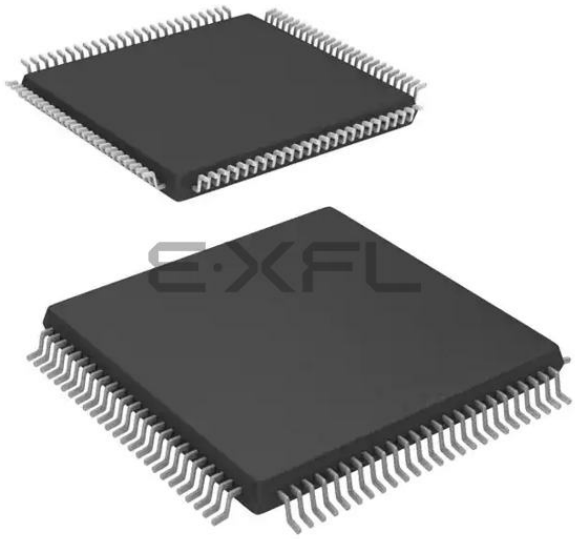

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Understanding Embedded - CPLDs (Complex Programmable Logic Devices)

Embedded - CPLDs, or Complex Programmable Logic Devices, are highly versatile digital logic devices used in electronic systems. These programmable components are designed to perform complex logical operations and can be customized for specific applications. Unlike fixed-function ICs, CPLDs offer the flexibility to reprogram their configuration, making them an ideal choice for various embedded systems. They consist of a set of logic gates and programmable interconnects, allowing designers to implement complex logic circuits without needing custom hardware.

Applications of Embedded - CPLDs

Details	
Product Status	Active
Programmable Type	In System Programmable
Delay Time tpd(1) Max	5.4 ns
Voltage Supply - Internal	1.71V ~ 1.89V
Number of Logic Elements/Blocks	570
Number of Macrocells	440
Number of Gates	-
Number of I/O	76
Operating Temperature	0°C ~ 85°C (TJ)
Mounting Type	Surface Mount
Package / Case	100-TQFP
Supplier Device Package	100-TQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/intel/epm570gt100c5

MAX II devices have an internal linear voltage regulator which supports external supply voltages of 3.3 V or 2.5 V, regulating the supply down to the internal operating voltage of 1.8 V. MAX IIG and MAX IIZ devices only accept 1.8 V as the external supply voltage. MAX IIZ devices are pin-compatible with MAX IIG devices in the 100-pin Micro FineLine BGA and 256-pin Micro FineLine BGA packages. Except for external supply voltage requirements, MAX II and MAX II G devices have identical pin-outs and timing specifications. Table 1–5 shows the external supply voltages supported by the MAX II family.

Table 1–5. MAX II External Supply Voltages

Devices	EPM240 EPM570 EPM1270 EPM2210	EPM240G EPM570G EPM1270G EPM2210G EPM240Z EPM570Z *(1)*
MultiVolt core external supply voltage (V_{CCINT}) *(2)*	3.3 V, 2.5 V	1.8 V
MultiVolt I/O interface voltage levels (V_{CCIO})	1.5 V, 1.8 V, 2.5 V, 3.3 V	1.5 V, 1.8 V, 2.5 V, 3.3 V

Notes to Table 1–5:

(1) MAX IIG and MAX IIZ devices only accept 1.8 V on their VCCINT pins. The 1.8-V V_{CCINT} external supply powers the device core directly.

(2) MAX II devices operate internally at 1.8 V.

Referenced Documents

This chapter references the following documents:

- *DC and Switching Characteristics* chapter in the *MAX II Device Handbook*
- *MAX II Logic Element to Macrocell Conversion Methodology* white paper

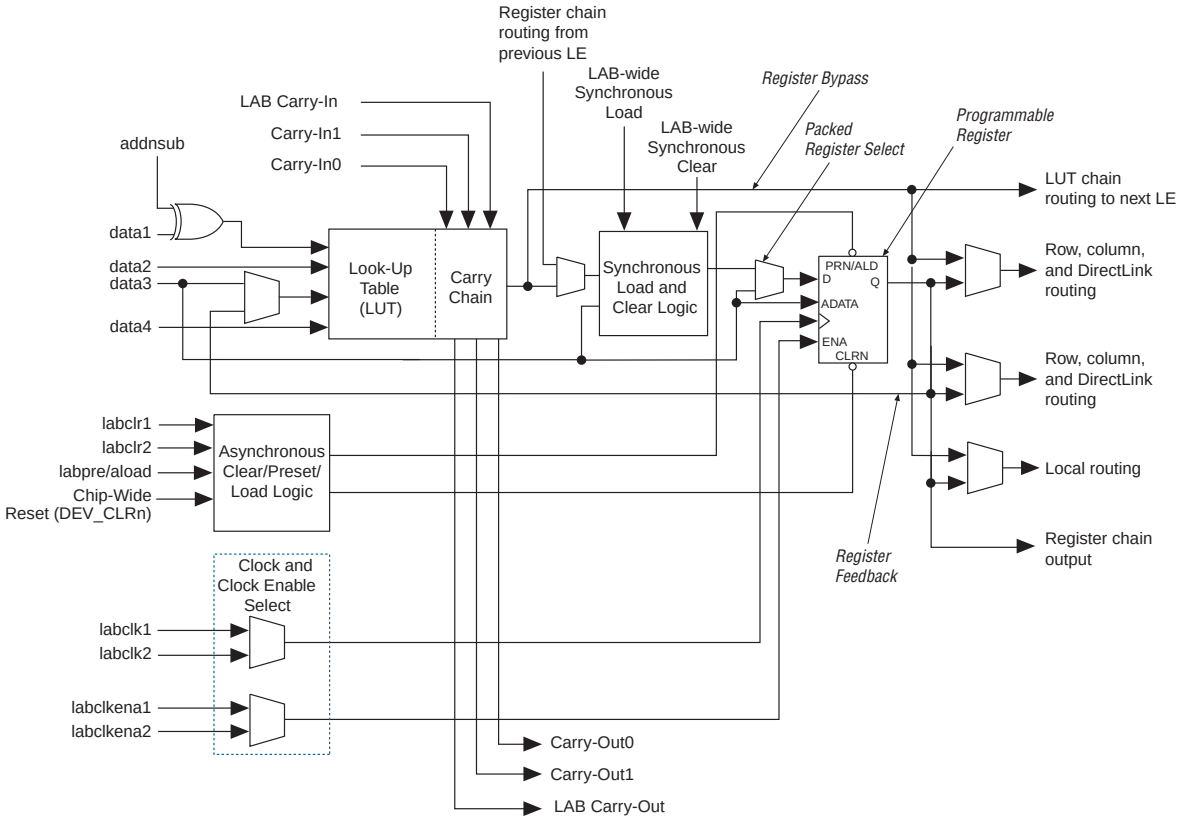
Document Revision History

Table 1–6 shows the revision history for this chapter.

Table 1–6. Document Revision History

Date and Revision	Changes Made	Summary of Changes
August 2009, version 1.9	■ Updated Table 1–2.	Added information for speed grade –8
October 2008, version 1.8	■ Updated "Introduction" section. ■ Updated new Document Format.	—
December 2007, version1.7	■ Updated Table 1–1 through Table 1–5. ■ Added "Referenced Documents" section.	Updated document with MAX IIZ information.
December 2006, version 1.6	■ Added document revision history.	—
August 2006, version 1.5	■ Minor update to features list.	—
July 2006, version 1.4	■ Minor updates to tables.	—

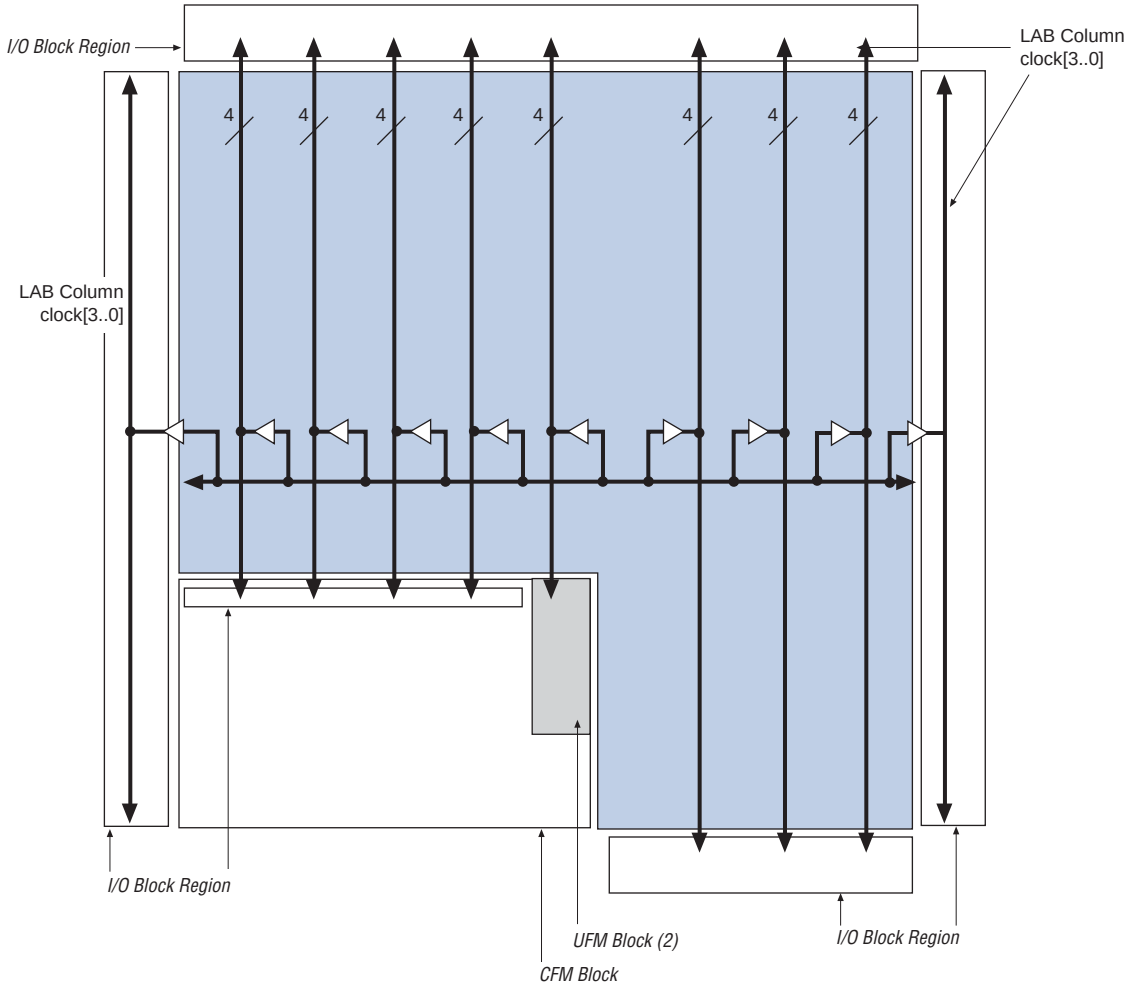
Figure 2–6. MAX II LE



Each LE's programmable register can be configured for D, T, JK, or SR operation. Each register has data, true asynchronous load data, clock, clock enable, clear, and asynchronous load/preset inputs. Global signals, general-purpose I/O pins, or any LE can drive the register's clock and clear control signals. Either general-purpose I/O pins or LEs can drive the clock enable, preset, asynchronous load, and asynchronous data. The asynchronous load data input comes from the data3 input of the LE. For combinational functions, the LUT output bypasses the register and drives directly to the LE outputs.

Each LE has three outputs that drive the local, row, and column routing resources. The LUT or register output can drive these three outputs independently. Two LE outputs drive column or row and DirectLink routing connections and one drives local interconnect resources. This allows the LUT to drive one output while the register drives another output. This register packing feature improves device utilization because the device can use the register and the LUT for unrelated functions. Another special packing mode allows the register output to feed back into the LUT of the same LE so that the register is packed with its own fan-out LUT. This provides another mechanism for improved fitting. The LE can also drive out registered and unregistered versions of the LUT output.

Figure 2–14. Global Clock Network *(Note 1)*



Notes to Figure 2–14:

(1) LAB column clocks in I/O block regions provide high fan-out output enable signals.

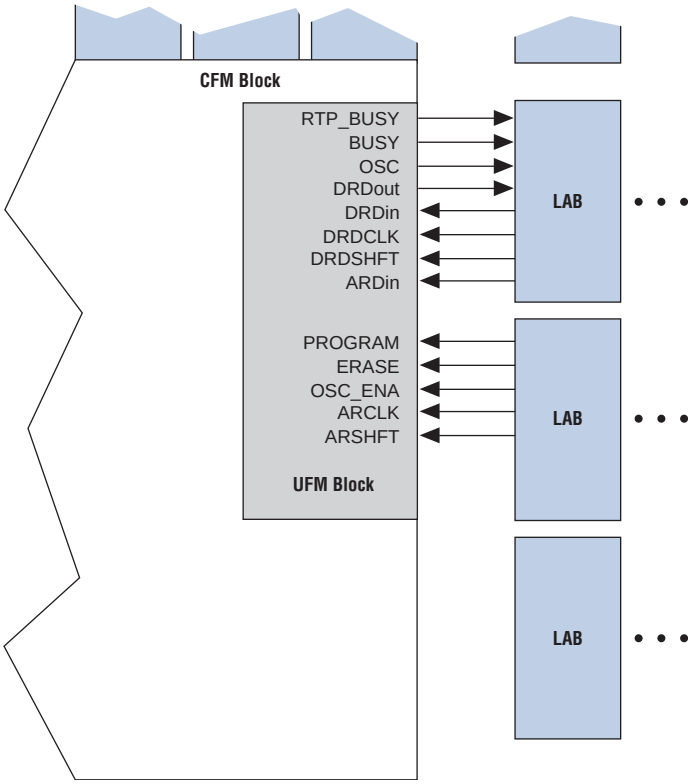
(2) LAB column clocks drive to the UFM block.

User Flash Memory Block

MAX II devices feature a single UFM block, which can be used like a serial EEPROM for storing non-volatile information up to 8,192 bits. The UFM block connects to the logic array through the MultiTrack interconnect, allowing any LE to interface to the UFM block. Figure 2–15 shows the UFM block and interface signals. The logic array is used to create customer interface or protocol logic to interface the UFM block data outside of the device. The UFM block offers the following features:

- Non-volatile storage up to 16-bit wide and 8,192 total bits
- Two sectors for partitioned sector erase
- Built-in internal oscillator that optionally drives logic array
- Program, erase, and busy signals

Figure 2–17. EPM570, EPM1270, and EPM2210 UFM Block LAB Row Interface

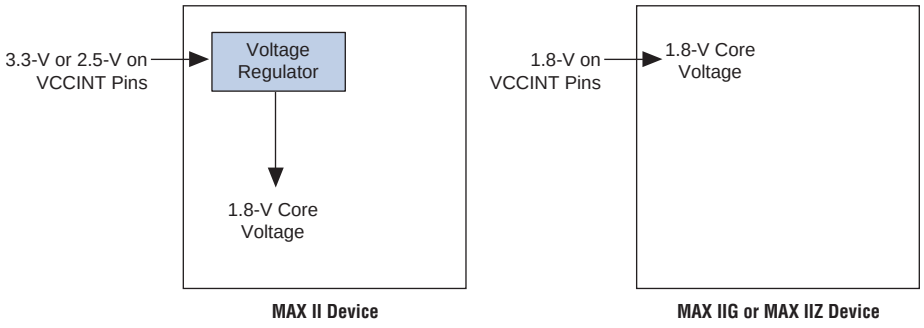


MultiVolt Core

The MAX II architecture supports the MultiVolt core feature, which allows MAX II devices to support multiple V_{CC} levels on the V_{CCINT} supply. An internal linear voltage regulator provides the necessary 1.8-V internal voltage supply to the device. The voltage regulator supports 3.3-V or 2.5-V supplies on its inputs to supply the 1.8-V internal voltage to the device, as shown in Figure 2–18. The voltage regulator is not guaranteed for voltages that are between the maximum recommended 2.5-V operating voltage and the minimum recommended 3.3-V operating voltage.

The MAX IIG and MAX IIZ devices use external 1.8-V supply. The 1.8-V V_{CC} external supply powers the device core directly.

Figure 2–18. MultiVolt Core Feature in MAX II Devices



I/O Structure

IOEs support many features, including:

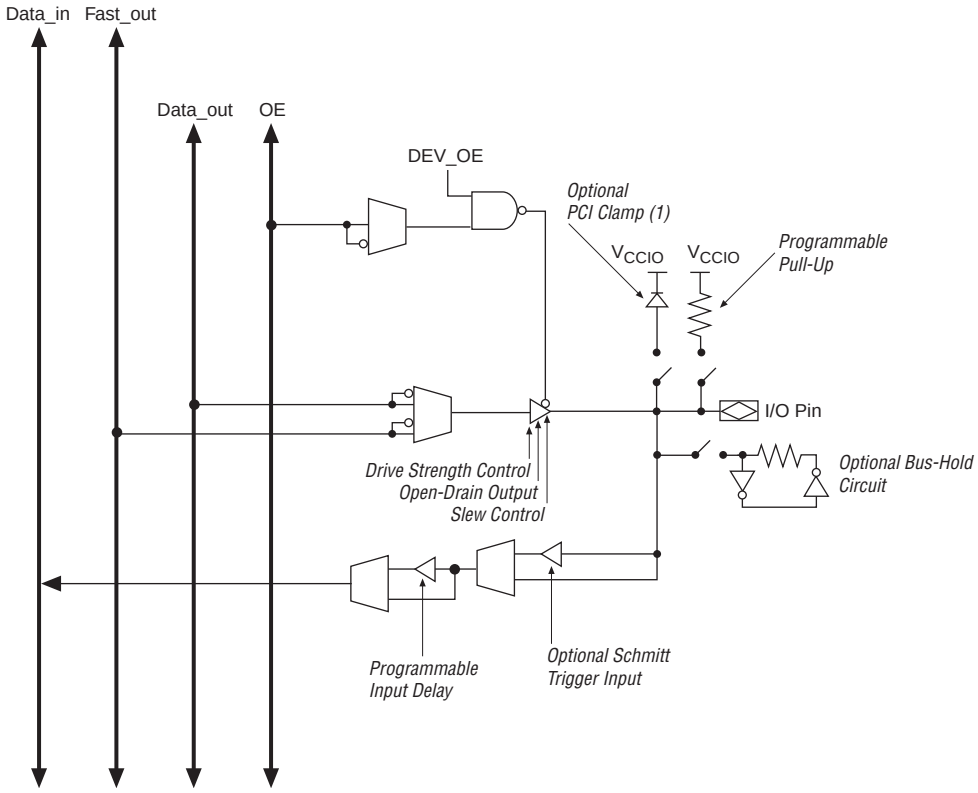
- LVTTL and LVCMOS I/O standards
- 3.3-V, 32-bit, 66-MHz PCI compliance
- Joint Test Action Group (JTAG) boundary-scan test (BST) support
- Programmable drive strength control
- Weak pull-up resistors during power-up and in system programming
- Slew-rate control
- Tri-state buffers with individual output enable control
- Bus-hold circuitry
- Programmable pull-up resistors in user mode
- Unique output enable per pin
- Open-drain outputs
- Schmitt trigger inputs
- Fast I/O connection
- Programmable input delay

MAX II device IOEs contain a bidirectional I/O buffer. Figure 2–19 shows the MAX II IOE structure. Registers from adjacent LABs can drive to or be driven from the IOE's bidirectional I/O buffers. The Quartus II software automatically attempts to place registers in the adjacent LAB with fast I/O connection to achieve the fastest possible clock-to-output and registered output enable timing. For input registers, the Quartus II software automatically routes the register to guarantee zero hold time. You can set timing assignments in the Quartus II software to achieve desired I/O timing.

Fast I/O Connection

A dedicated fast I/O connection from the adjacent LAB to the IOEs within an I/O block provides faster output delays for clock-to-output and t_{PD} propagation delays. This connection exists for data output signals, not output enable signals or input signals. Figure 2–20, Figure 2–21, and Figure 2–22 illustrate the fast I/O connection.

Figure 2–19. MAX II IOE Structure



Note to Figure 2–19:

(1) Available in EPM1270 and EPM2210 devices only.

I/O Blocks

The IOEs are located in I/O blocks around the periphery of the MAX II device. There are up to seven IOEs per row I/O block (5 maximum in the EPM240 device) and up to four IOEs per column I/O block. Each column or row I/O block interfaces with its adjacent LAB and MultiTrack interconnect to distribute signals throughout the device. The row I/O blocks drive row, column, or DirectLink interconnects. The column I/O blocks drive column interconnects.

Connect VCCIO pins to either a 1.5-V, 1.8 V, 2.5-V, or 3.3-V power supply, depending on the output requirements. The output levels are compatible with systems of the same voltage as the power supply (that is, when VCCIO pins are connected to a 1.5-V power supply, the output levels are compatible with 1.5-V systems). When VCCIO pins are connected to a 3.3-V power supply, the output high is 3.3 V and is compatible with 3.3-V or 5.0-V systems. Table 2–7 summarizes MAX II MultiVolt I/O support.

Table 2–7. MAX II MultiVolt I/O Support *(Note 1)*

	Input Signal					Output Signal				
VCCIO (V)	**1.5 V**	**1.8 V**	**2.5 V**	**3.3 V**	**5.0 V**	**1.5 V**	**1.8 V**	**2.5 V**	**3.3 V**	**5.0 V**
1.5	✓	✓	✓	✓	—	✓	—	—	—	—
1.8	✓	✓	✓	✓	—	✓ *(2)*	✓	—	—	—
2.5	—	—	✓	✓	—	✓ *(3)*	✓ *(3)*	✓	—	—
3.3	—	—	✓ *(4)*	✓	✓ *(5)*	✓ *(6)*	✓ *(6)*	✓ *(6)*	✓	✓ *(7)*

Notes to Table 2–7:

(1) To drive inputs higher than V_{CCIO} but less than 4.0 V including the overshoot, disable the I/O clamp diode. However, to drive 5.0-V inputs to the device, enable the I/O clamp diode to prevent V_I from rising above 4.0 V.

(2) When V_{CCIO} = 1.8 V, a MAX II device can drive a 1.5-V device with 1.8-V tolerant inputs.

(3) When V_{CCIO} = 2.5 V, a MAX II device can drive a 1.5-V or 1.8-V device with 2.5-V tolerant inputs.

(4) When V_{CCIO} = 3.3 V and a 2.5-V input signal feeds an input pin, the VCCIO supply current will be slightly larger than expected.

(5) MAX II devices can be 5.0-V tolerant with the use of an external resistor and the internal I/O clamp diode on the EPM1270 and EPM2210 devices.

(6) When V_{CCIO} = 3.3 V, a MAX II device can drive a 1.5-V, 1.8-V, or 2.5-V device with 3.3-V tolerant inputs.

(7) When V_{CCIO} = 3.3 V, a MAX II device can drive a device with 5.0-V TTL inputs but not 5.0-V CMOS inputs. In the case of 5.0-V CMOS, open-drain setting with internal I/O clamp diode (available only on EPM1270 and EPM2210 devices) and external resistor is required.

For information about output pin source and sink current guidelines, refer to the *AN 428: MAX II CPLD Design Guidelines*.

Referenced Documents

This chapter referenced the following documents:

- *AN 428: MAX II CPLD Design Guidelines*
- *DC and Switching Characteristics* chapter in the *MAX II Device Handbook*
- *Hot Socketing and Power-On Reset in MAX II Devices* chapter in the *MAX II Device Handbook*
- *Using User Flash Memory in MAX II Devices* chapter in the *MAX II Device Handbook*

3. JTAG and In-System Programmability

MII51003-1.6

Introduction

This chapter discusses how to use the IEEE Standard 1149.1 Boundary-Scan Test (BST) circuitry in MAX II devices and includes the following sections:

IEEE Std. 1149.1 (JTAG) Boundary-Scan Support

All MAX® II devices provide Joint Test Action Group (JTAG) boundary-scan test (BST) circuitry that complies with the IEEE Std. 1149.1-2001 specification. JTAG boundary-scan testing can only be performed at any time after V_{CCINT} and all V_{CCIO} banks have been fully powered and a t_{CONFIG} amount of time has passed. MAX II devices can also use the JTAG port for in-system programming together with either the Quartus® II software or hardware using Programming Object Files (**.pof**), JamTM Standard Test and Programming Language (STAPL) Files (**.jam**), or Jam Byte-Code Files (**.jbc**).

The JTAG pins support 1.5-V, 1.8-V, 2.5-V, or 3.3-V I/O standards. The supported voltage level and standard are determined by the V_{CCIO} of the bank where it resides. The dedicated JTAG pins reside in Bank 1 of all MAX II devices.

MAX II devices support the JTAG instructions shown in Table 3–1.

Table 3–1. MAX II JTAG Instructions (Part 1 of 2)

JTAG Instruction	Instruction Code	Description
SAMPLE/PRELOAD	00 0000 0101	Allows a snapshot of signals at the device pins to be captured and examined during normal device operation, and permits an initial data pattern to be output at the device pins.
EXTEST *(1)*	00 0000 1111	Allows the external circuitry and board-level interconnects to be tested by forcing a test pattern at the output pins and capturing test results at the input pins.
BYPASS	11 1111 1111	Places the 1-bit bypass register between the TDI and TDO pins, which allows the BST data to pass synchronously through selected devices to adjacent devices during normal device operation.
USERCODE	00 0000 0111	Selects the 32-bit USERCODE register and places it between the TDI and TDO pins, allowing the USERCODE to be serially shifted out of TDO. This register defaults to all 1's if not specified in the Quartus II software.
IDCODE	00 0000 0110	Selects the IDCODE register and places it between TDI and TDO, allowing the IDCODE to be serially shifted out of TDO.
HIGHZ *(1)*	00 0000 1011	Places the 1-bit bypass register between the TDI and TDO pins, which allows the boundary scan test data to pass synchronously through selected devices to adjacent devices during normal device operation, while tri-stating all of the I/O pins.

Table 3–1. MAX II JTAG Instructions (Part 2 of 2)

JTAG Instruction	Instruction Code	Description
CLAMP *(1)*	00 0000 1010	Places the 1-bit bypass register between the TDI and TDO pins, which allows the boundary scan test data to pass synchronously through selected devices to adjacent devices during normal device operation, while holding I/O pins to a state defined by the data in the boundary-scan register.
USER0	00 0000 1100	This instruction allows you to define the scan chain between TDI and TDO in the MAX II logic array. This instruction is also used for custom logic and JTAG interfaces.
USER1	00 0000 1110	This instruction allows you to define the scan chain between TDI and TDO in the MAX II logic array. This instruction is also used for custom logic and JTAG interfaces.
IEEE 1532 instructions	*(2)*	IEEE 1532 ISC instructions used when programming a MAX II device via the JTAG port.

Notes to Table 3–1:

(1) HIGHZ, CLAMP, and EXTEST instructions do not disable weak pull-up resistors or bus hold features.

(2) These instructions are shown in the 1532 BSDL files, which will be posted on the Altera® website at www.altera.com when they are available.

WARNING

Unsupported JTAG instructions should not be issued to the MAX II device as this may put the device into an unknown state, requiring a power cycle to recover device operation.

The MAX II device instruction register length is 10 bits and the USERCODE register length is 32 bits. Table 3–2 and Table 3–3 show the boundary-scan register length and device IDCODE information for MAX II devices.

Table 3–2. MAX II Boundary-Scan Register Length

Device	Boundary-Scan Register Length
EPM240	240
EPM570	480
EPM1270	636
EPM2210	816

Table 3–3. 32-Bit MAX II Device IDCODE (Part 1 of 2)

Device	Binary IDCODE (32 Bits) *(1)*				HEX IDCODE
	Version (4 Bits)	Part Number	Manufacturer Identity (11 Bits)	LSB (1 Bit) *(2)*	
EPM240 EPM240G	0000	0010 0000 1010 0001	000 0110 1110	1	0x020A10DD
EPM570 EPM570G	0000	0010 0000 1010 0010	000 0110 1110	1	0x020A20DD
EPM1270 EPM1270G	0000	0010 0000 1010 0011	000 0110 1110	1	0x020A30DD
EPM2210 EPM2210G	0000	0010 0000 1010 0100	000 0110 1110	1	0x020A40DD

IEEE 1532 Support

The JTAG circuitry and ISP instruction set in MAX II devices is compliant to the IEEE 1532-2002 programming specification. This provides industry-standard hardware and software for in-system programming among multiple vendor programmable logic devices (PLDs) in a JTAG chain.

The MAX II 1532 BSDL files will be released on the Altera website when available.

Jam Standard Test and Programming Language (STAPL)

The Jam STAPL JEDEC standard, JESD71, can be used to program MAX II devices with in-circuit testers, PCs, or embedded processors. The Jam byte code is also supported for MAX II devices. These software programming protocols provide a compact embedded solution for programming MAX II devices.

For more information, refer to the *Using Jam STAPL for ISP via an Embedded Processor* chapter in the *MAX II Device Handbook*.

Programming Sequence

During in-system programming, 1532 instructions, addresses, and data are shifted into the MAX II device through the `TDI` input pin. Data is shifted out through the `TDO` output pin and compared against the expected data. Programming a pattern into the device requires the following six ISP steps. A stand-alone verification of a programmed pattern involves only stages 1, 2, 5, and 6. These steps are automatically executed by third-party programmers, the Quartus II software, or the Jam STAPL and Jam Byte-Code Players.

1. *Enter ISP*—The enter ISP stage ensures that the I/O pins transition smoothly from user mode to ISP mode.
2. *Check ID*—Before any program or verify process, the silicon ID is checked. The time required to read this silicon ID is relatively small compared to the overall programming time.
3. *Sector Erase*—Erasing the device in-system involves shifting in the instruction to erase the device and applying an erase pulse(s). The erase pulse is automatically generated internally by waiting in the run/test/idle state for the specified erase pulse time of 500 ms for the CFM block and 500 ms for each sector of the UFM block.
4. *Program*—Programming the device in-system involves shifting in the address, data, and program instruction and generating the program pulse to program the flash cells. The program pulse is automatically generated internally by waiting in the run/test/idle state for the specified program pulse time of 75 µs. This process is repeated for each address in the CFM and UFM blocks.
5. *Verify*—Verifying a MAX II device in-system involves shifting in addresses, applying the verify instruction to generate the read pulse, and shifting out the data for comparison. This process is repeated for each CFM and UFM address.
6. *Exit ISP*—An exit ISP stage ensures that the I/O pins transition smoothly from ISP mode to user mode.

I/O Pins Remain Tri-Stated during Power-Up

A device that does not support hot-socketing may interrupt system operation or cause contention by driving out before or during power-up. In a hot socketing situation, the MAX II device's output buffers are turned off during system power-up. MAX II devices do not drive out until the device attains proper operating conditions and is fully configured. Refer to "Power-On Reset Circuitry" on page 4–5 for information about turn-on voltages.

Signal Pins Do Not Drive the V_{CCIO} or V_{CCINT} Power Supplies

MAX II devices do not have a current path from I/O pins or GCLK[3..0] pins to the V_{CCIO} or V_{CCINT} pins before or during power-up. A MAX II device may be inserted into (or removed from) a system board that was powered up without damaging or interfering with system-board operation. When hot socketing, MAX II devices may have a minimal effect on the signal integrity of the backplane.

AC and DC Specifications

You can power up or power down the V_{CCIO} and V_{CCINT} pins in any sequence. During hot socketing, the I/O pin capacitance is less than 8 pF. MAX II devices meet the following hot socketing specifications:

- The hot socketing DC specification is: $| I_{IOPIN} | < 300$ µA.
- The hot socketing AC specification is: $| I_{IOPIN} | < 8$ mA for 10 ns or less.

MAX II devices are immune to latch-up when hot socketing. If the TCK JTAG input pin is driven high during hot socketing, the current on that pin might exceed the specifications above.

I_{IOPIN} is the current at any user I/O pin on the device. The AC specification applies when the device is being powered up or powered down. This specification takes into account the pin capacitance but not board trace and external loading capacitance. Additional capacitance for trace, connector, and loading must be taken into consideration separately. The peak current duration due to power-up transients is 10 ns or less.

The DC specification applies when all V_{CC} supplies to the device are stable in the powered-up or powered-down conditions.

Hot Socketing Feature Implementation in MAX II Devices

The hot socketing feature turns off (tri-states) the output buffer during the power-up event (either V_{CCINT} or V_{CCIO} supplies) or power-down event. The hot-socket circuit generates an internal HOTSCKT signal when either V_{CCINT} or V_{CCIO} is below the threshold voltage during power-up or power-down. The HOTSCKT signal cuts off the output buffer to make sure that no DC current (except for weak pull-up leaking) leaks through the pin. When V_{CC} ramps up very slowly during power-up, V_{CC} may still be relatively low even after the power-on reset (POR) signal is released and device configuration is complete.

Power-Up Timing

Table 5–12 shows the power-up timing characteristics for MAX II devices.

Table 5–12. MAX II Power-Up Timing

Symbol	Parameter	Device	Min	Typ	Max	Unit
t_{CONFIG} *(1)*	The amount of time from when minimum V_{CCINT} is reached until the device enters user mode *(2)*	EPM240	—	—	200	µs
		EPM570	—	—	300	µs
		EPM1270	—	—	300	µs
		EPM2210	—	—	450	µs

Notes to Table 5–12:

(1) Table 5–12 values apply to commercial and industrial range devices. For extended temperature range devices, the t_{CONFIG} maximum values are as follows:

Device	Maximum
EPM240	300 µs
EPM570	400 µs
EPM1270	400 µs
EPM2210	500 µs

(2) For more information about POR trigger voltage, refer to the *Hot Socketing and Power-On Reset in MAX II Devices* chapter in the *MAX II Device Handbook*.

Power Consumption

Designers can use the Altera® PowerPlay Early Power Estimator and PowerPlay Power Analyzer to estimate the device power.

For more information about these power analysis tools, refer to the *Understanding and Evaluating Power in MAX II Devices* chapter in the *MAX II Device Handbook* and the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

Timing Model and Specifications

MAX II devices timing can be analyzed with the Altera Quartus® II software, a variety of popular industry-standard EDA simulators and timing analyzers, or with the timing model shown in Figure 5–2.

MAX II devices have predictable internal delays that enable the designer to determine the worst-case timing of any design. The software provides timing simulation, point-to-point delay prediction, and detailed timing analysis for device-wide performance evaluation.

Table 5–13. MAX II Device Timing Model Status (Part 2 of 2)

Device	Preliminary	Final
EPM1270	—	✓
EPM2210	—	✓

Note to Table 5–13:

(1) The MAX IIZ device timing models are only available in the Quartus II software version 8.0 and later.

Performance

Table 5–14 shows the MAX II device performance for some common designs. All performance values were obtained with the Quartus II software compilation of megafunctions. Performance values for –3, –4, and –5 speed grades are based on an EPM1270 device target, while –6, –7, and –8 speed grades are based on an EPM570Z device target.

Table 5–14. MAX II Device Performance

Resource Used	Design Size and Function	Resources Used			Performance						Unit
					MAX II / MAX IIG			MAX IIZ			
		Mode	LEs	UFM Blocks	–3 Speed Grade	–4 Speed Grade	–5 Speed Grade	–6 Speed Grade	–7 Speed Grade	–8 Speed Grade	
LE	16-bit counter *(1)*	—	16	0	304.0	247.5	201.1	184.1	123.5	118.3	MHz
	64-bit counter *(1)*	—	64	0	201.5	154.8	125.8	83.2	83.2	80.5	MHz
	16-to-1 multiplexer	—	11	0	6.0	8.0	9.3	17.4	17.3	20.4	ns
	32-to-1 multiplexer	—	24	0	7.1	9.0	11.4	12.5	22.8	25.3	ns
	16-bit XOR function	—	5	0	5.1	6.6	8.2	9.0	15.0	16.1	ns
	16-bit decoder with single address line	—	5	0	5.2	6.6	8.2	9.2	15.0	16.1	ns
UFM	512 × 16	None	3	1	10.0	10.0	10.0	10.0	10.0	10.0	MHz
	512 × 16	SPI *(2)*	37	1	8.0	8.0	8.0	9.7	9.7	9.7	MHz
	512 × 8	Parallel *(3)*	73	1	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	MHz
	512 × 16	I^2C *(3)*	142	1	100 *(5)*	100 *(5)*	100 *(5)*	100 *(5)*	100 *(5)*	100 *(5)*	kHz

Notes to Table 5–14:

(1) This design is a binary loadable up counter.
(2) This design is configured for read-only operation in Extended mode. Read and write ability increases the number of LEs used.
(3) This design is configured for read-only operation. Read and write ability increases the number of LEs used.
(4) This design is asynchronous.
(5) The I^2C megafunction is verified in hardware up to 100-kHz serial clock line (SCL) rate.

Table 5–21. UFM Block Internal Timing Microparameters (Part 2 of 3)

Symbol	Parameter	MAX II / MAX IIG						MAX IIZ						Unit
		–3 Speed Grade		–4 Speed Grade		–5 Speed Grade		–6 Speed Grade		–7 Speed Grade		–8 Speed Grade		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{DDS}	Data register data in setup to data register clock	20	—	20	—	20	—	20	—	20	—	20	—	ns
t_{DDH}	Data register data in hold from data register clock	20	—	20	—	20	—	20	—	20	—	20	—	ns
t_{DP}	Program signal to data clock hold time	0	—	0	—	0	—	0	—	0	—	0	—	ns
t_{PB}	Maximum delay between program rising edge to UFM busy signal rising edge	—	960	—	960	—	960	—	960	—	960	—	960	ns
t_{BP}	Minimum delay allowed from UFM busy signal going low to program signal going low	20	—	20	—	20	—	20	—	20	—	20	—	ns
t_{PPMX}	Maximum length of busy pulse during a program	—	100	—	100	—	100	—	100	—	100	—	100	µs
t_{AE}	Minimum erase signal to address clock hold time	0	—	0	—	0	—	0	—	0	—	0	—	ns
t_{EB}	Maximum delay between the erase rising edge to the UFM busy signal rising edge	—	960	—	960	—	960	—	960	—	960	—	960	ns
t_{BE}	Minimum delay allowed from the UFM busy signal going low to erase signal going low	20	—	20	—	20	—	20	—	20	—	20	—	ns
t_{EPMX}	Maximum length of busy pulse during an erase	—	500	—	500	—	500	—	500	—	500	—	500	ms
t_{DCO}	Delay from data register clock to data register output	—	5	—	5	—	5	—	5	—	5	—	5	ns

Table 5–21. UFM Block Internal Timing Microparameters (Part 3 of 3)

Symbol	Parameter	MAX II / MAX IIG						MAX IIZ						Unit
		–3 Speed Grade		–4 Speed Grade		–5 Speed Grade		–6 Speed Grade		–7 Speed Grade		–8 Speed Grade		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{OE}	Delay from data register clock to data register output	180	—	180	—	180	—	180	—	180	—	180	—	ns
t_{RA}	Maximum read access time	—	65	—	65	—	65	—	65	—	65	—	65	ns
t_{OSCS}	Maximum delay between the OSC_ENA rising edge to the erase/program signal rising edge	250	—	250	—	250	—	250	—	250	—	250	—	ns
t_{OSCH}	Minimum delay allowed from the erase/program signal going low to OSC_ENA signal going low	250	—	250	—	250	—	250	—	250	—	250	—	ns

Figure 5–3 through Figure 5–5 show the read, program, and erase waveforms for UFM block timing parameters shown in Table 5–21.

Figure 5–3. UFM Read Waveforms

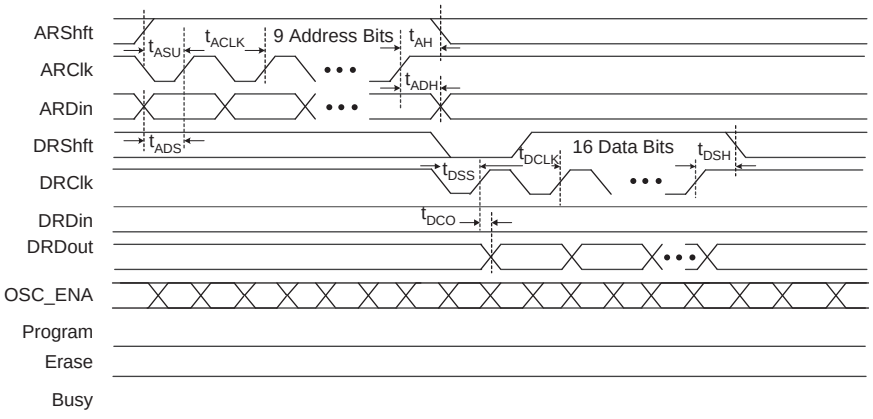


Table 5–26 shows the external I/O timing parameters for EPM2210 devices.

Table 5–26. EPM2210 Global Clock External I/O Timing Parameters

Symbol	Parameter	Condition	MAX II / MAX IIG						Unit
			–3 Speed Grade		–4 Speed Grade		–5 Speed Grade		
			Min	Max	Min	Max	Min	Max	
t_{PD1}	Worst case pin-to-pin delay through 1 look-up table (LUT)	10 pF	—	7.0	—	9.1	—	11.2	ns
t_{PD2}	Best case pin-to-pin delay through 1 LUT	10 pF	—	3.7	—	4.8	—	5.9	ns
t_{SU}	Global clock setup time	—	1.2	—	1.5	—	1.9	—	ns
t_{H}	Global clock hold time	—	0	—	0	—	0	—	ns
t_{CO}	Global clock to output delay	10 pF	2.0	4.6	2.0	6.0	2.0	7.4	ns
t_{CH}	Global clock high time	—	166	—	216	—	266	—	ps
t_{CL}	Global clock low time	—	166	—	216	—	266	—	ps
t_{CNT}	Minimum global clock period for 16-bit counter	—	3.3	—	4.0	—	5.0	—	ns
f_{CNT}	Maximum global clock frequency for 16-bit counter	—	—	304.0 *(1)*	—	247.5	—	201.1	MHz

Note to Table 5–26:

(1) The maximum frequency is limited by the I/O standard on the clock input pin. The 16-bit counter critical delay performs faster than this global clock input pin maximum frequency.

External Timing I/O Delay Adders

The I/O delay timing parameters for I/O standard input and output adders, and input delays are specified by speed grade independent of device density.

Table 5–27 through Table 5–31 show the adder delays associated with I/O pins for all packages. The delay numbers for –3, –4, and –5 speed grades shown in Table 5–27 through Table 5–33 are based on an EPM1270 device target, while –6, –7, and –8 speed grade values are based on an EPM570Z device target. If an I/O standard other than 3.3-V LVTTL is selected, add the input delay adder to the external t_{SU} timing parameters shown in Table 5–23 through Table 5–26. If an I/O standard other than 3.3-V LVTTL with 16 mA drive strength and fast slew rate is selected, add the output delay adder to the external t_{CO} and t_{PD} shown in Table 5–23 through Table 5–26.

Table 5–27. External Timing Input Delay Adders (Part 1 of 2)

I/O Standard		MAX II / MAX IIG						MAX IIZ						Unit
		–3 Speed Grade		–4 Speed Grade		–5 Speed Grade		–6 Speed Grade		–7 Speed Grade		–8 Speed Grade		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LVTTL	Without Schmitt Trigger	—	0	—	0	—	0	—	0	—	0	—	0	ps
	With Schmitt Trigger	—	334	—	434	—	535	—	387	—	434	—	442	ps

Table 5–33. MAX II Maximum Output Clock Rate for I/O

I/O Standard		MAX II / MAX IIG			MAX IIZ		
		–3 Speed Grade	–4 Speed Grade	–5 Speed Grade	–6 Speed Grade	–7 Speed Grade	–8 Speed Grade
3.3-V LVTTL	304	304	304	304	304	304	MHz
3.3-V LVCMOS	304	304	304	304	304	304	MHz
2.5-V LVTTL	220	220	220	220	220	220	MHz
2.5-V LVCMOS	220	220	220	220	220	220	MHz
1.8-V LVTTL	200	200	200	200	200	200	MHz
1.8-V LVCMOS	200	200	200	200	200	200	MHz
1.5-V LVCMOS	150	150	150	150	150	150	MHz
3.3-V PCI	304	304	304	304	304	304	MHz

JTAG Timing Specifications

Figure 5–6 shows the timing waveforms for the JTAG signals.

Figure 5–6. MAX II JTAG Timing Waveforms

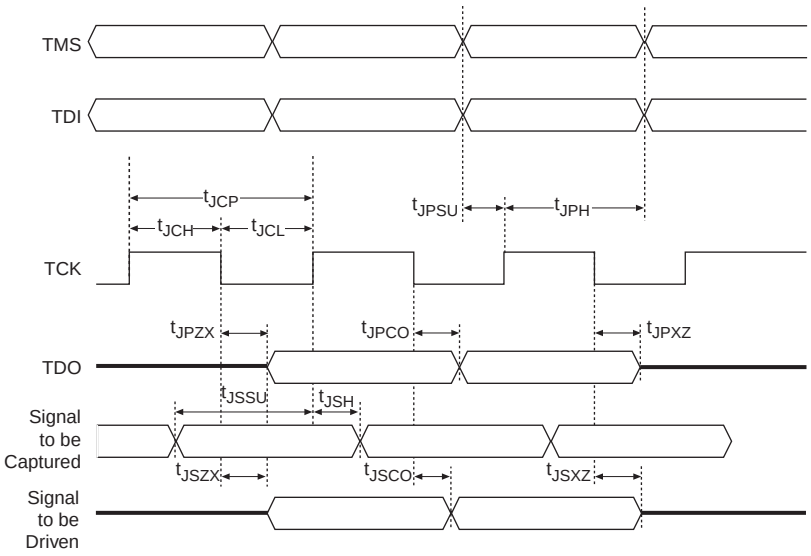


Table 5–34 shows the JTAG Timing parameters and values for MAX II devices.

Table 5–34. MAX II JTAG Timing Parameters (Part 1 of 2)

Symbol	Parameter	Min	Max	Unit
t_{JCP} *(1)*	TCK clock period for V_{CCIO1} = 3.3 V	55.5	—	ns
	TCK clock period for V_{CCIO1} = 2.5 V	62.5	—	ns
	TCK clock period for V_{CCIO1} = 1.8 V	100	—	ns
	TCK clock period for V_{CCIO1} = 1.5 V	143	—	ns
t_{JCH}	TCK clock high time	20	—	ns
t_{JCL}	TCK clock low time	20	—	ns

Table 5–34. MAX II JTAG Timing Parameters (Part 2 of 2)

Symbol	Parameter	Min	Max	Unit
t_{JPSU}	JTAG port setup time *(2)*	8	—	ns
t_{JPH}	JTAG port hold time	10	—	ns
t_{JPCO}	JTAG port clock to output *(2)*	—	15	ns
t_{JPZX}	JTAG port high impedance to valid output *(2)*	—	15	ns
t_{JPXZ}	JTAG port valid output to high impedance *(2)*	—	15	ns
t_{JSSU}	Capture register setup time	8	—	ns
t_{JSH}	Capture register hold time	10	—	ns
t_{JSCO}	Update register clock to output	—	25	ns
t_{JSZX}	Update register high impedance to valid output	—	25	ns
t_{JSXZ}	Update register valid output to high impedance	—	25	ns

Notes to Table 5–34:

(1) Minimum clock period specified for 10 pF load on the TDO pin. Larger loads on TDO will degrade the maximum TCK frequency.

(2) This specification is shown for 3.3-V LVTTL/LVCMOS and 2.5-V LVTTL/LVCMOS operation of the JTAG pins. For 1.8-V LVTTL/LVCMOS and 1.5-V LVCMOS, the t_{JPSU} minimum is 6 ns and t_{JPCO}, t_{JPZX}, and t_{JPXZ} are maximum values at 35 ns.

Referenced Documents

This chapter references the following documents:

- *I/O Structure* section in the *MAX II Architecture* chapter in the *MAX II Device Handbook*
- *Hot Socketing and Power-On Reset in MAX II Devices* chapter in the *MAX II Device Handbook*
- *Operating Requirements for Altera Devices Data Sheet*
- *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*
- *Understanding and Evaluating Power in MAX II Devices* chapter in the *MAX II Device Handbook*
- *Understanding Timing in MAX II Devices* chapter in the *MAX II Device Handbook*
- *Using MAX II Devices in Multi-Voltage Systems* chapter in the *MAX II Device Handbook*

Table 5–35. Document Revision History (Part 2 of 2)

Date and Revision	Changes Made	Summary of Changes
June 2005, version 1.3	■ Updated the R_{PULLUP} parameter in Table 5-4. ■ Added Note 2 to Tables 5-8 and 5-9. ■ Updated Table 5-13. ■ Added "Output Drive Characteristics" section. ■ Added I^2C mode and Notes 5 and 6 to Table 5-14. ■ Updated timing values to Tables 5-14 through 5-33.	—
December 2004, version 1.2	■ Updated timing Tables 5-2, 5-4, 5-12, and Tables 15-14 through 5-34. ■ Table 5-31 is new.	—
June 2004, version 1.1	■ Updated timing Tables 5-15 through 5-32.	—