

Radiation-Tolerant ProASIC3 Low-Power Space-Flight Flash FPGAs



with Flash*Freeze Technology

Features and Benefits

MIL-STD-883 Class B Qualified Packaging

- Ceramic Column Grid Array with Six Sigma Copper-Wrapped Lead-Tin Columns
- Land Grid Array

Low Power

- Dramatic Reduction in Dynamic and Static Power
- 1.2 V to 1.5 V Core and I/O Voltage Support for Low Power
- Low Power Consumption in Flash*Freeze Mode Enables Instantaneous Entry To / Exit From Low-Power Flash*Freeze Mode
- Supports Single-Voltage System Operation
- Low-Impedance Switches

Radiation Tolerant

- 15 krad Total Ionizing Dose (TID)
- Wafer-Lot-Specific TID Reports

High Capacity

- 600 k to 3 M System Gates
- Up to 504 kbits of True Dual-Port SRAM
- Up to 620 User I/Os

Reprogrammable Flash Technology

- 130-nm, 7-Layer Metal (6 Copper), Flash-Based CMOS Process
- Live-at-Power-Up (LAPU) Level 0 Support
- Single-Chip Solution
- Retains Programmed Design when Powered Off

High Performance

- 350 MHz (1.5 V) and 250 MHz (1.2 V) System Performance
- 3.3 V, 66 MHz, 66-Bit PCI (1.5 V); 66 MHz, 32-Bit PCI (1.2 V)

In-System Programming (ISP) and Security

- Secure ISP Using On-Chip 128-Bit Advanced Encryption Standard (AES) Decryption via JTAG (IEEE 1532-compliant)
- FlashLock® to Secure FPGA Contents

High-Performance Routing Hierarchy

- Segmented, Hierarchical Routing and Clock Structure

- High-Performance, Low-Skew Global Network
- Architecture Supports Ultra-High Utilization

Advanced and Pro (Professional) I/Os

- 700 Mbps DDR, LVDS-Capable I/Os
- 1.2 V, 1.5 V, 1.8 V, 2.5 V, and 3.3 V Mixed-Voltage Operation
- Bank-Selectable I/O Voltages—up to 8 Banks per Chip
- Single-Ended I/O Standards: LVTTTL, LVCMOS 3.3 V / 2.5 V / 1.8 V / 1.5 V / 1.2 V, 3.3 V PCI / 3.3 V PCI-X, and LVCMOS 2.5 V / 5.0 V Input
- Differential I/O Standards: LVPECL, LVDS, B-LVDS, and M-LVDS
- Voltage-Referenced I/O Standards: GTL+ 2.5 V / 3.3 V, GTL 2.5 V / 3.3 V, HSTL Class I and II, SSTL2 Class I and II, SSTL3 Class I and II (RT3PE3000L only)
- I/O Registers on Input, Output, and Enable Paths
- Hot-Swappable and Cold-Sparing I/Os
- Programmable Output Slew Rate and Drive Strength
- Programmable Input Delay (RT3PE3000L only)
- Schmitt Trigger Option on Single-Ended Inputs (RT3PE3000L)
- Weak Pull-Up/-Down
- IEEE 1149.1 (JTAG) Boundary Scan Test
- Pin-Compatible Packages across the Radiation-Tolerant ProASIC®3 Family

Clock Conditioning Circuit (CCC) and PLL

- Six CCC Blocks, All with Integrated PLL (RT ProASIC3)
- Configurable Phase Shift, Multiply/Divide, Delay Capabilities, and External Feedback
- Wide Input Frequency Range 1.5 MHz to 250 MHz (1.2 V systems) and 350 MHz (1.5 V systems)

SRAMs and FIFOs

- Variable-Aspect-Ratio 4,608-Bit RAM Blocks (x1, x2, x4, x9, and x18 organizations available)
- True Dual-Port SRAM (except x18)
- 24 SRAM and FIFO Blocks with Synchronous Operation:
 - 250 MHz: For 1.2 V Systems
 - 350 MHz: For 1.5 V Systems

Table I-1 • Radiation-Tolerant (RT) ProASIC3 Low-Power Space-Flight FPGAs

RT ProASIC3 Devices	RT3PE600L	RT3PE3000L
System Gates	600 k	3 M
VersaTiles (D-flip-flops)	13,824	75,264
RAM kbits (1,024 bits)	108	504
4,608-Bit Blocks	24	112
FlashROM Bits	1 k	1 k
Secure (AES) ISP	Yes	Yes
Integrated PLL in CCCs	6	6
VersaNet Globals	18	18
I/O Banks	8	8
Maximum User I/Os	270	620
Package Pins CCGA/LGA	CG/LG484	CG/LG484, CG/LG896

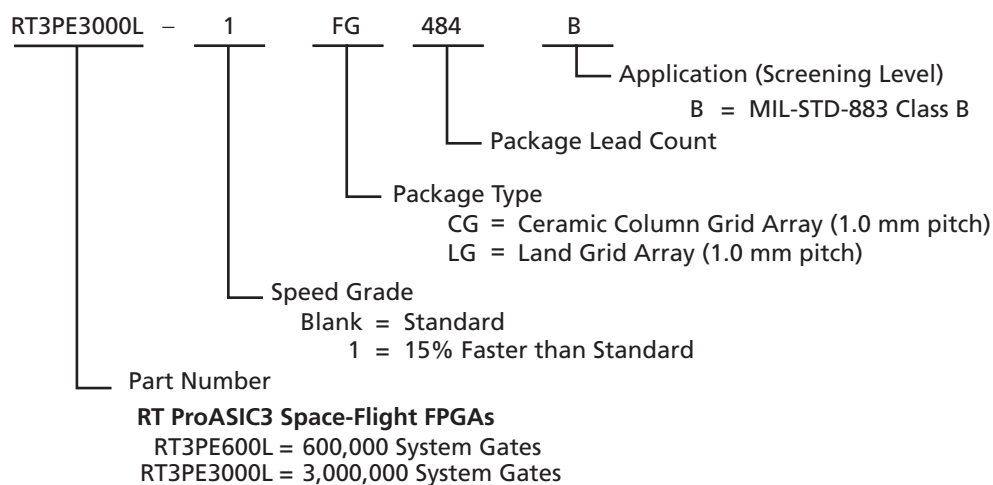
I/Os Per Package¹

Radiation-Tolerant ProASIC3 Low-Power Devices	RT3PE600L		RT3PE3000L	
	Single-Ended I/Os ²	Differential I/O Pairs	Single-Ended I/Os ²	Differential I/O Pairs
CG/LG484	270	135	341	168
CG/LG896	–	–	620	300

Notes:

1. When considering migrating your design to a lower- or higher-density device, refer to the packaging section of the datasheet to ensure you are complying with design and board migration requirements.
2. Each used differential I/O pair reduces the number of single-ended I/Os available by two.
3. For RT3PE3000L devices, the usage of certain I/O standards is limited as follows:
 - SSTL3(I) and (II): up to 40 I/Os per north or south bank
 - LVPECL / GTL+ 3.3 V / GTL 3.3 V: up to 48 I/Os per north or south bank
 - SSTL2(I) and (II) / GTL+ 2.5 V / GTL 2.5 V: up to 72 I/Os per north or south bank
4. When the Flash*Freeze pin is used to directly enable Flash*Freeze mode and not as a regular I/O, the number of single-ended user I/Os available is reduced by one.

RT ProASIC3 Ordering Information



Temperature Grade Offerings

Package	RT3PE600L	RT3PE3000L
CG/LG484	B	B
CG/LG896	–	B

Note: B = MIL-STD-883 Class B screening

Speed Grade and Temperature Grade Matrix

Temperature Grade	Std.	–1
B	✓	✓

Note: B = MIL-STD-883 Class B screening

Contact your local Actel representative for device availability: <http://www.actel.com/contact/default.aspx>.

1 – Radiation-Tolerant ProASIC3 Low-Power Space-Flight FPGA Overview

General Description

The radiation-tolerant (RT) ProASIC3 family of Actel flash FPGAs dramatically reduces dynamic power consumption by 40% and static power by 50%. These power savings are coupled with performance, density, true single chip, 1.2 V to 1.5 V core and I/O operation, reprogrammability, and advanced features. The RT ProASIC3 FPGA is based on Actel's ProASIC3EL family of low-power FPGAs.

Actel's proven Flash*Freeze technology enables RT ProASIC3 device users to shut off dynamic power instantaneously and switch the device to static mode without the need to switch off clocks or power supplies, and retaining internal states of the device. This greatly simplifies power management. In addition, optimized software tools using power-driven layout provide instant push-button power reduction.

Nonvolatile flash technology gives RT ProASIC3 devices the advantage of being a secure, low-power, single-chip solution that is live at power-up (LAPU). RT ProASIC3 devices offer dramatic dynamic power savings, giving FPGA users flexibility to combine low power with high performance.

These features enable designers to create high-density systems using existing ASIC or FPGA design flows and tools.

RT ProASIC3 devices offer 1 kbit of on-chip, reprogrammable, nonvolatile FlashROM storage as well as clock conditioning circuitry (CCC) based on an integrated phase-locked loop (PLL). RT ProASIC3 devices support devices from 600 k system gates to 3 million system gates with up to 504 kbits of true dual-port SRAM and 620 user I/Os.

Flash*Freeze Technology

RT ProASIC3 devices offer Actel's proven Flash*Freeze technology, which allows instantaneous switching from an active state to a static state. When Flash*Freeze mode is activated, RT ProASIC3 devices enter a static state while retaining the contents of registers and SRAM. Power is conserved without the need for additional external components to turn off I/Os or clocks. Flash*Freeze technology is combined with in-system programmability, which enables users to quickly and easily upgrade and update their designs in the final stages of manufacturing or in the field. The ability of RT ProASIC3 devices to support a 1.2 V core voltage allows for an even greater reduction in power consumption, which enables low total system power.

When the RT ProASIC3 device enters Flash*Freeze mode, the device automatically shuts off the clocks and inputs to the FPGA core; when the device exits Flash*Freeze mode, all activity resumes and data is retained.

The availability of low-power modes, combined with a reprogrammable, single-chip, single-voltage solution, make RT ProASIC3 devices suitable for low-power data transfer and manipulation in military-temperature applications where available power may be limited (e.g., in battery-powered equipment); or where heat dissipation may be limited (e.g., in enclosures with no forced cooling).

Flash Advantages

Low Power

The RT ProASIC3 family of Actel flash-based FPGAs provides a low-power advantage, and when coupled with high performance, enables designers to make power-smart choices using a single-chip, reprogrammable, and live-at-power-up device.

RT ProASIC3 devices offer 40% dynamic power and 50% static power savings by reducing the core operating voltage to 1.2 V. In addition, the power-driven layout (PDL) feature in Libero® Integrated Design Environment (IDE) offers up to 30% additional power reduction. With Flash*Freeze

technology, an RT ProASIC3 device is able to retain device SRAM and logic while dynamic power is reduced to a minimum, without the need to stop clock or power supplies. Combining these features provides a low-power, feature-rich, and high-performance solution.

Security

Nonvolatile, flash-based RT ProASIC3 devices do not require a boot PROM, so there is no vulnerable external bitstream that can be easily copied. RT ProASIC3 devices incorporate FlashLock, which provides a unique combination of reprogrammability and design security without external overhead, advantages that only an FPGA with nonvolatile flash programming can offer.

RT ProASIC3 devices utilize a 128-bit flash-based lock and a separate AES key to secure programmed intellectual property and configuration data. In addition, all FlashROM data in RT ProASIC3 devices can be encrypted prior to loading, using the industry-leading AES-128 (FIPS192) bit block cipher encryption standard. AES was adopted by the National Institute of Standards and Technology (NIST) in 2000 and replaces the 1977 DES standard. RT ProASIC3 devices have a built-in AES decryption engine and a flash-based AES key that make them the most comprehensive programmable logic device security solution available today. RT ProASIC3 devices with AES-based security allow for secure, remote field updates over public networks such as the Internet, and ensure that valuable IP remains out of the hands of system overbuilders, system cloners, and IP thieves. The contents of a programmed device cannot be read back, although secure design verification is possible.

Security, built into the FPGA fabric, is an inherent component of the RT ProASIC3 family. The flash cells are located beneath seven metal layers, and many device design and layout techniques have been used to make invasive attacks extremely difficult. The RT ProASIC3 family, with FlashLock and AES security, is unique in being highly resistant to both invasive and noninvasive attacks. Your valuable IP is protected and secure, making remote ISP possible. An RT ProASIC3 device provides the most impenetrable security for programmable logic designs.

Single Chip

Flash-based FPGAs store their configuration information in on-chip flash cells. Once programmed, the configuration data is an inherent part of the FPGA structure, and no external configuration data needs to be loaded at system power-up (unlike SRAM-based FPGAs). Therefore, flash-based RT ProASIC3 FPGAs do not require system configuration components such as EEPROMs or microcontrollers to load device configuration data. This reduces bill-of-materials costs and PCB area, and increases security and system reliability.

Live at Power-Up

Actel flash-based RT ProASIC3 devices support Level 0 of the LAPU classification standard. This feature helps in system component initialization, execution of critical tasks before the processor wakes up, setup and configuration of memory blocks, clock generation, and bus activity management. The LAPU feature of flash-based RT ProASIC3 devices greatly simplifies total system design and reduces total system cost, often eliminating the need for CPLDs and clock generation PLLs. In addition, glitches and brownouts in system power will not corrupt the device's flash configuration, and unlike SRAM-based FPGAs, the device will not have to be reloaded when system power is restored. This enables the reduction or complete removal of the configuration PROM, expensive voltage monitor, brownout detection, and clock generator devices from the PCB design. Flash-based RT ProASIC3 devices simplify total system design and reduce cost and design risk while increasing system reliability and improving system initialization time.

Reduced Cost of Ownership

Advantages to the designer extend beyond low unit cost, performance, and ease of use. Unlike SRAM-based FPGAs, flash-based RT ProASIC3 devices allow all functionality to be live at power-up; no external boot PROM is required. On-board security mechanisms prevent access to all the programming information and enable secure remote updates of the FPGA logic. Designers can perform secure remote in-system reprogramming to support future design iterations and field upgrades with confidence that valuable intellectual property cannot be compromised or copied. Secure ISP can be performed using the industry-standard AES algorithm. The RT ProASIC3 family device architecture mitigates the need for ASIC migration at higher volumes. This makes the RT ProASIC3 family a cost-effective ASIC replacement.

Advanced Flash Technology

The RT ProASIC3 family offers many benefits, including nonvolatility and reprogrammability, through an advanced flash-based, 130-nm LVC MOS process with 7 layers of metal. Standard CMOS design techniques are used to implement logic and control functions. The combination of fine granularity, enhanced flexible routing resources, and abundant flash switches allows for very high logic utilization without compromising device routability or performance. Logic functions within the device are interconnected through a four-level routing hierarchy.

Advanced Architecture

The proprietary RT ProASIC3 architecture provides granularity comparable to standard-cell ASICs. The RT ProASIC3 device consists of five distinct and programmable architectural features (Figure 1-1):

- FPGA VersaTiles
- Dedicated FlashROM
- Dedicated SRAM/FIFO memory
- Extensive CCCs and PLLs
- I/O structure

The FPGA core consists of a sea of VersaTiles. Each VersaTile can be configured as a three-input logic function, a D-flip-flop (with or without enable), or a latch by programming the appropriate flash switch interconnections. The versatility of the RT ProASIC3 core tile, as either a three-input lookup table (LUT) equivalent or a D-flip-flop/latch with enable, allows for efficient use of the FPGA fabric. The VersaTile capability is unique to the Actel ProASIC family of third-generation-architecture flash FPGAs. VersaTiles are connected with any of the four levels of routing hierarchy. Flash switches are distributed throughout the device to provide nonvolatile, reconfigurable interconnect programming. Maximum core utilization is possible for virtually any design.

In addition, extensive on-chip programming circuitry allows for rapid, single-voltage (3.3 V) programming of RT ProASIC3 devices via an IEEE 1532 JTAG interface.

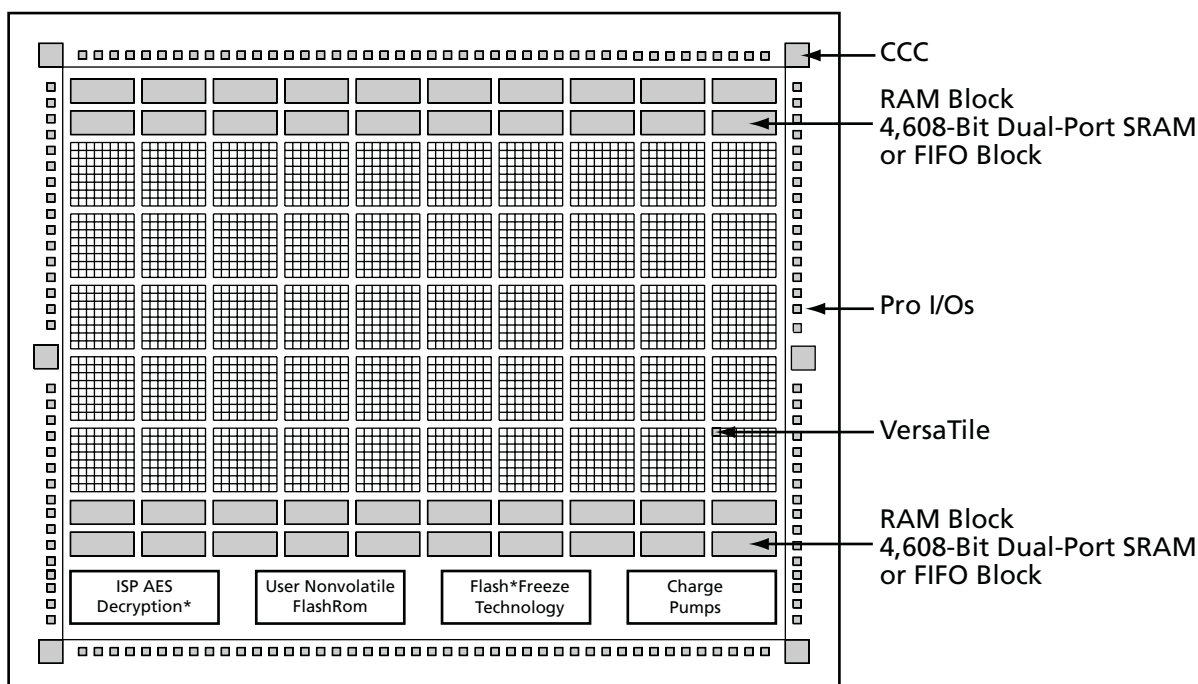


Figure 1-1 • RT ProASIC3 Device Architecture Overview

Flash*Freeze Technology

RT ProASIC3 devices offer Actel's proven Flash*Freeze technology, which enables designers to instantaneously shut off dynamic power consumption while retaining all SRAM and register information. Flash*Freeze technology enables the user to quickly (within 1 μ s) enter and exit Flash*Freeze mode by activating the Flash*Freeze (FF) pin while all power supplies are kept at their original values. In addition, I/Os and global I/Os can still be driven and can be toggling without impact on power consumption; clocks can still be driven or can be toggling without impact on power consumption; all core registers and SRAM cells retain their states. I/Os are tristated during Flash*Freeze mode or can be set to a certain state using weak pull-up or pull-down I/O attribute configuration. No power is consumed by the I/O banks, clocks, JTAG pins, or PLLs. Flash*Freeze technology allows the user to switch to active mode on demand, thus simplifying the power management of the device.

The FF pin (active low) can be routed internally to the core to allow the user's logic to decide when it is safe to transition to this mode. It is also possible to use the FF pin as a regular I/O if Flash*Freeze mode usage is not planned, which is advantageous because of the inherent low-power static and dynamic capabilities of the RT ProASIC3 device. Refer to [Figure 1-2](#) for an illustration of entering/exiting Flash*Freeze mode.

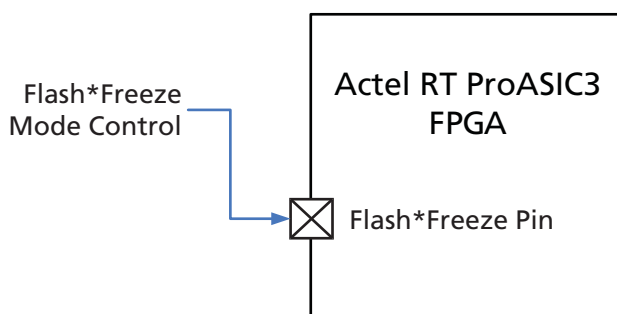


Figure 1-2 • RT ProASIC3 Flash*Freeze Mode

VersaTiles

The RT ProASIC3 core consists of VersaTiles, which have been enhanced beyond the ProASIC^{PLUS}® core tiles. The RT ProASIC3 VersaTile supports the following:

- All 3-input logic functions—LUT-3 equivalent
- Latch with clear or set
- D-flip-flop with clear or set
- Enable D-flip-flop with clear or set

Refer to [Figure 1-3](#) for VersaTile configurations.

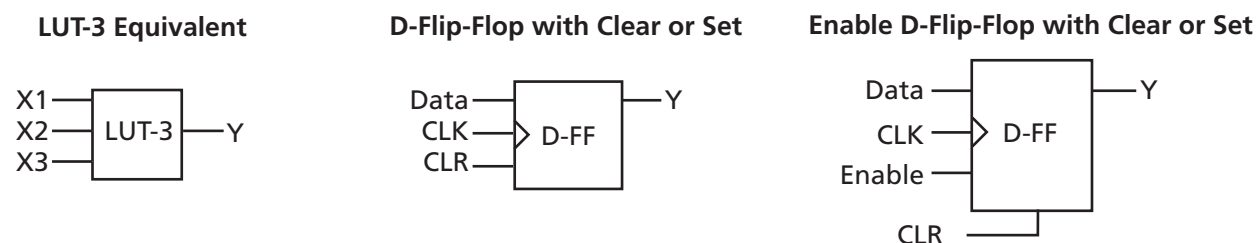


Figure 1-3 • VersaTile Configurations

User Nonvolatile FlashROM

Actel RT ProASIC3 devices have 1 kbit of on-chip, user-accessible, nonvolatile FlashROM. The FlashROM can be used in diverse system applications:

- Internet protocol addressing (wireless or fixed)
- System calibration settings
- Device serialization and/or inventory control
- Subscription-based business models (for example, set-top boxes)
- Secure key storage for secure communications algorithms
- Asset management/tracking
- Date stamping
- Version management

FlashROM is written using the standard RT ProASIC3 IEEE 1532 JTAG programming interface. The core can be individually programmed (erased and written), and on-chip AES decryption can be used selectively to securely load data over public networks, as in security keys stored in the FlashROM for a user design.

FlashROM can be programmed via the JTAG programming interface, and its contents can be read back either through the JTAG programming interface or via direct FPGA core addressing. Note that the FlashROM can only be programmed from the JTAG interface and cannot be programmed from the internal logic array.

FlashROM is programmed as 8 banks of 128 bits; however, reading is performed on a byte-by-byte basis using a synchronous interface. A 7-bit address from the FPGA core defines which of the 8 banks and which of the 16 bytes within that bank are being read. The three most significant bits (MSBs) of the FlashROM address determine the bank, and the four least significant bits (LSBs) of the FlashROM address define the byte.

The Actel RT ProASIC3 development software solutions, Libero IDE and Designer, have extensive support for the FlashROM. One such feature is auto-generation of sequential programming files for applications requiring a unique serial number in each part. Another feature allows the inclusion of static data for system version control. Data for the FlashROM can be generated quickly and easily using Actel Libero IDE and Designer software tools. Comprehensive programming file support is also included to allow for easy programming of large numbers of parts with differing FlashROM contents.

SRAM and FIFO

RT ProASIC3 devices have embedded SRAM blocks along their north and south sides. Each variable-aspect-ratio SRAM block is 4,608 bits in size. Available memory configurations are 256×18, 512×9, 1k×4, 2k×2, and 4k×1 bits. The individual blocks have independent read and write ports that can be configured with different bit widths on each port. For example, data can be sent through a 4-bit port and read as a single bitstream. The embedded SRAM blocks can be initialized via the device JTAG port (ROM emulation mode) using the UJTAG macro.

In addition, every SRAM block has an embedded FIFO control unit. The control unit allows the SRAM block to be configured as a synchronous FIFO without using additional core VersaTiles. The FIFO width and depth are programmable. The FIFO also features programmable Almost Empty (AEMPTY) and Almost Full (AFULL) flags in addition to the normal Empty and Full flags. The embedded FIFO control unit contains the counters necessary for generation of the read and write address pointers. The embedded SRAM/FIFO blocks can be cascaded to create larger configurations.

PLL and CCC

RT ProASIC3 space-flight FPGAs provide designers with flexible clock conditioning circuit (CCC) capabilities. Each member of the RT ProASIC3 family contains six CCCs, located at the four corners and the centers of the east and west sides. All six CCC blocks are equipped with a PLL. All six CCC blocks are usable; the four corner CCCs and the east CCC allow simple clock delay operations as well as clock spine access.

The inputs of the six CCC blocks are accessible from the FPGA core or from one of several inputs located near the CCC that have dedicated connections to the CCC block.

The CCC block has these key features:

- Wide input frequency range (f_{IN_CCC}) = 1.5 MHz up to 250 MHz
- Output frequency range (f_{OUT_CCC}) = 0.75 MHz up to 250 MHz
- 2 programmable delay types for clock skew minimization
- Clock frequency synthesis

Additional CCC specifications:

- Internal phase shift = 0°, 90°, 180°, and 270°. Output phase shift depends on the output divider configuration.
- Output duty cycle = 50% $\pm$ 1.5% or better
- Low output jitter: worst case < 2.5% $\times$ clock period peak-to-peak period jitter when single global network used
- Maximum acquisition time is 300 μ s
- Exceptional tolerance to input period jitter—allowable input jitter is up to 1.5 ns
- Four precise phases; maximum misalignment between adjacent phases of $40 \text{ ps} \times 250 \text{ MHz} / f_{OUT_CCC}$

Global Clocking

RT ProASIC3 devices have extensive support for multiple clocking domains. In addition to the CCC and PLL support described above, there is a comprehensive global clock distribution network.

Each VersaTile input and output port has access to nine VersaNets: six chip (main) and three quadrant global networks. The VersaNets can be driven by the CCC or directly accessed from the core via multiplexers (MUXes). The VersaNets can be used to distribute low-skew clock signals or for rapid distribution of high-fanout nets.

I/Os with Advanced I/O Standards

The RT ProASIC3 family of FPGAs features a flexible I/O structure, supporting a range of voltages (1.5 V, 1.8 V, 2.5 V, and 3.3 V). In addition, 1.2 V I/O operation is supported for RT ProASIC3 devices. RT ProASIC3 FPGAs support different I/O standards, including single-ended, differential, and voltage-referenced. The I/Os are organized into banks, with eight banks per device. The configuration of these banks determines the I/O standards supported. For RT ProASIC3, each I/O bank is subdivided into V_{REF} minibanks, which are used by voltage-referenced I/Os. V_{REF} minibanks contain 8 to 18 I/Os. All the I/Os in a given minibank share a common V_{REF} line. Therefore, if any I/O in a given V_{REF} minibank is configured as a V_{REF} pin, the remaining I/Os in that minibank will be able to use that reference voltage.

Each I/O module contains several input, output, and enable registers. These registers allow the implementation of the following:

- Single-data-rate applications (e.g., PCI 66 MHz, bidirectional SSTL 2 and 3, Class I and II)
- Double-data-Rate applications (e.g., DDR LVDS, B-LVDS, and M-LVDS I/Os for point-to-point communications, and DDR 200 MHz SRAM using bidirectional HSTL Class II).

RT ProASIC3 banks support LVPECL, LVDS, B-LVDS, and M-LVDS. B-LVDS and M-LVDS can support up to 20 loads.

Part Number and Revision Date

Part Number 51700107-001-0

Revised September 2008

Datasheet Categories

Categories

In order to provide the latest information to designers, some datasheets are published before data has been fully characterized. Datasheets are designated as "Product Brief," "Advance," "Preliminary," and "Production." The definition of these categories are as follows:

Product Brief

The product brief is a summarized version of a datasheet (advance or production) and contains general product information. This document gives an overview of specific device and family information.

Advance

This version contains initial estimated information based on simulation, other products, devices, or speed grades. This information can be used as estimates, but not for production. This label only applies to the DC and Switching Characteristics chapter of the datasheet and will only be used when the data has not been fully characterized.

Preliminary

The datasheet contains information based on simulation and/or initial characterization. The information is believed to be correct, but changes are possible.

Unmarked (production)

This version contains information that is considered to be final.

Export Administration Regulations (EAR)

The products described in this document are subject to the Export Administration Regulations (EAR). They could require an approved export license prior to export from the United States. An export includes release of product or disclosure of technology to a foreign national inside or outside the United States.

Actel Safety Critical, Life Support, and High-Reliability Applications Policy

The Actel products described in this advance status document may not have completed Actel's qualification process. Actel may amend or enhance products during the product introduction and qualification process, resulting in changes in device functionality or performance. It is the responsibility of each customer to ensure the fitness of any Actel product (but especially a new product) for a particular purpose, including appropriateness for safety-critical, life-support, and other high-reliability applications. Consult Actel's Terms and Conditions for specific liability exclusions relating to life-support applications. A reliability report covering all of Actel's products is available on the Actel website at http://www.actel.com/documents/ORT_Report.pdf. Actel also offers a variety of enhanced qualification and lot acceptance screening procedures. Contact your local Actel sales office for additional reliability information.



2 – Radiation-Tolerant ProASIC3 DC and Switching Characteristics

General Specifications

Operating Conditions

Stresses beyond those listed in [Table 2-1](#) may cause permanent damage to the device.

Exposure to absolute maximum rating conditions for extended periods may affect device reliability. absolute maximum ratings are stress ratings only; functional operation of the device at these or any other conditions beyond those listed under the Recommended Operating Conditions specified in [Table 2-2 on page 2-2](#) is not implied.

Table 2-1 • Absolute Maximum Ratings

Symbol	Parameter	Limits	Units
V_{CC}	DC core supply voltage	–0.3 to 1.65	V
V_{JTAG}	JTAG DC voltage	–0.3 to 3.75	V
V_{PUMP}	Programming voltage	–0.3 to 3.75	V
V_{CCPLL}	Analog power supply (PLL)	–0.3 to 1.65	V
V_{CCI} and VMV^3	DC I/O buffer supply voltage	–0.3 to 3.75	V
V_I	I/O input voltage	–0.3 V to 3.6 V (when I/O hot insertion mode is enabled) –0.3 V to ($V_{CCI} + 1$ V) or 3.6 V, whichever voltage is lower (when I/O hot-insertion mode is disabled)	V
T_{STG}^2	Storage temperature	–65 to +150	°C
T_J^2	Junction temperature	+150	°C

Notes:

1. The device should be operated within the limits specified by the datasheet. During transitions, the input signal may undershoot or overshoot according to the limits shown in [Table 2-4 on page 2-7](#).
2. For flash programming and retention maximum limits, refer to [Table 2-3 on page 2-3](#), and for recommended operating limits, refer to [Table 2-2 on page 2-2](#).
3. VMV pins must be connected to the corresponding V_{CCI} pins. Refer to the [Pin Descriptions](#) chapter for further information.

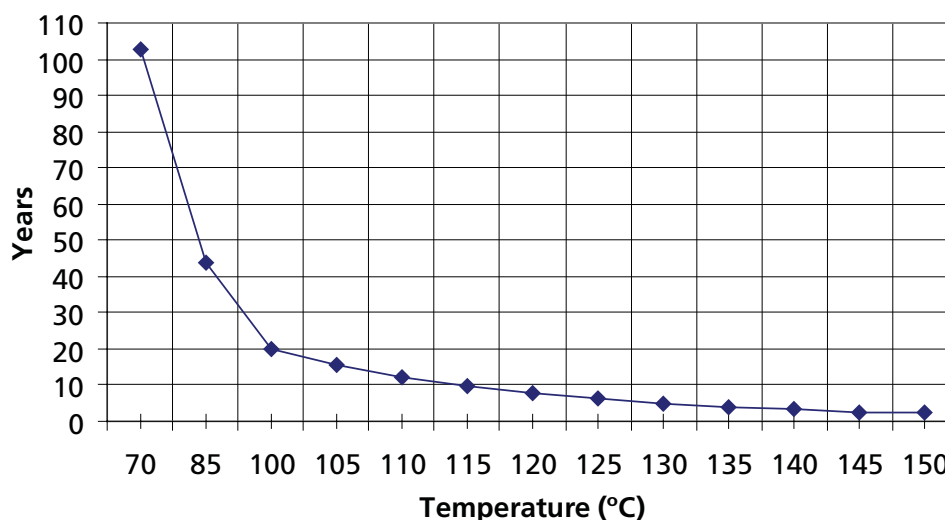
Table 2-2 • Recommended Operating Conditions²

Symbol	Parameter		Military	Units
T _A	Ambient temperature		–55 to 125	°C
T _J	Junction temperature		–55 to 125	°C
V _{CC}	DC core supply voltage		1.14 to 1.575	V
V _{JTAG}	JTAG DC voltage		1.4 to 3.45	V
V _{PUMP} ³	Programming voltage	Programming mode	3.15 to 3.45	V
		Operation ³	0 to 3.6	V
V _{CCPLL}	Analog power supply (PLL)	DC core supply voltage	1.14 to 1.575	V
V _{CCI} and VMV ⁴	1.2 V DC supply voltage		1.14 to 1.26	V
	1.5 V DC supply voltage		1.425 to 1.575	V
	1.8 V DC supply voltage		1.7 to 1.9	V
	2.5 V DC supply voltage		2.3 to 2.7	V
	3.3 V DC supply voltage		3.0 to 3.6	V
	LVDS differential I/O		2.375 to 2.625	V
	LVPECL differential I/O		3.0 to 3.6	V

Notes:

1. The ranges given here are for power supplies only. The recommended input voltage ranges specific to each I/O standard are given in [Table 2-17 on page 2-22](#). VMV and V_{CCI} should be at the same voltage within a given I/O bank.
2. All parameters representing voltages are measured with respect to GND unless otherwise specified.
3. V_{PUMP} can be left floating during normal operation (not programming mode).
4. VMV pins must be connected to the corresponding V_{CCI} pins. See the [Pin Descriptions](#) chapter for further information.

T _J (°C)	HTR Lifetime (yrs)
70	102.7
85	43.8
100	20.0
105	15.6
110	12.3
115	9.7
120	7.7
125	6.2
130	5.0
135	4.0
140	3.3
145	2.7
150	2.2



Note: HTR time is the period during which you would not expect a verify failure due to flash cell leakage.

Figure 2-1 • High-Temperature Data Retention (HTR)

Table 2-3 • Overshoot and Undershoot Limits

V_{CC1} and VMV	Average V_{CC1} -GND Overshoot or Undershoot Duration as a Percentage of Clock Cycle	Maximum Overshoot/ Undershoot (125°C)
2.7 V or less	10%	0.72 V
	5%	0.82 V
3 V	10%	0.72 V
	5%	0.81 V
3.3 V	10%	0.69 V
	5%	0.79 V
3.6 V	10%	N/A
	5%	N/A

Notes:

1. The duration is allowed at one out of six clock cycles. If the overshoot/undershoot occurs at one out of two cycles, the maximum overshoot/undershoot has to be reduced by 0.15 V.
2. This table does not provide PCI overshoot/undershoot limits.

I/O Power-Up and Supply Voltage Thresholds for Power-On Reset

Sophisticated power-up management circuitry is designed into every ProASIC[®]3 device. These circuits ensure easy transition from the powered-off state to the powered-up state of the device. The many different supplies can power up in any sequence with minimized current spikes or surges. In addition, the I/O will be in a known state through the power-up sequence. The basic principle is shown in [Figure 2-2 on page 2-5](#) and [Figure 2-3 on page 2-6](#).

There are five regions to consider during power-up.

RT ProASIC3 I/Os are activated only if ALL of the following three conditions are met:

1. V_{CC} and V_{CCI} are above the minimum specified trip points ([Figure 2-2 on page 2-5](#) and [Figure 2-3 on page 2-6](#)).
2. $V_{CCI} > V_{CC} - 0.75 \text{ V}$ (typical)
3. Chip is in the operating mode.

V_{CCI} Trip Point:

Ramping up: $0.6 \text{ V} < \text{trip_point_up} < 1.2 \text{ V}$

Ramping down: $0.5 \text{ V} < \text{trip_point_down} < 1.1 \text{ V}$

V_{CC} Trip Point:

Ramping up: $0.6 \text{ V} < \text{trip_point_up} < 1.1 \text{ V}$

Ramping down: $0.5 \text{ V} < \text{trip_point_down} < 1 \text{ V}$

V_{CC} and V_{CCI} ramp-up trip points are about 100 mV higher than ramp-down trip points. This specifically built-in hysteresis prevents undesirable power-up oscillations and current surges. Note the following:

- During programming, I/Os become tristated and weakly pulled up to V_{CCI} .
- JTAG supply, PLL power supplies, and charge pump V_{PUMP} supply have no influence on I/O behavior.

PLL Behavior at Brownout Condition

Actel recommends using monotonic power supplies or voltage regulators to ensure proper power-up behavior. Power ramp-up should be monotonic, at least until V_{CC} and V_{CCPLX} exceed brownout activation levels. The V_{CC} activation level is specified as 1.1 V worst-case (see Figure 2-2 and Figure 2-3 on page 2-6 for more details).

When PLL power supply voltage and/or V_{CC} levels drop below the V_{CC} brownout levels ($0.75\text{ V} \pm 0.25\text{ V}$), the PLL output lock signal goes low and/or the output clock is lost. Refer to the [Power-Up/Down Behavior of Low-Power Flash Devices](#) chapter of the handbook for information on clock and lock recovery.

Internal Power-Up Activation Sequence

1. Core
2. Input buffers

Output buffers, after 200 ns delay from input buffer activation.

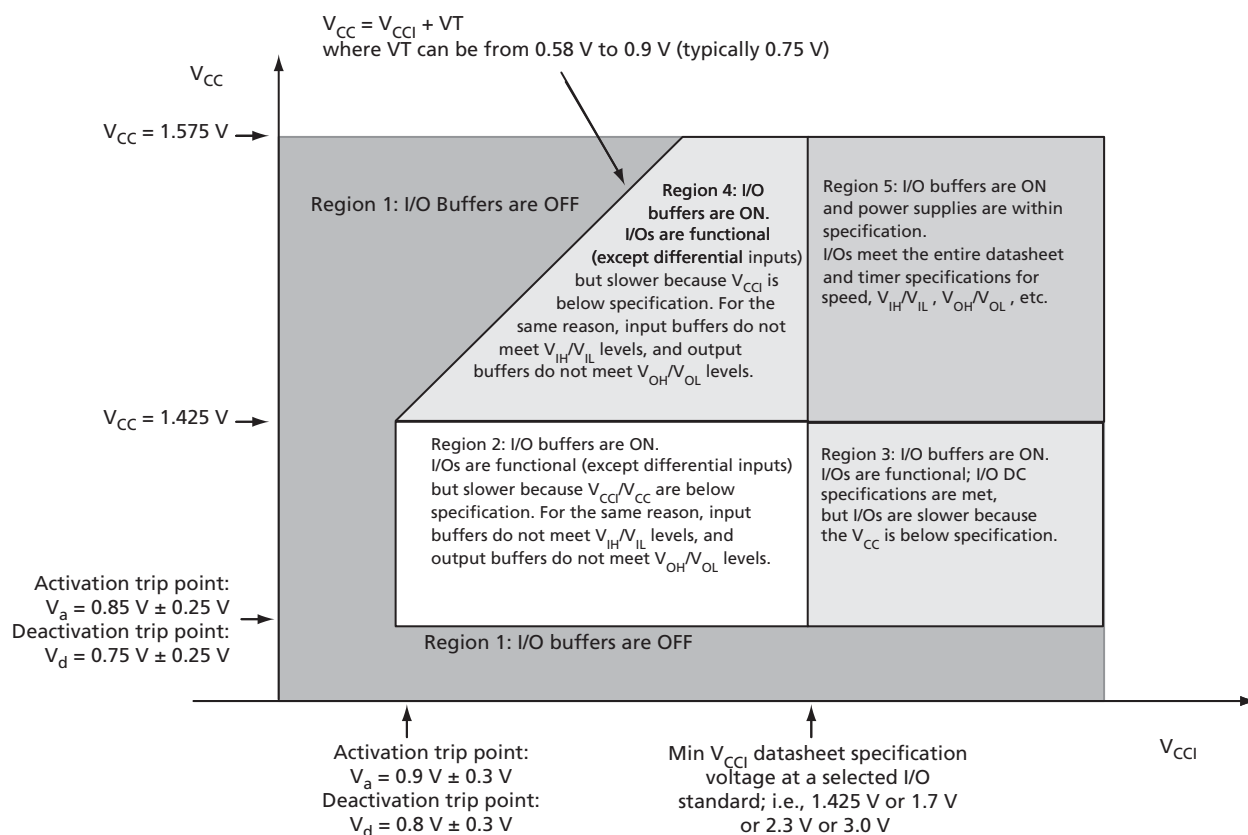


Figure 2-2 • Devices Operating at 1.5 V Core – I/O State as a Function of V_{CCI} and V_{CC} Voltage Levels

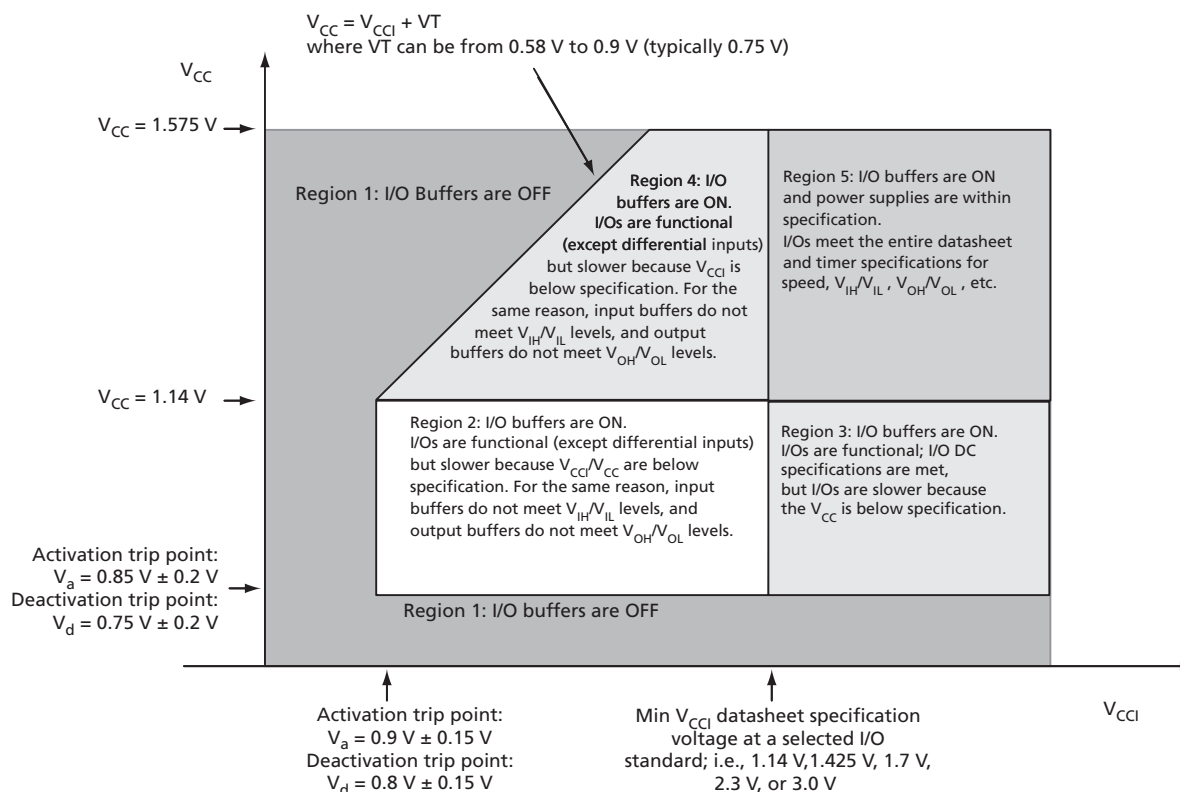


Figure 2-3 • Device Operating at 1.2 V Core Voltage – I/O State as a Function of V_{CCI} and V_{CC} Voltage Levels

Thermal Characteristics

Introduction

The temperature variable in the Actel Designer software refers to the junction temperature, not the ambient temperature. This is an important distinction because dynamic and static power consumption cause the chip junction temperature to be higher than the ambient temperature.

EQ 2-1 can be used to calculate junction temperature.

$$T_J = \text{Junction Temperature} = \Delta T + T_A$$

EQ 2-1

where:

T_A = Ambient Temperature

ΔT = Temperature gradient between junction (silicon) and ambient $\Delta T = \theta_{ja} * P$

θ_{ja} = Junction-to-ambient of the package. θ_{ja} numbers are located in Table 2-4.

P = Power dissipation

Package Thermal Characteristics

The device junction-to-case thermal resistivity is θ_{jc} and the junction-to-ambient air thermal resistivity is θ_{ja} . The thermal characteristics for θ_{ja} are shown for two air flow rates. The recommended maximum junction temperature is 125°C. EQ 2-2 shows a sample calculation of the recommended maximum power dissipation allowed for a 484-pin CCGA package with the junction at 125°C and with the case temperature maintained at 70°C.

$$\text{Maximum Power Allowed} = \frac{\text{Max. junction temp. (°C)} - \text{Max. case temp. (°C)}}{\theta_{jc} (\text{°C/W})}$$

EQ 2-2

Table 2-4 • Package Thermal Resistivities

Package Type	Device	Pin Count	θ_{jc}	θ_{ja}			Units
				Still Air	200 ft./min.	500 ft./min.	
Ceramic Column Grid Array (CCGA)	RT3PE600L	484	TBD	TBD	TBD	TBD	C/W
	RT3PE3000L	484	TBD	TBD	TBD	TBD	C/W
	RT3PE3000L	896	TBD	TBD	TBD	TBD	C/W

Temperature and Voltage Derating Factors

Table 2-5 • Temperature and Voltage Derating Factors for Timing Delays
(normalized to $T_J = 125^\circ\text{C}$, $V_{CC} = 1.14\text{ V}$)

Array Voltage V_{CC} (V)	Junction Temperature						
	-55°C	-40°C	0°C	25°C	70°C	85°C	125°C
1.14	0.86	0.87	0.90	0.92	0.96	0.98	1.00
1.2	0.83	0.84	0.87	0.89	0.93	0.94	0.96
1.26	0.79	0.80	0.83	0.85	0.89	0.90	0.92
1.3	0.77	0.78	0.81	0.83	0.86	0.88	0.90
1.35	0.75	0.75	0.78	0.80	0.83	0.85	0.87
1.4	0.72	0.73	0.75	0.77	0.80	0.81	0.83
1.425	0.70	0.71	0.74	0.76	0.79	0.80	0.82
1.5	0.67	0.67	0.70	0.71	0.75	0.76	0.78
1.575	0.64	0.65	0.67	0.69	0.72	0.73	0.75

Calculating Power Dissipation

Quiescent Supply Current

Table 2-6 • Quiescent Supply Current (I_{DD}) Characteristics When Using Flash*Freeze Mode in RT ProASIC3*

	Core Voltage	RT3PE600L	RT3PE3000L	Units
Typical (25°C)	1.2 V		2.75	mA
	1.5 V			mA

* I_{DD} includes V_{CC} , V_{PUMP} , V_{CCI} , V_{JTAG} , and V_{CCPLL} currents. Values do not include I/O static contribution (P_{DC6} and P_{DC7}).

Table 2-7 • Quiescent Supply Current (I_{DD}) Characteristics, RT ProASIC3 Sleep Mode ($V_{CC} = 0$ V)*

	Core Voltage	RT3PE600L	RT3PE3000L	Units
$V_{CCI} / V_{JTAG} = 1.2$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.7	1.7	μ A
$V_{CCI} / V_{JTAG} = 1.5$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.8	1.8	μ A
$V_{CCI} / V_{JTAG} = 1.8$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.9	1.9	μ A
$V_{CCI} / V_{JTAG} = 2.5$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	2.2	2.2	μ A
$V_{CCI} / V_{JTAG} = 3.3$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	2.5	2.5	μ A

* I_{DD} includes V_{CC} , V_{PUMP} , and V_{CCPLL} currents. Values do not include I/O static contribution (P_{DC6} and P_{DC7}).

Table 2-8 • Quiescent Supply Current (I_{DD}) Characteristics Shutdown Mode, (V_{CC} and $V_{CCI} = 0$ V)*

	Core Voltage	RT3PE600L	RT3PE3000L
Typical (25°C)	1.2 V / 1.5 V	0 μ A	

* I_{DD} includes V_{CC} , V_{PUMP} , V_{CCI} , V_{JTAG} , and V_{CCPLL} currents. Values do not include I/O static contribution (P_{DC6} and P_{DC7}).

Table 2-9 • Quiescent Supply Current (I_{DD}), RT ProASIC3 Flash*Freeze Mode¹

	Core Voltage	RT3PE600L	RT3PE3000L	Units
I_{CCA} Current²				
Typical (25°C)	1.2 V		2.75	mA
	1.5 V			mA
I_{CCI} or I_{JTAG} Current^{3, 4}				
$V_{CCI} / V_{JTAG} = 1.2$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.7	1.7	μ A
$V_{CCI} / V_{JTAG} = 1.5$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.8	1.8	μ A
$V_{CCI} / V_{JTAG} = 1.8$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	1.9	1.9	μ A
$V_{CCI} / V_{JTAG} = 2.5$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	2.2	2.2	μ A
$V_{CCI} / V_{JTAG} = 3.3$ V (per bank) Typical (25°C)	1.2 V / 1.5 V	2.5	2.5	μ A

Notes:

1. To calculate total device I_{DD} , multiply the number of banks used by I_{CCI} and add I_{CCA} contribution.
2. Includes V_{CC} , V_{CCPLL} , and V_{PUMP} currents.
3. Per V_{CCI} or V_{JTAG} bank.
4. Values do not include I/O static contribution (P_{DC6} and P_{DC7}).

Power per I/O Pin

Table 2-10 • Summary of I/O Input Buffer Power (Per Pin) – Default I/O Software Settings

	V_{CCI} (V)	Static Power P_{DC6} (mW) ¹	Dynamic Power P_{AC9} (μ W/MHz) ²
Single-Ended			
3.3 V LVTTTL/LVCMOS	3.3	–	16.34
3.3 V LVTTTL/LVCMOS – Schmitt trigger	3.3	–	24.49
2.5 V LVCMOS	2.5	–	4.71
2.5 V LVCMOS – Schmitt trigger	2.5	–	6.13
1.8 V LVCMOS	1.8	–	1.66
1.8 V LVCMOS – Schmitt trigger	1.8	–	1.78
1.5 V LVCMOS (JESD8-11)	1.5	–	1.01
1.5 V LVCMOS (JESD8-11) – Schmitt trigger	1.5	–	0.97
1.2 V LVCMOS ³	1.2	–	0.60
1.2 V LVCMOS (JESD8-11) – Schmitt trigger ³	1.2	–	0.53
3.3 V PCI	3.3	–	17.76
3.3 V PCI – Schmitt trigger	3.3	–	19.10
3.3 V PCI-X	3.3	–	17.76
3.3 V PCI-X – Schmitt trigger	3.3	–	19.10
Voltage-Referenced			
3.3 V GTL	3.3	2.90	7.07
2.5 V GTL	2.5	2.13	3.62
3.3 V GTL+	3.3	2.81	2.97
2.5 V GTL+	2.5	2.57	2.55
HSTL (I)	1.5	0.17	0.85
HSTL (II)	1.5	0.17	0.85
SSTL2 (I)	2.5	1.38	3.30
SSTL2 (II)	2.5	1.38	3.30
SSTL3 (I)	3.3	3.21	8.08
SSTL3 (II)	3.3	3.21	8.08
Differential			
LVDS	2.5	2.26	0.95
LVPECL	3.3	5.71	1.62

Notes:

1. P_{DC6} is the static power (where applicable) measured on V_{CCI} .
2. P_{AC9} is the total dynamic power measured on V_{CCI} .

Table 2-11 • Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings¹

	C_{LOAD} (pF)	V_{CCI} (V)	Static Power P_{DC7} (mW) ²	Dynamic Power P_{AC10} (μW/MHz) ³
Single-Ended				
3.3 V LVTTTL/LVCMOS	5	3.3	–	148.00
2.5 V LVCMOS	5	2.5	–	83.23
1.8 V LVCMOS	5	1.8	–	54.58
1.5 V LVCMOS (JESD8-11)	5	1.5	–	37.05
1.2 V LVCMOS ⁴	5	1.2	–	17.94
3.3 V PCI	10	3.3	–	204.61
3.3 V PCI-X	10	3.3	–	204.61
Voltage-Referenced				
3.3 V GTL	10	3.3	–	24.08
2.5 V GTL	10	2.5	–	13.52
3.3 V GTL+	10	3.3	–	24.10
2.5 V GTL+	10	2.5	–	13.54
HSTL (I)	20	1.5	7.08	26.22
HSTL (II)	20	1.5	13.88	27.22
SSTL2 (I)	30	2.5	16.69	105.56
SSTL2 (II)	30	2.5	25.91	116.60
SSTL3 (I)	30	3.3	26.02	114.87
SSTL3 (II)	30	3.3	42.21	131.76
Differential				
LVDS	–	2.5	7.70	89.62
LVPECL	–	3.3	19.42	168.02

Notes:

1. Dynamic power consumption is given for standard load and software default drive strength and output slew.
2. P_{DC7} is the static power (where applicable) measured on V_{CCI} .
3. P_{AC10} is the total dynamic power measured on V_{CCI} .

Power Consumption of Various Internal Resources

Table 2-12 • Different Components Contributing to Dynamic Power Consumption in Devices Operating at 1.2 V V_{CC}

Parameter	Definition	Device-Specific Dynamic Power ($\mu\text{W}/\text{MHz}$)	
		RT3PE3000L	RT3PE600L
P _{AC1}	Clock contribution of a Global Rib	12.61	
P _{AC2}	Clock contribution of a Global Spine	2.66	
P _{AC3}	Clock contribution of a VersaTile row	0.56	
P _{AC4}	Clock contribution of a VersaTile used as a sequential module	0.07	
P _{AC5}	First contribution of a VersaTile used as a sequential module	0.05	
P _{AC6}	Second contribution of a VersaTile used as a sequential module	0.19	
P _{AC7}	Contribution of a VersaTile used as a combinatorial module	0.11	
P _{AC8}	Average contribution of a routing net	0.45	
P _{AC9}	Contribution of an I/O input pin (standard-dependent)	See Table 2-10 on page 2-11 .	
P _{AC10}	Contribution of an I/O output pin (standard-dependent)	See Table 2-11 on page 2-12 .	
P _{AC11}	Average contribution of a RAM block during a read operation	25.00	
P _{AC12}	Average contribution of a RAM block during a write operation	30.00	
P _{AC13}	Dynamic contribution for PLL	1.74	

Table 2-13 • Different Components Contributing to Dynamic Power Consumption in RT ProASIC3 Devices at 1.5 V V_{CC}

Parameter	Definition	Device-Specific Dynamic Power ($\mu\text{W}/\text{MHz}$)	
		RT3PE3000L	RT3PE600L
P _{AC1}	Clock contribution of a Global Rib	19.7	
P _{AC2}	Clock contribution of a Global Spine	4.16	
P _{AC3}	Clock contribution of a VersaTile row	0.88	
P _{AC4}	Clock contribution of a VersaTile used as a sequential module	0.12	
P _{AC5}	First contribution of a VersaTile used as a sequential module	0.07	
P _{AC6}	Second contribution of a VersaTile used as a sequential module	0.29	
P _{AC7}	Contribution of a VersaTile used as a combinatorial module	0.29	
P _{AC8}	Average contribution of a routing net	0.70	
P _{AC9}	Contribution of an I/O input pin (standard-dependent)	See Table 2-10 on page 2-11.	
P _{AC10}	Contribution of an I/O output pin (standard-dependent)	See Table 2-11 on page 2-12.	
P _{AC11}	Average contribution of a RAM block during a read operation	25.00	
P _{AC12}	Average contribution of a RAM block during a write operation	30.00	
P _{AC13}	Dynamic contribution for PLL	2.60	

Table 2-14 • Different Components Contributing to the Static Power Consumption in RT ProASIC3 Devices

Parameter	Definition	Device-Specific Dynamic Power (μW)	
		RT3PE3000L	RT3PE600L
P _{DC1}	Array static power in Active mode	See Table 2-9 on page 2-10.	
P _{DC2}	Array static power in Static (Idle) mode	See Table 2-9 on page 2-10.	
P _{DC3}	Array static power in Flash*Freeze mode	See Table 2-6 on page 2-9.	
P _{DC4}	Static PLL contribution at 1.2 V operating core voltage	1.42 mW	
	Static PLL contribution 1.5 V operating core voltage	2.55 mW	
P _{DC5}	Bank quiescent power (V_{CC1} -dependent)	See Table 2-6 on page 2-9, Table 2-7 on page 2-9, Table 2-9 on page 2-10.	
P _{DC6}	I/O input pin static power (standard-dependent)	See Table 2-10 on page 2-11.	
P _{DC7}	I/O output pin static power (standard-dependent)	See Table 2-11 on page 2-12.	

* For a different output load, drive strength, or slew rate, Actel recommends using the Actel power spreadsheet calculator or SmartPower tool in Libero® Integrated Design Environment (IDE).

Power Calculation Methodology

This section describes a simplified method to estimate power consumption of an application. For more accurate and detailed power estimations, use the SmartPower tool in Actel Libero IDE software.

The power calculation methodology described below uses the following variables:

- The number of PLLs as well as the number and the frequency of each output clock generated
- The number of combinatorial and sequential cells used in the design
- The internal clock frequencies
- The number and the standard of I/O pins used in the design
- The number of RAM blocks used in the design
- Toggle rates of I/O pins as well as VersaTiles—guidelines are provided in [Table 2-15 on page 2-17](#).
- Enable rates of output buffers—guidelines are provided for typical applications in [Table 2-16 on page 2-17](#).
- Read rate and write rate to the memory—guidelines are provided for typical applications in [Table 2-16 on page 2-17](#). The calculation should be repeated for each clock domain defined in the design.

Methodology

Total Power Consumption— P_{TOTAL}

$$P_{TOTAL} = P_{STAT} + P_{DYN}$$

P_{STAT} is the total static power consumption.

P_{DYN} is the total dynamic power consumption.

Total Static Power Consumption— P_{STAT}

$$P_{STAT} = (P_{DC1} \text{ or } P_{DC2} \text{ or } P_{DC3}) + N_{BANKS} * P_{DC5} + N_{INPUTS} * P_{DC6} + N_{OUTPUTS} * P_{DC7}$$

N_{INPUTS} is the number of I/O input buffers used in the design.

$N_{OUTPUTS}$ is the number of I/O output buffers used in the design.

N_{BANKS} is the number of I/O banks powered in the design.

Total Dynamic Power Consumption— P_{DYN}

$$P_{DYN} = P_{CLOCK} + P_{S-CELL} + P_{C-CELL} + P_{NET} + P_{INPUTS} + P_{OUTPUTS} + P_{MEMORY} + P_{PLL}$$

Global Clock Contribution— P_{CLOCK}

$$P_{CLOCK} = (P_{AC1} + N_{SPINE} * P_{AC2} + N_{ROW} * P_{AC3} + N_{S-CELL} * P_{AC4}) * F_{CLK}$$

N_{SPINE} is the number of global spines used in the user design—guidelines are provided in [Table 2-15 on page 2-17](#).

N_{ROW} is the number of VersaTile rows used in the design—guidelines are provided in [Table 2-15 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

N_{S-CELL} is the number of VersaTiles used as sequential modules in the design.

P_{AC1} , P_{AC2} , P_{AC3} , and P_{AC4} are device-dependent.

Sequential Cells Contribution— P_{S-CELL}

$$P_{S-CELL} = N_{S-CELL} * (P_{AC5} + \alpha_1 / 2 * P_{AC6}) * F_{CLK}$$

N_{S-CELL} is the number of VersaTiles used as sequential modules in the design. When a multi-tile sequential cell is used, it should be accounted for as 1.

α_1 is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-15 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

Combinatorial Cells Contribution— P_{C-CELL}

$$P_{C-CELL} = N_{C-CELL} * \alpha_1 / 2 * P_{AC7} * F_{CLK}$$

N_{C-CELL} is the number of VersaTiles used as combinatorial modules in the design.

α_1 is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-15 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

Routing Net Contribution— P_{NET}

$$P_{NET} = (N_{S-CELL} + N_{C-CELL}) * \alpha_1 / 2 * P_{AC8} * F_{CLK}$$

N_{S-CELL} is the number of VersaTiles used as sequential modules in the design.

N_{C-CELL} is the number of VersaTiles used as combinatorial modules in the design.

α_1 is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-15 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

I/O Input Buffer Contribution— P_{INPUTS}

$$P_{INPUTS} = N_{INPUTS} * \alpha_2 / 2 * P_{AC9} * F_{CLK}$$

N_{INPUTS} is the number of I/O input buffers used in the design.

α_2 is the I/O buffer toggle rate—guidelines are provided in [Table 2-15 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

I/O Output Buffer Contribution— $P_{OUTPUTS}$

$$P_{OUTPUTS} = N_{OUTPUTS} * \alpha_2 / 2 * \beta_1 * P_{AC10} * F_{CLK}$$

$N_{OUTPUTS}$ is the number of I/O output buffers used in the design.

α_2 is the I/O buffer toggle rate—guidelines are provided in [Table 2-15 on page 2-17](#).

β_1 is the I/O buffer enable rate—guidelines are provided in [Table 2-16 on page 2-17](#).

F_{CLK} is the global clock signal frequency.

RAM Contribution— P_{MEMORY}

$$P_{MEMORY} = P_{AC11} * N_{BLOCKS} * F_{READ-CLOCK} * \beta_2 + P_{AC12} * N_{BLOCK} * F_{WRITE-CLOCK} * \beta_3$$

N_{BLOCKS} is the number of RAM blocks used in the design.

$F_{READ-CLOCK}$ is the memory read clock frequency.

β_2 is the RAM enable rate for read operations.

$F_{WRITE-CLOCK}$ is the memory write clock frequency.

β_3 is the RAM enable rate for write operations—guidelines are provided in [Table 2-16 on page 2-17](#).

PLL Contribution— P_{PLL}

$$P_{PLL} = P_{DC4} + P_{AC13} * F_{CLKOUT}$$

F_{CLKOUT} is the output clock frequency.¹

1. If a PLL is used to generate more than one output clock, include each output clock in the formula by adding its corresponding contribution ($P_{AC13} * F_{CLKOUT}$ product) to the total PLL contribution.

Guidelines

Toggle Rate Definition

A toggle rate defines the frequency of a net or logic element relative to a clock. It is a percentage. If the toggle rate of a net is 100%, this means that this net switches at half the clock frequency. Below are some examples:

- The average toggle rate of a shift register is 100% because all flip-flop outputs toggle at half of the clock frequency.
- The average toggle rate of an 8-bit counter is 25%:
 - Bit 0 (LSB) = 100%
 - Bit 1 = 50%
 - Bit 2 = 25%
 - ...
 - Bit 7 (MSB) = 0.78125%
 - Average toggle rate = $(100\% + 50\% + 25\% + 12.5\% + \dots + 0.78125\%) / 8$

Enable Rate Definition

Output enable rate is the average percentage of time during which tristate outputs are enabled. When nontristate output buffers are used, the enable rate should be 100%.

Table 2-15 • Toggle Rate Guidelines Recommended for Power Calculation

Component	Definition	Guideline
α_1	Toggle rate of VersaTile outputs	10%
α_2	I/O buffer toggle rate	10%

Table 2-16 • Enable Rate Guidelines Recommended for Power Calculation

Component	Definition	Guideline
β_1	I/O output buffer enable rate	100%
β_2	RAM enable rate for read operations	12.5%
β_3	RAM enable rate for write operations	12.5%

User I/O Characteristics

Timing Model

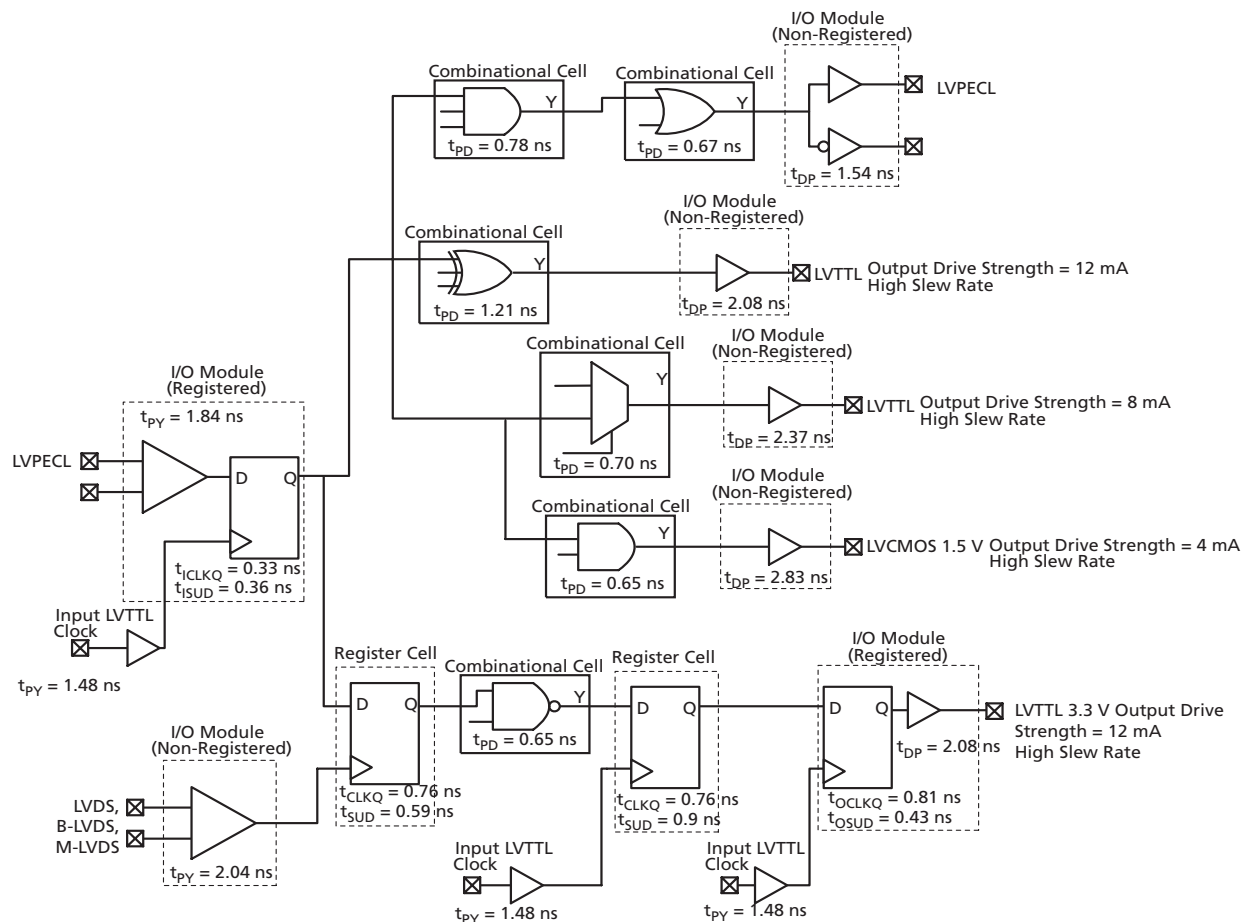


Figure 2-4 • Timing Model

Operating Conditions: –1 Speed, Military Temperature Range ($T_J = 125^\circ\text{C}$), Worst-Case $V_{CC} = 1.14$ V (example for RT3PE3000L and RT3PE600L)

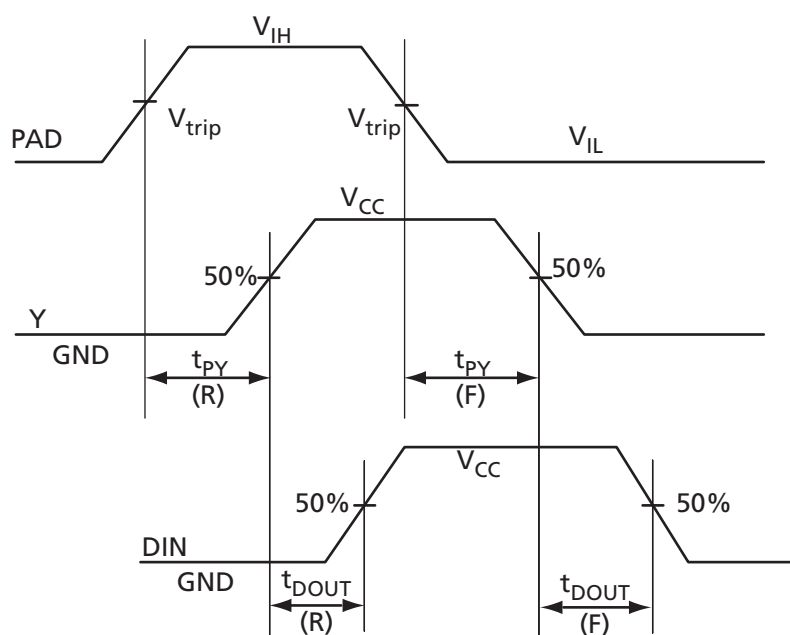
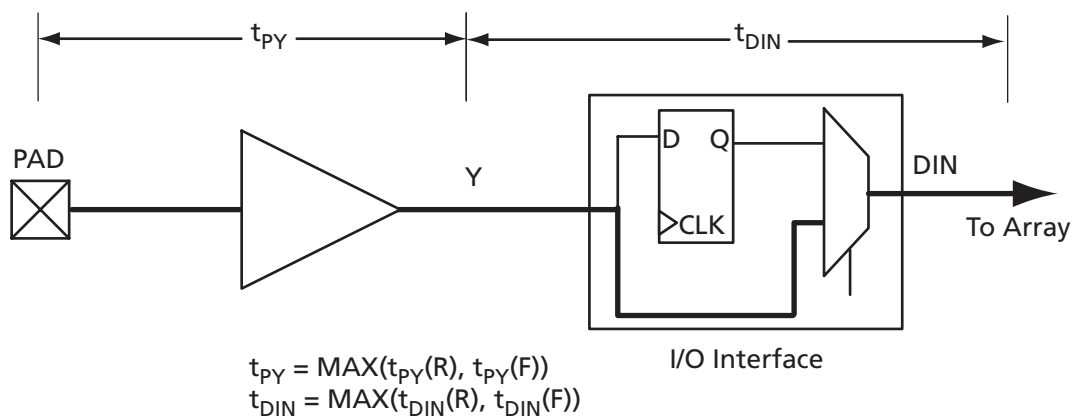


Figure 2-5 • Input Buffer Timing Model and Delays (example)

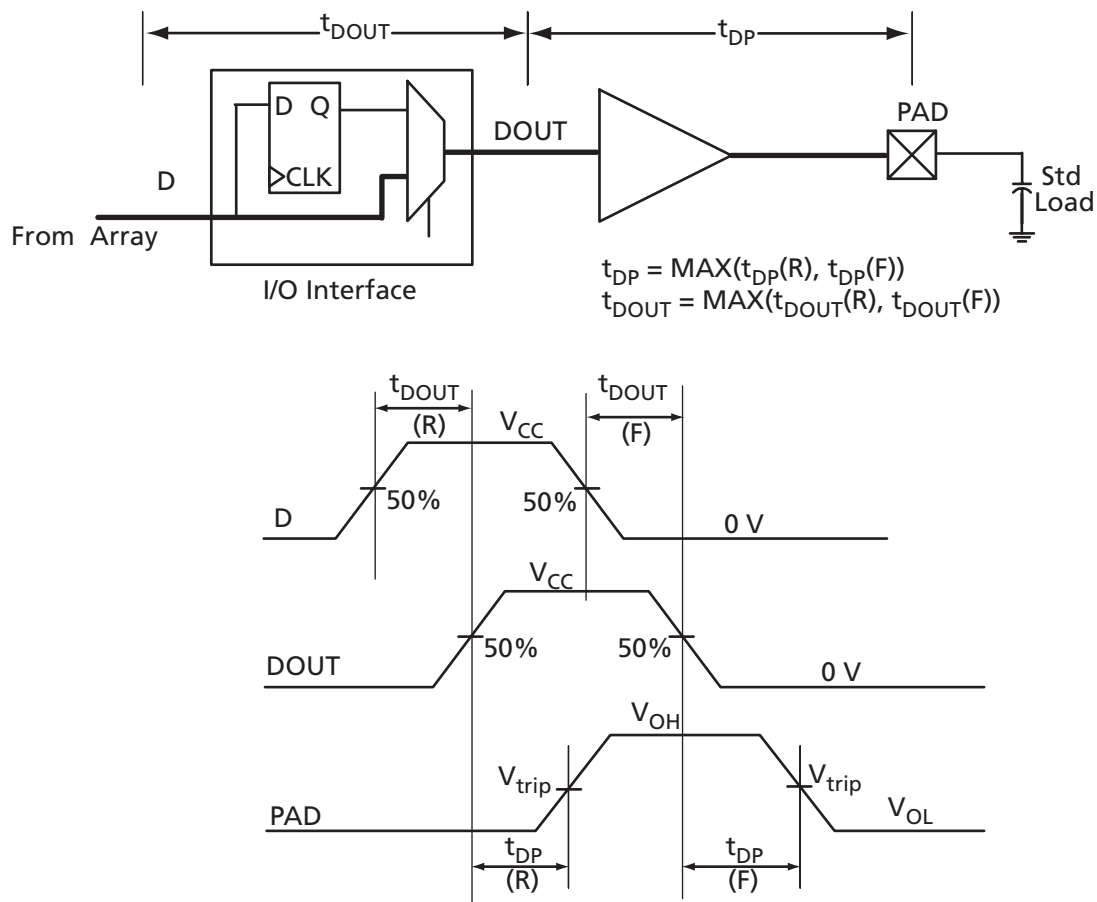


Figure 2-6 • Output Buffer Model and Delays (example)

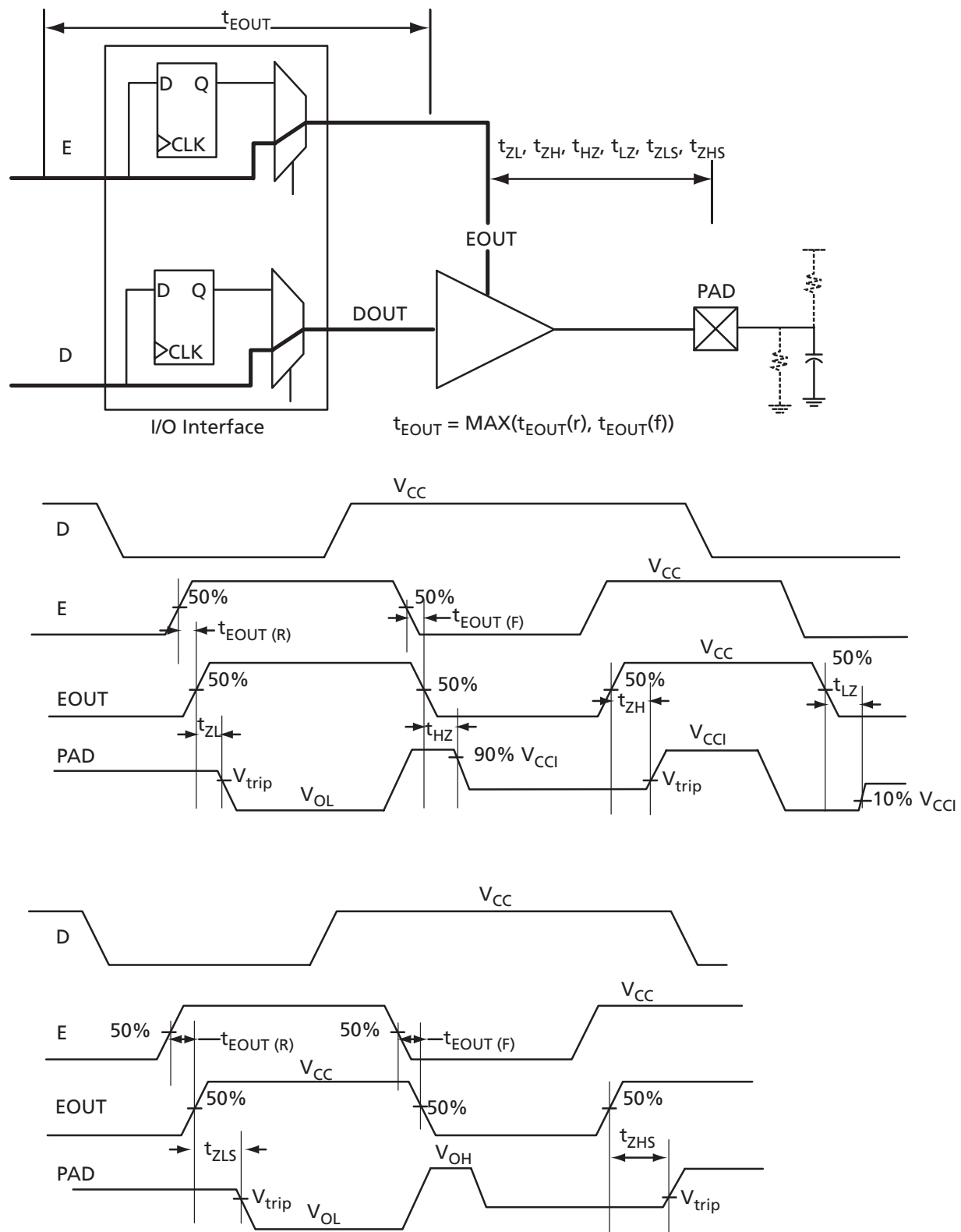


Figure 2-7 • Tristate Output Buffer Timing Model and Delays (example)

Overview of I/O Performance

Summary of I/O DC Input and Output Levels – Default I/O Software Settings

**Table 2-17 • Summary of Maximum and Minimum DC Input and Output Levels
Applicable to Military Conditions—Software Default Settings**

I/O Standard	Drive Strength	Slew Rate	V _{IL}		V _{IH}		V _{OL}	V _{OH}	I _{OL} ¹	I _{OH} ¹
			Min, V	Max, V	Min, V	Max, V	Max, V	Min, V	mA	mA
3.3 V LVTTTL / 3.3 V LVCMOS	12 mA	High	–0.3	0.8	2	3.6	0.4	2.4	12	12
2.5 V LVCMOS	12 mA	High	–0.3	0.7	1.7	2.7	0.7	1.7	12	12
1.8 V LVCMOS	12 mA	High	–0.3	0.35 * V _{CCl}	0.65 * V _{CCl}	1.9	0.45	V _{CCl} – 0.45	12	12
1.5 V LVCMOS	12 mA	High	–0.3	0.35 * V _{CCl}	0.65 * V _{CCl}	1.575	0.25 * V _{CCl}	0.75 * V _{CCl}	12	12
1.2 V LVCMOS	2 mA	High	–0.3	0.35 * V _{CCl}	0.65 * V _{CCl}	1.26	0.25 * V _{CCl}	0.75 * V _{CCl}	2	2
3.3 V PCI	Per PCI Specification									
3.3 V PCI-X	Per PCI-X Specification									
3.3 V GTL	25 mA ²	High	–0.3	V _{REF} – 0.05	V _{REF} + 0.05	3.6	0.4	–	25	25
2.5 V GTL	25 mA ²	High	–0.3	V _{REF} – 0.05	V _{REF} + 0.05	2.7	0.4	–	25	25
3.3 V GTL+	35 mA	High	–0.3	V _{REF} – 0.1	V _{REF} + 0.1	3.6	0.6	–	51	51
2.5 V GTL+	33 mA	High	–0.3	V _{REF} – 0.1	V _{REF} + 0.1	2.7	0.6	–	40	40
HSTL (I)	8 mA	High	–0.3	V _{REF} – 0.1	V _{REF} + 0.1	1.575	0.4	V _{CCl} – 0.4	8	8
HSTL (II)	15 mA ²	High	–0.3	V _{REF} – 0.1	V _{REF} + 0.1	1.575	0.4	V _{CCl} – 0.4	15	15
SSTL2 (I)	15 mA	High	–0.3	V _{REF} – 0.2	V _{REF} + 0.2	2.7	0.54	V _{CCl} – 0.62	15	15
SSTL2 (II)	18 mA	High	–0.3	V _{REF} – 0.2	V _{REF} + 0.2	2.7	0.35	V _{CCl} – 0.43	18	18
SSTL3 (I)	14 mA	High	–0.3	V _{REF} – 0.2	V _{REF} + 0.2	3.6	0.7	V _{CCl} – 1.1	14	14
SSTL3 (II)	21 mA	High	–0.3	V _{REF} – 0.2	V _{REF} + 0.2	3.6	0.5	V _{CCl} – 0.9	21	21

Notes:

1. Currents are measured at 125°C junction temperature.
2. Output drive strength is below JEDEC specification.
3. Output slew rate can be extracted using the IBIS Models.

Table 2-18 • Summary of Maximum and Minimum DC Input Levels

DC I/O Standard	Military	
	I _{IL}	I _{IH}
	μA	μA
3.3 V LVTTTL / 3.3 V LVCMOS	15	15
2.5 V LVCMOS	15	15
1.8 V LVCMOS	15	15
1.5 V LVCMOS	15	15
1.2 V LVCMOS	15	15
3.3 V PCI	15	15
3.3 V PCI-X	15	15
3.3 V GTL	15	15
2.5 V GTL	15	15
3.3 V GTL+	15	15
2.5 V GTL+	15	15
HSTL (I)	15	15
HSTL (II)	15	15
SSTL2 (I)	15	15
SSTL2 (II)	15	15
SSTL3 (I)	15	15
SSTL3 (II)	15	15

Note: Military temperature range: –55°C to 125°C

Summary of I/O Timing Characteristics – Default I/O Software Settings

Table 2-19 • Summary of AC Memory Points*

Standard	Input Reference Voltage (V_{REF_TYP})	Board Termination Voltage (V_{TT_REF})	Measuring Trip Point (V_{trip})
3.3 V LVTTTL / 3.3 V LVCMOS	–	–	1.4 V
2.5 V LVCMOS	–	–	1.2 V
1.8 V LVCMOS	–	–	0.90 V
1.5 V LVCMOS	–	–	0.75 V
1.2 V LVCMOS*	–	–	0.6V
3.3 V PCI	–	–	$0.285 * V_{CCI(RR)}$
			$0.615 * V_{CCI(FF)}$
3.3 V PCI-X	–	–	$0.285 * V_{CCI(RR)}$
			$0.615 * V_{CCI(FF)}$
3.3 V GTL	0.8 V	1.2 V	V_{REF}
2.5 V GTL	0.8 V	1.2 V	V_{REF}
3.3 V GTL+	1.0 V	1.5 V	V_{REF}
2.5 V GTL+	1.0 V	1.5 V	V_{REF}
HSTL (I)	0.75 V	0.75 V	V_{REF}
HSTL (II)	0.75 V	0.75 V	V_{REF}
SSTL2 (I)	1.25 V	1.25 V	V_{REF}
SSTL2 (II)	1.25 V	1.25 V	V_{REF}
SSTL3 (I)	1.5 V	1.485 V	V_{REF}
SSTL3 (II)	1.5 V	1.485 V	V_{REF}
LVDS	–	–	Cross point
LVPECL	–	–	Cross point

* Applicable to RT3PE600L and RT3PE3000L devices operating at 1.2 V core regions only.

Table 2-20 • I/O AC Parameter Definitions

Parameter	Parameter Definition
t_{DP}	Data to Pad delay through the Output Buffer
t_{PY}	Pad to Data delay through the Input Buffer
t_{DOUT}	Data to Output Buffer delay through the I/O interface
t_{EOUT}	Enable to Output Buffer Tristate Control delay through the I/O interface
t_{DIN}	Input Buffer to Data delay through the I/O interface
t_{HZ}	Enable to Pad delay through the Output Buffer—HIGH to Z
t_{ZH}	Enable to Pad delay through the Output Buffer—Z to HIGH
t_{LZ}	Enable to Pad delay through the Output Buffer—LOW to Z
t_{ZL}	Enable to Pad delay through the Output Buffer—Z to LOW
t_{ZHS}	Enable to Pad delay through the Output Buffer with delayed enable—Z to HIGH
t_{ZLS}	Enable to Pad delay through the Output Buffer with delayed enable—Z to LOW

1.2 V Core Operating Voltage

Table 2-21 • Summary of I/O Timing Characteristics—Software Default Settings

–1 Speed Grade, Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst Case $V_{CC} = 1.14\text{ V}$, Worst Case V_{CCI}

Standard	Drive Strength (mA)	Slew Rate	Capacitive Load (pF)	External Resistor (Ω)	t_{DOUT} (ns)	t_{DP} (ns)	t_{DIN} (ns)	t_{PY} (ns)	t_{PYS} (ns)	t_{EOUT} (ns)	t_{ZL} (ns)	t_{ZH} (ns)	t_{LZ} (ns)	t_{HZ} (ns)	t_{ZLS} (ns)	t_{ZHS} (ns)	Units
3.3 V LVTTTL / 3.3 V LVCMOS	12 mA	High	5	–	0.68	2.08	0.05	1.48	2.03	0.44	2.12	1.56	2.76	3.04	4.00	3.44	ns
2.5 V LVCMOS	12 mA	High	5	–	0.68	2.12	0.05	1.74	2.16	0.44	2.16	1.74	2.84	2.94	4.04	3.63	ns
1.8 V LVCMOS	12 mA	High	5	–	0.68	2.36	0.05	1.69	2.38	0.44	2.40	1.94	3.14	3.57	4.28	3.82	ns
1.5 V LVCMOS	12 mA	High	5	–	0.68	2.71	0.05	1.86	2.59	0.44	2.76	2.24	3.34	3.68	4.64	4.12	ns
1.2 V LVCMOS	2mA	High	5	–	0.68	4.40	0.05	2.23	3.20	0.44	4.21	3.71	4.35	4.11	6.02	5.52	ns
3.3 V PCI	Per PCI spec	High	10	25	0.68	2.36	0.05	2.31	3.12	0.44	2.41	1.68	2.76	3.04	4.29	3.56	ns
3.3 V PCI-X	Per PCI-X spec	High	10	25	0.68	2.36	0.05	2.31	3.12	0.44	2.41	1.68	2.76	3.04	4.29	3.56	ns
3.3 V GTL	25 mA	High	10	25	0.68	1.75	0.05	1.98	–	0.44	1.72	1.75	–	–	3.60	3.63	ns
2.5 V GTL	25 mA	High	10	25	0.68	1.79	0.05	1.92	–	0.44	1.82	1.79	–	–	3.70	3.68	ns
3.3 V GTL+	35 mA	High	10	25	0.68	1.73	0.05	1.98	–	0.44	1.76	1.73	–	–	3.65	3.61	ns
2.5 V GTL+	33 mA	High	10	25	0.68	1.86	0.05	1.92	–	0.44	1.89	1.77	–	–	3.78	3.65	ns
HSTL (I)	8 mA	High	20	25	0.68	2.68	0.05	2.34	–	0.44	2.73	2.65	–	–	4.61	4.53	ns
HSTL (II)	15 mA	High	20	50	0.68	2.55	0.05	2.34	–	0.44	2.59	2.29	–	–	4.48	4.17	ns
SSTL2 (I)	15 mA	High	30	25	0.68	1.79	0.05	1.77	–	0.44	1.82	1.56	–	–	1.82	1.56	ns
SSTL2 (II)	18 mA	High	30	50	0.68	1.83	0.05	1.77	–	0.44	1.86	1.49	–	–	1.86	1.49	ns
SSTL3 (I)	14 mA	High	30	25	0.68	1.94	0.05	1.69	–	0.44	1.98	1.55	–	–	1.98	1.55	ns
SSTL3 (II)	21 mA	High	30	50	0.68	1.74	0.05	1.69	–	0.44	1.77	1.41	–	–	1.77	1.41	ns
LVDS	24 mA	High	–	–	0.68	1.57	0.05	2.04	–	–	–	–	–	–	–	–	ns
LVPECL	24 mA	High	–	–	0.68	1.54	0.05	1.84	–	–	–	–	–	–	–	–	ns

Notes:

1. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-13 on page 2-44](#) for connectivity. This resistor is not required during normal operation.

1.5 V Core Voltage

Table 2-22 • Summary of I/O Timing Characteristics—Software Default Settings
 –1 Speed Grade, Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst Case V_{CCI}

Standard	Drive Strength (mA)	Slew Rate	Capacitive Load (pF)	External Resistor (Ω)	t_{DOUT} (ns)	t_{DP} (ns)	t_{DIN} (ns)	t_{PY} (ns)	t_{PYS} (ns)	t_{EOUT} (ns)	t_{ZL} (ns)	t_{ZH} (ns)	t_{LZ} (ns)	t_{HZ} (ns)	t_{ZLS} (ns)	t_{ZHS} (ns)	Units
3.3 V LVTTTL / 3.3 V LVCMOS	12 mA	High	5	–	0.52	2.08	0.03	1.48	2.03	0.34	2.12	1.56	2.76	3.04	4.00	3.44	ns
2.5 V LVCMOS	12 mA	High	5	–	0.52	2.12	0.03	1.74	2.16	0.34	2.16	1.74	2.84	2.94	4.04	3.63	ns
1.8 V LVCMOS	12 mA	High	5	–	0.52	2.36	0.03	1.69	2.38	0.34	2.40	1.94	3.14	3.57	4.28	3.82	ns
1.5 V LVCMOS	12 mA	High	5	–	0.52	2.71	0.03	1.86	2.59	0.34	2.76	2.24	3.34	3.68	4.64	4.12	ns
3.3 V PCI	Per PCI spec	High	10	25	0.52	2.36	0.03	2.31	3.12	0.34	2.41	1.68	2.76	3.04	4.29	3.56	ns
3.3 V PCI-X	Per PCI-X spec	High	10	25	0.52	2.36	0.03	2.31	3.12	0.34	2.41	1.68	2.76	3.04	4.29	3.56	ns
3.3 V GTL	25 mA	High	10	25	0.52	1.75	0.03	1.98	–	0.34	1.72	1.75	–	–	3.60	3.63	ns
2.5 V GTL	25 mA	High	10	25	0.52	1.79	0.03	1.92	–	0.34	1.82	1.79	–	–	3.70	3.68	ns
3.3 V GTL+	35 mA	High	10	25	0.52	1.73	0.03	1.98	–	0.34	1.76	1.73	–	–	3.65	3.61	ns
2.5 V GTL+	33 mA	High	10	25	0.52	1.86	0.03	1.92	–	0.34	1.89	1.77	–	–	3.78	3.65	ns
HSTL (I)	8 mA	High	20	25	0.52	2.68	0.03	2.34	–	0.34	2.73	2.65	–	–	4.61	4.53	ns
HSTL (II)	15 mA	High	20	50	0.52	2.55	0.03	2.34	–	0.34	2.59	2.29	–	–	4.48	4.17	ns
SSTL2 (I)	15 mA	High	30	25	0.52	1.79	0.03	1.77	–	0.34	1.82	1.56	–	–	1.82	1.56	ns
SSTL2 (II)	18 mA	High	30	50	0.52	1.83	0.03	1.77	–	0.34	1.86	1.49	–	–	1.86	1.49	ns
SSTL3 (I)	14 mA	High	30	25	0.52	1.94	0.03	1.69	–	0.34	1.98	1.55	–	–	1.98	1.55	ns
SSTL3 (II)	21 mA	High	30	50	0.52	1.74	0.03	1.69	–	0.34	1.77	1.41	–	–	1.77	1.41	ns
LVDS	24 mA	High	–	–	0.52	1.57	0.03	2.04	–	–	–	–	–	–	–	–	ns
LVPECL	24 mA	High	–	–	0.52	1.54	0.03	1.84	–	–	–	–	–	–	–	–	ns

Notes:

1. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-13 on page 2-44](#) for connectivity. This resistor is not required during normal operation.

Detailed I/O DC Characteristics

Table 2-23 • Input Capacitance

Symbol	Definition	Conditions	Min.	Max.	Units
C_{IN}	Input capacitance	$V_{IN} = 0$, $f = 1.0\text{ MHz}$		8	pF
C_{INCLK}	Input capacitance on the clock pin	$V_{IN} = 0$, $f = 1.0\text{ MHz}$		8	pF

Table 2-24 • I/O Output Buffer Maximum Resistances¹

Standard	Drive Strength	$R_{PULL-DOWN}$ (Ω) ²	$R_{PULL-UP}$ (Ω) ³
3.3 V LVTTTL / 3.3 V LVCMOS	4 mA	100	300
	8 mA	50	150
	12 mA	25	75
	16 mA	17	50
	24 mA	11	33
2.5 V LVCMOS	4 mA	100	200
	8 mA	50	100
	12 mA	25	50
	16 mA	20	40
	24 mA	11	22
1.8 V LVCMOS	2 mA	200	225
	4 mA	100	112
	6 mA	50	56
	8 mA	50	56
	12 mA	20	22
	16 mA	20	22
1.5 V LVCMOS	2 mA	200	224
	4 mA	100	112
	6 mA	67	75
	8 mA	33	37
	12 mA	33	37
1.2 V LVCMOS	2 mA	TBD	TBD
3.3 V PCI/PCI-X	Per PCI/PCI-X specification	25	75
3.3 V GTL	25 mA	11	–
2.5 V GTL	25 mA	14	–
3.3 V GTL+	35 mA	12	–
2.5 V GTL+	33 mA	15	–
HSTL (I)	8 mA	50	50
HSTL (II)	15 mA	25	25
SSTL2 (I)	15 mA	27	31
SSTL2 (II)	18 mA	13	15
SSTL3 (I)	14 mA	44	69
SSTL3 (II)	21 mA	18	32

Notes:

1. These maximum values are provided for informational reasons only. Minimum output buffer resistance values depend on V_{CC} , drive strength selection, temperature, and process. For board design considerations and detailed output buffer resistances, use the corresponding IBIS models located on the Actel website at <http://www.actel.com/download/ibis/default.aspx>.
2. $R_{(PULL-DOWN-MAX)} = (V_{OLspec}) / I_{OLspec}$
3. $R_{(PULL-UP-MAX)} = (V_{CCImax} - V_{OHspec}) / I_{OHspec}$

Table 2-25 • I/O Weak Pull-Up/Pull-Down Resistances
Minimum and Maximum Weak Pull-Up/Pull-Down Resistance Values

V _{CCI}	$R_{(WEAK\ PULL-UP)}^1$ (Ω)		$R_{(WEAK\ PULL-DOWN)}^2$ (Ω)	
	Min.	Max.	Min.	Max.
3.3 V	10 k	45 k	10 k	45 k
2.5 V	11 k	55 k	12 k	74 k
1.8 V	18 k	70 k	17 k	110 k
1.5 V	19 k	90 k	19 k	140 k
1.2 V	TBD	TBD	TBD	TBD

Notes:

1. $R_{(WEAK\ PULL-UP-MAX)} = (V_{OLspec}) / I_{(WEAK\ PULL-UP-MIN)}$
2. $R_{(WEAK\ PULL-UP-MAX)} = (V_{CCImax} - V_{OHspec}) / I_{(WEAK\ PULL-UP-MIN)}$

Table 2-26 • I/O Short Currents I_{OSH}/I_{OSL}

	Drive Strength	I_{OSL} (mA)*	I_{OSH} (mA)*
3.3 V LVTTTL / 3.3 V LVCMOS	4 mA	25	27
	8 mA	51	54
	12 mA	103	109
	16 mA	132	127
	24 mA	268	181
2.5 V LVCMOS	4 mA	16	18
	8 mA	32	37
	12 mA	65	74
	16 mA	83	87
	24 mA	169	124
1.8 V LVCMOS	2 mA	9	11
	4 mA	17	22
	6 mA	35	44
	8 mA	45	51
	12 mA	91	74
	16 mA	91	74
1.5 V LVCMOS	2 mA	13	16
	4 mA	25	33
	6 mA	32	39
	8 mA	66	55
	12 mA	66	55
1.2 V LVCMOS	2mA	TBD	TBD
3.3 V PCI/PCIX	Per PCI/PCI-X Specification	Per PCI Curves	
3.3 V GTL	25 mA	268	181
2.5 V GTL	25 mA	169	124
3.3 V GTL+	35 mA	268	181
2.5 V GTL+	33 mA	169	124
HSTL (I)	8 mA	32	39
HSTL (II)	15 mA	66	55
SSTL2 (I)	15 mA	83	87
SSTL2 (II)	18 mA	169	124
SSTL3 (I)	14 mA	51	54
SSTL3 (II)	21 mA	103	109

* $T_J = 100^{\circ}\text{C}$

Table 2-27 • Schmitt Trigger Input Hysteresis, Hysteresis Voltage Value (typical) for Schmitt Mode Input Buffers Applicable

Input Buffer Configuration	Hysteresis Value (typical)
3.3 V LVTTTL/LVCMOS/PCI/PCI-X (Schmitt trigger mode)	240 mV
2.5 V LVCMOS (Schmitt trigger mode)	140 mV
1.8 V LVCMOS (Schmitt trigger mode)	80 mV
1.5 V LVCMOS (Schmitt trigger mode)	60 mV
1.2 V LVCMOS (Schmitt trigger mode)	40 mV

The length of time an I/O can withstand I_{OSH}/I_{OSL} events depends on the junction temperature. The reliability data below is based on a 3.3 V, 12 mA I/O setting, which is the worst case for this type of analysis.

For example, at 110°C, the short current condition would have to be sustained for more than three months to cause a reliability concern. The I/O design does not contain any short circuit protection, but such protection would only be needed in extremely prolonged stress conditions.

Table 2-28 • Duration of Short Circuit Event before Failure

Temperature	Time before Failure
-40°C	> 20 years
0°C	> 20 years
25°C	> 20 years
70°C	5 years
85°C	2 years
100°C	6 months
110°C	3 months
125°C	1 month

Table 2-29 • I/O Input Rise Time, Fall Time, and Related I/O Reliability

Input Buffer	Input Rise/Fall Time (min.)	Input Rise/Fall Time (max.)	Reliability
LVTTTL/LVCMOS	No requirement	10 ns *	20 years (110°C)
LVDS/B-LVDS/ M-LVDS/LVPECL	No requirement	10 ns *	10 years (100°C)

* The maximum input rise/fall time is related to the noise induced in the input buffer trace. If the noise is low, the rise time and fall time of input buffers can be increased beyond the maximum value. The longer the rise/fall times, the more susceptible the input signal is to the board noise. Actel recommends signal integrity evaluation/characterization of the system to ensure that there is no excessive noise coupling into input signals.

Single-Ended I/O Characteristics

3.3 V LVTTTL / 3.3 V LVCMOS

Low-Voltage Transistor–Transistor Logic (LVTTTL) is a general-purpose standard (EIA/JESD) for 3.3 V applications. It uses an LVTTTL input buffer and push-pull output buffer.

Table 2-30 • Minimum and Maximum DC Input and Output Levels

3.3 V LVTTTL / 3.3 V LVCMOS	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
4 mA	–0.3	0.8	2	3.6	0.4	2.4	4	4	25	27	15	15
8 mA	–0.3	0.8	2	3.6	0.4	2.4	8	8	51	54	15	15
12 mA	–0.3	0.8	2	3.6	0.4	2.4	12	12	103	109	15	15
16 mA	–0.3	0.8	2	3.6	0.4	2.4	16	16	132	127	15	15
24 mA	–0.3	0.8	2	3.6	0.4	2.4	24	24	268	181	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Software default selection highlighted in gray.

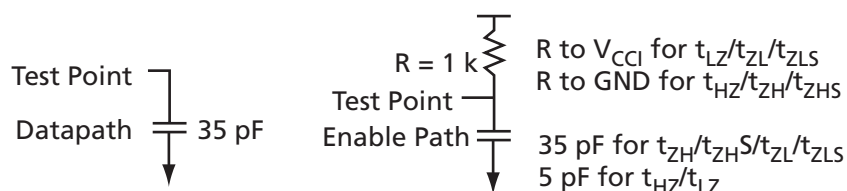


Figure 2-8 • AC Loading

Table 2-31 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C_{LOAD} (pF)
0	3.3	1.4	5

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-32 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.80	6.03	0.05	1.74	2.39	0.52	6.14	4.84	2.66	2.42	8.35	7.06	ns
	–1	0.68	5.13	0.05	1.48	2.03	0.44	5.22	4.12	2.27	2.06	7.11	6.00	ns
8 mA	Std.	0.80	4.93	0.05	1.74	2.39	0.52	5.02	4.14	3.01	3.03	7.23	6.35	ns
	–1	0.68	4.19	0.05	1.48	2.03	0.44	4.27	3.52	2.56	2.58	6.15	5.40	ns
12 mA	Std.	0.80	4.15	0.05	1.74	2.39	0.52	4.22	3.61	3.24	3.43	6.44	5.82	ns
	–1	0.68	3.53	0.05	1.48	2.03	0.44	3.59	3.07	2.76	2.92	5.47	4.95	ns
16 mA	Std.	0.80	3.92	0.05	1.74	2.39	0.52	3.99	3.49	3.29	3.54	6.21	5.71	ns
	–1	0.68	3.34	0.05	1.48	2.03	0.44	3.40	2.97	2.80	3.01	5.28	4.85	ns
24 mA	Std.	0.80	3.81	0.05	1.74	2.39	0.52	3.88	3.51	3.35	3.92	6.09	5.72	ns
	–1	0.68	3.24	0.05	1.48	2.03	0.44	3.30	2.98	2.85	3.34	5.18	4.87	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-33 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.80	3.39	0.05	1.74	2.39	0.52	3.45	2.60	2.66	2.56	5.67	4.81	ns
	–1	0.68	2.89	0.05	1.48	2.03	0.44	2.94	2.21	2.27	2.18	4.82	4.10	ns
8 mA	Std.	0.80	2.79	0.05	1.74	2.39	0.52	2.84	2.08	3.02	3.18	5.05	4.30	ns
	–1	0.68	2.37	0.05	1.48	2.03	0.44	2.42	1.77	2.57	2.70	4.30	3.65	ns
12 mA	Std.	0.80	2.45	0.05	1.74	2.39	0.52	2.49	1.83	3.24	3.58	4.71	4.05	ns
	–1	0.68	2.08	0.05	1.48	2.03	0.44	2.12	1.56	2.76	3.04	4.00	3.44	ns
16 mA	Std.	0.80	2.39	0.05	1.74	2.39	0.52	2.43	1.79	3.30	3.69	4.65	4.00	ns
	–1	0.68	2.03	0.05	1.48	2.03	0.44	2.07	1.52	2.80	3.14	3.95	3.40	ns
24 mA	Std.	0.80	2.41	0.05	1.74	2.39	0.52	2.46	1.72	3.35	4.08	4.67	3.94	ns
	–1	0.68	2.05	0.05	1.48	2.03	0.44	2.09	1.47	2.85	3.47	3.97	3.35	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

1.5 V DC Core Voltage

Table 2-34 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.61	6.03	0.04	1.74	2.39	0.40	6.14	4.84	2.66	2.42	8.35	7.06	ns
	–1	0.52	5.13	0.03	1.48	2.03	0.34	5.22	4.12	2.27	2.06	7.11	6.00	ns
8 mA	Std.	0.61	4.93	0.04	1.74	2.39	0.40	5.02	4.14	3.01	3.03	7.23	6.35	ns
	–1	0.52	4.19	0.03	1.48	2.03	0.34	4.27	3.52	2.56	2.58	6.15	5.40	ns
12 mA	Std.	0.61	4.15	0.04	1.74	2.39	0.40	4.22	3.61	3.24	3.43	6.44	5.82	ns
	–1	0.52	3.53	0.03	1.48	2.03	0.34	3.59	3.07	2.76	2.92	5.47	4.95	ns
16 mA	Std.	0.61	3.92	0.04	1.74	2.39	0.40	3.99	3.49	3.29	3.54	6.21	5.71	ns
	–1	0.52	3.34	0.03	1.48	2.03	0.34	3.40	2.97	2.80	3.01	5.28	4.85	ns
24 mA	Std.	0.61	3.81	0.04	1.74	2.39	0.40	3.88	3.51	3.35	3.92	6.09	5.72	ns
	–1	0.52	3.24	0.03	1.48	2.03	0.34	3.30	2.98	2.85	3.34	5.18	4.87	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-35 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.61	3.39	0.04	1.74	2.39	0.40	3.45	2.60	2.66	2.56	5.67	4.81	ns
	–1	0.52	2.89	0.03	1.48	2.03	0.34	2.94	2.21	2.27	2.18	4.82	4.10	ns
8 mA	Std.	0.61	2.79	0.04	1.74	2.39	0.40	2.84	2.08	3.02	3.18	5.05	4.30	ns
	–1	0.52	2.37	0.03	1.48	2.03	0.34	2.42	1.77	2.57	2.70	4.30	3.65	ns
12 mA	Std.	0.61	2.45	0.04	1.74	2.39	0.40	2.49	1.83	3.24	3.58	4.71	4.05	ns
	–1	0.52	2.08	0.03	1.48	2.03	0.34	2.12	1.56	2.76	3.04	4.00	3.44	ns
16 mA	Std.	0.61	2.39	0.04	1.74	2.39	0.40	2.43	1.79	3.30	3.69	4.65	4.00	ns
	–1	0.52	2.03	0.03	1.48	2.03	0.34	2.07	1.52	2.80	3.14	3.95	3.40	ns
24 mA	Std.	0.61	2.41	0.04	1.74	2.39	0.40	2.46	1.72	3.35	4.08	4.67	3.94	ns
	–1	0.52	2.05	0.03	1.48	2.03	0.34	2.09	1.47	2.85	3.47	3.97	3.35	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

2.5 V LVCMOS

Low-Voltage CMOS for 2.5 V is an extension of the LVCMOS standard (JESD8-5) used for general-purpose 2.5 V applications. It uses a 5 V-tolerant input buffer and push-pull output buffer.

Table 2-36 • Minimum and Maximum DC Input and Output Levels

2.5 V LVCMOS	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
4 mA	-0.3	0.7	1.7	2.7	0.7	1.7	4	4	16	18	15	15
8 mA	-0.3	0.7	1.7	2.7	0.7	1.7	8	8	32	37	15	15
12 mA	-0.3	0.7	1.7	2.7	0.7	1.7	12	12	65	74	15	15
16 mA	-0.3	0.7	1.7	2.7	0.7	1.7	16	16	83	87	15	15
24 mA	-0.3	0.7	1.7	2.7	0.7	1.7	24	24	169	124	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Software default selection highlighted in gray.

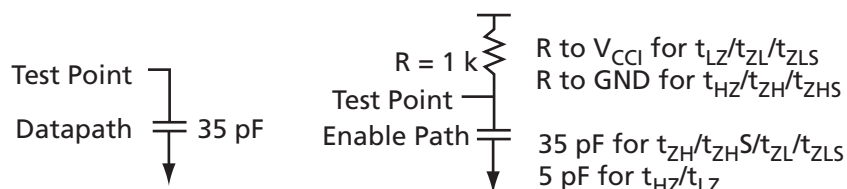


Figure 2-9 • AC Loading

Table 2-37 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C_{LOAD} (pF)
0	2.5	1.2	5

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-38 • 2.5 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.61	6.86	0.04	2.04	2.54	0.40	6.99	5.83	2.69	2.17	9.20	8.04	ns
	–1	0.52	5.84	0.03	1.74	2.16	0.34	5.95	4.96	2.29	1.85	7.83	6.84	ns
8 mA	Std.	0.61	5.61	0.04	2.04	2.54	0.40	5.72	4.94	3.07	2.90	7.93	7.15	ns
	–1	0.52	4.77	0.03	1.74	2.16	0.34	4.86	4.20	2.61	2.47	6.75	6.08	ns
12 mA	Std.	0.61	4.72	0.04	2.04	2.54	0.40	4.81	4.30	3.33	3.36	7.02	6.51	ns
	–1	0.52	4.02	0.03	1.74	2.16	0.34	4.09	3.66	2.84	2.86	5.98	5.54	ns
16 mA	Std.	0.61	4.45	0.04	2.04	2.54	0.40	4.53	4.16	3.39	3.49	6.75	6.37	ns
	–1	0.52	3.79	0.03	1.74	2.16	0.34	3.86	3.54	2.88	2.97	5.74	5.42	ns
24 mA	Std.	0.61	4.33	0.04	2.04	2.54	0.40	4.41	4.18	3.46	3.96	6.63	6.39	ns
	–1	0.52	3.69	0.03	1.74	2.16	0.34	3.76	3.55	2.94	3.37	5.64	5.43	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-39 • 2.5 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.80	3.50	0.05	2.04	2.54	0.52	3.57	3.13	2.69	2.26	5.78	5.34	ns
	–1	0.68	2.98	0.05	1.74	2.16	0.44	3.03	2.66	2.29	1.93	4.92	4.54	ns
8 mA	Std.	0.80	2.87	0.05	2.04	2.54	0.52	2.92	2.41	3.07	3.00	5.13	4.62	ns
	–1	0.68	2.44	0.05	1.74	2.16	0.44	2.48	2.05	2.61	2.55	4.37	3.93	ns
12 mA	Std.	0.80	2.49	0.05	2.04	2.54	0.52	2.53	2.05	3.33	3.46	4.75	4.26	ns
	–1	0.68	2.12	0.05	1.74	2.16	0.44	2.16	1.74	2.84	2.94	4.04	3.63	ns
16 mA	Std.	0.80	2.42	0.05	2.04	2.54	0.52	2.47	1.99	3.39	3.59	4.68	4.20	ns
	–1	0.68	2.06	0.05	1.74	2.16	0.44	2.10	1.69	2.88	3.05	3.98	3.57	ns
24 mA	Std.	0.80	2.43	0.05	2.04	2.54	0.52	2.48	1.90	3.46	4.07	4.69	4.11	ns
	–1	0.68	2.07	0.05	1.74	2.16	0.44	2.11	1.61	2.94	3.46	3.99	3.50	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-40 • 2.5 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.61	6.86	0.04	2.04	2.54	0.40	6.99	5.83	2.69	2.17	9.20	8.04	ns
	–1	0.52	5.84	0.03	1.74	2.16	0.34	5.95	4.96	2.29	1.85	7.83	6.84	ns
8 mA	Std.	0.61	5.61	0.04	2.04	2.54	0.40	5.72	4.94	3.07	2.90	7.93	7.15	ns
	–1	0.52	4.77	0.03	1.74	2.16	0.34	4.86	4.20	2.61	2.47	6.75	6.08	ns
12 mA	Std.	0.61	4.72	0.04	2.04	2.54	0.40	4.81	4.30	3.33	3.36	7.02	6.51	ns
	–1	0.52	4.02	0.03	1.74	2.16	0.34	4.09	3.66	2.84	2.86	5.98	5.54	ns
16 mA	Std.	0.61	4.45	0.04	2.04	2.54	0.40	4.53	4.16	3.39	3.49	6.75	6.37	ns
	–1	0.52	3.79	0.03	1.74	2.16	0.34	3.86	3.54	2.88	2.97	5.74	5.42	ns
24 mA	Std.	0.61	4.33	0.04	2.04	2.54	0.40	4.41	4.18	3.46	3.96	6.63	6.39	ns
	–1	0.52	3.69	0.03	1.74	2.16	0.34	3.76	3.55	2.94	3.37	5.64	5.43	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-41 • 2.5 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	0.61	3.50	0.04	2.04	2.54	0.40	3.57	3.13	2.69	2.26	5.78	5.34	ns
	–1	0.52	2.98	0.03	1.74	2.16	0.34	3.03	2.66	2.29	1.93	4.92	4.54	ns
8 mA	Std.	0.61	2.87	0.04	2.04	2.54	0.40	2.92	2.41	3.07	3.00	5.13	4.62	ns
	–1	0.52	2.44	0.03	1.74	2.16	0.34	2.48	2.05	2.61	2.55	4.37	3.93	ns
12 mA	Std.	0.61	2.49	0.04	2.04	2.54	0.40	2.53	2.05	3.33	3.46	4.75	4.26	ns
	–1	0.52	2.12	0.03	1.74	2.16	0.34	2.16	1.74	2.84	2.94	4.04	3.63	ns
16 mA	Std.	0.61	2.42	0.04	2.04	2.54	0.40	2.47	1.99	3.39	3.59	4.68	4.20	ns
	–1	0.52	2.06	0.03	1.74	2.16	0.34	2.10	1.69	2.88	3.05	3.98	3.57	ns
24 mA	Std.	0.61	2.43	0.04	2.04	2.54	0.40	2.48	1.90	3.46	4.07	4.69	4.11	ns
	–1	0.52	2.07	0.03	1.74	2.16	0.34	2.11	1.61	2.94	3.46	3.99	3.50	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.8 V LVCMOS

Low-voltage CMOS for 1.8 V is an extension of the LVCMOS standard (JESD8-5) used for general-purpose 1.8 V applications. It uses a 1.8 V input buffer and a push-pull output buffer.

Table 2-42 • Minimum and Maximum DC Input and Output Levels

1.8 V LVCMOS	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
2 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	2	2	9	11	15	15
4 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	4	4	17	22	15	15
6 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	6	6	35	44	15	15
8 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	8	8	45	51	15	15
12 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	12	12	91	74	15	15
16 mA	−0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.9	0.45	$V_{CCI} - 0.45$	16	16	91	74	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Software default selection highlighted in gray.

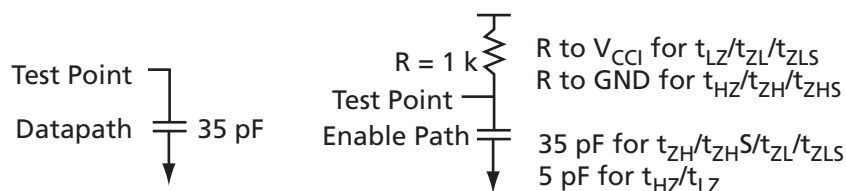


Figure 2-10 • AC Loading

Table 2-43 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C _{LOAD} (pF)
0	1.8	0.9	5

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-44 • 1.8 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 1.7\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	9.15	0.05	1.98	2.80	0.52	9.32	7.69	2.75	1.57	11.54	9.90	ns
	–1	0.68	7.79	0.05	1.69	2.38	0.44	7.93	6.54	2.34	1.33	9.81	8.42	ns
4 mA	Std.	0.80	7.54	0.05	1.98	2.80	0.52	7.68	6.48	3.22	2.74	9.89	8.69	ns
	–1	0.68	6.41	0.05	1.69	2.38	0.44	6.53	5.51	2.74	2.33	8.42	7.39	ns
6 mA	Std.	0.80	6.39	0.05	1.98	2.80	0.52	6.51	5.65	3.53	3.32	8.72	7.86	ns
	–1	0.68	5.44	0.05	1.69	2.38	0.44	5.54	4.80	3.00	2.83	7.42	6.69	ns
8 mA	Std.	0.80	6.01	0.05	1.98	2.80	0.52	6.12	5.48	3.60	3.49	8.33	7.70	ns
	–1	0.68	5.11	0.05	1.69	2.38	0.44	5.20	4.66	3.07	2.97	7.09	6.55	ns
12 mA	Std.	0.80	5.89	0.05	1.98	2.80	0.52	6.00	5.49	3.70	4.07	8.22	7.71	ns
	–1	0.68	5.01	0.05	1.69	2.38	0.44	5.11	4.67	3.15	3.46	6.99	6.56	ns
16 mA	Std.	0.80	5.89	0.05	1.98	2.80	0.52	6.00	5.49	3.70	4.07	8.22	7.71	ns
	–1	0.68	5.01	0.05	1.69	2.38	0.44	5.11	4.67	3.15	3.46	6.99	6.56	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-45 • 1.8 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 1.7\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	4.14	0.05	1.98	2.80	0.52	4.21	4.05	2.75	1.62	6.43	6.27	ns
	–1	0.68	3.52	0.05	1.69	2.38	0.44	3.58	3.45	2.34	1.38	5.47	5.33	ns
4 mA	Std.	0.80	3.35	0.05	1.98	2.80	0.52	3.42	3.01	3.22	2.84	5.63	5.22	ns
	–1	0.68	2.85	0.05	1.69	2.38	0.44	2.91	2.56	2.74	2.41	4.79	4.44	ns
6 mA	Std.	0.80	2.87	0.05	1.98	2.80	0.52	2.93	2.49	3.53	3.43	5.14	4.71	ns
	–1	0.68	2.44	0.05	1.69	2.38	0.44	2.49	2.12	3.00	2.92	4.37	4.00	ns
8 mA	Std.	0.80	2.78	0.05	1.98	2.80	0.52	2.83	2.40	3.60	3.59	5.05	4.61	ns
	–1	0.68	2.37	0.05	1.69	2.38	0.44	2.41	2.04	3.06	3.05	4.29	3.92	ns
12 mA	Std.	0.80	2.77	0.05	1.98	2.80	0.52	2.82	2.28	3.70	4.19	5.03	4.49	ns
	–1	0.68	2.36	0.05	1.69	2.38	0.44	2.40	1.94	3.14	3.57	4.28	3.82	ns
16 mA	Std.	0.80	2.77	0.05	1.98	2.80	0.52	2.82	2.28	3.70	4.19	5.03	4.49	ns
	–1	0.68	2.36	0.05	1.69	2.38	0.44	2.40	1.94	3.14	3.57	4.28	3.82	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

1.5 V DC Core Voltage

Table 2-46 • 1.8 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 1.7\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	9.15	0.04	1.98	2.80	0.40	9.32	7.69	2.75	1.57	11.54	9.90	ns
	–1	0.52	7.79	0.03	1.69	2.38	0.34	7.93	6.54	2.34	1.33	9.81	8.42	ns
4 mA	Std.	0.61	7.54	0.04	1.98	2.80	0.40	7.68	6.48	3.22	2.74	9.89	8.69	ns
	–1	0.52	6.41	0.03	1.69	2.38	0.34	6.53	5.51	2.74	2.33	8.42	7.39	ns
6 mA	Std.	0.61	6.39	0.04	1.98	2.80	0.40	6.51	5.65	3.53	3.32	8.72	7.86	ns
	–1	0.52	5.44	0.03	1.69	2.38	0.34	5.54	4.80	3.00	2.83	7.42	6.69	ns
8 mA	Std.	0.61	6.01	0.04	1.98	2.80	0.40	6.12	5.48	3.60	3.49	8.33	7.70	ns
	–1	0.52	5.11	0.03	1.69	2.38	0.34	5.20	4.66	3.07	2.97	7.09	6.55	ns
12 mA	Std.	0.61	5.89	0.04	1.98	2.80	0.40	6.00	5.49	3.70	4.07	8.22	7.71	ns
	–1	0.52	5.01	0.03	1.69	2.38	0.34	5.11	4.67	3.15	3.46	6.99	6.56	ns
16 mA	Std.	0.61	5.89	0.04	1.98	2.80	0.40	6.00	5.49	3.70	4.07	8.22	7.71	ns
	–1	0.52	5.01	0.03	1.69	2.38	0.34	5.11	4.67	3.15	3.46	6.99	6.56	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-47 • 1.8 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 1.7\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	4.14	0.04	1.98	2.80	0.40	4.21	4.05	2.75	1.62	6.43	6.27	ns
	–1	0.52	3.52	0.03	1.69	2.38	0.34	3.58	3.45	2.34	1.38	5.47	5.33	ns
4 mA	Std.	0.61	3.35	0.04	1.98	2.80	0.40	3.42	3.01	3.22	2.84	5.63	5.22	ns
	–1	0.52	2.85	0.03	1.69	2.38	0.34	2.91	2.56	2.74	2.41	4.79	4.44	ns
6 mA	Std.	0.61	2.87	0.04	1.98	2.80	0.40	2.93	2.49	3.53	3.43	5.14	4.71	ns
	–1	0.52	2.44	0.03	1.69	2.38	0.34	2.49	2.12	3.00	2.92	4.37	4.00	ns
8 mA	Std.	0.61	2.78	0.04	1.98	2.80	0.40	2.83	2.40	3.60	3.59	5.05	4.61	ns
	–1	0.52	2.37	0.03	1.69	2.38	0.34	2.41	2.04	3.06	3.05	4.29	3.92	ns
12 mA	Std.	0.61	2.77	0.04	1.98	2.80	0.40	2.82	2.28	3.70	4.19	5.03	4.49	ns
	–1	0.52	2.36	0.03	1.69	2.38	0.34	2.40	1.94	3.14	3.57	4.28	3.82	ns
16 mA	Std.	0.61	2.77	0.04	1.98	2.80	0.40	2.82	2.28	3.70	4.19	5.03	4.49	ns
	–1	0.52	2.36	0.03	1.69	2.38	0.34	2.40	1.94	3.14	3.57	4.28	3.82	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V LVCMOS (JESD8-11)

Low-Voltage CMOS for 1.5 V is an extension of the LVCMOS standard (JESD8-5) used for general-purpose 1.5 V applications. It uses a 1.5 V input buffer and a push-pull output buffer.

Table 2-48 • Minimum and Maximum DC Input and Output Levels

1.5 V LVCMOS	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
2 mA	-0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.575	$0.25 * V_{CCI}$	$0.75 * V_{CCI}$	2	2	13	16	15	15
4 mA	-0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.575	$0.25 * V_{CCI}$	$0.75 * V_{CCI}$	4	4	25	33	15	15
6 mA	-0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.575	$0.25 * V_{CCI}$	$0.75 * V_{CCI}$	6	6	32	39	15	15
8 mA	-0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.575	$0.25 * V_{CCI}$	$0.75 * V_{CCI}$	8	8	66	55	15	15
12 mA	-0.3	$0.35 * V_{CCI}$	$0.65 * V_{CCI}$	1.575	$0.25 * V_{CCI}$	$0.75 * V_{CCI}$	12	12	66	55	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Software default selection highlighted in gray.

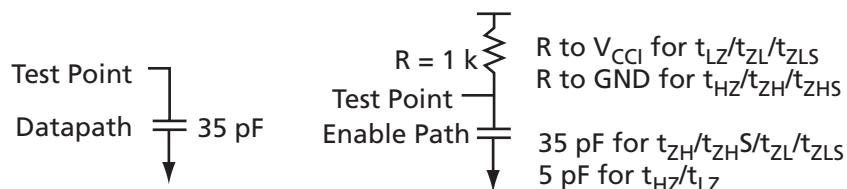


Figure 2-11 • AC Loading

Table 2-49 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C_{LOAD} (pF)
0	1.5	0.75	5

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-50 • 1.5 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 1.4\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	9.52	0.05	2.19	3.05	0.52	9.69	7.89	3.37	2.65	11.91	10.10	ns
	–1	0.68	8.10	0.05	1.86	2.59	0.44	8.25	6.71	2.87	2.26	10.13	8.59	ns
4 mA	Std.	0.80	8.14	0.05	2.19	3.05	0.52	8.29	6.89	3.73	3.32	10.50	9.10	ns
	–1	0.68	6.92	0.05	1.86	2.59	0.44	7.05	5.86	3.17	2.83	8.93	7.74	ns
6 mA	Std.	0.80	7.64	0.05	2.19	3.05	0.52	7.78	6.70	3.80	3.51	9.99	8.92	ns
	–1	0.68	6.50	0.05	1.86	2.59	0.44	6.62	5.70	3.24	2.99	8.50	7.59	ns
8 mA	Std.	0.80	7.54	0.05	2.19	3.05	0.52	7.68	6.71	3.93	4.18	9.89	8.92	ns
	–1	0.68	6.41	0.05	1.86	2.59	0.44	6.53	5.71	3.34	3.55	8.41	7.59	ns
12 mA	Std.	0.80	7.54	0.05	2.19	3.05	0.52	7.68	6.71	3.93	4.18	9.89	8.92	ns
	–1	0.68	6.41	0.05	1.86	2.59	0.44	6.53	5.71	3.34	3.55	8.41	7.59	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-51 • 1.5 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 1.4\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	3.91	0.05	2.19	3.05	0.52	3.98	3.54	3.36	2.76	6.19	5.76	ns
	–1	0.68	3.32	0.05	1.86	2.59	0.44	3.38	3.01	2.86	2.35	5.27	4.90	ns
4 mA	Std.	0.80	3.33	0.05	2.19	3.05	0.52	3.39	2.90	3.71	3.44	5.61	5.12	ns
	–1	0.68	2.83	0.05	1.86	2.59	0.44	2.89	2.47	3.16	2.93	4.77	4.35	ns
6 mA	Std.	0.80	3.22	0.05	2.19	3.05	0.52	3.28	2.78	3.80	3.63	5.49	5.00	ns
	–1	0.68	2.74	0.05	1.86	2.59	0.44	2.79	2.37	3.23	3.09	4.67	4.25	ns
8 mA	Std.	0.80	3.18	0.05	2.19	3.05	0.52	3.24	2.63	3.92	4.33	5.46	4.85	ns
	–1	0.68	2.71	0.05	1.86	2.59	0.44	2.76	2.24	3.34	3.68	4.64	4.12	ns
12 mA	Std.	0.80	3.18	0.05	2.19	3.05	0.52	3.24	2.63	3.92	4.33	5.46	4.85	ns
	–1	0.68	2.71	0.05	1.86	2.59	0.44	2.76	2.24	3.34	3.68	4.64	4.12	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-52 • 1.5 V LVC MOS Low Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 1.4\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	9.52	0.04	2.19	3.05	0.40	9.69	7.89	3.37	2.65	11.91	10.10	ns
	–1	0.52	8.10	0.03	1.86	2.59	0.34	8.25	6.71	2.87	2.26	10.13	8.59	ns
4 mA	Std.	0.61	8.14	0.04	2.19	3.05	0.40	8.29	6.89	3.73	3.32	10.50	9.10	ns
	–1	0.52	6.92	0.03	1.86	2.59	0.34	7.05	5.86	3.17	2.83	8.93	7.74	ns
6 mA	Std.	0.61	7.64	0.04	2.19	3.05	0.40	7.78	6.70	3.80	3.51	9.99	8.92	ns
	–1	0.52	6.50	0.03	1.86	2.59	0.34	6.62	5.70	3.24	2.99	8.50	7.59	ns
8 mA	Std.	0.61	7.54	0.04	2.19	3.05	0.40	7.68	6.71	3.93	4.18	9.89	8.92	ns
	–1	0.52	6.41	0.03	1.86	2.59	0.34	6.53	5.71	3.34	3.55	8.41	7.59	ns
12 mA	Std.	0.61	7.54	0.04	2.19	3.05	0.40	7.68	6.71	3.93	4.18	9.89	8.92	ns
	–1	0.52	6.41	0.03	1.86	2.59	0.34	6.53	5.71	3.34	3.55	8.41	7.59	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-53 • 1.5 V LVC MOS High Slew

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 1.4\text{ V}$

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	3.91	0.04	2.19	3.05	0.40	3.98	3.54	3.36	2.76	6.19	5.76	ns
	–1	0.52	3.32	0.03	1.86	2.59	0.34	3.38	3.01	2.86	2.35	5.27	4.90	ns
4 mA	Std.	0.61	3.33	0.04	2.19	3.05	0.40	3.39	2.90	3.71	3.44	5.61	5.12	ns
	–1	0.52	2.83	0.03	1.86	2.59	0.34	2.89	2.47	3.16	2.93	4.77	4.35	ns
6 mA	Std.	0.61	3.22	0.04	2.19	3.05	0.40	3.28	2.78	3.80	3.63	5.49	5.00	ns
	–1	0.52	2.74	0.03	1.86	2.59	0.34	2.79	2.37	3.23	3.09	4.67	4.25	ns
8 mA	Std.	0.61	3.18	0.04	2.19	3.05	0.40	3.24	2.63	3.92	4.33	5.46	4.85	ns
	–1	0.52	2.71	0.03	1.86	2.59	0.34	2.76	2.24	3.34	3.68	4.64	4.12	ns
12 mA	Std.	0.61	3.18	0.04	2.19	3.05	0.40	3.24	2.63	3.92	4.33	5.46	4.85	ns
	–1	0.52	2.71	0.03	1.86	2.59	0.34	2.76	2.24	3.34	3.68	4.64	4.12	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.2 V LVCMOS (JESD8-12A)

Low-Voltage CMOS for 1.2 V complies with the LVCMOS standard JESD8-12A for general purpose 1.2 V applications. It uses a 1.2 V input buffer and a push-pull output buffer.

Table 2-54 • Minimum and Maximum DC Input and Output Levels
Applicable to I/Os Operating at 1.2 V Core Voltage

1.2 V LVCMOS	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSH}^1	I_{OSL}^1	I_{IL}^2	I_{IH}^2
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA	Max., mA	μA	μA
2 mA	-0.3	$0.35 * V_{CC1}$	$0.65 * V_{CC1}$	1.26	$0.25 * V_{CC1}$	$0.75 * V_{CC1}$	2	2	TBD	TBD	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Software default selection highlighted in gray.

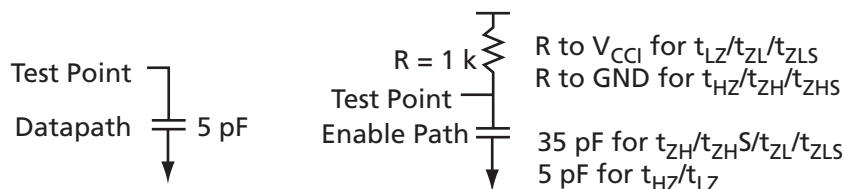


Figure 2-12 • AC Loading

Table 2-55 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C_{LOAD} (pF)
0	1.2	0.6	5

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-56 • 1.2 V LVCMOS Low Slew

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14$ V, Worst-Case $V_{CC1} = 1.4$ V

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	12.62	0.05	2.62	3.76	0.52	12.07	9.47	5.12	4.68	14.20	11.60	ns
	-1	0.68	10.73	0.05	2.23	3.20	0.44	10.27	8.05	4.36	3.98	12.08	9.87	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-57 • 1.2 V LVCMOS High Slew

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14$ V, Worst-Case $V_{CC1} = 1.4$ V

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.80	5.17	0.05	2.62	3.76	0.52	4.95	4.36	5.11	4.83	7.08	6.49	ns
	-1	0.68	4.40	0.05	2.23	3.20	0.44	4.21	3.71	4.35	4.11	6.02	5.52	ns

Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

3.3 V PCI, 3.3 V PCI-X

Peripheral Component Interface for 3.3 V standard specifies support for 33 MHz and 66 MHz PCI Bus applications.

Table 2-58 • Minimum and Maximum DC Input and Output Levels

3.3 V PCI/PCI-X	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min, V	Max, V	Min, V	Max, V	Max, V	Min, V	mA	mA	Max, mA ¹	Max, mA ¹	μA^2	μA^2
Per PCI specification	Per PCI curves										15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

AC loadings are defined per the PCI/PCI-X specifications for the database; Actel loadings for enable path characterization are described in [Figure 2-13](#).

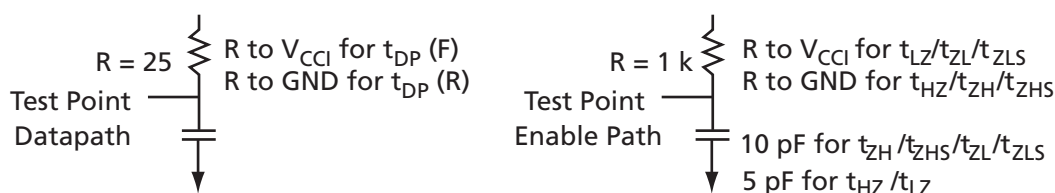


Figure 2-13 • AC Loading

AC loadings are defined per PCI/PCI-X specifications for the datapath; Actel loading for tristate is described in [Table 2-59](#).

Table 2-59 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	C_{LOAD} (pF)
0	3.3	0.285 * V_{CC1} for $t_{DP}(R)$ 0.615 * V_{CC1} for $t_{DP}(F)$	10

* Measuring point = V_{trip} . See [Table 2-19 on page 2-24](#) for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-60 • 3.3 V PCI/PCI-X

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14$ V, Worst-Case $V_{CCI} = 3.0$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.78	0.05	2.72	3.67	0.52	2.83	1.98	3.24	3.58	5.04	4.19	ns
-1	0.68	2.36	0.05	2.31	3.12	0.44	2.41	1.68	2.76	3.04	4.29	3.56	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-61 • 3.3 V PCI/PCI-X

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425$ V, Worst-Case $V_{CCI} = 3.0$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.78	0.04	2.72	3.67	0.40	2.83	1.98	3.24	3.58	5.04	4.19	ns
-1	0.52	2.36	0.03	2.31	3.12	0.34	2.41	1.68	2.76	3.04	4.29	3.56	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Voltage-Referenced I/O Characteristics

3.3 V GTL

Gunning Transceiver Logic is a high-speed bus standard (JESD8-3). It provides a differential amplifier input buffer and an open-drain output buffer. The V_{CCI} pin should be connected to 3.3 V.

Table 2-62 • Minimum and Maximum DC Input and Output Levels

3.3 V GTL	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
25 mA ³	-0.3	$V_{REF} - 0.05$	$V_{REF} + 0.05$	3.6	0.4	-	25	25	268	181	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Output drive strength is below JEDEC specification.

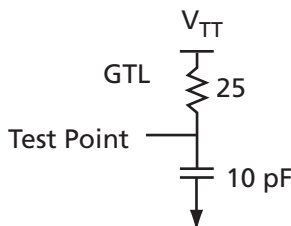


Figure 2-14 • AC Loading

Table 2-63 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.05$	$V_{REF} + 0.05$	0.8	0.8	1.2	10

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-64 • 3.3 V GTL

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14$ V,
Worst-Case $V_{CCI} = 3.0$ V, $V_{REF} = 0.8$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.05	0.05	2.33	0.52	2.02	2.05			4.23	4.27	ns
-1	0.68	1.75	0.05	1.98	0.44	1.72	1.75			3.60	3.63	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-65 • 3.3 V GTL

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425$ V,
Worst-Case $V_{CCI} = 3.0$ V, $V_{REF} = 0.8$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.05	0.04	2.33	0.40	2.02	2.05			4.23	4.27	ns
-1	0.52	1.75	0.03	1.98	0.34	1.72	1.75			3.60	3.63	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

2.5 V GTL

Gunning Transceiver Logic is a high-speed bus standard (JESD8-3). It provides a differential amplifier input buffer and an open-drain output buffer. The V_{CCI} pin should be connected to 2.5 V.

Table 2-66 • Minimum and Maximum DC Input and Output Levels

2.5 GTL	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
25 mA ³	-0.3	$V_{REF} - 0.05$	$V_{REF} + 0.05$	2.7	0.4	–	25	25	169	124	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Output drive strength is below JEDEC specification.

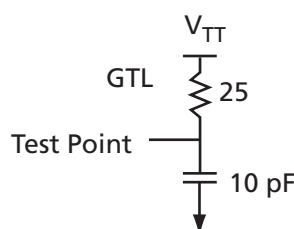


Figure 2-15 • AC Loading

Table 2-67 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.05$	$V_{REF} + 0.05$	0.8	0.8	1.2	10

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-68 • 2.5 V GTL

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 0.8 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.11	0.05	2.26	0.52	2.14	2.11			4.35	4.32	ns
-1	0.68	1.79	0.05	1.92	0.44	1.82	1.79			3.70	3.68	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-69 • 2.5 V GTL

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 0.8 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.11	0.04	2.26	0.40	2.14	2.11			4.35	4.32	ns
-1	0.52	1.79	0.03	1.92	0.34	1.82	1.79			3.70	3.68	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

3.3 V GTL+

Gunning Transceiver Logic Plus is a high-speed bus standard (JESD8-3). It provides a differential amplifier input buffer and an open-drain output buffer. The V_{CCI} pin should be connected to 3.3 V.

Table 2-70 • Minimum and Maximum DC Input and Output Levels

3.3 V GTL+	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
35 mA	-0.3	$V_{REF} - 0.1$	$V_{REF} + 0.1$	3.6	0.6	–	35	35	268	181	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

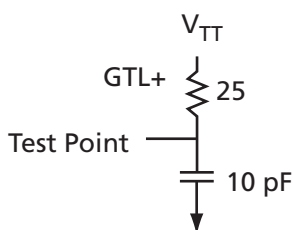


Figure 2-16 • AC Loading

Table 2-71 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.1$	$V_{REF} + 0.1$	1.0	1.0	1.5	10

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-72 • 3.3 V GTL+

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14$ V,
Worst-Case $V_{CCI} = 3.0$ V, $V_{REF} = 1.0$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.03	0.05	2.33	0.52	2.07	2.03			4.29	4.25	ns
-1	0.68	1.73	0.05	1.98	0.44	1.76	1.73			3.65	3.61	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-73 • 3.3 V GTL+

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425$ V,
Worst-Case $V_{CCI} = 3.0$ V, $V_{REF} = 1.0$ V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.03	0.04	2.33	0.40	2.07	2.03			4.29	4.25	ns
-1	0.52	1.73	0.03	1.98	0.34	1.76	1.73			3.65	3.61	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

2.5 V GTL+

Gunning Transceiver Logic Plus is a high-speed bus standard (JESD8-3). It provides a differential amplifier input buffer and an open-drain output buffer. The V_{CCI} pin should be connected to 2.5 V.

Table 2-74 • Minimum and Maximum DC Input and Output Levels

2.5 V GTL+	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
33 mA	-0.3	$V_{REF} - 0.1$	$V_{REF} + 0.1$	2.7	0.6	–	33	33	169	124	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

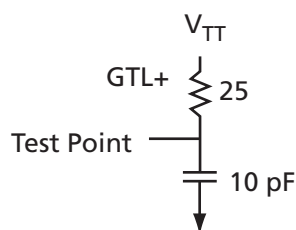


Figure 2-17 • AC Loading

Table 2-75 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.1$	$V_{REF} + 0.1$	1.0	1.0	1.5	10

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-76 • 2.5 V GTL+

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$,
Worst-Case $V_{CCI} = 2.3\text{ V}$, $V_{REF} = 1.0\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.18	0.05	2.26	0.52	2.22	2.08			4.44	4.29	ns
-1	0.68	1.86	0.05	1.92	0.44	1.89	1.77			3.78	3.65	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-77 • 2.5 V GTL+

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$,
Worst-Case $V_{CCI} = 2.3\text{ V}$, $V_{REF} = 1.0\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.18	0.04	2.26	0.40	2.22	2.08			4.44	4.29	ns
-1	0.52	1.86	0.03	1.92	0.34	1.89	1.77			3.78	3.65	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

HSTL Class I

High-Speed Transceiver Logic is a general-purpose high-speed 1.5 V bus standard (EIA/JESD8-6). RT ProASIC3 devices support Class I. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-78 • Minimum and Maximum DC Input and Output Levels

HSTL Class I	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
8 mA	-0.3	$V_{REF} - 0.1$	$V_{REF} + 0.1$	1.575	0.4	$V_{CCI} - 0.4$	8	8	32	39	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

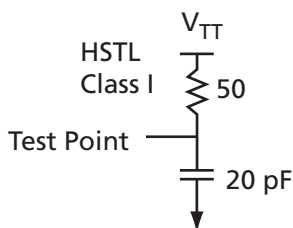


Figure 2-18 • AC Loading

Table 2-79 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.1$	$V_{REF} + 0.1$	0.75	0.75	0.75	20

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-80 • HSTL Class I

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14 V$,
Worst-Case $V_{CCI} = 1.4 V$, $V_{REF} = 0.75 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	3.15	0.05	2.75	0.52	3.21	3.11			5.42	5.33	ns
-1	0.68	2.68	0.05	2.34	0.44	2.73	2.65			4.61	4.53	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-81 • HSTL Class I

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425 V$,
Worst-Case $V_{CCI} = 1.4 V$, $V_{REF} = 0.75 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	3.15	0.04	2.75	0.40	3.21	3.11			5.42	5.33	ns
-1	0.52	2.68	0.03	2.34	0.34	2.73	2.65			4.61	4.53	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

HSTL Class II

High-Speed Transceiver Logic is a general-purpose high-speed 1.5 V bus standard (EIA/JESD8-6). RT ProASIC3 devices support Class II. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-82 • Minimum and Maximum DC Input and Output Levels

HSTL Class II	V _{IL}		V _{IH}		V _{OL}	V _{OH}	I _{OL}	I _{OH}	I _{OSL}	I _{OSH}	I _{IL}	I _{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA ²	μA ²
15 mA ³	-0.3	V _{REF} - 0.1	V _{REF} + 0.1	1.575	0.4	V _{CCI} - 0.4	15	15	66	55	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.
3. Output drive strength is below JEDEC specification.

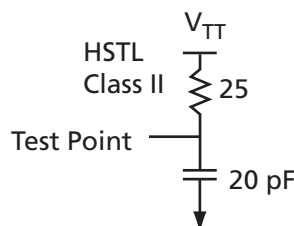


Figure 2-19 • AC Loading

Table 2-83 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V _{REF} (typ.) (V)	V _{TT} (typ.) (V)	C _{LOAD} (pF)
V _{REF} - 0.1	V _{REF} + 0.1	0.75	0.75	0.75	20

* Measuring point = V_{trip}. See [Table 2-19 on page 2-24](#) for a complete table of trip points.

Timing Characteristics

Table 2-84 • HSTL Class II

Military-Case Conditions: T_J = 125°C, Worst-Case V_{CC} = 1.14 V,
Worst-Case V_{CCI} = 1.4 V, V_{REF} = 0.75 V

Speed Grade	t _{DOUT}	t _{DP}	t _{DIN}	t _{PY}	t _{EOUT}	t _{ZL}	t _{ZH}	t _{LZ}	t _{HZ}	t _{ZLS}	t _{ZHS}	Units
Std.	0.80	2.99	0.05	2.75	0.52	3.05	2.69			5.26	4.90	ns
-1	0.68	2.55	0.05	2.34	0.44	2.59	2.29			4.48	4.17	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-85 • HSTL Class II

Military-Case Conditions: T_J = 125°C, V_{CC} = 1.425 V,
Worst-Case V_{CCI} = 1.4 V, V_{REF} = 0.75 V

Speed Grade	t _{DOUT}	t _{DP}	t _{DIN}	t _{PY}	t _{EOUT}	t _{ZL}	t _{ZH}	t _{LZ}	t _{HZ}	t _{ZLS}	t _{ZHS}	Units
Std.	0.61	2.99	0.04	2.75	0.40	3.05	2.69			5.26	4.90	ns
-1	0.52	2.55	0.03	2.34	0.34	2.59	2.29			4.48	4.17	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

SSTL2 Class I

Stub-Speed Terminated Logic for 2.5 V memory bus standard (JESD8-9). RT ProASIC3 devices support Class I. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-86 • Minimum and Maximum DC Input and Output Levels

SSTL2 Class I	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
15 mA	-0.3	$V_{REF} - 0.2$	$V_{REF} + 0.2$	2.7	0.54	$V_{CCI} - 0.62$	15	15	83	87	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

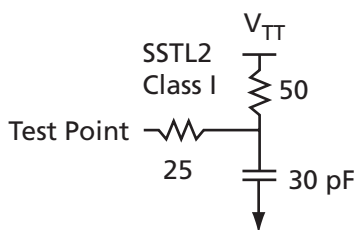


Figure 2-20 • AC Loading

Table 2-87 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.2$	$V_{REF} + 0.2$	1.25	1.25	1.25	30

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-88 • SSTL2 Class I

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14 V$,
Worst-Case $V_{CCI} = 2.3 V$, $V_{REF} = 1.25 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.11	0.05	2.08	0.52	2.14	1.83			2.14	1.83	ns
-1	0.68	1.79	0.05	1.77	0.44	1.82	1.56			1.82	1.56	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-89 • SSTL2 Class I

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425 V$,
Worst-Case $V_{CCI} = 2.3 V$, $V_{REF} = 1.25 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.11	0.04	2.08	0.40	2.14	1.83			2.14	1.83	ns
-1	0.52	1.79	0.03	1.77	0.34	1.82	1.56			1.82	1.56	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

SSTL2 Class II

Stub-Speed Terminated Logic for 2.5 V memory bus standard (JESD8-9). RT ProASIC3 devices support Class II. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-90 • Minimum and Maximum DC Input and Output Levels

SSTL2 Class II	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
18 mA	-0.3	$V_{REF} - 0.2$	$V_{REF} + 0.2$	2.7	0.35	$V_{CCI} - 0.43$	18	18	169	124	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

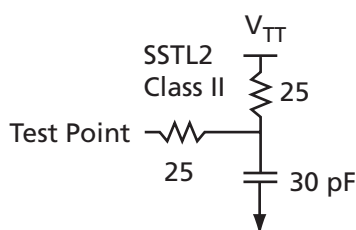


Figure 2-21 • AC Loading

Table 2-91 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.2$	$V_{REF} + 0.2$	1.25	1.25	1.25	30

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-92 • SSTL2 Class II

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$,
Worst-Case $V_{CCI} = 2.3\text{ V}$, $V_{REF} = 1.25\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.15	0.05	2.08	0.52	2.19	1.75			2.19	1.75	ns
-1	0.68	1.83	0.05	1.77	0.44	1.86	1.49			1.86	1.49	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-93 • SSTL2 Class II

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$,
Worst-Case $V_{CCI} = 2.3\text{ V}$, $V_{REF} = 1.25\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.15	0.04	2.08	0.40	2.19	1.75			2.19	1.75	ns
-1	0.52	1.83	0.03	1.77	0.34	1.86	1.49			1.86	1.49	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

SSTL3 Class I

Stub-Speed Terminated Logic for 3.3 V memory bus standard (JESD8-8). RT ProASIC3 devices support Class I. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-94 • Minimum and Maximum DC Input and Output Levels

SSTL3 Class I	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
14 mA	-0.3	$V_{REF} - 0.2$	$V_{REF} + 0.2$	3.6	0.7	$V_{CCI} - 1.1$	14	14	51	54	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

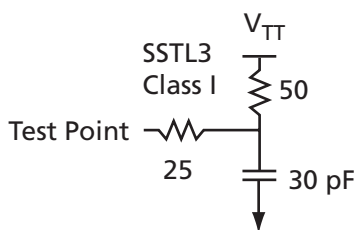


Figure 2-22 • AC Loading

Table 2-95 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.2$	$V_{REF} + 0.2$	1.5	1.5	1.485	30

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-96 • SSTL3 Class I

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 1.5 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.28	0.05	1.99	0.52	2.33	1.82			2.33	1.82	ns
-1	0.68	1.94	0.05	1.69	0.44	1.98	1.55			1.98	1.55	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-97 • SSTL3 Class I

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 1.5 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.28	0.04	1.99	0.40	2.33	1.82			2.33	1.82	ns
-1	0.52	1.94	0.03	1.69	0.34	1.98	1.55			1.98	1.55	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

SSTL3 Class II

Stub-Speed Terminated Logic for 3.3 V memory bus standard (JESD8-8). RT ProASIC3 devices support Class II. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-98 • Minimum and Maximum DC Input and Output Levels

SSTL3 Class II	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL}	I_{IH}
Drive Strength	Min., V	Max., V	Min., V	Max., V	Max., V	Min., V	mA	mA	Max., mA ¹	Max., mA ¹	μA^2	μA^2
21 mA	-0.3	$V_{REF} - 0.2$	$V_{REF} + 0.2$	3.6	0.5	$V_{CCI} - 0.9$	21	21	103	109	15	15

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 125°C junction temperature.

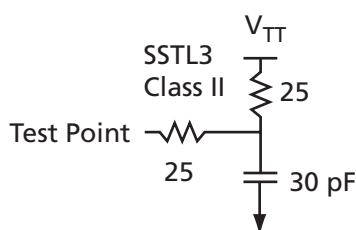


Figure 2-23 • AC Loading

Table 2-99 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)	V_{REF} (typ.) (V)	V_{TT} (typ.) (V)	C_{LOAD} (pF)
$V_{REF} - 0.2$	$V_{REF} + 0.2$	1.5	1.5	1.485	30

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

Table 2-100 • SSTL3 Class II

Military-Case Conditions: $T_J = 125^\circ C$, Worst-Case $V_{CC} = 1.14 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 1.5 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.04	0.05	1.99	0.52	2.08	1.65			2.08	1.65	ns
-1	0.68	1.74	0.05	1.69	0.44	1.77	1.41			1.77	1.41	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-101 • SSTL3 Class II

Military-Case Conditions: $T_J = 125^\circ C$, $V_{CC} = 1.425 V$,
Worst-Case $V_{CCI} = 3.0 V$, $V_{REF} = 1.5 V$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.04	0.04	1.99	0.40	2.08	1.65			2.08	1.65	ns
-1	0.52	1.74	0.03	1.69	0.34	1.77	1.41			1.77	1.41	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Differential I/O Characteristics

Physical Implementation

Configuration of the I/O modules as a differential pair is handled by Actel Designer software when the user instantiates a differential I/O macro in the design.

Differential I/Os can also be used in conjunction with the embedded Input Register (InReg), Output Register (OutReg), Enable Register (EnReg), and Double Data Rate (DDR). However, there is no support for bidirectional I/Os or tristates with the LVPECL standards.

LVDS

Low-Voltage Differential Signaling (ANSI/TIA/EIA-644) is a high-speed, differential I/O standard. It requires that one data bit be carried through two signal lines, so two pins are needed. It also requires external resistor termination.

The full implementation of the LVDS transmitter and receiver is shown in an example in [Figure 2-24](#). The building blocks of the LVDS transmitter-receiver are one transmitter macro, one receiver macro, three board resistors at the transmitter end, and one resistor at the receiver end. The values for the three driver resistors are different from those used in the LVPECL implementation because the output standard specifications are different.

Along with LVDS I/O, military ProASIC3 also supports Bus LVDS structure and Multipoint LVDS (M-LVDS) configuration (up to 40 nodes).

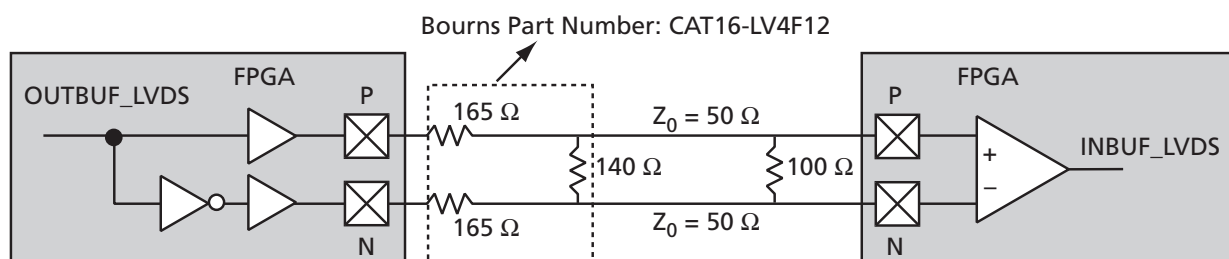


Figure 2-24 • LVDS Circuit Diagram and Board-Level Implementation

Table 2-102 • Minimum and Maximum DC Input and Output Levels

DC Parameter	Description	Min.	Typ.	Max.	Units
V_{CCI}	Supply Voltage	2.375	2.5	2.625	V
V_{OL}	Output Low Voltage	0.9	1.075	1.25	V
V_{OH}	Output High Voltage	1.25	1.425	1.6	V
I_{OL}^4	Output Lower Current	0.65	0.91	1.16	mA
I_{OH}^4	Output High Current	0.65	0.91	1.16	mA
V_I	Input Voltage	0		2.925	V
I_{IH}^3	Input High Leakage Current			10	μ A
I_{IL}^3	Input Low Leakage Current			10	μ A
V_{ODIFF}	Differential Output Voltage	250	350	450	mV
V_{OCM}	Output Common Mode Voltage	1.125	1.25	1.375	V
V_{ICM}	Input Common Mode Voltage	0.05	1.25	2.35	V
V_{IDIFF}	Input Differential Voltage	100	350		mV

Notes:

1. $\pm 5\%$
2. Differential input voltage = ± 350 mV.
3. Currents are measured at 125°C junction temperature.
4. I_{OL}/I_{OH} is defined by $V_{ODIFF}/(\text{Resistor Network})$.

Table 2-103 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)
1.075	1.325	Cross point

* Measuring point = V_{trip} . See Table 2-19 on page 2-24 for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-104 • LVDS

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	Units
Std.	0.80	1.81	0.05	2.39	ns
-1	0.68	1.57	0.05	2.04	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-105 • LVDS

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 2.3\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	Units
Std.	0.61	1.81	0.04	2.39	ns
-1	0.52	1.57	0.03	2.04	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

B-LVDS/M-LVDS

Bus LVDS (B-LVDS) and Multipoint LVDS (M-LVDS) specifications extend the existing LVDS standard to high-performance multipoint bus applications. Multidrop and multipoint bus configurations may contain any combination of drivers, receivers, and transceivers. Actel LVDS drivers provide the higher drive current required by B-LVDS and M-LVDS to accommodate the loading. The drivers require series terminations for better signal quality and to control voltage swing. Termination is also required at both ends of the bus since the driver can be located anywhere on the bus. These configurations can be implemented using the TRIBUF_LVDS and BIBUF_LVDS macros along with appropriate terminations. Multipoint designs using Actel LVDS macros can achieve up to 200 MHz with a maximum of 20 loads. A sample application is given in [Figure 2-25](#). The input and output buffer delays are available in the LVDS section in [Table 2-102](#) on [page 2-56](#).

Example: For a bus consisting of 20 equidistant loads, the following terminations provide the required differential voltage, in worst-case Industrial operating conditions, at the farthest receiver: $R_S = 60\ \Omega$ and $R_T = 70\ \Omega$, given $Z_0 = 50\ \Omega$ (2") and $Z_{stub} = 50\ \Omega$ (~1.5").

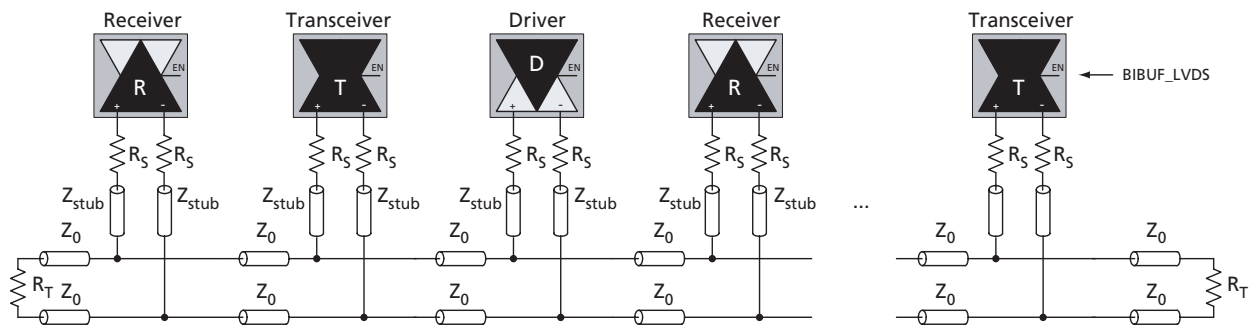


Figure 2-25 • B-LVDS/M-LVDS Multipoint Application Using LVDS I/O Buffers

LVPECL

Low-Voltage Positive Emitter-Coupled Logic (LVPECL) is another differential I/O standard. It requires that one data bit be carried through two signal lines. Like LVDS, two pins are needed. It also requires external resistor termination.

The full implementation of the LVDS transmitter and receiver is shown in an example in [Figure 2-26](#). The building blocks of the LVPECL transmitter-receiver are one transmitter macro, one receiver macro, three board resistors at the transmitter end, and one resistor at the receiver end. The values for the three driver resistors are different from those used in the LVDS implementation because the output standard specifications are different.

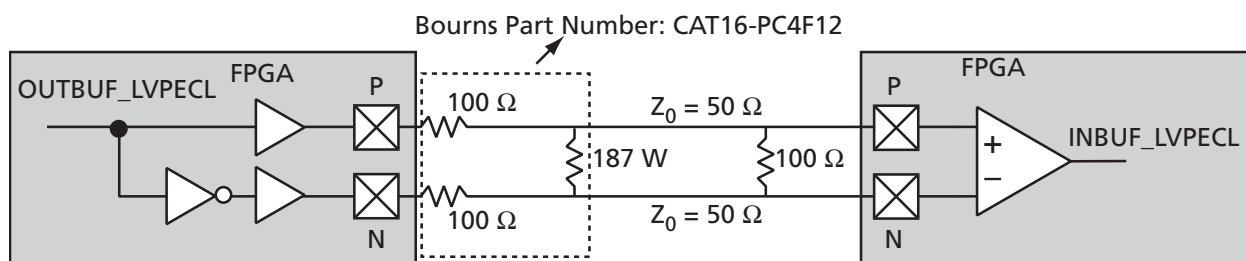


Figure 2-26 • LVPECL Circuit Diagram and Board-Level Implementation

Table 2-106 • Minimum and Maximum DC Input and Output Levels

DC Parameter	Description	Min.	Max.	Min.	Max.	Min.	Max.	Units
V_{CCI}	Supply Voltage	3.0	3.3	3.6				V
V_{OL}	Output LOW Voltage	0.96	1.27	1.06	1.43	1.30	1.57	V
V_{OH}	Output HIGH Voltage	1.8	2.11	1.92	2.28	2.13	2.41	V
V_{IL}, V_{IH}	Input LOW, Input HIGH Voltages	0	3.3	0	3.6	0	3.9	V
V_{ODIFF}	Differential Output Voltage	0.625	0.97	0.625	0.97	0.625	0.97	V
V_{OCM}	Output Common-Mode Voltage	1.762	1.98	1.762	1.98	1.762	1.98	V
V_{ICM}	Input Common-Mode Voltage	1.01	2.57	1.01	2.57	1.01	2.57	V
V_{IDIFF}	Input Differential Voltage	300		300		300		mV

Table 2-107 • AC Waveforms, Measuring Points, and Capacitive Loads

Input LOW (V)	Input HIGH (V)	Measuring Point* (V)
1.64	1.94	Cross point

* Measuring point = V_{trip} . See [Table 2-19 on page 2-24](#) for a complete table of trip points.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-108 • LVPECL

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{pY}	Units
Std.	0.80	1.81	0.05	2.16	ns
-1	0.68	1.54	0.05	1.84	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-109 • LVPECL

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$, Worst-Case $V_{CCI} = 3.0\text{ V}$

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{pY}	Units
Std.	0.61	1.81	0.04	2.16	ns
-1	0.52	1.54	0.03	1.84	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

I/O Register Specifications

Fully Registered I/O Buffers with Synchronous Enable and Asynchronous Preset

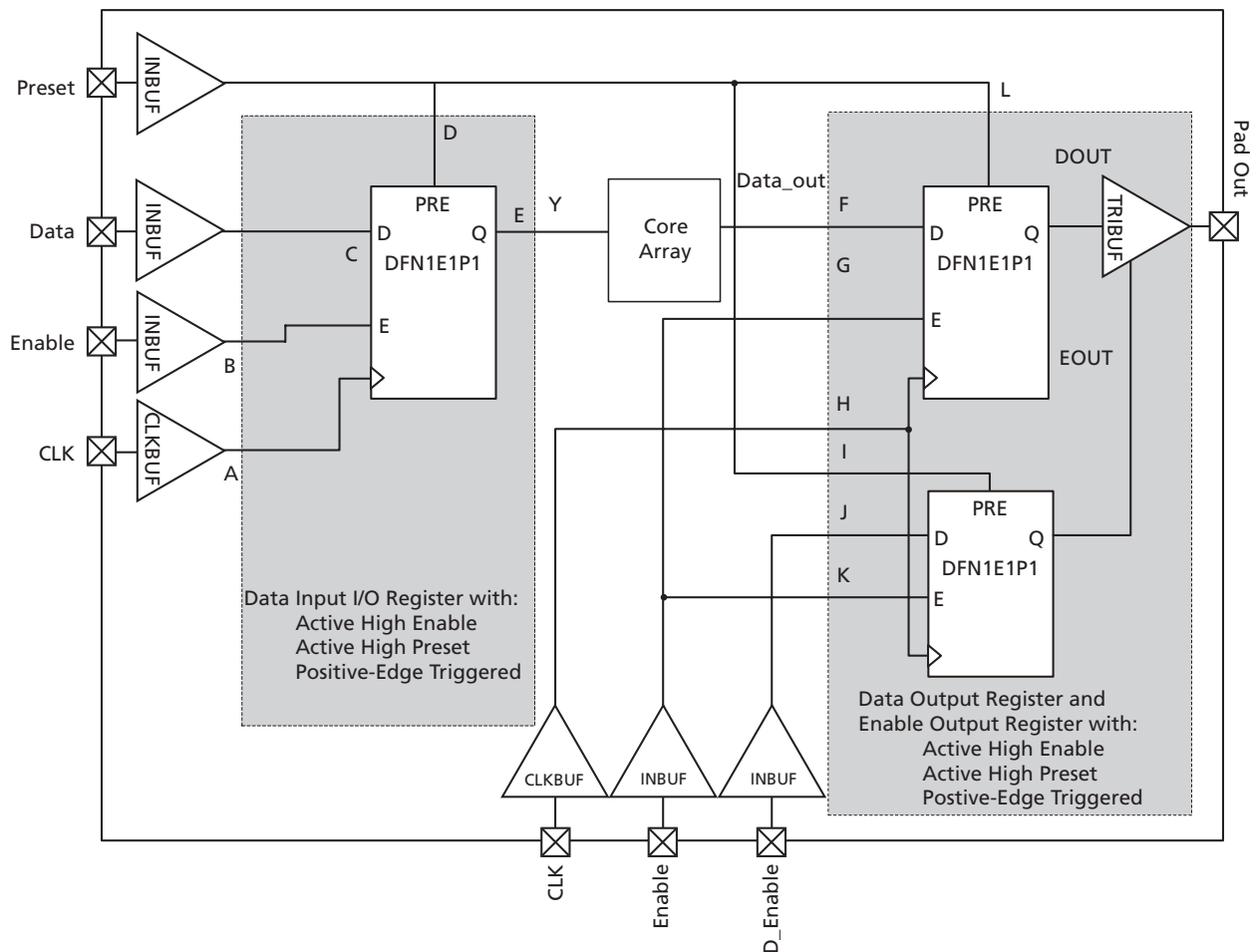


Figure 2-27 • Timing Model of Registered I/O Buffers with Synchronous Enable and Asynchronous Preset

Table 2-110 • Parameter Definition and Measuring Nodes

Parameter Name	Parameter Definition	Measuring Nodes (from, to)*
t _{CLKQ}	Clock-to-Q of the Output Data Register	H, DOUT
t _{OSUD}	Data Setup Time for the Output Data Register	F, H
t _{OHD}	Data Hold Time for the Output Data Register	F, H
t _{OSUE}	Enable Setup Time for the Output Data Register	G, H
t _{OHE}	Enable Hold Time for the Output Data Register	G, H
t _{OPRE2Q}	Asynchronous Preset-to-Q of the Output Data Register	L, DOUT
t _{OEMPRE}	Asynchronous Preset Removal Time for the Output Data Register	L, H
t _{OECPRE}	Asynchronous Preset Recovery Time for the Output Data Register	L, H
t _{OCLKQ}	Clock-to-Q of the Output Enable Register	H, EOUT
t _{OSUD}	Data Setup Time for the Output Enable Register	J, H
t _{OHD}	Data Hold Time for the Output Enable Register	J, H
t _{OSUE}	Enable Setup Time for the Output Enable Register	K, H
t _{OHE}	Enable Hold Time for the Output Enable Register	K, H
t _{OEPRE2Q}	Asynchronous Preset-to-Q of the Output Enable Register	I, EOUT
t _{OEMPRE}	Asynchronous Preset Removal Time for the Output Enable Register	I, H
t _{OECPRE}	Asynchronous Preset Recovery Time for the Output Enable Register	I, H
t _{CLKQ}	Clock-to-Q of the Input Data Register	A, E
t _{ISUD}	Data Setup Time for the Input Data Register	C, A
t _{IHD}	Data Hold Time for the Input Data Register	C, A
t _{ISUE}	Enable Setup Time for the Input Data Register	B, A
t _{IHE}	Enable Hold Time for the Input Data Register	B, A
t _{IPRE2Q}	Asynchronous Preset-to-Q of the Input Data Register	D, E
t _{IEMPRE}	Asynchronous Preset Removal Time for the Input Data Register	D, A
t _{IECPRE}	Asynchronous Preset Recovery Time for the Input Data Register	D, A

* See [Figure 2-27 on page 2-61](#) for more information.

The diagram illustrates the internal architecture of the Data Input I/O Register and Data Output Register. It features two DFN1E1C1 flip-flops. The first flip-flop, labeled 'Data Input I/O Register', has its D input connected to the output of an INBUF, its E input to another INBUF, its CLR input to a third INBUF, and its clock input to a CLKBUF. Its Q output is connected to the Core Array. The second flip-flop, labeled 'Data Output Register and Enable Output Register', has its D input connected to the Core Array, its E input to an INBUF, its CLR input to another INBUF, and its clock input to a CLKBUF. Its Q output is connected to the output of a TRIBUF, which is then connected to the Pad Out. The diagram also shows various control signals like Data, Enable, CLK, and CLR entering through multiplexers at the top left.

Figure 2-28 • Timing Model of the Registered I/O Buffers with Synchronous Enable and Asynchronous Clear

Table 2-111 • Parameter Definition and Measuring Nodes

Parameter Name	Parameter Definition	Measuring Nodes (from, to)*
t _{OCLKQ}	Clock-to-Q of the Output Data Register	HH, DOUT
t _{OSUD}	Data Setup Time for the Output Data Register	FF, HH
t _{OHD}	Data Hold Time for the Output Data Register	FF, HH
t _{OSUE}	Enable Setup Time for the Output Data Register	GG, HH
t _{OHE}	Enable Hold Time for the Output Data Register	GG, HH
t _{OCLR2Q}	Asynchronous Clear-to-Q of the Output Data Register	LL, DOUT
t _{OREMCLR}	Asynchronous Clear Removal Time for the Output Data Register	LL, HH
t _{ORECCLR}	Asynchronous Clear Recovery Time for the Output Data Register	LL, HH
t _{OELCKQ}	Clock-to-Q of the Output Enable Register	HH, EOUT
t _{OESUD}	Data Setup Time for the Output Enable Register	JJ, HH
t _{OEHd}	Data Hold Time for the Output Enable Register	JJ, HH
t _{OESUE}	Enable Setup Time for the Output Enable Register	KK, HH
t _{OEHd}	Enable Hold Time for the Output Enable Register	KK, HH
t _{OELCR2Q}	Asynchronous Clear-to-Q of the Output Enable Register	II, EOUT
t _{OEREMCLR}	Asynchronous Clear Removal Time for the Output Enable Register	II, HH
t _{OERECCLR}	Asynchronous Clear Recovery Time for the Output Enable Register	II, HH
t _{ICLKQ}	Clock-to-Q of the Input Data Register	AA, EE
t _{ISUD}	Data Setup Time for the Input Data Register	CC, AA
t _{IHD}	Data Hold Time for the Input Data Register	CC, AA
t _{ISUE}	Enable Setup Time for the Input Data Register	BB, AA
t _{IHE}	Enable Hold Time for the Input Data Register	BB, AA
t _{ICLR2Q}	Asynchronous Clear-to-Q of the Input Data Register	DD, EE
t _{IREMCLR}	Asynchronous Clear Removal Time for the Input Data Register	DD, AA
t _{IRECCLR}	Asynchronous Clear Recovery Time for the Input Data Register	DD, AA

* See [Figure 2-28 on page 2-63](#) for more information.

Input Register

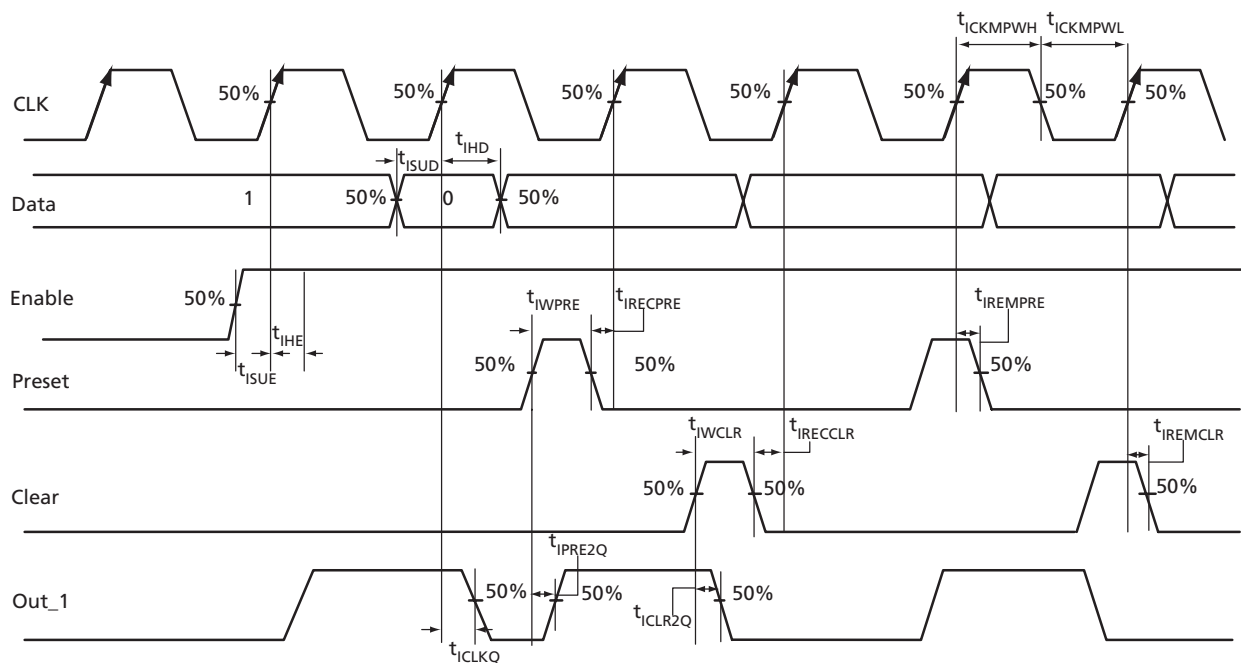


Figure 2-29 • Input Register Timing Diagram

Timing Characteristics

Table 2-112 • Input Data Register Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	-1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Input Data Register	0.33	0.39	ns
t_{ISUD}	Data Setup Time for the Input Data Register	0.36	0.43	ns
t_{IHD}	Data Hold Time for the Input Data Register	0.00	0.00	ns
t_{ISUE}	Enable Setup Time for the Input Data Register	0.51	0.60	ns
t_{IHE}	Enable Hold Time for the Input Data Register	0.00	0.00	ns
t_{ICLR2Q}	Asynchronous Clear-to-Q of the Input Data Register	0.63	0.74	ns
t_{IPRE2Q}	Asynchronous Preset-to-Q of the Input Data Register	0.63	0.74	ns
t_{IREMCLR}	Asynchronous Clear Removal Time for the Input Data Register	0.00	0.00	ns
t_{IRECCLR}	Asynchronous Clear Recovery Time for the Input Data Register	0.31	0.36	ns
t_{IREMPRE}	Asynchronous Preset Removal Time for the Input Data Register	0.00	0.00	ns
t_{IRECPRE}	Asynchronous Preset Recovery Time for the Input Data Register	0.31	0.36	ns
t_{IWCLR}	Asynchronous Clear Minimum Pulse Width for the Input Data Register	0.19	0.22	ns
t_{IWPRE}	Asynchronous Preset Minimum Pulse Width for the Input Data Register	0.19	0.22	ns
t_{ICKMPWH}	Clock Minimum Pulse Width HIGH for the Input Data Register	0.31	0.36	ns
t_{ICKMPWL}	Clock Minimum Pulse Width LOW for the Input Data Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-113 • Input Data Register Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	-1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Input Data Register	0.25	0.30	ns
t_{ISUD}	Data Setup Time for the Input Data Register	0.28	0.33	ns
t_{IHD}	Data Hold Time for the Input Data Register	0.00	0.00	ns
t_{ISUE}	Enable Setup Time for the Input Data Register	0.39	0.46	ns
t_{IHE}	Enable Hold Time for the Input Data Register	0.00	0.00	ns
t_{ICLR2Q}	Asynchronous Clear-to-Q of the Input Data Register	0.48	0.56	ns
t_{IPRE2Q}	Asynchronous Preset-to-Q of the Input Data Register	0.48	0.56	ns
t_{IREMCLR}	Asynchronous Clear Removal Time for the Input Data Register	0.00	0.00	ns
t_{IRECCLR}	Asynchronous Clear Recovery Time for the Input Data Register	0.24	0.28	ns
t_{IREMPRE}	Asynchronous Preset Removal Time for the Input Data Register	0.00	0.00	ns
t_{IRECPRE}	Asynchronous Preset Recovery Time for the Input Data Register	0.24	0.28	ns
t_{IWCLR}	Asynchronous Clear Minimum Pulse Width for the Input Data Register	0.19	0.22	ns
t_{IWPRE}	Asynchronous Preset Minimum Pulse Width for the Input Data Register	0.19	0.22	ns
t_{ICKMPWH}	Clock Minimum Pulse Width HIGH for the Input Data Register	0.31	0.36	ns
t_{ICKMPWL}	Clock Minimum Pulse Width LOW for the Input Data Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Output Register

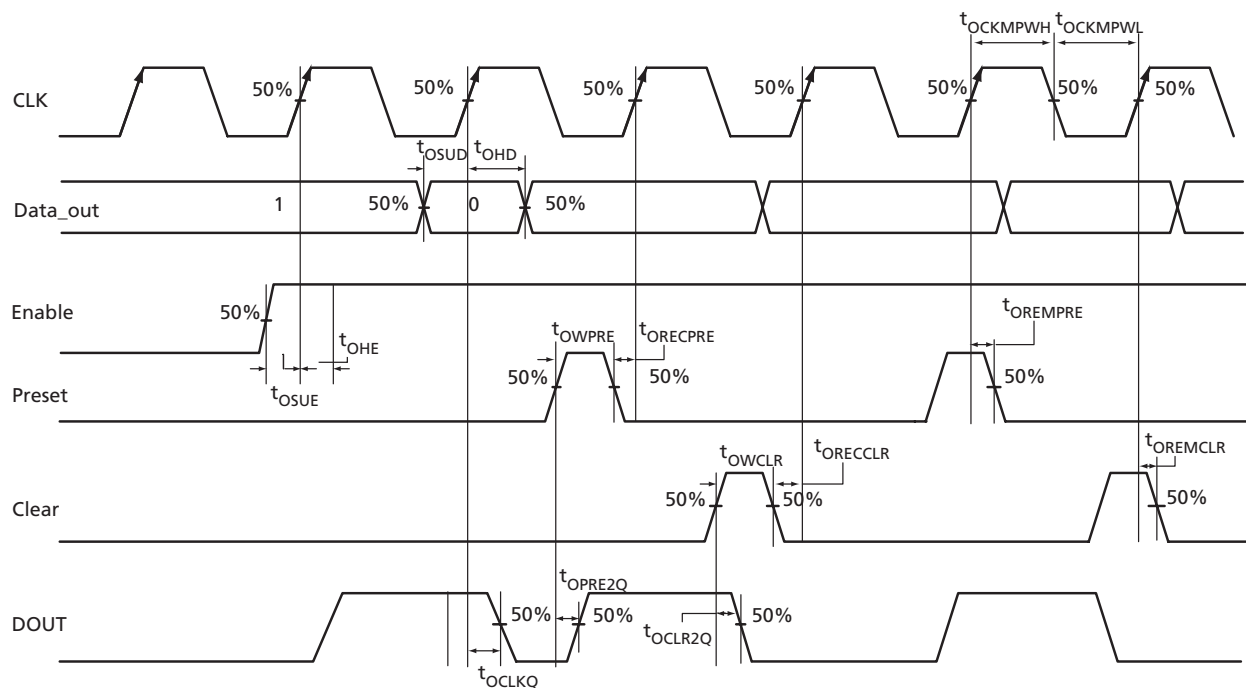


Figure 2-30 • Output Register Timing Diagram

Timing Characteristics

Table 2-114 • Output Data Register Propagation Delays
Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Output Data Register	0.81	0.96	ns
t_{OSUD}	Data Setup Time for the Output Data Register	0.43	0.51	ns
t_{OHD}	Data Hold Time for the Output Data Register	0.00	0.00	ns
t_{OSUE}	Enable Setup Time for the Output Data Register	0.61	0.71	ns
t_{OHE}	Enable Hold Time for the Output Data Register	0.00	0.00	ns
t_{OCLR2Q}	Asynchronous Clear-to-Q of the Output Data Register	1.11	1.31	ns
t_{OPRE2Q}	Asynchronous Preset-to-Q of the Output Data Register	1.11	1.31	ns
t_{OREMCLR}	Asynchronous Clear Removal Time for the Output Data Register	0.00	0.00	ns
t_{ORECCLR}	Asynchronous Clear Recovery Time for the Output Data Register	0.31	0.36	ns
t_{OREMPRE}	Asynchronous Preset Removal Time for the Output Data Register	0.00	0.00	ns
t_{ORECPRE}	Asynchronous Preset Recovery Time for the Output Data Register	0.31	0.36	ns
t_{OWCLR}	Asynchronous Clear Minimum Pulse Width for the Output Data Register	0.19	0.22	ns
t_{OWPRE}	Asynchronous Preset Minimum Pulse Width for the Output Data Register	0.19	0.22	ns
t_{OCKMPWH}	Clock Minimum Pulse Width HIGH for the Output Data Register	0.31	0.36	ns
t_{OCKMPWL}	Clock Minimum Pulse Width LOW for the Output Data Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-115 • Output Data Register Propagation Delays
Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Output Data Register	0.62	0.73	ns
t_{OSUD}	Data Setup Time for the Output Data Register	0.33	0.39	ns
t_{OHD}	Data Hold Time for the Output Data Register	0.00	0.00	ns
t_{OSUE}	Enable Setup Time for the Output Data Register	0.46	0.55	ns
t_{OHE}	Enable Hold Time for the Output Data Register	0.00	0.00	ns
t_{OCLR2Q}	Asynchronous Clear-to-Q of the Output Data Register	0.85	1.00	ns
t_{OPRE2Q}	Asynchronous Preset-to-Q of the Output Data Register	0.85	1.00	ns
t_{OREMCLR}	Asynchronous Clear Removal Time for the Output Data Register	0.00	0.00	ns
t_{ORECCLR}	Asynchronous Clear Recovery Time for the Output Data Register	0.24	0.28	ns
t_{OREMPRE}	Asynchronous Preset Removal Time for the Output Data Register	0.00	0.00	ns
t_{ORECPRE}	Asynchronous Preset Recovery Time for the Output Data Register	0.24	0.28	ns
t_{OWCLR}	Asynchronous Clear Minimum Pulse Width for the Output Data Register	0.19	0.22	ns
t_{OWPRE}	Asynchronous Preset Minimum Pulse Width for the Output Data Register	0.19	0.22	ns
t_{OCKMPWH}	Clock Minimum Pulse Width HIGH for the Output Data Register	0.31	0.36	ns
t_{OCKMPWL}	Clock Minimum Pulse Width LOW for the Output Data Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Output Enable Register

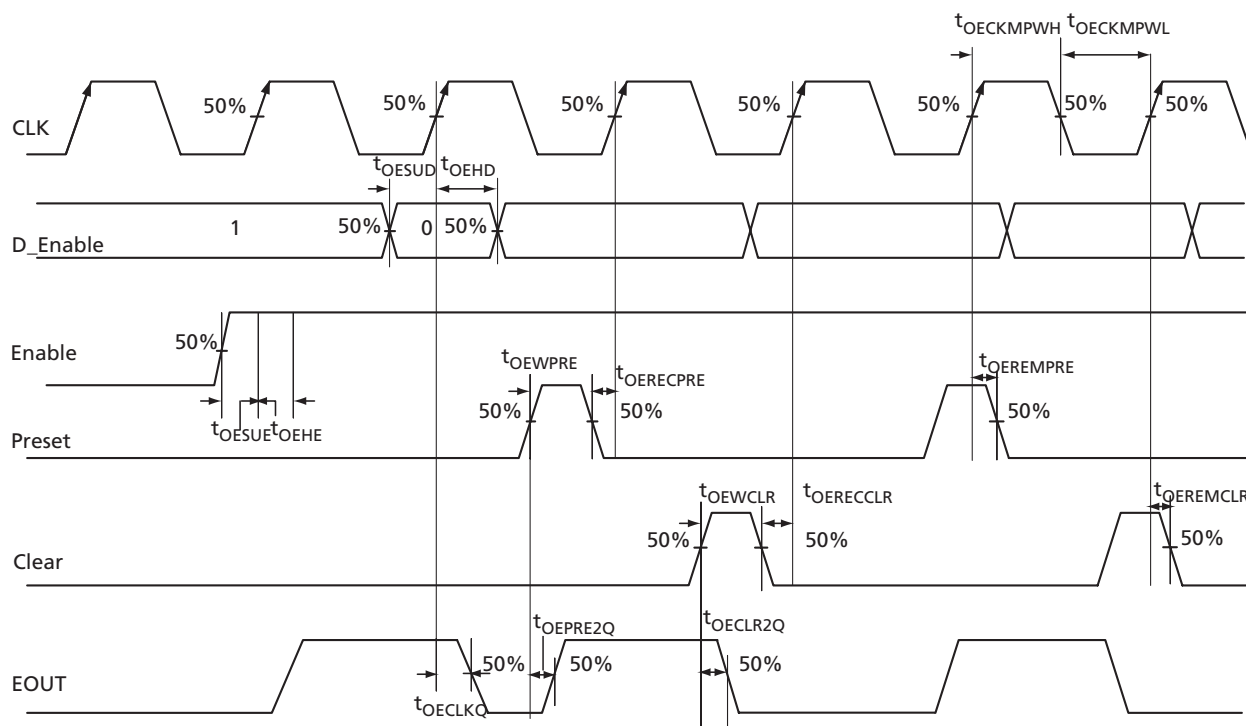


Figure 2-31 • Output Enable Register Timing Diagram

Timing Characteristics

Table 2-116 • Output Enable Register Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{OECLKQ}	Clock-to-Q of the Output Enable Register	0.62	0.72	ns
t_{OESUD}	Data Setup Time for the Output Enable Register	0.43	0.51	ns
t_{OEHD}	Data Hold Time for the Output Enable Register	0.00	0.00	ns
t_{OESUE}	Enable Setup Time for the Output Enable Register	0.60	0.71	ns
t_{OEHE}	Enable Hold Time for the Output Enable Register	0.00	0.00	ns
$t_{OECLR2Q}$	Asynchronous Clear-to-Q of the Output Enable Register	0.92	1.08	ns
$t_{OEPRE2Q}$	Asynchronous Preset-to-Q of the Output Enable Register	0.92	1.08	ns
$t_{OEREMCLR}$	Asynchronous Clear Removal Time for the Output Enable Register	0.00	0.00	ns
$t_{OERECCLR}$	Asynchronous Clear Recovery Time for the Output Enable Register	0.31	0.36	ns
$t_{OEREMPRE}$	Asynchronous Preset Removal Time for the Output Enable Register	0.00	0.00	ns
$t_{OERECPRE}$	Asynchronous Preset Recovery Time for the Output Enable Register	0.31	0.36	ns
$t_{OEWCCLR}$	Asynchronous Clear Minimum Pulse Width for the Output Enable Register	0.19	0.22	ns
t_{OEWPPE}	Asynchronous Preset Minimum Pulse Width for the Output Enable Register	0.19	0.22	ns
$t_{OECKMPWH}$	Clock Minimum Pulse Width HIGH for the Output Enable Register	0.31	0.36	ns
$t_{OECKMPWL}$	Clock Minimum Pulse Width LOW for the Output Enable Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-117 • Output Enable Register Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{OECLKQ}	Clock-to-Q of the Output Enable Register	0.47	0.55	ns
t_{OESUD}	Data Setup Time for the Output Enable Register	0.33	0.39	ns
t_{OEHD}	Data Hold Time for the Output Enable Register	0.00	0.00	ns
t_{OESUE}	Enable Setup Time for the Output Enable Register	0.46	0.54	ns
t_{OEHE}	Enable Hold Time for the Output Enable Register	0.00	0.00	ns
$t_{OECLR2Q}$	Asynchronous Clear-to-Q of the Output Enable Register	0.70	0.83	ns
$t_{OEPRE2Q}$	Asynchronous Preset-to-Q of the Output Enable Register	0.70	0.83	ns
$t_{OEREMCLR}$	Asynchronous Clear Removal Time for the Output Enable Register	0.00	0.00	ns
$t_{OERECCLR}$	Asynchronous Clear Recovery Time for the Output Enable Register	0.24	0.28	ns
$t_{OEREMPRE}$	Asynchronous Preset Removal Time for the Output Enable Register	0.00	0.00	ns
$t_{OERECPRE}$	Asynchronous Preset Recovery Time for the Output Enable Register	0.24	0.28	ns
$t_{OEWCCLR}$	Asynchronous Clear Minimum Pulse Width for the Output Enable Register	0.19	0.22	ns
t_{OEWPPE}	Asynchronous Preset Minimum Pulse Width for the Output Enable Register	0.19	0.22	ns
$t_{OECKMPWH}$	Clock Minimum Pulse Width HIGH for the Output Enable Register	0.31	0.36	ns
$t_{OECKMPWL}$	Clock Minimum Pulse Width LOW for the Output Enable Register	0.28	0.32	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

DDR Module Specifications

Input DDR Module

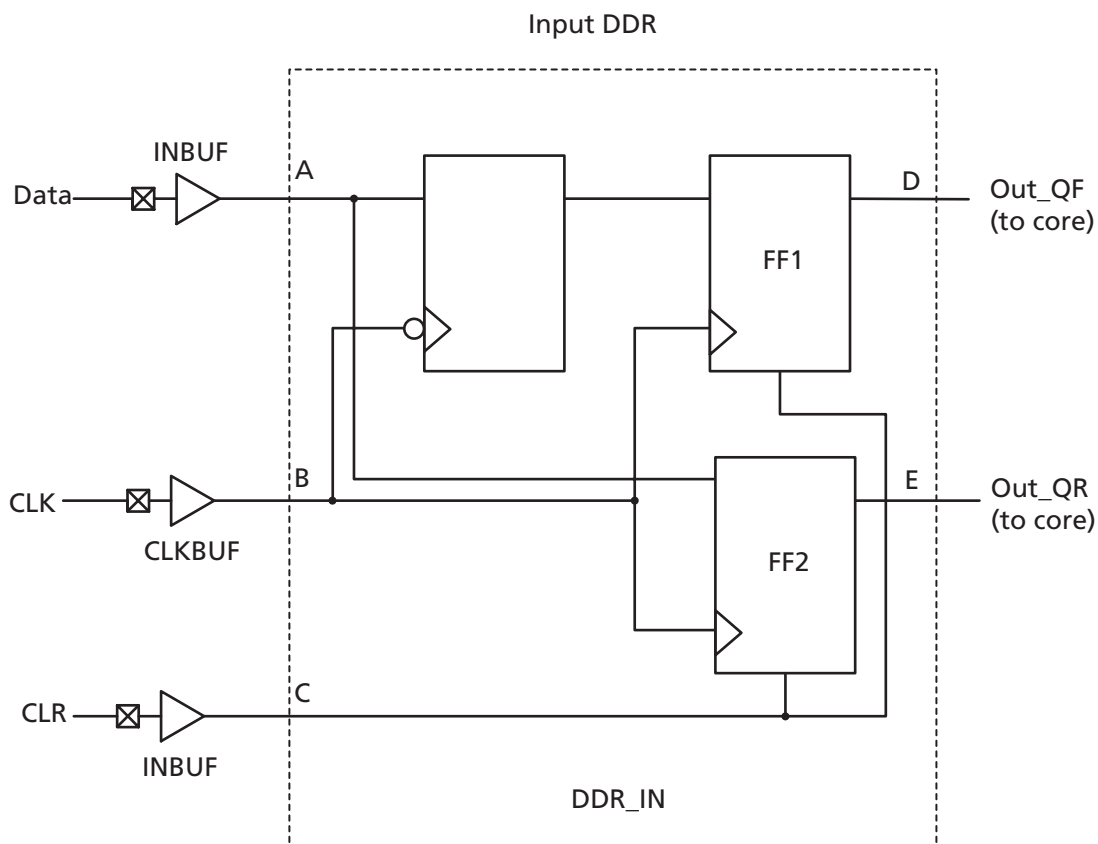


Figure 2-32 • Input DDR Timing Model

Table 2-118 • Parameter Definitions

Parameter Name	Parameter Definition	Measuring Nodes (from, to)
$t_{DDRICKQ1}$	Clock-to-Out Out_QR	B, D
$t_{DDRICKQ2}$	Clock-to-Out Out_QF	B, E
$t_{DDRISUD}$	Data Setup Time of DDR input	A, B
t_{DDRILD}	Data Hold Time of DDR input	A, B
$t_{DDRICLR2Q1}$	Clear-to-Out Out_QR	C, D
$t_{DDRICLR2Q2}$	Clear-to-Out Out_QF	C, E
$t_{DDRIREMCLR}$	Clear Removal	C, B
$t_{DDRIRECCLR}$	Clear Recovery	C, B

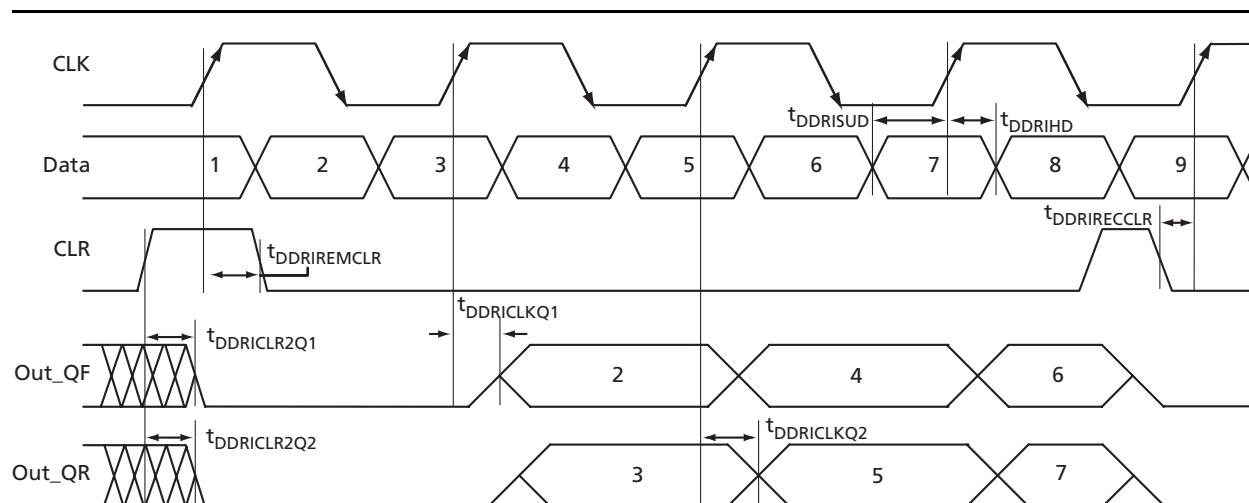


Figure 2-33 • Input DDR Timing Diagram

Timing Characteristics

Table 2-119 • Input DDR Propagation Delays

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	-1	Std.	Units
t_{DDRCLKQ1}	Clock-to-Out Out_QR for Input DDR	0.38	0.45	ns
t_{DDRCLKQ2}	Clock-to-Out Out_QF for Input DDR	0.54	0.63	ns
t_{DDRISUD1}	Data Setup for Input DDR (fall)	0.39	0.46	ns
t_{DDRISUD2}	Data Setup for Input DDR (rise)	0.34	0.40	ns
t_{DDRIHD1}	Data Hold for Input DDR (fall)	0.00	0.00	ns
t_{DDRIHD2}	Data Hold for Input DDR (rise)	0.00	0.00	ns
$t_{\text{DDRCLR2Q1}}$	Asynchronous Clear-to-Out Out_QR for Input DDR	0.64	0.75	ns
$t_{\text{DDRCLR2Q2}}$	Asynchronous Clear-to-Out Out_QF for Input DDR	0.79	0.93	ns
$t_{\text{DDRREMCLR}}$	Asynchronous Clear Removal Time for Input DDR	0.00	0.00	ns
$t_{\text{DDRRECCCLR}}$	Asynchronous Clear Recovery Time for Input DDR	0.31	0.36	ns
t_{DDRIVCLR}	Asynchronous Clear Minimum Pulse Width for Input DDR	0.19	0.22	ns
$t_{\text{DDRICKMPWH}}$	Clock Minimum Pulse Width HIGH for Input DDR	0.31	0.36	ns
$t_{\text{DDRICKMPWL}}$	Clock Minimum Pulse Width LOW for Input DDR	0.28	0.32	ns
F_{DDRIMAX}	Maximum Frequency for Input DDR	TBD	TBD	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-120 • Input DDR Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	-1	Std.	Units
t_{DDRICKQ1}	Clock-to-Out Out_QR for Input DDR	0.29	0.34	ns
t_{DDRICKQ2}	Clock-to-Out Out_QF for Input DDR	0.41	0.48	ns
t_{DDRISUD1}	Data Setup for Input DDR (fall)	0.30	0.35	ns
t_{DDRISUD2}	Data Setup for Input DDR (rise)	0.26	0.31	ns
t_{DDRILD1}	Data Hold for Input DDR (fall)	0.00	0.00	ns
t_{DDRILD2}	Data Hold for Input DDR (rise)	0.00	0.00	ns
$t_{\text{DDRICLR2Q1}}$	Asynchronous Clear-to-Out Out_QR for Input DDR	0.49	0.58	ns
$t_{\text{DDRICLR2Q2}}$	Asynchronous Clear-to-Out Out_QF for Input DDR	0.60	0.71	ns
$t_{\text{DDRIREMCLR}}$	Asynchronous Clear Removal Time for Input DDR	0.00	0.00	ns
$t_{\text{DDRIRECCLR}}$	Asynchronous Clear Recovery Time for Input DDR	0.24	0.28	ns
$t_{\text{DDRILWCLR}}$	Asynchronous Clear Minimum Pulse Width for Input DDR	0.19	0.22	ns
$t_{\text{DDRICKMPWH}}$	Clock Minimum Pulse Width HIGH for Input DDR	0.31	0.36	ns
$t_{\text{DDRICKMPWL}}$	Clock Minimum Pulse Width LOW for Input DDR	0.28	0.32	ns
F_{DDRIMAX}	Maximum Frequency for Input DDR	TBD	TBD	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Output DDR Module

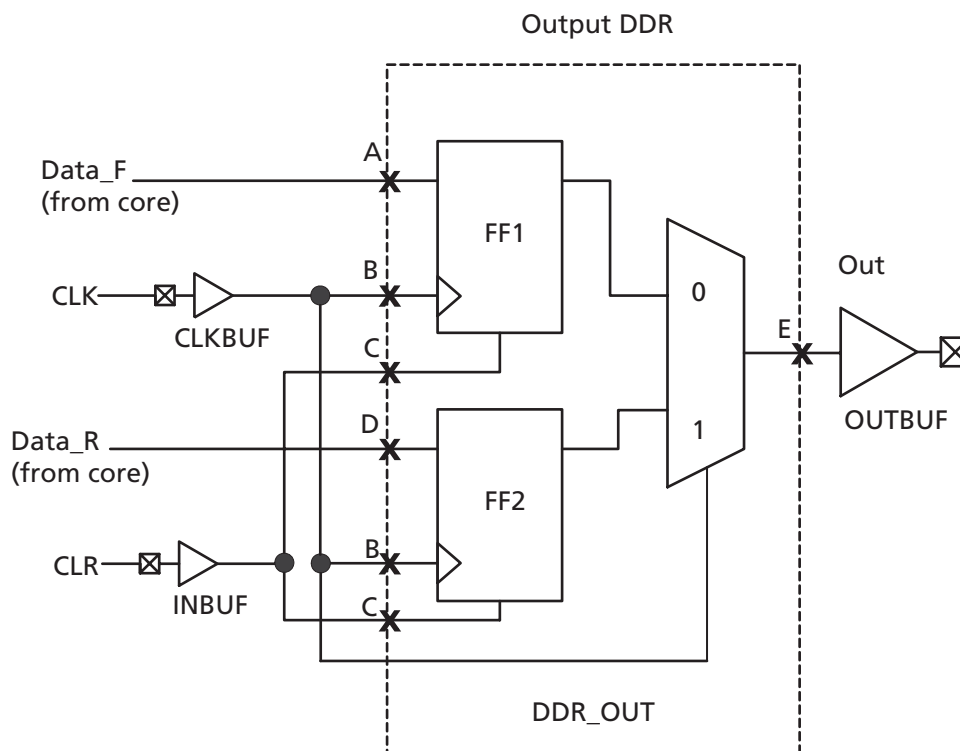


Figure 2-34 • Output DDR Timing Model

Table 2-121 • Parameter Definitions

Parameter Name	Parameter Definition	Measuring Nodes (from, to)
t_{DDROCLKQ}	Clock-to-Out	B, E
$t_{\text{DDROCLR2Q}}$	Asynchronous Clear-to-Out	C, E
$t_{\text{DDROREMCLR}}$	Clear Removal	C, B
$t_{\text{DDRORECCLR}}$	Clear Recovery	C, B
t_{DDROSUD1}	Data Setup Data_F	A, B
t_{DDROSUD2}	Data Setup Data_R	D, B
t_{DDROHD1}	Data Hold Data_F	A, B
t_{DDROHD2}	Data Hold Data_R	D, B

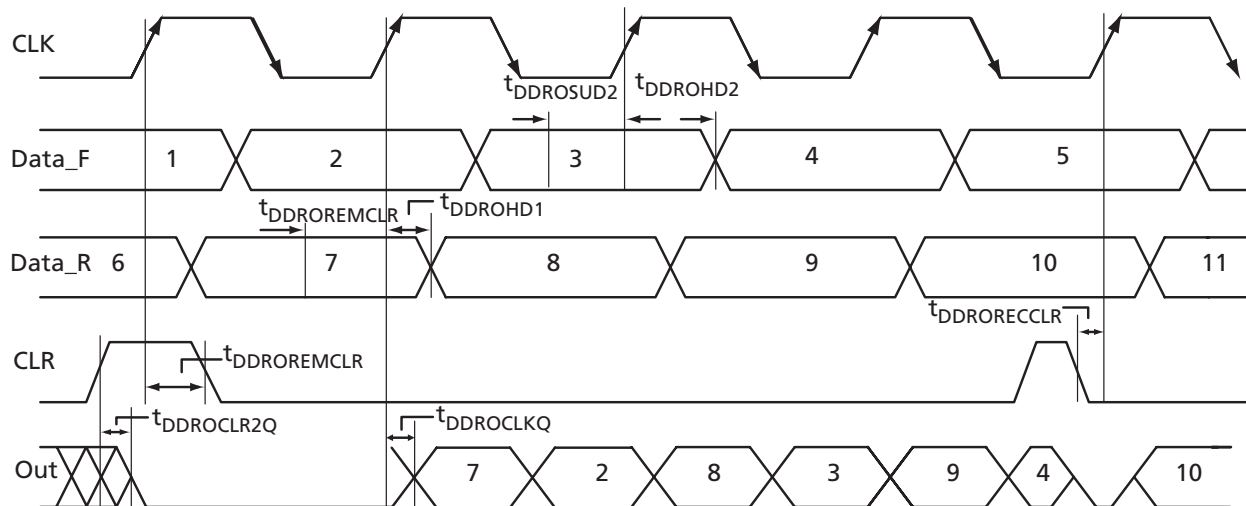


Figure 2-35 • Output DDR Timing Diagram

Timing Characteristics

Table 2-122 • Output DDR Propagation Delays

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	-1	Std.	Units
t_{DDROCLKQ}	Clock-to-Out of DDR for Output DDR	0.97	1.14	ns
t_{DDRISUD1}	Data_F Data Setup for Output DDR	0.52	0.62	ns
t_{DDROSUD2}	Data_R Data Setup for Output DDR	0.52	0.62	ns
t_{DDROHD1}	Data_F Data Hold for Output DDR	0.00	0.00	ns
t_{DDROHD2}	Data_R Data Hold for Output DDR	0.00	0.00	ns
$t_{\text{DDROCLR2Q}}$	Asynchronous Clear-to-Out for Output DDR	1.11	1.30	ns
$t_{\text{DDROEMCLR}}$	Asynchronous Clear Removal Time for Output DDR	0.00	0.00	ns
$t_{\text{DDROECCLR}}$	Asynchronous Clear Recovery Time for Output DDR	0.31	0.36	ns
$t_{\text{DDROWCLR1}}$	Asynchronous Clear Minimum Pulse Width for Output DDR	0.19	0.22	ns
$t_{\text{DDROCKMPWH}}$	Clock Minimum Pulse Width HIGH for the Output DDR	0.31	0.36	ns
$t_{\text{DDROCKMPWL}}$	Clock Minimum Pulse Width LOW for the Output DDR	0.28	0.32	ns
F_{DDOMAX}	Maximum Frequency for the Output DDR	TBD	TBD	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-123 • Output DDR Propagation Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{DDROCLKQ}	Clock-to-Out of DDR for Output DDR	0.74	0.87	ns
t_{DDRISUD1}	Data_F Data Setup for Output DDR	0.40	0.47	ns
t_{DDROSUD2}	Data_R Data Setup for Output DDR	0.40	0.47	ns
t_{DDROHD1}	Data_F Data Hold for Output DDR	0.00	0.00	ns
t_{DDROHD2}	Data_R Data Hold for Output DDR	0.00	0.00	ns
$t_{\text{DDROCLR2Q}}$	Asynchronous Clear-to-Out for Output DDR	0.85	1.00	ns
$t_{\text{DDROREMCLR}}$	Asynchronous Clear Removal Time for Output DDR	0.00	0.00	ns
$t_{\text{DDROECCLR}}$	Asynchronous Clear Recovery Time for Output DDR	0.24	0.28	ns
$t_{\text{DDROWCLR1}}$	Asynchronous Clear Minimum Pulse Width for Output DDR	0.19	0.22	ns
$t_{\text{DDROCKMPWH}}$	Clock Minimum Pulse Width HIGH for the Output DDR	0.31	0.36	ns
$t_{\text{DDROCKMPWL}}$	Clock Minimum Pulse Width LOW for the Output DDR	0.28	0.32	ns
F_{DDOMAX}	Maximum Frequency for the Output DDR	TBD	TBD	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

VersaTile Characteristics

VersaTile Specifications as a Combinatorial Module

The RT ProASIC3 library offers all combinations of LUT-3 combinatorial functions. In this section, timing characteristics are presented for a sample of the library. For more details, refer to the *IGLOO, Fusion, and ProASIC3 Macro Library Guide*.

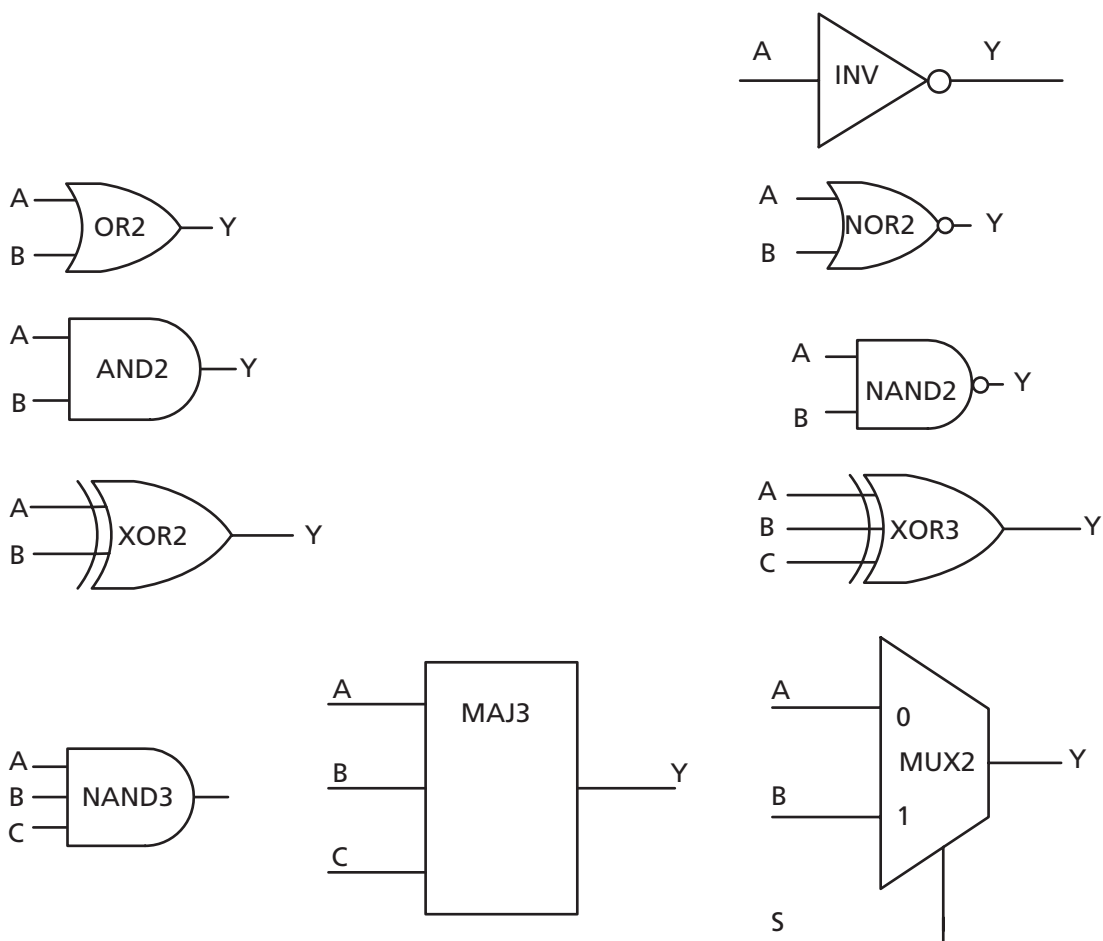


Figure 2-36 • Sample of Combinatorial Cells

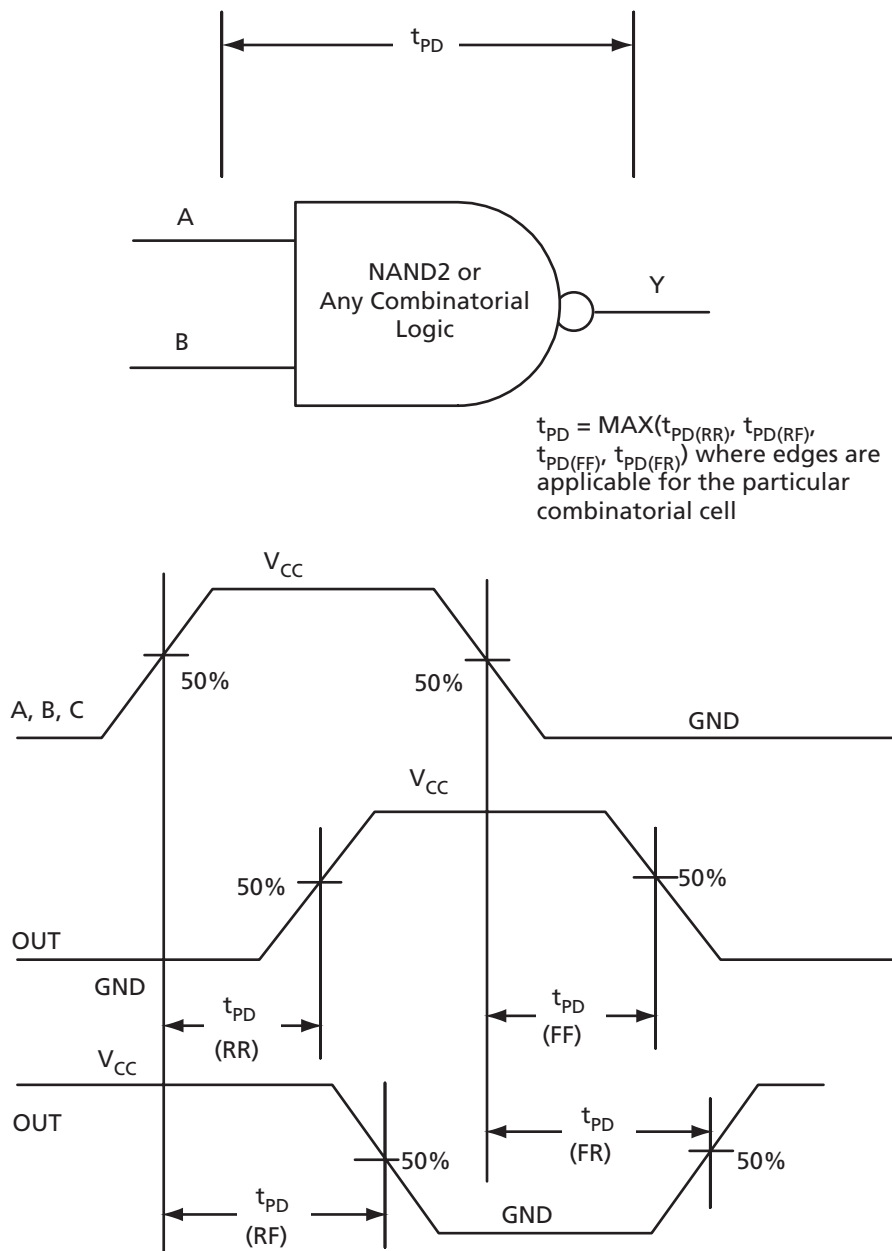


Figure 2-37 • Timing Model and Waveforms

Timing Characteristics

Table 2-124 • Combinatorial Cell Propagation Delays

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Combinatorial Cell	Equation	Parameter	–1	Std.	Units
INV	$Y = !A$	t_{PD}	0.56	0.65	ns
AND2	$Y = A \cdot B$	t_{PD}	0.65	0.77	ns
NAND2	$Y = !(A \cdot B)$	t_{PD}	0.65	0.77	ns
OR2	$Y = A + B$	t_{PD}	0.67	0.79	ns
NOR2	$Y = !(A + B)$	t_{PD}	0.67	0.79	ns
XOR2	$Y = A \oplus B$	t_{PD}	1.02	1.20	ns
MAJ3	$Y = \text{MAJ}(A, B, C)$	t_{PD}	0.97	1.14	ns
XOR3	$Y = A \oplus B \oplus C$	t_{PD}	1.21	1.42	ns
MUX2	$Y = A \text{ IS } + B \text{ S}$	t_{PD}	0.70	0.82	ns
AND3	$Y = A \cdot B \cdot C$	t_{PD}	0.78	0.91	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-125 • Combinatorial Cell Propagation Delays

Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$

Combinatorial Cell	Equation	Parameter	–1	Std.	Units
INV	$Y = !A$	t_{PD}	0.43	0.50	ns
AND2	$Y = A \cdot B$	t_{PD}	0.50	0.59	ns
NAND2	$Y = !(A \cdot B)$	t_{PD}	0.50	0.59	ns
OR2	$Y = A + B$	t_{PD}	0.51	0.61	ns
NOR2	$Y = !(A + B)$	t_{PD}	0.51	0.61	ns
XOR2	$Y = A \oplus B$	t_{PD}	0.78	0.92	ns
MAJ3	$Y = \text{MAJ}(A, B, C)$	t_{PD}	0.74	0.87	ns
XOR3	$Y = A \oplus B \oplus C$	t_{PD}	0.93	1.09	ns
MUX2	$Y = A \text{ IS } + B \text{ S}$	t_{PD}	0.54	0.63	ns
AND3	$Y = A \cdot B \cdot C$	t_{PD}	0.59	0.70	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

VersaTile Specifications as a Sequential Module

The RT ProASIC3 library offers a wide variety of sequential cells, including flip-flops and latches. Each has a data input and optional enable, clear, or preset. In this section, timing characteristics are presented for a representative sample from the library. For more details, refer to the *IGLOO, Fusion, and ProASIC3 Macro Library Guide*.

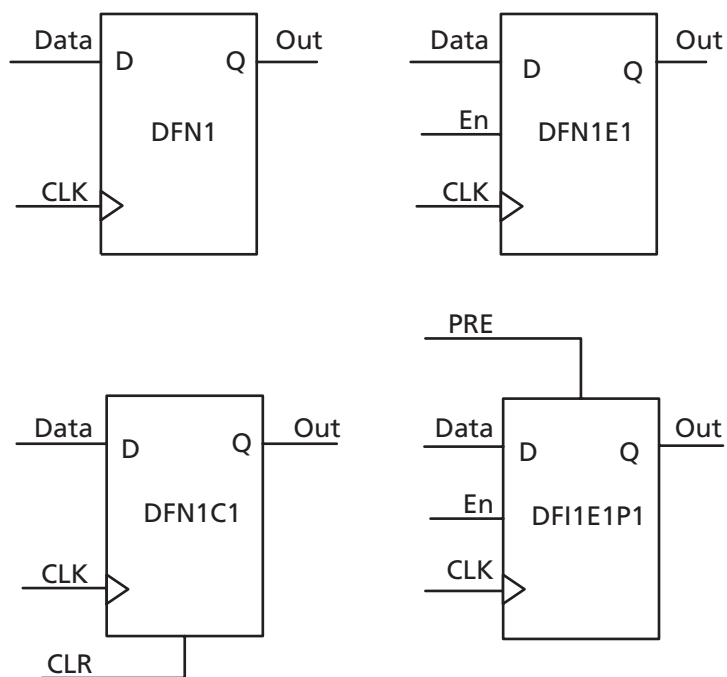


Figure 2-38 • Sample of Sequential Cells

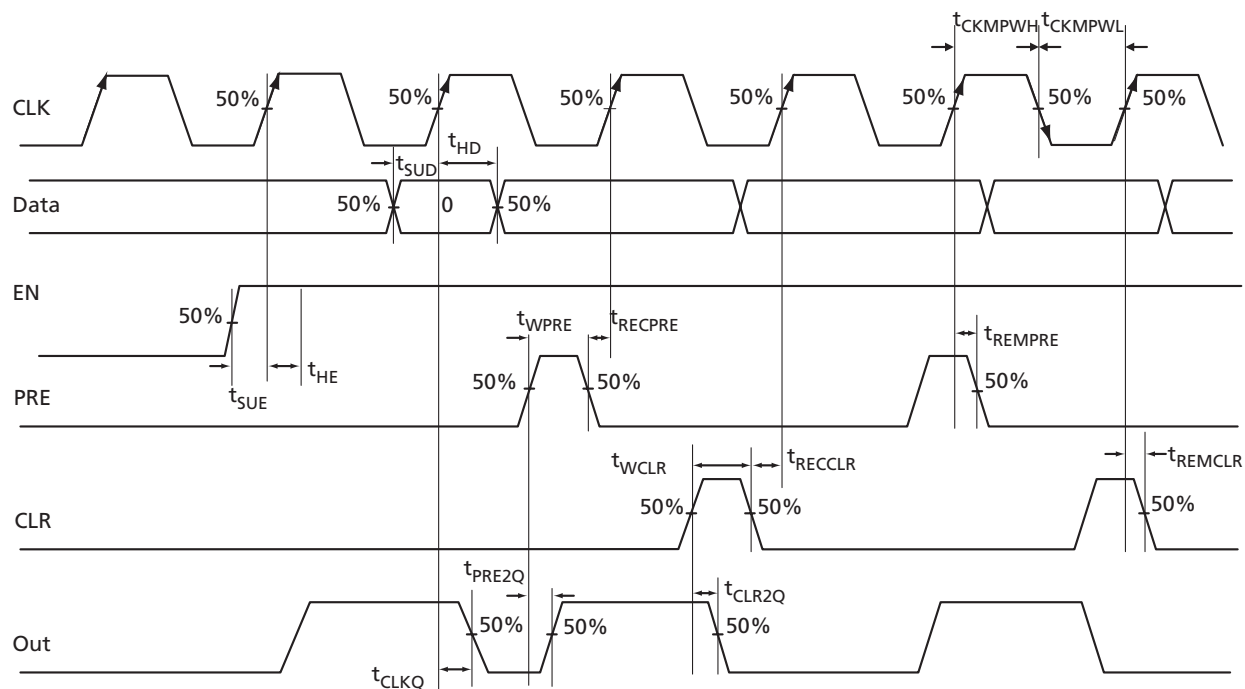


Figure 2-39 • Timing Model and Waveforms

Timing Characteristics

Table 2-126 • Register Delays

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Core Register	0.76	0.90	ns
t_{SUD}	Data Setup Time for the Core Register	0.59	0.70	ns
t_{HD}	Data Hold Time for the Core Register	0.00	0.00	ns
t_{SUE}	Enable Setup Time for the Core Register	0.63	0.74	ns
t_{HE}	Enable Hold Time for the Core Register	0.00	0.00	ns
t_{CLR2Q}	Asynchronous Clear-to-Q of the Core Register	0.55	0.65	ns
t_{PRE2Q}	Asynchronous Preset-to-Q of the Core Register	0.55	0.65	ns
t_{REMCLR}	Asynchronous Clear Removal Time for the Core Register	0.00	0.00	ns
t_{RECCLR}	Asynchronous Clear Recovery Time for the Core Register	0.31	0.36	ns
t_{REMPRE}	Asynchronous Preset Removal Time for the Core Register	0.00	0.00	ns
t_{RECPRE}	Asynchronous Preset Recovery Time for the Core Register	0.31	0.36	ns
t_{WCLR}	Asynchronous Clear Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{WPRE}	Asynchronous Preset Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{CKMPWH}	Clock Minimum Pulse Width HIGH for the Core Register	0.56	0.64	ns
t_{CKMPWL}	Clock Minimum Pulse Width LOW for the Core Register	0.56	0.64	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-127 • Register Delays
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Core Register	0.58	0.69	ns
t_{SUD}	Data Setup Time for the Core Register	0.45	0.53	ns
t_{HD}	Data Hold Time for the Core Register	0.00	0.00	ns
t_{SUE}	Enable Setup Time for the Core Register	0.48	0.57	ns
t_{HE}	Enable Hold Time for the Core Register	0.00	0.00	ns
t_{CLR2Q}	Asynchronous Clear-to-Q of the Core Register	0.42	0.50	ns
t_{PRE2Q}	Asynchronous Preset-to-Q of the Core Register	0.42	0.50	ns
t_{REMCLR}	Asynchronous Clear Removal Time for the Core Register	0.00	0.00	ns
t_{RECCLR}	Asynchronous Clear Recovery Time for the Core Register	0.24	0.28	ns
t_{REMPRE}	Asynchronous Preset Removal Time for the Core Register	0.00	0.00	ns
t_{RECPRE}	Asynchronous Preset Recovery Time for the Core Register	0.24	0.28	ns
t_{WCLR}	Asynchronous Clear Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{WPRE}	Asynchronous Preset Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{CKMPWH}	Clock Minimum Pulse Width HIGH for the Core Register	0.56	0.64	ns
t_{CKMPWL}	Clock Minimum Pulse Width LOW for the Core Register	0.56	0.64	ns

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Global Resource Characteristics

RT3PE600L Clock Tree Topology

Clock delays are device-specific. [Figure 2-40](#) is an example of a global tree used for clock routing. The global tree presented in [Figure 2-40](#) is driven by a CCC located on the west side of the RT3PE600L device. It is used to drive all D-flip-flops in the device.

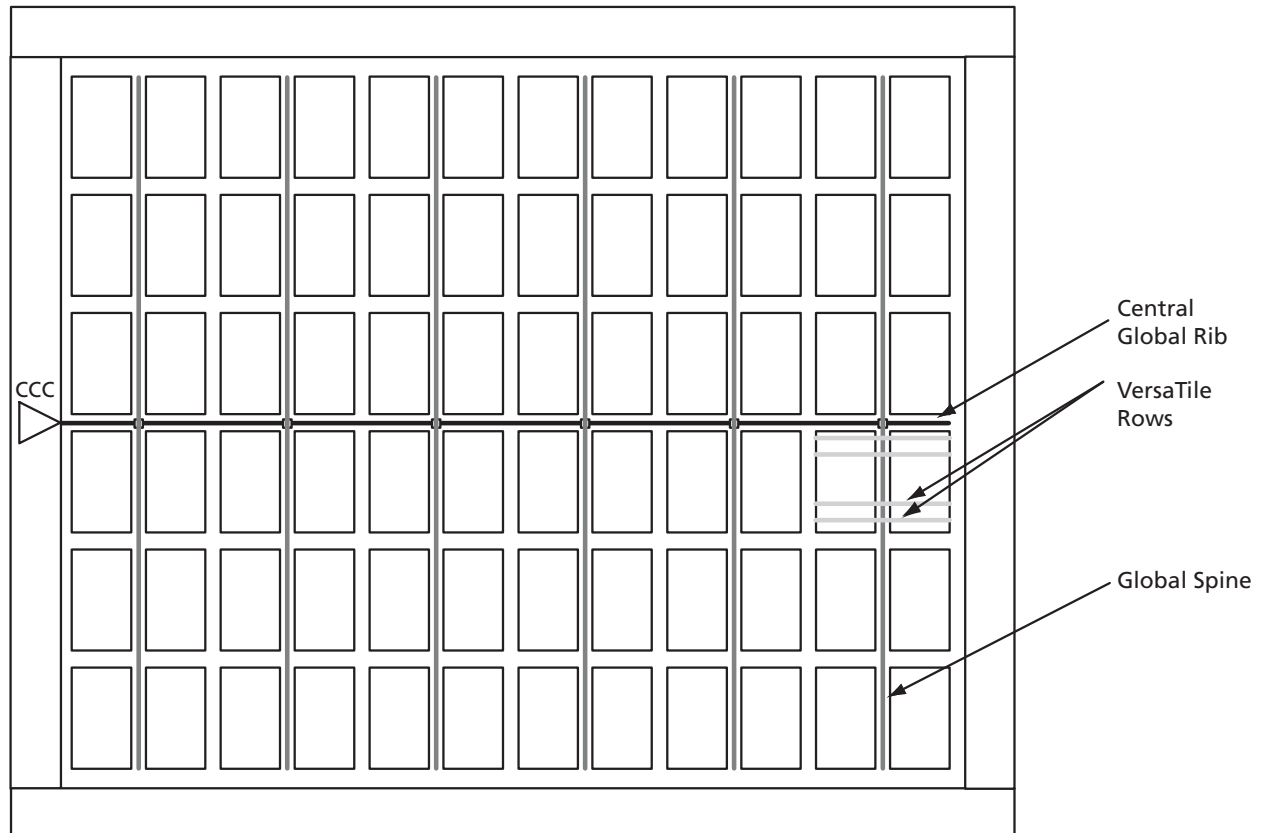


Figure 2-40 • Example of Global Tree Use in an RT3PE600L Device for Clock Routing

Global Tree Timing Characteristics

Global clock delays include the central rib delay, the spine delay, and the row delay. Delays do not include I/O input buffer clock delays, as these are I/O standard-dependent, and the clock may be driven and conditioned internally by the CCC module. For more details on clock conditioning capabilities, refer to the ["Clock Conditioning Circuits" section on page 2-87](#). [Table 2-128](#) to [Table 2-131 on page 2-86](#) present minimum and maximum global clock delays within each device. Minimum and maximum delays are measured with minimum and maximum loading.

Timing Characteristics

1.2 V DC Core Voltage

Table 2-128 • RT3PE600L Global Resource
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.14\text{ V}$

Parameter	Description	-1		Std.		Units
		Min. ¹	Max. ²	Min. ¹	Max. ²	
t_{RCKL}	Input LOW Delay for Global Clock					ns
t_{RCKH}	Input HIGH Delay for Global Clock					ns
$t_{RCKMPWH}$	Minimum Pulse Width HIGH for Global Clock					ns
$t_{RCKMPWL}$	Minimum Pulse Width LOW for Global Clock					ns
t_{RCKSW}	Maximum Skew for Global Clock					ns
F_{RMAX}	Maximum Frequency for Global Clock					MHz

Notes:

1. Value reflects minimum load. The delay is measured from the CCC output to the clock pin of a sequential element, located in a lightly loaded row (single element is connected to the global net).
2. Value reflects maximum load. The delay is measured on the clock pin of the farthest sequential element, located in a fully loaded row (all available flip-flops are connected to the global net in the row).
3. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-129 • RT3PE3000L Global Resource
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.14\text{ V}$

Parameter	Description	-1		Std.		Units
		Min. ¹	Max. ²	Min. ¹	Max. ²	
t_{RCKL}	Input LOW Delay for Global Clock	1.80	2.06	2.12	2.42	ns
t_{RCKH}	Input HIGH Delay for Global Clock	1.79	2.09	2.11	2.45	ns
$t_{RCKMPWH}$	Minimum Pulse Width HIGH for Global Clock					ns
$t_{RCKMPWL}$	Minimum Pulse Width LOW for Global Clock					ns
t_{RCKSW}	Maximum Skew for Global Clock		0.30		0.35	ns
F_{RMAX}	Maximum Frequency for Global Clock					MHz

Notes:

1. Value reflects minimum load. The delay is measured from the CCC output to the clock pin of a sequential element, located in a lightly loaded row (single element is connected to the global net).
2. Value reflects maximum load. The delay is measured on the clock pin of the farthest sequential element, located in a fully loaded row (all available flip-flops are connected to the global net in the row).
3. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

1.5 V DC Core Voltage

Table 2-130 • RT3PE600L Global Resource
Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1		Std.		Units
		Min. ¹	Max. ²	Min. ¹	Max. ²	
t_{RCKL}	Input LOW Delay for Global Clock					ns
t_{RCKH}	Input HIGH Delay for Global Clock					ns
$t_{RCKMPWH}$	Minimum Pulse Width HIGH for Global Clock					ns
$t_{RCKMPWL}$	Minimum Pulse Width LOW for Global Clock					ns
t_{RCKSW}	Maximum Skew for Global Clock					ns
F_{RMAX}	Maximum Frequency for Global Clock					MHz

Notes:

1. Value reflects minimum load. The delay is measured from the CCC output to the clock pin of a sequential element, located in a lightly loaded row (single element is connected to the global net).
2. Value reflects maximum load. The delay is measured on the clock pin of the farthest sequential element, located in a fully loaded row (all available flip-flops are connected to the global net in the row).
3. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-131 • RT3PE3000L Global Resource
Military-Case Conditions: $T_J = 125^\circ\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1		Std.		Units
		Min. ¹	Max. ²	Min. ¹	Max. ²	
t_{RCKL}	Input LOW Delay for Global Clock	1.61	1.85	1.89	2.17	ns
t_{RCKH}	Input HIGH Delay for Global Clock	1.60	1.87	1.88	2.20	ns
$t_{RCKMPWH}$	Minimum Pulse Width HIGH for Global Clock					ns
$t_{RCKMPWL}$	Minimum Pulse Width LOW for Global Clock					ns
t_{RCKSW}	Maximum Skew for Global Clock		0.27		0.32	ns
F_{RMAX}	Maximum Frequency for Global Clock					MHz

Notes:

1. Value reflects minimum load. The delay is measured from the CCC output to the clock pin of a sequential element, located in a lightly loaded row (single element is connected to the global net).
2. Value reflects maximum load. The delay is measured on the clock pin of the farthest sequential element, located in a fully loaded row (all available flip-flops are connected to the global net in the row).
3. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Clock Conditioning Circuits

CCC Electrical Specifications

Timing Characteristics

Table 2-132 • RT ProASIC3 CCC/PLL Specification
For Devices Operating at 1.2 V DC Core Voltage

Parameter	Min.	Typ.	Max.	Units
Clock Conditioning Circuitry Input Frequency f_{IN_CCC}	1.5		250	MHz
Clock Conditioning Circuitry Output Frequency f_{OUT_CCC}	0.75		250	MHz
Delay Increments in Programmable Delay Blocks ^{1, 2}		270		ps
Number of Programmable Values in Each Programmable Delay Block			32	
Serial Clock (SCLK) for Dynamic PLL ³			100	MHz
Input Cycle-to-Cycle Jitter (peak magnitude)			1	ns
CCC Output Peak-to-Peak Period Jitter F_{CCC_OUT}	Max Peak-to-Peak Period Jitter			
	1 Global Network Used	External FB Used	3 Global Networks Used	
0.75 MHz to 24 MHz	0.50%	0.75%	0.70%	
24 MHz to 100 MHz	1.00%	1.50%	1.20%	
100 MHz to 250 MHz	2.50%	3.75%	2.75%	
Acquisition Time				
	LockControl = 0		300	μs
	LockControl = 1		6.0	ms
Tracking Jitter				
	LockControl = 0		2	ns
	LockControl = 1		1	ns
Output Duty Cycle	48.5		51.5	%
Delay Range in Block: Programmable Delay 1 ^{1, 2}	1.2		15.65	ns
Delay Range in Block: Programmable Delay 2 ^{1, 2}	0.025		15.65	ns
Delay Range in Block: Fixed Delay ^{1, 2}		3.1		ns

Notes:

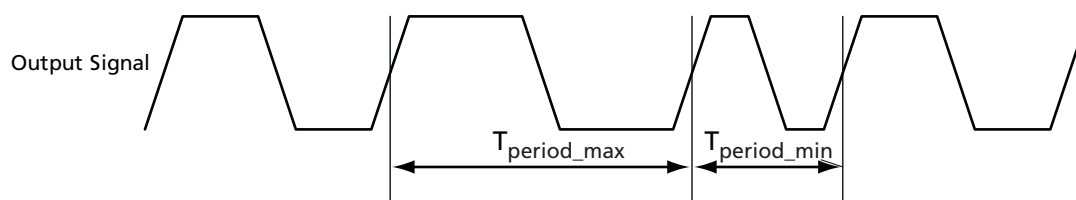
1. This delay is a function of voltage and temperature. See [Table 2-5 on page 2-8](#) for deratings.
2. $T_J = 25^\circ\text{C}$, $V_{CC} = 1.2\text{ V}$
3. Maximum value obtained for a Std. speed grade device in worst-case military conditions. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.
4. Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by period jitter parameter.

Table 2-133 • RT ProASIC3 CCC/PLL Specification
For Devices Operating at 1.5 V DC Core Voltage

Parameter	Min.	Typ.	Max.	Units
Clock Conditioning Circuitry Input Frequency f_{IN_CCC}	1.5		350	MHz
Clock Conditioning Circuitry Output Frequency f_{OUT_CCC}	0.75		350	MHz
Serial Clock (SCLK) for Dynamic PLL ⁵			110	MHz
Delay Increments in Programmable Delay Blocks ^{1, 2}		200		ps
Number of Programmable Values in Each Programmable Delay Block			32	
Input Period Jitter			1.5	ns
CCC Output Peak-to-Peak Period Jitter F_{CCC_OUT}	Max Peak-to-Peak Period Jitter			
	1 Global Network Used		3 Global Networks Used	
0.75 MHz to 24 MHz	0.50%		0.70%	
24 MHz to 100 MHz	1.00%		1.20%	
100 MHz to 250 MHz	1.75%		2.00%	
250 MHz to 350 MHz	2.50%		5.60%	
Acquisition Time				
	LockControl = 0		300	μs
	LockControl = 1		6.0	ms
Tracking Jitter				
	LockControl = 0		1.6	ns
	LockControl = 1		0.8	ns
Output Duty Cycle	48.5		51.5	%
Delay Range in Block: Programmable Delay 1 ^{1, 2}	0.6		5.56	ns
Delay Range in Block: Programmable Delay 2 ^{1, 2}	0.025		5.56	ns
Delay Range in Block: Fixed Delay ^{1, 2}		2.2		ns

Notes:

1. This delay is a function of voltage and temperature. See [Table 2-5 on page 2-8](#) for deratings.
2. $T_J = 25^\circ\text{C}$, $V_{CC} = 1.5\text{ V}$
3. Maximum value obtained for a Std. speed grade device in worst-case military conditions. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.
4. Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by period jitter parameter.
5. Maximum value obtained for a -1 speed grade device in worst-case military conditions. For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.



Note: Peak-to-peak jitter measurements are defined by $T_{\text{peak-to-peak}} = T_{\text{period_max}} - T_{\text{period_min}}$.

Figure 2-41 • Peak-to-Peak Jitter Definition

Embedded SRAM and FIFO Characteristics

SRAM

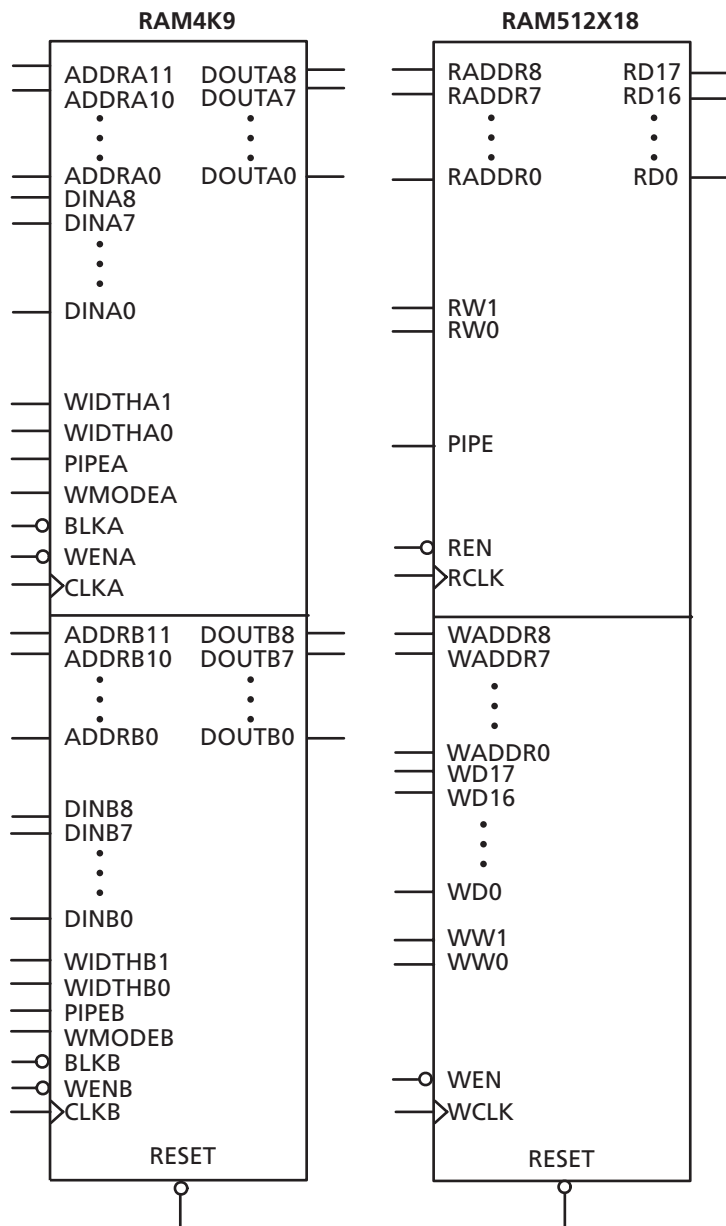


Figure 2-42 • RAM Models

Timing Waveforms

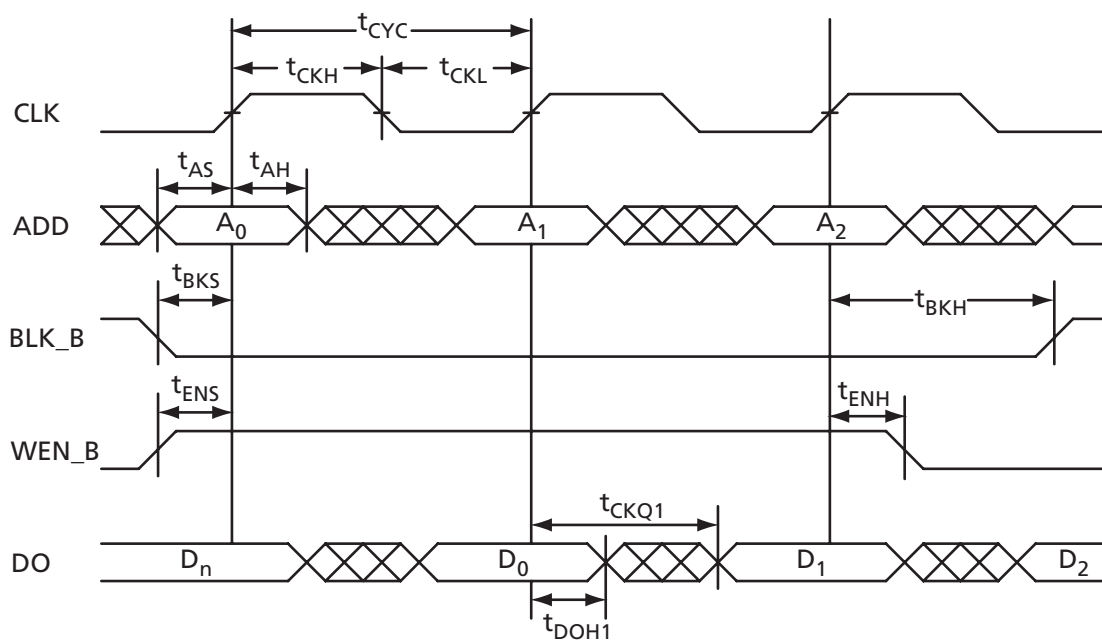


Figure 2-43 • RAM Read for Pass-Through Output

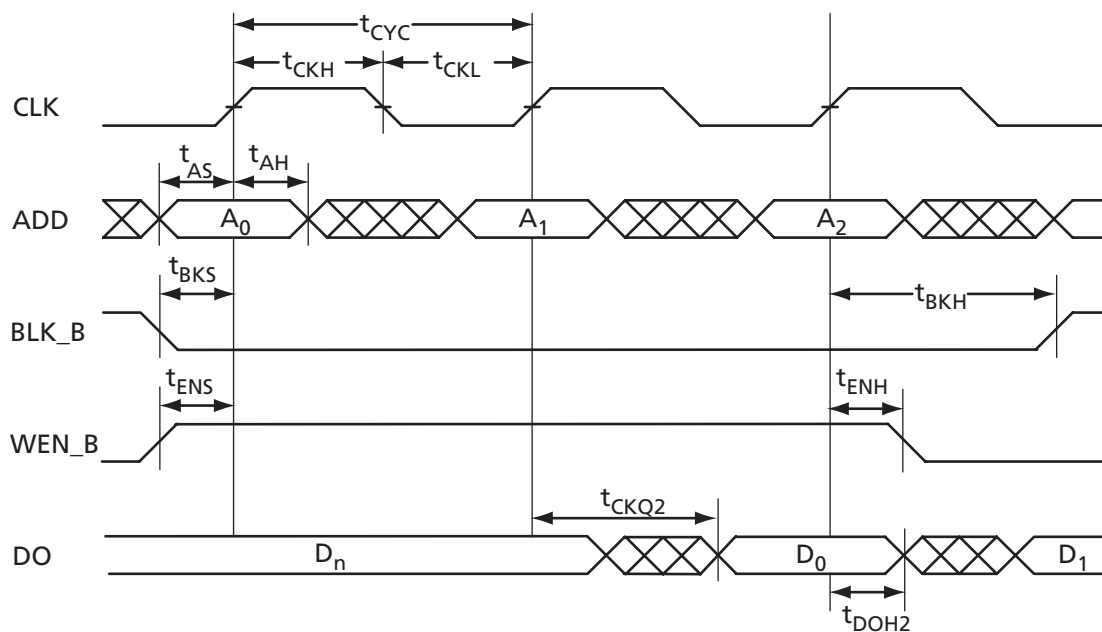


Figure 2-44 • RAM Read for Pipelined Output

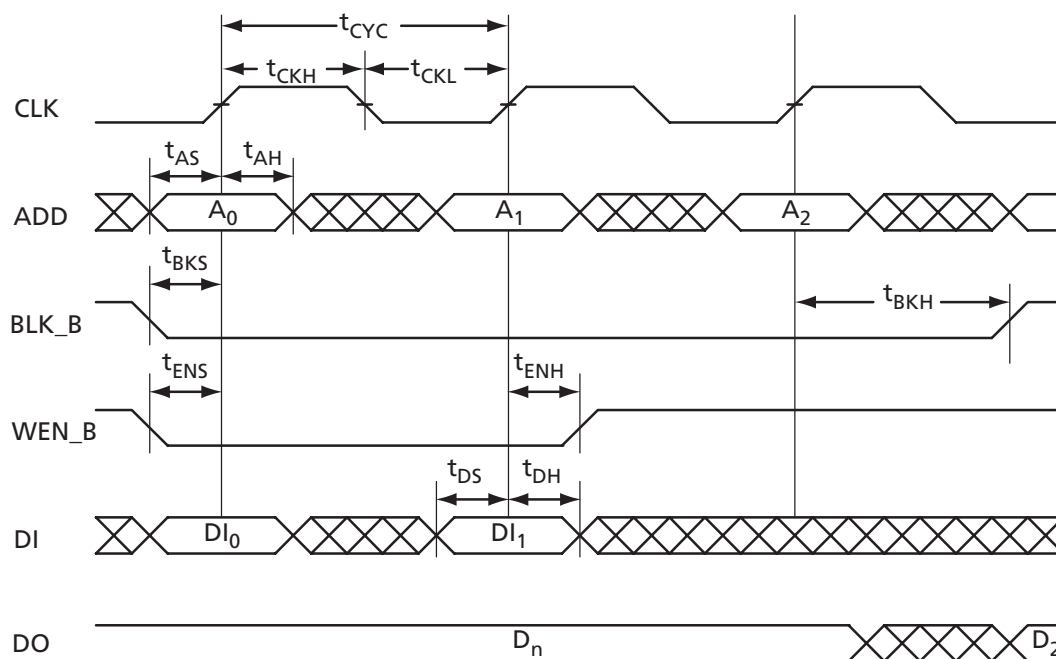


Figure 2-45 • RAM Write, Output Retained (WMODE = 0)

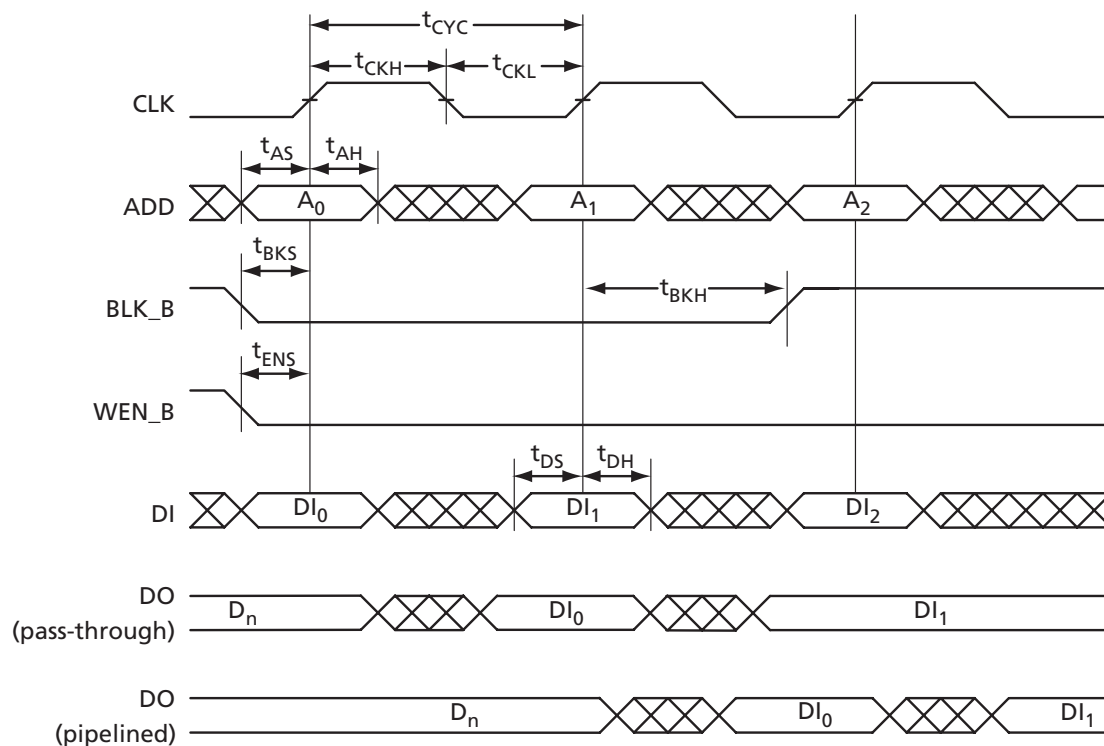


Figure 2-46 • RAM Write, Output as Write Data (WMODE = 1)

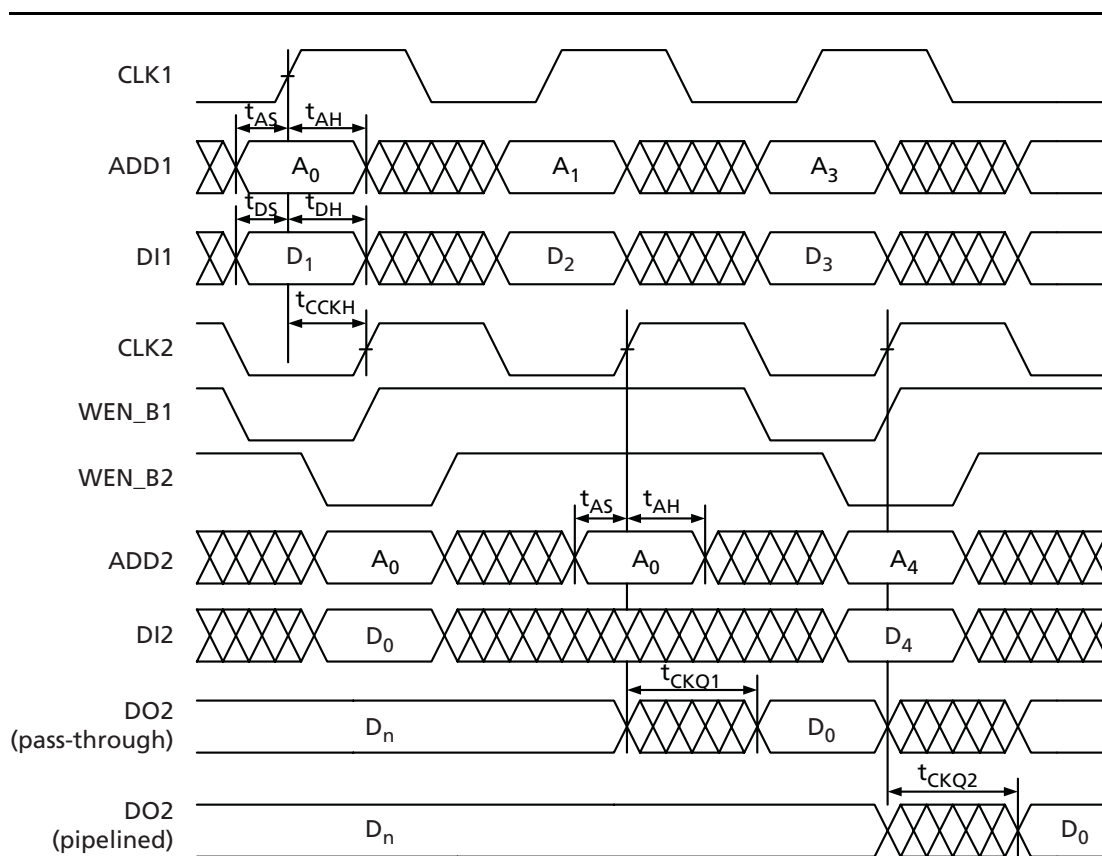


Figure 2-47 • Write Access after Write onto Same Address

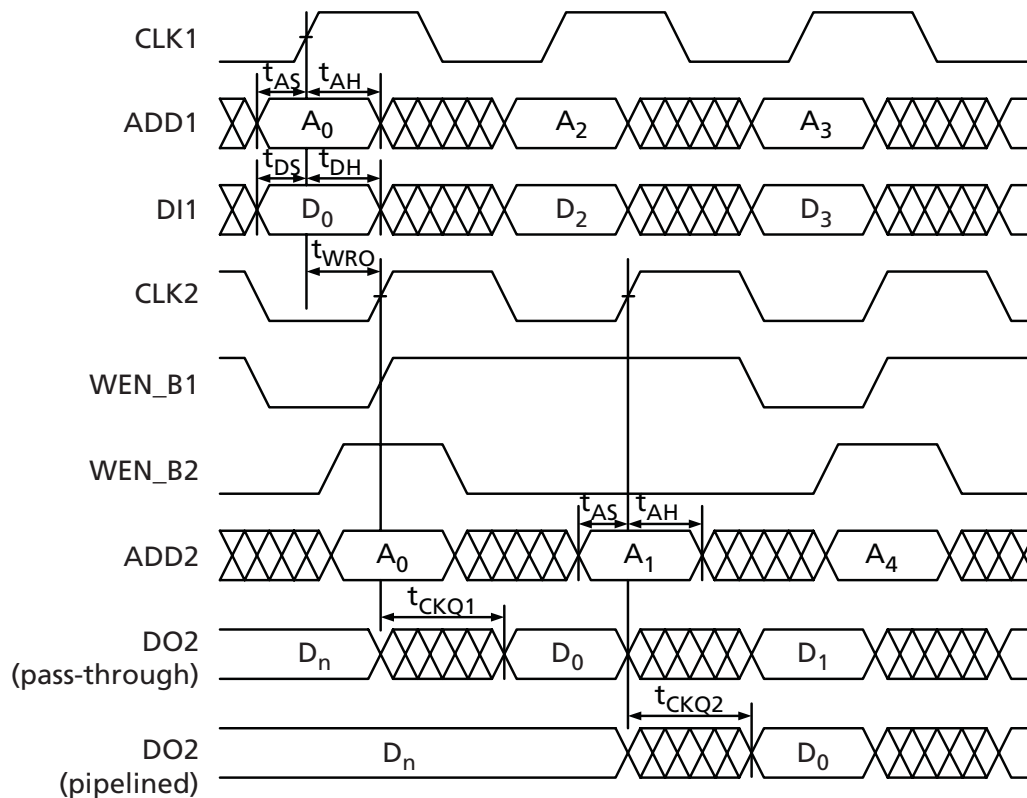


Figure 2-48 • Read Access after Write onto Same Address

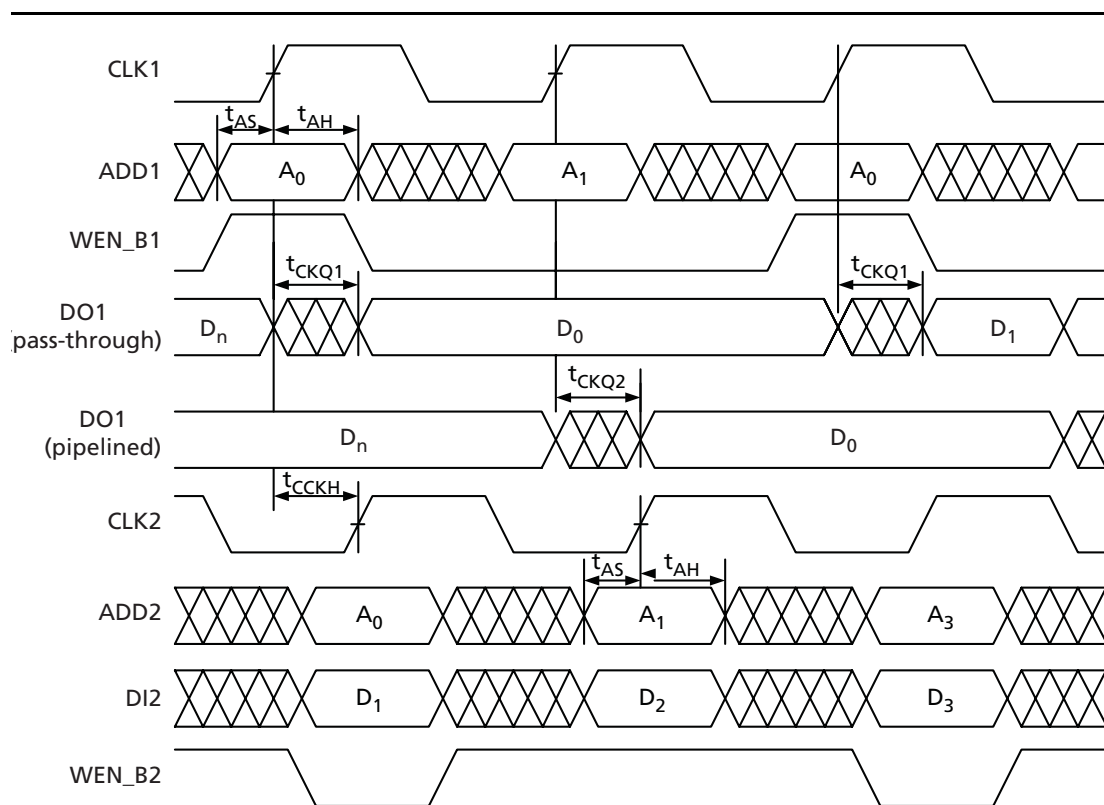


Figure 2-49 • Write Access after Read onto Same Address

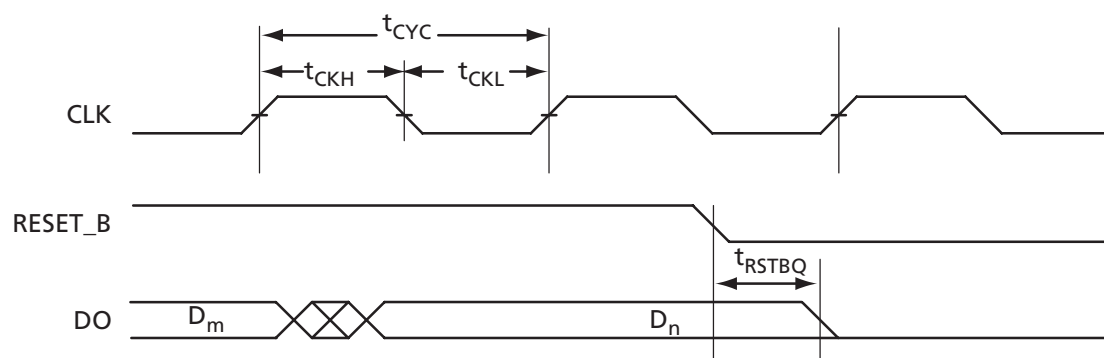


Figure 2-50 • RAM Reset

Timing Characteristics

Table 2-134 • RAM4K9

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{AS}	Address setup time	0.35	0.41	ns
t_{AH}	Address hold time	0.00	0.00	ns
t_{ENS}	REN_B, WEN_B setup time	0.20	0.23	ns
t_{ENH}	REN_B, WEN_B hold time	0.13	0.16	ns
t_{BKS}	BLK_B setup time	0.32	0.38	ns
t_{BKH}	BLK_B hold time	0.03	0.03	ns
t_{DS}	Input data (DI) setup time	0.25	0.30	ns
t_{DH}	Input data (DI) hold time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to new data valid on DO (output retained, WMODE = 0)	2.47	2.91	ns
	Clock HIGH to new data valid on DO (flow-through, WMODE = 1)	3.26	3.84	ns
t_{CKQ2}	Clock HIGH to new data valid on DO (pipelined)	1.24	1.46	ns
t_{WRO}	Address collision clk-to-clk delay for reliable read access after write on same address	TBD	TBD	ns
t_{CCKH}	Address collision clk-to-clk delay for reliable write access after write/read on same address	TBD	TBD	ns
t_{RSTBQ}	RESET_B LOW to data out LOW on DO (flow-through)	1.28	1.50	ns
	RESET_B LOW to data out LOW on DO (pipelined)	1.28	1.50	ns
$t_{REMRSTB}$	RESET_B removal	0.40	0.47	ns
$t_{RECRSTB}$	RESET_B recovery	2.08	2.44	ns
$t_{MPWRSTB}$	RESET_B minimum pulse width	0.66	0.76	ns
t_{CYC}	Clock cycle time	6.08	6.99	ns
F_{MAX}	Maximum frequency	164	143	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-135 • RAM4K9
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{AS}	Address setup time	0.26	0.31	ns
t_{AH}	Address hold time	0.00	0.00	ns
t_{ENS}	REN_B, WEN_B setup time	0.15	0.18	ns
t_{ENH}	REN_B, WEN_B hold time	0.10	0.12	ns
t_{BKS}	BLK_B setup time	0.25	0.29	ns
t_{BKH}	BLK_B hold time	0.02	0.02	ns
t_{DS}	Input data (DI) setup time	0.19	0.23	ns
t_{DH}	Input data (DI) hold time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to new data valid on DO (output retained, WMODE = 0)	1.89	2.22	ns
	Clock HIGH to new data valid on DO (flow-through, WMODE = 1)	2.50	2.93	ns
t_{CKQ2}	Clock HIGH to new data valid on DO (pipelined)	0.95	1.11	ns
t_{WRO}	Address collision clk-to-clk delay for reliable read access after write on same address	TBD	TBD	ns
t_{CCKH}	Address collision clk-to-clk delay for reliable write access after write/read on same address	TBD	TBD	ns
t_{RSTBQ}	RESET_B LOW to data out LOW on DO (flow-through)	0.98	1.15	ns
	RESET_B LOW to data out LOW on DO (pipelined)	0.98	1.15	ns
$t_{REMRSTB}$	RESET_B removal	0.30	0.36	ns
$t_{RECRSTB}$	RESET_B recovery	1.59	1.87	ns
$t_{MPWRSTB}$	RESET_B minimum pulse width	0.59	0.67	ns
t_{CYC}	Clock cycle time	5.39	6.20	ns
F_{MAX}	Maximum frequency	185	161	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-136 • RAM512X18**Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$**

Parameter	Description	–1	Std.	Units
t_{AS}	Address setup time	0.35	0.41	ns
t_{AH}	Address hold time	0.00	0.00	ns
t_{ENS}	REN_B, WEN_B setup time	0.13	0.15	ns
t_{ENH}	REN_B, WEN_B hold time	0.08	0.09	ns
t_{DS}	Input data (DI) setup time	0.25	0.30	ns
t_{DH}	Input data (DI) hold time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to new data valid on DO (output retained, WMODE = 0)	2.99	3.52	ns
t_{CKQ2}	Clock HIGH to new data valid on DO (pipelined)	1.24	1.46	ns
t_{WRO}	Address collision clk-to-clk delay for reliable read access after write on same address	TBD	TBD	ns
t_{CCKH}	Address collision clk-to-clk delay for reliable write access after write/read on same address	TBD	TBD	ns
t_{RSTBQ}	RESET_B LOW to data out LOW on DO (flow through)	1.28	1.50	ns
	RESET_B LOW to data out LOW on DO (pipelined)	1.28	1.50	ns
$t_{REMRSTB}$	RESET_B removal	0.40	0.47	ns
$t_{RECRSTB}$	RESET_B recovery	2.08	2.44	ns
$t_{MPWRSTB}$	RESET_B minimum pulse width	0.66	0.76	ns
t_{CYC}	Clock cycle time	6.08	6.99	ns
F_{MAX}	Maximum frequency	164	143	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-137 • RAM512X18
Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{AS}	Address setup time	0.26	0.31	ns
t_{AH}	Address hold time	0.00	0.00	ns
t_{ENS}	REN_B, WEN_B setup time	0.10	0.11	ns
t_{ENH}	REN_B, WEN_B hold time	0.06	0.07	ns
t_{DS}	Input data (DI) setup time	0.19	0.23	ns
t_{DH}	Input data (DI) hold time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to new data valid on DO (output retained, WMODE = 0)	2.29	2.69	ns
t_{CKQ2}	Clock HIGH to new data valid on DO (pipelined)	0.95	1.12	ns
t_{WRO}	Address collision clk-to-clk delay for reliable read access after write on same address	TBD	TBD	ns
t_{CCKH}	Address collision clk-to-clk delay for reliable write access after write/read on same address	TBD	TBD	ns
t_{RSTBQ}	RESET_B LOW to data out LOW on DO (flow through)	0.98	1.15	ns
	RESET_B LOW to data out LOW on DO (pipelined)	0.98	1.15	ns
$t_{REMRSTB}$	RESET_B removal	0.30	0.36	ns
$t_{RECRSTB}$	RESET_B recovery	1.59	1.87	ns
$t_{MPWRSTB}$	RESET_B minimum pulse width	0.59	0.67	ns
t_{CYC}	Clock cycle time	5.39	6.20	ns
F_{MAX}	Maximum frequency	185	161	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

FIFO

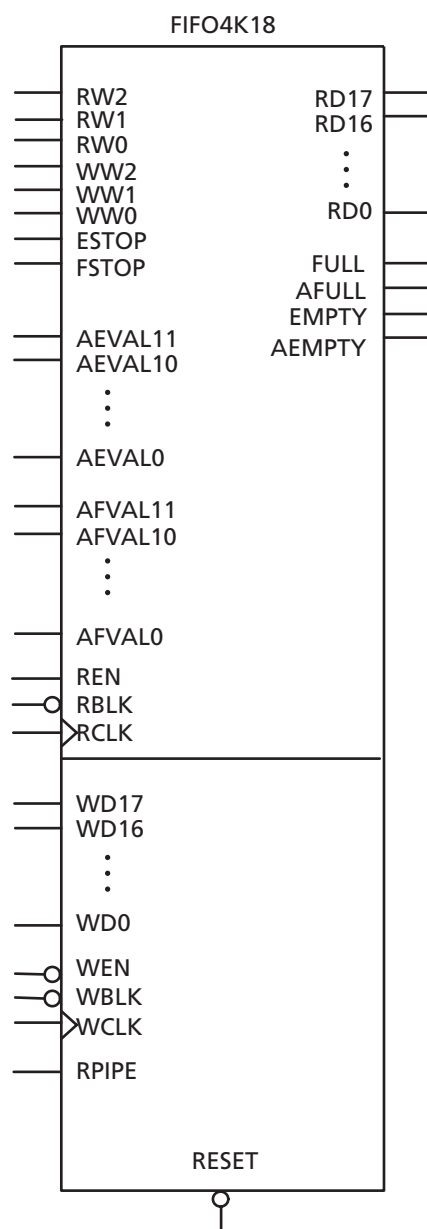


Figure 2-51 • FIFO Model

Timing Waveforms

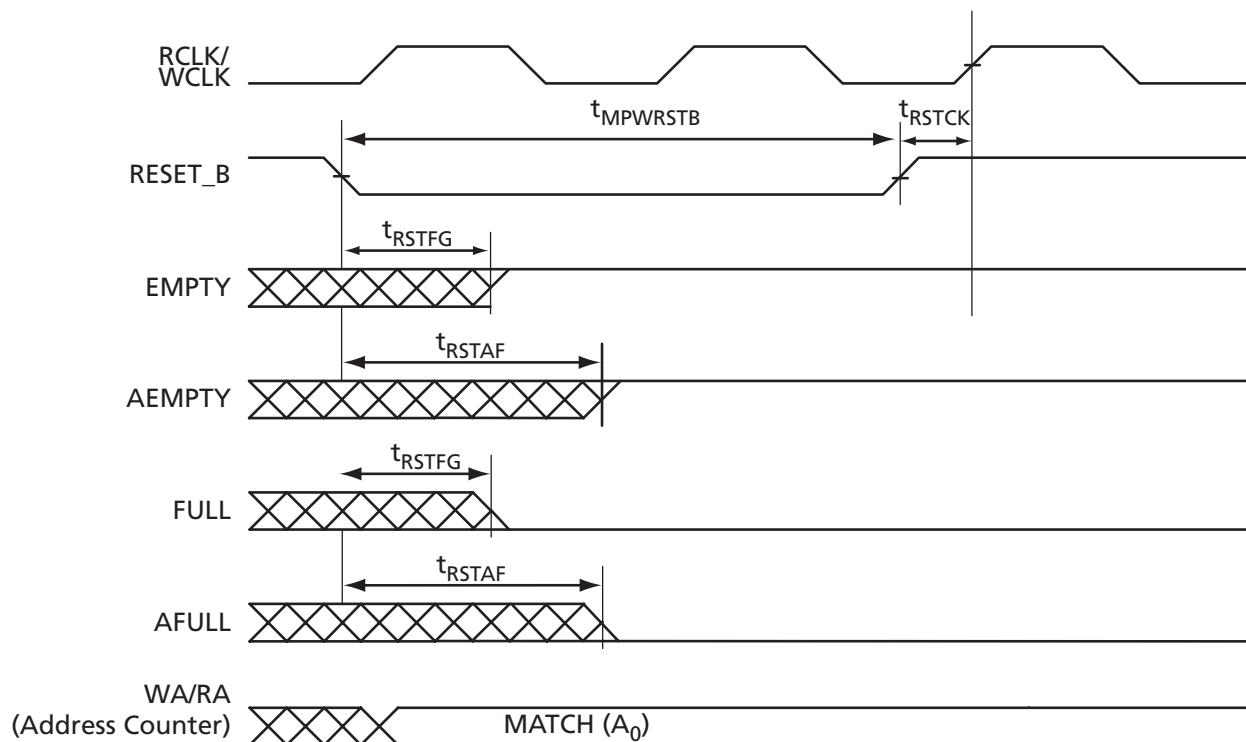


Figure 2-52 • FIFO Reset

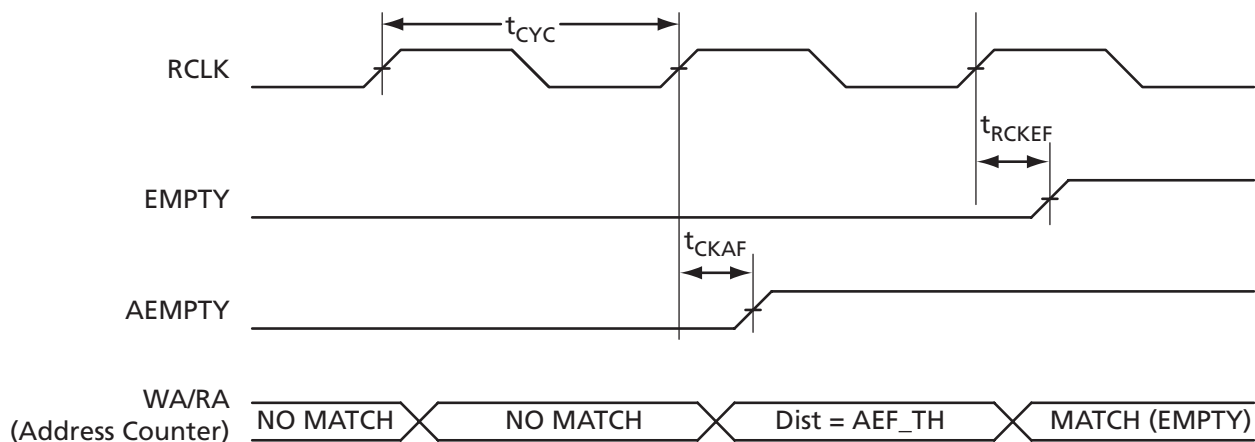


Figure 2-53 • FIFO EMPTY Flag and AEMPTY Flag Assertion

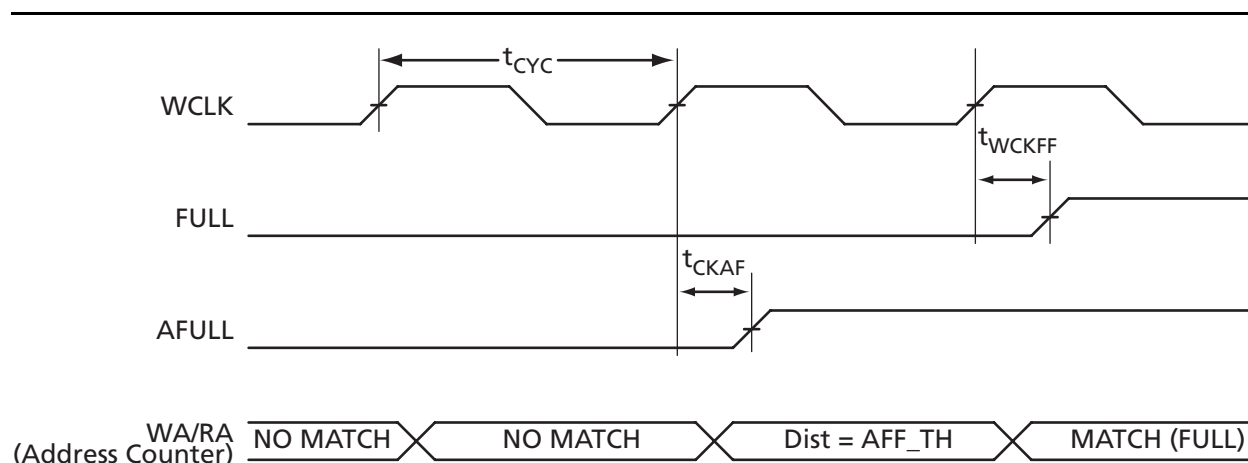


Figure 2-54 • FIFO FULL Flag and AFULL Flag Assertion

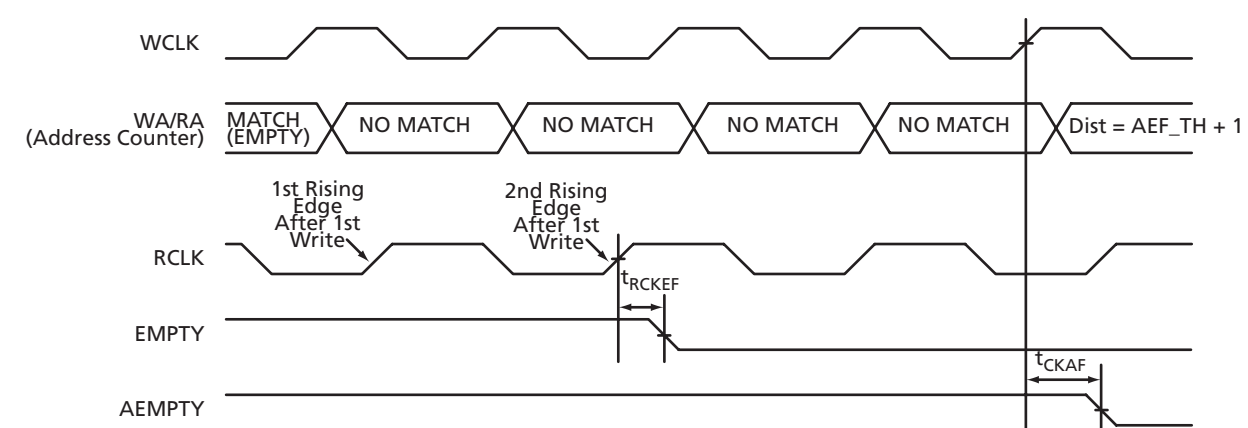


Figure 2-55 • FIFO EMPTY Flag and AEMPTY Flag Deassertion

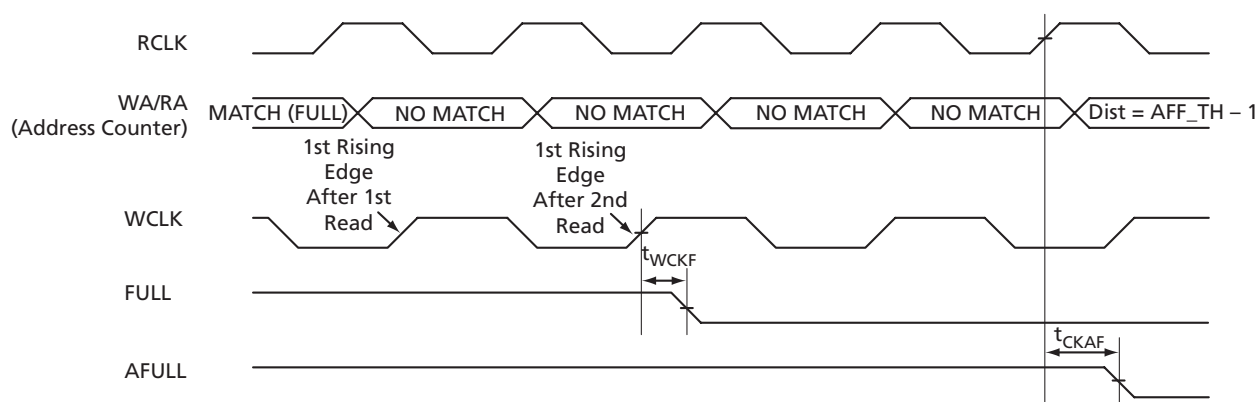


Figure 2-56 • FIFO FULL Flag and AFULL Flag Deassertion

Timing Characteristics

Table 2-138 • FIFO
Worst Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{ENS}	REN_B, WEN_B Setup Time	1.91	2.24	ns
t_{ENH}	REN_B, WEN_B Hold Time	0.03	0.03	ns
t_{BKS}	BLK_B Setup Time	0.40	0.47	ns
t_{BKH}	BLK_B Hold Time	0.00	0.00	ns
t_{DS}	Input Data (DI) Setup Time	0.25	0.30	ns
t_{DH}	Input Data (DI) Hold Time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to New Data Valid on DO (flow-through)	3.26	3.84	ns
t_{CKQ2}	Clock HIGH to New Data Valid on DO (pipelined)	1.24	1.46	ns
t_{RCKEF}	RCLK HIGH to Empty Flag Valid	2.38	2.80	ns
t_{WCKFF}	WCLK HIGH to Full Flag Valid	2.26	2.66	ns
t_{CKAF}	Clock HIGH to Almost Empty/Full Flag Valid	8.57	10.08	ns
t_{RSTFG}	RESET_B LOW to Empty/Full Flag Valid	2.34	2.76	ns
t_{RSTAF}	RESET_B LOW to Almost Empty/Full Flag Valid	8.48	9.97	ns
t_{RSTBQ}	RESET_B LOW to Data Out LOW on DO (flow-through)	1.28	1.50	ns
	RESET_B LOW to Data Out LOW on DO (pipelined)	1.28	1.50	ns
$t_{REMRSTB}$	RESET_B Removal	0.40	0.47	ns
$t_{RECRSTB}$	RESET_B Recovery	2.08	2.44	ns
$t_{MPWRSTB}$	RESET_B Minimum Pulse Width	0.66	0.76	ns
t_{CYC}	Clock Cycle Time	6.08	6.99	ns
F_{MAX}	Maximum Frequency for FIFO	164	143	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Table 2-139 • FIFO**Worst Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$**

Parameter	Description	–1	Std.	Units
t_{ENS}	REN_B, WEN_B Setup Time	1.46	1.71	ns
t_{ENH}	REN_B, WEN_B Hold Time	0.02	0.02	ns
t_{BKS}	BLK_B Setup Time	0.40	0.47	ns
t_{BKH}	BLK_B Hold Time	0.00	0.00	ns
t_{DS}	Input Data (DI) Setup Time	0.19	0.23	ns
t_{DH}	Input Data (DI) Hold Time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to New Data Valid on DO (flow-through)	2.50	2.93	ns
t_{CKQ2}	Clock HIGH to New Data Valid on DO (pipelined)	0.95	1.11	ns
t_{RCKEF}	RCLK HIGH to Empty Flag Valid	1.82	2.14	ns
t_{WCKFF}	WCLK HIGH to Full Flag Valid	1.73	2.03	ns
t_{CKAF}	Clock HIGH to Almost Empty/Full Flag Valid	6.56	7.71	ns
t_{RSTFG}	RESET_B LOW to Empty/Full Flag Valid	1.79	2.11	ns
t_{RSTAF}	RESET_B LOW to Almost Empty/Full Flag Valid	6.49	7.63	ns
t_{RSTBQ}	RESET_B LOW to Data Out LOW on DO (flow-through)	0.98	1.15	ns
	RESET_B LOW to Data Out LOW on DO (pipelined)	0.98	1.15	ns
$t_{REMRSTB}$	RESET_B Removal	0.30	0.36	ns
$t_{RECRSTB}$	RESET_B Recovery	1.59	1.87	ns
$t_{MPWRSTB}$	RESET_B Minimum Pulse Width	0.59	0.67	ns
t_{CYC}	Clock Cycle Time	5.39	6.20	ns
F_{MAX}	Maximum Frequency for FIFO	185	161	MHz

Note: For specific junction temperature and voltage supply levels, refer to [Table 2-5 on page 2-8](#) for derating values.

Embedded FlashROM Characteristics

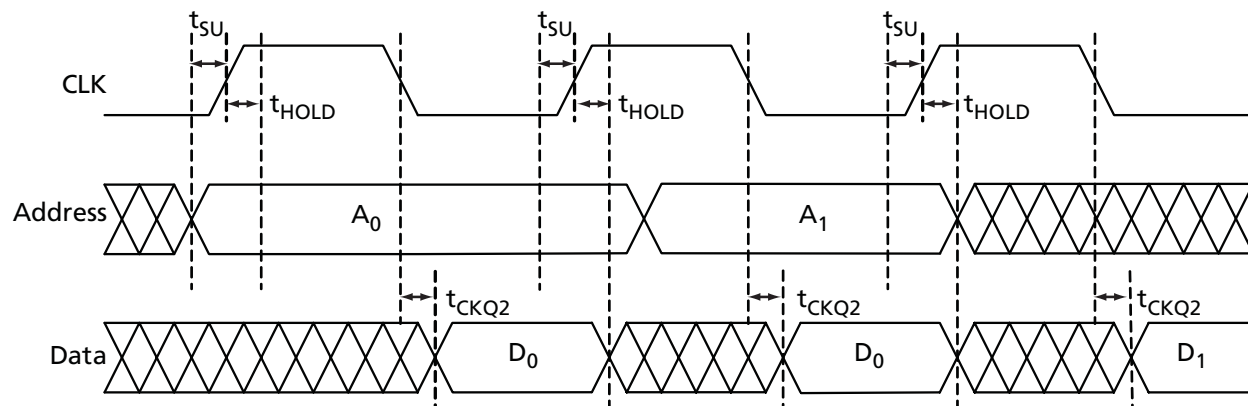


Figure 2-57 • Timing Diagram

Timing Characteristics

Table 2-140 • Embedded FlashROM Access Time

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{SU}	Address Setup Time	0.74	0.87	ns
t_{HOLD}	Address Hold Time	0.00	0.00	ns
t_{CKQ2}	Clock to Out	22.47	26.42	ns
F_{MAX}	Maximum Clock Frequency	15	15	MHz

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-141 • Embedded FlashROM Access Time

Military-Case Conditions: $T_J = 125^{\circ}\text{C}$, $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{SU}	Address Setup Time	0.56	0.66	ns
t_{HOLD}	Address Hold Time	0.00	0.00	ns
t_{CKQ2}	Clock to Out	17.19	20.21	ns
F_{MAX}	Maximum Clock Frequency	15	15	MHz

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

JTAG 1532 Characteristics

JTAG timing delays do not include JTAG I/Os. To obtain complete JTAG timing, add I/O buffer delays to the corresponding standard selected; refer to the I/O timing characteristics in the "User I/O Characteristics" section on page 2-18 for more details.

Timing Characteristics

Table 2-142 • JTAG 1532

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.14\text{ V}$

Parameter	Description	–1	Std.	Units
t_{DISU}	Test Data Input Setup Time	0.80	0.94	ns
t_{DIHD}	Test Data Input Hold Time	1.60	1.88	ns
t_{TMSU}	Test Mode Select Setup Time	0.80	0.94	ns
t_{TMDHD}	Test Mode Select Hold Time	1.60	1.88	ns
t_{TCK2Q}	Clock to Q (data out)	6.39	7.52	ns
t_{RSTB2Q}	Reset to Q (data out)	26.63	31.33	ns
F_{TCKMAX}	TCK Maximum Frequency	18.70	15.90	MHz
t_{TRSTREM}	ResetB Removal Time	0.48	0.56	ns
t_{TRSTREC}	ResetB Recovery Time	0.00	0.00	ns
t_{TRSTMPW}	ResetB Minimum Pulse	TBD	TBD	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Table 2-143 • JTAG 1532

Military-Case Conditions: $T_J = 125^\circ\text{C}$, Worst-Case $V_{CC} = 1.425\text{ V}$

Parameter	Description	–1	Std.	Units
t_{DISU}	Test Data Input Setup Time	0.60	0.71	ns
t_{DIHD}	Test Data Input Hold Time	1.21	1.42	ns
t_{TMSU}	Test Mode Select Setup Time	0.60	0.71	ns
t_{TMDHD}	Test Mode Select Hold Time	1.21	1.42	ns
t_{TCK2Q}	Clock to Q (data out)	6.04	7.10	ns
t_{RSTB2Q}	Reset to Q (data out)	24.15	28.41	ns
F_{TCKMAX}	TCK Maximum Frequency	22.00	19.00	MHz
t_{TRSTREM}	ResetB Removal Time	0.00	0.00	ns
t_{TRSTREC}	ResetB Recovery Time	0.24	0.28	ns
t_{TRSTMPW}	ResetB Minimum Pulse	TBD	TBD	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-5 on page 2-8 for derating values.

Part Number and Revision Date

Part Number 51700107-002-0

Revised September 2008

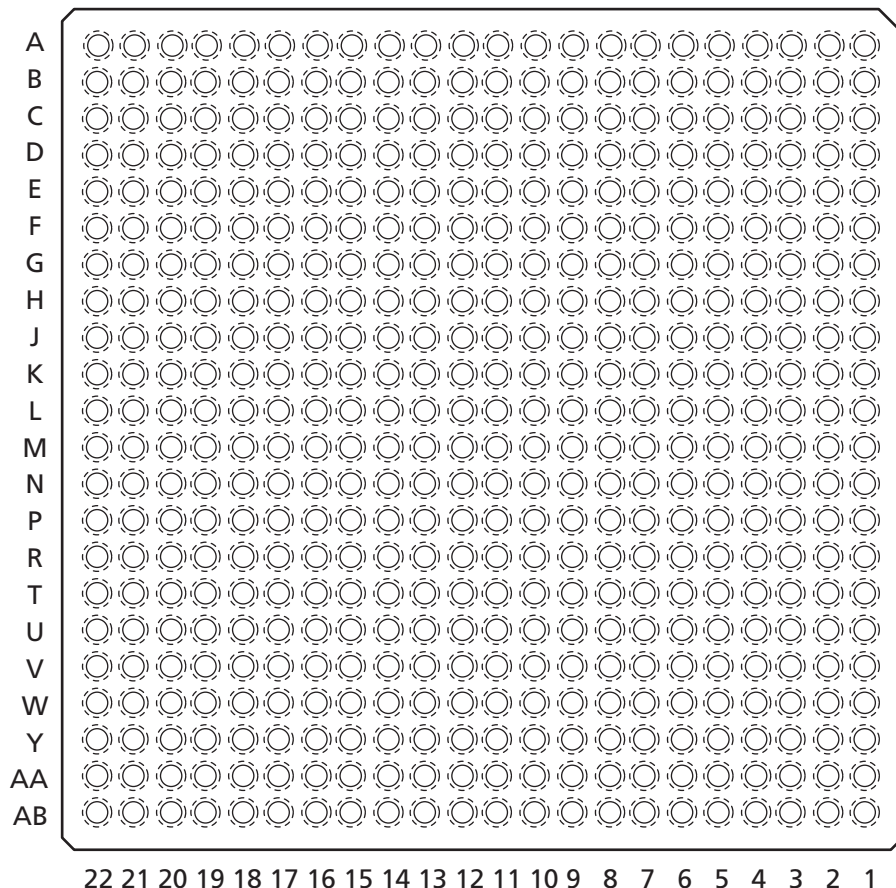
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3 – Package Pin Assignments

484-Pin CCGA



Note: This is the bottom view of the package.

Note

For Package Manufacturing and Environmental information, visit the Resource Center at <http://www.actel.com/products/solutions/package/docs.aspx>.

484-Pin CCGA	
Pin Number	RT3PE600L
A1	GND
A2	GND
A3	V _{CC} B0
A4	IO06NDB0V1
A5	IO06PDB0V1
A6	IO08NDB0V1
A7	IO08PDB0V1
A8	IO11PDB0V1
A9	IO17PDB0V2
A10	IO18NDB0V2
A11	IO18PDB0V2
A12	IO22PDB1V0
A13	IO26PDB1V0
A14	IO29NDB1V1
A15	IO29PDB1V1
A16	IO31NDB1V1
A17	IO31PDB1V1
A18	IO32NDB1V1
A19	NC
A20	V _{CC} B1
A21	GND
A22	GND
AA1	GND
AA2	V _{CC} B6
AA3	NC
AA4	IO98PDB5V2
AA5	IO96NDB5V2
AA6	IO96PDB5V2
AA7	IO86NDB5V0
AA8	IO86PDB5V0
AA9	IO85PDB5V0
AA10	IO85NDB5V0
AA11	IO78PPB4V1
AA12	IO79NDB4V1
AA13	IO79PDB4V1
AA14	NC

484-Pin CCGA	
Pin Number	RT3PE600L
AA15	NC
AA16	IO71NDB4V0
AA17	IO71PDB4V0
AA18	NC
AA19	NC
AA20	NC
AA21	V _{CC} B3
AA22	GND
AB1	GND
AB2	GND
AB3	V _{CC} B5
AB4	IO97NDB5V2
AB5	IO97PDB5V2
AB6	IO93NDB5V1
AB7	IO93PDB5V1
AB8	IO87NDB5V0
AB9	IO87PDB5V0
AB10	NC
AB11	NC
AB12	IO75NDB4V1
AB13	IO75PDB4V1
AB14	IO72NDB4V0
AB15	IO72PDB4V0
AB16	IO73NDB4V0
AB17	IO73PDB4V0
AB18	NC
AB19	NC
AB20	V _{CC} B4
AB21	GND
AB22	GND
B1	GND
B2	V _{CC} B7
B3	NC
B4	IO03NDB0V0
B5	IO03PDB0V0
B6	IO07NDB0V1

484-Pin CCGA	
Pin Number	RT3PE600L
B7	IO07PDB0V1
B8	IO11NDB0V1
B9	IO17NDB0V2
B10	IO14PDB0V2
B11	IO19PDB0V2
B12	IO22NDB1V0
B13	IO26NDB1V0
B14	NC
B15	NC
B16	IO30NDB1V1
B17	IO30PDB1V1
B18	IO32PDB1V1
B19	NC
B20	NC
B21	V _{CC} B2
B22	GND
C1	V _{CC} B7
C2	NC
C3	NC
C4	NC
C5	GND
C6	IO04NDB0V0
C7	IO04PDB0V0
C8	V _{CC}
C9	V _{CC}
C10	IO14NDB0V2
C11	IO19NDB0V2
C12	NC
C13	NC
C14	V _{CC}
C15	V _{CC}
C16	NC
C17	NC
C18	GND
C19	NC
C20	NC

484-Pin CCGA	
Pin Number	RT3PE600L
C21	NC
C22	V _{CC} B2
D1	NC
D2	NC
D3	NC
D4	GND
D5	GAA0/IO00NDB0V0
D6	GAA1/IO00PDB0V0
D7	GAB0/IO01NDB0V0
D8	IO05PDB0V0
D9	IO10PDB0V1
D10	IO12PDB0V2
D11	IO16NDB0V2
D12	IO23NDB1V0
D13	IO23PDB1V0
D14	IO28NDB1V1
D15	IO28PDB1V1
D16	GBB1/IO34PDB1V1
D17	GBA0/IO35NDB1V1
D18	GBA1/IO35PDB1V1
D19	GND
D20	NC
D21	NC
D22	NC
E1	NC
E2	NC
E3	GND
E4	GAB2/IO133PDB7V1
E5	GAA2/IO134PDB7V1
E6	GNDQ

484-Pin CCGA	
Pin Number	RT3PE600L
E7	GAB1/IO01PDB0V0
E8	IO05NDB0V0
E9	IO10NDB0V1
E10	IO12NDB0V2
E11	IO16PDB0V2
E12	IO20NDB1V0
E13	IO24NDB1V0
E14	IO24PDB1V0
E15	GBC1/IO33PDB1V1
E16	GBB0/IO34NDB1V1
E17	GNDQ
E18	GBA2/IO36PDB2V0
E19	IO42NDB2V0
E20	GND
E21	NC
E22	NC
F1	NC
F2	IO131NDB7V1
F3	IO131PDB7V1
F4	IO133NDB7V1
F5	IO134NDB7V1
F6	VMV7
F7	V _{CC} PLA
F8	GAC0/IO02NDB0V0
F9	GAC1/IO02PDB0V0
F10	IO15NDB0V2
F11	IO15PDB0V2
F12	IO20PDB1V0
F13	IO25NDB1V0
F14	IO27PDB1V0
F15	GBC0/IO33NDB1V1
F16	V _{CC} PLB

484-Pin CCGA	
Pin Number	RT3PE600L
F17	VMV2
F18	IO36NDB2V0
F19	IO42PDB2V0
F20	NC
F21	NC
F22	NC
G1	IO127NDB7V1
G2	IO127PDB7V1
G3	NC
G4	IO128PDB7V1
G5	IO129PDB7V1
G6	GAC2/IO132PDB7V1
G7	V _{COM} PLA
G8	GNDQ
G9	IO09NDB0V1
G10	IO09PDB0V1
G11	IO13PDB0V2
G12	IO21PDB1V0
G13	IO25PDB1V0
G14	IO27NDB1V0
G15	GNDQ
G16	V _{COM} PLB
G17	GBB2/IO37PDB2V0
G18	IO39PDB2V0
G19	IO39NDB2V0
G20	IO43PDB2V0
G21	IO43NDB2V0
G22	NC
H1	NC
H2	NC
H3	V _{CC}
H4	IO128NDB7V1
H5	IO129NDB7V1
H6	IO132NDB7V1
H7	IO130PDB7V1

484-Pin CCGA	
Pin Number	RT3PE600L
H8	VMV0
H9	V _{CCI} B0
H10	V _{CCI} B0
H11	IO13NDB0V2
H12	IO21NDB1V0
H13	V _{CCI} B1
H14	V _{CCI} B1
H15	VMV1
H16	GBC2/IO38PDB2V0
H17	IO37NDB2V0
H18	IO41NDB2V0
H19	IO41PDB2V0
H20	V _{CC}
H21	NC
H22	NC
J1	IO123NDB7V0
J2	IO123PDB7V0
J3	NC
J4	IO124PDB7V0
J5	IO125PDB7V0
J6	IO126PDB7V0
J7	IO130NDB7V1
J8	V _{CCI} B7
J9	GND
J10	V _{CC}
J11	V _{CC}
J12	V _{CC}
J13	V _{CC}
J14	GND
J15	V _{CCI} B2
J16	IO38NDB2V0
J17	IO40NDB2V0
J18	IO40PDB2V0
J19	IO45PPB2V1
J20	NC
J21	IO48PDB2V1

484-Pin CCGA	
Pin Number	RT3PE600L
J22	IO46PDB2V1
K1	IO121NDB7V0
K2	IO121PDB7V0
K3	NC
K4	IO124NDB7V0
K5	IO125NDB7V0
K6	IO126NDB7V0
K7	GFC1/IO120PPB7V0
K8	V _{CCI} B7
K9	V _{CC}
K10	GND
K11	GND
K12	GND
K13	GND
K14	V _{CC}
K15	V _{CCI} B2
K16	GCC1/IO50PPB2V1
K17	IO44NDB2V1
K18	IO44PDB2V1
K19	IO49NPB2V1
K20	IO45NPB2V1
K21	IO48NDB2V1
K22	IO46NDB2V1
L1	NC
L2	IO122PDB7V0
L3	IO122NDB7V0
L4	GFB0/IO119NPB7V0
L5	GFA0/IO118NDB6V1
L6	GFB1/IO119PPB7V0
L7	V _{COMPLF}
L8	GFC0/IO120NPB7V0
L9	V _{CC}

484-Pin CCGA	
Pin Number	RT3PE600L
L10	GND
L11	GND
L12	GND
L13	GND
L14	V _{CC}
L15	GCC0/IO50NPB2V1
L16	GCB1/IO51PPB2V1
L17	GCA0/IO52NPB3V0
L18	V _{COMPLC}
L19	GCB0/IO51NPB2V1
L20	IO49PPB2V1
L21	IO47NDB2V1
L22	IO47PDB2V1
M1	NC
M2	IO114NPB6V1
M3	IO117NDB6V1
M4	GFA2/IO117PDB6V1
M5	GFA1/IO118PDB6V1
M6	V _{CCPLF}
M7	IO116NDB6V1
M8	GFB2/IO116PDB6V1
M9	V _{CC}
M10	GND
M11	GND
M12	GND
M13	GND
M14	V _{CC}
M15	GCB2/IO54PPB3V0
M16	GCA1/IO52PPB3V0
M17	GCC2/IO55PPB3V0
M18	V _{CCPLC}
M19	GCA2/IO53PDB3V0

484-Pin CCGA	
Pin Number	RT3PE600L
M20	IO53NDB3V0
M21	IO56PDB3V0
M22	NC
N1	IO114PPB6V1
N2	IO111NDB6V1
N3	NC
N4	GFC2/IO115PPB6V1
N5	IO113PPB6V1
N6	IO112PDB6V1
N7	IO112NDB6V1
N8	V _{CC} B6
N9	V _{CC}
N10	GND
N11	GND
N12	GND
N13	GND
N14	V _{CC}
N15	V _{CC} B3
N16	IO54NPB3V0
N17	IO57NPB3V0
N18	IO55NPB3V0
N19	IO57PPB3V0
N20	NC
N21	IO56NDB3V0
N22	IO58PDB3V0
P1	NC
P2	IO111PDB6V1
P3	IO115NPB6V1
P4	IO113NPB6V1
P5	IO109PPB6V0
P6	IO108PDB6V0
P7	IO108NDB6V0
P8	V _{CC} B6
P9	GND
P10	V _{CC}

484-Pin CCGA	
Pin Number	RT3PE600L
P11	V _{CC}
P12	V _{CC}
P13	V _{CC}
P14	GND
P15	V _{CC} B3
P16	GDB0/IO66NPB3V1
P17	IO60NDB3V1
P18	IO60PDB3V1
P19	IO61PDB3V1
P20	NC
P21	IO59PDB3V0
P22	IO58NDB3V0
R1	NC
R2	IO110PDB6V0
R3	V _{CC}
R4	IO109NPB6V0
R5	IO106NDB6V0
R6	IO106PDB6V0
R7	GEC0/IO104NPB6V0
R8	VMV5
R9	V _{CC} B5
R10	V _{CC} B5
R11	IO84NDB5V0
R12	IO84PDB5V0
R13	V _{CC} B4
R14	V _{CC} B4
R15	VMV3
R16	V _{CC} PLD
R17	GDB1/IO66PPB3V1
R18	GDC1/IO65PDB3V1
R19	IO61NDB3V1
R20	V _{CC}
R21	IO59NDB3V0
R22	IO62PDB3V1

484-Pin CCGA	
Pin Number	RT3PE600L
T1	NC
T2	IO110NDB6V0
T3	NC
T4	IO105PDB6V0
T5	IO105NDB6V0
T6	GEC1/IO104PPB6V0
T7	V _{CC} PLE
T8	GNDQ
T9	GEA2/IO101PPB5V2
T10	IO92NDB5V1
T11	IO90NDB5V1
T12	IO82NDB5V0
T13	IO74NDB4V1
T14	IO74PDB4V1
T15	GNDQ
T16	V _{CC} PLD
T17	V _{JTAG}
T18	GDC0/IO65NDB3V1
T19	GDA1/IO67PDB3V1
T20	NC
T21	IO64PDB3V1
T22	IO62NDB3V1
U1	NC
U2	IO107PDB6V0
U3	IO107NDB6V0
U4	GEB1/IO103PDB6V0
U5	GEB0/IO103NDB6V0
U6	VMV6
U7	V _{CC} PLE
U8	IO101NPB5V2
U9	IO95PPB5V1
U10	IO92PDB5V1

484-Pin CCGA	
Pin Number	RT3PE600L
U11	IO90PDB5V1
U12	IO82PDB5V0
U13	IO76NDB4V1
U14	IO76PDB4V1
U15	VMV4
U16	TCK
U17	V _{PUMP}
U18	TRST
U19	GDA0/IO67NDB3V1
U20	NC
U21	IO64NDB3V1
U22	IO63PDB3V1
V1	NC
V2	NC
V3	GND
V4	GEA1/IO102PDB6V0
V5	GEA0/IO102NDB6V0
V6	GNDQ
V7	GEC2/IO99PDB5V2
V8	IO95NPB5V1
V9	IO91NDB5V1
V10	IO91PDB5V1
V11	IO83NDB5V0
V12	IO83PDB5V0
V13	IO77NDB4V1
V14	IO77PDB4V1
V15	IO69NDB4V0
V16	GDB2/IO69PDB4V0
V17	TDI
V18	GNDQ
V19	TDO
V20	GND
V21	NC

484-Pin CCGA	
Pin Number	RT3PE600L
V22	IO63NDB3V1
W1	NC
W2	NC
W3	NC
W4	GND
W5	IO100NDB5V2
W6	FF/GEB2/IO100PDB5V2
W7	IO99NDB5V2
W8	IO88NDB5V0
W9	IO88PDB5V0
W10	IO89NDB5V0
W11	IO80NDB4V1
W12	IO81NDB4V1
W13	IO81PDB4V1
W14	IO70NDB4V0
W15	GDC2/IO70PDB4V0
W16	IO68NDB4V0
W17	GDA2/IO68PDB4V0
W18	TMS
W19	GND
W20	NC
W21	NC
W22	NC
Y1	V _{CCI} B6
Y2	NC
Y3	NC
Y4	IO98NDB5V2
Y5	GND
Y6	IO94NDB5V1
Y7	IO94PDB5V1
Y8	V _{CC}
Y9	V _{CC}
Y10	IO89PDB5V0
Y11	IO80PDB4V1

484-Pin CCGA	
Pin Number	RT3PE600L
Y12	IO78NPB4V1
Y13	NC
Y14	V _{CC}
Y15	V _{CC}
Y16	NC
Y17	NC
Y18	GND
Y19	NC
Y20	NC
Y21	NC
Y22	V _{CCI} B3

484-Pin CCGA	
Pin Number	RT3PE3000L Function
A1	GND
A2	GND
A3	V _{CC} I B0
A4	IO10NDB0V1
A5	IO10PDB0V1
A6	IO16NDB0V1
A7	IO16PDB0V1
A8	IO18PDB0V2
A9	IO24PDB0V2
A10	IO28NDB0V3
A11	IO28PDB0V3
A12	IO46PDB1V0
A13	IO54PDB1V1
A14	IO56NDB1V1
A15	IO56PDB1V1
A16	IO64NDB1V2
A17	IO64PDB1V2
A18	IO72NDB1V3
A19	IO74NDB1V4
A20	V _{CC} I B1
A21	GND
A22	GND
AA1	GND
AA2	V _{CC} I B6
AA3	IO228PDB5V4
AA4	IO224PDB5V3
AA5	IO218NDB5V3
AA6	IO218PDB5V3
AA7	IO212NDB5V2
AA8	IO212PDB5V2
AA9	IO198PDB5V0
AA10	IO198NDB5V0
AA11	IO188PPB4V4
AA12	IO180NDB4V3
AA13	IO180PDB4V3
AA14	IO170NDB4V2

484-Pin CCGA	
Pin Number	RT3PE3000L Function
AA15	IO170PDB4V2
AA16	IO166NDB4V1
AA17	IO166PDB4V1
AA18	IO160NDB4V0
AA19	IO160PDB4V0
AA20	IO158NPB4V0
AA21	V _{CC} I B3
AA22	GND
AB1	GND
AB2	GND
AB3	V _{CC} I B5
AB4	IO216NDB5V2
AB5	IO216PDB5V2
AB6	IO210NDB5V2
AB7	IO210PDB5V2
AB8	IO208NDB5V1
AB9	IO208PDB5V1
AB10	IO197NDB5V0
AB11	IO197PDB5V0
AB12	IO174NDB4V2
AB13	IO174PDB4V2
AB14	IO172NDB4V2
AB15	IO172PDB4V2
AB16	IO168NDB4V1
AB17	IO168PDB4V1
AB18	IO162NDB4V1
AB19	IO162PDB4V1
AB20	V _{CC} I B4
AB21	GND
AB22	GND
B1	GND
B2	V _{CC} I B7
B3	IO06PPB0V0
B4	IO08NDB0V0
B5	IO08PDB0V0
B6	IO14NDB0V1

484-Pin CCGA	
Pin Number	RT3PE3000L Function
B7	IO14PDB0V1
B8	IO18NDB0V2
B9	IO24NDB0V2
B10	IO34PDB0V4
B11	IO40PDB0V4
B12	IO46NDB1V0
B13	IO54NDB1V1
B14	IO62NDB1V2
B15	IO62PDB1V2
B16	IO68NDB1V3
B17	IO68PDB1V3
B18	IO72PDB1V3
B19	IO74PDB1V4
B20	IO76NPB1V4
B21	V _{CC} I B2
B22	GND
C1	V _{CC} I B7
C2	IO303PDB7V3
C3	IO305PDB7V3
C4	IO06NPB0V0
C5	GND
C6	IO12NDB0V1
C7	IO12PDB0V1
C8	V _{CC}
C9	V _{CC}
C10	IO34NDB0V4
C11	IO40NDB0V4
C12	IO48NDB1V0
C13	IO48PDB1V0
C14	V _{CC}
C15	V _{CC}
C16	IO70NDB1V3
C17	IO70PDB1V3
C18	GND
C19	IO76PPB1V4
C20	IO88NDB2V0

484-Pin CCGA	
Pin Number	RT3PE3000L Function
C21	IO94PPB2V1
C22	V _{CC} B2
D1	IO293PDB7V2
D2	IO303NDB7V3
D3	IO305NDB7V3
D4	GND
D5	GAA0/IO00NDB0V0
D6	GAA1/IO00PDB0V0
D7	GAB0/IO01NDB0V0
D8	IO20PDB0V2
D9	IO22PDB0V2
D10	IO30PDB0V3
D11	IO38NDB0V4
D12	IO52NDB1V1
D13	IO52PDB1V1
D14	IO66NDB1V3
D15	IO66PDB1V3
D16	GBB1/IO80PDB1V4
D17	GBA0/IO81NDB1V4
D18	GBA1/IO81PDB1V4
D19	GND
D20	IO88PDB2V0
D21	IO90PDB2V1
D22	IO94NPB2V1
E1	IO293NDB7V2
E2	IO299PPB7V3
E3	GND
E4	GAB2/IO308PDB7V4
E5	GAA2/IO309PDB7V4
E6	GNDQ
E7	GAB1/IO01PDB0V0
E8	IO20NDB0V2
E9	IO22NDB0V2
E10	IO30NDB0V3
E11	IO38PDB0V4
E12	IO44NDB1V0

484-Pin CCGA	
Pin Number	RT3PE3000L Function
E13	IO58NDB1V2
E14	IO58PDB1V2
E15	GBC1/IO79PDB1V4
E16	GBB0/IO80NDB1V4
E17	GNDQ
E18	GBA2/IO82PDB2V0
E19	IO86NDB2V0
E20	GND
E21	IO90NDB2V1
E22	IO98PDB2V2
F1	IO299NPB7V3
F2	IO301NDB7V3
F3	IO301PDB7V3
F4	IO308NDB7V4
F5	IO309NDB7V4
F6	VMV7
F7	V _{CC} PLA
F8	GAC0/IO02NDB0V0
F9	GAC1/IO02PDB0V0
F10	IO32NDB0V3
F11	IO32PDB0V3
F12	IO44PDB1V0
F13	IO50NDB1V1
F14	IO60PDB1V2
F15	GBC0/IO79NDB1V4
F16	V _{CC} PLB
F17	VMV2
F18	IO82NDB2V0
F19	IO86PDB2V0
F20	IO96PDB2V1
F21	IO96NDB2V1
F22	IO98NDB2V2
G1	IO289NDB7V1
G2	IO289PDB7V1
G3	IO291PPB7V2
G4	IO295PDB7V2

484-Pin CCGA	
Pin Number	RT3PE3000L Function
G5	IO297PDB7V2
G6	GAC2/IO307PDB7V4
G7	V _{COMPLA}
G8	GNDQ
G9	IO26NDB0V3
G10	IO26PDB0V3
G11	IO36PDB0V4
G12	IO42PDB1V0
G13	IO50PDB1V1
G14	IO60NDB1V2
G15	GNDQ
G16	V _{COMPLB}
G17	GBB2/IO83PDB2V0
G18	IO92PDB2V1
G19	IO92NDB2V1
G20	IO102PDB2V2
G21	IO102NDB2V2
G22	IO105NDB2V2
H1	IO286PSB7V1
H2	IO291NPB7V2
H3	V _{CC}
H4	IO295NDB7V2
H5	IO297NDB7V2
H6	IO307NDB7V4
H7	IO287PDB7V1
H8	VMV0
H9	V _{CC} B0
H10	V _{CC} B0
H11	IO36NDB0V4
H12	IO42NDB1V0
H13	V _{CC} B1
H14	V _{CC} B1
H15	VMV1
H16	GBC2/IO84PDB2V0
H17	IO83NDB2V0
H18	IO100NDB2V2

484-Pin CCGA	
Pin Number	RT3PE3000L Function
H19	IO100PDB2V2
H20	V _{CC}
H21	VMV2
H22	IO105PDB2V2
J1	IO285NDB7V1
J2	IO285PDB7V1
J3	VMV7
J4	IO279PDB7V0
J5	IO283PDB7V1
J6	IO281PDB7V0
J7	IO287NDB7V1
J8	V _{CCI} B7
J9	GND
J10	V _{CC}
J11	V _{CC}
J12	V _{CC}
J13	V _{CC}
J14	GND
J15	V _{CCI} B2
J16	IO84NDB2V0
J17	IO104NDB2V2
J18	IO104PDB2V2
J19	IO106PPB2V3
J20	GNDQ
J21	IO109PDB2V3
J22	IO107PDB2V3
K1	IO277NDB7V0
K2	IO277PDB7V0
K3	GNDQ
K4	IO279NDB7V0
K5	IO283NDB7V1
K6	IO281NDB7V0
K7	GFC1/IO275PPB7V0
K8	V _{CCI} B7
K9	V _{CC}
K10	GND

484-Pin CCGA	
Pin Number	RT3PE3000L Function
K11	GND
K12	GND
K13	GND
K14	V _{CC}
K15	V _{CCI} B2
K16	GCC1/IO112PPB2V3
K17	IO108NDB2V3
K18	IO108PDB2V3
K19	IO110NPB2V3
K20	IO106NPB2V3
K21	IO109NDB2V3
K22	IO107NDB2V3
L1	IO257PSB6V2
L2	IO276PDB7V0
L3	IO276NDB7V0
L4	GFB0/IO274NPB7V0
L5	GFA0/IO273NDB6V4
L6	GFB1/IO274PPB7V0
L7	V _{COMPLF}
L8	GFC0/IO275NPB7V0
L9	V _{CC}
L10	GND
L11	GND
L12	GND
L13	GND
L14	V _{CC}
L15	GCC0/IO112NPB2V3
L16	GCB1/IO113PPB2V3
L17	GCA0/IO114NPB3V0
L18	V _{COMPLC}
L19	GCB0/IO113NPB2V3
L20	IO110PPB2V3
L21	IO111NDB2V3
L22	IO111PDB2V3
M1	GNDQ
M2	IO255NPB6V2

484-Pin CCGA	
Pin Number	RT3PE3000L Function
M3	IO272NDB6V4
M4	GFA2/IO272PDB6V4
M5	GFA1/IO273PDB6V4
M6	V _{CCPLF}
M7	IO271NDB6V4
M8	GFB2/IO271PDB6V4
M9	V _{CC}
M10	GND
M11	GND
M12	GND
M13	GND
M14	V _{CC}
M15	GCB2/IO116PPB3V0
M16	GCA1/IO114PPB3V0
M17	GCC2/IO117PPB3V0
M18	V _{CCPLC}
M19	GCA2/IO115PDB3V0
M20	IO115NDB3V0
M21	IO126PDB3V1
M22	IO124PSB3V1
N1	IO255PPB6V2
N2	IO253NDB6V2
N3	VMV6
N4	GFC2/IO270PPB6V4
N5	IO261PPB6V3
N6	IO263PDB6V3
N7	IO263NDB6V3
N8	V _{CCI} B6
N9	V _{CC}
N10	GND
N11	GND
N12	GND
N13	GND
N14	V _{CC}
N15	V _{CCI} B3
N16	IO116NPB3V0

484-Pin CCGA	
Pin Number	RT3PE3000L Function
N17	IO132NPB3V2
N18	IO117NPB3V0
N19	IO132PPB3V2
N20	GNDQ
N21	IO126NDB3V1
N22	IO128PDB3V1
P1	IO247PDB6V1
P2	IO253PDB6V2
P3	IO270NPB6V4
P4	IO261NPB6V3
P5	IO249PPB6V1
P6	IO259PDB6V3
P7	IO259NDB6V3
P8	V _{CC} B6
P9	GND
P10	V _{CC}
P11	V _{CC}
P12	V _{CC}
P13	V _{CC}
P14	GND
P15	V _{CC} B3
P16	GDB0/IO152NPB3V4
P17	IO136NDB3V2
P18	IO136PDB3V2
P19	IO138PDB3V3
P20	VMV3
P21	IO130PDB3V2
P22	IO128NDB3V1
R1	IO247NDB6V1
R2	IO245PDB6V1
R3	V _{CC}
R4	IO249NPB6V1
R5	IO251NDB6V2
R6	IO251PDB6V2
R7	GEC0/IO236NPB6V0
R8	VMV5

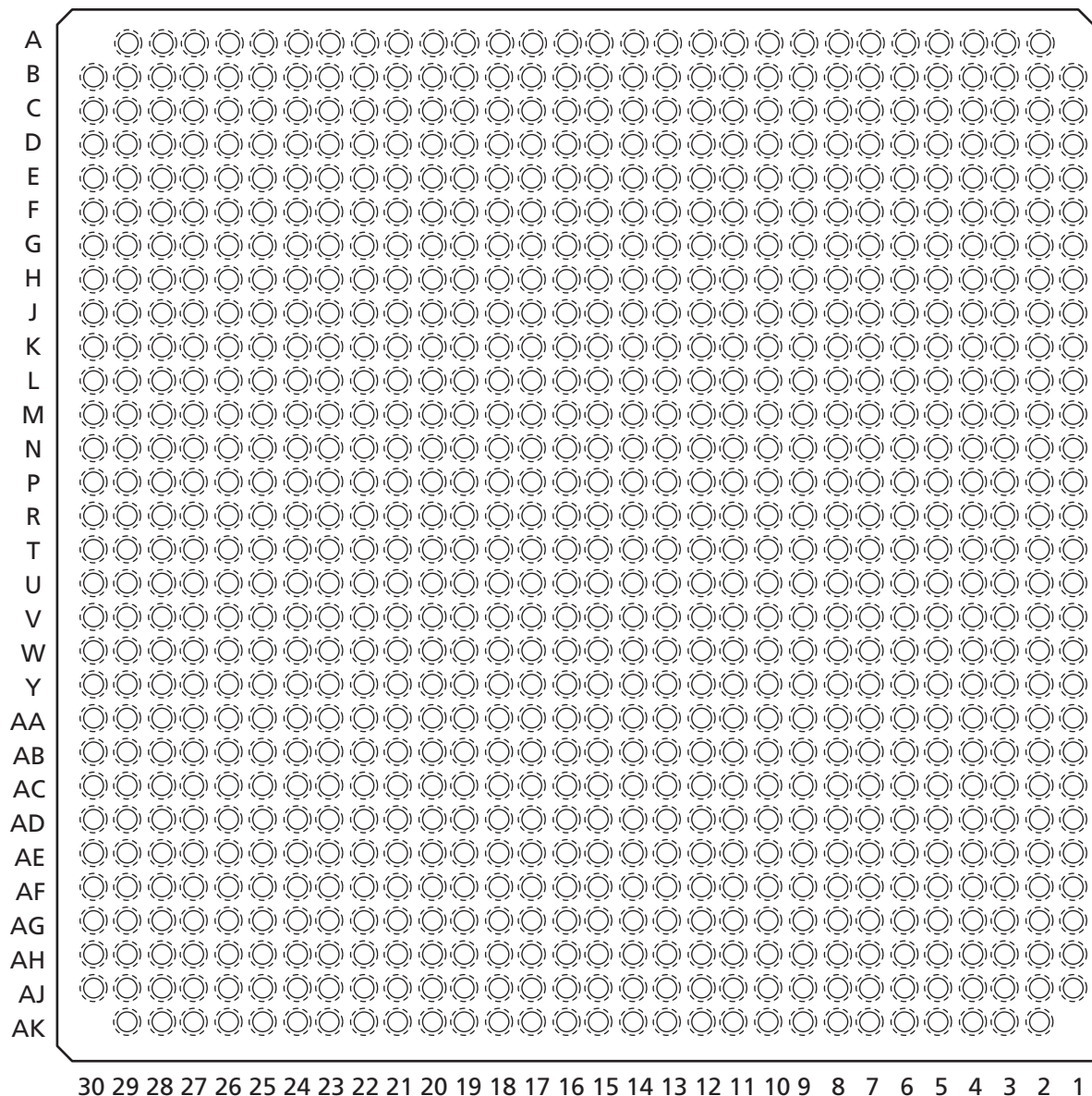
484-Pin CCGA	
Pin Number	RT3PE3000L Function
R9	V _{CC} B5
R10	V _{CC} B5
R11	IO196NDB5V0
R12	IO196PDB5V0
R13	V _{CC} B4
R14	V _{CC} B4
R15	VMV3
R16	V _{CC} PLD
R17	GDB1/IO152PPB3V4
R18	GDC1/IO151PDB3V4
R19	IO138NDB3V3
R20	V _{CC}
R21	IO130NDB3V2
R22	IO134PDB3V2
T1	IO243PPB6V1
T2	IO245NDB6V1
T3	IO243NPB6V1
T4	IO241PDB6V0
T5	IO241NDB6V0
T6	GEC1/IO236PPB6V0
T7	V _{CC} OMPLE
T8	GNDQ
T9	GEA2/IO233PPB5V4
T10	IO206NDB5V1
T11	IO202NDB5V1
T12	IO194NDB5V0
T13	IO186NDB4V4
T14	IO186PDB4V4
T15	GNDQ
T16	V _{CC} OMPLD
T17	V _{JTAG}
T18	GDC0/IO151NDB3V4
T19	GDA1/IO153PDB3V4
T20	IO144PDB3V3
T21	IO140PDB3V3
T22	IO134NDB3V2

484-Pin CCGA	
Pin Number	RT3PE3000L Function
U1	IO240PPB6V0
U2	IO238PDB6V0
U3	IO238NDB6V0
U4	GEB1/IO235PDB6V0
U5	GEB0/IO235NDB6V0
U6	VMV6
U7	V _{CC} PLE
U8	IO233NPB5V4
U9	IO222PPB5V3
U10	IO206PDB5V1
U11	IO202PDB5V1
U12	IO194PDB5V0
U13	IO176NDB4V2
U14	IO176PDB4V2
U15	VMV4
U16	TCK
U17	V _{PUMP}
U18	TRST
U19	GDA0/IO153NDB3V4
U20	IO144NDB3V3
U21	IO140NDB3V3
U22	IO142PDB3V3
V1	IO239PDB6V0
V2	IO240NPB6V0
V3	GND
V4	GEA1/IO234PDB6V0
V5	GEA0/IO234NDB6V0
V6	GNDQ
V7	GEC2/IO231PDB5V4
V8	IO222NPB5V3
V9	IO204NDB5V1
V10	IO204PDB5V1
V11	IO195NDB5V0
V12	IO195PDB5V0
V13	IO178NDB4V3
V14	IO178PDB4V3

484-Pin CCGA	
Pin Number	RT3PE3000L Function
V15	IO155NDB4V0
V16	GDB2/IO155PDB4V0
V17	TDI
V18	GNDQ
V19	TDO
V20	GND
V21	IO146PDB3V4
V22	IO142NDB3V3
W1	IO239NDB6V0
W2	IO237PDB6V0
W3	IO230PSB5V4
W4	GND
W5	IO232NDB5V4
W6	FF/GE2/IO232PDB5V4
W7	IO231NDB5V4
W8	IO214NDB5V2
W9	IO214PDB5V2
W10	IO200NDB5V0
W11	IO192NDB4V4
W12	IO184NDB4V3
W13	IO184PDB4V3
W14	IO156NDB4V0
W15	GDC2/IO156PDB4V0
W16	IO154NDB4V0
W17	GDA2/IO154PDB4V0
W18	TMS
W19	GND
W20	IO150NDB3V4
W21	IO146NDB3V4
W22	IO148PPB3V4
Y1	V _{CC} B6
Y2	IO237NDB6V0
Y3	IO228NDB5V4
Y4	IO224NDB5V3
Y5	GND

484-Pin CCGA	
Pin Number	RT3PE3000L Function
Y6	IO220NDB5V3
Y7	IO220PDB5V3
Y8	V _{CC}
Y9	V _{CC}
Y10	IO200PDB5V0
Y11	IO192PDB4V4
Y12	IO188NPB4V4
Y13	IO187PSB4V4
Y14	V _{CC}
Y15	V _{CC}
Y16	IO164NDB4V1
Y17	IO164PDB4V1
Y18	GND
Y19	IO158PPB4V0
Y20	IO150PDB3V4
Y21	IO148NPB3V4
Y22	V _{CC} B3

896-Pin CCGA



Note: This is the bottom view.

Note

For Package Manufacturing and Environmental information, visit the Resource Center at <http://www.actel.com/products/solutions/package/docs.aspx>.

896-CCGA		896-CCGA		896-CCGA	
Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
A2	GND	AA9	GEB1/IO235PPB6V0	AB15	IO198PDB5V0
A3	GND	AA10	V _{CC}	AB16	IO192NDB4V4
A4	IO14NPB0V1	AA11	IO226PPB5V4	AB17	IO192PDB4V4
A5	GND	AA12	V _{CC} B5	AB18	IO178NDB4V3
A6	IO07NPB0V0	AA13	V _{CC} B5	AB19	IO178PDB4V3
A7	GND	AA14	V _{CC} B5	AB20	IO174NDB4V2
A8	IO09NDB0V1	AA15	V _{CC} B5	AB21	IO162NPB4V1
A9	IO17NDB0V2	AA16	V _{CC} B4	AB22	V _{CC}
A10	IO17PDB0V2	AA17	V _{CC} B4	AB23	V _{CC} PLD
A11	IO21NDB0V2	AA18	V _{CC} B4	AB24	V _{CC} B3
A12	IO21PDB0V2	AA19	V _{CC} B4	AB25	IO150PDB3V4
A13	IO33NDB0V4	AA20	IO174PDB4V2	AB26	IO148PDB3V4
A14	IO33PDB0V4	AA21	V _{CC}	AB27	IO147NDB3V4
A15	IO35NDB0V4	AA22	IO142NPB3V3	AB28	IO145PDB3V3
A16	IO35PDB0V4	AA23	IO144NDB3V3	AB29	IO143PDB3V3
A17	IO41NDB1V0	AA24	IO144PDB3V3	AB30	IO137PDB3V2
A18	IO43NDB1V0	AA25	IO146NDB3V4	AC1	IO254PDB6V2
A19	IO43PDB1V0	AA26	IO146PDB3V4	AC2	IO254NDB6V2
A20	IO45NDB1V0	AA27	IO147PDB3V4	AC3	IO240PDB6V0
A21	IO45PDB1V0	AA28	IO139NDB3V3	AC4	GEC1/IO236PDB6V0
A22	IO57NDB1V2	AA29	IO139PDB3V3	AC5	IO237PDB6V0
A23	IO57PDB1V2	AA30	IO133NDB3V2	AC6	IO237NDB6V0
A24	GND	AB1	IO256NDB6V2	AC7	V _{COMPLE}
A25	IO69PPB1V3	AB2	IO244PDB6V1	AC8	GND
A26	GND	AB3	IO244NDB6V1	AC9	IO226NPB5V4
A27	GBC1/IO79PPB1V4	AB4	IO241PDB6V0	AC10	IO222NDB5V3
A28	GND	AB5	IO241NDB6V0	AC11	IO216NPB5V2
A29	GND	AB6	IO243NPB6V1	AC12	IO210NPB5V2
AA1	IO256PDB6V2	AB7	V _{CC} B6	AC13	IO204NDB5V1
AA2	IO248PDB6V1	AB8	V _{CC} PLE	AC14	IO204PDB5V1
AA3	IO248NDB6V1	AB9	V _{CC}	AC15	IO194NDB5V0
AA4	IO246NDB6V1	AB10	IO222PDB5V3	AC16	IO188NDB4V4
AA5	GEB1/IO234PDB6V0	AB11	IO218PPB5V3	AC17	IO188PDB4V4
AA6	GEB0/IO234NDB6V0	AB12	IO206NDB5V1	AC18	IO182PPB4V3
AA7	IO243PPB6V1	AB13	IO206PDB5V1	AC19	IO170NPB4V2
AA8	IO245NDB6V1	AB14	IO198NDB5V0	AC20	IO164NDB4V1

896-CCGA		896-CCGA		896-CCGA	
Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
AC21	IO164PDB4V1	AD27	GDA0/IO153NDB3V4	AF3	V _{CC} B6
AC22	IO162PPB4V1	AD28	GDC0/IO151NDB3V4	AF4	IO220NPB5V3
AC23	GND	AD29	GDC1/IO151PDB3V4	AF5	V _{CC}
AC24	V _{COMPLD}	AD30	GND	AF6	IO228NDB5V4
AC25	IO150NDB3V4	AE1	IO242PPB6V1	AF7	V _{CC} B5
AC26	IO148NDB3V4	AE2	V _{CC}	AF8	IO230PDB5V4
AC27	GDA1/IO153PDB3V4	AE3	IO239PDB6V0	AF9	IO229NDB5V4
AC28	IO145NDB3V3	AE4	IO239NDB6V0	AF10	IO229PDB5V4
AC29	IO143NDB3V3	AE5	VMV6	AF11	IO214PPB5V2
AC30	IO137NDB3V2	AE6	GND	AF12	IO208NDB5V1
AD1	GND	AE7	GNDQ	AF13	IO208PDB5V1
AD2	IO242NPB6V1	AE8	IO230NDB5V4	AF14	IO200PDB5V0
AD3	IO240NDB6V0	AE9	IO224NPB5V3	AF15	IO196NDB5V0
AD4	GEC0/IO236NDB6V0	AE10	IO214NPB5V2	AF16	IO186NDB4V4
AD5	V _{CC} B6	AE11	IO212NDB5V2	AF17	IO186PDB4V4
AD6	GNDQ	AE12	IO212PDB5V2	AF18	IO180NDB4V3
AD7	V _{CC}	AE13	IO202NPB5V1	AF19	IO180PDB4V3
AD8	VMV5	AE14	IO200NDB5V0	AF20	IO168NDB4V1
AD9	V _{CC} B5	AE15	IO196PDB5V0	AF21	IO168PDB4V1
AD10	IO224PPB5V3	AE16	IO190NDB4V4	AF22	IO160NDB4V0
AD11	IO218NPB5V3	AE17	IO184PDB4V3	AF23	IO158NPB4V0
AD12	IO216PPB5V2	AE18	IO184NDB4V3	AF24	V _{CC} B4
AD13	IO210PPB5V2	AE19	IO172PDB4V2	AF25	IO154NPB4V0
AD14	IO202PPB5V1	AE20	IO172NDB4V2	AF26	V _{CC}
AD15	IO194PDB5V0	AE21	IO166NDB4V1	AF27	TDO
AD16	IO190PDB4V4	AE22	IO160PDB4V0	AF28	V _{CC} B3
AD17	IO182NPB4V3	AE23	GNDQ	AF29	GNDQ
AD18	IO176NDB4V2	AE24	VMV4	AF30	GND
AD19	IO176PDB4V2	AE25	GND	AG1	IO238NPB6V0
AD20	IO170PPB4V2	AE26	GDB0/IO152NDB3V4	AG2	V _{CC}
AD21	IO166PDB4V1	AE27	GDB1/IO152PDB3V4	AG3	IO232NPB5V4
AD22	V _{CC} B4	AE28	VMV3	AG4	GND
AD23	TCK	AE29	V _{CC}	AG5	IO220PPB5V3
AD24	V _{CC}	AE30	IO149PDB3V4	AG6	IO228PDB5V4
AD25	TRST	AF1	GND	AG7	IO231NDB5V4
AD26	V _{CC} B3	AF2	IO238PPB6V0	AG8	GEC2/IO231PDB5V4

896-CCGA		896-CCGA		896-CCGA	
Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
AG9	IO225NPB5V3	AH14	IO205PPB5V1	AJ20	IO173NDB4V2
AG10	IO223NPB5V3	AH15	IO195NDB5V0	AJ21	IO173PDB4V2
AG11	IO221PDB5V3	AH16	IO185NDB4V3	AJ22	IO163NDB4V1
AG12	IO221NDB5V3	AH17	IO185PDB4V3	AJ23	IO163PDB4V1
AG13	IO205NPB5V1	AH18	IO181PDB4V3	AJ24	IO167NPB4V1
AG14	IO199NDB5V0	AH19	IO177NDB4V2	AJ25	V _{CC}
AG15	IO199PDB5V0	AH20	IO171NPB4V2	AJ26	IO156NPB4V0
AG16	IO187NDB4V4	AH21	IO165PPB4V1	AJ27	V _{CC}
AG17	IO187PDB4V4	AH22	IO161PPB4V0	AJ28	TMS
AG18	IO181NDB4V3	AH23	IO157NDB4V0	AJ29	GND
AG19	IO171PPB4V2	AH24	IO157PDB4V0	AJ30	GND
AG20	IO165NPB4V1	AH25	IO155NDB4V0	AK2	GND
AG21	IO161NPB4V0	AH26	V _{CC} B4	AK3	GND
AG22	IO159NDB4V0	AH27	TDI	AK4	IO217PPB5V2
AG23	IO159PDB4V0	AH28	V _{CC}	AK5	GND
AG24	IO158PPB4V0	AH29	V _{PUMP}	AK6	IO215PPB5V2
AG25	GDB2/IO155PDB4V0	AH30	GND	AK7	GND
AG26	GDA2/IO154PPB4V0	AJ1	GND	AK8	IO207NDB5V1
AG27	GND	AJ2	GND	AK9	IO207PDB5V1
AG28	V _{JTAG}	AJ3	GEA2/IO233PPB5V4	AK10	IO201NDB5V0
AG29	V _{CC}	AJ4	V _{CC}	AK11	IO201PDB5V0
AG30	IO149NDB3V4	AJ5	IO217NPB5V2	AK12	IO193NDB4V4
AH1	GND	AJ6	V _{CC}	AK13	IO193PDB4V4
AH2	IO233NPB5V4	AJ7	IO215NPB5V2	AK14	IO197PDB5V0
AH3	V _{CC}	AJ8	IO213NDB5V2	AK15	IO191NDB4V4
AH4	FF/GEB2/IO232PPB5V4	AJ9	IO213PDB5V2	AK16	IO191PDB4V4
AH5	V _{CC} B5	AJ10	IO209NDB5V1	AK17	IO189NDB4V4
AH6	IO219NDB5V3	AJ11	IO209PDB5V1	AK18	IO189PDB4V4
AH7	IO219PDB5V3	AJ12	IO203NDB5V1	AK19	IO179PPB4V3
AH8	IO227NDB5V4	AJ13	IO203PDB5V1	AK20	IO175NDB4V2
AH9	IO227PDB5V4	AJ14	IO197NDB5V0	AK21	IO175PDB4V2
AH10	IO225PPB5V3	AJ15	IO195PDB5V0	AK22	IO169NDB4V1
AH11	IO223PPB5V3	AJ16	IO183NDB4V3	AK23	IO169PDB4V1
AH12	IO211NDB5V2	AJ17	IO183PDB4V3	AK24	GND
AH13	IO211PDB5V2	AJ18	IO179NPB4V3	AK25	IO167PPB4V1
		AJ19	IO177PDB4V2	AK26	GND

896-CCGA		896-CCGA		896-CCGA	
Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
AK27	GDC2/IO156PPB4V0	C4	GAA0/IO00NPB0V0	D10	IO11NDB0V1
AK28	GND	C5	V _{CC} B0	D11	IO11PDB0V1
AK29	GND	C6	IO03PDB0V0	D12	IO23NDB0V2
B1	GND	C7	IO03NDB0V0	D13	IO23PDB0V2
B2	GND	C8	GAB1/IO01PDB0V0	D14	IO27PDB0V3
B3	GAA2/IO309PPB7V4	C9	IO05PDB0V0	D15	IO40PDB0V4
B4	V _{CC}	C10	IO15NPB0V1	D16	IO47NDB1V0
B5	IO14PPB0V1	C11	IO25NDB0V3	D17	IO47PDB1V0
B6	V _{CC}	C12	IO25PDB0V3	D18	IO55NPB1V1
B7	IO07PPB0V0	C13	IO31NPB0V3	D19	IO65NDB1V3
B8	IO09PDB0V1	C14	IO27NDB0V3	D20	IO65PDB1V3
B9	IO15PPB0V1	C15	IO39NDB0V4	D21	IO71NDB1V3
B10	IO19NDB0V2	C16	IO39PDB0V4	D22	IO71PDB1V3
B11	IO19PDB0V2	C17	IO55PPB1V1	D23	IO73NDB1V4
B12	IO29NDB0V3	C18	IO51PDB1V1	D24	IO73PDB1V4
B13	IO29PDB0V3	C19	IO59NDB1V2	D25	IO74NDB1V4
B14	IO31PPB0V3	C20	IO63NDB1V2	D26	GGB0/IO80NPB1V4
B15	IO37NDB0V4	C21	IO63PDB1V2	D27	GND
B16	IO37PDB0V4	C22	IO67NDB1V3	D28	GBA0/IO81NPB1V4
B17	IO41PDB1V0	C23	IO67PDB1V3	D29	V _{CC}
B18	IO51NDB1V1	C24	IO75NDB1V4	D30	GBA2/IO82PPB2V0
B19	IO59PDB1V2	C25	IO75PDB1V4	E1	GND
B20	IO53PDB1V1	C26	V _{CC} B1	E2	IO303NPB7V3
B21	IO53NDB1V1	C27	IO64PPB1V2	E3	V _{CC} B7
B22	IO61NDB1V2	C28	V _{CC}	E4	IO305PPB7V3
B23	IO61PDB1V2	C29	GAB1/IO81PPB1V4	E5	V _{CC}
B24	IO69NPB1V3	C30	GND	E6	GAC0/IO02NDB0V0
B25	V _{CC}	D1	IO303PPB7V3	E7	V _{CC} B0
B26	GBC0/IO79NPB1V4	D2	V _{CC}	E8	IO06PPB0V0
B27	V _{CC}	D3	IO305NPB7V3	E9	IO24NDB0V2
B28	IO64NPB1V2	D4	GND	E10	IO24PDB0V2
B29	GND	D5	GAA1/IO00PPB0V0	E11	IO13NDB0V1
B30	GND	D6	GAC1/IO02PDB0V0	E12	IO13PDB0V1
C1	GND	D7	IO06NPB0V0	E13	IO34NDB0V4
C2	IO309NPB7V4	D8	GAB0/IO01NDB0V0	E14	IO34PDB0V4
C3	V _{CC}	D9	IO05NDB0V0	E15	IO40NDB0V4

896-CCGA		896-CCGA		896-CCGA	
Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
E16	IO49NDB1V1	F22	IO72NDB1V3	G28	IO92NDB2V1
E17	IO49PDB1V1	F23	IO72PDB1V3	G29	IO100PPB2V2
E18	IO50PDB1V1	F24	GNDQ	G30	GND
E19	IO58PDB1V2	F25	GND	H1	IO294PDB7V2
E20	IO60NDB1V2	F26	VMV2	H2	IO294NDB7V2
E21	IO77PDB1V4	F27	IO86PDB2V0	H3	IO300NDB7V3
E22	IO68NDB1V3	F28	IO92PDB2V1	H4	IO300PDB7V3
E23	IO68PDB1V3	F29	V _{CC}	H5	IO295PDB7V2
E24	V _{CC} B1	F30	IO100NPB2V2	H6	IO299PDB7V3
E25	IO74PDB1V4	G1	GND	H7	V _{COMPLA}
E26	V _{CC}	G2	IO296NPB7V2	H8	GND
E27	GBB1/IO80PPB1V4	G3	IO306NDB7V4	H9	IO08NDB0V0
E28	V _{CC} B2	G4	IO297NDB7V2	H10	IO08PDB0V0
E29	IO82NPB2V0	G5	V _{CC} B7	H11	IO18PDB0V2
E30	GND	G6	GNDQ	H12	IO26NPB0V3
F1	IO296PPB7V2	G7	V _{CC}	H13	IO28NDB0V3
F2	V _{CC}	G8	VMV0	H14	IO28PDB0V3
F3	IO306PDB7V4	G9	V _{CC} B0	H15	IO38PPB0V4
F4	IO297PDB7V2	G10	IO10NDB0V1	H16	IO42NDB1V0
F5	VMV7	G11	IO16NDB0V1	H17	IO52NDB1V1
F6	GND	G12	IO22PDB0V2	H18	IO52PDB1V1
F7	GNDQ	G13	IO26PPB0V3	H19	IO62NDB1V2
F8	IO12NDB0V1	G14	IO38NPB0V4	H20	IO62PDB1V2
F9	IO12PDB0V1	G15	IO36NDB0V4	H21	IO70NDB1V3
F10	IO10PDB0V1	G16	IO46NDB1V0	H22	IO70PDB1V3
F11	IO16PDB0V1	G17	IO46PDB1V0	H23	GND
F12	IO22NDB0V2	G18	IO56NDB1V1	H24	V _{COMPLB}
F13	IO30NDB0V3	G19	IO56PDB1V1	H25	GBC2/IO84PDB2V0
F14	IO30PDB0V3	G20	IO66NDB1V3	H26	IO84NDB2V0
F15	IO36PDB0V4	G21	IO66PDB1V3	H27	IO96PDB2V1
F16	IO48NDB1V0	G22	V _{CC} B1	H28	IO96NDB2V1
F17	IO48PDB1V0	G23	VMV1	H29	IO89PDB2V0
F18	IO50NDB1V1	G24	V _{CC}	H30	IO89NDB2V0
F19	IO58NDB1V2	G25	GNDQ	J1	IO290NDB7V2
F20	IO60PDB1V2	G26	V _{CC} B2	J2	IO290PDB7V2
F21	IO77NDB1V4	G27	IO86NDB2V0	J3	IO302NDB7V3

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Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
J4	IO302PDB7V3	K10	V _{CC}	L16	V _{CC}
J5	IO295NDB7V2	K11	IO04PPB0V0	L17	V _{CC}
J6	IO299NDB7V3	K12	V _{CC} B0	L18	V _{CC}
J7	V _{CC} B7	K13	V _{CC} B0	L19	V _{CC}
J8	V _{CC} PLA	K14	V _{CC} B0	L20	V _{CC}
J9	V _{CC}	K15	V _{CC} B0	L21	IO78NPB1V4
J10	IO04NPB0V0	K16	V _{CC} B1	L22	IO104NPB2V2
J11	IO18NDB0V2	K17	V _{CC} B1	L23	IO98NDB2V2
J12	IO20NDB0V2	K18	V _{CC} B1	L24	IO98PDB2V2
J13	IO20PDB0V2	K19	V _{CC} B1	L25	IO87PDB2V0
J14	IO32NDB0V3	K20	IO76PPB1V4	L26	IO87NDB2V0
J15	IO32PDB0V3	K21	V _{CC}	L27	IO97PDB2V1
J16	IO42PDB1V0	K22	IO78PPB1V4	L28	IO101PDB2V2
J17	IO44NDB1V0	K23	IO88NDB2V0	L29	IO103PDB2V2
J18	IO44PDB1V0	K24	IO88PDB2V0	L30	IO119NDB3V0
J19	IO54NDB1V1	K25	IO94PDB2V1	M1	IO282NDB7V1
J20	IO54PDB1V1	K26	IO94NDB2V1	M2	IO282PDB7V1
J21	IO76NPB1V4	K27	IO85PDB2V0	M3	IO292NDB7V2
J22	V _{CC}	K28	IO85NDB2V0	M4	IO292PDB7V2
J23	V _{CC} PLB	K29	IO93PDB2V1	M5	IO283NDB7V1
J24	V _{CC} B2	K30	IO93NDB2V1	M6	IO285PDB7V1
J25	IO90PDB2V1	L1	IO286NDB7V1	M7	IO287PDB7V1
J26	IO90NDB2V1	L2	IO286PDB7V1	M8	IO289PDB7V1
J27	GBB2/IO83PDB2V0	L3	IO298NDB7V3	M9	IO289NDB7V1
J28	IO83NDB2V0	L4	IO298PDB7V3	M10	V _{CC} B7
J29	IO91PDB2V1	L5	IO283PDB7V1	M11	V _{CC}
J30	IO91NDB2V1	L6	IO291NDB7V2	M12	GND
K1	IO288NDB7V1	L7	IO291PDB7V2	M13	GND
K2	IO288PDB7V1	L8	IO293PDB7V2	M14	GND
K3	IO304NDB7V3	L9	IO293NDB7V2	M15	GND
K4	IO304PDB7V3	L10	IO307NPB7V4	M16	GND
K5	GAB2/IO308PDB7V4	L11	V _{CC}	M17	GND
K6	IO308NDB7V4	L12	V _{CC}	M18	GND
K7	IO301PDB7V3	L13	V _{CC}	M19	GND
K8	IO301NDB7V3	L14	V _{CC}	M20	V _{CC}
K9	GAC2/IO307PPB7V4	L15	V _{CC}	M21	V _{CC} B2

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Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
M22	NC	N28	IO99PDB2V2	R4	GFA0/IO273NDB6V4
M23	IO104PPB2V2	N29	IO107PDB2V3	R5	GFB0/IO274NPB7V0
M24	IO102PDB2V2	N30	IO107NDB2V3	R6	IO271NDB6V4
M25	IO102NDB2V2	P1	IO276NDB7V0	R7	GFB2/IO271PDB6V4
M26	IO95PDB2V1	P2	IO278NDB7V0	R8	IO269PDB6V4
M27	IO97NDB2V1	P3	IO280NDB7V0	R9	IO269NDB6V4
M28	IO101NDB2V2	P4	IO284NDB7V1	R10	V _{CCI} B7
M29	IO103NDB2V2	P5	IO279NDB7V0	R11	V _{CC}
M30	IO119PDB3V0	P6	GFC1/IO275PDB7V0	R12	GND
N1	IO276PDB7V0	P7	GFC0/IO275NDB7V0	R13	GND
N2	IO278PDB7V0	P8	IO277PDB7V0	R14	GND
N3	IO280PDB7V0	P9	IO277NDB7V0	R15	GND
N4	IO284PDB7V1	P10	V _{CCI} B7	R16	GND
N5	IO279PDB7V0	P11	V _{CC}	R17	GND
N6	IO285NDB7V1	P12	GND	R18	GND
N7	IO287NDB7V1	P13	GND	R19	GND
N8	IO281NDB7V0	P14	GND	R20	V _{CC}
N9	IO281PDB7V0	P15	GND	R21	V _{CCI} B2
N10	V _{CCI} B7	P16	GND	R22	GCC0/IO112NDB2V3
N11	V _{CC}	P17	GND	R23	GCB2/IO116PDB3V0
N12	GND	P18	GND	R24	IO118PDB3V0
N13	GND	P19	GND	R25	IO111PPB2V3
N14	GND	P20	V _{CC}	R26	IO122PPB3V1
N15	GND	P21	V _{CCI} B2	R27	GCA0/IO114NPB3V0
N16	GND	P22	GCC1/IO112PDB2V3	R28	V _{COMPLC}
N17	GND	P23	IO110PDB2V3	R29	GCB1/IO113PPB2V3
N18	GND	P24	IO110NDB2V3	R30	IO115NPB3V0
N19	GND	P25	IO109PPB2V3	T1	IO270NDB6V4
N20	V _{CC}	P26	IO111NPB2V3	T2	V _{CCPLF}
N21	V _{CCI} B2	P27	IO105PDB2V2	T3	GFA2/IO272PPB6V4
N22	IO106NDB2V3	P28	IO105NDB2V2	T4	GFA1/IO273PDB6V4
N23	IO106PDB2V3	P29	GCC2/IO117PDB3V0	T5	IO272NPB6V4
N24	IO108PDB2V3	P30	IO117NDB3V0	T6	IO267NDB6V4
N25	IO108NDB2V3	R1	GFC2/IO270PDB6V4	T7	IO267PDB6V4
N26	IO95NDB2V1	R2	GFB1/IO274PPB7V0	T8	IO265PDB6V3
N27	IO99NDB2V2	R3	V _{COMPLF}	T9	IO263PDB6V3

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Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function	Pin Number	RT3PE3000L Function
T10	V _{CCI} B6	U16	GND	V22	IO120NDB3V0
T11	V _{CC}	U17	GND	V23	IO128NDB3V1
T12	GND	U18	GND	V24	IO132PDB3V2
T13	GND	U19	GND	V25	IO130PPB3V2
T14	GND	U20	V _{CC}	V26	IO126NDB3V1
T15	GND	U21	V _{CCI} B3	V27	IO129NDB3V1
T16	GND	U22	IO120PDB3V0	V28	IO127NDB3V1
T17	GND	U23	IO128PDB3V1	V29	IO125NDB3V1
T18	GND	U24	IO124PDB3V1	V30	IO123PDB3V1
T19	GND	U25	IO124NDB3V1	W1	IO266NDB6V4
T20	V _{CC}	U26	IO126PDB3V1	W2	IO262NDB6V3
T21	V _{CCI} B3	U27	IO129PDB3V1	W3	IO260NDB6V3
T22	IO109NPB2V3	U28	IO127PDB3V1	W4	IO252NDB6V2
T23	IO116NDB3V0	U29	IO125PDB3V1	W5	IO251NDB6V2
T24	IO118NDB3V0	U30	IO121NDB3V0	W6	IO251PDB6V2
T25	IO122NPB3V1	V1	IO268NDB6V4	W7	IO255NDB6V2
T26	GCA1/IO114PPB3V0	V2	IO262PDB6V3	W8	IO249PPB6V1
T27	GCB0/IO113NPB2V3	V3	IO260PDB6V3	W9	IO253PDB6V2
T28	GCA2/IO115PPB3V0	V4	IO252PDB6V2	W10	V _{CCI} B6
T29	V _{CCPLC}	V5	IO257NPB6V2	W11	V _{CC}
T30	IO121PDB3V0	V6	IO261NPB6V3	W12	GND
U1	IO268PDB6V4	V7	IO255PDB6V2	W13	GND
U2	IO264NDB6V3	V8	IO259PDB6V3	W14	GND
U3	IO264PDB6V3	V9	IO259NDB6V3	W15	GND
U4	IO258PDB6V3	V10	V _{CCI} B6	W16	GND
U5	IO258NDB6V3	V11	V _{CC}	W17	GND
U6	IO257PPB6V2	V12	GND	W18	GND
U7	IO261PPB6V3	V13	GND	W19	GND
U8	IO265NDB6V3	V14	GND	W20	V _{CC}
U9	IO263NDB6V3	V15	GND	W21	V _{CCI} B3
U10	V _{CCI} B6	V16	GND	W22	IO134PDB3V2
U11	V _{CC}	V17	GND	W23	IO138PDB3V3
U12	GND	V18	GND	W24	IO132NDB3V2
U13	GND	V19	GND	W25	IO136NPB3V2
U14	GND	V20	V _{CC}	W26	IO130NPB3V2
U15	GND	V21	V _{CCI} B3	W27	IO141PDB3V3

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Pin Number	RT3PE3000L Function
W28	IO135PDB3V2
W29	IO131PDB3V2
W30	IO123NDB3V1
Y1	IO266PDB6V4
Y2	IO250PDB6V2
Y3	IO250NDB6V2
Y4	IO246PDB6V1
Y5	IO247NDB6V1
Y6	IO247PDB6V1
Y7	IO249NPB6V1
Y8	IO245PDB6V1
Y9	IO253NDB6V2
Y10	GEB0/IO235NPB6V0
Y11	V _{CC}
Y12	V _{CC}
Y13	V _{CC}
Y14	V _{CC}
Y15	V _{CC}
Y16	V _{CC}
Y17	V _{CC}
Y18	V _{CC}
Y19	V _{CC}
Y20	V _{CC}
Y21	IO142PPB3V3
Y22	IO134NDB3V2
Y23	IO138NDB3V3
Y24	IO140NDB3V3
Y25	IO140PDB3V3
Y26	IO136PPB3V2
Y27	IO141NDB3V3
Y28	IO135NDB3V2
Y29	IO131NDB3V2
Y30	IO133PDB3V2

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Datasheet Categories

Categories

In order to provide the latest information to designers, some datasheets are published before data has been fully characterized. Datasheets are designated as "Product Brief," "Advance," "Preliminary," and "Production." The definition of these categories are as follows:

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Advance

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Preliminary

The datasheet contains information based on simulation and/or initial characterization. The information is believed to be correct, but changes are possible.

Unmarked (production)

This version contains information that is considered to be final.

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