

••••• Low Power FPGA Combining Performance, Density, and Embedded RAM

Device Highlights

Flexible Programmable Logic

- 0.18 μ m, six layer metal CMOS process
- 1.8 V Vcc, 1.8/2.5/3.3 V drive capable I/O
- Up to 4,008 dedicated flip-flops
- Up to 55.3 K embedded RAM Bits
- Up to 313 I/O
- Up to 370 K system gates
- IEEE 1149.1 Boundary Scan Testing Compliant
- Low Power Capability

Embedded Dual Port SRAM

- Up to twenty-four 2,304 bit Dual Port High Performance SRAM Blocks
- Up to 55,296 embedded RAM bits
- RAM/ROM/FIFO Wizard for automatic configuration
- Configurable and cascadable

Programmable I/O

- High performance I/O cell with $T_{CO} < 3$ ns
- Programmable Slew Rate Control
- Programmable I/O Standards:
 - LVTTTL, LVCMOS, LVCMOS18, PCI, GTL+, SSTL2, and SSTL3
- Independent I/O Banks capable of supporting multiple standards in one device
- I/O Register Configurations: Input, Output, Output Enable (OE)

Advanced Clock Network

- Multiple dedicated Low Skew Clock Networks
- High drive input-only networks
- Quadrant-based segmentable clock networks
- User Programmable Phase Locked Loops

Embedded Computational Units (ECUs)

Hardwired DSP building blocks with integrated Multiply, Add, and Accumulate Functions.

Security Features

The QuickLogic products come with secure ViaLink® technology that protects intellectual property from design theft and reverse engineering. No external configuration memory needed; Instant-on at Power-up.

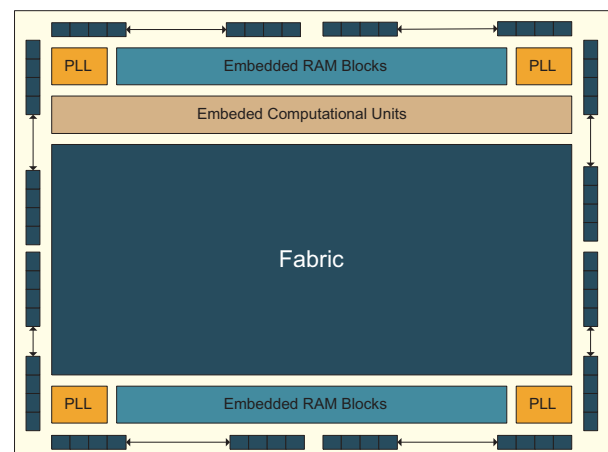


Figure 1: Eclipse-II Block Diagram

Table 1: Eclipse-II Product Family Members

		QL8025	QL8050	QL8150	QL8250	QL8325
	Max Gates	47,052	63,840	188,946	248,160	320,640
	Logic Array	16 x 8	16 x 16	32 x 20	40 x 24	48 x 32
	Logic Cells	128	256	640	960	1,536
	Max Flip-Flops	526	884	1,697	2,670	4,002
	Max I/O	90	124	139	250	310
	RAM Modules	4	4	16	20	24
	RAM Bits	9,216	9,216	36,864	46,100	55,300
	PLLs	0	0	0	4	4
	ECUs	0	0	0	10	12
Packages	VQFP	100	100	100	-	-
	CSBGA (0.8 mm)	196	196	196	-	-
	PQFP	208	208	208	208	208
	FBGA (0.8 mm)	-	-	-	280	280
	BGA (1.0 mm)	-	-	-	484	484

Table 2: Max I/O per Device/Package Combination

Device	100 VQFP	196 CSBGA	208 PQFP	280 CSBGA	484 PBGA
QL8025	62	90	90	-	-
QL8050	62	100	124	-	-
QL8150	62	100	139	-	-
QL8250	-	-	115	163	250
QL8325	-	-	115	163	310

QuickWorks Design Software

The QuickWorks® package provides the most complete ESP and FPGA software solution from design entry to logic synthesis, to place and route, and simulation. The package provides a solution for designers who use third party tools from Cadence, Mentor, OrCAD, Synopsys, Viewlogic, and other third-party tools for design entry, synthesis, or simulation.

Process Data

Eclipse-II is fabricated on a 0.18 μ , six layer metal CMOS process. The core voltage is 1.8 V Vcc supply and the I/Os are up to 3.3 V tolerant. The Eclipse-II product line is available in commercial, industrial, and military temperature grades.

Programmable Logic Architectural Overview

The Eclipse-II logic cell structure is presented in **Figure 2**. This architectural feature addresses today's register-intensive designs.

Table 3: Performance Standards

Function	Description	Slowest Speed Grade	Fastest Speed Grade
Multiplexer	16:1	5 ns	2.8 ns
Parity Tree	24	6 ns	3.4 ns
Counter	36	6 ns	3.4 ns
	16 bit	250 MHz	450 MHz
	32 bit	250 MHz	450 MHz
FIFO	128 x 32	155 MHz	280 MHz
	256 x 16	155 MHz	280 MHz
	128 x 64	155 MHz	280 MHz
Clock-to-Out		4.5 ns	2.5 ns
System clock		200 MHz	400 MHz

The Eclipse-II logic cell structure presented in **Figure 2** is a dual register, multiplexor-based logic cell. It is designed for wide fan-in and multiple, simultaneous output functions. Both registers share CLK, SET, and RESET inputs. The second register has a two-to-one multiplexer controlling its input. The register can be loaded from the NZ output or directly from a dedicated input.

NOTE: The input PP is not an "input" in the classical sense. It is a static input to the logic cell and selects which path (NZ or PS) is used as an input to the Q2Z register. All other inputs are dynamic and can be connected to multiple routing channels.

The complete logic cell consists of two 6-input AND gates, four two-input AND gates, seven two-to-one multiplexers, and two D flip-flops with asynchronous SET and RESET controls. The cell has a fan-in of 30 (including register control lines), fits a wide range of functions with up to 17 simultaneous inputs, and has six outputs (four combinatorial and two registered). The high logic capacity and fan-in of the logic cell accommodates many user functions with a single level of logic delay while other architectures require two or more levels of delay.

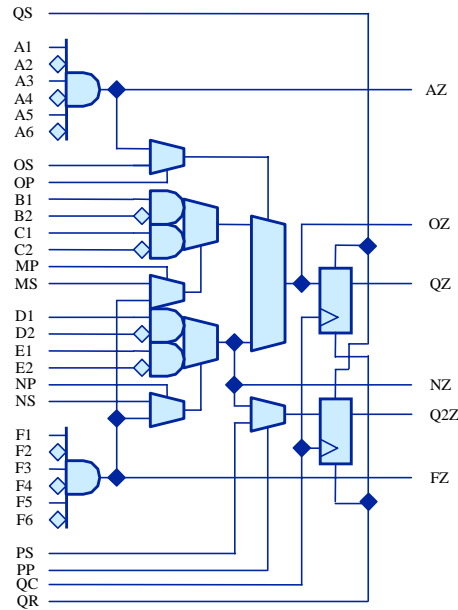


Figure 2: Eclipse-II LogicCell

RAM Modules

The Eclipse-II Product Family includes up to 24 dual-port 2,304-bit RAM modules for implementing RAM, ROM, and FIFO functions. Each module is user-configurable into four different block organizations and can be cascaded horizontally to increase their effective width, or vertically to increase their effective depth as shown in **Figure 4**.

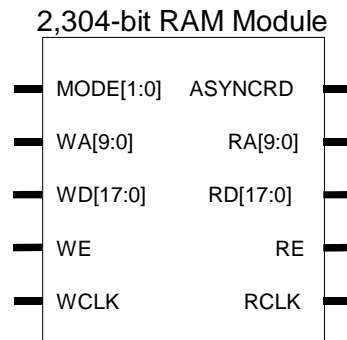


Figure 3: 2,304-bit RAM Module

The number of RAM modules varies from 4 to 24 blocks for a total of 9.2 K to 55.3 K bits of RAM. Using two "mode" pins, designers can configure each module into 128 x 18 (Mode 0), 256 x 9 (Mode 1), 512 x 4 (Mode 2), or 1024 x 2 blocks (Mode 3). The blocks are also easily cascadable to increase their effective width and/or depth (see **Figure 4**).

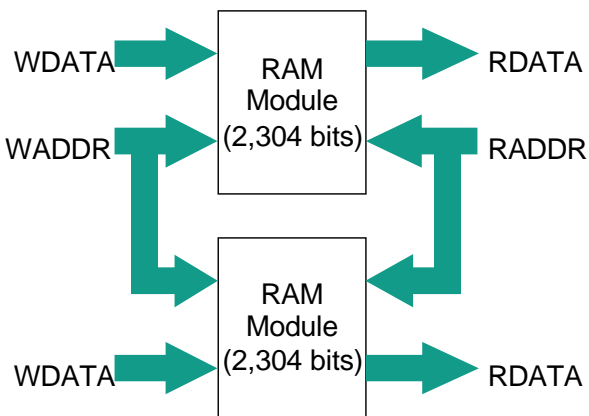


Figure 4: Cascaded RAM Modules

The RAM modules are dual-port, with completely independent READ and WRITE ports and separate READ and WRITE clocks. The READ ports support asynchronous and synchronous operation, while the WRITE ports support synchronous operation. Each port has 18 data lines and 10 address lines, allowing word lengths of up to 18 bits and address spaces of up to 1,024 words. Depending on the mode selected, however, some higher order data or address lines may not be used.

The Write Enable (WE) line acts as a clock enable for synchronous write operation. The Read Enable (RE) acts as a clock enable for synchronous READ operation (ASYNCRD input low), or as a flow-through enable for asynchronous READ operation (ASYNCRD input high).

Designers can cascade multiple RAM modules to increase the depth or width allowed in single modules by connecting corresponding address lines together and dividing the words between modules.

A similar technique can be used to create depths greater than 512 words. In this case address signals higher than the ninth bit are encoded onto the write enable (WE) input for WRITE operations. The READ data outputs are multiplexed together using encoded higher READ address bits for the multiplexer SELECT signals.

The RAM blocks can be loaded with data generated internally (typically for RAM or FIFO functions) or with data from an external PROM (typically for ROM functions).

Embedded Computational Unit (ECU)

Traditional Programmable Logic architectures do not implement arithmetic functions efficiently or effectively—these functions require high logic cell usage while garnering only moderate performance results.

The Eclipse-II architecture allows for functionality above and beyond that achievable using programmable logic devices. By embedding a dynamically reconfigurable computational unit, the Eclipse-II device can address various arithmetic functions efficiently. This approach offers greater performance than traditional programmable logic implementations. The embedded block is implemented at the transistor level as shown in [Figure 5](#).

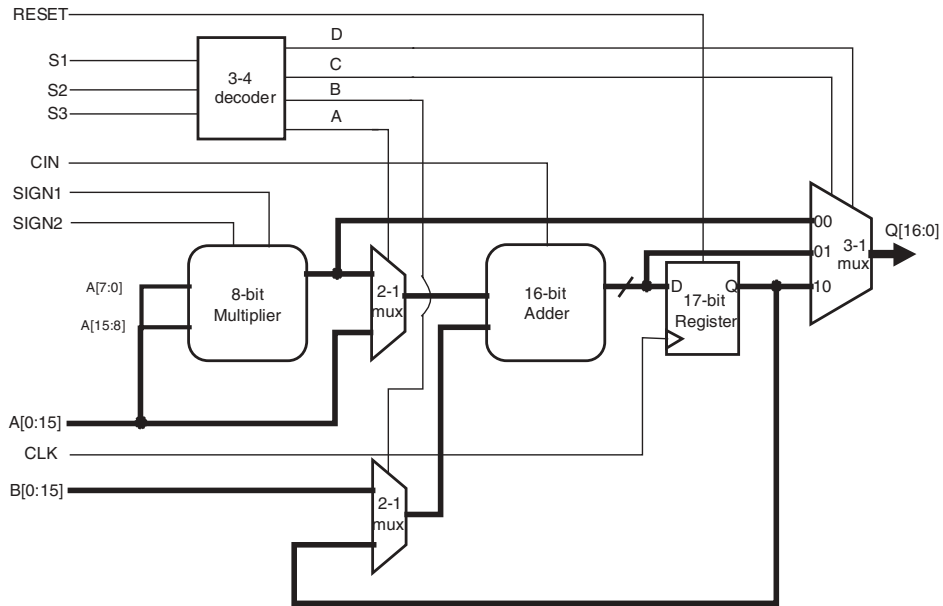


Figure 5: ECU Block Diagram

The Eclipse-II ECU blocks (Table 4) are placed next to the SRAM circuitry for efficient memory/instruction fetch and addressing for DSP algorithmic implementations.

Table 4: Eclipse-II ECUs Blocks

Device	ECUs
QL8325	12
QL8250	10
QL8150	0
QL8050	0
QL8025	0

Up to twelve 8-bit MAC functions can be implemented per cycle for a total of 1 billion MACs/s when clocked at 100 MHz. Additional multiply-accumulate functions can be implemented in the programmable logic.

The modes for the ECU block are dynamically re-programmable through the programmable logic.

Table 5: ECU Mode Select Criteria

Instruction			Operation	ECU Performance ^a , -7 WCC		
S1	S2	S3		t _{PD}	t _{SU}	t _{CO}
0	0	0	Multiply	6.6 ns max		
0	0	1	Multiply-Add	8.8 ns max		
0	1	0	Accumulate ^b		3.9 ns min	1.2 ns max
0	1	1	Add	3.1 ns max		
1	0	0	Multiply (registered) ^c		9.6 ns min	1.2 ns max
1	0	1	Multiply- Add (registered)		9.6 ns min	1.2 ns max
1	1	0	Multiply - Accumulate		9.6 ns min	1.2 ns max
1	1	1	Add (registered)		3.9 ns min	1.2 ns max

- a. t_{PD}, t_{SU} and t_{CO} do not include routing paths in/out of the ECU block.
 b. Internal feedback path in ECU restricts max clk frequency to 238 MHz.
 c. B [15:0] set to zero.

NOTE: Timing numbers in **Table 5** represent -7 Worst Case Commercial conditions.

Phase Locked Loop (PLL) Information

Instead of requiring extra components, designers simply need to instantiate one of the pre-configured models (described in this section). The QuickLogic built-in PLLs support a wider range of frequencies than many other PLLs. These PLLs also have the ability to support different ranges of frequency multiplications or divisions, driving the device at a faster or slower rate than the incoming clock frequency. When PLLs are cascaded, the clock signal must be routed off-chip through the PLLPAD_OUT pin prior to routing into another PLL; internal routing cannot be used for cascading PLLs.

PLLs 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 6 illustrates a QuickLogic PLL.

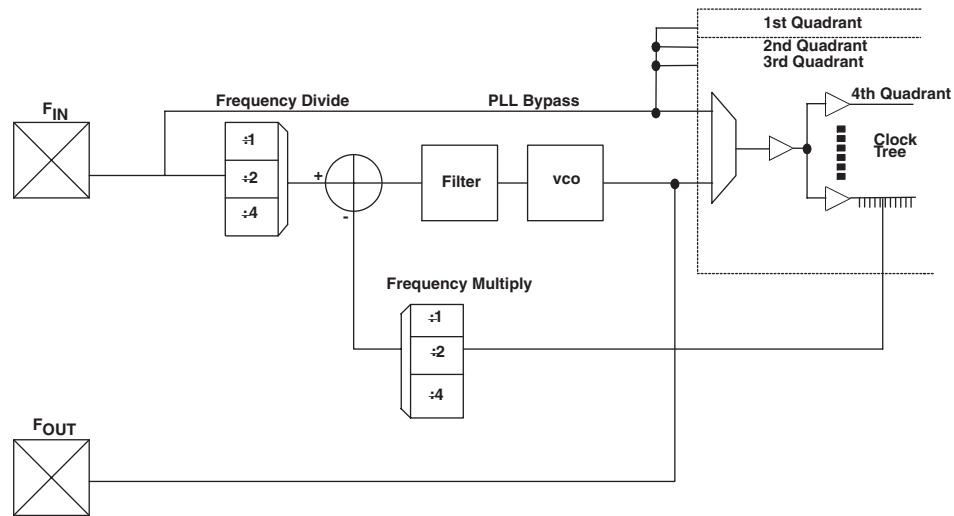


Figure 6: PLL Block Diagram

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 6) 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 6). 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 emerging from the output pad (the output signal PLLPAD_OUT is explained in Table 7). This clock signal is meaningful only when the PLL is configured for external use; otherwise, it remains in high Z state.

Most QuickLogic products contain four PLLs. The PLL presented in Figure 6 controls the clock tree in the fourth quadrant of its FPGA. QuickLogic PLLs compensate for the additional delay created by the clock tree itself, as previously noted, by subtracting the clock tree delay through the feedback path.

For more specific information on the Phase Locked Loops, please refer to QuickLogic Application Note 58.

PLL Modes of Operation

QuickLogic PLLs have eight modes of operation, based on the input frequency and desired output frequency—Table 6 indicates the features of each mode.

NOTE: "HF" stands for "high frequency" and "LF" stands for "low frequency."

Table 6: PLL Mode Frequencies

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

The input frequency can range from 16 MHz to 300 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.

PLL Signals

Table 7 summarizes the key signals in QuickLogic's PLLs.

Table 7: QuickLogic PLL Signals

Signal Name	Description
PLLCLK_IN	Input clock signal
PLL_RESET	Active High Reset If PLL_RESET 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	PLL output 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	Out to internal gates 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	Out from PLL to internal gates 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	Out to off-chip This outgoing signal is used off-chip. For this to work, ONn_OFFCHIP signal must be tied to VCC.
LOCK_DETECT	Active High Lock detection signal 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.

NOTE: Because PLLCLK_IN and PLL_RESET signals have PLL_INPAD, and PLLPAD_OUT has OUTPAD, you do not have to add additional pads to your design.

I/O Cell Structure

Eclipse-II features a variety of distinct I/O pins to maximize performance, functionality, and flexibility with bi-directional I/O pins and input-only pins. All input and I/O pins are 1.8 V, 2.5 V, and 3.3 V tolerant and comply with the specific I/O standard selected. For single ended I/O standards, VCCIO specifies the input tolerance and the output drive. For voltage referenced I/O standards (e.g SSTL), the voltage supplied to the INREF pins in each bank specifies the input switch point. For example, the VCCIO pins must be tied to a 3.3 V supply to provide 3.3 V compliance. Eclipse-II can also support the LVDS and LVPECL I/O standards with the use of external resistors (see [Table 8](#)).

Table 8: I/O Standards and Applications

I/O Standard	Reference Voltage	Output Voltage	Application
LVTTL	n/a	3.3 V	General Purpose
LVC MOS25	n/a	2.5 V	General Purpose
LVC MOS18	n/a	1.8 V	General Purpose
PCI	n/a	3.3 V	PCI Bus Applications
GTL+	1	n/a	Backplane
SSTL3	1.5	3.3 V	SDRAM
SSTL2	1.25	2.5 V	SDRAM

As designs become more complex and requirements more stringent, several application-specific I/O standards have emerged for specific applications. I/O standards for processors, memories, and a variety of bus applications have become commonplace and a requirement for many systems. In addition, I/O timing has become a greater issue with specific requirements for setup, hold, clock to out, and switching times. Eclipse-II has addressed these new system requirements and now includes a completely new I/O cell which consists of programmable I/Os as well as a new cell structure consisting of three registers—Input, Output, and OE.

Eclipse-II offers banks of programmable I/Os that address many of the bus standards that are popular today. As shown in [Figure 7](#) each bi-directional I/O pin is associated with an I/O cell which features an input register, an input buffer, an output register, a three-state output buffer, an output enable register, and 2 two-to-one output multiplexers.

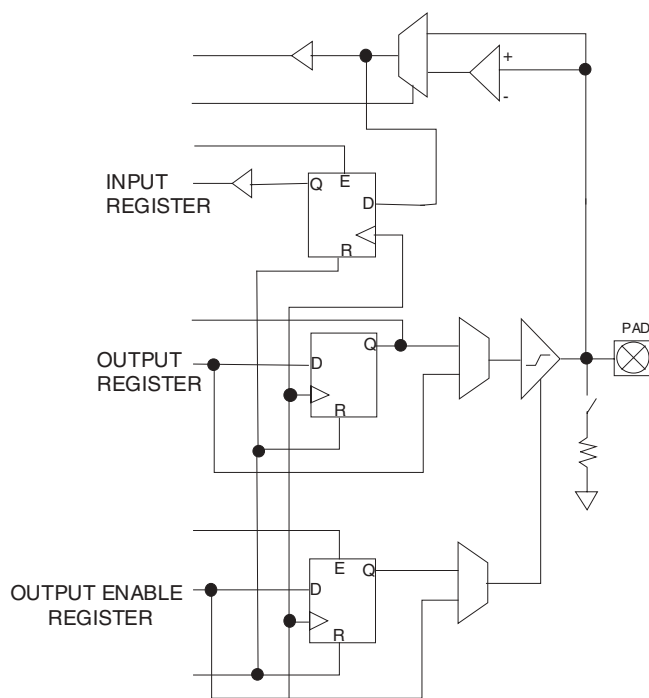


Figure 7: Eclipse-II I/O Cell

The bi-directional I/O pin options can be programmed for input, output, or bi-directional operation. As shown in **Figure 7**, each bi-directional I/O pin is associated with an I/O cell which features an input register, an input buffer, an output register, a three-state output buffer, an output enable register, and 2 two-to-one multiplexers. The select lines of the two-to-one multiplexers are static and must be connected to either Vcc or GND.

For input functions, I/O pins can provide combinatorial, registered data, or both options simultaneously to the logic array. For combinatorial input operation, data is routed from I/O pins through the input buffer to the array logic. For registered input operation, I/O pins drive the D input of input cell registers, allowing data to be captured with fast set-up times without consuming internal logic cell resources. The comparator and multiplexer in the input path allows for native support of I/O standards with reference points offset from traditional ground.

For output functions, I/O pins can receive combinatorial or registered data from the logic array. For combinatorial output operation, data is routed from the logic array through a multiplexer to the I/O pin. For registered output operation, the array logic drives the D input of the output cell register which in turn drives the I/O pin through a multiplexer. The multiplexer allows either a combinatorial or a registered signal to be driven to the I/O pin. The addition of an output register will also decrease the Tco. Since the output register does not need to drive the routing the length of the output path is also reduced.

The three-state output buffer controls the flow of data from the array logic to the I/O pin and allows the I/O pin to act as an input and/or output. The buffer's output enable can be individually controlled by the logic cell array or any pin (through the regular routing resources), or it can be bank-controlled through one of the global networks. The signal can also be either combinatorial

or registered. This is identical to that of the flow for the output cell. For combinatorial control operation data is routed from the logic array through a multiplexer to the three-state control. The IOCTRL pins can directly drive the OE and CLK signals for all I/O cells within the same bank.

For registered control operation, the array logic drives the D input of the OE cell register which in turn drives the three-state control through a multiplexer. The multiplexer allows either a combinatorial or a registered signal to be driven to the three-state control.

When I/O pins are unused, the OE controls can be permanently disabled, allowing the output cell register to be used for registered feedback into the logic array.

I/O cell registers are controlled by clock, clock enable, and reset signals, which can come from the regular routing resources, from one of the global networks, or from two IOCTRL input pins per bank of I/O's. The CLK and RESET signals share common lines, while the clock enables for each register can be independently controlled. I/O interface support is programmable on a per bank basis. The two larger Eclipse-II devices contain eight I/O banks. The two smaller Eclipse-II devices contain two I/O banks per device. **Figure 8** illustrates the I/O bank configurations.

Each I/O bank is independent of other I/O banks and each I/O bank has its own VCCIO and INREF supply inputs. A mixture of different I/O standards can be used on the device; however, there is a limitation as to which I/O standards can be supported within a given bank. Only standards that share a common VCCIO and INREF can be shared within the same bank (e.g. PCI and LVTTL).

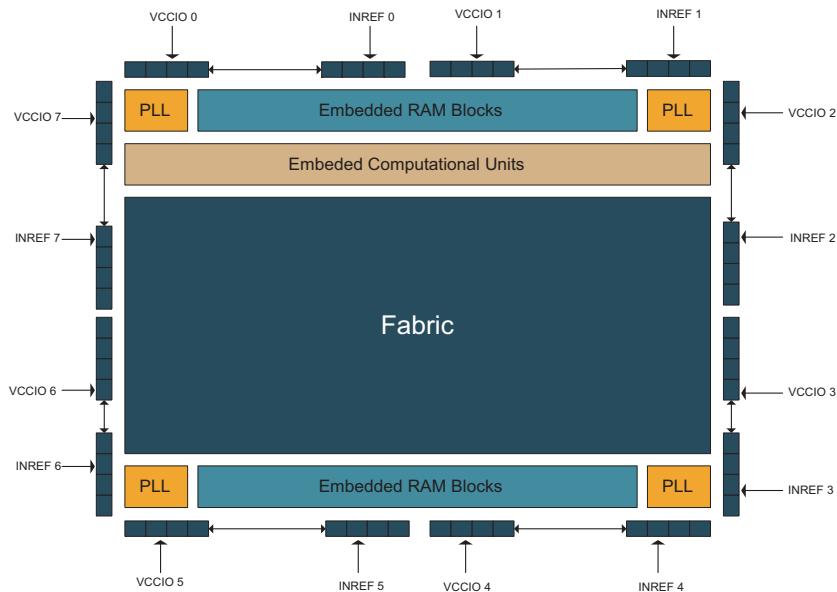


Figure 8: Multiple I/O Banks

Programmable Slew Rate

Each I/O has programmable slew rate capability—the slew rate can be either fast or slow. The slower rate can be used to reduce the switching times of each I/O.

Programmable Weak Pull-Down

A programmable Weak Pull-Down resistor is available on each I/O. The I/O Weak Pull-Down eliminates the need for external pull down resistors for used I/Os. The spec for pull-down current is maximum of 150 μ A under worst case condition.

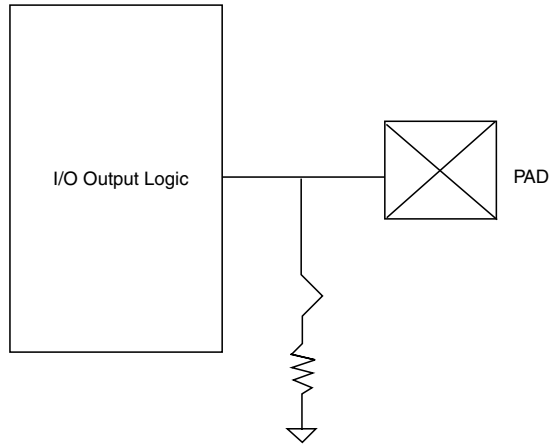


Figure 9: Programmable I/O Weak Pull-Down

Clock Networks

Global Clocks

There are a maximum of eight global clock networks in each Eclipse-II device. Global clocks can drive logic cells and I/O registers, ECUs, and RAM blocks in the device. All global clocks have access to a Quad Net (local clock network) connection with a programmable connection to the logic cell's register clock input.

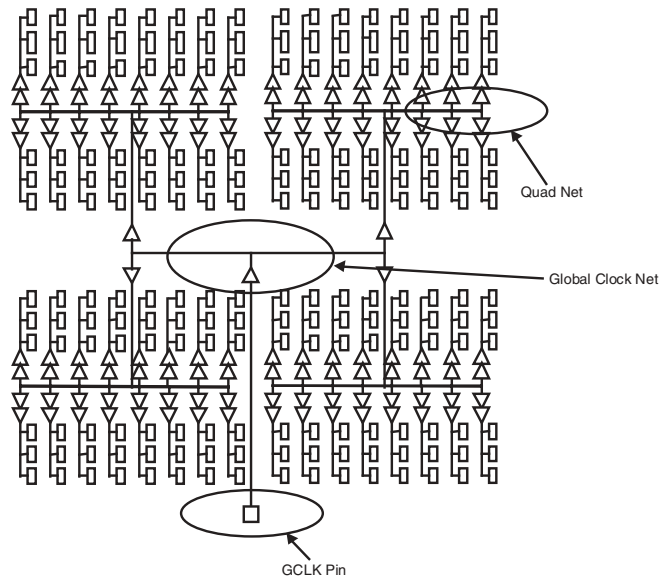


Figure 10: Global Clock Architecture

Quad-Net Network

There are five Quad-Net local clock networks in each quadrant for a total of 20 in a device. Each Quad-Net is local to a quadrant. Before driving the columns clock buffers, the quad-net is driven by the output of a mux which selects between the GCLK input and an internally generated clock source (see Figure 11).

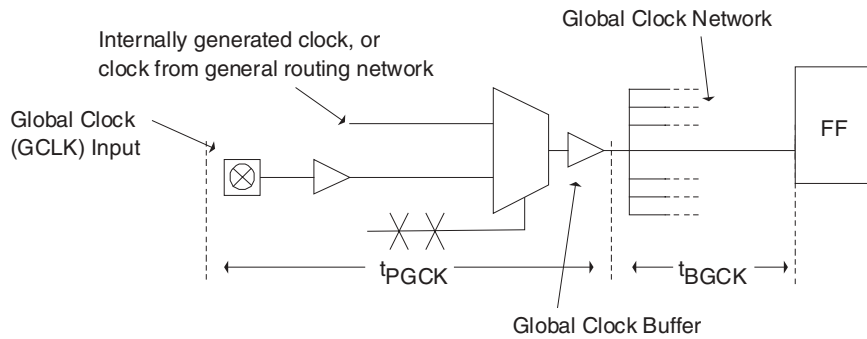


Figure 11: Global Clock Structure Schematic

Dedicated Clock

There is one dedicated clock in the two larger devices of the Eclipse-II Family (QL8325 and QL8250). This clock connects to the clock input of the LogicCell and I/O registers, and RAM blocks through a hardwired connection and is multiplexed with the programmable clock input. The dedicated clock provides a fast global network with low skew. Users have the ability to select either the dedicated clock or the programmable clock (**Figure 12**).

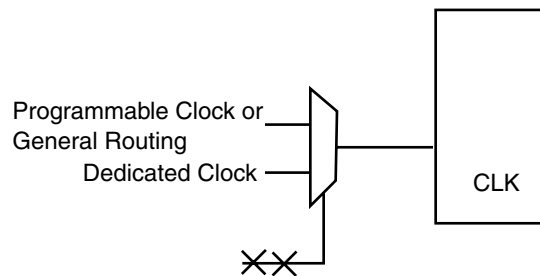


Figure 12: Dedicated Clock Circuitry within Logic Cell

NOTE: For more information on the clocking capabilities of Eclipse-II FPGAs, please see the QuickLogic Application Note 68.

I/O Control and Local Hi-Drives

Each bank of I/Os has two input-only pins that can be programmed to drive the RST, CLK, and EN inputs of I/Os in that bank. These input-only pins also serve as high drive inputs to a quadrant. These buffers can be driven by the internal logic both as an I/O control or high drive. The performance of these drives is presented in **Table 9**.

Table 9: I/O Control Network/Local High-Drive

Destination TT, 25 C, 2.5 V	From Pad	From Array
I/O (far)	1.00 ns	1.14 ns
I/O (near)	0.63 ns	0.78 ns
Skew	0.37 ns	0.36 ns

Programmable Logic Routing

Eclipse-II devices are delivered with six types of routing resources as follows: short (sometimes called segmented) wires, dual wires, quad wires, express wires, distributed networks, and default wires. Short wires span the length of one logic cell, always in the vertical direction. Dual wires run horizontally and span the length of two logic cells. Short and dual wires are predominantly used for local connections. Default wires supply VCC and GND (Logic '1' and Logic '0') to each column of logic cells.

Quad wires have passive link interconnect elements every fourth logic cell. As a result, these wires are typically used to implement intermediate length or medium fan-out nets.

Express lines run the length of the programmable logic uninterrupted. Each of these lines has a higher capacitance than a quad, dual, or short wire, but less capacitance than shorter wires connected to run the length of the device. The resistance will also be lower because the express wires don't require the use of "pass" links. Express wires provide higher performance for long routes or high fan-out nets.

Distributed networks are described in the clock/control section. These wires span the programmable logic and are driven by "column clock" buffers. All clock network pin buffers (both Dedicated and Global) are hard wired to individual sets of column clock buffers.

Global Power-On Reset (POR)

The Eclipse-II family of devices features a global power-on reset. This reset is hardwired to all registers and resets them to Logic '0' upon power-up of the device. In QuickLogic devices, the asynchronous Reset input to flip-flops has priority over the Set input; therefore, the Global POR will reset all flip-flops during power-up. If you want to set the flip-flops to Logic '1', you must assert the "Set" signal after the Global POR signal has been deasserted.

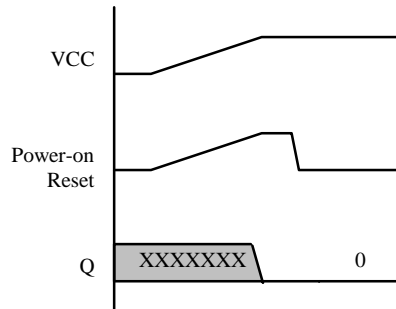


Figure 13: Power-On Reset

Low Power Mode

Power consumption of the two smaller Eclipse-II devices can be reduced significantly by deactivating the charge pumps inside the architecture. By applying 3.3 V to the Vpump pin, the internal charge pump is de-activated—this effectively reduces the dynamic power consumption of the device. Users who have a 3.3 V supply available in their system should take advantage of this low power feature by tying the Vpump pin to 3.3 V. Otherwise, if a 3.3 V supply is not available, this pin should be tied to ground.

Joint Test Access Group (JTAG) Information

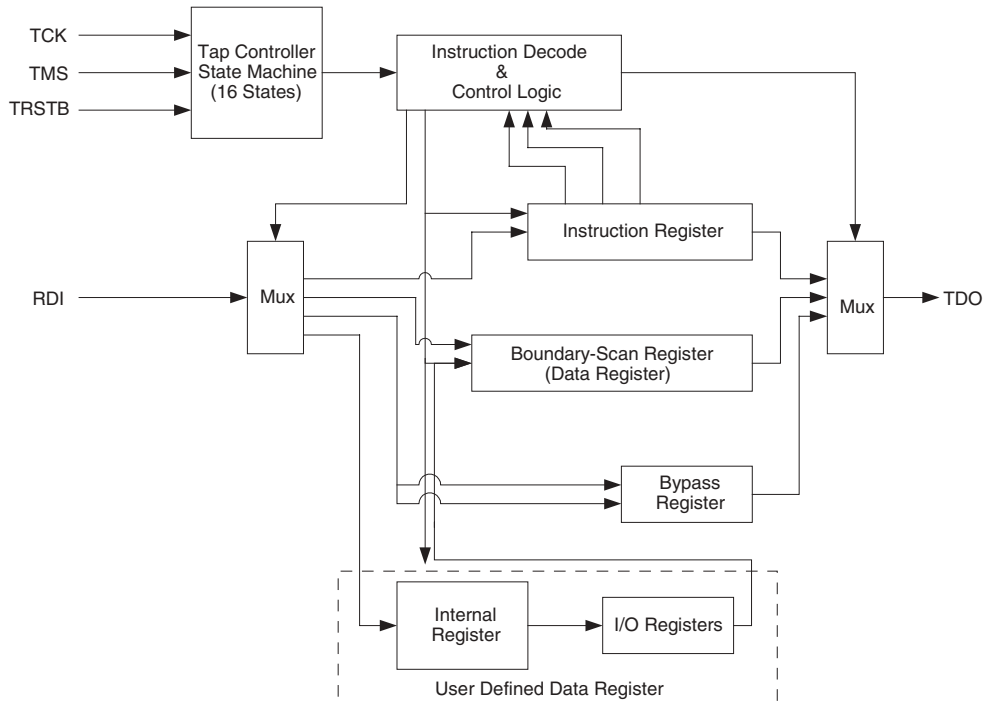


Figure 14: JTAG Block Diagram

Microprocessors and Application Specific Integrated Circuits (ASICs) pose many design challenges, one problem being the accessibility of test points. 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.

JTAG BSDL Support

- BSDL-Boundary Scan Description Language
- Machine-readable data for test equipment to generate testing vectors and software
- BSDL files available for all device/ package combinations from QuickLogic
- Extensive industry support available and ATVG (Automatic Test Vector Generation)

Security fuses

There are two security links: one to disable reading logic from the array, and the second to disable JTAG access to the device. Programming these optional links completely disables access to the device from the outside world and provides an extra level of design security not possible in SRAM-based FPGAs. The option to program these fuses is selectable via QuickWorks in the Tools/Options/Device Programming window in SpDE.

Flexibility fuse

The flexibility link enables Power-Up loading of the Embedded RAM blocks. If the link is programmed, the Power Up Loading state machine is activated during power-up of the device. The state machine communicates with an external EPROM via the JTAG pins to download memory contents into the on-chip RAM. If the link is not programmed, Power-Up Loading is not enabled and the JTAG pins function as they normally would. The option to program this bit is selectable via QuickWorks in the Tools/Options/Device Programming window in SpDE. For more information on Power-Up Loading refer to QuickLogic Application Note 55.

Electrical Specifications

DC Characteristics

The DC Specifications are provided in **Table 10** through **Table 12**.

Table 10: Absolute Maximum Ratings

Parameter	Value	Parameter	Value
V _{CC} Voltage	-0.5 V to 2.0 V	DC Input Current	±20 mA
V _{CCIO} Voltage	-0.5 V to 4.0 V	ESD Pad Protection	±2000 V
INREF Voltage	0.5 V to V _{CCIO}	Leaded Package Storage Temperature	-65° C to + 150° C
Input Voltage	-0.5 V to V _{CCIO} + 0.5 V	Laminate Package (BGA) Storage Temperature	-55° C to + 125° C
Latch-up Immunity	±100 mA		

Table 11: Operating Range

Symbol	Parameter	Military		Industrial		Commercial		Unit	
		Min	Max	Min	Max	Min	Max		
V _{CC}	Supply Voltage	1.71	1.98	1.71	1.98	1.71	1.98	V	
V _{CCIO}	I/O Input Tolerance Voltage	1.71	3.60	1.71	3.60	1.71	3.60	V	
TA	Ambient Temperature	-55	-	-40	85	0	70	°C	
TC	Case Temperature	-	125	-	-	-	-	°C	
K	Delay Factor	-7 Speed Grade	0.42	1.35	0.43	1.26	0.46	1.23	n/a
		-8 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	μA
I_{OZ}	3-State Output Leakage Current	$V_I = V_{CCIO}$ or GND	-	10	μA
C_I	I/O Input Capacitance ^a	-	-	8	pF
C_{CLOCK}	Clock Input Capacitance	-	-	8	pF
I_{OS}	Output Short Circuit Current ^b	$V_o = \text{GND}$ $V_o = V_{CC}$	-15 40	-180 210	mA mA
I_{ded}	D.C. Supply Current on V_{ded}	-	-	-	mA
I_{REF}	D.C. Supply Current on INREF	-	-10	10	μA
I_{PD}	Current on programmable Pull-down	$V_{CCIO} = 3.6 \text{ V}$ $V_{CCIO} = 2.5 \text{ V}$ $V_{CCIO} = 1.8 \text{ V}$	-	150	μA

- 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.

Table 13: Icc Characteristics

Device	$V_{pump} = 0 \text{ V}$	$V_{pump} = 3.3 \text{ V}$
QL8025	-	-
QL8050	-	-
QL8150	-	-
QL8250 ^a	2 mA	-
QL8325 ^a	2 mA	-

- a. For -7/-8 commercial grade devices only. Maximum I_{CC} is 3 mA for all industrial grade devices and 5 mA for all military devices.

Table 14: DC Input and Output Levels^a

	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	2.2	$V_{CCIO} + 0.3$	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
LVC MOS18	n/a	n/a	-0.3	0.63	1.2	$V_{CCIO} + 0.3$	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

- a. The data provided in **Table 8** and **Table 9** are JEDEC and PCI Specifications. QuickLogic devices either meet or exceed these requirements. For data specific to QuickLogic I/Os, see preceding **Table 20** through **Table 24**, **Figure 7** through **Figure 9**, and **Figure 23** through **Figure 26**.

NOTE: All CLK and IOCTRL pins are clamped to the V_{ded} rail. Therefore, these pins can be driven up to $V_{ded} + 0.3$ V.

AC Characteristics

The AC Specifications (at $V_{CC} = 1.8\text{ V}$, $T_A = 25^\circ\text{ C}$, Worst Case Corner, Speed Grade = -7 (K = 1.16)) are provided from **Table 15** to **Table 24**. Logic Cell diagrams and waveforms are provided from **Figure 15** to **Figure 27**.

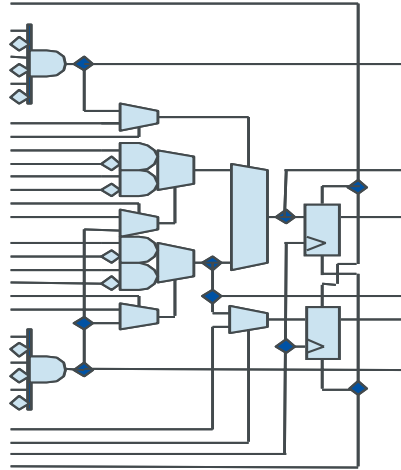


Figure 15: Eclipse-II Logic Cell

Table 15: Logic Cells

Symbol Logic Cells	Parameter	Value	
		Min	Max
t_{PD}	Combinatorial Delay of the longest path: time taken by the combinatorial circuit to output	-	0.257 ns
t_{SU}	Setup time: time the synchronous input of the flip-flop must be stable before the active clock edge	0.22 ns	-
t_{HL}	Hold time: time the synchronous input of the flip-flop must be stable after the active clock edge	0 ns	-
t_{CO}	Clock-to-out delay: the amount of time taken by the flip-flop to output after the active clock edge.	-	0.255 ns
t_{CWHI}	Clock High Time: required minimum time the clock stays high	0.46 ns	-
t_{CWLO}	Clock Low Time: required minimum time that the clock stays low	0.46 ns	-
t_{SET}	Set Delay: time between when the flip-flop is "set" (high) and when the output is consequently "set" (high)	-	0.18 ns
t_{RESET}	Reset Delay: time between when the flip-flop is "reset" (low) and when the output is consequently "reset" (low)	-	0.09 ns
t_{SW}	Set Width: time that the SET signal must remain high/low	0.3 ns	-
t_{RW}	Reset Width: time that the RESET signal must remain high/low	0.3 ns	-

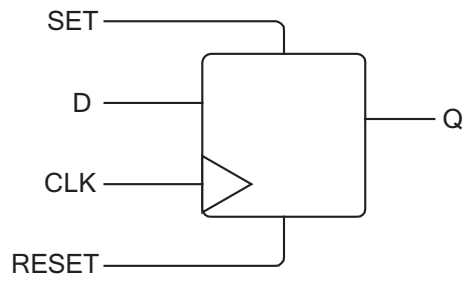


Figure 16: Logic Cell Flip-flop

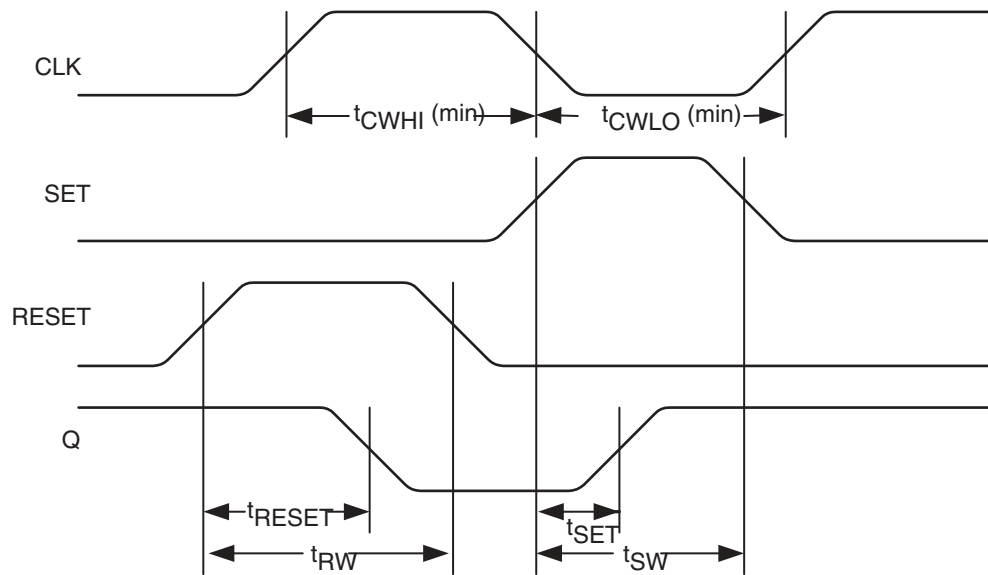


Figure 17: Logic Cell Flip-Flop Timings—First Waveform

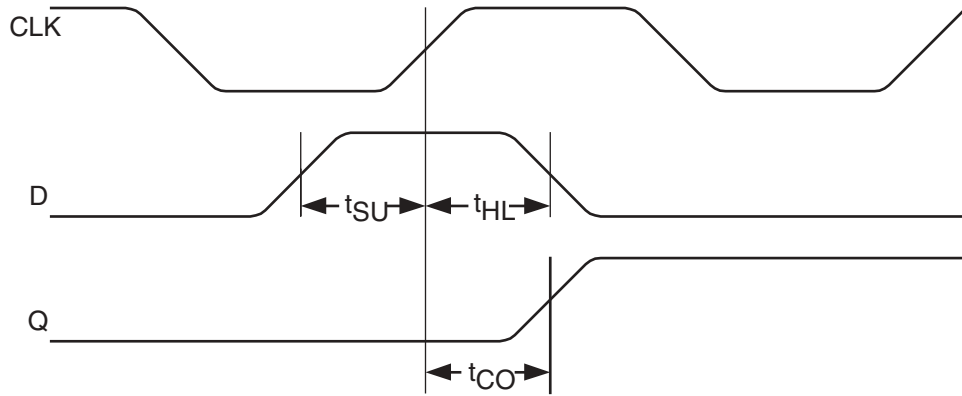


Figure 18: Logic Cell Flip-Flop Timings—Second Waveform

Table 16: Eclipse-II Clock Delay

Clock Source	Parameters	Clock Performance	
		Global	Dedicated
Logic Cells (Internal)	Clock signal generated internally	1.51 ns (max)	-
Clock Pad	Clock signal generated externally	2.06 ns (max)	1.73 ns

Table 17: Eclipse-II Global Clock Delay

Clock Segment	Parameter	Value	
		Min	Max
t_{PGCK}	Global clock pin delay to quad net	-	1.34 ns
t_{BGCK}	Global clock tree delay (quad net to flip-flop)	-	0.56 ns

NOTE: When using a PLL, t_{PGCK} and t_{BGCK} are effectively zero due to delay adjustment by Phase Locked Loop.

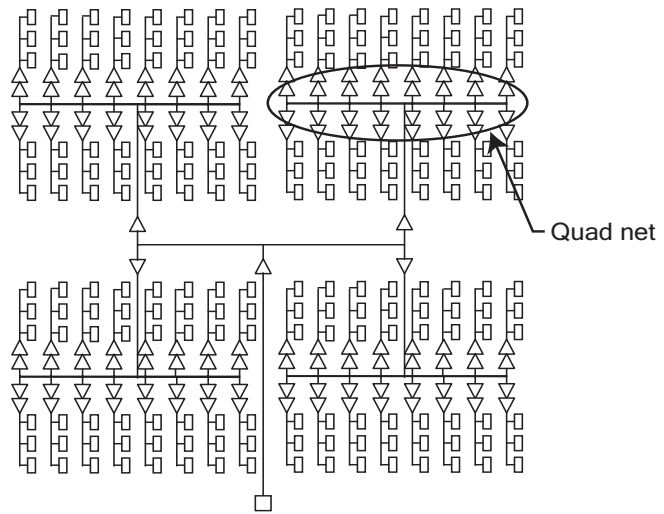


Figure 19: Global Clock Structure Schematic

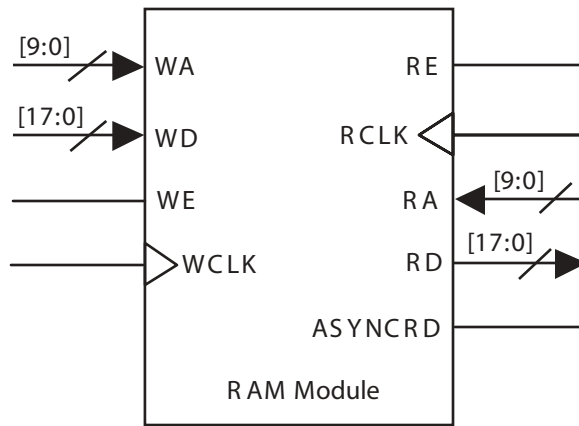


Figure 20: RAM Module

Table 18: RAM Cell Synchronous Write Timing

Symbol	Parameter	Value	
		Min	Max
RAM Cell Synchronous Write Timing			
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	0.623 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	-	4.38 ns

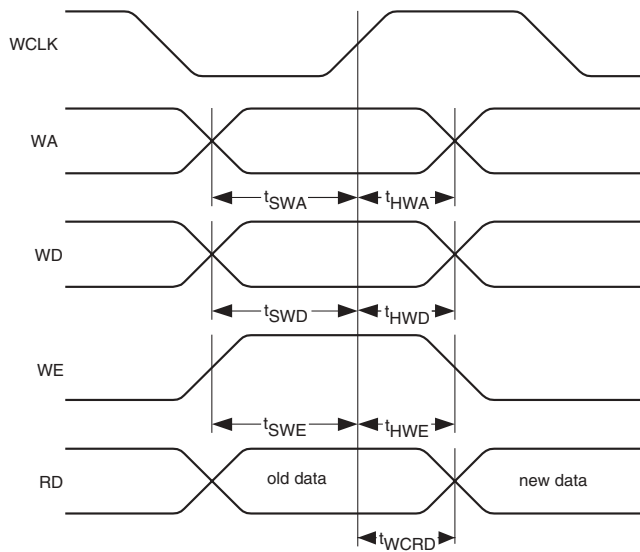


Figure 21: RAM Cell Synchronous Write Timing

Table 19: RAM Cell Synchronous and Asynchronous Read Timing

Symbol	Parameter	Value	
		Min	Max
RAM Cell Synchronous Read Timing			
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	-	4.38 ns
RAM Cell Asynchronous Read Timing			
t_{PDRD}	RA to RD: time between when the READ ADDRESS is input and when the DATA is output	-	2.06 ns

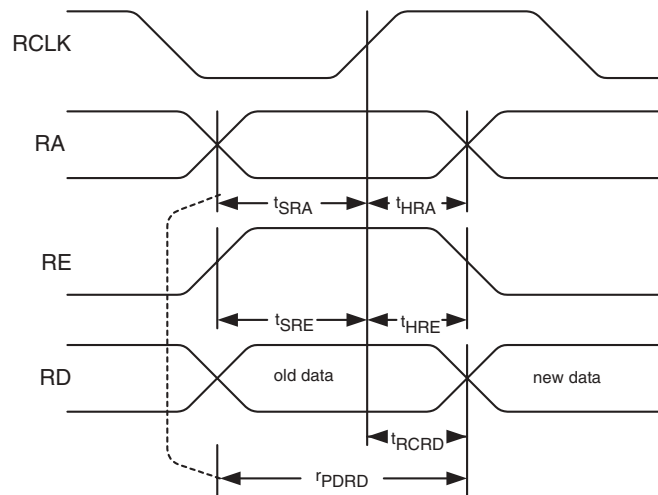


Figure 22: RAM Cell Synchronous and Asynchronous Read Timing

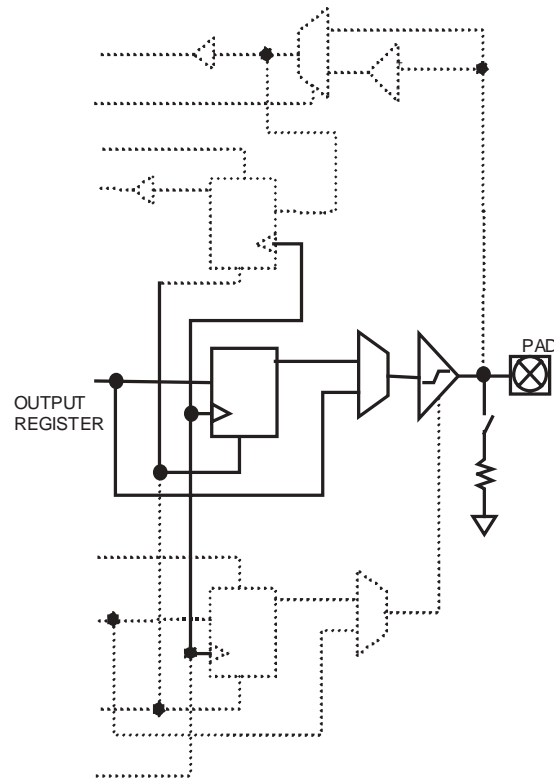


Figure 23: Eclipse-II Cell I/O

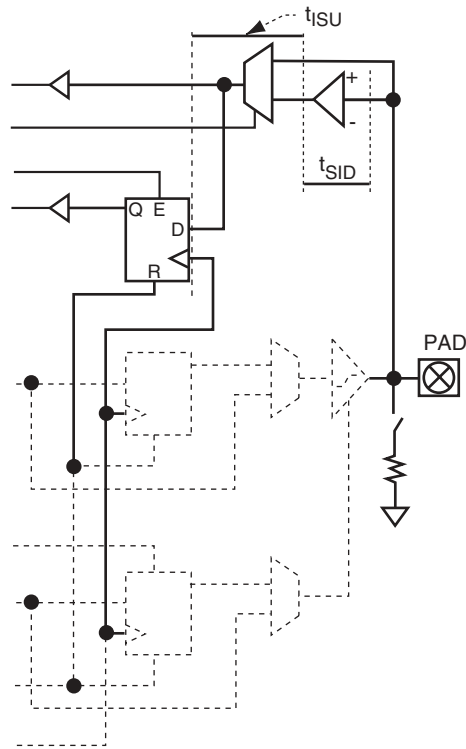


Figure 24: Eclipse-II Input Register Cell

Table 20: Input Register Cell

Symbol (Input Register Cell Only)	Parameter	Value	
		Min	Max
t_{SU}	Input register setup time: time the synchronous input of the flip-flop must be stable before the active clock edge	2.50 ns	-
t_{Hl}	Input register hold time: time the synchronous input of the flip-flop must be stable after the active clock edge	-	0 ns
t_{CO}	Input register clock-to-out: time taken by the flip-flop to output after the active clock edge	-	1.08 ns

Table 20: Input Register Cell

Symbol (Input Register Cell Only)	Parameter	Value	
		Min	Max
t_{IRST}	Input register reset delay: time between when the flip-flop is “reset”(low) and when the output is consequently “reset” (low)	-	0.99 ns
t_{IESU}	Input register clock enable setup time: time “enable” must be stable before the active clock edge	0.37 ns	-
t_{IEH}	Input register clock enable hold time: time “enable” must be stable after the active clock edge	0 ns	-

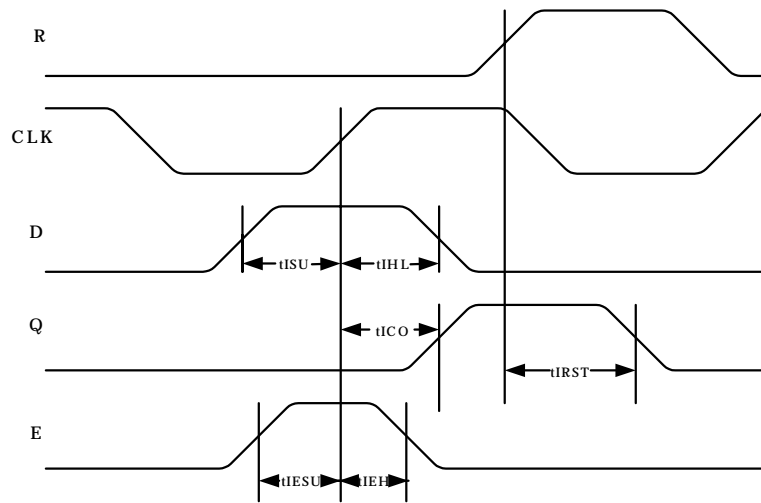


Figure 25: Eclipse-II Input Register Cell Timing

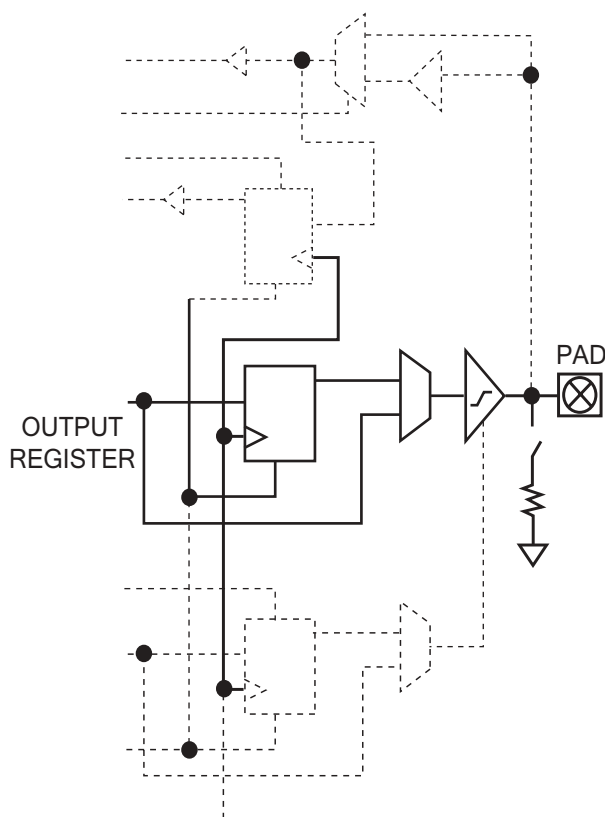


Figure 26: Eclipse-II Output Register Cell

Table 21: Standard Input Delays

Symbol	Parameter	Value	
		Min	Max
t_{SID} (LVTTTL)	LVTTTL input delay: Low Voltage TTL for 3.3 V applications	-	0.34 ns
t_{SID} (LVCMOS2)	LVCMOS2 input delay: Low Voltage CMOS for 2.5 V and lower applications	-	0.42 ns
t_{SID} (LVCMOS18)	LVCMOS18 input delay: Low Voltage CMOS for 1.8 V applications	-	-
t_{SID} (GTL+)	GTL+ input delay: Gunning Transceiver Logic	-	0.68 ns
t_{SID} (SSTL3)	SSTL3 input delay: Stub Series Terminated Logic for 3.3 V	-	0.55 ns
t_{SID} (SSTL2)	SSTL2 input delay: Stub Series Terminated Logic for 2.5 V	-	0.61 ns

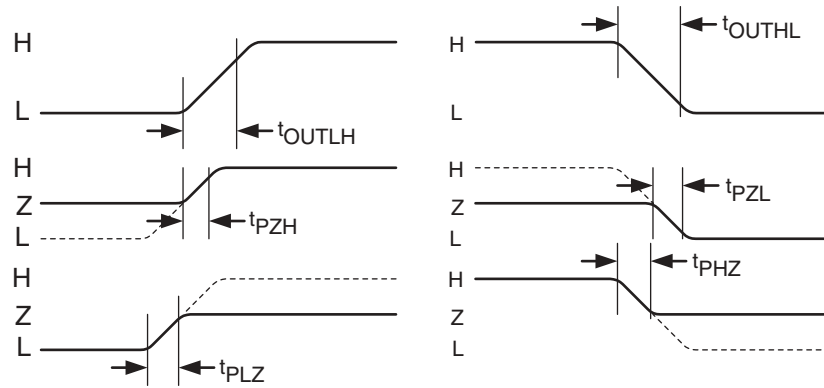


Figure 27: Eclipse-II Output Register Cell Timing

Table 22: Output Slew Rates @ $V_{CCIO} = 3.3\text{ V}$, $T = 25^\circ\text{ C}$

	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 23: Output Slew Rates @ $V_{CCIO} = 2.5\text{ V}$, $T = 25^\circ\text{ C}$

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

Table 24: Output Slew Rates @ $V_{CCIO} = 1.8\text{ V}$, $T = 25^\circ\text{ C}$

	Fast Slew	Slow Slew
Rising Edge	-	-
Falling Edge	-	-

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:

θ_{JC} : Junction-to-case thermal resistance

θ_{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 θ_{JA} from **Table 25**, pick an appropriate T_{AMAX} and use:

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

Table 25: Package Thermal Characteristics

Package Description		θ_{JA} (° C/W) @ various flow rates (m/sec)				θ_{JC} (° C/W)
Pin Count	Package Type	0	0.5	1	2	
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
208	PQFP	26.0	24.5	23.0	22.0	11.0

Kv and Kt Graphs

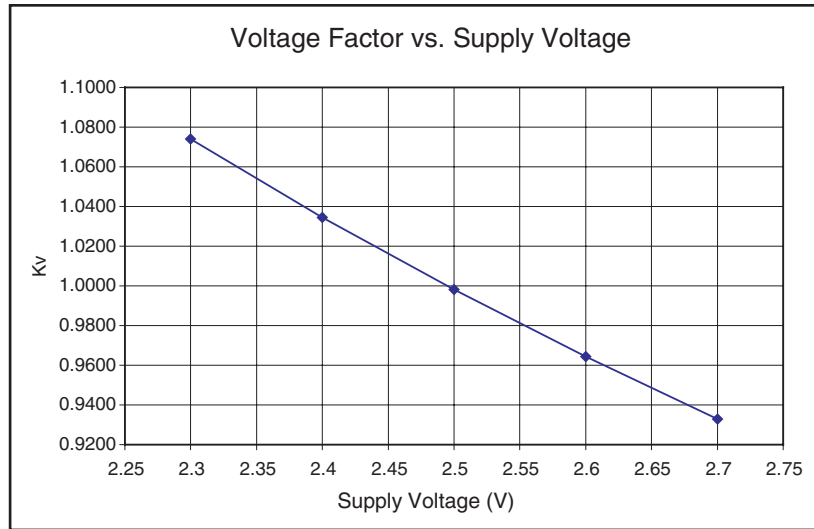


Figure 28: Voltage Factor vs. Supply Voltage

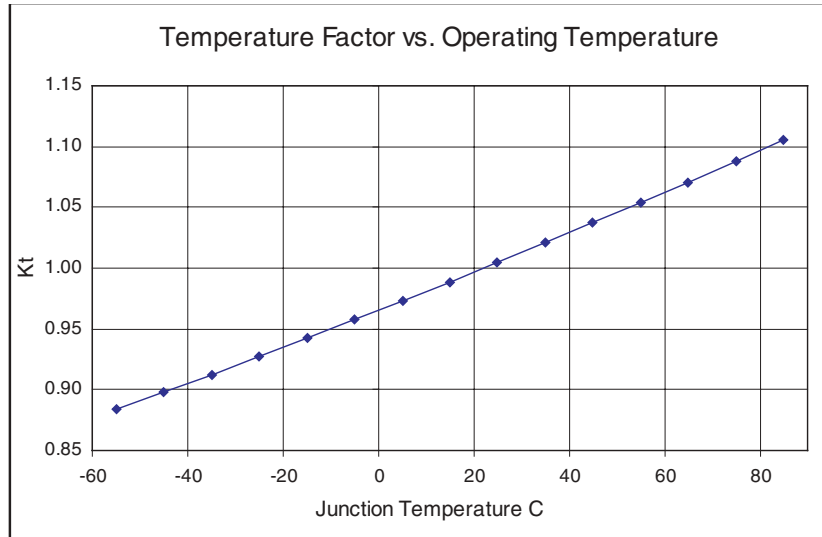


Figure 29: Temperature Factor vs. Operating Temperature

Power vs. Operating Frequency

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

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

Where

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

NOTE: To learn more about power consumption, please refer to Application Note #60.

Power-up Sequencing

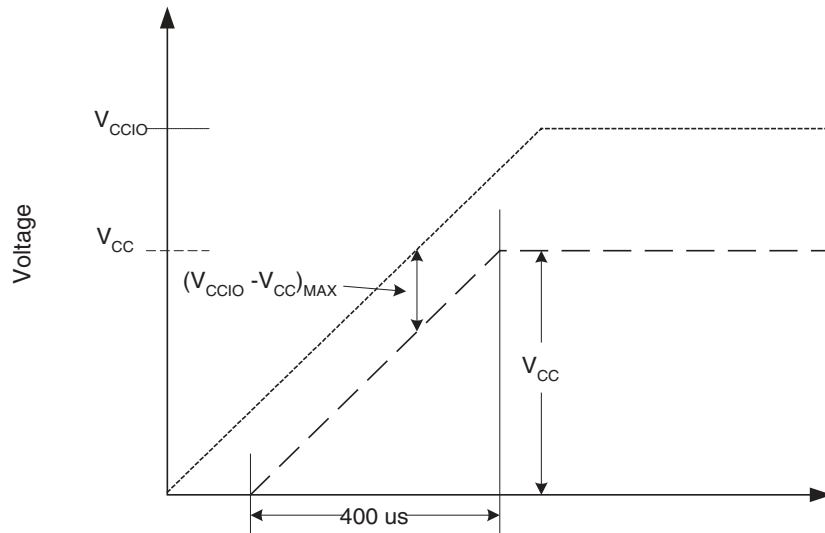


Figure 30: Power-up Sequencing

The following requirements must be met when powering up a device (refer to **Figure 30**):

- When ramping up the power supplies keep $(V_{\text{CCIO}} - V_{\text{CC}})_{\text{MAX}} \leq 500 \text{ mV}$. Deviation from this recommendation can cause permanent damage to the device.
- V_{CCIO} must lead V_{CC} when ramping the device.
- The power supply must be greater than or equal to $400 \mu\text{s}$ to reach V_{CC} . Ramping to $V_{\text{CC}}/V_{\text{CCIO}}$ before reaching $400 \mu\text{s}$ can cause the device to behave improperly.

Pin Descriptions

Table 26: 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

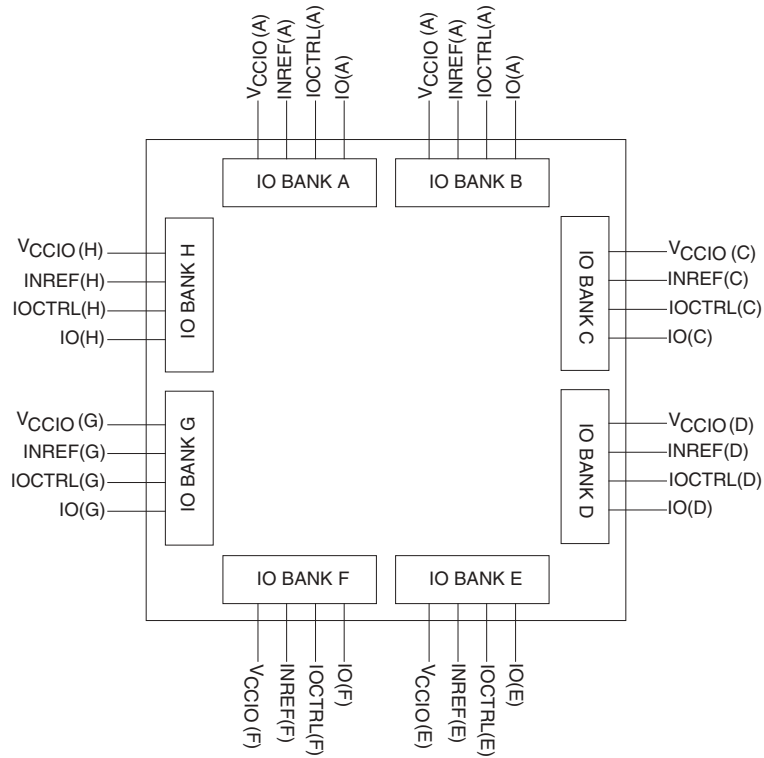


Figure 31: I/O Banks with Relevant Pins

Table 27: Dedicated Pin Descriptions

Pin	Function	Description
GCLK	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, CLOCK of the ECUs, and Output Enables of the I/Os.
I/O(A)	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 _{CC} , or TriState during programming.
V _{CC}	Power supply pin	Connect to 1.8 V supply
V _{CCIO} (A)	Input voltage tolerance pin	This pin provides the flexibility to interface the device with either a 3.3 V, 2.5 V, or 1.8 V device. The A inside the parenthesis means that V _{CCIO} is located in BANK A. Every I/O pin in Bank A will be tolerant of V _{CCIO} input signals and will output V _{CCIO} level signals. This pin must be connected to either 3.3 V, 2.5 V, or 1.8 V.
GND	Ground pin	Connect to ground
PLLIN	PLL clock input	Clock input for PLL
DEDCLK	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, Flip Flops).
GNDPLL	Ground pin for PLL	Connect to GND
INREF(A)	Differential reference voltage	The INREF is the reference voltage pin for GTL+, SSTL2, and STTL3 standards. Follow the recommendations provided in Table 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	PLL output pin	Dedicated PLL output pin; otherwise, may be left unconnected
IOCTRL(A)	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. There is an internal pulldown resistor to Ground on this pin. This pin should be tied to Ground if it is not used. For backwards compatibility with Eclipse, it can be tied to V _{CC} or Ground. If tied to V _{CC} , it will draw no more than 20 μ A per IOCTRL pin due to the pulldown resistor.

(Sheet 1 of 2)

Table 27: Dedicated Pin Descriptions

Pin	Function	Description
Vpump	Charge Pump Disable	This pin disables the internal charge pump for lower static power operation. To disable the charge pump, connect Vpump to 3.3 V. If the Disable Charge Pump feature is not used, connect Vpump to Ground. For backwards compatibility with Eclipse and EclipsePlus devices, connect Vpump to Ground.
Vded	Voltage tolerance for clocks, JTAG, and IOCTRL/Voltage Drive for PLLOUT and JTAG pins	This pin specifies the input voltage tolerance for CLK, JTAG, and IOCTRL dedicated input pins, as well as the output voltage drive for PLLOUT and JTAG pins. If the PLLs are used, Vded must be the same as V _{CC} PLL. For backwards compatibility with Eclipse and EclipsePlus devices, connect Vded to 2.5 V.
VccPLL	Power Supply pin for PLL	Connect to 2.5 V supply or 3.3 V supply. For backwards compatibility with Eclipse and EclipsePlus devices, connect to 2.5 V.

(Sheet 2 of 2)

Recommended Unused Pin Terminations for the Eclipse-II 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 28**.

Table 28: Recommended Unused Pin Terminations

Signal Name	Recommended Termination
PLLOUT<x> ^a	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> ^b	There is an internal pulldown resistor to Ground on this pin. This pin should be tied to Ground if it is not used. For backwards compatibility with Eclipse, it can be tied to V_{CC} or Ground. If tied to V_{CC} , it will draw no more than 20 μA per IOCTRL pin due to the pulldown resistor.
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.
INREF<y>	If an I/O bank does not require the use of INREF signal the pin should be connected to GND.

a. x represents a number.

b. y represents an alphabetical character.

208 PQFP Pinout Diagram



208 PQFP Pinout Table

Table 29: 208 PQFP Pinout Table

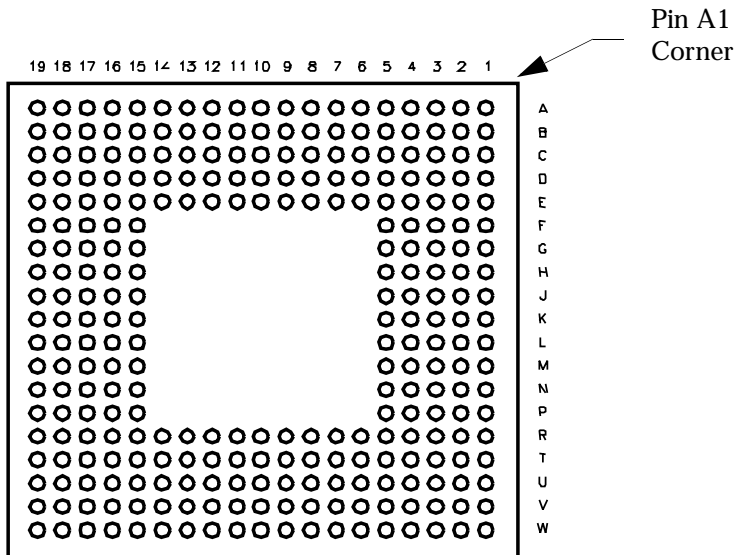
PQFP	Function	PQFP	Function	PQFP	Function	PQFP	Function	PQFP	Function
1	PLLST(3)	43	IO(B)	85	IO(D)	127	CLK(5),PLLIN(3)	169	IO(G)
2	V _{CCPLL} (3)	44	V _{CCIO} (B)	86	V _{CC}	128	CLK(6)	170	INREF(G)
3	GND	45	IO(B)	87	IO(D)	129	V _{dcd}	171	IO(G)
4	GND	46	V _{CC}	88	IO(D)	130	CLK(7)	172	IO(G)
5	IO(A)	47	IO(B)	89	V _{CC}	131	V _{CC}	173	IO(G)
6	IO(A)	48	IO(B)	90	IO(D)	132	CLK(8)	174	IO(V)
7	IO(A)	49	GND	91	IO(D)	133	TMS	175	V _{CC}
8	V _{CCIO} (A)	50	TDO	92	IO(D)	134	IO(F)	176	IO(G)
9	IO(A)	51	PLLOUT(1)	93	INREF(D)	135	IO(F)	177	V _{CCIO} (G)
10	IO(A)	52	GNDPLL(2)	94	IO(D)	136	IO(F)	178	GND
11	IO(A)	53	GND	95	IO(D)	137	GND	179	IO(G)
12	V _{CC}	54	V _{CCPLL} (2)	96	IO(D)	138	V _{CCIO} (F)	180	IO(G)
13	INREF(A)	55	PLLST(2)	97	IO(D)	139	IO(F)	181	IO(G)
14	IO(A)	56	V _{CC}	98	V _{CCIO} (D)	140	IO(F)	182	V _{CC}
15	IO(A)	57	IO(C)	99	IO(D)	141	IO(F)	183	TCK
16	IO(A)	58	GND	100	IO(D)	142	IO(F)	184	V _{CC}
17	IO(A)	59	IO(C)	101	V _{pump}	143	IO(F)	185	IO(H)
18	IO(A)	60	V _{CCIO} (C)	102	PLLOUT(0)	144	IO(F)	186	IO(H)
19	V _{CCIO} (A)	61	IO(C)	103	GND	145	INREF(F)	187	IO(H)
20	IO(A)	62	IO(C)	104	GNDPLL(1)	146	V _{CC}	188	GND
21	GND	63	IO(C)	105	PLLST(1)	147	IO(F)	189	V _{CCIO} (H)
22	IO(A)	64	IO(C)	106	V _{CCPLL} (1)	148	IO(F)	190	IO(H)
23	TDI	65	IO(C)	107	IO(E)	149	IO(F)	191	IO(H)
24	CLK(0)	66	IO(C)	108	GND	150	V _{CCIO} (F)	192	IO(H)
25	CLK(1)	67	IO(C)	109	IO(E)	151	IO(F)	193	IO(H)
26	V _{CC}	68	INREF(C)	110	IO(E)	152	IO(F)	194	IN(H)
27	CLK(2),PLLIN(2)	69	IO(C)	111	V _{CCIO} (E)	153	GND	195	V _{CC}
28	CLK(3),PLLIN(1)	70	IO(C)	112	IO(E)	154	IO(F)	196	IO(H)
29	V _{dcd}	71	IO(C)	113	V _{CC}	155	PLLOUT(3)	197	IO(H)
30	CLK(4), DEDCLK,PLLIN(0)	72	V _{CCIO} (C)	114	IO(E)	156	GNDPLL(0)	198	IO(H)
31	IO(B)	73	IO(C)	115	IO(E)	157	GND	199	IO(H)
32	IO(B)	74	IO(C)	116	IO(E)	158	V _{CCPLL} (0)	200	IO(H)
33	GND	75	GND	117	IO(E)	159	PLLST(0)	201	IO(H)
34	V _{CCIO} (B)	76	V _{CC}	118	INREF(E)	160	GND	202	IO(H)
35	IO(B)	77	IO(C)	119	IO(E)	161	IO(G)	203	V _{CCIO} (H)
36	IO(B)	78	TRSTB	120	IO(E)	162	V _{CCIO} (G)	204	GND
37	IO(B)	79	V _{CC}	121	IO(E)	163	IO(G)	205	IO(H)
38	IO(B)	80	IO(D)	122	V _{CCIO} (E)	164	IO(G)	206	PLLOUT(2)
39	IO(B)	81	IO(D)	123	GND	165	V _{CC}	207	GND
40	INREF(B)	82	IO(D)	124	IO(E)	166	IO(G)	208	GNDPLL(3)
41	IO(B)	83	GND	125	IO(E)	167	IO(G)		
42	IO(B)	84	V _{CCIO} (D)	126	IO(E)	168	IO(G)		

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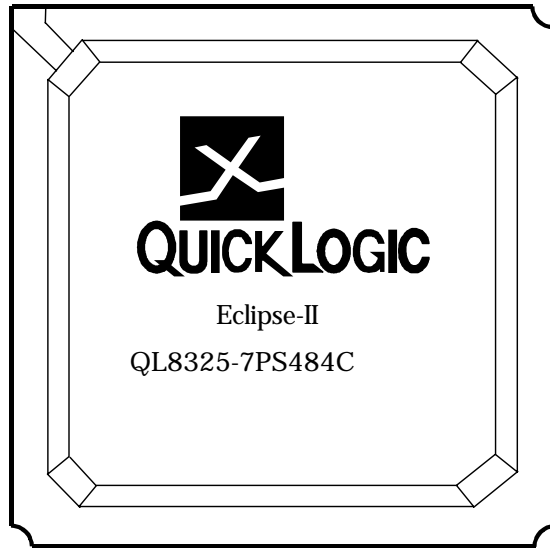
280 PBGA Pinout Table

Table 30: 280 PBGA Pinout Table

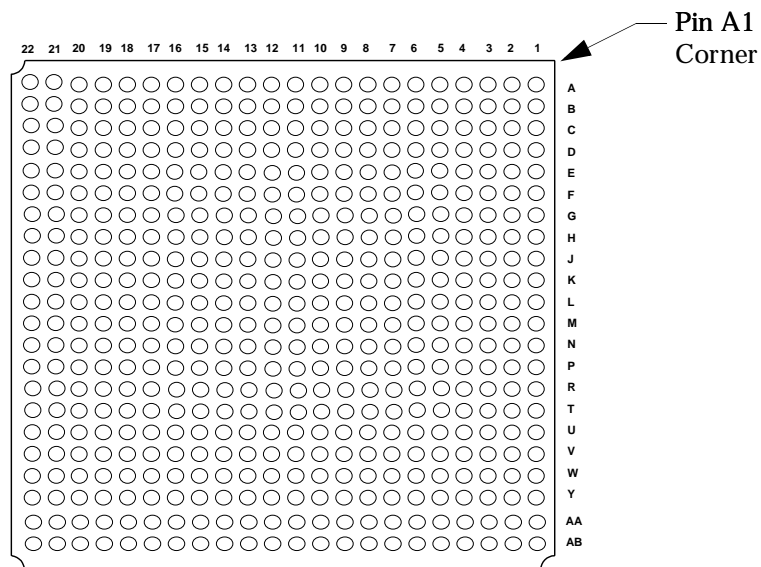
PBGA	Function	PBGA	Function	PBGA	Function	PBGA	Function	PBGA	Function	PBGA	Function
A1	PLLOUT<3>	C10	CLK<5>/PLLIN<3>	E19	IOCTRL<D>	K16	I/O<C>	R4	I/O<H>	U13	I/O
A2	GNDPLL<0>	C11	V _{ccio} <E>	F1	INREF<G>	K17	I/O<D>	R5	GND	U14	IOCTRL
A3	I/O<F>	C12	I/O<E>	F2	IOCTRL<G>	K18	I/O<C>	R6	GND	U15	V _{ccio}
A4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

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484 PBGA Pinout Table

Table 31: 484 PBGA Pinout Table

PBGA	Function	PBGA	Function	PBGA	Function	PBGA	Function	PBGA	Function	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	PLLRST<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 _{CCPLL} <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	N/C	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 _{CC}	L8	GND
A9	I/O<H>	C9	IOCTRL<H>	E9	I/O<H>	G9	I/O<H>	J9	GND	L9	GND
A10	N/C	C10	I/O<H>	E10	I/O<H>	G10	I/O<H>	J10	V _{CC}	L10	GND
A11	N/C	C11	I/O<H>	E11	V _{CC}	G11	I/O<G>	J11	V _{CC}	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 _{CC}	L13	GND
A14	I/O<G>	C14	I/O<G>	E14	I/O<G>	G14	I/O<G>	J14	GND	L14	V _{CC}
A15	I/O<G>	C15	I/O<G>	E15	IOCTRL<G>	G15	I/O<G>	J15	V _{CC}	L15	V _{CC}
A16	I/O<G>	C16	I/O<G>	E16	I/O<G>	G16	V _{pump}	J16	I/O<F>	L16	CLK<6>
A17	I/O<G>	C17	I/O<G>	E17	INREF<G>	G17	V _{CCIO} <F>	J17	V _{CCIO} <F>	L17	V _{CCIO} <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
B2	GND	D2	I/O<A>	F2	INREF<A>	H2	I/O<A>	K2	I/O<A>	M2	I/O
B3	GNDPLL<3>	D3	I/O<A>	F3	I/O<A>	H3	I/O<A>	K3	I/O<A>	M3	I/O
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
B6	I/O<H>	D6	I/O<H>	F6	V _{CCIO} <A>	H6	V _{CCIO} <A>	K6	V _{CCIO} <A>	M6	V _{CCIO}
B7	I/O<H>	D7	I/O<H>	F7	V _{CCIO} <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 _{CC}	M8	V _{CC}
B9	I/O<H>	D9	I/O<H>	F9	V _{CCIO} <H>	H9	V _{CC}	K9	V _{CC}	M9	V _{CC}
B10	I/O<H>	D10	I/O<H>	F10	I/O<H>	H10	V _{CC}	K10	GND	M10	GND
B11	I/O<H>	D11	I/O<H>	F11	V _{CCIO} <H>	H11	V _{ded}	K11	GND	M11	GND
B12	N/C	D12	I/O<G>	F12	V _{CCIO} <G>	H12	GND	K12	GND	M12	GND
B13	N/C	D13	I/O<G>	F13	I/O<G>	H13	V _{CC}	K13	GND	M13	GND
B14	N/C	D14	I/O<G>	F14	V _{CCIO} <G>	H14	V _{CC}	K14	V _{CC}	M14	GND
B15	I/O<G>	D15	IOCTRL<G>	F15	N/C	H15	GND	K15	V _{CC}	M15	GND
B16	I/O<G>	D16	I/O<G>	F16	V _{CCIO} <G>	H16	I/O<F>	K16	I/O<F>	M16	GND
B17	I/O<G>	D17	I/O<G>	F17	N/C	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	PLLRST<0>	D19	V _{CCPLL} <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 31: 484 PBGA Pinout Table (Continued)

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

(Sheet 2 of 2)

Packaging Information

The Eclipse-II product family packaging information is presented in **Table 32**.

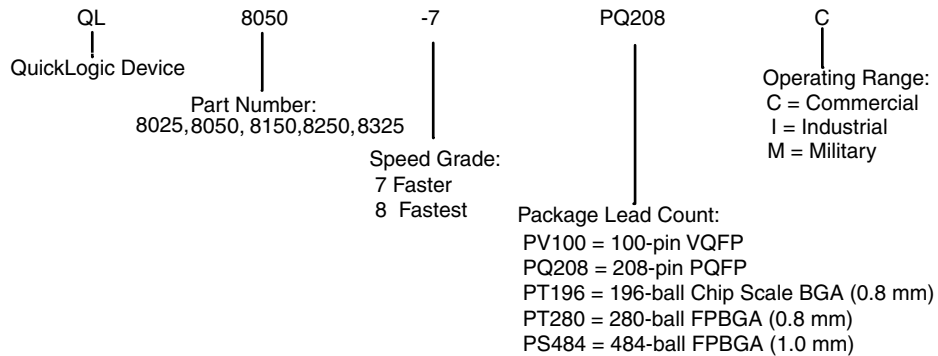
NOTE: Military temperature range plastic packages will be added as follow on products to the commercial and industrial products.

Table 32: Packaging Options

Device Information	Device									
	QL8325		QL8250		QL8150		QL8050		QL8025	
	Pin	Pitch	Pin	Pitch	Pin	Pitch	Pin	Pitch	Pin	Pitch
	208 PQFP	0.50	208 PQFP	0.50 mm	100 VQFP	0.50 mm	100 VQFP	0.50 mm	100 VQFP	0.50 mm
Package Definitions ^a	280 FBGA	0.80 mm	280 FBGA	0.80 mm	208 PQFP	0.50 mm	208 PQFP	0.50 mm	208 PQFP	0.50 mm
	484 BGA	1.0 mm	484 BGA	1.0 mm	196 CSBGA	0.80 mm	196 CSBGA	0.80 mm	196 CSBGA	0.80 mm

a. PQFP = Plastic Quad Flat Pack; BGA= Ball Grid Array; VQFP = Very Thin Quad Flat Pack; CSBGA = Chip Scale Ball Grid Array; FBGA = Fine Pitch Ball Grid Array

Ordering Information



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Revision History

Table 33: Revision History

Revision	Date	Comments
A Preliminary	August 2002	Brian Faith, Judd Heape, Andreea Rotaru
Rev A	December 2002	Brian Faith, Andreea Rotaru
Rev B	January 2003	Brian Faith, Andreea Rotaru

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