

## ••••• Combining Performance, Density, and Embedded RAM

### Device Highlights

#### Flexible Programmable Logic

- 0.25  $\mu\text{m}$ , Five layer metal CMOS Process
- 2.5 V  $V_{CC}$ , 2.5/3.3 V Drive Capable I/O
- 4,032 Logic Cells
- 583,008 Max System Gates
- Up to 347 I/O Pins

#### Embedded Dual Port SRAM

- Thirty-six 2,304-bit Dual Port High Performance SRAM Blocks
- 82,900 RAM Bits
- RAM/ROM/FIFO Wizard for Automatic Configuration
- Configurable and Cascadable

#### Programmable I/O

- High performance Enhanced I/O (EIO): Less than 3 ns  $T_{CO}$
- Programmable Slew Rate Control
- Programmable I/O Standards:
  - LVTTTL, LVCMOS, PCI, GTL+, SSTL2, and SSTL3
- Eight Independent I/O Banks
- Three Register Configurations: Input, Output, and Output Enable

### Advanced Clock Network

- Nine Global Clock Networks:
  - One Dedicated
  - Eight Programmable
- 20 Quad-Net Networks: Five per Quadrant
- 16 I/O Controls: Two per I/O Bank

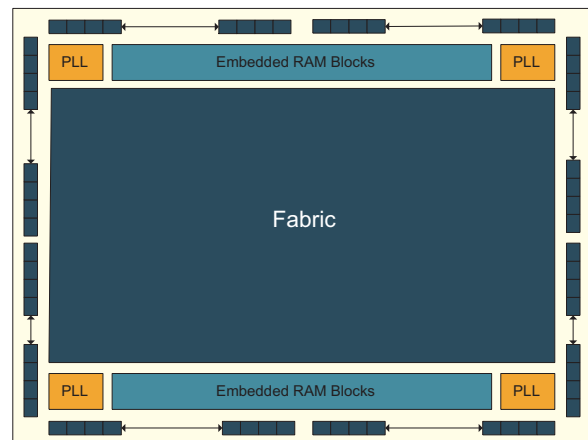


Figure 1: Eclipse Block Diagram

## Electrical Specifications

### AC Characteristics at $V_{CC} = 2.5\text{ V}$ , $T_A = 25^\circ\text{ C}$ ( $K = 1.00$ )

The AC Specifications are provided from **Table 1** to **Table 9**. Logic Cell diagrams and waveforms are provided from **Figure 2** to **Figure 15**.

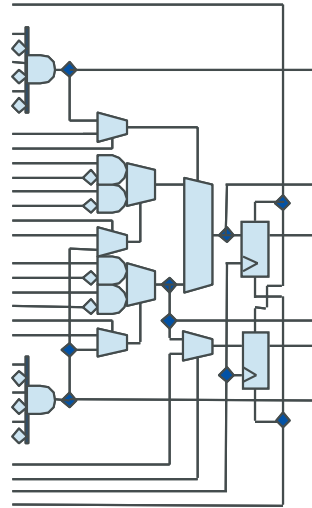


Figure 2: Eclipse Logic Cell

Table 1: Logic Cells

Symbol Logic Cells	Parameter	Value (ns)	
		Min	Max
$t_{PD}$	Combinatorial Delay of the longest path: time taken by the combinatorial circuit to output	0.205	1.01
$t_{SU}$	Setup time: time the synchronous input of the flip flop must be stable before the active clock edge	0.231	-
$t_{HL}$	Hold time: time the synchronous input of the flip flop must be stable after the active clock edge	0	-
$t_{CO}$	Clock to out delay: the amount of time taken by the flip flop to output after the active clock edge.	-	0.427
$t_{CWHI}$	Clock High Time: required minimum time the clock stays high	0.46	-
$t_{CWLO}$	Clock Low Time: required minimum time that the clock stays low	0.46	-
$t_{SET}$	Set Delay: time between when the flip flop is "set" (high) and when the output is consequently "set" (high)	-	0.585
$t_{RESET}$	Reset Delay: time between when the flip flop is "reset" (low) and when the output is consequently "reset" (low)	-	0.658
$t_{SW}$	Set Width: time that the SET signal remains high/low	0.3	-
$t_{RW}$	Reset Width: time that the RESET signal remains high/low	0.3	-

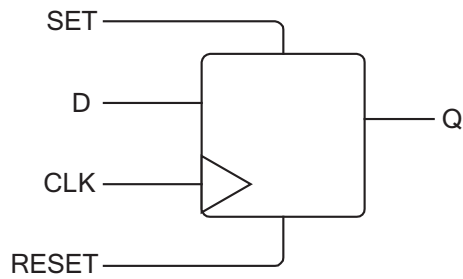


Figure 3: Logic Cell Flip Flop

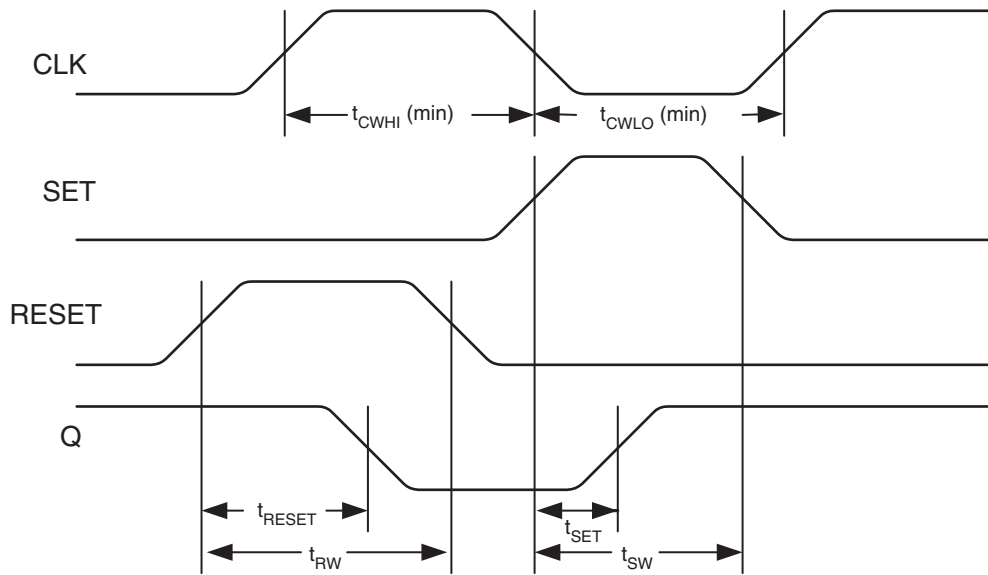


Figure 4: Logic Cell Flip Flop Timings - First Waveform

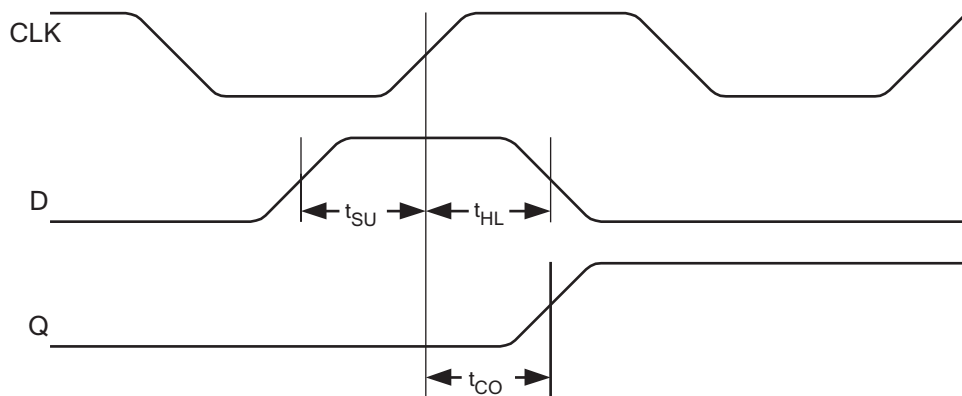


Figure 5: Logic Cell Flip Flop Timings - Second Waveform

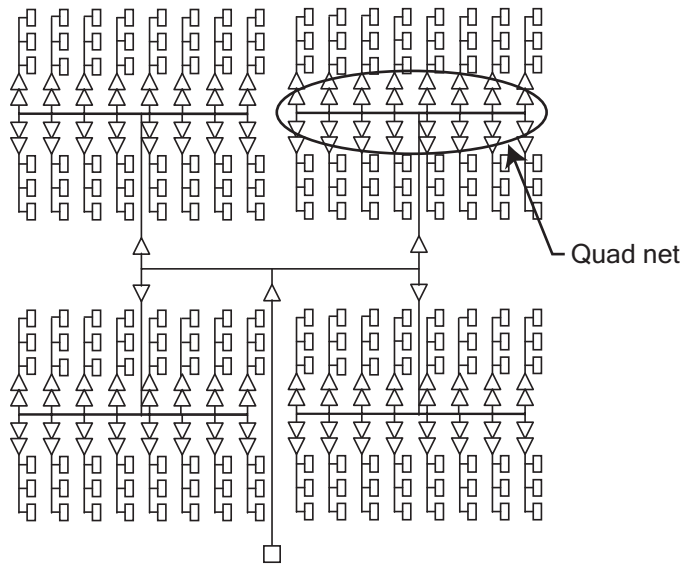


Figure 6: Eclipse Global Clock Structure

Table 2: Eclipse Global Clock Tree Delays

Clock Segment	Parameter	Value (ns)	
		Max. Rise	Max. Fall
$t_{PGCK}$	Global clock pin delay to quad net	0.990	1.386
$t_{BGCK}$	Global clock buffer delay (quad net to flip flop)	0.534	1.865

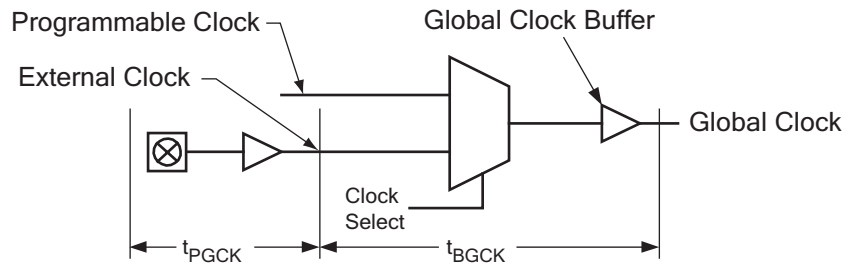


Figure 7: Global Clock Structure Schematic

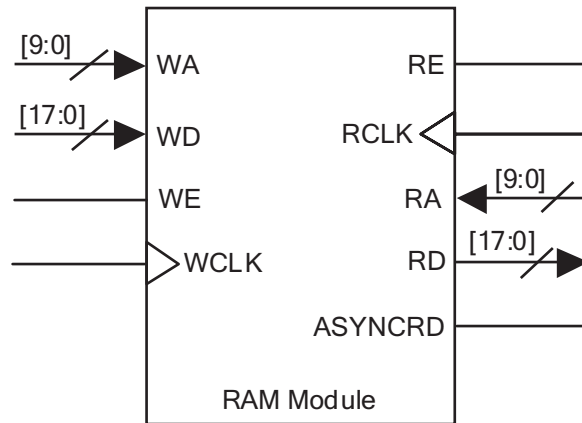


Figure 8: RAM Module

Table 3: RAM Cell Synchronous Write Timing

Symbol	Parameter	Value (ns)	
		Min	Max
<b>RAM Cell Synchronous Write Timing</b>			
$t_{SWA}$	WA setup time to WCLK: time the WRITE ADDRESS must be stable before the active edge of the WRITE CLOCK	0.675 ns	-
$t_{HWA}$	WA hold time to WCLK: time the WRITE ADDRESS must be stable after the active edge of the WRITE CLOCK	0 ns	-
$t_{SWD}$	WD setup time to WCLK: time the WRITE DATA must be stable before the active edge of the WRITE CLOCK	0.654 ns	-
$t_{HWD}$	WD hold time to WCLK: time the WRITE DATA must be stable after the active edge of the WRITE CLOCK	0 ns	-
$t_{SWE}$	WE setup time to WCLK: time the WRITE ENABLE must be stable before the active edge of the WRITE CLOCK	0.276 ns	-
$t_{HWE}$	WE hold time to WCLK: time the WRITE ENABLE must be stable after the active edge of the WRITE CLOCK	0 ns	-
$t_{WCRD}$	WCLK to RD (WA = RA): time between the active WRITE CLOCK edge and the time when the data is available at RD	-	2.796 ns

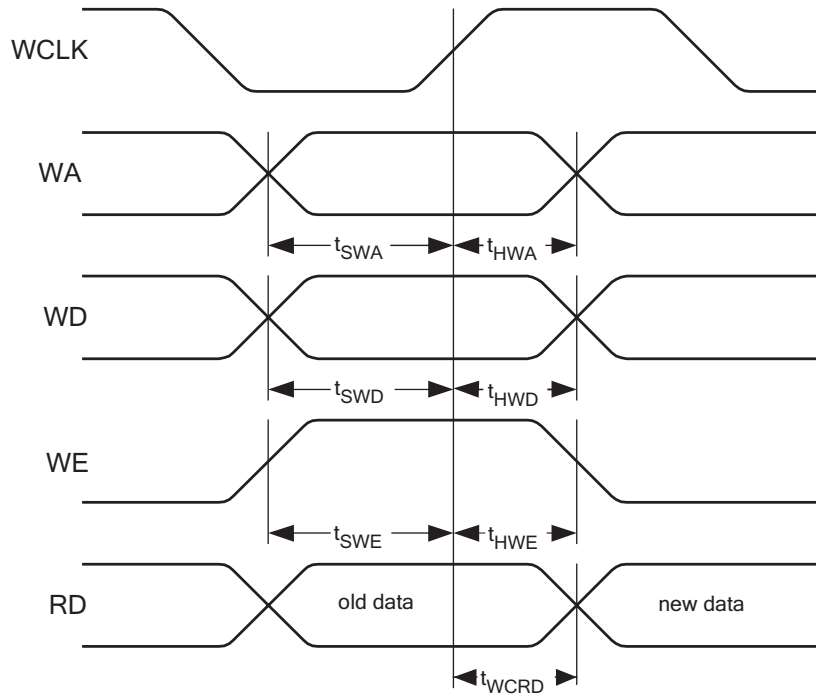


Figure 9: RAM Cell Synchronous Write Timing

Table 4: RAM Cell Synchronous & Asynchronous Read Timing

Symbol	Parameter	Value (ns)	
		Min	Max
<b>RAM Cell Synchronous Read Timing</b>			
$t_{SRA}$	RA setup time to RCLK: time the READ ADDRESS must be stable before the active edge of the READ CLOCK	0.686 ns	-
$t_{HRA}$	RA hold time to RCLK: time the READ ADDRESS must be stable after the active edge of the READ CLOCK	0 ns	-
$t_{SRE}$	RE setup time to WCLK: time the READ ENABLE must be stable before the active edge of the READ CLOCK	0.243 ns	-
$t_{HRE}$	RE hold time to WCLK: time the READ ENABLE must be stable after the active edge of the READ CLOCK	0 ns	-
$t_{RCRD}$	RCLK to RD: time between the active READ CLOCK edge and the time when the data is available at RD	-	2.225 ns
<b>RAM Cell Asynchronous Read Timing</b>			
$t_{PDRD}$	RA to RD: time between when the READ ADDRESS is input and when the DATA is output	-	2.405 ns



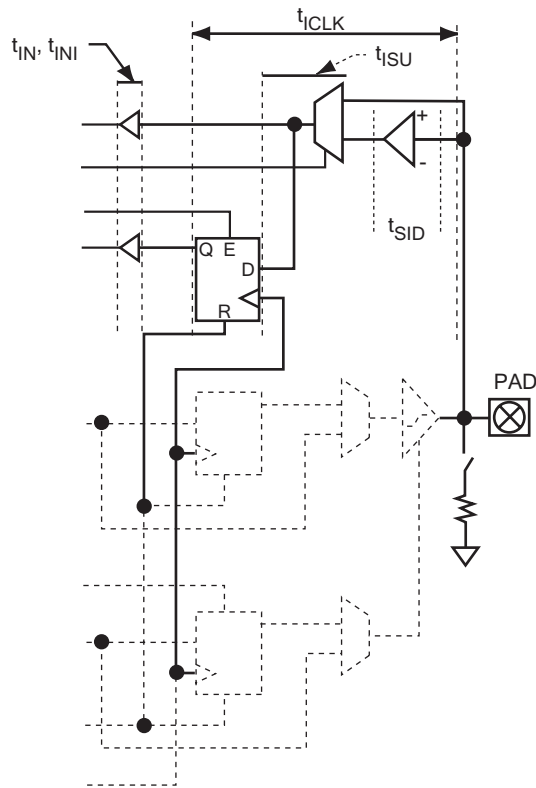


Figure 12: Eclipse Input Register Cell

Table 5: Input Register Cell

Symbol	Parameter	Value (ns)	
		Min	Max
<b>Input Register Cell Only</b>			
$t_{ISU}$	Input register setup time: time the synchronous input of the pin must be stable before the active clock edge	3.308 ns	3.526 ns
$t_{IHL}$	Input register hold time: time the synchronous input of the flip-flop must be stable after the active clock edge	0 ns	-
$t_{ICO}$	Input register clock to out: time taken by the flip-flop to output after the active clock edge	-	0.494 ns
$t_{IRST}$	Input register reset delay: time between when the flip-flop is “reset” (low) and when the output is consequently “reset” (low)	-	0.464 ns
$t_{IESU}$	Input register clock enable setup time: time “enable” must be stable before the active clock edge	0.830 ns	0.987 ns
$t_{IEH}$	Input register clock enable hold time: time “enable” must be stable after the active clock edge	0 ns	-



Table 6: Standard Input Delays

Symbol	Parameter	Value (ns)	
		Min	Max
$t_{SID}$ (LVTTTL)	LVTTTL input delay: Low Voltage TTL for 3.3 V applications	-	0.34
$t_{SID}$ (LVCMOS2)	LVCMOS2 input delay: Low Voltage CMOS for 2.5 V and lower applications	-	0.42
$t_{SID}$ (GTL+)	GTL+ input delay: Gunning Transceiver Logic	-	0.68
$t_{SID}$ (SSTL3)	SSTL3 input delay: Stub Series Terminated Logic for 3.3 V	-	0.55
$t_{SID}$ (SSTL2)	SSTL2 input delay: Stub Series Terminated Logic for 2.5 V	-	0.61

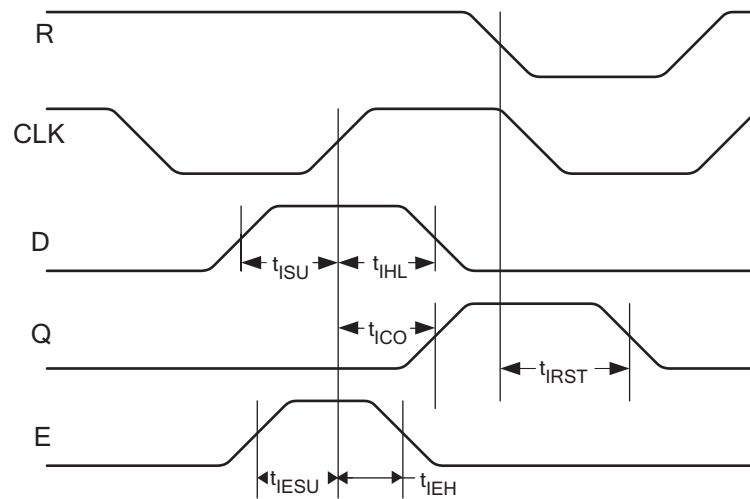


Figure 13: Eclipse Input Register Cell Timing

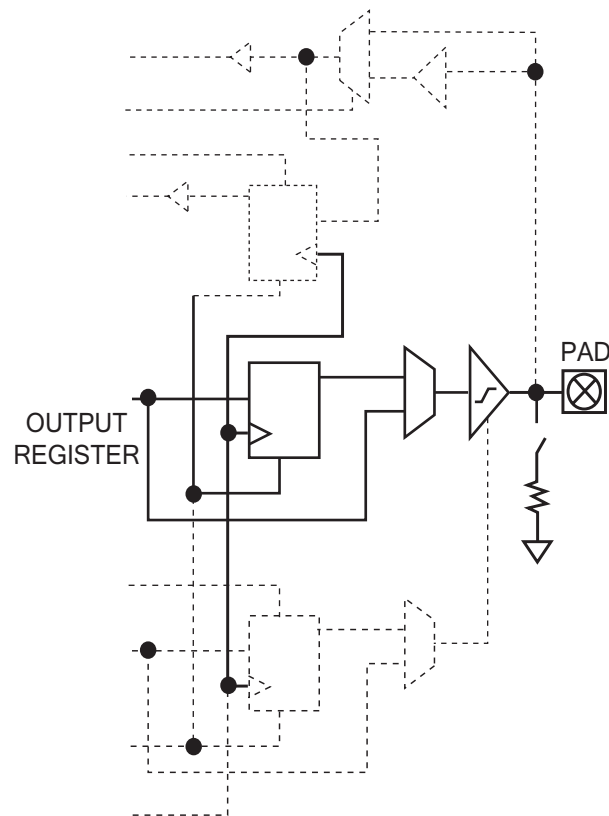


Figure 14: Eclipse Output Register Cell

Table 7: Eclipse Output Register Cell

Symbol	Parameter	Value (ns)	
		Min	Max
<b>Output Register Cell Only</b>			
$t_{OUTLH}$	Output Delay low to high (90% of H)	-	2.594
$t_{OUTHl}$	Output Delay high to low (10% of L)	-	2.163
$t_{PZH}$	Output Delay tri-state to high (90% of H)	-	3.056
$t_{PZL}$	Output Delay tri-state to low (10% of L)	-	2.709
$t_{PHZ}$	Output Delay high to tri-State	-	3.434
$t_{PLZ}$	Output Delay low to tri-State	-	3.318
$t_{COP}$	Clock-to-out delay (does not include clock tree delays)	-	2.667 (fast slew) 8.999 (slow slew)

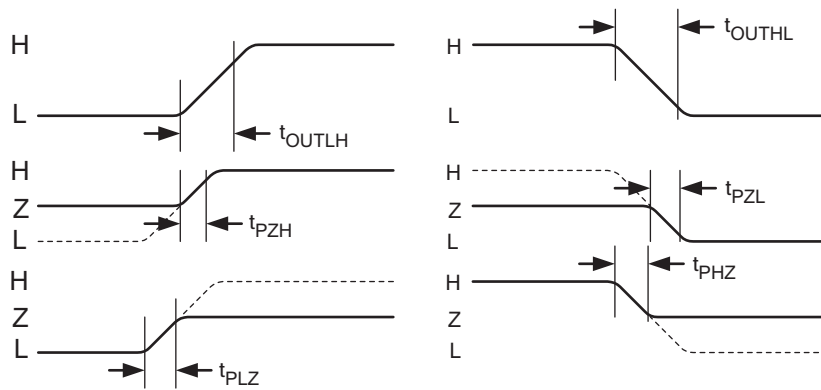


Figure 15: Eclipse Output Register Cell Timing

Table 8: Output Slew Rates @  $V_{CCIO} = 3.3\text{ V}$

	Fast Slew	Slow Slew
Rising Edge	2.8 V/ns	1.0 V/ns
Falling Edge	2.86 V/ns	1.0 V/ns

Table 9: Output Slew Rates @  $V_{CCIO} = 2.5\text{ V}$

	Fast Slew	Slow Slew
Rising Edge	1.7 V/ns	0.6 V/ns
Falling Edge	1.9 V/ns	0.6 V/ns

**NOTE:** For tips to minimize ground bounce, refer to Application Note 66 at <http://www.quicklogic.com/images/appnote66.pdf>.

## DC Characteristics

The DC Specifications are provided in **Table 10** through **Table 13**.

Table 10: Absolute Maximum Ratings

Parameter	Value	Parameter	Value
V <sub>CC</sub> Voltage	-0.5 V to 3.6 V	DC Input Current	±20 mA
V <sub>CCIO</sub> Voltage	-0.5 V to 4.6 V	ESD Pad Protection	±2000 V
INREF Voltage	2.7 V	Leaded Package Storage Temperature	-65° C to + 150° C
Input Voltage <sup>a</sup>	-0.5 V to V <sub>CCIO</sub> +0.5 V	Laminate Package (BGA) Storage Temperature	-55° C to + 125° C
Latch-up Immunity	±100 mA		

a. All dedicated inputs including the CLK, DEDCLK, PLLIN, PLLRST, and IOCTRL pins, are clamped to the V<sub>CC</sub> rail, not the V<sub>CCIO</sub>. Therefore, these pins can only be driven up to V<sub>CC</sub> + 0.3 V. These input pins are LVCMOS2 compliant only (2.5 V).

Table 11: Operating Range

Symbol	Parameter	Military		Industrial		Commercial		Unit	
		Min	Max	Min	Max	Min	Max		
V <sub>CC</sub>	Supply Voltage	2.3	2.7	2.3	2.7	2.3	2.7	V	
V <sub>CCIO</sub>	I/O Input Tolerance Voltage	2.3	3.6	2.3	3.6	2.3	3.6	V	
TA	Ambient Temperature	-55		-40	85	0	70	°C	
TC	Case Temperature	-	125	-	-	-	-	°C	
K	Delay Factor	-4 Speed Grade	0.42	2.3	0.43	2.16	0.47	2.11	n/a
		-5 Speed Grade	0.42	1.92	0.43	1.80	0.46	1.76	n/a
		-6 Speed Grade	0.42	1.35	0.43	1.26	0.46	1.23	n/a
		-7 Speed Grade	0.42	1.27	0.43	1.19	0.46	1.16	n/a

Table 12: DC Characteristics

Symbol	Parameter	Conditions	Min	Max	Units
$I_I$	I or I/O Input Leakage Current	$V_I = V_{CCIO}$ or GND	-10	10	$\mu\text{A}$
$I_{OZ}$	3-State Output Leakage Current	$V_I = V_{CCIO}$ or GND	-10	10	$\mu\text{A}$
$C_I$	Input Capacitance <sup>a</sup>	-	-	8	pF
$I_{OS}$	Output Short Circuit Current <sup>b</sup>	$V_o = \text{GND}$ $V_o = V_{CC}$	-15 40	-180 210	$\text{mA}$ $\text{mA}$
$I_{CC}$	D.C. Supply Current <sup>c</sup>	$V_I, V_o = V_{CCIO}$ or GND	0.50 (typ)	2	$\text{mA}$
$I_{CCIO}$	D.C. Supply Current on $V_{CCIO}$	-	0	2	$\text{mA}$
$I_{CCIO(DIF)}$	D.C. Supply Current on $V_{CCIO}$ for Differential I/O	-	-	-	$\text{mA}$
$I_{REF}$	D.C. Supply Current on INREF	-	-10	10	$\mu\text{A}$
$I_{PD}$	Pad Pull-down (programmable)	$V_{CCIO} = 3.6 \text{ V}$	-	150	$\mu\text{A}$

- a. Capacitance is sample tested only. Clock pins are 12 pF maximum.
- b. Only one output at a time. Duration should not exceed 30 seconds.
- c. For -4/-5/-6/-7 commercial grade devices only. See **Table 13** for more details on  $I_{CC}$  characteristics.

Table 13:  $I_{CC}$  Characteristics

Characteristic	Condition	Temperature		
		Commercial	Industrial	Military
$I_{CC}$	$V_{CCPLL} = \text{GND}$	2 mA (max)	3 mA (max)	5 mA (max)
	$V_{CCPLL} = V_{CC}$	3.25 mA (max)	5 mA (max)	10 mA (max)

**NOTE:** If PLLs are not used, the  $V_{CCPLL}$  and PLLRST pins may be grounded to the lower  $I_{CC}$  for the device.

## I/O Characteristics

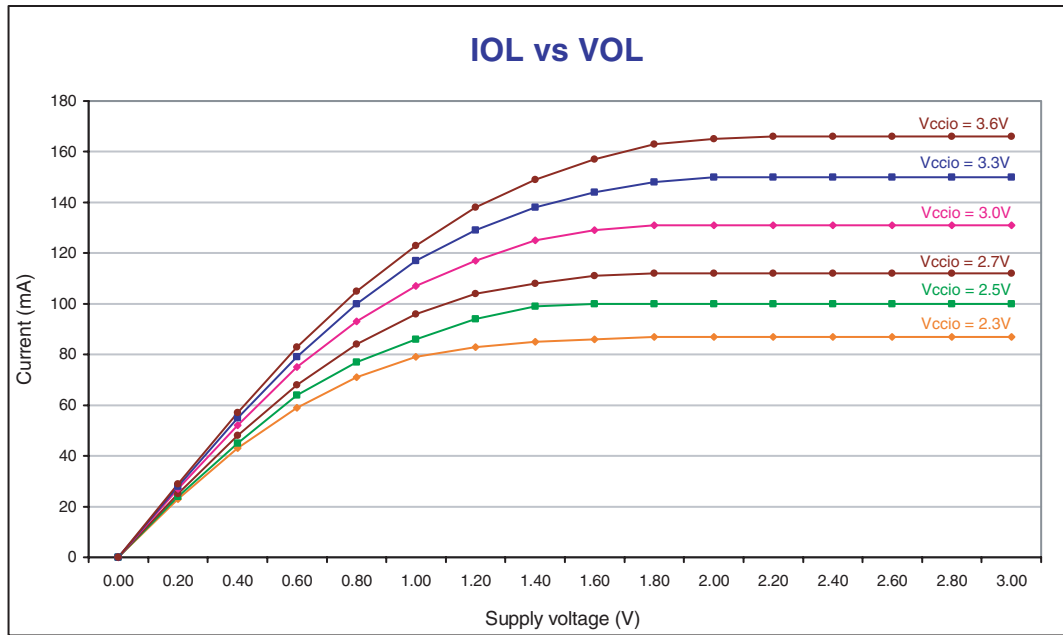


Figure 16: IOL vs. VOL

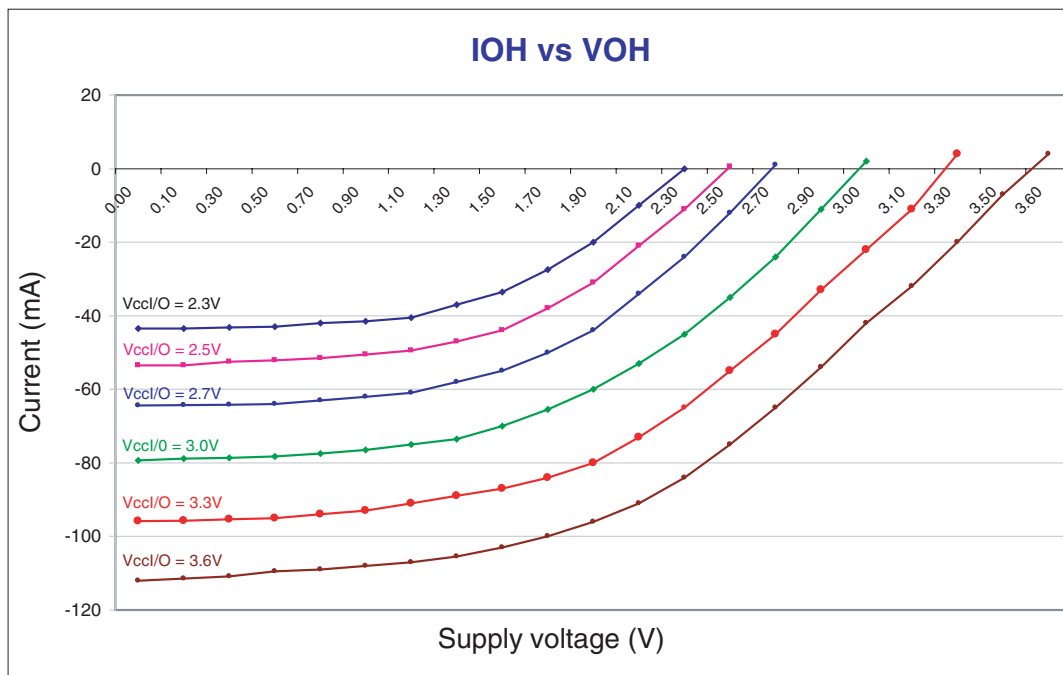


Figure 17: IOH vs. VOH

Table 14: DC Input and Output Levels

	INREF		$V_{IL}$		$V_{IH}$		$V_{OL}$	$V_{OH}$	$I_{OL}$	$I_{OH}$
	$V_{MIN}$	$V_{MAX}$	$V_{MIN}$	$V_{MAX}$	$V_{MIN}$	$V_{MAX}$	$V_{MAX}$	$V_{MIN}$	mA	mA
LVTTTL	n/a	n/a	-0.3	0.8	2.0	$V_{CCIO} + 0.3$	0.4	2.4	2.0	-2.0
LVC MOS2	n/a	n/a	-0.3	0.7	1.7	$V_{CCIO} + 0.3$	0.7	1.7	2.0	-2.0
GTL+	0.88	1.12	-0.3	INREF - 0.2	INREF + 0.2	$V_{CCIO} + 0.3$	0.6	n/a	40	n/a
PCI	n/a	n/a	-0.3	$0.3 \times V_{CCIO}$	$0.5 \times V_{CCIO}$	$V_{CCIO} + 0.5$	$0.1 \times V_{CCIO}$	$0.9 \times V_{CCIO}$	1.5	-0.5
SSTL2	1.15	1.35	-0.3	INREF - 0.18	INREF + 0.18	$V_{CCIO} + 0.3$	0.74	1.76	7.6	-7.6
SSTL3	1.3	1.7	-0.3	INREF - 0.2	INREF + 0.2	$V_{CCIO} + 0.3$	1.10	1.90	8	-8

**NOTE:** The data provided in **Table 14** are JEDEC and PCI Specifications. QuickLogic® devices either meet or exceed these requirements. For data specific to QuickLogic I/Os, see **Table 1** through **Table 13** and **Figure 1** through **Figure 17**.

**NOTE:** All dedicated inputs including the CLK, DEDCLK, PLLIN, PLLRST, and IOCTRL pins, are clamped to the  $V_{CC}$  rail, not the  $V_{CCIO}$ . Therefore, these pins can only be driven up to  $V_{CC} + 0.3$  V. These input pins are LVC MOS2 compliant only (2.5 V).

Table 15: Max I/O per Device /Package Combination

Device	280 BGA	484 BGA	516 BGA
QL6600	163	327	347

## Package Thermal Characteristics

Thermal Resistance Equations:

$$\theta_{JC} = (T_J - T_C) / P$$

$$\theta_{JA} = (T_J - T_A) / P$$

$$P_{MAX} = (T_{JMAX} - T_{AMAX}) / \theta_{JA}$$

Parameter Description:

$\theta_{JC}$ : Junction-to-case thermal resistance

$\theta_{JA}$ : Junction-to-ambient thermal resistance

$T_J$ : Junction temperature

$T_A$ : Ambient temperature

P: Power dissipated by the device while operating

$P_{MAX}$ : The maximum power dissipation for the device

$T_{JMAX}$ : Maximum junction temperature

$T_{AMAX}$ : Maximum ambient temperature

**NOTE:** Maximum junction temperature ( $T_{JMAX}$ ) is 150° C. To calculate the maximum power dissipation for a device package look up  $\theta_{JA}$  from **Table 16**, pick an appropriate  $T_{AMAX}$  and use:

$$P_{MAX} = (150^\circ \text{ C} - T_{AMAX}) / \theta_{JA}$$

Table 16: Package Thermal Characteristics

Package Description		$\theta_{JA}$ (°C/W) @ various flow rates (m/sec)				$\theta_{JC}$ (°C/W)
Pin Count	Package Type	0	0.5	1	2	
516	PBGA	20.0	19.0	17.5	16.0	7.0
484	PBGA	28.0	26.0	25.0	23.0	9.0
280	LF-PBGA	18.5	17.0	15.5	14.0	7.0



## Kv and Kt Graphs

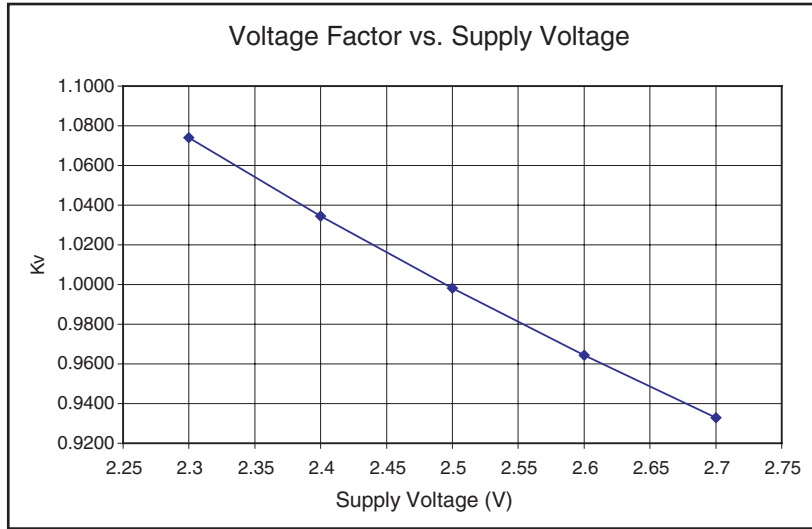


Figure 18: Voltage Factor vs. Supply Voltage

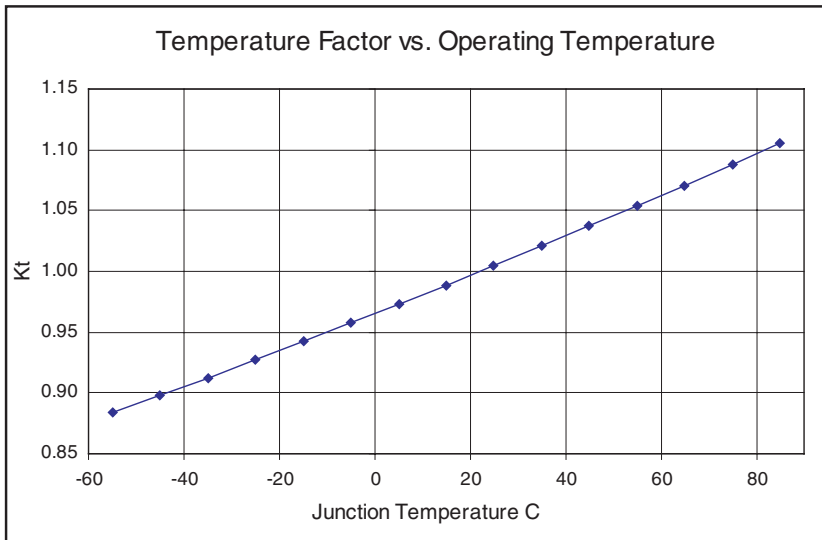


Figure 19: Temperature Factor vs. Operating Temperature

## Power vs. Operating Frequency

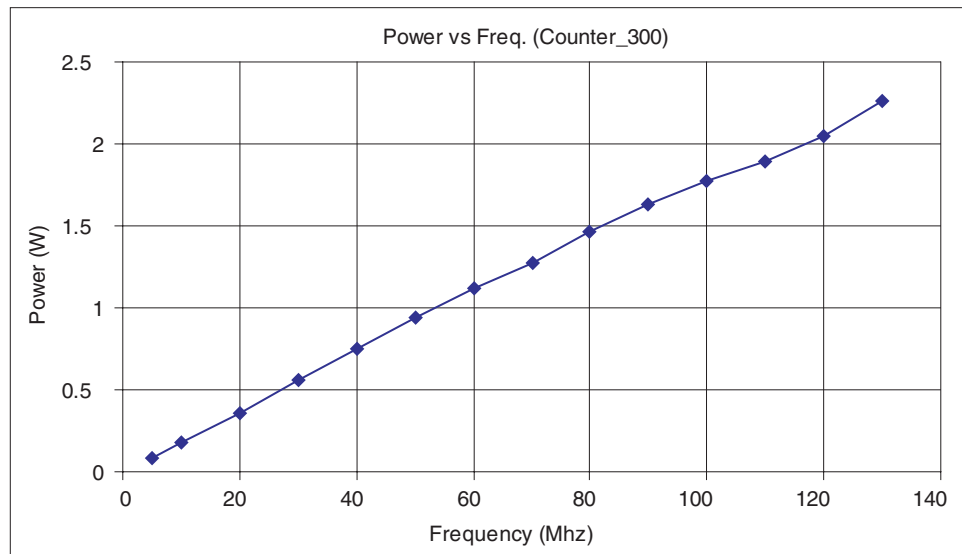
The basic power equation which best models power consumption is given below:

$$P_{TOTAL} = 0.350 + f[0.0031 \eta_{LC} + 0.0948 \eta_{CKBF} + 0.01 \eta_{CLBF} + 0.0263 \eta_{CKLD} + 0.543 \eta_{RAM} + 0.20 \eta_{PLL} + 0.0035 \eta_{INP} + 0.0257 \eta_{OUTP}] \text{ (mW)}$$

Where

- $\eta_{LC}$  is the total number of logic cells in the design
- $\eta_{CKBF}$  = # of clock buffers
- $\eta_{CLBF}$  = # of column clock buffers
- $\eta_{CKLD}$  = # of loads connected to the column clock buffers
- $\eta_{RAM}$  = # of RAM blocks
- $\eta_{PLL}$  = # of PLLs
- $\eta_{INP}$  is the number of input pins
- $\eta_{OUTP}$  is the number of output pins

**Figure 20** exhibits the power consumption in an Eclipse QL6600 device. The chip was filled with (300) 8-bit counters—approximately 76% logic cell utilization.



*Figure 20: Power Consumption*

**Figure 21** illustrates the theoretical worst-case scenarios for 50%, 70%, and 90% utilizations of the 6500-516 package. The resources of the device are divided exactly in half; meaning, for 50% utilization, exactly 50% of the I/Os, Logic Cells, RAM blocks, clock network, etc. are utilized. These situations may never occur in a real design, but they do provide a very rough quantitative measure of power consumption when talking in terms of 50% or 70% utilization of an Eclipse device.

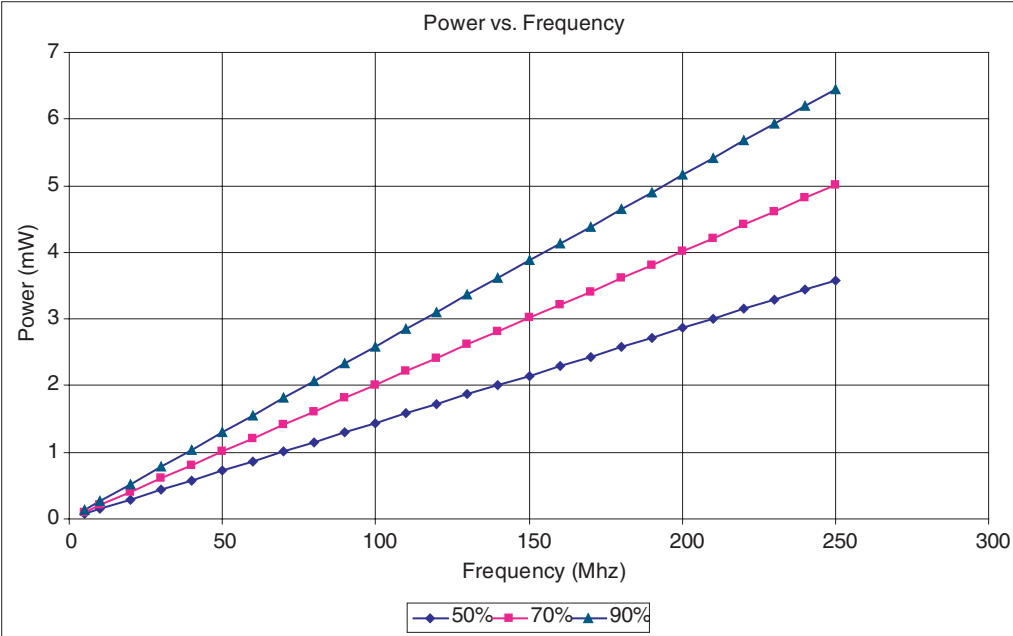


Figure 21: Power vs. Frequency (Absolute 50%, 70%, and 90% of the Available Resources on Chip)

To learn more about power consumption, please refer to application note #60 which is located at [www.quicklogic.com](http://www.quicklogic.com).

## Power-up Sequencing

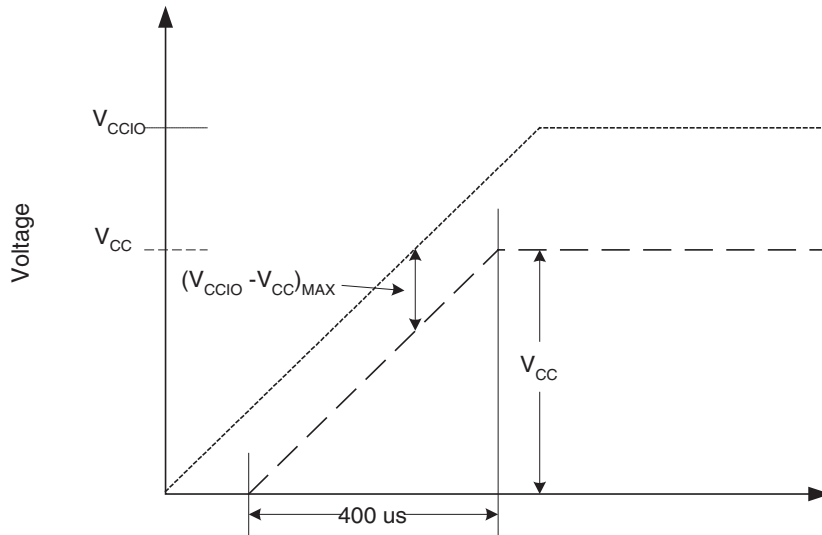


Figure 22: Power-up Requirements/Recommendations

When powering up a device, the  $V_{CC}/V_{CCIO}$  rails must take 400  $\mu$ s or longer to reach the maximum value (refer to **Figure 22**).

**NOTE:** Ramping  $V_{CC}/V_{CCIO}$  to the maximum voltage faster than 400  $\mu$ s can cause the device to behave improperly.

For users with a limited power budget, keep  $(V_{CCIO} - V_{CC})_{MAX} \leq 500$  mV when ramping up the power supply.

## Joint Test Access Group (JTAG)

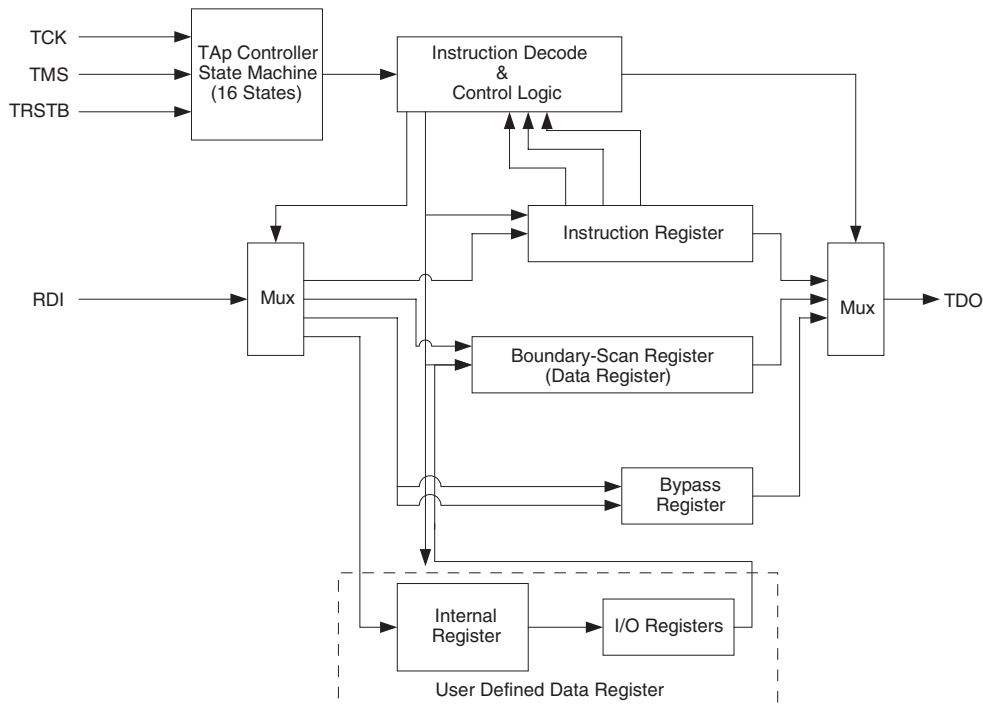


Figure 23: JTAG Block Diagram

Microprocessors and Application Specific Integrated Circuits (ASICs) pose many design challenges, not in the least of which concerns the accessibility of test points. The Joint Test Access Group (JTAG) formed in response to this challenge, resulting in IEEE standard 1149.1, the Standard Test Access Port and Boundary Scan Architecture.

The JTAG boundary scan test methodology allows complete observation and control of the boundary pins of a JTAG-compatible device through JTAG software. A Test Access Port (TAP) controller works in concert with the Instruction Register (IR), which allow users to run three required tests along with several user-defined tests.

JTAG tests allow users to reduce system debug time, reuse test platforms and tools, and reuse subsystem tests for fuller verification of higher level system elements.

The 1149.1 standard requires the following three tests:

- **Exttest Instruction.** The Exttest instruction performs a PCB interconnect test. This test places a device into an external boundary test mode, selecting the boundary scan register to be connected between the TAP's Test Data In (TDI) and Test Data Out (TDO) pins. Boundary scan cells are preloaded with test patterns (via the Sample/Preload Instruction), and input boundary cells capture the input data for analysis.
- **Sample/Preload Instruction.** This instruction allows a device to remain in its functional mode, while selecting the boundary scan register to be connected between the TDI and TDO pins. For this test, the boundary scan register can be accessed via a data scan operation, allowing users to sample the functional data entering and leaving the device.
- **Bypass Instruction.** The Bypass instruction allows data to skip a device's boundary scan entirely, so the data passes through the bypass register. The Bypass instruction allows users to test a device without passing through other devices. The bypass register is connected between the TDI and TDO pins, allowing serial data to be transferred through a device without affecting the operation of the device.

## Pin Descriptions

Table 17: JTAG Pin Descriptions

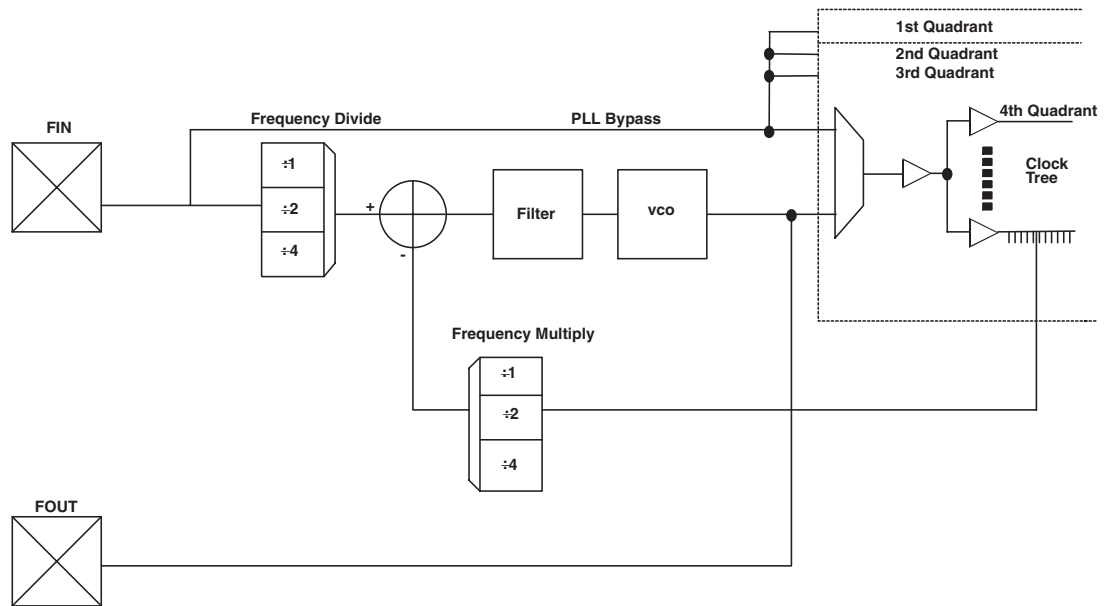
Pin	Function	Description
TDI/RSI	Test Data In for JTAG/RAM init. Serial Data In	Hold HIGH during normal operation. Connects to serial PROM data in for RAM initialization. Connect to $V_{CC}$ if unused
TRSTB/RRO	Active low Reset for JTAG/RAM init. reset out	Hold LOW during normal operation. Connects to serial PROM reset for RAM initialization. Connect to GND if unused
TMS	Test Mode Select for JTAG	Hold HIGH during normal operation. Connect to $V_{CC}$ if not used for JTAG
TCK	Test Clock for JTAG	Hold HIGH or LOW during normal operation. Connect to $V_{CC}$ or ground if not used for JTAG
TDO/RCO	Test data out for JTAG/RAM init. clock out	Connect to serial PROM clock for RAM initialization. Must be left unconnected if not used for JTAG or RAM initialization

**NOTE:** All JTAG inputs are clamped to the  $V_{CC}$  rail, not the  $V_{CCIO}$ . Therefore, these pins can only be driven up to  $V_{CC} + 0.3$  V. These input pins are LVCMOS2 compliant only (2.5 V). All JTAG outputs are driven by the  $V_{CC}$  rail, not  $V_{CCIO}$ . Therefore, these output pins can only drive up to  $V_{CC} + 0.3$  V. These output pins are LVCMOS2 compliant only (2.5 V).

## Phase Locked Loops (PLLs)

Instead of requiring extra components, designers simply need to instantiate one of the pre-configured models described in this section and listed in [Table 18](#). The QuickLogic built-in PLLs support a wider range of frequencies than many other PLLs. Also, QuickLogic PLLs can be cascaded to support different ranges of frequency multiplications or divisions, driving the device at a faster or slower rate than the incoming clock frequency. Most importantly, they achieve a very short clock-to-out time—generally less than 3 ns. This low clock-to-out time is achieved by the PLL subtracting the clock tree delay through the feedback path, effectively making the clock tree delay zero.

**Figure 24** illustrates a typical QuickLogic ESP PLL.



*Figure 24: PLL Block*

$F_{in}$  represents a very stable high-frequency input clock and produces an accurate signal reference. This signal can either bypass the PLL entirely, thus entering the clock tree directly, or it can pass through the PLL itself.

Within the PLL, a voltage-controlled oscillator (VCO) is added to the circuit. The external  $F_{in}$  signal and the local VCO form a control loop. The VCO is multiplied or divided down to the reference frequency, so that a phase detector (the crossed circle in [Figure 24](#)) can compare the two signals. If the phases of the external and local signals are not within the tolerance required, the phase detector sends a signal through the charge pump and loop filter ([Figure 24](#)). The charge pump generates an error voltage to bring the VCO back into alignment and the loop filter removes any high frequency noise before the error voltage enters the VCO. This new VCO signal enters the clock tree to drive the chip's circuitry.

$F_{out}$  represents the clock signal that emerges from the output pad (the output signal PLLPAD\_OUT is explained in [Table 19](#)). This clock signal is meaningful only when the PLL is configured for external use; otherwise, it remains in high Z state, as shown in the post-simulation waveform.



Most QuickLogic products contain four PLLs, one to be used in each quadrant. The PLL presented in **Figure 24** controls the clock tree in the fourth Quadrant of its ESP. As previously mentioned, QuickLogic PLLs compensate for the additional delay created by the clock tree itself by subtracting the clock tree delay through the feedback path.

For more specific information on the Phase Locked Loops, please refer to Application Note 58 at <http://www.quicklogic.com/images/appnote58.pdf>

## PLL Modes of Operation

QuickLogic PLLs have eight modes of operation, based on the input frequency and desired output frequency—**Table 18** indicates the features of each mode.

Table 18: PLL Mode Frequencies

PLL Model	Output Frequency	Input Frequency Range <sup>a</sup>	Output Frequency Range
PLL_HF <sup>b</sup>	Same as input frequency	66 MHz–150 MHz	66 MHz–150 MHz
PLL_LF	Same as input frequency	25 MHz–133 MHz	25 MHz–133 MHz
PLL_MULT2HF	2 × input frequency	50 MHz–125 MHz	100 MHz–250 MHz
PLL_MULT2LF	2 × input frequency	16 MHz–50 MHz	32 MHz–100 MHz
PLL_DIV2HF	1/2 × input frequency	100 MHz–250 MHz	50 MHz–125 MHz
PLL_DIV2LF	1/2 × input frequency	50 MHz–100 MHz	25 MHz–50 MHz
PLL_MULT4	4 × input frequency	16 MHz–40 MHz	64 MHz–160 MHz
PLL_DIV4	1/4 × input frequency	100 MHz–300 MHz	25 MHz–75 MHz

- a. The input frequency can range from 12.5 MHz to 500 MHz, while output frequency ranges from 25 MHz to 250 MHz. When you add PLLs to your top-level design, be sure that the PLL mode matches your desired input and output frequencies.
- b. HF stands for high frequency and LF stands for low frequency.

## PLL Signals

Table 19 summarizes the key signals in QuickLogic’s PLLs.

Table 19: PLL Signals

Signal Name	Description
PLLCLK_IN <sup>a</sup>	Input clock signal
PLL_RST	<b>Active High Reset</b> If PLL_RST is asserted, then CLKNET_OUT and PLLPAD_OUT are reset to 0. This signal must be asserted and then released in order for the LOCK_DETECT to work.
ONn_OFFCHIP	<b>PLL output</b> This signal selects whether the PLL will drive the internal clock network or be used off-chip. This is a static signal, not a dynamic signal.  Tied to GND = outgoing signal drives internal gates.  Tied to VCC = outgoing signal used off-chip.
CLKNET_OUT	<b>Out to internal gates</b> This signal bypasses the PLL logic before driving the internal gates. Note that this signal cannot be used in the same quadrant where the PLL signal is used (PLLCLK_OUT).
PLLCLK_OUT	<b>Out from PLL to internal gates</b> This signal can drive the internal gates after going through the PLL. For this to work, ONn_OFFCHIP must be tied to GND.
PLLPAD_OUT	<b>Out to off-chip</b> This outgoing signal is used off-chip. For this to work, ONn_OFFCHIP signal must be tied to VCC.
LOCK_DETECT	<b>Active High Lock detection signal</b> NOTE: For simulation purposes, this signal gets asserted after 10 clock cycles. However, it can take a maximum of 200 clock cycles to sync with the input clock upon release of the RESET signal.

a. Because PLLCLK\_IN and PLL\_RST signals have INPAD, and PLLPAD\_OUT has OUTPAD, you do not have to add additional pads to your design.

**NOTE:** For PLL AC specifications, contact the factory.

Table 20 describes the pins/balls of all Eclipse devices.

Table 20: Dedicated Pin Descriptions

Pin	Direction	Function	Description
CLK <sup>a</sup>	I	Global clock network driver	Low skew global clock. This pin provides access to a dedicated, distributed network capable of driving the CLOCK, SET, RESET, F1, and A2 inputs to the Logic Cell, READ and WRITE CLOCKS, Read and Write Enables of the Embedded RAM Blocks, and Output Enables of the I/Os.
I/O(A)	I/O	Input/Output pin	The I/O pin is a bi-directional pin, configurable to either an input-only, output-only, or bi-directional pin. The A inside the parenthesis means that the I/O is located in Bank A. If an I/O is not used, SpDE (QuickWorks Tool) provides the option of tying that pin to GND, V <sub>CC</sub> , or TriState during programming.
V <sub>CC</sub>	I	Power supply pin	Connect to 2.5 V supply
V <sub>CCIO</sub> (A)	I	Input voltage tolerance pin	This pin provides the flexibility to interface the device with either a 3.3 V device or a 2.5 V device. The A inside the parenthesis means that V <sub>CCIO</sub> is located in BANK A. Every I/O pin in Bank A will be tolerant of V <sub>CCIO</sub> input signals and will output V <sub>CCIO</sub> level signals. This pin must be connected to either 3.3 V or V <sub>CC</sub> .
V <sub>CCPLL</sub> <sup>b</sup>	I	Phase locked loop power supply pin	Connect to 2.5 V supply. VCCPLL should be connected to 2.5 V supply if the PLLs are used. If the PLLs are not used, V <sub>CCPLL</sub> can be connected to 2.5 V supply or GND. See <b>Table 13</b> for for I <sup>CC</sup> differences when V <sub>CCPLL</sub> is connected to 2.5 V or GND.
GND	I	Ground pin	Connect to ground
PLLIN <sup>a</sup>	I	PLL clock input	Clock input for PLL
DEDCLK <sup>a</sup>	I	Dedicated clock pin	Low skew global clock. This pin provides access to a dedicated, distributed clock network capable of driving the CLOCK inputs of all sequential elements of the device (e.g., RAM and flip-flops).
GNDPLL	I	Ground pin for PLL	Connect to GND
INREF(A)	I	Differential reference voltage	The INREF is the reference voltage pin for GTL+, SSTL2, and STTL3 standards. Follow the recommendations provided in <b>Table 14</b> for the appropriate standard. The A inside the parenthesis means that INREF is located in BANK A. This pin should be tied to GND if not needed.
PLLOUT	O	PLL output pin	Dedicated PLL output pin. Otherwise may be left unconnected
PLL <sub>RST</sub> <sup>a</sup>	I	Reset input pin for PLL	Reset input for PLL. If PLLs are not used, PLL <sub>RST</sub> should be connected to the same voltage as V <sub>CCPLL</sub> (e.g., V <sub>CC</sub> or GND).
IOCTRL(A) <sup>a</sup>	I	Highdrive input	This pin provides fast RESET, SET, CLOCK, and ENABLE access to the I/O cell flip-flops, providing fast clock-to-out and fast I/O response times. This pin can also double as a high-drive pin to the internal logic cells. The A inside the parenthesis means that IOCTRL is located in Bank A. This pin should be tied to GND or V <sub>CC</sub> if it is not used.

- a. All dedicated inputs including the CLK, DEDCLK, PLLIN, PLL<sub>RST</sub>, and IOCTRL pins, are clamped to the V<sub>CC</sub> rail, not the V<sub>CCIO</sub>. Therefore, these pins can only be driven up to V<sub>CC</sub> + 0.3 V. These input pins are LVCMOS2 compliant only (2.5 V).
- b. All PLLOUT output pins are driven by the V<sub>CC</sub> rail, not the V<sub>CCIO</sub> rail. These output pins are LVCMOS2 compliant only (2.5 V).

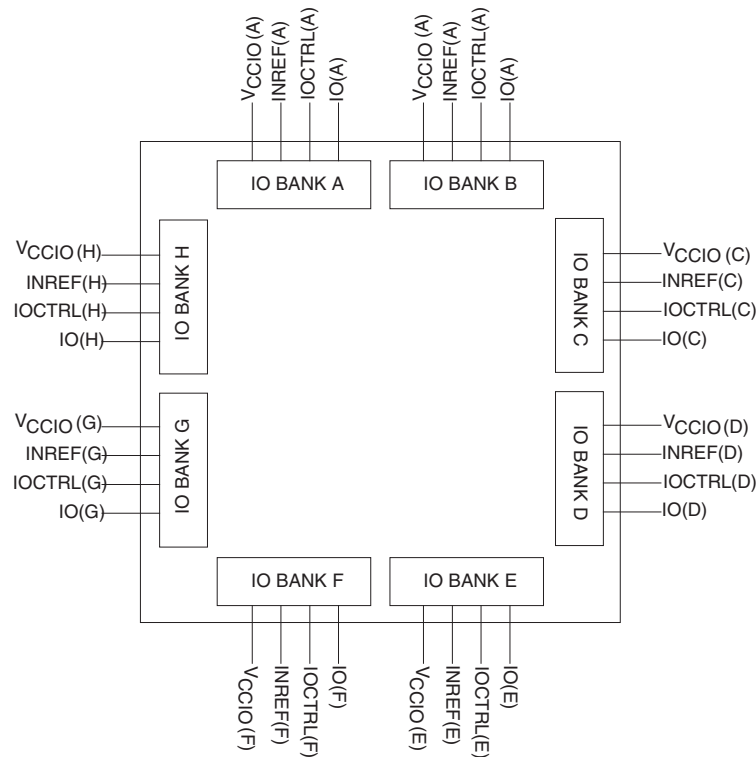


Figure 25: I/O Banks with Relevant Pins

### Recommended Unused Pin Terminations for the Eclipse devices

All unused, general purpose I/O pins can be tied to  $V_{CC}$ , GND, or HIZ (high impedance) internally using the Configuration Editor. This option is given in the bottom-right corner of the placement window. To use the Placement Editor, choose **Constraint** → **Fix Placement** in the Option pull-down menu of SpDE.

The rest of the pins should be terminated at the board level in the manner presented in **Table 21**.

Table 21: Recommended Unused Pin Terminations

Signal Name	Recommended Termination
PLLOUT<x>	Unused PLL output pins must be connected to either $V_{CC}$ or GND so that their associated input buffer never floats. Utilized PLL output pins that route the PLL clock outside of the chip should not be tied to either $V_{CC}$ or GND.
IOCTRL<y>	Any unused pins of this type must be connected to either $V_{CC}$ or GND.
CLK/PLLIN<x>	Any unused clock pins should be connected to $V_{CC}$ or GND.
PLLRST<x>	If a PLL module is not used, then the associated PLLRST<x> must be connected to $V_{CC}$ ; under normal operation, use it as needed. If PLLs are not used, the associated PLLRST pin must be connected to the same voltage as $V_{CC,PLL}$ (2.5 V or GND).
INREF<y>	If an I/O bank does not require the use of INREF signal the pin should be connected to GND.

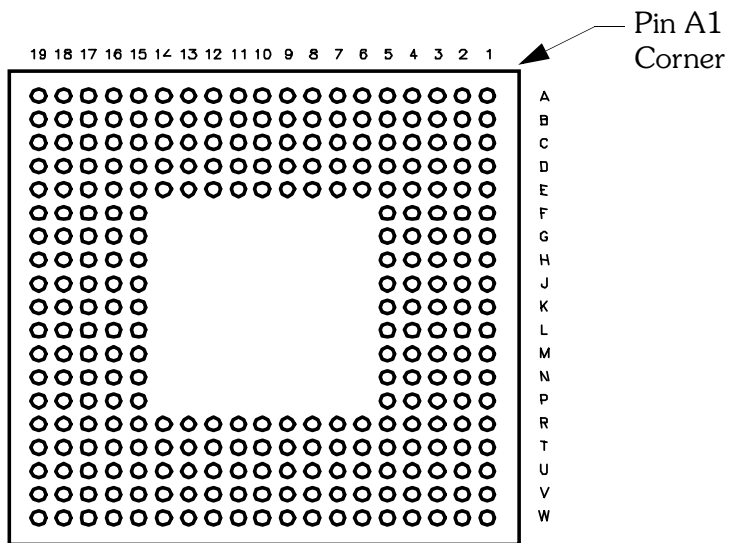
**NOTE:** x -> number, y -> alphabetical character.

## 280 PBGA Pinout Diagram

### Top



### Bottom



## 280 PBGA Pinout Table

Table 22: 280 PBGA Pinout Table

280 PBGA	Function	280 PBGA	Function	280 PBGA	Function	280 PBGA	Function	280 PBGA	Function	280 PBGA	Function
A1	PLLOUT<3>	C10	CLK<5>/PLLI N<3>	E19	IOCTRL<D>	K16	I/O<C>	R4	I/O<H>	U13	I/O<B>
A2	GNDPLL<0>	C11	V <sub>ccio</sub> <E>	F1	INREF<G>	K17	I/O<D>	R5	GND	U14	IOCTRL<B>
A3	I/O<F>	C12	I/O<E>	F2	IOCTRL<G>	K18	I/O<C>	R6	GND	U15	V <sub>ccio</sub> <B>
A4	I/O<F>	C13	I/O<E>	F3	I/O<G>	K19	TRSTB	R7	V <sub>cc</sub>	U16	I/O<B>
A5	I/O<F>	C14	I/O<E>	F4	I/O<G>	L1	I/O<H>	R8	V <sub>cc</sub>	U17	TDO
A6	IOCTRL<F>	C15	V <sub>ccio</sub> <E>	F5	GND	L2	I/O<H>	R9	GND	U18	PLLRST<2>
A7	I/O<F>	C16	I/O<E>	F15	V <sub>cc</sub>	L3	V <sub>ccio</sub> <H>	R10	GND	U19	I/O<B>
A8	I/O<F>	C17	I/O<E>	F16	IOCTRL<D>	L4	I/O<H>	R11	V <sub>cc</sub>	V1	PLLOUT<2>
A9	I/O<F>	C18	I/O<E>	F17	I/O<D>	L5	V <sub>cc</sub>	R12	V <sub>cc</sub>	V2	GNDPLL<3>
A10	CLK<7>	C19	I/O<E>	F18	I/O<D>	L15	GND	R13	V <sub>cc</sub>	V3	GND
A11	I/O<E>	D1	I/O<G>	F19	I/O<D>	L16	I/O<C>	R14	V <sub>cc</sub>	V4	I/O<A>
A12	I/O<E>	D2	I/O<G>	G1	I/O<G>	L17	V <sub>ccio</sub> <C>	R15	GND	V5	I/O<A>
A13	I/O<E>	D3	I/O<F>	G2	I/O<G>	L18	I/O<C>	R16	I/O<C>	V6	IOCTRL<A>
A14	IOCTRL<E>	D4	I/O<F>	G3	IOCTRL<G>	L19	I/O<C>	R17	V <sub>ccio</sub> <C>	V7	I/O<A>
A15	I/O<E>	D5	I/O<F>	G4	I/O<G>	M1	I/O<H>	R18	I/O<C>	V8	I/O<A>
A16	I/O<E>	D6	I/O<F>	G5	V <sub>cc</sub>	M2	I/O<H>	R19	I/O<C>	V9	I/O<A>
A17	I/O<E>	D7	I/O<F>	G15	V <sub>cc</sub>	M3	I/O<H>	T1	I/O<H>	V10	CLK<1>
A18	PLLRST<1>	D8	I/O<F>	G16	I/O<D>	M4	I/O<H>	T2	I/O<H>	V11	CLK<4>/DEDC LK/PLLIN<0>
A19	GND	D9	CLK<8>	G17	I/O<D>	M5	V <sub>cc</sub>	T3	I/O<A>	V12	I/O<B>
B1	PLLRST<0>	D10	I/O<E>	G18	I/O<D>	M15	V <sub>cc</sub>	T4	I/O<A>	V13	I/O<B>
B2	GND	D11	I/O<E>	G19	I/O<D>	M16	INREF<C>	T5	I/O<A>	V14	INREF<B>
B3	I/O<F>	D12	I/O<E>	H1	I/O<G>	M17	I/O<C>	T6	IOCTRL<A>	V15	I/O<B>
B4	I/O<F>	D13	INREF<E>	H2	I/O<G>	M18	I/O<C>	T7	I/O<A>	V16	I/O<B>
B5	I/O<F>	D14	I/O<E>	H3	I/O<G>	M19	I/O<C>	T8	I/O<A>	V17	I/O<B>
B6	INREF<F>	D15	I/O<E>	H4	I/O<G>	N1	IOCTRL<H>	T9	I/O<A>	V18	GNDPLL<2>
B7	I/O<F>	D16	I/O<D>	H5	V <sub>cc</sub>	N2	I/O<H>	T10	I/O<A>	V19	GND
B8	I/O<F>	D17	I/O<D>	H15	V <sub>cc</sub>	N3	I/O<H>	T11	CLK<3>/PLLI N<1>	W1	GND
B9	TMS	D18	I/O<D>	H16	V <sub>cc</sub>	N4	I/O<H>	T12	I/O<B>	W2	PLLRST<3>
B10	CLK<6>	D19	I/O<D>	H17	I/O<D>	N5	V <sub>cc</sub>	T13	I/O<B>	W3	I/O<A>
B11	I/O<E>	E1	I/O<G>	H18	I/O<D>	N15	V <sub>cc</sub>	T14	I/O<B>	W4	I/O<A>
B12	I/O<E>	E2	I/O<G>	H19	I/O<D>	N16	I/O<C>	T15	I/O<B>	W5	I/O<A>
B13	IOCTRL<E>	E3	V <sub>ccio</sub> <G>	J1	I/O<G>	N17	I/O<C>	T16	I/O<B>	W6	I/O<A>
B14	I/O<E>	E4	I/O<F>	J2	I/O<G>	N18	IOCTRL<C>	T17	V <sub>cc</sub> PLL<2>	W7	I/O<A>
B15	I/O<E>	E5	GND	J3	V <sub>ccio</sub> <G>	N19	IOCTRL<C>	T18	I/O<B>	W8	I/O<A>
B16	I/O<E>	E6	V <sub>cc</sub>	J4	I/O<G>	P1	I/O<H>	T19	I/O<B>	W9	TDI
B17	V <sub>cc</sub> PLL<1>	E7	V <sub>cc</sub>	J5	GND	P2	I/O<H>	U1	I/O<A>	W10	CLK<2>/PLLI N<2>
B18	GNDPLL<1>	E8	V <sub>cc</sub>	J15	V <sub>cc</sub>	P3	IOCTRL<H>	U2	I/O<A>	W11	I/O<B>
B19	PLLOUT<0>	E9	V <sub>cc</sub>	J16	I/O<C>	P4	INREF<H>	U3	V <sub>cc</sub> PLL<3>	W12	I/O<B>
C1	I/O<F>	E10	GND	J17	V <sub>ccio</sub> <D>	P5	V <sub>cc</sub>	U4	I/O<A>	W13	I/O<B>
C2	V <sub>cc</sub> PLL<0>	E11	GND	J18	I/O<D>	P15	GND	U5	V <sub>ccio</sub> <A>	W14	IOCTRL<B>
C3	I/O<F>	E12	V <sub>cc</sub>	J19	I/O<D>	P16	I/O<C>	U6	INREF<A>	W15	I/O<B>
C4	I/O<F>	E13	V <sub>cc</sub>	K1	V <sub>cc</sub>	P17	I/O<C>	U7	I/O<A>	W16	I/O<B>
C5	V <sub>ccio</sub> <F>	E14	GND	K2	TCK	P18	I/O<C>	U8	I/O<A>	W17	I/O<B>
C6	IOCTRL<F>	E15	GND	K3	I/O<G>	P19	I/O<C>	U9	V <sub>ccio</sub> <A>	W18	I/O<B>
C7	I/O<F>	E16	I/O<D>	K4	I/O<G>	R1	I/O<H>	U10	CLK<0>	W19	PLLOUT<1>
C8	I/O<F>	E17	V <sub>ccio</sub> <D>	K5	GND	R2	I/O<H>	U11	V <sub>ccio</sub> <B>		
C9	V <sub>ccio</sub> <F>	E18	INREF<D>	K15	GND	R3	V <sub>ccio</sub> <H>	U12	I/O<B>		

# 280 PBGA Packaging Drawing

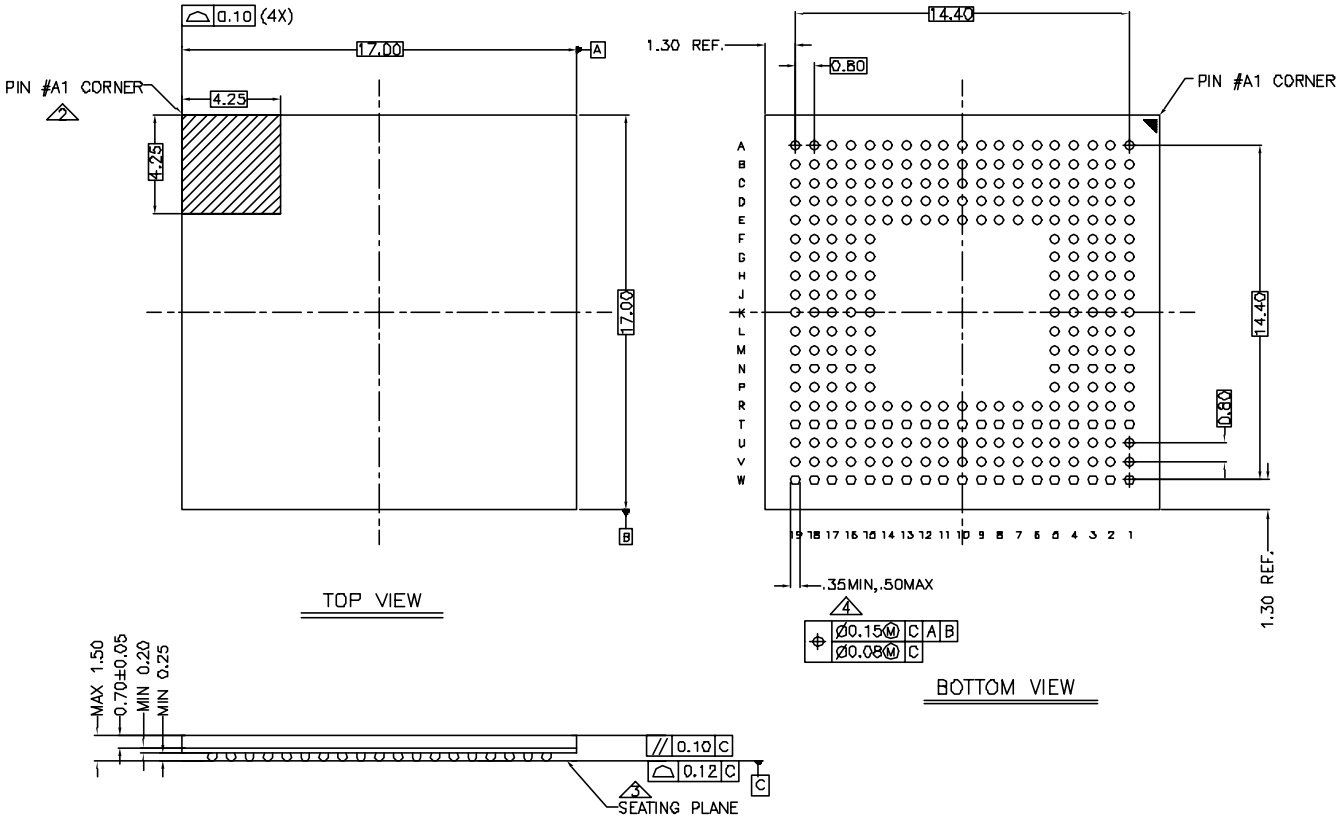
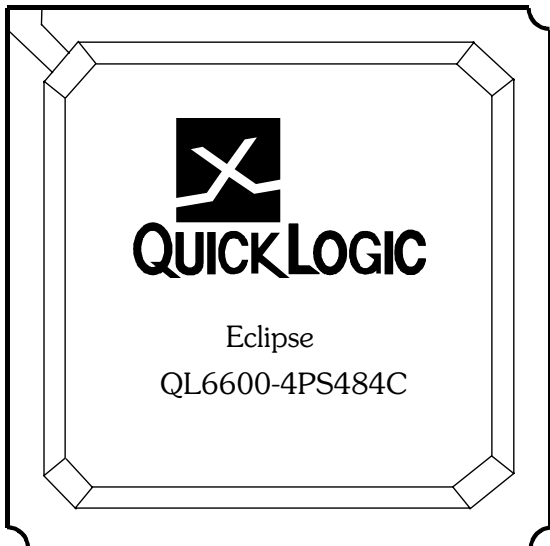


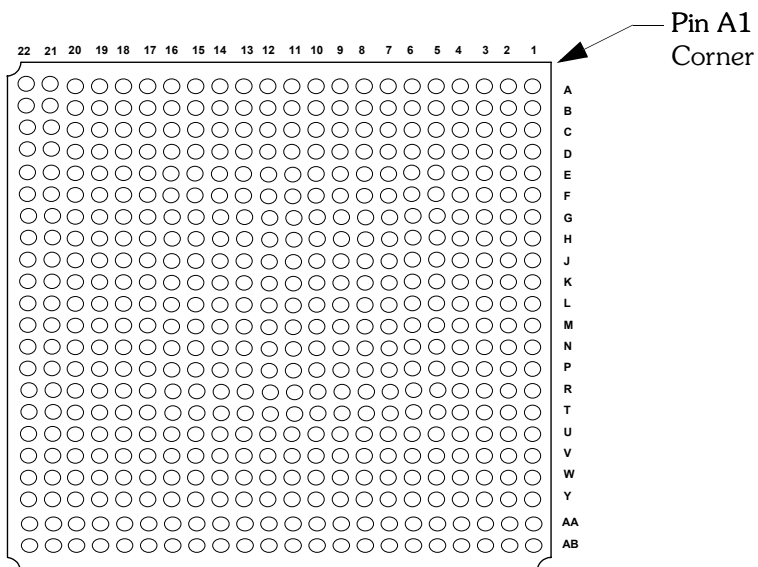
Figure 26: 280 PBGA Packaging Drawing

# 484 PBGA Pinout Diagram

## Top



## Bottom





# 484 PBGA Pinout Table

Table 23: 484 PBGA Pinout Table

484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function
A1	I/O<A>	C1	I/O<A>	E1	IOCTRL<A>	G1	I/O<A>	J1	I/O<A>	L1	CLK<4> DEDCLK/PLLIN<0>
A2	PLLST<3>	C2	I/O<A>	E2	I/O<A>	G2	I/O<A>	J2	I/O<A>	L2	CLK<0>
A3	I/O<A>	C3	V <sub>CC</sub> PLL<3>	E3	I/O<A>	G3	I/O<A>	J3	I/O<A>	L3	CLK<2>/PLLIN<2>
A4	I/O<A>	C4	PLLOUT<2>	E4	I/O<A>	G4	I/O<A>	J4	I/O<A>	L4	I/O<A>
A5	I/O<A>	C5	I/O<A>	E5	I/O<A>	G5	I/O<A>	J5	I/O<A>	L5	I/O<A>
A6	I/O<H>	C6	I/O<H>	E6	I/O<H>	G6	I/O<A>	J6	I/O<A>	L6	I/O<A>
A7	I/O<H>	C7	I/O<H>	E7	I/O<H>	G7	GND	J7	I/O<A>	L7	GND
A8	IOCTRL<H>	C8	I/O<H>	E8	I/O<H>	G8	I/O<H>	J8	V <sub>CC</sub>	L8	GND
A9	I/O<H>	C9	IOCTRL<H>	E9	I/O<H>	G9	I/O<H>	J9	GND	L9	GND
A10	I/O<H>	C10	I/O<H>	E10	I/O<H>	G10	I/O<H>	J10	V <sub>CC</sub>	L10	GND
A11	I/O<H>	C11	I/O<H>	E11	V <sub>CC</sub>	G11	I/O<G>	J11	V <sub>CC</sub>	L11	GND
A12	TCK	C12	I/O<H>	E12	I/O<G>	G12	GND	J12	GND	L12	GND
A13	I/O<G>	C13	I/O<G>	E13	I/O<G>	G13	I/O<G>	J13	V <sub>CC</sub>	L13	GND
A14	I/O<G>	C14	I/O<G>	E14	I/O<G>	G14	I/O<G>	J14	GND	L14	V <sub>CC</sub>
A15	I/O<G>	C15	I/O<G>	E15	IOCTRL<G>	G15	I/O<G>	J15	V <sub>CC</sub>	L15	V <sub>CC</sub>
A16	I/O<G>	C16	I/O<G>	E16	I/O<G>	G16	GND	J16	I/O<F>	L16	CLK<6>
A17	I/O<G>	C17	I/O<G>	E17	INREF<G>	G17	V <sub>CCIO</sub> <F>	J17	V <sub>CCIO</sub> <F>	L17	V <sub>CCIO</sub> <F>
A18	I/O<G>	C18	I/O<G>	E18	I/O<G>	G18	I/O<F>	J18	I/O<F>	L18	I/O<F>
A19	I/O<F>	C19	I/O<F>	E19	I/O<F>	G19	I/O<F>	J19	I/O<F>	L19	CLK<8>
A20	GND	C20	GNDPLL<0>	E20	I/O<F>	G20	I/O<F>	J20	I/O<F>	L20	I/O<F>
A21	PLLOUT<3>	C21	I/O<F>	E21	I/O<F>	G21	INREF<F>	J21	I/O<F>	L21	I/O<F>
A22	I/O<F>	C22	I/O<F>	E22	I/O<F>	G22	I/O<F>	J22	I/O<F>	L22	I/O<F>
B1	I/O<A>	D1	I/O<A>	F1	I/O<A>	H1	I/O<A>	K1	TDI	M1	I/O<B>
B2	GND	D2	I/O<A>	F2	INREF<A>	H2	I/O<A>	K2	I/O<A>	M2	I/O<B>
B3	GNDPLL<3>	D3	I/O<A>	F3	I/O<A>	H3	I/O<A>	K3	I/O<A>	M3	I/O<B>
B4	GND	D4	I/O<A>	F4	I/O<A>	H4	I/O<A>	K4	I/O<A>	M4	CLK<3>/PLLIN<1>
B5	I/O<A>	D5	I/O<A>	F5	I/O<A>	H5	IOCTRL<A>	K5	I/O<A>	M5	I/O<B>
B6	I/O<H>	D6	I/O<H>	F6	V <sub>CCIO</sub> <A>	H6	V <sub>CCIO</sub> <A>	K6	V <sub>CCIO</sub> <A>	M6	V <sub>CCIO</sub> <B>
B7	I/O<H>	D7	I/O<H>	F7	V <sub>CCIO</sub> <H>	H7	I/O<H>	K7	I/O<A>	M7	CLK<1>
B8	INREF<H>	D8	I/O<H>	F8	I/O<H>	H8	GND	K8	V <sub>CC</sub>	M8	V <sub>CC</sub>
B9	I/O<H>	D9	I/O<H>	F9	V <sub>CCIO</sub> <H>	H9	V <sub>CC</sub>	K9	V <sub>CC</sub>	M9	V <sub>CC</sub>
B10	I/O<H>	D10	I/O<H>	F10	I/O<H>	H10	V <sub>CC</sub>	K10	GND	M10	GND
B11	I/O<H>	D11	I/O<H>	F11	V <sub>CCIO</sub> <H>	H11	V <sub>CC</sub>	K11	GND	M11	GND
B12	I/O<G>	D12	I/O<G>	F12	V <sub>CCIO</sub> <G>	H12	GND	K12	GND	M12	GND
B13	I/O<G>	D13	I/O<G>	F13	I/O<G>	H13	V <sub>CC</sub>	K13	GND	M13	GND
B14	I/O<G>	D14	I/O<G>	F14	V <sub>CCIO</sub> <G>	H14	V <sub>CC</sub>	K14	V <sub>CC</sub>	M14	GND
B15	I/O<G>	D15	IOCTRL<G>	F15	I/O<G>	H15	GND	K15	V <sub>CC</sub>	M15	GND
B16	I/O<G>	D16	I/O<G>	F16	V <sub>CCIO</sub> <G>	H16	I/O<F>	K16	I/O<F>	M16	GND
B17	I/O<G>	D17	I/O<G>	F17	I/O<G>	H17	I/O<F>	K17	I/O<F>	M17	I/O<E>
B18	I/O<G>	D18	I/O<F>	F18	I/O<F>	H18	I/O<F>	K18	I/O<F>	M18	I/O<E>
B19	PLLST<0>	D19	V <sub>CC</sub> PLL<0>	F19	I/O<F>	H19	I/O<F>	K19	I/O<F>	M19	I/O<E>
B20	I/O<F>	D20	I/O<F>	F20	IOCTRL<F>	H20	I/O<F>	K20	I/O<F>	M20	CLK<7>
B21	I/O<F>	D21	I/O<F>	F21	I/O<F>	H21	I/O<F>	K21	I/O<F>	M21	CLK<5>/PLLIN<3>
B22	I/O<F>	D22	I/O<F>	F22	IOCTRL<F>	H22	I/O<F>	K22	I/O<F>	M22	TMS

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Table 23: 484 PBGA Pinout Table (Continued)

484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function	484 PBGA	Function
N1	I/O<B>	P16	I/O<E>	T9	I/O<C>	V2	I/O<B>	W17	I/O<D>	AA10	I/O<C>
N2	I/O<B>	P17	I/O<E>	T10	TRSTB	V3	I/O<B>	W18	I/O<E>	AA11	I/O<C>
N3	I/O<B>	P18	I/O<E>	T11	GND	V4	I/O<B>	W19	I/O<E>	AA12	I/O<D>
N4	I/O<B>	P19	I/O<E>	T12	I/O<C>	V5	I/O<B>	W20	I/O<E>	AA13	I/O<D>
N5	I/O<B>	P20	I/O<E>	T13	I/O<D>	V6	I/O<C>	W21	I/O<E>	AA14	I/O<D>
N6	I/O<B>	P21	I/O<E>	T14	I/O<D>	V7	I/O<C>	W22	I/O<E>	AA15	I/O<D>
N7	I/O<B>	P22	I/O<E>	T15	I/O<D>	V8	I/O<C>	Y1	I/O<B>	AA16	I/O<D>
N8	V <sub>CC</sub>	R1	I/O<B>	T16	GND	V9	I/O<C>	Y2	I/O<B>	AA17	I/O<D>
N9	V <sub>CC</sub>	R2	INREF<B>	T17	I/O<E>	V10	I/O<C>	Y3	V <sub>CC</sub> PLL<2>	AA18	I/O<D>
N10	GND	R3	I/O<B>	T18	I/O<E>	V11	I/O<C>	Y4	I/O<C>	AA19	I/O<E>
N11	GND	R4	I/O<B>	T19	I/O<E>	V12	V <sub>CC</sub>	Y5	I/O<C>	AA20	GNDPLL<1>
N12	GND	R5	I/O<B>	T20	I/O<E>	V13	I/O<D>	Y6	I/O<C>	AA21	I/O<E>
N13	GND	R6	I/O<B>	T21	IOCTRL<E>	V14	I/O<D>	Y7	I/O<C>	AA22	I/O<E>
N14	V <sub>CC</sub>	R7	I/O<B>	T22	I/O<E>	V15	I/O<D>	Y8	IOCTRL<C>	AB1	I/O<B>
N15	V <sub>CC</sub>	R8	GND	U1	IOCTRL<B>	V16	INREF<D>	Y9	I/O<C>	AB2	GNDPLL<2>
N16	I/O<E>	R9	V <sub>CC</sub>	U2	I/O<B>	V17	I/O<D>	Y10	I/O<C>	AB3	PLLST<2>
N17	V <sub>CC</sub> IO<E>	R10	V <sub>CC</sub>	U3	IOCTRL<B>	V18	I/O<E>	Y11	I/O<D>	AB4	I/O<B>
N18	I/O<E>	R11	GND	U4	I/O<B>	V19	I/O<E>	Y12	I/O<D>	AB5	I/O<B>
N19	I/O<E>	R12	V <sub>CC</sub>	U5	I/O<B>	V20	I/O<E>	Y13	I/O<D>	AB6	I/O<C>
N20	I/O<E>	R13	V <sub>CC</sub>	U6	I/O<C>	V21	I/O<E>	Y14	I/O<D>	AB7	I/O<C>
N21	I/O<E>	R14	V <sub>CC</sub>	U7	V <sub>CC</sub> IO<C>	V22	I/O<E>	Y15	IOCTRL<D>	AB8	IOCTRL<C>
N22	I/O<E>	R15	GND	U8	I/O<C>	W1	I/O<B>	Y16	I/O<D>	AB9	I/O<C>
P1	I/O<B>	R16	I/O<D>	U9	V <sub>CC</sub> IO<C>	W2	I/O<B>	Y17	I/O<D>	AB10	I/O<C>
P2	I/O<B>	R17	V <sub>CC</sub> IO<E>	U10	I/O<C>	W3	I/O<B>	Y18	I/O<E>	AB11	I/O<C>
P3	I/O<B>	R18	I/O<E>	U11	V <sub>CC</sub> IO<C>	W4	I/O<B>	Y19	PLLOUT<0>	AB12	I/O<D>
P4	I/O<B>	R19	I/O<E>	U12	V <sub>CC</sub> IO<D>	W5	I/O<B>	Y20	PLLST<1>	AB13	I/O<D>
P5	I/O<B>	R20	I/O<E>	U13	I/O<D>	W6	I/O<C>	Y21	I/O<E>	AB14	I/O<D>
P6	V <sub>CC</sub> IO<B>	R21	I/O<E>	U14	V <sub>CC</sub> IO<D>	W7	I/O<C>	Y22	I/O<E>	AB15	I/O<D>
P7	I/O<B>	R22	I/O<E>	U15	I/O<D>	W8	I/O<C>	AA1	TDO	AB16	IOCTRL<D>
P8	V <sub>CC</sub>	T1	I/O<B>	U16	V <sub>CC</sub> IO<D>	W9	I/O<C>	AA2	PLLOUT<1>	AB17	I/O<D>
P9	GND	T2	I/O<B>	U17	V <sub>CC</sub> IO<E>	W10	I/O<C>	AA3	GND	AB18	I/O<D>
P10	V <sub>CC</sub>	T3	I/O<B>	U18	I/O<E>	W11	I/O<C>	AA4	I/O<B>	AB19	I/O<E>
P11	GND	T4	I/O<B>	U19	I/O<E>	W12	I/O<D>	AA5	I/O<C>	AB20	GND
P12	V <sub>CC</sub>	T5	I/O<B>	U20	IOCTRL<E>	W13	I/O<D>	AA6	I/O<C>	AB21	V <sub>CC</sub> PLL<1>
P13	V <sub>CC</sub>	T6	V <sub>CC</sub> IO<B>	U21	I/O<E>	W14	I/O<D>	AA7	I/O<C>	AB22	I/O<E>
P14	GND	T7	GND	U22	INREF<E>	W15	I/O<D>	AA8	INREF<C>		
P15	V <sub>CC</sub>	T8	I/O<C>	V1	I/O<B>	W16	I/O<D>	AA9	I/O<C>		

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# 484 PBGA Packaging Drawing

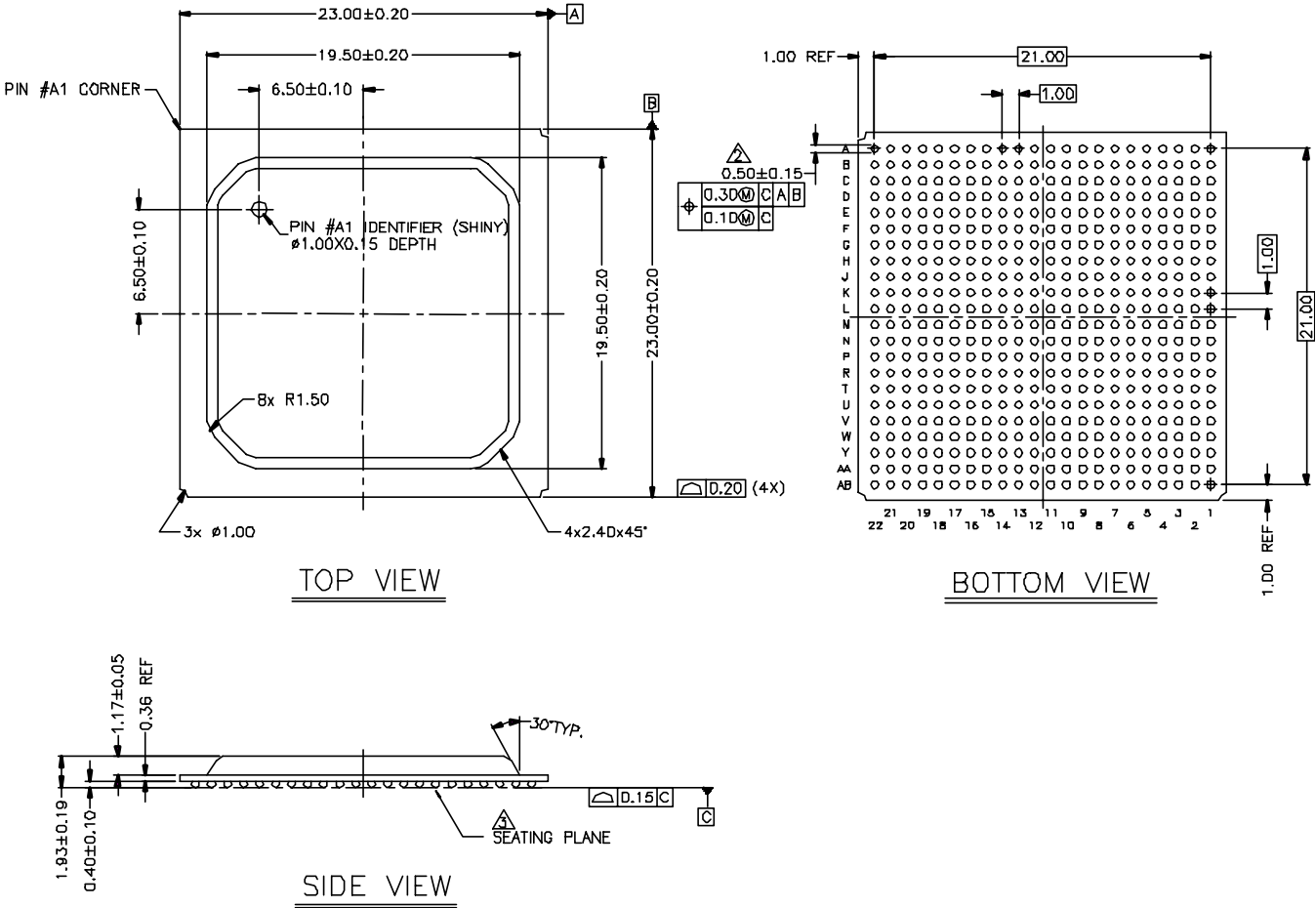
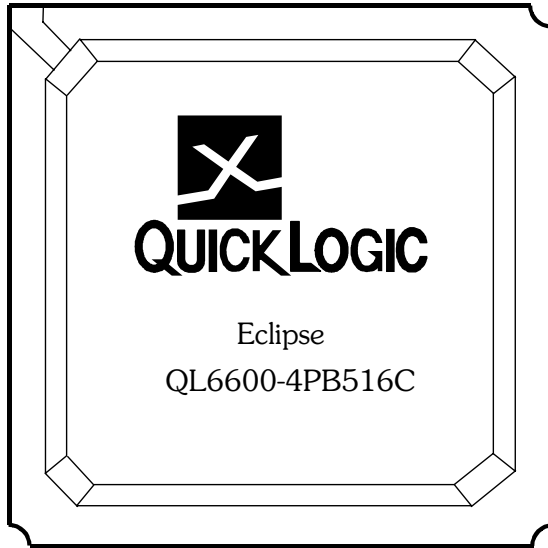


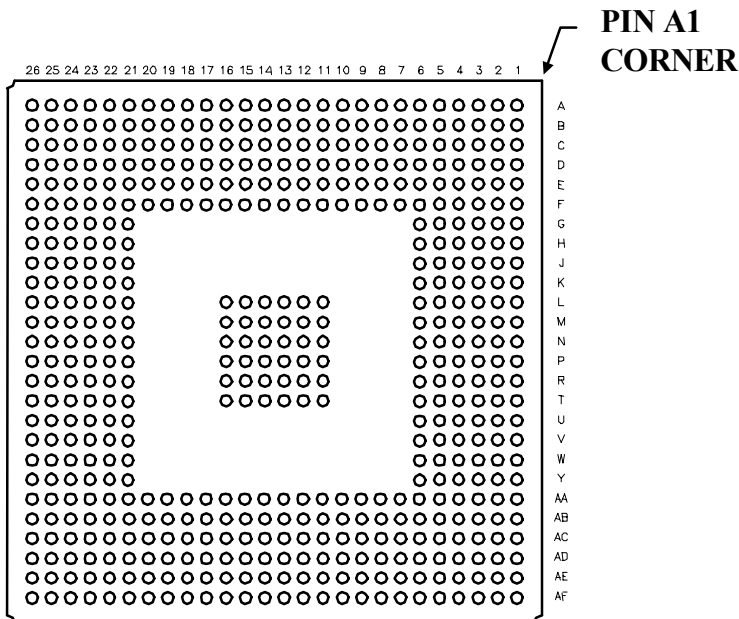
Figure 27: 484 PBGA Packaging Drawing

# 516 PBGA Pinout Diagram

## Top



## Bottom



# 516 PBGA Pinout Table

Table 24: 516 PBGA Pinout Table

516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function
A1	GND	C1	I/O<F>	E1	I/O<G>	G1	I/O<G>	L5	V <sub>CC</sub>	P3	I/O<H>
A2	I/O<F>	C2	I/O<F>	E2	I/O<G>	G2	INREF<G>	L6	V <sub>CC</sub>	P4	V <sub>CC</sub>
A3	I/O<F>	C3	I/O<F>	E3	I/O<G>	G3	I/O<G>	L11	GND	P5	I/O<H>
A4	I/O<F>	C4	PLLOUT<3>	E4	V <sub>CC</sub> PLL<0>	G4	I/O<G>	L12	GND	P6	V <sub>CCIO&lt;H&gt;</sub>
A5	I/O<F>	C5	I/O<F>	E5	I/O<F>	G5	I/O<G>	L13	GND	P11	GND
A6	I/O<F>	C6	I/O<F>	E6	I/O<F>	G6	V <sub>CCIO&lt;G&gt;</sub>	L14	GND	P12	GND
A7	IOCTRL<F>	C7	I/O<F>	E7	I/O<F>	G21	V <sub>CCIO&lt;D&gt;</sub>	L15	GND	P13	GND
A8	I/O<F>	C8	INREF<F>	E8	V <sub>CC</sub>	G22	I/O<D>	L16	GND	P14	GND
A9	I/O<F>	C9	I/O<F>	E9	I/O<F>	G23	I/O<D>	L21	V <sub>CC</sub>	P15	GND
A10	I/O<F>	C10	I/O<F>	E10	I/O<F>	G24	I/O<D>	L22	I/O<D>	P16	GND
A11	I/O<F>	C11	I/O<F>	E11	I/O<F>	G25	I/O<D>	L23	I/O<D>	P21	V <sub>CCIO&lt;C&gt;</sub>
A12	I/O<F>	C12	I/O<F>	E12	V <sub>CC</sub>	G26	INREF<D>	L24	I/O<D>	P22	I/O<C>
A13	I/O<E>	C13	CLK<7>	E13	I/O<F>	H1	I/O<G>	L25	I/O<D>	P23	V <sub>CC</sub>
A14	I/O<E>	C14	I/O<E>	E14	I/O<F>	H2	I/O<G>	L26	I/O<D>	P24	I/O<C>
A15	I/O<E>	C15	I/O<E>	E15	I/O<E>	H3	IOCTRL<G>	M1	I/O<G>	P25	I/O<C>
A16	I/O<E>	C16	I/O<E>	E16	V <sub>CC</sub>	H4	I/O<G>	M2	I/O<G>	P26	TRSTB
A17	I/O<E>	C17	I/O<E>	E17	CLK<6>	H5	I/O<G>	M3	I/O<G>	R1	I/O<H>
A18	IOCTRL<E>	C18	I/O<E>	E18	I/O<E>	H6	V <sub>CC</sub>	M4	I/O<G>	R2	I/O<H>
A19	IOCTRL<E>	C19	I/O<E>	E19	I/O<E>	H21	V <sub>CC</sub>	M5	I/O<G>	R3	I/O<H>
A20	I/O<E>	C20	I/O<E>	E20	I/O<E>	H22	V <sub>CC</sub>	M6	V <sub>CCIO&lt;G&gt;</sub>	R4	I/O<H>
A21	I/O<E>	C21	I/O<E>	E21	I/O<E>	H23	I/O<D>	M11	GND	R5	V <sub>CC</sub>
A22	I/O<E>	C22	I/O<E>	E22	I/O<E>	H24	IOCTRL<D>	M12	GND	R6	V <sub>CC</sub>
A23	I/O<E>	C23	I/O<E>	E23	GNDPLL<1>	H25	IOCTRL<D>	M13	GND	R11	GND
A24	I/O<E>	C24	I/O<E>	E24	I/O<E>	H26	I/O<D>	M14	GND	R12	GND
A25	PLL_RST<1>	C25	I/O<E>	E25	I/O<D>	J1	I/O<G>	M15	GND	R13	GND
A26	GND	C26	I/O<E>	E26	I/O<D>	J2	I/O<G>	M16	GND	R14	GND
B1	I/O<F>	D1	I/O<G>	F1	IOCTRL<G>	J3	I/O<G>	M21	V <sub>CCIO&lt;D&gt;</sub>	R15	GND
B2	PLL_RST<0>	D2	I/O<G>	F2	I/O<G>	J4	I/O<G>	M22	V <sub>CC</sub>	R16	GND
B3	I/O<F>	D3	I/O<F>	F3	I/O<G>	J5	I/O<G>	M23	I/O<D>	R21	V <sub>CC</sub>
B4	I/O<F>	D4	I/O<F>	F4	I/O<G>	J6	V <sub>CCIO&lt;G&gt;</sub>	M24	I/O<D>	R22	I/O<C>
B5	I/O<F>	D5	GNDPLL<0>	F5	I/O<F>	J21	V <sub>CCIO&lt;D&gt;</sub>	M25	I/O<D>	R23	I/O<C>
B6	I/O<F>	D6	I/O<F>	F6	GND	J22	I/O<D>	M26	I/O<D>	R24	I/O<C>
B7	IOCTRL<F>	D7	I/O<F>	F7	V <sub>CCIO&lt;F&gt;</sub>	J23	I/O<D>	N1	TCK	R25	I/O<C>
B8	I/O<F>	D8	I/O<F>	F8	V <sub>CC</sub>	J24	I/O<D>	N2	I/O<H>	R26	I/O<C>
B9	I/O<F>	D9	I/O<F>	F9	V <sub>CCIO&lt;F&gt;</sub>	J25	I/O<D>	N3	I/O<G>	T1	I/O<H>
B10	I/O<F>	D10	I/O<F>	F10	GND	J26	I/O<D>	N4	I/O<G>	T2	I/O<H>
B11	I/O<F>	D11	I/O<F>	F11	V <sub>CC</sub>	K1	I/O<G>	N5	I/O<G>	T3	I/O<H>
B12	I/O<F>	D12	I/O<F>	F12	V <sub>CCIO&lt;F&gt;</sub>	K2	I/O<G>	N6	GND	T4	I/O<H>
B13	CLK<5>/ PLLIN<3>	D13	TMS	F13	GND	K3	I/O<G>	N11	GND	T5	I/O<H>
B14	I/O<E>	D14	I/O<E>	F14	V <sub>CCIO&lt;E&gt;</sub>	K4	I/O<G>	N12	GND	T6	V <sub>CC</sub>
B15	I/O<E>	D15	I/O<E>	F15	V <sub>CC</sub>	K5	I/O<G>	N13	GND	T11	GND
B16	I/O<E>	D16	I/O<F>	F16	V <sub>CC</sub>	K6	GND	N14	GND	T12	GND
B17	I/O<E>	D17	I/O<E>	F17	GND	K21	GND	N15	GND	T13	GND
B18	INREF<E>	D18	I/O<F>	F18	V <sub>CCIO&lt;E&gt;</sub>	K22	I/O<D>	N16	GND	T14	GND
B19	I/O<E>	D19	CLK<8>	F19	V <sub>CC</sub>	K23	I/O<D>	N21	GND	T15	GND
B20	I/O<E>	D20	I/O<E>	F20	V <sub>CCIO&lt;E&gt;</sub>	K24	I/O<D>	N22	I/O<D>	T16	GND
B21	I/O<E>	D21	I/O<E>	F21	GND	K25	I/O<D>	N23	I/O<D>	T21	V <sub>CC</sub>
B22	I/O<E>	D22	I/O<E>	F22	I/O<E>	K26	I/O<D>	N24	I/O<D>	T22	V <sub>CC</sub>
B23	I/O<E>	D23	V <sub>CC</sub> PLL<1>	F23	I/O<D>	L1	I/O<G>	N25	I/O<D>	T23	I/O<C>
B24	I/O<E>	D24	I/O<E>	F24	I/O<D>	L2	I/O<G>	N26	I/O<D>	T24	I/O<C>
B25	I/O<E>	D25	I/O<E>	F25	I/O<D>	L3	I/O<G>	P1	I/O<H>	T25	I/O<C>
B26	PLLOUT<0>	D26	I/O<D>	F26	I/O<D>	L4	I/O<G>	P2	I/O<H>	T26	I/O<C>

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Table 24: 516 PBGA Pinout Table (Continued)

516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function	516 PBGA	Function
U1	I/O<H>	W25	INREF<C>	AA21	GND	AC3	I/O<A>	AD11	I/O<A>	AE19	I/O<B>
U2	I/O<H>	W26	I/O<C>	AA22	V <sub>CC</sub> PLL<2>	AC4	I/O<A>	AD12	TDI	AE20	I/O<B>
U3	I/O<H>	Y1	I/O<H>	AA23	I/O<C>	AC5	I/O<A>	AD13	CLK<4> DEDCLK/PLLIN<0>	AE21	I/O<B>
U4	I/O<H>	Y2	I/O<H>	AA24	I/O<C>	AC6	I/O<A>	AD14	I/O<A>	AE22	I/O<B>
U5	I/O<H>	Y3	I/O<H>	AA25	I/O<C>	AC7	I/O<A>	AD15	I/O<B>	AE23	I/O<B>
U6	GND	Y4	I/O<H>	AA26	I/O<C>	AC8	I/O<A>	AD16	I/O<B>	AE24	I/O<B>
U21	GND	Y5	I/O<H>	AB1	I/O<H>	AC9	I/O<A>	AD17	I/O<B>	AE25	PLL <sub>RST</sub> <2>
U22	I/O<C>	Y6	V <sub>CCIO</sub> <H>	AB2	I/O<H>	AC10	I/O<A>	AD18	INREF<B>	AE26	I/O<B>
U23	I/O<C>	Y21	V <sub>CCIO</sub> <C>	AB3	I/O<A>	AC11	I/O<A>	AD19	I/O<B>	AF1	I/O<A>
U24	I/O<C>	Y22	I/O<C>	AB4	GNDPLL<3>	AC12	I/O<A>	AD20	I/O<B>	AF2	I/O<A>
U25	I/O<C>	Y23	I/O<C>	AB5	V <sub>CC</sub> PLL<3>	AC13	I/O<A>	AD21	I/O<B>	AF3	I/O<A>
U26	I/O<C>	Y24	I/O<C>	AB6	I/O<A>	AC14	CLK<1>	AD22	I/O<B>	AF4	I/O<A>
V1	I/O<H>	Y25	I/O<C>	AB7	I/O<A>	AC15	I/O<B>	AD23	I/O<B>	AF5	I/O<A>
V2	IOCTRL<H>	Y26	IOCTRL<C>	AB8	I/O<A>	AC16	I/O<B>	AD24	GND	AF6	IOCTRL<A>
V3	IOCTRL<H>	AA1	I/O<H>	AB9	I/O<A>	AC17	I/O<B>	AD25	I/O<B>	AF7	I/O<A>
V4	I/O<H>	AA2	I/O<H>	AB10	I/O<A>	AC18	I/O<B>	AD26	I/O<B>	AF8	I/O<A>
V5	I/O<H>	AA3	I/O<H>	AB11	V <sub>CC</sub>	AC19	I/O<B>	AE1	GND	AF9	I/O<A>
V6	V <sub>CCIO</sub> <H>	AA4	I/O<A>	AB12	I/O<A>	AC20	I/O<B>	AE2	GND	AF10	I/O<A>
V21	V <sub>CCIO</sub> <C>	AA5	I/O<A>	AB13	I/O<A>	AC21	I/O<B>	AE3	I/O<A>	AF11	I/O<A>
V22	I/O<C>	AA6	GND	AB14	CLK<3>/PLLIN<1>	AC22	TDO	AE4	I/O<A>	AF12	CLK<2> /PLLIN<2>
V23	I/O<C>	AA7	V <sub>CCIO</sub> <A>	AB15	V <sub>CC</sub>	AC23	PLL <sub>OUT</sub> <1>	AE5	I/O<A>	AF13	I/O<B>
V24	IOCTRL<C>	AA8	V <sub>CC</sub>	AB16	I/O<B>	AC24	I/O<B>	AE6	I/O<A>	AF14	I/O<B>
V25	I/O<C>	AA9	V <sub>CCIO</sub> <A>	AB17	I/O<B>	AC25	I/O<B>	AE7	INREF<A>	AF15	I/O<B>
V26	I/O<C>	AA10	GND	AB18	I/O<B>	AC26	I/O<C>	AE8	I/O<A>	AF16	I/O<B>
W1	INREF<H>	AA11	V <sub>CC</sub>	AB19	V <sub>CC</sub>	AD1	I/O<A>	AE9	I/O<A>	AF17	I/O<B>
W2	I/O<H>	AA12	V <sub>CCIO</sub> <A>	AB20	I/O<B>	AD2	PLL <sub>OUT</sub> <2>	AE10	I/O<A>	AF18	I/O<B>
W3	I/O<H>	AA13	GND	AB21	I/O<B>	AD3	PLL <sub>RST</sub> <3>	AE11	I/O<A>	AF19	IOCTRL<B>
W4	I/O<H>	AA14	V <sub>CCIO</sub> <B>	AB22	GNDPLL<2>	AD4	I/O<A>	AE12	CLK<0>	AF20	IOCTRL<B>
W5	V <sub>CC</sub>	AA15	V <sub>CC</sub>	AB23	I/O<B>	AD5	I/O<A>	AE13	I/O<B>	AF21	I/O<B>
W6	V <sub>CC</sub>	AA16	V <sub>CC</sub>	AB24	I/O<C>	AD6	I/O<A>	AE14	I/O<B>	AF22	I/O<B>
W21	V <sub>CC</sub>	AA17	GND	AB25	I/O<C>	AD7	I/O<A>	AE15	I/O<B>	AF23	I/O<B>
W22	I/O<C>	AA18	V <sub>CCIO</sub> <B>	AB26	I/O<C>	AD8	IOCTRL<A>	AE16	I/O<B>	AF24	I/O<B>
W23	I/O<C>	AA19	V <sub>CC</sub>	AC1	I/O<A>	AD9	I/O<A>	AE17	I/O<B>	AF25	I/O<B>
W24	I/O<C>	AA20	V <sub>CCIO</sub> <B>	AC2	I/O<A>	AD10	I/O<A>	AE18	I/O<B>	AF26	I/O<B>

(Sheet 2 of 2)

# 516 PBGA Packaging Drawing

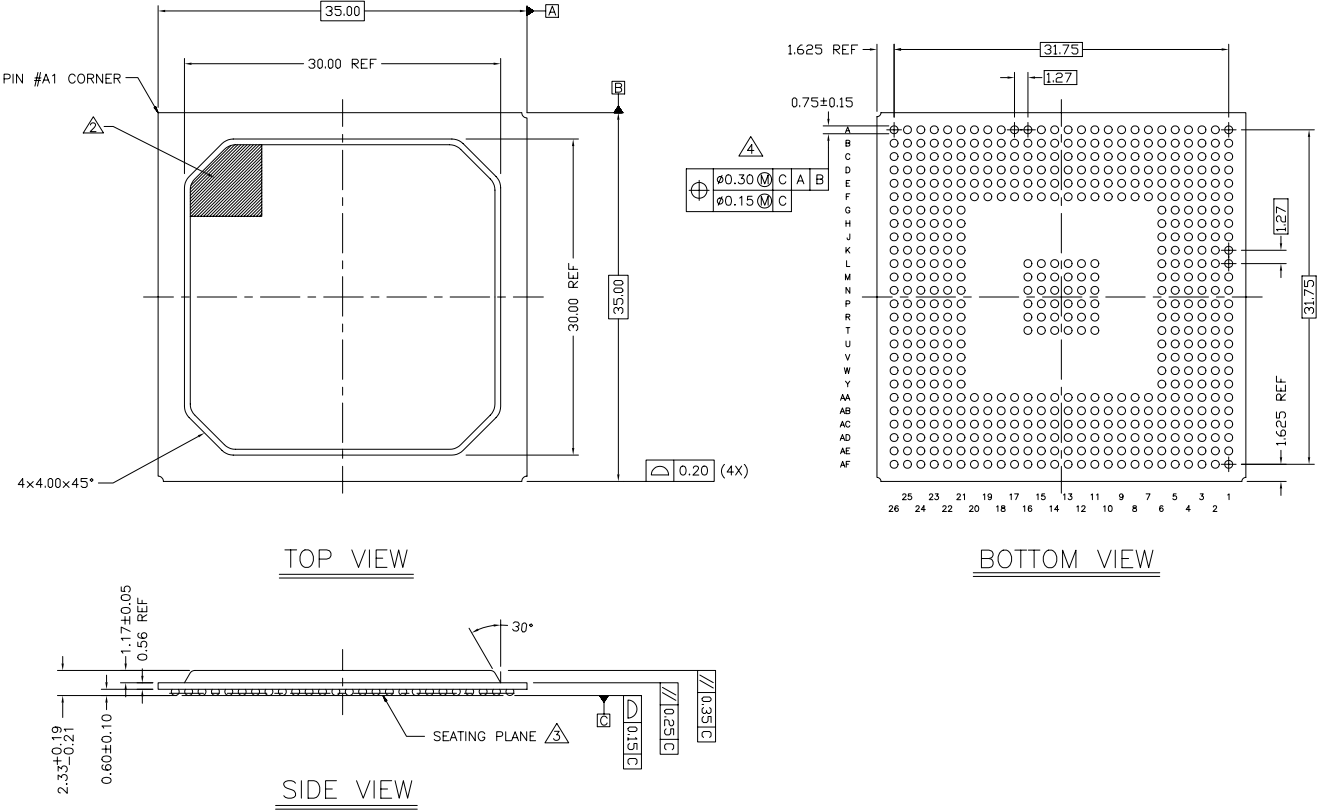


Figure 28: 516 PBGA Packaging Drawing

## Ordering Information

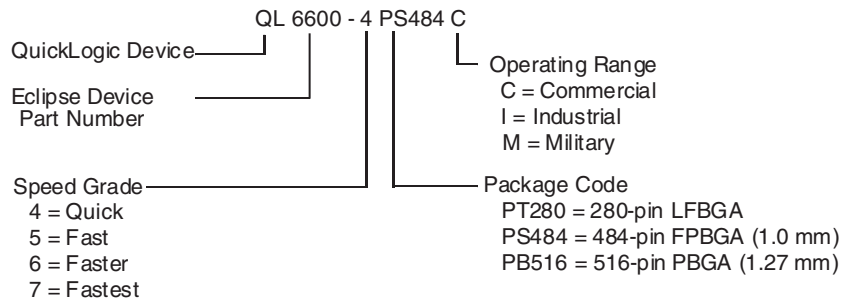


Figure 29: Ordering Information

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## Revision History

Table 25: Revision History

Revision	Date	Comments
A	April 2001	First release.
B	Jan 2002	Re-evaluation of AC/DC Specs and reformat
C	June 2002	Added Kfactor, Power-up, JTAG and mechanical drawing information.
D	April 2003	Brian Faith, Kathleen Murchek Incorporated comments, added PLL section, removed 672 pinout diagram, table, and pkg. dwg.
E	May 2003	Brian Faith, Kathleen Murchek

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