Max
$V_{CCO}$	2.3	2.5	2.7
$V_{REF} = 0.5 \times V_{CCO}$	1.15	1.25	1.35
$V_{TT} = V_{REF} + N^{(1)}$	1.11	1.25	1.39
$V_{IH} \geq V_{REF} + 0.18$	1.33	1.43	3.0 <sup>(2)</sup>
$V_{IL} \leq V_{REF} - 0.18$	-0.3 <sup>(3)</sup>	1.07	1.17
$V_{OH} \geq V_{REF} + 0.8$	1.95	-	-
$V_{OL} \leq V_{REF} - 0.8$	-	-	0.55
$I_{OH}$ at $V_{OH}$ (mA)	-15.2	-	-
$I_{OL}$ at $V_{OL}$ (mA)	15.2	-	-

**Notes:**

1. N must be greater than or equal to  $-0.04$  and less than or equal to  $0.04$ .
2.  $V_{IH}$  maximum is  $V_{CCO} + 0.3$ .
3.  $V_{IH}$  minimum does not conform to the formula.

## Recommended Operating Conditions

Symbol	Description		Min	Max	Units
T <sub>J</sub>	Junction temperature <sup>(1)</sup>	Commercial	0	85	°C
		Industrial	−40	100	°C
V <sub>CCINT</sub>	Supply voltage relative to GND <sup>(2,5)</sup>	Commercial	2.5 − 5%	2.5 + 5%	V
		Industrial	2.5 − 5%	2.5 + 5%	V
V <sub>CCO</sub>	Supply voltage relative to GND <sup>(3,5)</sup>	Commercial	1.4	3.6	V
		Industrial	1.4	3.6	V
T <sub>IN</sub>	Input signal transition time <sup>(4)</sup>		-	250	ns

### Notes:

- At junction temperatures above those listed as Operating Conditions, all delay parameters increase by 0.35% per °C.
- Functional operation is guaranteed down to a minimum  $V_{CCINT}$  of 2.25V (Nominal  $V_{CCINT}$  – 10%). For every 50 mV reduction in  $V_{CCINT}$  below 2.375V (nominal  $V_{CCINT}$  – 5%), all delay parameters increase by 3%.
- Minimum and maximum values for  $V_{CCO}$  vary according to the I/O standard selected.
- Input and output measurement threshold is ~50% of  $V_{CCO}$ . See "Delay Measurement Methodology," page 60 for specific levels.
- Supply voltages may be applied in any order desired.

## DC Characteristics Over Operating Conditions

Symbol	Description			Min	Typ	Max	Units
V <sub>DRINT</sub>	Data Retention V <sub>CCINT</sub> voltage (below which configuration data may be lost)			2.0	-	-	V
V <sub>DRIO</sub>	Data Retention V <sub>CCO</sub> voltage (below which configuration data may be lost)			1.2	-	-	V
I <sub>CCINTQ</sub>	Quiescent V <sub>CCINT</sub> supply current <sup>(1)</sup>	XC2S15	Commercial	-	10	30	mA
			Industrial	-	10	60	mA
		XC2S30	Commercial	-	10	30	mA
			Industrial	-	10	60	mA
		XC2S50	Commercial	-	12	50	mA
			Industrial	-	12	100	mA
		XC2S100	Commercial	-	12	50	mA
			Industrial	-	12	100	mA
		XC2S150	Commercial	-	15	50	mA
			Industrial	-	15	100	mA
		XC2S200	Commercial	-	15	75	mA
			Industrial	-	15	150	mA
I <sub>CCOQ</sub>	Quiescent V <sub>CCO</sub> supply current <sup>(1)</sup>			-	-	2	mA
I <sub>REF</sub>	V <sub>REF</sub> current per V <sub>REF</sub> pin			-	-	20	μA
I <sub>L</sub>	Input or output leakage current <sup>(2)</sup>			-10	-	+10	μA
C <sub>IN</sub>	Input capacitance (sample tested)	VQ, CS, TQ, PQ, FG packages		-	-	8	pF
I <sub>RPU</sub>	Pad pull-up (when selected) @ V <sub>IN</sub> = 0V, V <sub>CCO</sub> = 3.3V (sample tested) <sup>(3)</sup>			-	-	0.25	mA
I <sub>RPD</sub>	Pad pull-down (when selected) @ V <sub>IN</sub> = 3.6V (sample tested) <sup>(3)</sup>			-	-	0.15	mA

### Notes:

- With no output current loads, no active input pull-up resistors, all I/O pins 3-stated and floating.
- The I/O leakage current specification applies only when the  $V_{CCINT}$  and  $V_{CCO}$  supply voltages have reached their respective minimum Recommended Operating Conditions.
- Internal pull-up and pull-down resistors guarantee valid logic levels at unconnected input pins. These pull-up and pull-down resistors do not provide valid logic levels when input pins are connected to other circuits.

## IOB Input Switching Characteristics<sup>(1)</sup>

Input delays associated with the pad are specified for LVTTTL levels. For other standards, adjust the delays with the values shown in "IOB Input Delay Adjustments for Different Standards," page 57.

Symbol	Description	Device	Speed Grade				Units
			-6		-5		
			Min	Max	Min	Max	
Propagation Delays							
T <sub>IOPI</sub>	Pad to I output, no delay	All	-	0.8	-	1.0	ns
T <sub>IOPID</sub>	Pad to I output, with delay	All	-	1.5	-	1.8	ns
T <sub>IOPLI</sub>	Pad to output IQ via transparent latch, no delay	All	-	1.7	-	2.0	ns
T <sub>IOPLID</sub>	Pad to output IQ via transparent latch, with delay	XC2S15	-	3.8	-	4.5	ns
		XC2S30	-	3.8	-	4.5	ns
		XC2S50	-	3.8	-	4.5	ns
		XC2S100	-	3.8	-	4.5	ns
		XC2S150	-	4.0	-	4.7	ns
		XC2S200	-	4.0	-	4.7	ns
Sequential Delays							
T <sub>IOCKIQ</sub>	Clock CLK to output IQ	All	-	0.7	-	0.8	ns
Setup/Hold Times with Respect to Clock CLK <sup>(2)</sup>							
T <sub>IOPICK</sub> / T <sub>IOICKP</sub>	Pad, no delay	All	1.7 / 0	-	1.9 / 0	-	ns
T <sub>IOPICKD</sub> / T <sub>IOICKPD</sub>	Pad, with delay <sup>(1)</sup>	XC2S15	3.8 / 0	-	4.4 / 0	-	ns
		XC2S30	3.8 / 0	-	4.4 / 0	-	ns
		XC2S50	3.8 / 0	-	4.4 / 0	-	ns
		XC2S100	3.8 / 0	-	4.4 / 0	-	ns
		XC2S150	3.9 / 0	-	4.6 / 0	-	ns
		XC2S200	3.9 / 0	-	4.6 / 0	-	ns
T <sub>IOICECK</sub> / T <sub>IOICKICE</sub>	ICE input	All	0.9 / 0.01	-	0.9 / 0.01	-	ns
Set/Reset Delays							
T <sub>IOSRCKI</sub>	SR input (IFF, synchronous)	All	-	1.1	-	1.2	ns
T <sub>IOSRIQ</sub>	SR input to IQ (asynchronous)	All	-	1.5	-	1.7	ns
T <sub>GSRQ</sub>	GSR to output IQ	All	-	9.9	-	11.7	ns

### Notes:

- Input timing for LVTTTL is measured at 1.4V. For other I/O standards, see the table "Delay Measurement Methodology," page 60.
- A zero hold time listing indicates no hold time or a negative hold time.



## CLB Switching Characteristics

Delays originating at F/G inputs vary slightly according to the input used. The values listed below are worst-case. Precise values are provided by the timing analyzer.

Symbol	Description	Speed Grade				Units
		-6		-5		
		Min	Max	Min	Max	
Combinatorial Delays						
T <sub>ILO</sub>	4-input function: F/G inputs to X/Y outputs	-	0.6	-	0.7	ns
T <sub>IF5</sub>	5-input function: F/G inputs to F5 output	-	0.7	-	0.9	ns
T <sub>IF5X</sub>	5-input function: F/G inputs to X output	-	0.9	-	1.1	ns
T <sub>IF6Y</sub>	6-input function: F/G inputs to Y output via F6 MUX	-	1.0	-	1.1	ns
T <sub>F5INY</sub>	6-input function: F5IN input to Y output	-	0.4	-	0.4	ns
T <sub>IFNCTL</sub>	Incremental delay routing through transparent latch to XQ/YQ outputs	-	0.7	-	0.9	ns
T <sub>BYYB</sub>	BY input to YB output	-	0.6	-	0.7	ns
Sequential Delays						
T <sub>CKO</sub>	FF clock CLK to XQ/YQ outputs	-	1.1	-	1.3	ns
T <sub>CKLO</sub>	Latch clock CLK to XQ/YQ outputs	-	1.2	-	1.5	ns
Setup/Hold Times with Respect to Clock CLK <sup>(1)</sup>						
T <sub>ICK</sub> / T <sub>CKI</sub>	4-input function: F/G inputs	1.3 / 0	-	1.4 / 0	-	ns
T <sub>IF5CK</sub> / T <sub>CKIF5</sub>	5-input function: F/G inputs	1.6 / 0	-	1.8 / 0	-	ns
T <sub>F5INCK</sub> / T <sub>CKF5IN</sub>	6-input function: F5IN input	1.0 / 0	-	1.1 / 0	-	ns
T <sub>IF6CK</sub> / T <sub>CKIF6</sub>	6-input function: F/G inputs via F6 MUX	1.6 / 0	-	1.8 / 0	-	ns
T <sub>DICK</sub> / T <sub>CKDI</sub>	BX/BY inputs	0.8 / 0	-	0.8 / 0	-	ns
T <sub>CECK</sub> / T <sub>CKCE</sub>	CE input	0.9 / 0	-	0.9 / 0	-	ns
T <sub>RCK</sub> / T <sub>CKR</sub>	SR/BY inputs (synchronous)	0.8 / 0	-	0.8 / 0	-	ns
Clock CLK						
T <sub>CH</sub>	Minimum pulse width, High	-	1.9	-	1.9	ns
T <sub>CL</sub>	Minimum pulse width, Low	-	1.9	-	1.9	ns
Set/Reset						
T <sub>RPW</sub>	Minimum pulse width, SR/BY inputs	3.1	-	3.1	-	ns
T <sub>RQ</sub>	Delay from SR/BY inputs to XQ/YQ outputs (asynchronous)	-	1.1	-	1.3	ns
T <sub>IOGSRQ</sub>	Delay from GSR to XQ/YQ outputs	-	9.9	-	11.7	ns
F <sub>TOG</sub>	Toggle frequency (for export control)	-	263	-	263	MHz

### Notes:

1. A zero hold time listing indicates no hold time or a negative hold time.

## XC2S15 Device Pinouts (Continued)

XC2S15 Pad Name		VQ100	TQ144	CS144	Bndry Scan
Function	Bank				
GND	-	-	P61	J12	-
I/O (D5)	3	P57	P60	J13	245
I/O	3	P58	P59	H10	248
I/O, V <sub>REF</sub>	3	P59	P58	H11	251
I/O (D4)	3	P60	P57	H12	254
I/O	3	-	P56	H13	257
V <sub>CCINT</sub>	-	P61	P55	G12	-
I/O, TRDY <sup>(1)</sup>	3	P62	P54	G13	260
V <sub>CCO</sub>	3	P63	P53	G11	-
V <sub>CCO</sub>	2	P63	P53	G11	-
GND	-	P64	P52	G10	-
I/O, IRDY <sup>(1)</sup>	2	P65	P51	F13	263
I/O	2	-	P50	F12	266
I/O (D3)	2	P66	P49	F11	269
I/O, V <sub>REF</sub>	2	P67	P48	F10	272
I/O	2	P68	P47	E13	275
I/O (D2)	2	P69	P46	E12	278
GND	-	-	P45	E11	-
I/O (D1)	2	P70	P44	E10	281
I/O	2	P71	P43	D13	284
I/O, V <sub>REF</sub>	2	P72	P41	D11	287
I/O	2	-	P40	C13	290
I/O (DIN, D0)	2	P73	P39	C12	293
I/O (DOUT, BUSY)	2	P74	P38	C11	296
CCLK	2	P75	P37	B13	299
V <sub>CCO</sub>	2	P76	P36	B12	-
V <sub>CCO</sub>	1	P76	P35	A13	-
TDO	2	P77	P34	A12	-
GND	-	P78	P33	B11	-
TDI	-	P79	P32	A11	-
I/O ( $\overline{\text{CS}}$ )	1	P80	P31	D10	0
I/O ( $\overline{\text{WRITE}}$ )	1	P81	P30	C10	3
I/O	1	-	P29	B10	6
I/O, V <sub>REF</sub>	1	P82	P28	A10	9
I/O	1	P83	P27	D9	12
I/O	1	P84	P26	C9	15
GND	-	-	P25	B9	-
V <sub>CCINT</sub>	-	P85	P24	A9	-
I/O	1	-	P23	D8	18
I/O	1	-	P22	C8	21

## XC2S15 Device Pinouts (Continued)

XC2S15 Pad Name		VQ100	TQ144	CS144	Bndry Scan
Function	Bank				
I/O, V <sub>REF</sub>	1	P86	P21	B8	24
I/O	1	-	P20	A8	27
I/O	1	P87	P19	B7	30
I, GCK2	1	P88	P18	A7	36
GND	-	P89	P17	C7	-
V <sub>CCO</sub>	1	P90	P16	D7	-
V <sub>CCO</sub>	0	P90	P16	D7	-
I, GCK3	0	P91	P15	A6	37
V <sub>CCINT</sub>	-	P92	P14	B6	-
I/O	0	-	P13	C6	44
I/O, V <sub>REF</sub>	0	P93	P12	D6	47
I/O	0	-	P11	A5	50
I/O	0	-	P10	B5	53
V <sub>CCINT</sub>	-	P94	P9	C5	-
GND	-	-	P8	D5	-
I/O	0	P95	P7	A4	56
I/O	0	P96	P6	B4	59
I/O, V <sub>REF</sub>	0	P97	P5	C4	62
I/O	0	-	P4	A3	65
I/O	0	P98	P3	B3	68
TCK	-	P99	P2	C3	-
V <sub>CCO</sub>	0	P100	P1	A2	-
V <sub>CCO</sub>	7	P100	P144	B2	-

04/18/01

### Notes:

1. IRDY and TRDY can only be accessed when using Xilinx PCI cores.
2. See "VCCO Banks" for details on V<sub>CCO</sub> banking.

## Additional XC2S15 Package Pins

### VQ100

Not Connected Pins					
P28	P29	-	-	-	-

11/02/00

### TQ144

Not Connected Pins					
P42	P64	P78	P101	P104	P105
P116	P138	-	-	-	-

11/02/00

### CS144

Not Connected Pins					
D3	D12	J4	K13	M3	M4
M10	N3	-	-	-	-

11/02/00

## XC2S30 Device Pinouts

XC2S30 Pad Name		VQ100	TQ144	CS144	PQ208	Bndry Scan
Function	Bank					
GND	-	P1	P143	A1	P1	-
TMS	-	P2	P142	B1	P2	-
I/O	7	P3	P141	C2	P3	113
I/O	7	-	P140	C1	P4	116
I/O	7	-	-	-	P5	119
I/O, V <sub>REF</sub>	7	P4	P139	D4	P6	122
I/O	7	-	P138	D3	P8	125
I/O	7	P5	P137	D2	P9	128
I/O	7	P6	P136	D1	P10	131
GND	-	-	P135	E4	P11	-
V <sub>CCO</sub>	7	-	-	-	P12	-
I/O	7	P7	P134	E3	P14	134
I/O	7	-	P133	E2	P15	137
I/O	7	-	-	-	P16	140
I/O	7	-	-	-	P17	143
I/O	7	-	-	-	P18	146
GND	-	-	-	-	P19	-
I/O, V <sub>REF</sub>	7	P8	P132	E1	P20	149
I/O	7	P9	P131	F4	P21	152
I/O	7	-	P130	F3	P22	155
I/O	7	-	-	-	P23	158
I/O, IRDY <sup>(1)</sup>	7	P10	P129	F2	P24	161
GND	-	P11	P128	F1	P25	-
V <sub>CCO</sub>	7	P12	P127	G2	P26	-
V <sub>CCO</sub>	6	P12	P127	G2	P26	-
I/O, TRDY <sup>(1)</sup>	6	P13	P126	G1	P27	164
V <sub>CCINT</sub>	-	P14	P125	G3	P28	-
I/O	6	-	P124	G4	P29	170
I/O	6	P15	P123	H1	P30	173
I/O, V <sub>REF</sub>	6	P16	P122	H2	P31	176
GND	-	-	-	-	P32	-
I/O	6	-	-	-	P33	179
I/O	6	-	-	-	P34	182
I/O	6	-	-	-	P35	185
I/O	6	-	P121	H3	P36	188
I/O	6	P17	P120	H4	P37	191
V <sub>CCO</sub>	6	-	-	-	P39	-
GND	-	-	P119	J1	P40	-
I/O	6	P18	P118	J2	P41	194
I/O	6	P19	P117	J3	P42	197
I/O	6	-	P116	J4	P43	200

## XC2S30 Device Pinouts (Continued)

XC2S30 Pad Name		VQ100	TQ144	CS144	PQ208	Bndry Scan
Function	Bank					
I/O, V <sub>REF</sub>	6	P20	P115	K1	P45	203
I/O	6	-	-	-	P46	206
I/O	6	-	P114	K2	P47	209
I/O	6	P21	P113	K3	P48	212
I/O	6	P22	P112	L1	P49	215
M1	-	P23	P111	L2	P50	218
GND	-	P24	P110	L3	P51	-
M0	-	P25	P109	M1	P52	219
V <sub>CCO</sub>	6	P26	P108	M2	P53	-
V <sub>CCO</sub>	5	P26	P107	N1	P53	-
M2	-	P27	P106	N2	P54	220
I/O	5	-	P103	K4	P57	227
I/O	5	-	-	-	P58	230
I/O, V <sub>REF</sub>	5	P30	P102	L4	P59	233
I/O	5	-	P101	M4	P61	236
I/O	5	P31	P100	N4	P62	239
I/O	5	P32	P99	K5	P63	242
GND	-	-	P98	L5	P64	-
V <sub>CCO</sub>	5	-	-	-	P65	-
V <sub>CCINT</sub>	-	P33	P97	M5	P66	-
I/O	5	-	P96	N5	P67	245
I/O	5	-	P95	K6	P68	248
I/O	5	-	-	-	P69	251
I/O	5	-	-	-	P70	254
I/O	5	-	-	-	P71	257
GND	-	-	-	-	P72	-
I/O, V <sub>REF</sub>	5	P34	P94	L6	P73	260
I/O	5	-	-	-	P74	263
I/O	5	-	P93	M6	P75	266
V <sub>CCINT</sub>	-	P35	P92	N6	P76	-
I, GCK1	5	P36	P91	M7	P77	275
V <sub>CCO</sub>	5	P37	P90	N7	P78	-
V <sub>CCO</sub>	4	P37	P90	N7	P78	-
GND	-	P38	P89	L7	P79	-
I, GCK0	4	P39	P88	K7	P80	276
I/O	4	P40	P87	N8	P81	280
I/O	4	-	P86	M8	P82	283
I/O	4	-	-	-	P83	286
I/O, V <sub>REF</sub>	4	P41	P85	L8	P84	289
GND	-	-	-	-	P85	-
I/O	4	-	-	-	P86	292

## XC2S50 Device Pinouts (Continued)

XC2S50 Pad Name		TQ144	PQ208	FG256	Bndry Scan
Function	Bank				
I/O	3	-	-	J14	503
I/O	3	P56	P127	K15	506
V <sub>CCINT</sub>	-	P55	P128	V <sub>CCINT</sub> *	-
I/O, TRDY <sup>(1)</sup>	3	P54	P129	J15	512
V <sub>CCO</sub>	3	P53	P130	V <sub>CCO</sub> Bank 3*	-
V <sub>CCO</sub>	2	P53	P130	V <sub>CCO</sub> Bank 2*	-
GND	-	P52	P131	GND*	-
I/O, IRDY <sup>(1)</sup>	2	P51	P132	H16	515
I/O	2	-	P133	H14	518
I/O	2	P50	P134	H15	521
I/O	2	-	-	J13	524
I/O (D3)	2	P49	P135	G16	527
I/O, V <sub>REF</sub>	2	P48	P136	H13	530
GND	-	-	P137	GND*	-
I/O	2	-	P138	G14	533
I/O	2	-	P139	G15	536
I/O	2	-	P140	G12	539
I/O	2	-	-	F16	542
I/O	2	P47	P141	G13	545
I/O (D2)	2	P46	P142	F15	548
V <sub>CCINT</sub>	-	-	P143	V <sub>CCINT</sub> *	-
V <sub>CCO</sub>	2	-	P144	V <sub>CCO</sub> Bank 2*	-
GND	-	P45	P145	GND*	-
I/O (D1)	2	P44	P146	E16	551
I/O	2	P43	P147	F14	554
I/O	2	P42	P148	D16	557
I/O	2	-	-	F12	560
I/O	2	-	P149	E15	563
I/O, V <sub>REF</sub>	2	P41	P150	F13	566
GND	-	-	-	GND*	-
I/O	2	-	P151	E14	569
I/O	2	-	-	C16	572
I/O	2	P40	P152	E13	575
I/O	2	-	-	B16	578
I/O (DIN, D0)	2	P39	P153	D14	581
I/O (DOUT, BUSY)	2	P38	P154	C15	584
CCLK	2	P37	P155	D15	587
V <sub>CCO</sub>	2	P36	P156	V <sub>CCO</sub> Bank 2*	-

## XC2S50 Device Pinouts (Continued)

XC2S50 Pad Name		TQ144	PQ208	FG256	Bndry Scan
Function	Bank				
V <sub>CCO</sub>	1	P35	P156	V <sub>CCO</sub> Bank 1*	-
TDO	2	P34	P157	B14	-
GND	-	P33	P158	GND*	-
TDI	-	P32	P159	A15	-
I/O ( $\overline{CS}$ )	1	P31	P160	B13	0
I/O ( $\overline{WRITE}$ )	1	P30	P161	C13	3
I/O	1	-	-	C12	6
I/O	1	P29	P162	A14	9
I/O	1	-	-	D12	12
I/O	1	-	P163	B12	15
GND	-	-	-	GND*	-
I/O, V <sub>REF</sub>	1	P28	P164	C11	18
I/O	1	-	P165	A13	21
I/O	1	-	-	D11	24
I/O	1	-	P166	A12	27
I/O	1	P27	P167	E11	30
I/O	1	P26	P168	B11	33
GND	-	P25	P169	GND*	-
V <sub>CCO</sub>	1	-	P170	V <sub>CCO</sub> Bank 1*	-
V <sub>CCINT</sub>	-	P24	P171	V <sub>CCINT</sub> *	-
I/O	1	P23	P172	A11	36
I/O	1	P22	P173	C10	39
I/O	1	-	P174	B10	45
I/O	1	-	P175	D10	48
I/O	1	-	P176	A10	51
GND	-	-	P177	GND*	-
I/O, V <sub>REF</sub>	1	P21	P178	B9	54
I/O	1	-	P179	E10	57
I/O	1	-	-	A9	60
I/O	1	P20	P180	D9	63
I/O	1	P19	P181	A8	66
I, GCK2	1	P18	P182	C9	72
GND	-	P17	P183	GND*	-
V <sub>CCO</sub>	1	P16	P184	V <sub>CCO</sub> Bank 1*	-
V <sub>CCO</sub>	0	P16	P184	V <sub>CCO</sub> Bank 0*	-
I, GCK3	0	P15	P185	B8	73
V <sub>CCINT</sub>	-	P14	P186	V <sub>CCINT</sub> *	-
I/O	0	P13	P187	A7	80

## XC2S150 Device Pinouts (Continued)

XC2S150 Pad Name		PQ208	FG256	FG456	Bndry Scan
Function	Bank				
I/O	1	P174	B10	C14	72
I/O	1	-	-	B14	75
I/O	1	P175	D10	D13	81
I/O	1	P176	A10	C13	84
GND	-	P177	GND*	GND*	-
V <sub>CCO</sub>	1	-	V <sub>CCO</sub> Bank 1*	V <sub>CCO</sub> Bank 1*	-
I/O, V <sub>REF</sub>	1	P178	B9	B13	87
I/O	1	P179	E10	E12	90
I/O	1	-	A9	B12	93
I/O	1	P180	D9	D12	96
I/O	1	-	-	C12	99
I/O	1	P181	A8	D11	102
I, GCK2	1	P182	C9	A11	108
GND	-	P183	GND*	GND*	-
V <sub>CCO</sub>	1	P184	V <sub>CCO</sub> Bank 1*	V <sub>CCO</sub> Bank 1*	-
V <sub>CCO</sub>	0	P184	V <sub>CCO</sub> Bank 0*	V <sub>CCO</sub> Bank 0*	-
I, GCK3	0	P185	B8	C11	109
V <sub>CCINT</sub>	-	P186	V <sub>CCINT</sub> *	V <sub>CCINT</sub> *	-
I/O	0	-	-	E11	116
I/O	0	P187	A7	A10	119
I/O	0	-	D8	B10	122
I/O	0	P188	A6	C10	125
I/O, V <sub>REF</sub>	0	P189	B7	A9	128
V <sub>CCO</sub>	0	-	V <sub>CCO</sub> Bank 0*	V <sub>CCO</sub> Bank 0*	-
GND	-	P190	GND*	GND*	-
I/O	0	P191	C8	B9	131
I/O	0	P192	D7	E10	134
I/O	0	-	-	D10	140
I/O	0	P193	E7	A8	143
I/O	0	-	-	D9	146
I/O	0	-	-	B8	149
I/O	0	P194	C7	E9	155
I/O	0	P195	B6	A7	158

## XC2S150 Device Pinouts (Continued)

XC2S150 Pad Name		PQ208	FG256	FG456	Bndry Scan
Function	Bank				
V <sub>CCINT</sub>	-	P196	V <sub>CCINT</sub> *	V <sub>CCINT</sub> *	-
V <sub>CCO</sub>	0	P197	V <sub>CCO</sub> Bank 0*	V <sub>CCO</sub> Bank 0*	-
GND	-	P198	GND*	GND*	-
I/O	0	P199	A5	B7	161
I/O, V <sub>REF</sub>	0	P200	C6	E8	164
I/O	0	-	-	D8	167
I/O	0	P201	B5	C7	170
I/O	0	-	D6	D7	173
I/O	0	-	-	B6	176
I/O	0	-	-	A5	179
I/O	0	P202	A4	D6	182
I/O, V <sub>REF</sub>	0	P203	B4	C6	185
V <sub>CCO</sub>	0	-	V <sub>CCO</sub> Bank 0*	V <sub>CCO</sub> Bank 0*	-
GND	-	-	GND*	GND*	-
I/O	0	P204	E6	B5	188
I/O	0	-	D5	E7	191
I/O	0	-	-	A4	194
I/O	0	-	-	E6	197
I/O	0	P205	A3	B4	200
GND	-	-	GND*	GND*	-
I/O	0	-	C5	A3	203
I/O	0	-	-	B3	206
I/O	0	-	-	D5	209
I/O	0	P206	B3	C5	212
TCK	-	P207	C4	C4	-
V <sub>CCO</sub>	0	P208	V <sub>CCO</sub> Bank 0*	V <sub>CCO</sub> Bank 0*	-
V <sub>CCO</sub>	7	P208	V <sub>CCO</sub> Bank 7*	V <sub>CCO</sub> Bank 7*	-

04/18/01

### Notes:

1. IRDY and TRDY can only be accessed when using Xilinx PCI cores.
2. Pads labelled GND\*, V<sub>CCINT</sub>\*, V<sub>CCO</sub> Bank 0\*, V<sub>CCO</sub> Bank 1\*, V<sub>CCO</sub> Bank 2\*, V<sub>CCO</sub> Bank 3\*, V<sub>CCO</sub> Bank 4\*, V<sub>CCO</sub> Bank 5\*, V<sub>CCO</sub> Bank 6\*, V<sub>CCO</sub> Bank 7\* are internally bonded to independent ground or power planes within the package.
3. See "VCCO Banks" for details on V<sub>CCO</sub> banking.

## Additional XC2S150 Package Pins

### PQ208

Not Connected Pins					
P55	P56	-	-	-	-

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### FG256

V <sub>CCINT</sub> Pins					
C3	C14	D4	D13	E5	E12
M5	M12	N4	N13	P3	P14
V <sub>CCO</sub> Bank 0 Pins					
E8	F8	-	-	-	-
V <sub>CCO</sub> Bank 1 Pins					
E9	F9	-	-	-	-
V <sub>CCO</sub> Bank 2 Pins					
H11	H12	-	-	-	-
V <sub>CCO</sub> Bank 3 Pins					
J11	J12	-	-	-	-
V <sub>CCO</sub> Bank 4 Pins					
L9	M9	-	-	-	-
V <sub>CCO</sub> Bank 5 Pins					
L8	M8	-	-	-	-
V <sub>CCO</sub> Bank 6 Pins					
J5	J6	-	-	-	-
V <sub>CCO</sub> Bank 7 Pins					
H5	H6	-	-	-	-
GND Pins					
A1	A16	B2	B15	F6	F7
F10	F11	G6	G7	G8	G9
G10	G11	H7	H8	H9	H10
J7	J8	J9	J10	K6	K7
K8	K9	K10	K11	L6	L7
L10	L11	R2	R15	T1	T16
Not Connected Pins					
P4	R4	-	-	-	-

11/02/00

## Additional XC2S150 Package Pins (Continued)

### FG456

V <sub>CCINT</sub> Pins					
E5	E18	F6	F17	G7	G8
G9	G14	G15	G16	H7	H16
J7	J16	P7	P16	R7	R16
T7	T8	T9	T14	T15	T16
U6	U17	V5	V18	-	-
V <sub>CCO</sub> Bank 0 Pins					
F7	F8	F9	F10	G10	G11
V <sub>CCO</sub> Bank 1 Pins					
F13	F14	F15	F16	G12	G13
V <sub>CCO</sub> Bank 2 Pins					
G17	H17	J17	K16	K17	L16
V <sub>CCO</sub> Bank 3 Pins					
M16	N16	N17	P17	R17	T17
V <sub>CCO</sub> Bank 4 Pins					
T12	T13	U13	U14	U15	U16
V <sub>CCO</sub> Bank 5 Pins					
T10	T11	U7	U8	U9	U10
V <sub>CCO</sub> Bank 6 Pins					
M7	N6	N7	P6	R6	T6
V <sub>CCO</sub> Bank 7 Pins					
G6	H6	J6	K6	K7	L7
GND Pins					
A1	A22	B2	B21	C3	C20
J9	J10	J11	J12	J13	J14
K9	K10	K11	K12	K13	K14
L9	L10	L11	L12	L13	L14
M9	M10	M11	M12	M13	M14
N9	N10	N11	N12	N13	N14
P9	P10	P11	P12	P13	P14
Y3	Y20	AA2	AA21	AB1	AB22
Not Connected Pins					
A2	A6	A12	A13	A14	B11
B16	C2	C8	C9	D1	D4
D18	D19	E13	E17	E19	F11
G2	G22	H21	J1	J4	K2
K18	K19	L2	L19	M2	M17
M21	N1	P1	P5	P22	R3
R20	R22	U3	U18	V6	W4
W13	W15	W19	Y5	Y22	AA1
AA3	AA9	AA10	AA11	AA16	AB7
AB8	AB12	AB14	AB21	-	-

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## Additional XC2S200 Package Pins (Continued)

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FG456

V <sub>CCINT</sub> Pins					
E5	E18	F6	F17	G7	G8
G9	G14	G15	G16	H7	H16
J7	J16	P7	P16	R7	R16
T7	T8	T9	T14	T15	T16
U6	U17	V5	V18	-	-
V <sub>CCO</sub> Bank 0 Pins					
F7	F8	F9	F10	G10	G11
V <sub>CCO</sub> Bank 1 Pins					
F13	F14	F15	F16	G12	G13
V <sub>CCO</sub> Bank 2 Pins					
G17	H17	J17	K16	K17	L16
V <sub>CCO</sub> Bank 3 Pins					
M16	N16	N17	P17	R17	T17
V <sub>CCO</sub> Bank 4 Pins					
T12	T13	U13	U14	U15	U16
V <sub>CCO</sub> Bank 5 Pins					
T10	T11	U7	U8	U9	U10
V <sub>CCO</sub> Bank 6 Pins					
M7	N6	N7	P6	R6	T6
V <sub>CCO</sub> Bank 7 Pins					

## Additional XC2S200 Package Pins (Continued)

G6	H6	J6	K6	K7	L7
GND Pins					
A1	A22	B2	B21	C3	C20
J9	J10	J11	J12	J13	J14
K9	K10	K11	K12	K13	K14
L9	L10	L11	L12	L13	L14
M9	M10	M11	M12	M13	M14
N9	N10	N11	N12	N13	N14
P9	P10	P11	P12	P13	P14
Y3	Y20	AA2	AA21	AB1	AB22
Not Connected Pins					
A2	A6	A12	B11	B16	C2
D1	D4	D18	D19	E17	E19
G2	G22	L2	L19	M2	M21
R3	R20	U3	U18	V6	W4
W19	Y5	Y22	AA1	AA3	AA11
AA16	AB7	AB12	AB21	-	-

11/02/00

## Revision History

Version No.	Date	Description
2.0	09/18/00	Sectioned the Spartan-II Family data sheet into four modules. Corrected all known errors in the pinout tables.
2.1	10/04/00	Added notes requiring $\overline{\text{PWDN}}$ to be tied to V <sub>CCINT</sub> when unused.
2.2	11/02/00	Removed the Power Down feature.
2.3	03/05/01	Added notes on pinout tables for IRDY and TRDY.
2.4	04/30/01	Reinstated XC2S50 V <sub>CCO</sub> Bank 7, GND, and "not connected" pins missing in version 2.3.
2.5	09/03/03	Added caution about Not Connected Pins to XC2S30 pinout tables on <a href="#">page 76</a> .
2.8	06/13/08	Added " <a href="#">Package Overview</a> " section. Added notes to clarify shared V <sub>CCO</sub> banks. Updated description and links. Updated all modules for continuous page, figure, and table numbering. Synchronized all modules to v2.8.