

# IGLOO Low-Power Flash FPGAs with Flash\*Freeze Technology



## Features and Benefits

### Low Power

- 1.2 V to 1.5 V Core Voltage Support for Low Power
- Supports Single-Voltage System Operation
- 5  $\mu$ W Power Consumption in Flash\*Freeze Mode
- Low-Power Active FPGA Operation
- Flash\*Freeze Technology Enables Ultra-Low Power Consumption while Maintaining FPGA Content
- Easy Entry to / Exit from Ultra-Low-Power Flash\*Freeze Mode

### High Capacity

- 15 k to 1 Million System Gates
- Up to 144 kbits of True Dual-Port SRAM
- Up to 300 User I/Os

### Reprogrammable Flash Technology

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

### In-System Programming (ISP) and Security

- Secure ISP Using On-Chip 128-Bit Advanced Encryption Standard (AES) Decryption (except ARM<sup>®</sup>-enabled IGLOO<sup>®</sup> devices) via JTAG (IEEE 1532-compliant)<sup>†</sup>
- FlashLock<sup>®</sup> to Secure FPGA Contents

### High-Performance Routing Hierarchy

- Segmented, Hierarchical Routing and Clock Structure

### Advanced I/O

- 700 Mbps DDR, LVDS-Capable I/Os (AGL250 and above)
- 1.2 V, 1.5 V, 1.8 V, 2.5 V, and 3.3 V Mixed-Voltage Operation

### IGLOO Product Family

- Bank-Selectable I/O Voltages—up to 4 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<sup>†</sup>, and LVCMOS 2.5 V / 5.0 V Input<sup>†</sup>
- Differential I/O Standards: LVPECL, LVDS, B-LVDS, and M-LVDS (AGL250 and above)
- Wide Range Power Supply Voltage Support per JESD8-B, Allowing I/Os to Operate from 2.7 V to 3.6 V
- Wide Range Power Supply Voltage Support per JESD8-12, Allowing I/Os to Operate from 1.14 V to 1.575 V
- I/O Registers on Input, Output, and Enable Paths
- Hot-Swappable and Cold-Sparing I/Os<sup>‡</sup>
- Programmable Output Slew Rate<sup>†</sup> and Drive Strength
- Weak Pull-Up/-Down
- IEEE 1149.1 (JTAG) Boundary Scan Test
- Pin-Compatible Packages across the IGLOO Family

### Clock Conditioning Circuit (CCC) and PLL<sup>†</sup>

- Six CCC Blocks, One with an Integrated PLL
- Configurable Phase Shift, Multiply/Divide, Delay Capabilities, and External Feedback
- Wide Input Frequency Range (1.5 MHz up to 250 MHz)

### Embedded Memory

- 1 kbit of FlashROM User Nonvolatile Memory
- SRAMs and FIFOs with Variable-Aspect-Ratio 4,608-Bit<sup>†</sup> RAM Blocks ( $\times 1$ ,  $\times 2$ ,  $\times 4$ ,  $\times 9$ , and  $\times 18$  organizations)
- True Dual-Port SRAM (except  $\times 18$ )<sup>†</sup>

### ARM Processor Support in IGLOO FPGAs

- M1 IGLOO Devices—Cortex<sup>™</sup>-M1 Soft Processor Available with or without Debug

| IGLOO Devices                        | AGL015 | AGL030                            | AGL060                      | AGL125         | AGL250                                     | AGL400                    | AGL600                    | AGL1000                   |
|--------------------------------------|--------|-----------------------------------|-----------------------------|----------------|--------------------------------------------|---------------------------|---------------------------|---------------------------|
| ARM-Enabled IGLOO Devices            |        |                                   |                             |                | M1AGL250                                   |                           | M1AGL600                  | M1AGL1000                 |
| System Gates                         | 15 k   | 30 k                              | 60 k                        | 125 k          | 250 k                                      | 400 k                     | 600 k                     | 1 M                       |
| Typical Equivalent Macrocells        | 128    | 256                               | 512                         | 1,024          | 2,048                                      | —                         | —                         | —                         |
| VersaTiles (D-flip-flops)            | 384    | 768                               | 1,536                       | 3,072          | 6,144                                      | 9,216                     | 13,824                    | 24,576                    |
| Flash*Freeze Mode (typical, $\mu$ W) | 5      | 5                                 | 10                          | 16             | 24                                         | 32                        | 36                        | 53                        |
| RAM kbits (1,024 bits)               | —      | —                                 | 18                          | 36             | 36                                         | 54                        | 108                       | 144                       |
| 4,608-Bit Blocks                     | —      | —                                 | 4                           | 8              | 8                                          | 12                        | 24                        | 32                        |
| FlashROM Bits                        | 1 k    | 1 k                               | 1 k                         | 1 k            | 1 k                                        | 1 k                       | 1 k                       | 1 k                       |
| Secure (AES) ISP <sup>1</sup>        | —      | —                                 | Yes                         | Yes            | Yes                                        | Yes                       | Yes                       | Yes                       |
| Integrated PLL in CCCs <sup>2</sup>  | —      | —                                 | 1                           | 1              | 1                                          | 1                         | 1                         | 1                         |
| VersaNet Globals <sup>3</sup>        | 6      | 6                                 | 18                          | 18             | 18                                         | 18                        | 18                        | 18                        |
| I/O Banks                            | 2      | 2                                 | 2                           | 2              | 4                                          | 4                         | 4                         | 4                         |
| Maximum User I/Os                    | 49     | 81                                | 96                          | 133            | 143                                        | 194                       | 235                       | 300                       |
| Package Pins                         |        |                                   |                             |                |                                            |                           |                           |                           |
| UC/CS<br>QFN                         | QN68   | UC81/CS81<br>QN48, QN68,<br>QN132 | CS121<br>QN132              | CS196<br>QN132 | CS196 <sup>4</sup><br>QN132 <sup>4,5</sup> | CS196                     | CS281                     | CS281                     |
| VQFP<br>FBGA                         |        | VQ100                             | VQ100<br>FG144 <sup>5</sup> | VQ100<br>FG144 | VQ100<br>FG144                             | FG144,<br>FG256,<br>FG484 | FG144,<br>FG256,<br>FG484 | FG144,<br>FG256,<br>FG484 |

#### Notes:

1. AES is not available for ARM-enabled IGLOO devices.
2. AGL060 in CS121 does not support the PLL.
3. Six chip (main) and twelve quadrant global networks are available for AGL060 and above.
4. The M1AGL250 device does not support this package.
5. Device/package support TBD
6. The IGLOOe handbook provides information on higher densities and additional features.

<sup>†</sup> AGL015 and AGL030 devices do not support this feature.

<sup>‡</sup> Supported only by AGL015 and AGL030 devices.

## I/Os Per Package<sup>1</sup>

| IGLOO Devices                | AGL015           | AGL030           | AGL060           | AGL125           | AGL250                        | AGL400                 | AGL600                        | AGL1000                |                               |                        |                               |                        |
|------------------------------|------------------|------------------|------------------|------------------|-------------------------------|------------------------|-------------------------------|------------------------|-------------------------------|------------------------|-------------------------------|------------------------|
| ARM-Enabled<br>IGLOO Devices |                  |                  |                  |                  | M1AGL250 <sup>3</sup>         | M1AGL400               | M1AGL600                      | M1AGL1000              |                               |                        |                               |                        |
| Package                      | I/O Type         |                  |                  |                  |                               |                        |                               |                        |                               |                        |                               |                        |
|                              | Single-Ended I/O | Single-Ended I/O | Single-Ended I/O | Single-Ended I/O | Single-Ended I/O <sup>2</sup> | Differential I/O Pairs | Single-Ended I/O <sup>2</sup> | Differential I/O Pairs | Single-Ended I/O <sup>2</sup> | Differential I/O Pairs | Single-Ended I/O <sup>2</sup> | Differential I/O Pairs |
| QN48                         | -                | 34               | -                | -                | -                             | -                      | -                             | -                      | -                             | -                      | -                             | -                      |
| QN68                         | 49               | 49               | -                | -                | -                             | -                      | -                             | -                      | -                             | -                      | -                             | -                      |
| UC81                         | -                | 66               | -                | -                | -                             | -                      | -                             | -                      | -                             | -                      | -                             | -                      |
| CS81                         | -                | 66               | -                | -                | -                             | -                      | -                             | -                      | -                             | -                      | -                             | -                      |
| CS121                        | -                | -                | 96               | -                | -                             | -                      | -                             | -                      | -                             | -                      | -                             | -                      |
| VQ100                        | -                | 77               | 71               | 71               | 68                            | 13                     | -                             | -                      | -                             | -                      | -                             | -                      |
| QN132                        | -                | 81               | 80               | 84               | 87 <sup>7</sup>               | 19 <sup>7</sup>        | -                             | -                      | -                             | -                      | -                             | -                      |
| CS196                        | -                | -                | -                | 133              | 143                           | 35                     | 143                           | 35                     | -                             | -                      | -                             | -                      |
| FG144                        | -                | -                | 96 <sup>7</sup>  | 97               | 97                            | 24                     | 97                            | 25                     | 97                            | 25                     | 97                            | 25                     |
| FG256                        | -                | -                | -                | -                | -                             | -                      | 178                           | 38                     | 177                           | 43                     | 177                           | 44                     |
| CS281                        | -                | -                | -                | -                | -                             | -                      | -                             | -                      | 215                           | 53                     | 215                           | 53                     |
| FG484                        | -                | -                | -                | -                | -                             | -                      | 194                           | 38                     | 235                           | 60                     | 300                           | 74                     |

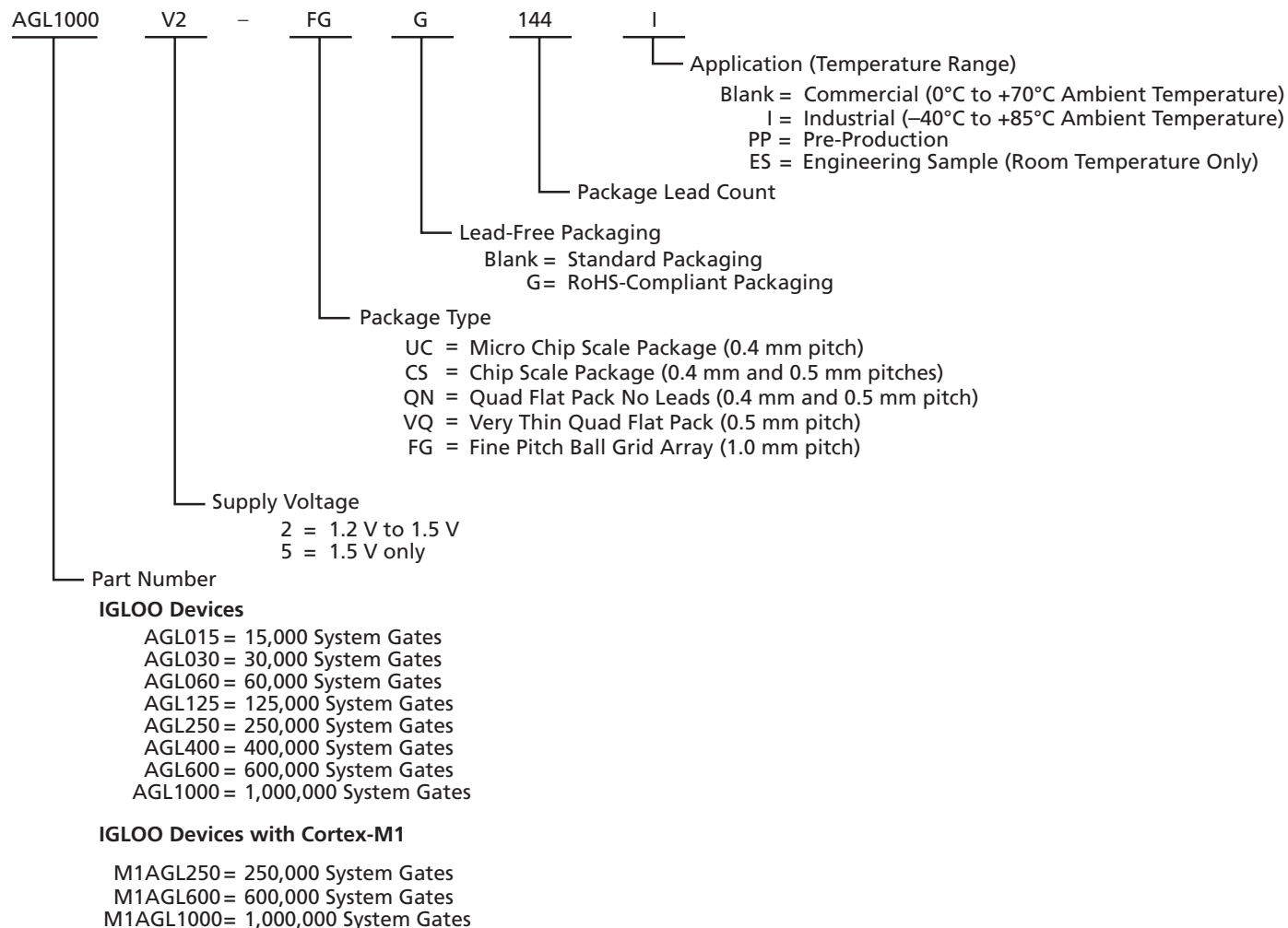
### Notes:

1. When considering migrating your design to a lower- or higher-density device, refer to the [IGLOO Low-Power Flash FPGAs handbook](#) to ensure compliance 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. The M1AGL250 device does not support QN132 or CS196 packages. Refer to the [IGLOO Low-Power Flash FPGAs handbook](#) for position assignments of the 15 LVPECL pairs.
4. FG256 and FG484 are footprint-compatible packages.
5. When the Flash\*Freeze pin is used to directly enable Flash\*Freeze mode and not used as a regular I/O, the number of single-ended user I/Os available is reduced by one.
6. "G" indicates RoHS-compliant packages. Refer to "[IGLOO Ordering Information](#)" on page III for the location of the "G" in the part number.
7. Device/package support TBD.

### IGLOO FPGAs Package Sizes Dimensions

| Package                            | UC81  | CS81  | CS121 | QN68  | QN132 | CS196 | CS281   | FG144   | VQ100   | FG256   | FG484   |
|------------------------------------|-------|-------|-------|-------|-------|-------|---------|---------|---------|---------|---------|
| Length × Width<br>(mm\mm)          | 4 × 4 | 5 × 5 | 6 × 6 | 8 × 8 | 8 × 8 | 8 × 8 | 10 × 10 | 13 × 13 | 14 × 14 | 17 × 17 | 23 × 23 |
| Nominal Area<br>(mm <sup>2</sup> ) | 16    | 25    | 36    | 64    | 64    | 64    | 100     | 169     | 196     | 289     | 529     |
| Pitch (mm)                         | 0.4   | 0.5   | 0.5   | 0.4   | 0.5   | 0.5   | 0.5     | 1.0     | 0.5     | 1.0     | 1.0     |
| Height (mm)                        | 0.80  | 0.80  | 0.99  | 0.90  | 0.75  | 1.20  | 1.05    | 1.45    | 1.00    | 1.60    | 2.23    |

## IGLOO Ordering Information



**Note:** Marking Information: IGLOO V2 devices do not have V2 marking, but IGLOO V5 devices are marked accordingly.

## Temperature Grade Offerings

| Package | AGL015 | AGL030 | AGL060            | AGL125 | AGL250                | AGL400 | AGL600   | AGL1000   |
|---------|--------|--------|-------------------|--------|-----------------------|--------|----------|-----------|
|         |        |        |                   |        | M1AGL250 <sup>4</sup> |        | M1AGL600 | M1AGL1000 |
| QN48    | –      | C, I   | –                 | –      | –                     | –      | –        | –         |
| QN68    | C, I   | –      | –                 | –      | –                     | –      | –        | –         |
| UC81    | –      | C, I   | –                 | –      | –                     | –      | –        | –         |
| CS81    | –      | C, I   | –                 | –      | –                     | –      | –        | –         |
| CS121   | –      | –      | C, I              | –      | –                     | –      | –        | –         |
| VQ100   | –      | C, I   | C, I              | C, I   | C, I                  | –      | –        | –         |
| QN132   | –      | C, I   | C, I <sup>3</sup> | C, I   | C, I <sup>3</sup>     | –      | –        | –         |
| CS196   | –      | –      | –                 | C, I   | C, I                  | C, I   | –        | –         |
| FG144   | –      | –      | C, I <sup>3</sup> | C, I   | C, I                  | C, I   | C, I     | C, I      |
| FG256   | –      | –      | –                 | –      | –                     | C, I   | C, I     | C, I      |
| CS281   | –      | –      | –                 | –      | –                     | –      | C, I     | C, I      |
| FG484   | –      | –      | –                 | –      | –                     | C, I   | C, I     | C, I      |

### Notes:

1. C = Commercial temperature range: 0°C to 70°C ambient temperature.
2. I = Industrial temperature range: –40°C to 85°C ambient temperature.
3. Device/package support TBD.
4. The M1AGL250 device does not support FG256 or QN132 packages.

References made to IGLOO devices also apply to ARM-enabled IGLOOe devices. The ARM-enabled part numbers start with M1 (Cortex-M1).

Contact your local Actel representative for device availability:

<http://www.actel.com/contact/default.aspx>.

### AGL015 and AGL030

The AGL015 and AGL030 are architecturally compatible; there are no RAM or PLL features.

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# 1 – IGLOO Device Family Overview

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## General Description

The IGLOO family of flash FPGAs, based on a 130-nm flash process, offers the lowest power FPGA, a single-chip solution, small footprint packages, reprogrammability, and an abundance of advanced features.

The Flash\*Freeze technology used in IGLOO devices enables entering and exiting an ultra-low-power mode that consumes as little as 5  $\mu$ W while retaining SRAM and register data. Flash\*Freeze technology simplifies power management through I/O and clock management with rapid recovery to operation mode.

The Low Power Active capability (static idle) allows for ultra-low-power consumption (from 12  $\mu$ W) while the IGLOO device is completely functional in the system. This allows the IGLOO device to control system power management based on external inputs (e.g., scanning for keyboard stimulus) while consuming minimal power.

Nonvolatile flash technology gives IGLOO devices the advantage of being a secure, low power, single-chip solution that is live at power-up (LAPU). IGLOO is reprogrammable and offers time-to-market benefits at an ASIC-level unit cost.

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

IGLOO devices offer 1 kbit of on-chip, reprogrammable, nonvolatile FlashROM storage as well as clock conditioning circuitry based on an integrated phase-locked loop (PLL). The AGL015 and AGL030 devices have no PLL or RAM support. IGLOO devices have up to 1 million system gates, supported with up to 144 kbits of true dual-port SRAM and up to 300 user I/Os.

M1 IGLOO devices support the high-performance, 32-bit Cortex-M1 processor developed by ARM for implementation in FPGAs. Cortex-M1 is a soft processor that is fully implemented in the FPGA fabric. It has a three-stage pipeline that offers a good balance between low-power consumption and speed when implemented in an M1 IGLOO device. The processor runs the ARMv6-M instruction set, has a configurable nested interrupt controller, and can be implemented with or without the debug block. Cortex-M1 is available for free from Actel for use in M1 IGLOO FPGAs.

The ARM-enabled devices have Actel ordering numbers that begin with M1AGL and do not support AES decryption.

## Flash\*Freeze Technology

The IGLOO device offers unique Flash\*Freeze technology, allowing the device to enter and exit ultra-low-power Flash\*Freeze mode. IGLOO devices do not need additional components to turn off I/Os or clocks while retaining the design information, SRAM content, and registers. 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 IGLOO V2 devices to support a wide range of core voltage (1.2 V to 1.5 V) allows further reduction in power consumption, thus achieving the lowest total system power.

When the IGLOO 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 reprogrammability, a single-chip and single-voltage solution, and availability of small-footprint, high pin-count packages, make IGLOO devices the best fit for portable electronics.

## Flash Advantages

### **Low Power**

Flash-based IGLOO devices exhibit power characteristics similar to those of an ASIC, making them an ideal choice for power-sensitive applications. IGLOO devices have only a very limited power-on current surge and no high-current transition period, both of which occur on many FPGAs.

IGLOO devices also have low dynamic power consumption to further maximize power savings; power is even further reduced by the use of a 1.2 V core voltage.

Low dynamic power consumption, combined with low static power consumption and Flash\*Freeze technology, gives the IGLOO device the lowest total system power offered by any FPGA.

### **Security**

The nonvolatile, flash-based IGLOO devices do not require a boot PROM, so there is no vulnerable external bitstream that can be easily copied. IGLOO 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.

IGLOO 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 IGLOO 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. IGLOO 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. IGLOO 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 IGLOO device cannot be read back, although secure design verification is possible.

Security, built into the FPGA fabric, is an inherent component of the IGLOO 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 IGLOO 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 IGLOO 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 IGLOO 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**

The Actel flash-based IGLOO 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 IGLOO 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 IGLOO 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 IGLOO devices simplify total system design and reduce cost and design risk while increasing system reliability and improving system initialization time.

IGLOO flash FPGAs allow the user to quickly enter and exit Flash\*Freeze mode. This is done almost instantly (within 1  $\mu$ s) and the device retains configuration and data in registers and RAM. Unlike SRAM-based FPGAs the device does not need to reload configuration and design state from

external memory components; instead it retains all necessary information to resume operation immediately.

### **Reduced Cost of Ownership**

Advantages to the designer extend beyond low unit cost, performance, and ease of use. Unlike SRAM-based FPGAs, Flash-based IGLOO 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 IGLOO family device architecture mitigates the need for ASIC migration at higher user volumes. This makes the IGLOO family a cost-effective ASIC replacement solution, especially for applications in the consumer, networking/communications, computing, and avionics markets.

### **Firm-Error Immunity**

Firm errors occur most commonly when high-energy neutrons, generated in the upper atmosphere, strike a configuration cell of an SRAM FPGA. The energy of the collision can change the state of the configuration cell and thus change the logic, routing, or I/O behavior in an unpredictable way. These errors are impossible to prevent in SRAM FPGAs. The consequence of this type of error can be a complete system failure. Firm errors do not exist in the configuration memory of IGLOO flash-based FPGAs. Once it is programmed, the flash cell configuration element of IGLOO FPGAs cannot be altered by high-energy neutrons and is therefore immune to them. Recoverable (or soft) errors occur in the user data SRAM of all FPGA devices. These can easily be mitigated by using error detection and correction (EDAC) circuitry built into the FPGA fabric.

### **Advanced Flash Technology**

The IGLOO family offers many benefits, including nonvolatility and reprogrammability, through an advanced flash-based, 130-nm LVCMOS process with seven 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.

IGLOO family FPGAs utilize design and process techniques to minimize power consumption in all modes of operation.

### **Advanced Architecture**

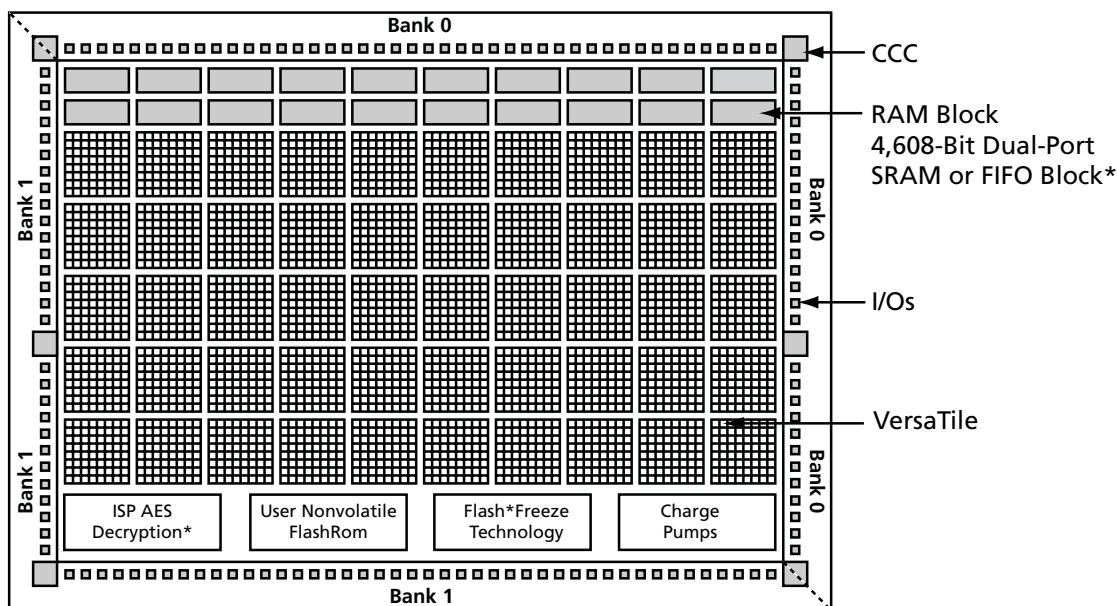
The proprietary IGLOO architecture provides granularity comparable to standard-cell ASICs. The IGLOO device consists of five distinct and programmable architectural features ([Figure 1-1 on page 1-4](#) and [Figure 1-2 on page 1-4](#)):

- Flash\*Freeze technology
- FPGA VersaTiles
- Dedicated FlashROM
- Dedicated SRAM/FIFO memory<sup>†</sup>
- Extensive CCCs and PLLs<sup>†</sup>
- Advanced 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 IGLOO 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.

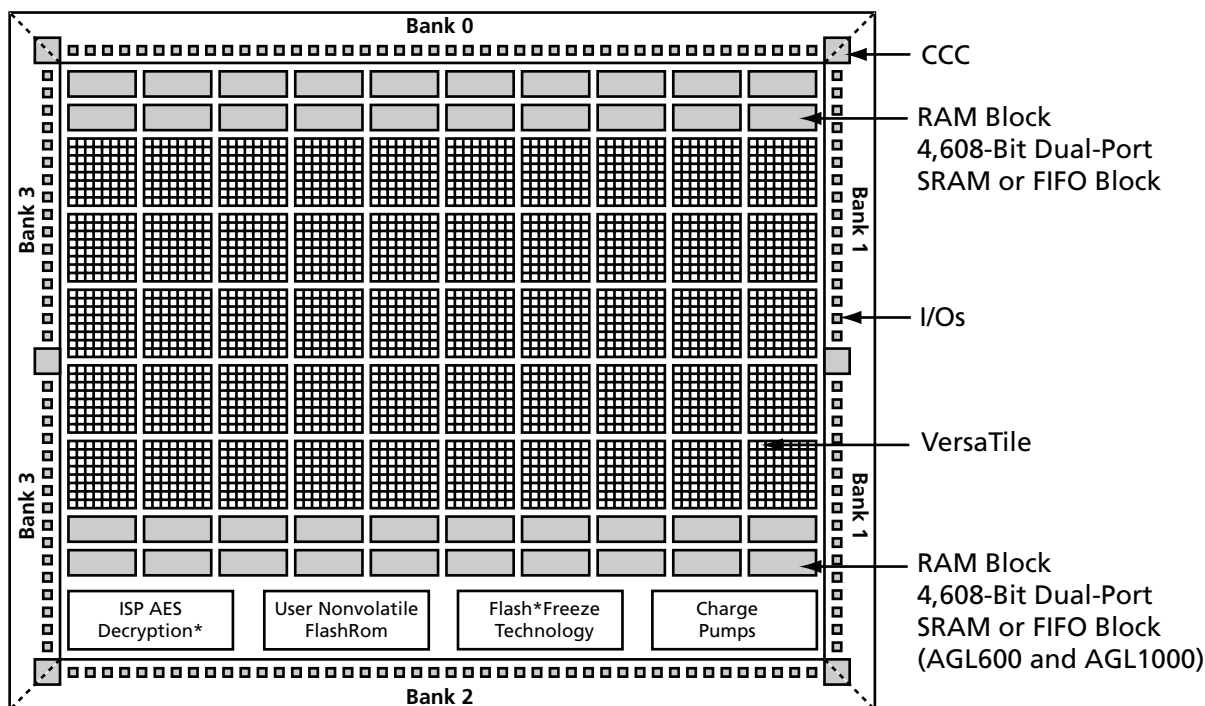
<sup>†</sup> The AGL015 and AGL030 do not support PLL or SRAM.

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



\* Not supported by AGL015 and AGL030 devices

**Figure 1-1 • IGLOO Device Architecture Overview with Two I/O Banks (AGL015, AGL030, AGL060, and AGL125)**



**Figure 1-2 • IGLOO Device Architecture Overview with Four I/O Banks (AGL250, AGL600, AGL400, and AGL1000)**

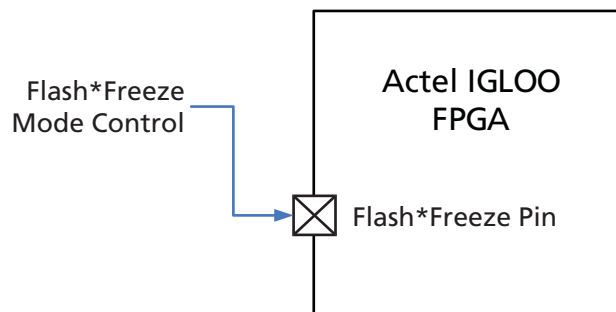


## Flash\*Freeze Technology

The IGLOO device has an ultra-low power static mode, called Flash\*Freeze mode, which retains all SRAM and register information and can still quickly return to normal operation. Flash\*Freeze technology enables the user to quickly (within 1  $\mu$ s) enter and exit Flash\*Freeze mode by activating the Flash\*Freeze 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, and the device retains all core registers, SRAM information, and states. I/O states 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 PLL, and the device consumes as little as 5  $\mu$ W in this mode.

Flash\*Freeze technology allows the user to switch to active mode on demand, thus simplifying the power management of the device.

The Flash\*Freeze 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 Flash\*Freeze pin as a regular I/O if Flash\*Freeze mode usage is not planned, which is advantageous because of the inherent low power static (as low as 12  $\mu$ W) and dynamic capabilities of the IGLOO device. Refer to [Figure 1-3](#) for an illustration of entering/exiting Flash\*Freeze mode.



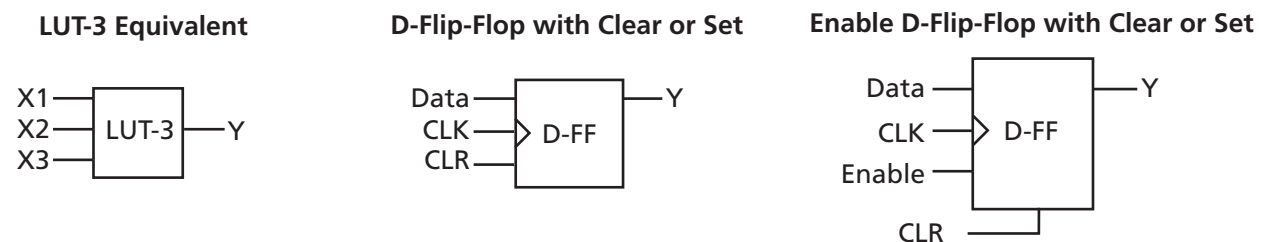
**Figure 1-3 • IGLOO Flash\*Freeze Mode**

## VersaTiles

The IGLOO core consists of VersaTiles, which have been enhanced beyond the ProASIC<sup>PLUS</sup> core tiles. The IGLOO 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 1-4](#) for VersaTile configurations.



**Figure 1-4 • VersaTile Configurations**

## **User Nonvolatile FlashROM**

Actel IGLOO 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

The FlashROM is written using the standard IGLOO 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 (except in the AGL015 and AGL030 devices), as in security keys stored in the FlashROM for a user design.

The 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.

The 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 IGLOO development software solutions, Libero® Integrated Design Environment (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**

IGLOO devices (except the AGL015 and AGL030 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 (except in the AGL015 and AGL030 devices).

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**

IGLOO devices provide designers with very flexible clock conditioning circuit (CCC) capabilities. Each member of the IGLOO family contains six CCCs. One CCC (center west side) has a PLL. The AGL015 and AGL030 do not have a PLL.

The six CCC blocks are located at the four corners and the centers of the east and west sides. One CCC (center west side) has 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 (for PLL only)

Additional CCC specifications:

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

### Global Clocking

IGLOO 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 IGLOO family of FPGAs features a flexible I/O structure, supporting a range of voltages (1.2 V, 1.5 V, 1.8 V, 2.5 V, 3.0 V wide range, and 3.3 V). IGLOO FPGAs support many different I/O standards—single-ended and differential.

The I/Os are organized into banks, with two or four banks per device. The configuration of these banks determines the I/O standards supported.

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

- Single-Data-Rate applications
- Double-Data-Rate applications—DDR LVDS, B-LVDS, and M-LVDS I/Os for point-to-point communications

IGLOO banks for the AGL250 device and above support LVPECL, LVDS, B-LVDS, and M-LVDS. B-LVDS and M-LVDS can support up to 20 loads.

## Wide Range I/O Support

Actel IGLOO devices support JEDEC-defined wide range I/O operation. IGLOO devices support both the JESD8-B specification, covering 3 V and 3.3 V supplies, for an effective operating range of 2.7 V to 3.6 V, and JESD8-12 with its 1.2 V nominal, supporting an effective operating range of 1.14 V to 1.575 V.

Wider I/O range means designers can eliminate power supplies or power conditioning components from the board or move to less costly components with greater tolerances. Wide range eases I/O bank management and provides enhanced protection from system voltage spikes, while providing the flexibility to easily run custom voltage applications.

## Part Number and Revision Date

Part Number 51700095-001-8

Revised April 2009

## List of Changes

The following table lists critical changes that were made in the current version of the document.

| Previous Version                  | Changes in Current Version (v1.5)                                                                                                                                                                                                                                                                                                      | Page       |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| v1.4<br>(February 2009)           | M1AGL400 is no longer offered and was removed from the "IGLOO Product Family" table, "IGLOO Ordering Information", and "Temperature Grade Offerings".                                                                                                                                                                                  | I, III, IV |
|                                   | The -F speed grade is no longer offered for IGLOO devices. The speed grade column and note regarding -F speed grade were removed from "IGLOO Ordering Information". The "Speed Grade and Temperature Grade Matrix" section was removed.                                                                                                | III, IV    |
| v1.3<br>(December 2008)           | The "Advanced I/O" section was revised to include two bullets regarding wide range power supply voltage support.                                                                                                                                                                                                                       | I          |
|                                   | 3.0 V wide range was added to the list of supported voltages in the "I/Os with Advanced I/O Standards" section. The "Wide Range I/O Support" section is new.                                                                                                                                                                           | 1-7        |
| v1.2<br>(October 2008)            | QN48 and QN68 were added to the AGL030 for the following tables:<br>"IGLOO Product Family"<br>"IGLOO Ordering Information"<br>"Temperature Grade Offerings"                                                                                                                                                                            | N/A        |
|                                   | QN132 is fully supported by AGL125 so footnote 3 was removed.                                                                                                                                                                                                                                                                          |            |
| v1.1<br>(July 2008)               | This document was updated to include AGL400 device information. The following sections were updated:<br>"IGLOO Product Family"<br>"IGLOO Ordering Information"<br>"Temperature Grade Offerings"<br>"IGLOO Product Family"<br>Figure 1-2 · IGLOO Device Architecture Overview with Four I/O Banks (AGL250, AGL600, AGL400, and AGL1000) | N/A        |
| v1.0<br>(March 2008)              | As a result of the Libero IDE v8.4 release, Actel now offers a wide range of core voltage support. The document was updated to change 1.2 V / 1.5 V to 1.2 V to 1.5 V.                                                                                                                                                                 | N/A        |
| 51700095-001-3<br>(March 2008)    | This document was divided into two sections and given a version number, starting at v1.0. The first section of the document includes features, benefits, ordering information, and temperature and speed grade offerings. The second section is a device family overview.                                                              | N/A        |
| 51700095-001-2<br>(February 2008) | The "Low Power" section was updated to change "1.2 V and 1.5 V Core Voltage" to "1.2 V and 1.5 V Core and I/O Voltage." The text "(from 12 $\mu$ W)" was removed from "Low-Power Active FPGA Operation."                                                                                                                               | I          |
|                                   | 1.2_V was added to the list of core and I/O voltages in the "Advanced I/O" and "I/Os with Advanced I/O Standards" sections.                                                                                                                                                                                                            | I, 1-7     |
|                                   | The "Embedded Memory" section was updated to remove the footnote reference from the section heading and place it instead after "4,608-Bit" and "True Dual-Port SRAM (except $\times 18$ )."                                                                                                                                            | I          |

| Previous Version                 | Changes in Current Version (v1.5)                                                                                                                                                                                                                                                                                                                                                                            | Page           |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 51700095-001-1<br>(January 2008) | This document was updated to include AGL015 device information. QN68 is a new package that was added because it is offered in the AGL015. The following sections were updated:<br>"Features and Benefits"<br>"IGLOO Ordering Information"<br>"Temperature Grade Offerings"<br>"IGLOO Product Family"<br>"IGLOO FPGAs Package Sizes Dimensions"<br>"AGL015 and AGL030" note<br>"IGLOO Device Family Overview" | N/A            |
|                                  | The "Temperature Grade Offerings" table was updated to include M1AGL600.                                                                                                                                                                                                                                                                                                                                     | IV             |
|                                  | In the "IGLOO Ordering Information" table, the QN package measurements were updated to include both 0.4 mm and 0.5 mm.                                                                                                                                                                                                                                                                                       | III            |
|                                  | In the "General Description" section, the number of I/Os was updated from 288 to 300.                                                                                                                                                                                                                                                                                                                        | 1-5            |
| 51700095-001-0<br>(January 2008) | The "Low Power" section was updated to change the description of low-power active FPGA operation to "from 12 $\mu$ W" from "from 25 $\mu$ W." The same update was made in the "General Description" section and the "Flash*Freeze Technology" section.                                                                                                                                                       | I, 1-1, 1-5    |
| Advance v0.7<br>(November 2007)  | This document was previously in datasheet Advance v0.7. As a result of moving to the handbook format, Actel has restarted the version numbers. The new version number is 51700095-001-0.                                                                                                                                                                                                                     | N/A            |
| Advance v0.6<br>(November 2007)  | Table 1 • IGLOO Product Family, the "I/Os Per Package1" table, and the Temperature Grade Offerings table were updated to reflect the following: CS196 is now supported for AGL250; device/package support for QN132 is to be determined for AGL250; the CS281 package was added for AGL600 and AGL1000.                                                                                                      | i, ii, iv      |
|                                  | Table 2 • IGLOO FPGAs Package Sizes Dimensions is new, and package sizes were removed from the "I/Os Per Package1" table.                                                                                                                                                                                                                                                                                    | ii             |
|                                  | The "I/Os Per Package1" table was updated to reflect 77 instead of 79 single-ended I/Os for the VG100 package for AGL030.                                                                                                                                                                                                                                                                                    | ii             |
| Advance v0.6<br>(November 2007)  | A note was added to "IGLOO Ordering Information" regarding marking information.                                                                                                                                                                                                                                                                                                                              | iii            |
| Advance v0.5<br>(September 2007) | Table 1 • IGLOO Product Family, the "I/Os Per Package1" table, and the "IGLOO Ordering Information", and the Temperature Grade Offerings table were updated to add the UC81 package.                                                                                                                                                                                                                         | i, ii, iii, iv |
| Advance v0.4<br>(September 2007) | Table 1 • IGLOO Product Family was updated for AGL030 in the Package Pins section to change CS181 to CS81.                                                                                                                                                                                                                                                                                                   | i              |
| Advance v0.3<br>(August 2007)    | Cortex-M1 device information was added to Table 1 • IGLOO Product Family, the "I/Os Per Package1" table, "IGLOO Ordering Information", and Temperature Grade Offerings.                                                                                                                                                                                                                                      | i, ii, iii, iv |
|                                  | The number of single-ended I/Os for the CS81 package for AGL030 was updated to 66 in the "I/Os Per Package1" table.                                                                                                                                                                                                                                                                                          | ii             |
| Advance v0.2<br>(July 2007)      | In Table 1 • IGLOO Product Family, the CS81 package was added for AGL030. The CS196 was replaced by the CS121 for AGL060. Table note 3 was moved to the specific packages to which it applies for AGL060: QN132 and FG144.                                                                                                                                                                                   | i              |
|                                  | The CS81 and CS121 packages were added to the "I/Os Per Package1" table. The number of single-ended I/Os was removed for the CS196 package in AGL060. Table note 6 was moved to the specific packages to which it applies for AGL060: QN132 and FG144.                                                                                                                                                       | ii             |

| Previous Version            | Changes in Current Version (v1.5)                                                                                                                                                                                                                               | Page    |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Advance v0.2<br>(continued) | The CS81 and CS121 packages were added to the Temperature Grade Offerings table. The temperature grade offerings were removed for the CS196 package in AGL060. Table note 3 was moved to the specific packages to which it applies for AGL060: QN132 and FG144. | iv      |
| Advance v0.1                | The words "ambient temperature" were added to the temperature range in the "IGLOO Ordering Information", Temperature Grade Offerings, and "Speed Grade and Temperature Grade Matrix" sections.                                                                  | iii, iv |

## 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 definitions 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](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 – IGLOO 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 $VMV$ <sup>3</sup> | 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)<br>–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     |
| $T_{STG}$ <sup>2</sup>           | Storage Temperature          | –65 to +150                                                                                                                                                             | °C    |
| $T_J$ <sup>2</sup>               | Junction Temperature         | +125                                                                                                                                                                    | °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 2-3](#).
2. For flash programming and retention, maximum limits refer to [Table 2-3 on page 2-2](#), 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. See [Pin Descriptions](#) for further information.

**Table 2-2 • Recommended Operating Conditions** <sup>4</sup>

| Symbol                                 | Parameter                                        |                                                  | Commercial            | Industrial              | Units |
|----------------------------------------|--------------------------------------------------|--------------------------------------------------|-----------------------|-------------------------|-------|
| T <sub>A</sub>                         | Ambient Temperature                              |                                                  | 0 to +70 <sup>6</sup> | –40 to +85 <sup>7</sup> | °C    |
| T <sub>J</sub>                         | Junction Temperature <sup>8</sup>                |                                                  | 0 to + 85             | –40 to +100             | °C    |
| V <sub>CC</sub> <sup>3</sup>           | 1.5 V DC core supply voltage <sup>1</sup>        |                                                  | 1.425 to 1.575        | 1.425 to 1.575          | V     |
|                                        | 1.2 V–1.5 V wide range core voltage <sup>2</sup> |                                                  | 1.14 to 1.575         | 1.14 to 1.575           | V     |
| V <sub>JTAG</sub>                      | JTAG DC voltage                                  |                                                  | 1.4 to 3.6            | 1.4 to 3.6              | V     |
| V <sub>PUMP</sub>                      | Programming voltage                              | Programming Mode                                 | 3.15 to 3.45          | 3.15 to 3.45            | V     |
|                                        |                                                  | Operation <sup>5</sup>                           | 0 to 3.45             | 0 to 3.45               | V     |
| V <sub>CCPLL</sub> <sup>9</sup>        | Analog power supply (PLL)                        | 1.5 V DC core supply voltage <sup>1</sup>        | 1.4 to 1.6            | 1.4 to 1.6              | V     |
|                                        |                                                  | 1.2 V–1.5 V wide range core voltage <sup>2</sup> | 1.14 to 1.575         | 1.14 to 1.575           | V     |
| V <sub>CCI</sub> and VMV <sup>10</sup> | 1.2 V DC core supply voltage <sup>2</sup>        |                                                  | 1.14 to 1.26          | 1.14 to 1.26            | V     |
|                                        | 1.5 V DC supply voltage                          |                                                  | 1.425 to 1.575        | 1.425 to 1.575          | V     |
|                                        | 1.8 V DC supply voltage                          |                                                  | 1.7 to 1.9            | 1.7 to 1.9              | V     |
|                                        | 2.5 V DC supply voltage                          |                                                  | 2.3 to 2.7            | 2.3 to 2.7              | V     |
|                                        | 3.3 V wide range DC supply voltage <sup>11</sup> |                                                  | 2.7 to 3.6            | 2.7 to 3.6              | V     |
|                                        | 3.3 V DC supply voltage                          |                                                  | 3.0 to 3.6            | 3.0 to 3.6              | V     |
|                                        | LVDS differential I/O                            |                                                  | 2.375 to 2.625        | 2.375 to 2.625          | V     |
|                                        | LVPECL differential I/O                          |                                                  | 3.0 to 3.6            | 3.0 to 3.6              | V     |

**Notes:**

1. For IGLOO® V5 devices
2. For IGLOO V2 devices only, operating at V<sub>CCI</sub> ≥ V<sub>CC</sub>
3. The ranges given here are for power supplies only. The recommended input voltage ranges specific to each I/O standard are given in [Table 2-24 on page 2-23](#). V<sub>CCI</sub> should be at the same voltage within a given I/O bank.
4. All parameters representing voltages are measured with respect to GND unless otherwise specified.
5. V<sub>PUMP</sub> can be left floating during operation (not programming mode).
6. Maximum T<sub>J</sub> = 85 °C.
7. Maximum T<sub>J</sub> = 100 °C.
8. To ensure targeted reliability standards are met across ambient and junction operating temperatures, Actel recommends that the user follow best design practices using Actel's timing and power simulation tools.
9. V<sub>CCPLL</sub> pins should be tied to V<sub>CC</sub> pins. See [Pin Descriptions](#) for further information.
10. VMV pins must be connected to the corresponding V<sub>CCI</sub> pins. See [Pin Descriptions](#) for further information.
11. 3.3 V wide range is compliant to the JDEC8a specification and supports 3.0 V V<sub>CCI</sub> operation.

**Table 2-3 • Flash Programming Limits – Retention, Storage, and Operating Temperature** <sup>1</sup>

| Product Grade | Programming Cycles | Program Retention (biased/unbiased) | Maximum Storage Temperature T <sub>STG</sub> (°C) <sup>2</sup> | Maximum Operating Junction Temperature T <sub>J</sub> (°C) <sup>2</sup> |
|---------------|--------------------|-------------------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------|
| Commercial    | 500                | 20 years                            | 110                                                            | 100                                                                     |
| Industrial    | 500                | 20 years                            | 110                                                            | 100                                                                     |

**Notes:**

1. This is a stress rating only; functional operation at any condition other than those indicated is not implied.
2. These limits apply for program/data retention only. Refer to [Table 2-1 on page 2-1](#) and [Table 2-2](#) for device operating conditions and absolute limits.

**Table 2-4 • Overshoot and Undershoot Limits<sup>1</sup>**

| $V_{CCI}$     | Average $V_{CCI}$ -GND Overshoot or Undershoot Duration as a Percentage of Clock Cycle <sup>2</sup> | Maximum Overshoot/Undershoot <sup>2</sup> |
|---------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------|
| 2.7 V or less | 10%                                                                                                 | 1.4 V                                     |
|               | 5%                                                                                                  | 1.49 V                                    |
| 3 V           | 10%                                                                                                 | 1.1 V                                     |
|               | 5%                                                                                                  | 1.19 V                                    |
| 3.3 V         | 10%                                                                                                 | 0.79 V                                    |
|               | 5%                                                                                                  | 0.88 V                                    |
| 3.6 V         | 10%                                                                                                 | 0.45 V                                    |
|               | 5%                                                                                                  | 0.54 V                                    |

**Notes:**

1. Based on reliability requirements at junction temperature at 85°C.
2. 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.
3. This table does not provide PCI overshoot/undershoot limits.

## I/O Power-Up and Supply Voltage Thresholds for Power-On Reset (Commercial and Industrial)

Sophisticated power-up management circuitry is designed into every IGLOO 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 2-1 on page 2-4](#) and [Figure 2-2 on page 2-5](#).

There are five regions to consider during power-up.

IGLOO 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 2-1 on page 2-4](#) and [Figure 2-2 on page 2-5](#)).
2.  $V_{CCI} > V_{CC} - 0.75$  V (typical)
3. Chip is in the operating mode.

 **$V_{CCI}$  Trip Point:**

Ramping up (V5 devices):  $0.6 \text{ V} < \text{trip\_point\_up} < 1.2 \text{ V}$

Ramping down (V5 Devices):  $0.5 \text{ V} < \text{trip\_point\_down} < 1.1 \text{ V}$

Ramping up (V2 devices):  $0.75 \text{ V} < \text{trip\_point\_up} < 1.05 \text{ V}$

Ramping down (V2 devices):  $0.65 \text{ V} < \text{trip\_point\_down} < 0.95 \text{ V}$

 **$V_{CC}$  Trip Point:**

Ramping up (V5 devices):  $0.6 \text{ V} < \text{trip\_point\_up} < 1.1 \text{ V}$

Ramping down (V5 devices):  $0.5 \text{ V} < \text{trip\_point\_down} < 1.0 \text{ V}$

Ramping up (V2 devices):  $0.65 \text{ V} < \text{trip\_point\_up} < 1.05 \text{ V}$

Ramping down (V2 devices):  $0.55 \text{ V} < \text{trip\_point\_down} < 0.95 \text{ V}$

$V_{CC}$  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 (see Figure 2-1 and Figure 2-2 on page 2-5 for more details).

When PLL power supply voltage and/or  $V_{CC}$  levels drop below the  $V_{CC}$  brownout levels ( $0.75\text{ V} \pm 0.25\text{ V}$  for V5 devices, and  $0.75\text{ V} \pm 0.2\text{ V}$  for V2 devices), the PLL output lock signal goes low and/or the output clock is lost. Refer to the Brownout Voltage section in the *Power-Up/Down Behavior of Low-Power Flash Devices* chapter of the *ProASIC®3* and *ProASIC3E* handbooks for information on clock and lock recovery.

### Internal Power-Up Activation Sequence

1. Core
2. Input buffers
3. Output buffers, after 200 ns delay from input buffer activation

To make sure the transition from input buffers to output buffers is clean, ensure that there is no path longer than 100 ns from input buffer to output buffer in your design.

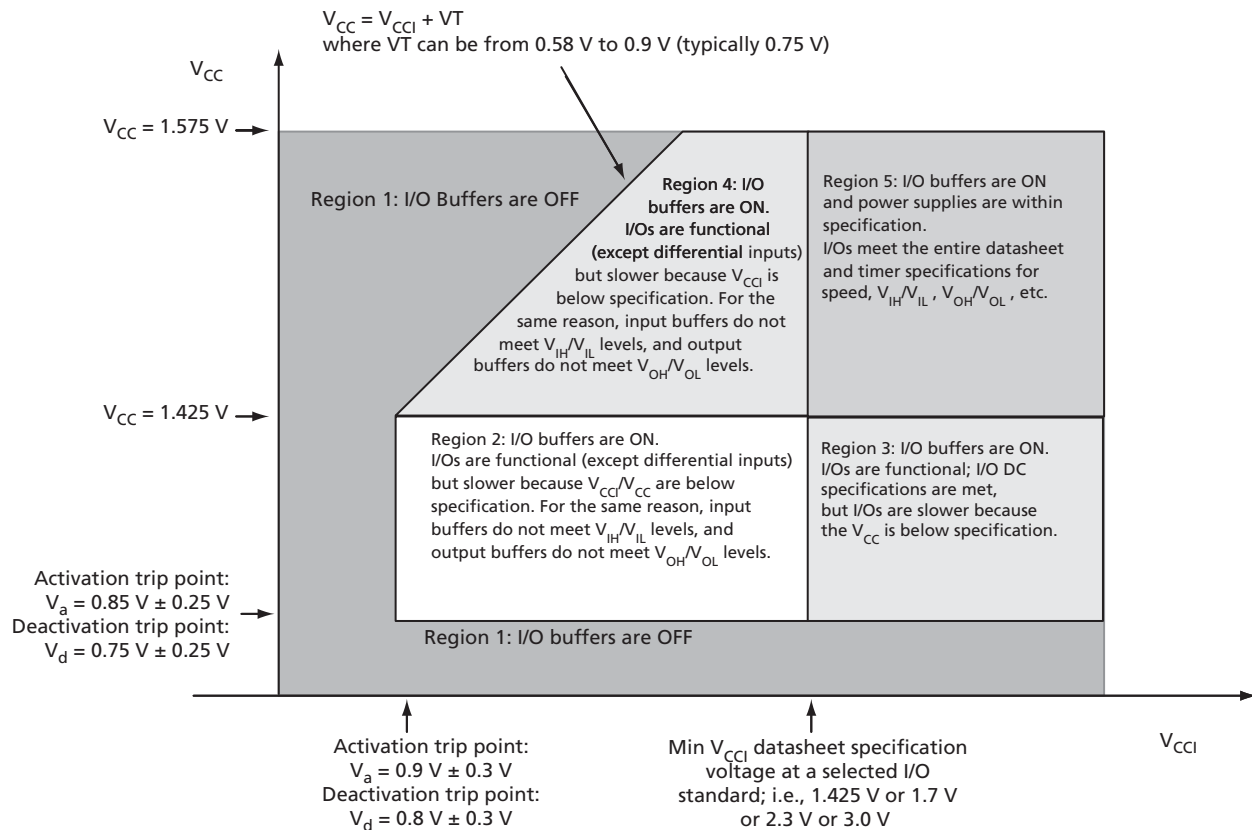


Figure 2-1 • V5 Devices – I/O State as a Function of  $V_{CCI}$  and  $V_{CC}$  Voltage Levels

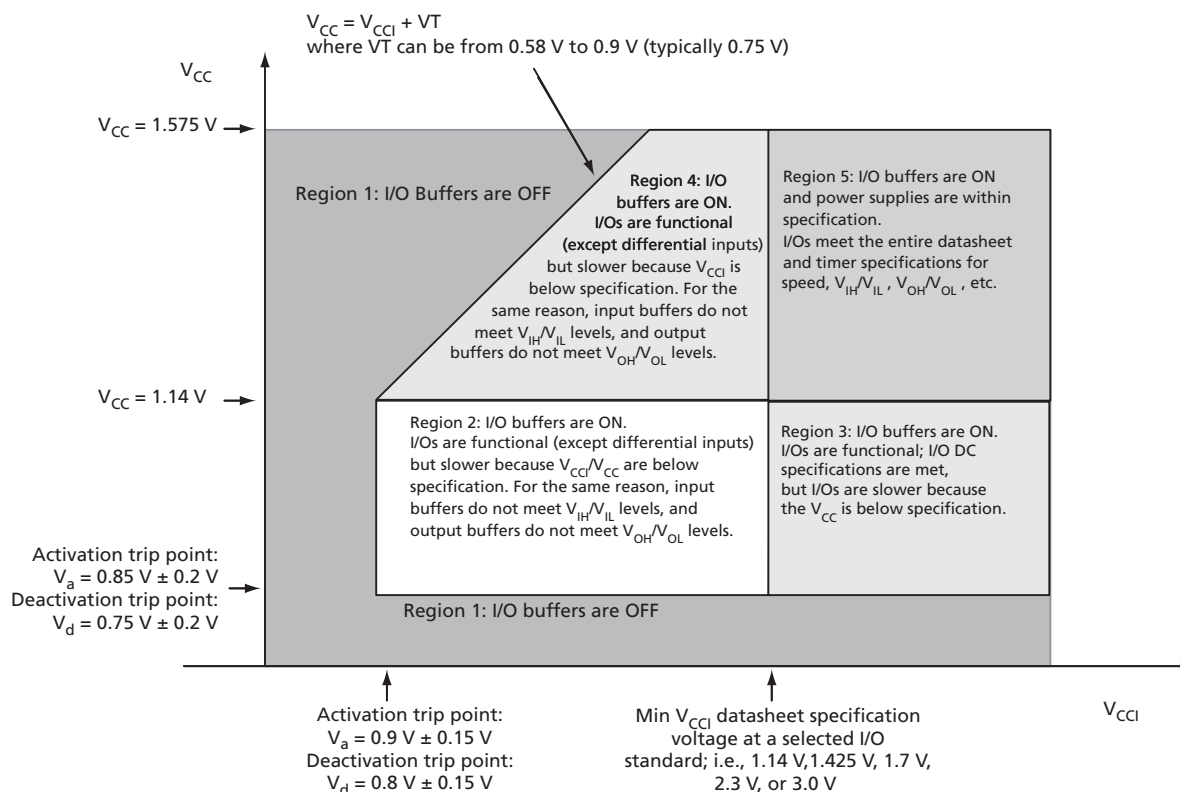


Figure 2-2 • V2 Devices – I/O State as a Function of  $V_{CCI}$  and  $V_{CC}$  Voltage Levels

## 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 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

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

$\theta_{ja}$  = Junction-to-ambient of the package.  $\theta_{ja}$  numbers are located in Table 2-5 on page 2-6.

P = Power dissipation

## Package Thermal Characteristics

The device junction-to-case thermal resistivity is  $\theta_{jc}$  and the junction-to-ambient air thermal resistivity is  $\theta_{ja}$ . The thermal characteristics for  $\theta_{ja}$  are shown for two air flow rates. The absolute maximum junction temperature is 110°C. EQ 2-2 shows a sample calculation of the absolute maximum power dissipation allowed for a 484-pin FBGA package at commercial temperature and in still air.

$$\text{Maximum Power Allowed} = \frac{\text{Max. junction temp. (}^{\circ}\text{C)} - \text{Max. ambient temp. (}^{\circ}\text{C)} }{\theta_{ja} (^{\circ}\text{C/W)}} = \frac{100^{\circ}\text{C} - 70^{\circ}\text{C}}{20.5^{\circ}\text{C/W}} = 1.463 \text{ W}$$

EQ 2-2

**Table 2-5 • Package Thermal Resistivities**

| Package Type                      | Device      | Pin Count | $\theta_{jc}$ | $\theta_{ja}$ |              |              | Units |
|-----------------------------------|-------------|-----------|---------------|---------------|--------------|--------------|-------|
|                                   |             |           |               | Still Air     | 200 ft./min. | 500 ft./min. |       |
| Quad Flat No Lead                 | AGL015      | 68        | TBD           | TBD           | TBD          | TBD          | C/W   |
|                                   | AGL030      | 132       | 0.4           | 21.4          | 16.8         | 15.3         | C/W   |
|                                   | AGL060      | 132       | 0.3           | 21.2          | 16.6         | 15.0         | C/W   |
|                                   | AGL125      | 132       | 0.2           | 21.1          | 16.5         | 14.9         | C/W   |
|                                   | AGL250      | 132       | 0.1           | 21.0          | 16.4         | 14.8         | C/W   |
| Very Thin Quad Flat Pack (VQFP)   | All devices | 100       | 10.0          | 35.3          | 29.4         | 27.1         | C/W   |
| Chip Scale Package (CSP)          | All devices | 196       |               | 57.8          | 47.6         | 43.3         | C/W   |
| Fine Pitch Ball Grid Array (FBGA) | See note*   | 144       | 3.8           | 26.9          | 22.9         | 21.5         | C/W   |
|                                   | See note*   | 256       | 3.8           | 26.6          | 22.8         | 21.5         | C/W   |
|                                   | See note*   | 484       | 3.2           | 20.5          | 17.0         | 15.9         | C/W   |
|                                   | See note*   | 896       | 2.4           | 13.6          | 10.4         | 9.4          | C/W   |
|                                   | AGL060      | 144       | 18.6          | 55.2          | 49.4         | 47.2         | C/W   |
|                                   | AGL1000     | 144       | 6.3           | 31.6          | 26.2         | 24.2         | C/W   |
|                                   | AGL250      | 256       | 12.0          | 38.6          | 34.7         | 33.0         | C/W   |
|                                   | AGL1000     | 256       | 6.6           | 28.1          | 24.4         | 22.7         | C/W   |
|                                   | AGL1000     | 484       | 8.0           | 23.3          | 19.0         | 16.7         | C/W   |

\* This information applies to all IGLOO devices except those listed below. Detailed device/package thermal information for all IGLOO devices will be available in future revisions of the datasheet.

## Temperature and Voltage Derating Factors

**Table 2-6 • Temperature and Voltage Derating Factors for Timing Delays (normalized to  $T_j = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425 \text{ V}$ )**  
For IGLOO V2 or V5 devices, 1.5 V DC Core Supply Voltage

| Array Voltage<br>$V_{CC}$ (V) | Junction Temperature ( $^{\circ}\text{C}$ ) |                     |                      |                      |                      |                       |
|-------------------------------|---------------------------------------------|---------------------|----------------------|----------------------|----------------------|-----------------------|
|                               | $-40^{\circ}\text{C}$                       | $0^{\circ}\text{C}$ | $25^{\circ}\text{C}$ | $70^{\circ}\text{C}$ | $85^{\circ}\text{C}$ | $110^{\circ}\text{C}$ |
| 1.425                         | 0.95                                        | 0.96                | 0.98                 | 1.00                 | 1.01                 | 1.02                  |
| 1.5                           | 0.88                                        | 0.89                | 0.91                 | 0.93                 | 0.93                 | 0.94                  |
| 1.575                         | 0.82                                        | 0.84                | 0.85                 | 0.87                 | 0.88                 | 0.89                  |

**Table 2-7 • Temperature and Voltage Derating Factors for Timing Delays (normalized to  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ )**  
For IGLOO V2, 1.2 V DC Core Supply Voltage

| Array Voltage<br>$V_{CC}$ (V) | Junction Temperature ( $^\circ\text{C}$ ) |                   |                    |                    |                    |                     |
|-------------------------------|-------------------------------------------|-------------------|--------------------|--------------------|--------------------|---------------------|
|                               | $-40^\circ\text{C}$                       | $0^\circ\text{C}$ | $25^\circ\text{C}$ | $70^\circ\text{C}$ | $85^\circ\text{C}$ | $110^\circ\text{C}$ |
| 1.14                          | 0.97                                      | 0.98              | 0.99               | 1.00               | 1.01               | 1.01                |
| 1.2                           | 0.86                                      | 0.87              | 0.89               | 0.89               | 0.90               | 0.91                |
| 1.26                          | 0.79                                      | 0.80              | 0.81               | 0.82               | 0.83               | 0.83                |

## Calculating Power Dissipation

### Quiescent Supply Current

Quiescent supply current ( $I_{DD}$ ) calculation depends on multiple factors, including operating voltages ( $V_{CC}$ ,  $V_{CCI}$ , and  $V_{JTAG}$ ), operating temperature, system clock frequency, and power modes usage. Actel recommends using the PowerCalculator and SmartPower software estimation tools to evaluate the projected static and active power based on the user design, power mode usage, operating voltage, and temperature.

**Table 2-8 • Quiescent Supply Current ( $I_{DD}$ ) Characteristics, IGLOO Flash\*Freeze Mode\***

|                                | Core Voltage | AGL015 | AGL030 | AGL060 | AGL125 | AGL250 | AGL400 | AGL600 | AGL1000 | Units         |
|--------------------------------|--------------|--------|--------|--------|--------|--------|--------|--------|---------|---------------|
| Typical ( $25^\circ\text{C}$ ) | 1.2 V        | 4      | 4      | 8      | 13     | 20     | 27     | 30     | 44      | $\mu\text{A}$ |
|                                | 1.5 V        | 6      | 6      | 10     | 18     | 34     | 51     | 72     | 127     | $\mu\text{A}$ |

\*  $I_{DD}$  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 ( $I_{DD}$ ) Characteristics, IGLOO Sleep Mode ( $V_{CC} = 0\text{ V}$ )\***

|                                                                             | Core Voltage  | AGL015 | AGL030 | AGL060 | AGL125 | AGL250 | AGL400 | AGL600 | AGL1000 | Units         |
|-----------------------------------------------------------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|---------|---------------|
| $V_{CCI}/V_{JTAG} = 1.2\text{ V}$ (per bank) Typical ( $25^\circ\text{C}$ ) | 1.2 V         | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7     | $\mu\text{A}$ |
| $V_{CCI}/V_{JTAG} = 1.5\text{ V}$ (per bank) Typical ( $25^\circ\text{C}$ ) | 1.2 V / 1.5 V | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8     | $\mu\text{A}$ |
| $V_{CCI}/V_{JTAG} = 1.8\text{ V}$ (per bank) Typical ( $25^\circ\text{C}$ ) | 1.2 V / 1.5 V | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9     | $\mu\text{A}$ |
| $V_{CCI}/V_{JTAG} = 2.5\text{ V}$ (per bank) Typical ( $25^\circ\text{C}$ ) | 1.2 V / 1.5 V | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2     | $\mu\text{A}$ |
| $V_{CCI}/V_{JTAG} = 3.3\text{ V}$ (per bank) Typical ( $25^\circ\text{C}$ ) | 1.2 V / 1.5 V | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5     | $\mu\text{A}$ |

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

**Table 2-10 • Quiescent Supply Current ( $I_{DD}$ ) Characteristics, IGLOO Shutdown Mode ( $V_{CC}$ ,  $V_{CCI} = 0\text{ V}$ )\***

|                                | Core Voltage  | AGL015 | AGL030 | Units         |
|--------------------------------|---------------|--------|--------|---------------|
| Typical ( $25^\circ\text{C}$ ) | 1.2 V / 1.5 V | 0      | 0      | $\mu\text{A}$ |

\*  $I_{DD}$  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 2-11 • Quiescent Supply Current ( $I_{DD}$ ), No IGLOO Flash\*Freeze Mode<sup>1</sup>**

|                                                                             | Core Voltage  | AGL015 | AGL030 | AGL060 | AGL125 | AGL250 | AGL400 | AGL600 | AGL1000 | Units |
|-----------------------------------------------------------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|---------|-------|
| <b><math>I_{CCA}</math> Current<sup>2</sup></b>                             |               |        |        |        |        |        |        |        |         |       |
| Typical (25°C)                                                              | 1.2 V         | 5      | 6      | 10     | 13     | 18     | 25     | 28     | 42      | μA    |
|                                                                             | 1.5 V         | 14     | 16     | 20     | 28     | 44     | 66     | 82     | 137     | μA    |
| <b><math>I_{CCI}</math> or <math>I_{JTAG}</math> Current<sup>3, 4</sup></b> |               |        |        |        |        |        |        |        |         |       |
| $V_{CCI}/V_{JTAG} = 1.2$ V (per bank) Typical (25°C)                        | 1.2 V         | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7    | 1.7     | μA    |
| $V_{CCI} / V_{JTAG} = 1.5$ V (per bank) Typical (25°C)                      | 1.2 V / 1.5 V | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8    | 1.8     | μA    |
| $V_{CCI}/V_{JTAG} = 1.8$ V (per bank) Typical (25°C)                        | 1.2 V / 1.5 V | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9    | 1.9     | μA    |
| $V_{CCI}/V_{JTAG} = 2.5$ V (per bank) Typical (25°C)                        | 1.2 V / 1.5 V | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2     | μA    |
| $V_{CCI}/V_{JTAG} = 3.3$ V (per bank) Typical (25°C)                        | 1.2 V / 1.5 V | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5    | 2.5     | μA    |

**Notes:**

1. To calculate total device  $I_{DD}$ , multiply the number of banks used by  $I_{CCI}$  and add  $I_{CCA}$  contribution.
2. Includes  $V_{CC}$ ,  $V_{PUMP}$  and  $V_{CCPLL}$  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 2-12 • Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings**  
Applicable to Advanced I/O Banks

|                                | $V_{CCI}$ (V) | Static Power<br>$P_{DC6}$ (mW) <sup>1</sup> | Dynamic Power<br>$P_{AC9}$ (μW/MHz) <sup>2</sup> |
|--------------------------------|---------------|---------------------------------------------|--------------------------------------------------|
| <b>Single-Ended</b>            |               |                                             |                                                  |
| 3.3 V LVTTTL /<br>3.3 V LVCMOS | 3.3           | –                                           | 16.27                                            |
| 2.5 V LVCMOS                   | 2.5           | –                                           | 4.65                                             |
| 1.8 V LVCMOS                   | 1.8           | –                                           | 1.61                                             |
| 1.5 V LVCMOS (JESD8-11)        | 1.5           | –                                           | 0.96                                             |
| 1.2 V LVCMOS <sup>3</sup>      | 1.2           | –                                           | 0.58                                             |
| 3.3 V PCI                      | 3.3           | –                                           | 17.67                                            |
| 3.3 V PCI-X                    | 3.3           | –                                           | 17.67                                            |
| <b>Differential</b>            |               |                                             |                                                  |
| LVDS                           | 2.5           | 2.26                                        | 0.89                                             |
| LVPECL                         | 3.3           | 5.72                                        | 1.63                                             |

**Notes:**

1.  $P_{DC6}$  is the static power (where applicable) measured on  $V_{CCI}$ .
2.  $P_{AC9}$  is the total dynamic power measured on  $V_{CCI}$ .
3. Applicable for IGLOO V2 devices only

**Table 2-13 • Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings**  
Applicable to Standard Plus I/O Banks

|                                | $V_{CCI}$ (V) | Static Power<br>$P_{DC6}$ (mW) <sup>1</sup> | Dynamic Power<br>$P_{AC9}$ (μW/MHz) <sup>2</sup> |
|--------------------------------|---------------|---------------------------------------------|--------------------------------------------------|
| <b>Single-Ended</b>            |               |                                             |                                                  |
| 3.3 V LVTTTL /<br>3.3 V LVCMOS | 3.3           | –                                           | 16.41                                            |
| 2.5 V LVCMOS                   | 2.5           | –                                           | 4.75                                             |
| 1.8 V LVCMOS                   | 1.8           | –                                           | 1.66                                             |
| 1.5 V LVCMOS (JESD8-11)        | 1.5           | –                                           | 1.00                                             |
| 1.2 V LVCMOS <sup>3</sup>      | 1.2           | –                                           | 0.61                                             |
| 3.3 V PCI                      | 3.3           | –                                           | 17.78                                            |
| 3.3 V PCI-X                    | 3.3           | –                                           | 17.78                                            |

**Notes:**

1.  $P_{DC6}$  is the static power (where applicable) measured on  $V_{CCI}$ .
2.  $P_{AC9}$  is the total dynamic power measured on  $V_{CCI}$ .
3. Applicable for IGLOO V2 devices only.

**Table 2-14 • Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings**  
Applicable to Standard I/O Banks

|                             | $V_{CCI}$ (V) | Static Power<br>$P_{DC6}$ (mW) <sup>1</sup> | Dynamic Power<br>$P_{AC9}$ (μW/MHz) <sup>2</sup> |
|-----------------------------|---------------|---------------------------------------------|--------------------------------------------------|
| <b>Single-Ended</b>         |               |                                             |                                                  |
| 3.3 V LVTTTL / 3.3 V LVCMOS | 3.3           | –                                           | 17.24                                            |
| 2.5 V LVCMOS                | 2.5           | –                                           | 5.64                                             |
| 1.8 V LVCMOS                | 1.8           | –                                           | 2.63                                             |
| 1.5 V LVCMOS (JESD8-11)     | 1.5           | –                                           | 1.97                                             |
| 1.2 V LVCMOS <sup>3</sup>   | 1.2           | –                                           | 0.57                                             |

**Notes:**

1.  $P_{DC6}$  is the static power (where applicable) measured on  $V_{CCI}$ .
2.  $P_{AC9}$  is the total dynamic power measured on  $V_{CCI}$ .
3. Applicable for IGLOO V2 devices only.

**Table 2-15 • Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings<sup>1</sup>**  
Applicable to Advanced I/O Banks

|                             | $C_{LOAD}$ (pF) | $V_{CCI}$ (V) | Static Power<br>$P_{DC7}$ (mW) <sup>2</sup> | Dynamic Power<br>$P_{AC10}$ (μW/MHz) <sup>3</sup> |
|-----------------------------|-----------------|---------------|---------------------------------------------|---------------------------------------------------|
| <b>Single-Ended</b>         |                 |               |                                             |                                                   |
| 3.3 V LVTTTL / 3.3 V LVCMOS | 5               | 3.3           | –                                           | 136.95                                            |
| 2.5 V LVCMOS                | 5               | 2.5           | –                                           | 76.84                                             |
| 1.8 V LVCMOS                | 5               | 1.8           | –                                           | 49.31                                             |
| 1.5 V LVCMOS (JESD8-11)     | 5               | 1.5           | –                                           | 33.36                                             |
| 1.2 V LVCMOS <sup>4</sup>   | 5               | 1.2           | –                                           | 16.24                                             |
| 3.3 V PCI                   | 10              | 3.3           | –                                           | 194.05                                            |
| 3.3 V PCI-X                 | 10              | 3.3           | –                                           | 194.05                                            |
| <b>Differential</b>         |                 |               |                                             |                                                   |
| LVDS                        | –               | 2.5           | 7.74                                        | 78.72                                             |
| LVPECL                      | –               | 3.3           | 19.54                                       | 143.99                                            |

**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  $V_{CCI}$ .
4. Applicable for IGLOO V2 devices only.

**Table 2-16 • Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings<sup>1</sup>**  
Applicable to Standard Plus I/O Banks

|                             | $C_{LOAD}$ (pF) | $V_{CCI}$ (V) | Static Power<br>$P_{DC7}$ (mW) <sup>2</sup> | Dynamic Power<br>$P_{AC10}$ (μW/MHz) <sup>3</sup> |
|-----------------------------|-----------------|---------------|---------------------------------------------|---------------------------------------------------|
| <b>Single-Ended</b>         |                 |               |                                             |                                                   |
| 3.3 V LVTTTL / 3.3 V LVCMOS | 5               | 3.3           | –                                           | 122.16                                            |
| 2.5 V LVCMOS                | 5               | 2.5           | –                                           | 68.37                                             |
| 1.8 V LVCMOS                | 5               | 1.8           | –                                           | 34.53                                             |
| 1.5 V LVCMOS (JESD8-11)     | 5               | 1.5           | –                                           | 23.66                                             |
| 1.2 V LVCMOS <sup>4</sup>   | 5               | 1.2           | –                                           | 14.90                                             |
| 3.3 V PCI                   | 10              | 3.3           | –                                           | 181.06                                            |
| 3.3 V PCI-X                 | 10              | 3.3           | –                                           | 181.06                                            |

**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  $V_{CCI}$ .
4. Applicable for IGLOO V2 devices only.

**Table 2-17 • Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings<sup>1</sup>**  
Applicable to Standard I/O Banks

|                             | $C_{LOAD}$ (pF) | $V_{CCI}$ (V) | Static Power<br>$P_{DC7}$ (mW) <sup>2</sup> | Dynamic Power<br>$P_{AC10}$ (μW/MHz) <sup>3</sup> |
|-----------------------------|-----------------|---------------|---------------------------------------------|---------------------------------------------------|
| <b>Single-Ended</b>         |                 |               |                                             |                                                   |
| 3.3 V LVTTTL / 3.3 V LVCMOS | 5               | 3.3           | –                                           | 104.38                                            |
| 2.5 V LVCMOS                | 5               | 2.5           | –                                           | 59.86                                             |
| 1.8 V LVCMOS                | 5               | 1.8           | –                                           | 31.26                                             |
| 1.5 V LVCMOS (JESD8-11)     | 5               | 1.5           | –                                           | 21.96                                             |
| 1.2 V LVCMOS <sup>4</sup>   | 5               | 1.2           | –                                           | 13.49                                             |

**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  $V_{CCI}$ .
4. Applicable for IGLOO V2 devices only.

## Power Consumption of Various Internal Resources

**Table 2-18 • Different Components Contributing to Dynamic Power Consumption in IGLOO Devices**  
For IGLOO V2 or V5 Devices, 1.5 V DC Core Supply Voltage

| Parameter         | Definition                                                     | Device Specific Dynamic Power<br>( $\mu\text{W}/\text{MHz}$ ) |        |        |        |        |        |        |        |
|-------------------|----------------------------------------------------------------|---------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|
|                   |                                                                | AGL1000                                                       | AGL600 | AGL400 | AGL250 | AGL125 | AGL060 | AGL030 | AGL015 |
| P <sub>AC1</sub>  | Clock contribution of a Global Rib                             | 14.48                                                         | 12.77  | 12.77  | 11.03  | 11.03  | 9.3    | 9.3    | 9.3    |
| P <sub>AC2</sub>  | Clock contribution of a Global Spine                           | 2.48                                                          | 1.85   | 1.58   | 1.58   | 0.81   | 0.81   | 0.41   | 0.41   |
| P <sub>AC3</sub>  | Clock contribution of a VersaTile row                          | 0.81                                                          |        |        |        |        |        |        |        |
| P <sub>AC4</sub>  | Clock contribution of a VersaTile used as a sequential module  | 0.11                                                          |        |        |        |        |        |        |        |
| P <sub>AC5</sub>  | First contribution of a VersaTile used as a sequential module  | 0.057                                                         |        |        |        |        |        |        |        |
| P <sub>AC6</sub>  | Second contribution of a VersaTile used as a sequential module | 0.207                                                         |        |        |        |        |        |        |        |
| P <sub>AC7</sub>  | Contribution of a VersaTile used as a combinatorial module     | 0.17                                                          |        |        |        |        |        |        |        |
| P <sub>AC8</sub>  | Average contribution of a routing net                          | 0.7                                                           |        |        |        |        |        |        |        |
| P <sub>AC9</sub>  | Contribution of an I/O input pin (standard-dependent)          | See Table 2-12 on page 2-9 through Table 2-14 on page 2-10.   |        |        |        |        |        |        |        |
| P <sub>AC10</sub> | Contribution of an I/O output pin (standard-dependent)         | See Table 2-15 on page 2-10 through Table 2-17 on page 2-11.  |        |        |        |        |        |        |        |
| P <sub>AC11</sub> | Average contribution of a RAM block during a read operation    | 25.00                                                         |        |        |        |        |        |        |        |
| P <sub>AC12</sub> | Average contribution of a RAM block during a write operation   | 30.00                                                         |        |        |        |        |        |        |        |
| P <sub>AC13</sub> | Dynamic PLL contribution                                       | 2.70                                                          |        |        |        |        |        |        |        |

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

**Table 2-19 • Different Components Contributing to the Static Power Consumption in IGLOO Devices**  
For IGLOO V2 or V5 Devices, 1.5 V DC Core Supply Voltage

| Parameter        | Definition                                         | Device-Specific Static Power (mW)                            |        |        |        |        |        |        |        |
|------------------|----------------------------------------------------|--------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|
|                  |                                                    | AGL1000                                                      | AGL600 | AGL400 | AGL250 | AGL125 | AGL060 | AGL030 | AGL015 |
| P <sub>DC1</sub> | Array static power in Active mode                  | See Table 2-11 on page 2-8.                                  |        |        |        |        |        |        |        |
| P <sub>DC2</sub> | Array static power in Static (Idle) mode           | See Table 2-10 on page 2-7.                                  |        |        |        |        |        |        |        |
| P <sub>DC3</sub> | Array static power in Flash*Freeze mode            | See Table 2-8 on page 2-7.                                   |        |        |        |        |        |        |        |
| P <sub>DC4</sub> | Static PLL contribution                            | 1.84                                                         |        |        |        |        |        |        |        |
| P <sub>DC5</sub> | Bank quiescent power (V <sub>CC1</sub> -dependent) | See Table 2-11 on page 2-8.                                  |        |        |        |        |        |        |        |
| P <sub>DC6</sub> | I/O input pin static power (standard-dependent)    | See Table 2-12 on page 2-9 through Table 2-14 on page 2-10.  |        |        |        |        |        |        |        |
| P <sub>DC7</sub> | I/O output pin static power (standard-dependent)   | See Table 2-15 on page 2-10 through Table 2-17 on page 2-11. |        |        |        |        |        |        |        |

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

**Table 2-20 • Different Components Contributing to Dynamic Power Consumption in IGLOO Devices For IGLOO V2 Devices, 1.2 V DC Core Supply Voltage**

| Parameter         | Definition                                                     | Device Specific Dynamic Power<br>( $\mu\text{W}/\text{MHz}$ ) |        |        |        |        |        |        |        |
|-------------------|----------------------------------------------------------------|---------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|
|                   |                                                                | AGL1000                                                       | AGL600 | AGL400 | AGL250 | AGL125 | AGL060 | AGL030 | AGL015 |
| P <sub>AC1</sub>  | Clock contribution of a Global Rib                             | 9.28                                                          | 8.19   | 8.19   | 7.07   | 7.07   | 5.96   | 5.96   | 5.96   |
| P <sub>AC2</sub>  | Clock contribution of a Global Spine                           | 1.59                                                          | 1.19   | 1.01   | 1.01   | 0.52   | 0.52   | 0.26   | 0.26   |
| P <sub>AC3</sub>  | Clock contribution of a VersaTile row                          | 0.52                                                          |        |        |        |        |        |        |        |
| P <sub>AC4</sub>  | Clock contribution of a VersaTile used as a sequential module  | 0.07                                                          |        |        |        |        |        |        |        |
| P <sub>AC5</sub>  | First contribution of a VersaTile used as a sequential module  | 0.045                                                         |        |        |        |        |        |        |        |
| P <sub>AC6</sub>  | Second contribution of a VersaTile used as a sequential module | 0.186                                                         |        |        |        |        |        |        |        |
| P <sub>AC7</sub>  | Contribution of a VersaTile used as a combinatorial module     | 0.11                                                          |        |        |        |        |        |        |        |
| P <sub>AC8</sub>  | Average contribution of a routing net                          | 0.45                                                          |        |        |        |        |        |        |        |
| P <sub>AC9</sub>  | Contribution of an I/O input pin (standard-dependent)          | See Table 2-12 on page 2-9 through Table 2-14 on page 2-10.   |        |        |        |        |        |        |        |
| P <sub>AC10</sub> | Contribution of an I/O output pin (standard-dependent)         | See Table 2-15 on page 2-10 through Table 2-17 on page 2-11.  |        |        |        |        |        |        |        |
| P <sub>AC11</sub> | Average contribution of a RAM block during a read operation    | 25.00                                                         |        |        |        |        |        |        |        |
| P <sub>AC12</sub> | Average contribution of a RAM block during a write operation   | 30.00                                                         |        |        |        |        |        |        |        |
| P <sub>AC13</sub> | Dynamic PLL contribution                                       | 2.10                                                          |        |        |        |        |        |        |        |

\* For a different output load, drive strength, or slew rate, Actel recommends using the Actel power spreadsheet calculator or SmartPower tool in Libero IDE.

**Table 2-21 • Different Components Contributing to the Static Power Consumption in IGLOO Device For IGLOO V2 Devices, 1.2 V DC Core Supply Voltage**

| Parameter        | Definition                                         | Device Specific Static Power (mW)                            |        |        |        |        |        |        |        |
|------------------|----------------------------------------------------|--------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|
|                  |                                                    | AGL1000                                                      | AGL600 | AGL400 | AGL250 | AGL125 | AGL060 | AGL030 | AGL015 |
| P <sub>DC1</sub> | Array static power in Active mode                  | See Table 2-11 on page 2-8.                                  |        |        |        |        |        |        |        |
| P <sub>DC2</sub> | Array static power in Static (Idle) mode           | See Table 2-10 on page 2-7.                                  |        |        |        |        |        |        |        |
| P <sub>DC3</sub> | Array static power in Flash*Freeze mode            | See Table 2-8 on page 2-7.                                   |        |        |        |        |        |        |        |
| P <sub>DC4</sub> | Static PLL contribution                            | 0.90                                                         |        |        |        |        |        |        |        |
| P <sub>DC5</sub> | Bank quiescent power (V <sub>CC1</sub> -Dependent) | See Table 2-11 on page 2-8.                                  |        |        |        |        |        |        |        |
| P <sub>DC6</sub> | I/O input pin static power (standard-dependent)    | See Table 2-12 on page 2-9 through Table 2-14 on page 2-10.  |        |        |        |        |        |        |        |
| P <sub>DC7</sub> | I/O output pin static power (standard-dependent)   | See Table 2-15 on page 2-10 through Table 2-17 on page 2-11. |        |        |        |        |        |        |        |

\* For a different output load, drive strength, or slew rate, Actel recommends using the Actel power spreadsheet calculator or SmartPower tool in Actel 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 2-22 on page 2-18](#).
- Enable rates of output buffers—guidelines are provided for typical applications in [Table 2-23 on page 2-18](#).
- Read rate and write rate to the memory—guidelines are provided for typical applications in [Table 2-23 on page 2-18](#). 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 2-22 on page 2-18](#).

$N_{ROW}$  is the number of VersaTile rows used in the design—guidelines are provided in [Table 2-22 on page 2-18](#).

$F_{CLK}$  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.

$\alpha_1$  is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-22 on page 2-18](#).

$F_{CLK}$  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.

$\alpha_1$  is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-22 on page 2-18](#).

$F_{CLK}$  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.

$\alpha_1$  is the toggle rate of VersaTile outputs—guidelines are provided in [Table 2-22 on page 2-18](#).

$F_{CLK}$  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.

$\alpha_2$  is the I/O buffer toggle rate—guidelines are provided in [Table 2-22 on page 2-18](#).

$F_{CLK}$  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.

$\alpha_2$  is the I/O buffer toggle rate—guidelines are provided in [Table 2-22 on page 2-18](#).

$\beta_1$  is the I/O buffer enable rate—guidelines are provided in [Table 2-23 on page 2-18](#).

$F_{CLK}$  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.

$\beta_2$  is the RAM enable rate for read operations.

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

$\beta_3$  is the RAM enable rate for write operations—guidelines are provided in [Table 2-23 on page 2-18](#).

### PLL Contribution— $P_{PLL}$

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

$F_{CLKOUT}$  is the output clock frequency.<sup>1</sup>

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 2-22 • Toggle Rate Guidelines Recommended for Power Calculation**

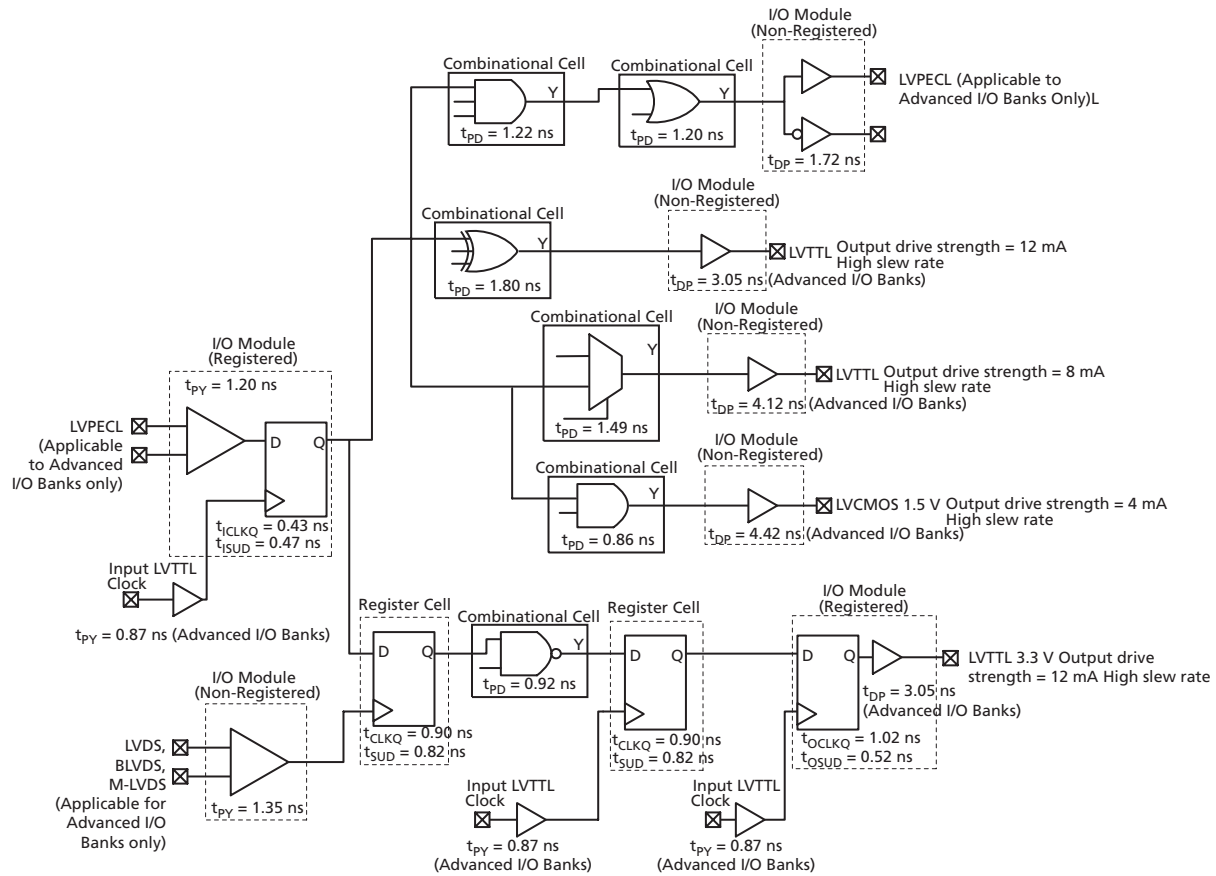
| Component  | Definition                       | Guideline |
|------------|----------------------------------|-----------|
| $\alpha_1$ | Toggle rate of VersaTile outputs | 10%       |
| $\alpha_2$ | I/O buffer toggle rate           | 10%       |

**Table 2-23 • Enable Rate Guidelines Recommended for Power Calculation**

| Component | Definition                           | Guideline |
|-----------|--------------------------------------|-----------|
| $\beta_1$ | I/O output buffer enable rate        | 100%      |
| $\beta_2$ | RAM enable rate for read operations  | 12.5%     |
| $\beta_3$ | RAM enable rate for write operations | 12.5%     |

# User I/O Characteristics

## Timing Model



**Figure 2-3 • Timing Model**

**Operating Conditions: Std. Speed, Commercial Temperature Range ( $T_J = 70^\circ\text{C}$ ), Worst-Case  $V_{CC} = 1.425$  V, for DC 1.5 V Core Voltage, Applicable to V2 and V5 Devices**

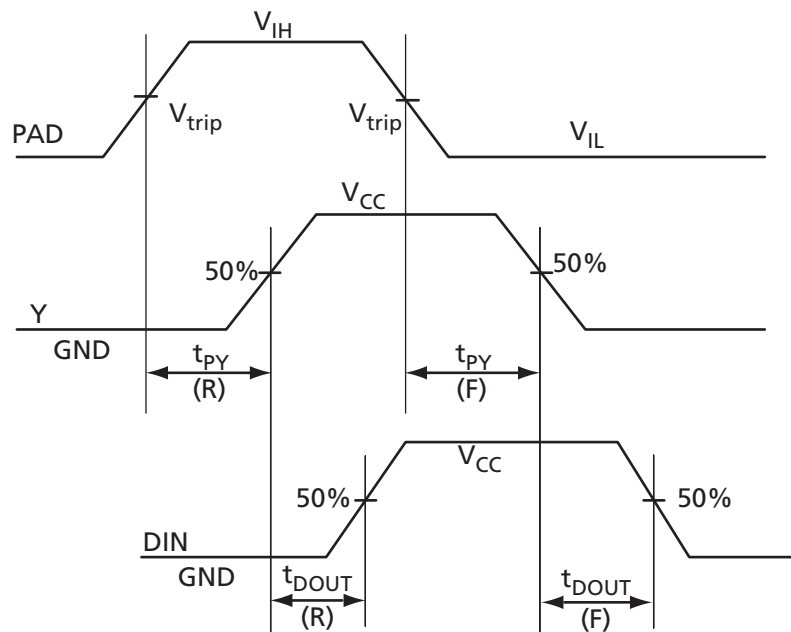
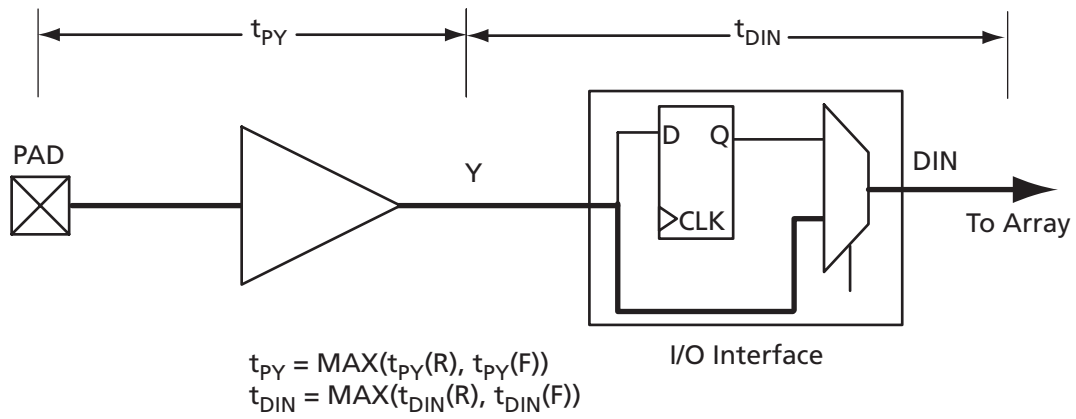


Figure 2-4 • Input Buffer Timing Model and Delays (example)

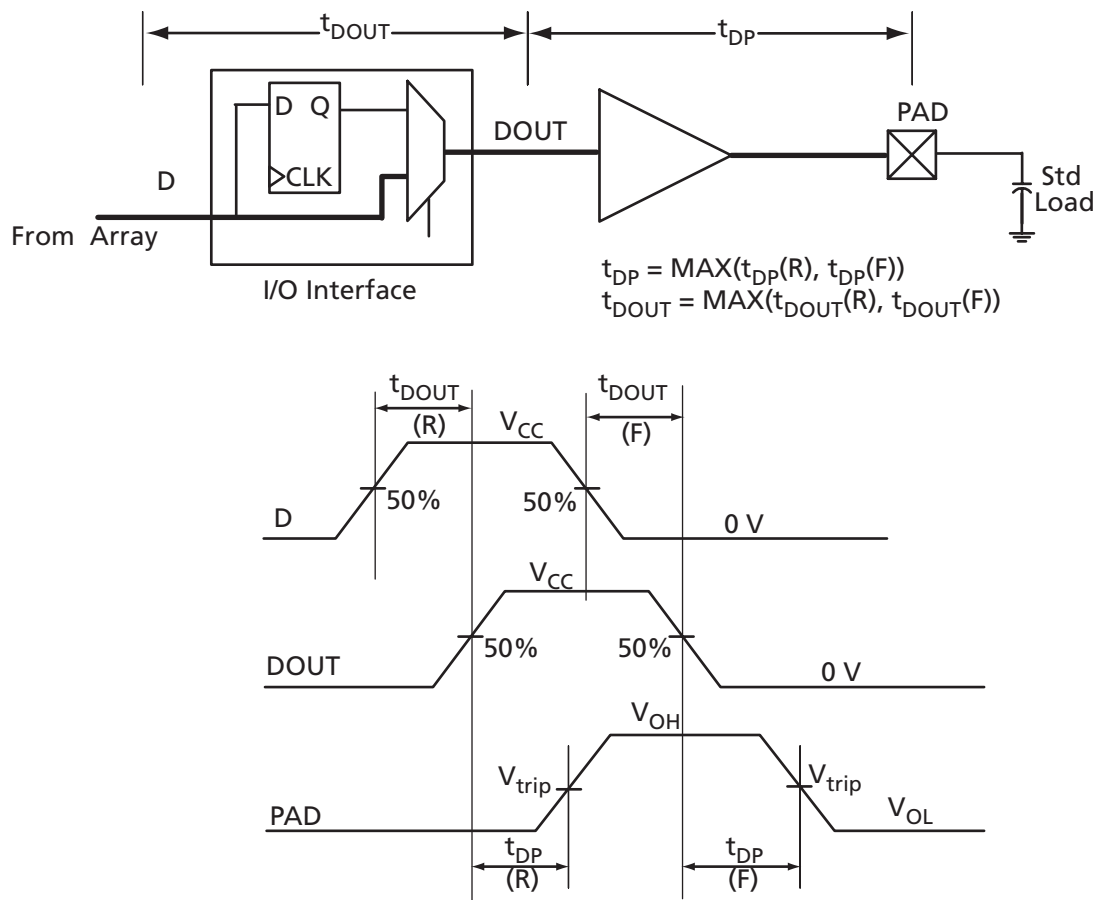


Figure 2-5 • Output Buffer Model and Delays (example)

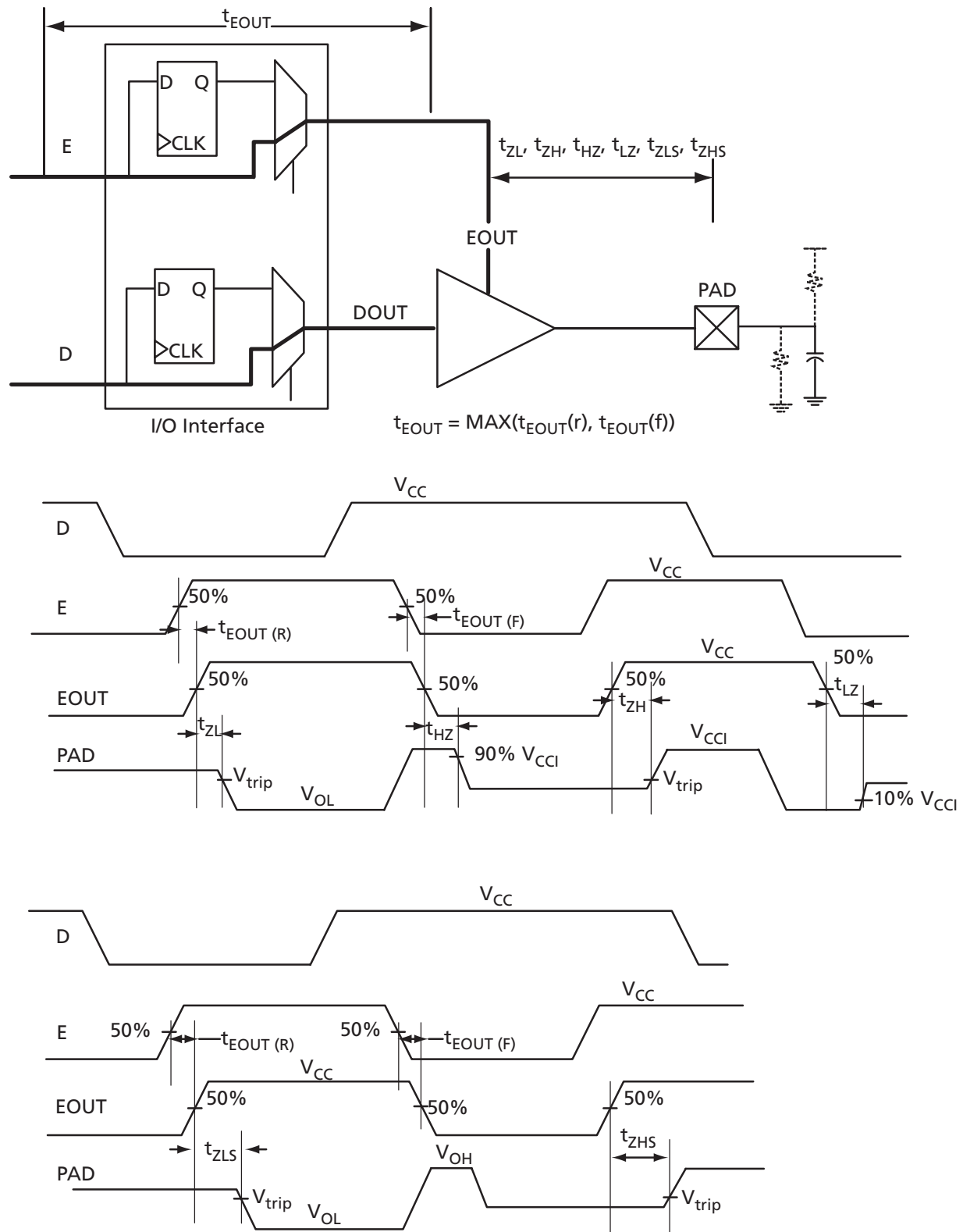


Figure 2-6 • Tristate Output Buffer Timing Model and Delays (example)

## Overview of I/O Performance

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

**Table 2-24 • Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings**  
Applicable to Advanced I/O Banks

| I/O Standard                | Drive Strength           | Slew Rate | V <sub>IL</sub> |                        | V <sub>IH</sub>        |         | V <sub>OL</sub>        | V <sub>OH</sub>        | I <sub>OL</sub> <sup>1</sup> | I <sub>OH</sub> <sup>1</sup> |
|-----------------------------|--------------------------|-----------|-----------------|------------------------|------------------------|---------|------------------------|------------------------|------------------------------|------------------------------|
|                             |                          |           | 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                           |
| 3.3 V LVCMOS Wide Range     | Any <sup>2</sup>         | High      | –0.3            | 0.8                    | 2                      | 3.6     | 0.2                    | V <sub>CC</sub> – 0.2  | 0.1                          | 0.1                          |
| 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 <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.9     | 0.45                   | V <sub>CC</sub> – 0.45 | 12                           | 12                           |
| 1.5 V LVCMOS                | 12 mA                    | High      | –0.3            | 0.35 * V <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.575   | 0.25 * V <sub>CC</sub> | 0.75 * V <sub>CC</sub> | 12                           | 12                           |
| 1.2 V LVCMOS <sup>3</sup>   | 2 mA                     | High      | –0.3            | 0.35 * V <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.26    | 0.25 * V <sub>CC</sub> | 0.75 * V <sub>CC</sub> | 2                            | 2                            |
| 3.3 V PCI                   | Per PCI specifications   |           |                 |                        |                        |         |                        |                        |                              |                              |
| 3.3 V PCI-X                 | Per PCI-X specifications |           |                 |                        |                        |         |                        |                        |                              |                              |

#### Notes:

1. Currents are measured at 85°C junction temperature.
2. All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JDEC8a specification.
3. Applicable to V2 Devices only.

**Table 2-25 • Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings**  
Applicable to Standard Plus I/O Banks

| I/O Standard                | Drive Strength           | Slew Rate | V <sub>IL</sub> |                        | V <sub>IH</sub>        |         | V <sub>OL</sub>        | V <sub>OH</sub>        | I <sub>OL</sub> | I <sub>OH</sub> |
|-----------------------------|--------------------------|-----------|-----------------|------------------------|------------------------|---------|------------------------|------------------------|-----------------|-----------------|
|                             |                          |           | 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              |
| 3.3 V LVCMOS Wide Range     | Any <sup>2</sup>         | High      | –0.3            | 0.8                    | 2                      | 3.6     | 0.2                    | V <sub>CC</sub> – 0.2  | 0.1             | 0.1             |
| 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                | 8 mA                     | High      | –0.3            | 0.35 * V <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.9     | 0.45                   | V <sub>CC</sub> – 0.45 | 8               | 8               |
| 1.5 V LVCMOS                | 4 mA                     | High      | –0.3            | 0.35 * V <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.575   | 0.25 * V <sub>CC</sub> | 0.75 * V <sub>CC</sub> | 4               | 4               |
| 1.2 V LVCMOS <sup>3</sup>   | 2 mA                     | High      | –0.3            | 0.35 * V <sub>CC</sub> | 0.65 * V <sub>CC</sub> | 1.26    | 0.25 * V <sub>CC</sub> | 0.75 * V <sub>CC</sub> | 2               | 2               |
| 3.3 V PCI                   | Per PCI specifications   |           |                 |                        |                        |         |                        |                        |                 |                 |
| 3.3 V PCI-X                 | Per PCI-X specifications |           |                 |                        |                        |         |                        |                        |                 |                 |

#### Notes:

1. Currents are measured at 85°C junction temperature.
2. All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JDEC8a specification.
3. Applicable to V2 Devices only.

**Table 2-26 • Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings**  
Applicable to Standard I/O Banks

| 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 | 8 mA             | High      | −0.3     | 0.8              | 2                | 3.6    | 0.4              | 2.4              | 8          | 8          |
| 3.3 V LVCMOS Wide Range     | Any <sup>2</sup> | High      | −0.3     | 0.8              | 2                | 3.6    | 0.2              | $V_{CC1} - 0.2$  | 0.1        | 0.1        |
| 2.5 V LVCMOS                | 8 mA             | High      | −0.3     | 0.7              | 1.7              | 2.7    | 0.7              | 1.7              | 8          | 8          |
| 1.8 V LVCMOS                | 4 mA             | High      | −0.3     | $0.35 * V_{CC1}$ | $0.65 * V_{CC1}$ | 1.9    | 0.45             | $V_{CC1} - 0.45$ | 4          | 4          |
| 1.5 V LVCMOS                | 2 mA             | High      | −0.3     | $0.35 * V_{CC1}$ | $0.65 * V_{CC1}$ | 1.575  | $0.25 * V_{CC1}$ | $0.75 * V_{CC1}$ | 2          | 2          |
| 1.2 V LVCMOS <sup>3</sup>   | 1 mA             | High      | −0.3     | $0.35 * V_{CC1}$ | $0.65 * V_{CC1}$ | 1.26   | $0.25 * V_{CC1}$ | $0.75 * V_{CC1}$ | 1          | 1          |

**Notes:**

1. Currents are measured at 85°C junction temperature.
2. All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JDEC8a specification.
3. Applicable to V2 Devices only.

**Table 2-27 • Summary of Maximum and Minimum DC Input Levels**  
Applicable to Commercial and Industrial Conditions

| DC I/O Standards            | Commercial <sup>1</sup> |          | Industrial <sup>2</sup> |          |
|-----------------------------|-------------------------|----------|-------------------------|----------|
|                             | $I_{IL}$                | $I_{IH}$ | $I_{IL}$                | $I_{IH}$ |
|                             | μA                      | μA       | μA                      | μA       |
| 3.3 V LVTTTL / 3.3 V LVCMOS | 10                      | 10       | 15                      | 15       |
| 3.3 V LVCMOS Wide Range     | 10                      | 10       | 15                      | 15       |
| 2.5 V LVCMOS                | 10                      | 10       | 15                      | 15       |
| 1.8 V LVCMOS                | 10                      | 10       | 15                      | 15       |
| 1.5 V LVCMOS                | 10                      | 10       | 15                      | 15       |
| 1.2 V LVCMOS <sup>3</sup>   | 10                      | 10       | 15                      | 15       |
| 3.3 V PCI                   | 10                      | 10       | 15                      | 15       |
| 3.3 V PCI-X                 | 10                      | 10       | 15                      | 15       |

**Notes:**

1. Commercial range ( $0^{\circ}\text{C} < T_A < 70^{\circ}\text{C}$ )
2. Industrial range ( $-40^{\circ}\text{C} < T_A < 85^{\circ}\text{C}$ )
3. Applicable to V2 Devices only.



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

**Table 2-28 • Summary of AC Measuring Points**

| Standard                    | 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                | 0.60 V                              |
| 3.3 V PCI                   | $0.285 * V_{CC1} (RR)$              |
|                             | $0.615 * V_{CC1} (FF)$              |
| 3.3 V PCI-X                 | $0.285 * V_{CC1} (RR)$              |
|                             | $0.615 * V_{CC1} (FF)$              |

**Table 2-29 • 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  |

**Table 2-30 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Advanced I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (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 pF                 | –                              | 0.97            | 2.09          | 0.19           | 0.85          | 0.66            | 2.13          | 1.67          | 2.67          | 3.04          | 5.66           | 5.20           | ns    |
| 2.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 0.97            | 2.09          | 0.19           | 1.07          | 0.66            | 2.13          | 1.82          | 2.73          | 2.93          | 5.66           | 5.35           | ns    |
| 1.8 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 0.97            | 2.24          | 0.19           | 1.01          | 0.66            | 2.28          | 1.99          | 3.02          | 3.39          | 5.81           | 5.52           | ns    |
| 1.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 0.97            | 2.50          | 0.19           | 1.17          | 0.66            | 2.55          | 2.26          | 3.20          | 3.48          | 6.08           | 5.79           | ns    |
| 3.3 V PCI                   | Per PCI spec        | High      | 10pF                 | 25 <sup>2</sup>                | 0.97            | 2.32          | 0.19           | 0.73          | 0.66            | 2.36          | 1.77          | 2.67          | 3.04          | 5.89           | 5.30           | ns    |
| 3.3 V PCI-X                 | Per PCI-X spec      | High      | 10pF                 | 25 <sup>2</sup>                | 0.97            | 2.32          | 0.19           | 0.70          | 0.66            | 2.36          | 1.77          | 2.67          | 3.04          | 5.89           | 5.30           | ns    |
| LVDS                        | 24 mA               | High      | –                    | –                              | 0.97            | 1.67          | 0.19           | 1.31          | –               | –             | –             | –             | –             | –              | –              | ns    |
| LVPECL                      | 24 mA               | High      | –                    | –                              | 0.97            | 1.67          | 0.19           | 1.16          | –               | –             | –             | –             | –             | –              | –              | ns    |

**Notes:**

1. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

**Table 2-31 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Standard Plus I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (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 pF                 | –                              | 0.97            | 1.75          | 0.19           | 0.85          | 0.66            | 1.78          | 1.39          | 2.36          | 2.79          | 5.31           | 4.92           | ns    |
| 2.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 0.97            | 1.75          | 0.19           | 1.08          | 0.66            | 1.78          | 1.51          | 2.38          | 2.69          | 5.32           | 5.04           | ns    |
| 1.8 V LVCMOS                | 8 mA                | High      | 5 pF                 | –                              | 0.97            | 1.97          | 0.19           | 1.01          | 0.66            | 2.01          | 1.76          | 2.46          | 2.66          | 5.54           | 5.29           | ns    |
| 1.5 V LVCMOS                | 4 mA                | High      | 5 pF                 | –                              | 0.97            | 2.25          | 0.19           | 1.17          | 0.66            | 2.29          | 1.99          | 2.53          | 2.68          | 5.82           | 5.52           | ns    |
| 3.3 V PCI                   | Per PCI spec        | High      | 10pF                 | 25 <sup>2</sup>                | 0.97            | 1.96          | 0.19           | 0.73          | 0.66            | 2.00          | 1.50          | 2.36          | 2.79          | 5.53           | 5.03           | ns    |
| 3.3 V PCI-X                 | Per PCI-X spec      | High      | 10pF                 | 25 <sup>2</sup>                | 0.97            | 1.96          | 0.19           | 0.70          | 0.66            | 2.00          | 1.50          | 2.36          | 2.79          | 5.53           | 5.03           | ns    |

**Notes:**

1. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

**Table 2-32 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Standard I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (ns) | $t_{EOUT}$ (ns) | $t_{ZL}$ (ns) | $t_{ZH}$ (ns) | $t_{LZ}$ (ns) | $t_{HZ}$ (ns) | Units |
|-----------------------------|---------------------|-----------|----------------------|--------------------------------|-----------------|---------------|----------------|---------------|-----------------|---------------|---------------|---------------|---------------|-------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 8 mA                | High      | 5 pF                 | –                              | 0.97            | 1.85          | 0.19           | 0.83          | 0.66            | 1.88          | 1.45          | 1.96          | 2.26          | ns    |
| 2.5 V LVCMOS                | 8 mA                | High      | 5 pF                 | –                              | 0.97            | 1.88          | 0.19           | 1.04          | 0.66            | 1.92          | 1.62          | 1.95          | 2.14          | ns    |
| 1.8 V LVCMOS                | 4 mA                | High      | 5 pF                 | –                              | 0.97            | 2.18          | 0.19           | 0.98          | 0.66            | 2.22          | 1.93          | 1.96          | 2.06          | ns    |
| 1.5 V LVCMOS                | 2 mA                | High      | 5 pF                 | –                              | 0.97            | 2.51          | 0.19           | 1.13          | 0.66            | 2.56          | 2.20          | 1.99          | 2.03          | ns    |

**Notes:**

1. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

**Table 2-33 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Advanced I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (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 pF                 | –                              | 1.55            | 2.66          | 0.26           | 0.98          | 1.10            | 2.71          | 2.18          | 3.23          | 3.92          | 8.52           | 7.99           | ns    |
| 2.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 1.55            | 2.63          | 0.26           | 1.20          | 1.10            | 2.68          | 2.30          | 3.28          | 3.77          | 8.48           | 8.10           | ns    |
| 1.8 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 1.55            | 2.71          | 0.26           | 1.11          | 1.10            | 2.76          | 2.44          | 3.56          | 4.17          | 8.57           | 8.24           | ns    |
| 1.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 1.55            | 2.95          | 0.26           | 1.27          | 1.10            | 3.00          | 2.70          | 3.74          | 4.21          | 8.81           | 8.51           | ns    |
| 1.2 V LVCMOS                | 2 mA                | High      | 5 p                  | –                              | 1.55            | 3.61          | 0.26           | 1.58          | 1.10            | 3.45          | 3.33          | 3.94          | 3.66          | 9.05           | 8.93           | ns    |
| 3.3 V PCI                   | Per PCI spec        | High      | 10pF                 | 25 <sup>2</sup>                | 1.55            | 2.90          | 0.26           | 0.86          | 1.10            | 2.95          | 2.29          | 3.23          | 3.92          | 8.76           | 8.10           | ns    |
| 3.3 V PCI-X                 | Per PCI-X spec      | High      | 10pF                 | 25 <sup>2</sup>                | 1.55            | 2.90          | 0.25           | 0.86          | 1.10            | 2.95          | 2.29          | 3.23          | 3.92          | 8.76           | 8.10           | ns    |
| LVDS                        | 24 mA               | High      | –                    | –                              | 1.55            | 2.19          | 0.25           | 1.52          | –               | –             | –             | –             | –             | –              | –              | ns    |
| LVPECL                      | 24 mA               | High      | –                    | –                              | 1.55            | 2.24          | 0.25           | 1.37          | –               | –             | –             | –             | –             | –              | –              | ns    |

**Notes:**

1. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.
2. Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

**Table 2-34 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Standard Plus I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (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 pF                 | –                              | 1.55            | 2.30          | 0.26           | 0.97          | 1.10            | 2.34          | 1.87          | 2.91          | 3.62          | 8.15           | 7.67           | ns    |
| 2.5 V LVCMOS                | 12 mA               | High      | 5 pF                 | –                              | 1.55            | 2.28          | 0.26           | 1.20          | 1.10            | 2.32          | 1.95          | 2.92          | 3.50          | 8.13           | 7.75           | ns    |
| 1.8 V LVCMOS                | 8 mA                | High      | 5 pF                 | –                              | 1.55            | 2.42          | 0.26           | 1.11          | 1.10            | 2.47          | 2.16          | 2.98          | 3.38          | 8.28           | 7.97           | ns    |
| 1.5 V LVCMOS                | 4 mA                | High      | 5 pF                 | –                              | 1.55            | 2.67          | 0.26           | 1.27          | 1.10            | 2.72          | 2.39          | 3.05          | 3.36          | 8.53           | 8.20           | ns    |
| 1.2 V LVCMOS                | 2 mA                | High      | 5 pF                 | –                              | 1.55            | 3.23          | 0.26           | 1.58          | 1.10            | 3.09          | 2.76          | 3.30          | 3.49          | 8.69           | 8.36           | ns    |
| 3.3 V PCI                   | Per PCI spec        | High      | 10pF                 | 25 <sup>2</sup>                | 1.55            | 2.52          | 0.26           | 0.85          | 1.10            | 2.57          | 1.98          | 2.91          | 3.62          | 8.37           | 7.78           | ns    |
| 3.3 V PCI-X                 | Per PCI-X spec      | High      | 10pF                 | 25 <sup>2</sup>                | 1.55            | 2.52          | 0.25           | 0.85          | 1.10            | 2.57          | 1.98          | 2.91          | 3.62          | 8.37           | 7.78           | ns    |

**Notes:**

- For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.
- Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

**Table 2-35 • Summary of I/O Timing Characteristics—Software Default Settings, Std. Speed Grade, Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$**   
Applicable to Standard I/O Banks

| I/O Standard                | Drive Strength (mA) | Slew Rate | Capacitive Load (pF) | External Resistor ( $\Omega$ ) | $t_{DOUT}$ (ns) | $t_{DP}$ (ns) | $t_{DIN}$ (ns) | $t_{PY}$ (ns) | $t_{EOUT}$ (ns) | $t_{ZL}$ (ns) | $t_{ZH}$ (ns) | $t_{LZ}$ (ns) | $t_{HZ}$ (ns) | Units |
|-----------------------------|---------------------|-----------|----------------------|--------------------------------|-----------------|---------------|----------------|---------------|-----------------|---------------|---------------|---------------|---------------|-------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 8 mA                | High      | 5 pF                 | –                              | 1.55            | 2.37          | 0.26           | 0.94          | 1.10            | 2.42          | 1.92          | 2.39          | 2.94          | ns    |
| 2.5 V LVCMOS                | 8 mA                | High      | 5 pF                 | –                              | 1.55            | 2.38          | 0.26           | 1.15          | 1.10            | 2.42          | 2.05          | 2.37          | 2.79          | ns    |
| 1.8 V LVCMOS                | 4 mA                | High      | 5 pF                 | –                              | 1.55            | 2.60          | 0.26           | 1.08          | 1.10            | 2.64          | 2.33          | 2.37          | 2.61          | ns    |
| 1.5 V LVCMOS                | 2 mA                | High      | 5 pF                 | –                              | 1.55            | 2.91          | 0.26           | 1.22          | 1.10            | 2.96          | 2.60          | 2.39          | 2.54          | ns    |
| 1.2 V LVCMOS                | 1 mA                | High      | 5 pF                 | –                              | 1.55            | 3.60          | 0.26           | 1.52          | 1.10            | 3.45          | 3.04          | 2.52          | 2.50          | ns    |

**Notes:**

- For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.
- Resistance is used to measure I/O propagation delays as defined in PCI specifications. See [Figure 2-12 on page 2-62](#) for connectivity. This resistor is not required during normal operation.

## Detailed I/O DC Characteristics

**Table 2-36 • Input Capacitance**

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

**Table 2-37 • I/O Output Buffer Maximum Resistances<sup>1</sup>**  
**Applicable to Advanced I/O Banks**

| Standard                    | Drive Strength              | $R_{PULL-DOWN}$<br>( $\Omega$ ) <sup>2</sup> | $R_{PULL-UP}$<br>( $\Omega$ ) <sup>3</sup> |
|-----------------------------|-----------------------------|----------------------------------------------|--------------------------------------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA                        | 100                                          | 300                                        |
|                             | 4 mA                        | 100                                          | 300                                        |
|                             | 6 mA                        | 50                                           | 150                                        |
|                             | 8 mA                        | 50                                           | 150                                        |
|                             | 12 mA                       | 25                                           | 75                                         |
|                             | 16 mA                       | 17                                           | 50                                         |
|                             | 24 mA                       | 11                                           | 33                                         |
| 2.5 V LVCMOS                | 2 mA                        | 100                                          | 300                                        |
|                             | 4 mA                        | 100                                          | 300                                        |
|                             | 6 mA                        | 50                                           | 150                                        |
|                             | 8 mA                        | 50                                           | 150                                        |
|                             | 12 mA                       | 25                                           | 75                                         |
|                             | 16 mA                       | 17                                           | 50                                         |
|                             | 24 mA                       | 11                                           | 33                                         |
| 1.8 V LVCMOS                | 2 mA                        | 100                                          | 200                                        |
|                             | 4 mA                        | 100                                          | 200                                        |
|                             | 6 mA                        | 50                                           | 100                                        |
|                             | 8 mA                        | 50                                           | 100                                        |
|                             | 12 mA                       | 25                                           | 50                                         |
|                             | 16 mA                       | 20                                           | 40                                         |
| 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                                         |

**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 2-38 • I/O Output Buffer Maximum Resistances<sup>1</sup>**  
Applicable to Standard Plus I/O Banks

| Standard                    | Drive Strength              | R <sub>PULL-DOWN</sub><br>(Ω) <sup>2</sup> | R <sub>PULL-UP</sub><br>(Ω) <sup>3</sup> |
|-----------------------------|-----------------------------|--------------------------------------------|------------------------------------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA                        | 100                                        | 300                                      |
|                             | 4 mA                        | 100                                        | 300                                      |
|                             | 6 mA                        | 50                                         | 150                                      |
|                             | 8 mA                        | 50                                         | 150                                      |
|                             | 12 mA                       | 25                                         | 75                                       |
|                             | 16 mA                       | 25                                         | 75                                       |
| 2.5 V LVCMOS                | 2 mA                        | 100                                        | 200                                      |
|                             | 4 mA                        | 100                                        | 200                                      |
|                             | 6 mA                        | 50                                         | 100                                      |
|                             | 8 mA                        | 50                                         | 100                                      |
|                             | 12 mA                       | 25                                         | 50                                       |
| 1.8 V LVCMOS                | 2 mA                        | 200                                        | 225                                      |
|                             | 4 mA                        | 100                                        | 112                                      |
|                             | 6 mA                        | 50                                         | 56                                       |
|                             | 8 mA                        | 50                                         | 56                                       |
| 1.5 V LVCMOS                | 2 mA                        | 200                                        | 224                                      |
|                             | 4 mA                        | 100                                        | 112                                      |
| 1.2 V LVCMOS                | 2 mA                        | TBD                                        | TBD                                      |
| 3.3 V PCI/PCI-X             | Per PCI/PCI-X specification | 25                                         | 75                                       |

**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 2-39 • I/O Output Buffer Maximum Resistances<sup>1</sup>**  
Applicable to Standard I/O Banks

| Standard                    | Drive Strength | $R_{PULL-DOWN}$<br>( $\Omega$ ) <sup>2</sup> | $R_{PULL-UP}$<br>( $\Omega$ ) <sup>3</sup> |
|-----------------------------|----------------|----------------------------------------------|--------------------------------------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA           | 100                                          | 300                                        |
|                             | 4 mA           | 100                                          | 300                                        |
|                             | 6 mA           | 50                                           | 150                                        |
|                             | 8 mA           | 50                                           | 150                                        |
| 2.5 V LVCMOS                | 2 mA           | 100                                          | 200                                        |
|                             | 4 mA           | 100                                          | 200                                        |
|                             | 6 mA           | 50                                           | 100                                        |
|                             | 8 mA           | 50                                           | 100                                        |
| 1.8 V LVCMOS                | 2 mA           | 200                                          | 225                                        |
|                             | 4 mA           | 100                                          | 112                                        |
| 1.5 V LVCMOS                | 2 mA           | 200                                          | 224                                        |
| 1.2 V LVCMOS                | 1 mA           | TBD                                          | TBD                                        |

**Notes:**

1. These maximum values are provided for informational reasons only. Minimum output buffer resistance values depend on  $V_{CCl}$ , 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.  $R_{(PULL-UP-MAX)} = (V_{CClmax} - V_{OHspec}) / I_{OHspec}$

**Table 2-40 • I/O Weak Pull-Up/Pull-Down Resistances**  
Minimum and Maximum Weak Pull-Up/Pull-Down Resistance Values

| $V_{CCl}$ | $R_{(WEAK PULL-UP)}$ <sup>1</sup><br>( $\Omega$ ) |      | $R_{(WEAK PULL-DOWN)}$ <sup>2</sup><br>( $\Omega$ ) |       |
|-----------|---------------------------------------------------|------|-----------------------------------------------------|-------|
|           | 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.  $R_{(WEAK PULL-UP-MAX)} = (V_{CClmax} - V_{OHspec}) / I_{(WEAK PULL-UP-MIN)}$



**Table 2-41 • I/O Short Currents  $I_{OSH}/I_{OSL}$**   
Applicable to Advanced I/O Banks

|                             | Drive Strength              | $I_{OSL}$ (mA)* | $I_{OSH}$ (mA)* |
|-----------------------------|-----------------------------|-----------------|-----------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA                        | 25              | 27              |
|                             | 4 mA                        | 25              | 27              |
|                             | 6 mA                        | 51              | 54              |
|                             | 8 mA                        | 51              | 54              |
|                             | 12 mA                       | 103             | 109             |
|                             | 16 mA                       | 132             | 127             |
|                             | 24 mA                       | 268             | 181             |
| 2.5 V LVCMOS                | 2 mA                        | 16              | 18              |
|                             | 4 mA                        | 16              | 18              |
|                             | 6 mA                        | 32              | 37              |
|                             | 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                | 2 mA                        | TBD             | TBD             |
| 3.3 V PCI/PCI-X             | Per PCI/PCI-X specification | 103             | 109             |

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

**Table 2-42 • I/O Short Currents  $I_{OSH}/I_{OSL}$**   
Applicable to Standard Plus I/O Banks

|                             | Drive Strength              | $I_{OSL}$ (mA)* | $I_{OSH}$ (mA)* |
|-----------------------------|-----------------------------|-----------------|-----------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA                        | 25              | 27              |
|                             | 4 mA                        | 25              | 27              |
|                             | 6 mA                        | 51              | 54              |
|                             | 8 mA                        | 51              | 54              |
|                             | 12 mA                       | 103             | 109             |
|                             | 16 mA                       | 103             | 109             |
| 2.5 V LVCMOS                | 2 mA                        | 16              | 18              |
|                             | 4 mA                        | 16              | 18              |
|                             | 6 mA                        | 32              | 37              |
|                             | 8 mA                        | 32              | 37              |
|                             | 12 mA                       | 65              | 74              |
| 1.8 V LVCMOS                | 2 mA                        | 9               | 11              |
|                             | 4 mA                        | 17              | 22              |
|                             | 6 mA                        | 35              | 44              |
|                             | 8 mA                        | 35              | 44              |
| 1.5 V LVCMOS                | 2 mA                        | 13              | 16              |
|                             | 4 mA                        | 25              | 33              |
| 1.2 V LVCMOS                | 2 mA                        | TBD             | TBD             |
| 3.3 V PCI/PCI-X             | Per PCI/PCI-X specification | 103             | 109             |

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

**Table 2-43 • I/O Short Currents  $I_{OSH}/I_{OSL}$**   
Applicable to Standard I/O Banks

|                             | Drive Strength | $I_{OSL}$ (mA)* | $I_{OSH}$ (mA)* |
|-----------------------------|----------------|-----------------|-----------------|
| 3.3 V LVTTTL / 3.3 V LVCMOS | 2 mA           | 25              | 27              |
|                             | 4 mA           | 25              | 27              |
|                             | 6 mA           | 51              | 54              |
|                             | 8 mA           | 51              | 54              |
| 2.5 V LVCMOS                | 2 mA           | 16              | 18              |
|                             | 4 mA           | 16              | 18              |
|                             | 6 mA           | 32              | 37              |
|                             | 8 mA           | 32              | 37              |
| 1.8 V LVCMOS                | 2 mA           | 9               | 11              |
|                             | 4 mA           | 17              | 22              |
| 1.5 V LVCMOS                | 2 mA           | 13              | 16              |
| 1.2 V LVCMOS                | 1 mA           | TBD             | TBD             |

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

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 2-44 • 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            |

**Table 2-45 • 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      |
|---------------------------|-----------------------------|-----------------------------|------------------|
| LVTTL/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 into the input buffer trace. If the noise is low, then 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. Furthermore, all LVCMOS 3.3 V software macros comply with LVCMOS 3.3 V wide range as specified in the JESD8a specification.

**Table 2-46 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced I/O Banks

| 3.3 V LVTTTL /<br>3.3 V LVCMOS | V <sub>IL</sub> |         | V <sub>IH</sub> |         | V <sub>OL</sub> | V <sub>OH</sub> | I <sub>OL</sub> | I <sub>OH</sub> | I <sub>OSL</sub>      | I <sub>OSH</sub>      | I <sub>IL</sub> | I <sub>IH</sub> |
|--------------------------------|-----------------|---------|-----------------|---------|-----------------|-----------------|-----------------|-----------------|-----------------------|-----------------------|-----------------|-----------------|
|                                | Min., V         | Max., V | Min., V         | Max., V | Max., V         | Min., V         | mA              | mA              | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | μA <sup>2</sup> | μA <sup>2</sup> |
| 2 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 2               | 2               | 25                    | 27                    | 10              | 10              |
| 4 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 4               | 4               | 25                    | 27                    | 10              | 10              |
| 6 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 6               | 6               | 51                    | 54                    | 10              | 10              |
| 8 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 8               | 8               | 51                    | 54                    | 10              | 10              |
| 12 mA                          | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 12              | 12              | 103                   | 109                   | 10              | 10              |
| 16 mA                          | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 16              | 16              | 132                   | 127                   | 10              | 10              |
| 24 mA                          | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 24              | 24              | 268                   | 181                   | 10              | 10              |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-47 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard Plus I/O Banks

| 3.3 V LVTTTL /<br>3.3 V LVCMOS | V <sub>IL</sub> |         | V <sub>IH</sub> |         | V <sub>OL</sub> | V <sub>OH</sub> | I <sub>OL</sub> | I <sub>OH</sub> | I <sub>OSL</sub>      | I <sub>OSH</sub>      | I <sub>IL</sub> | I <sub>IH</sub> |
|--------------------------------|-----------------|---------|-----------------|---------|-----------------|-----------------|-----------------|-----------------|-----------------------|-----------------------|-----------------|-----------------|
|                                | Min., V         | Max., V | Min., V         | Max., V | Max., V         | Min., V         | mA              | mA              | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | μA <sup>2</sup> | μA <sup>2</sup> |
| 2 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 2               | 2               | 25                    | 27                    | 10              | 10              |
| 4 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 4               | 4               | 25                    | 27                    | 10              | 10              |
| 6 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 6               | 6               | 51                    | 54                    | 10              | 10              |
| 8 mA                           | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 8               | 8               | 51                    | 54                    | 10              | 10              |
| 12 mA                          | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 12              | 12              | 103                   | 109                   | 10              | 10              |
| 16 mA                          | –0.3            | 0.8     | 2               | 3.6     | 0.4             | 2.4             | 16              | 16              | 103                   | 109                   | 10              | 10              |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-48 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard I/O Banks

| 3.3 V LVTTTL /<br>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 <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA                           | -0.3     | 0.8     | 2        | 3.6     | 0.4      | 2.4      | 2        | 2        | 25                    | 27                    | 10        | 10        |
| 4 mA                           | -0.3     | 0.8     | 2        | 3.6     | 0.4      | 2.4      | 4        | 4        | 25                    | 27                    | 10        | 10        |
| 6 mA                           | -0.3     | 0.8     | 2        | 3.6     | 0.4      | 2.4      | 6        | 6        | 51                    | 54                    | 10        | 10        |
| 8 mA                           | -0.3     | 0.8     | 2        | 3.6     | 0.4      | 2.4      | 8        | 8        | 51                    | 54                    | 10        | 10        |

**Notes:**

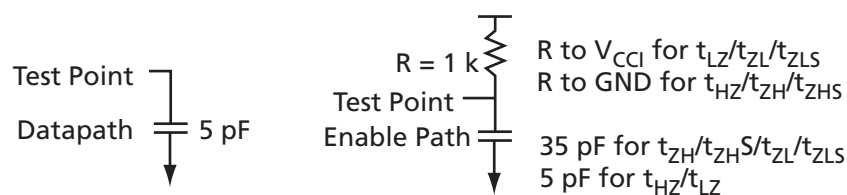
1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-49 • Minimum and Maximum DC Input and Output Levels for LVCMOS 3.3 V Wide Range**  
Applicable to Advanced, Standard Plus, and Standard I/O Banks

| 3.3 V LVCMOS Wide Range | $V_{IL}$ |         | $V_{IH}$ |         | $V_{OL}$ | $V_{OH}$        | $I_{OL}$ | $I_{OH}$ | $I_{IL}$  | $I_{IH}$  |
|-------------------------|----------|---------|----------|---------|----------|-----------------|----------|----------|-----------|-----------|
| Drive Strength          | Min., V  | Max., V | Min., V  | Max., V | Max., V  | Min., V         | mA       | mA       | $\mu A^2$ | $\mu A^2$ |
| All <sup>2</sup>        | -0.3     | 0.8     | 2        | 3.6     | 0.2      | $V_{CC1} - 0.2$ | 0.1      | 0.1      | 10        | 10        |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JDEC8a specification.



**Figure 2-7 • AC Loading**

**Table 2-50 • 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 2-28 on page 2-25 for a complete table of trip points.

## Timing Characteristics

*Applies to 1.5 V DC Core Voltage*

**Table 2-51 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 4.46     | 0.19      | 0.85     | 0.66       | 4.55     | 3.88     | 2.24     | 2.19     | 8.08      | 7.41      | ns    |
| 6 mA           | Std.        | 0.97       | 3.74     | 0.19      | 0.85     | 0.66       | 3.81     | 3.36     | 2.49     | 2.63     | 7.34      | 6.89      | ns    |
| 8 mA           | Std.        | 0.97       | 3.74     | 0.19      | 0.85     | 0.66       | 3.81     | 3.36     | 2.49     | 2.63     | 7.34      | 6.89      | ns    |
| 12 mA          | Std.        | 0.97       | 3.23     | 0.19      | 0.85     | 0.66       | 3.29     | 2.97     | 2.66     | 2.91     | 6.82      | 6.50      | ns    |
| 16 mA          | Std.        | 0.97       | 3.08     | 0.19      | 0.85     | 0.66       | 3.13     | 2.88     | 2.70     | 2.99     | 6.66      | 6.41      | ns    |
| 24 mA          | Std.        | 0.97       | 3.00     | 0.19      | 0.85     | 0.66       | 3.05     | 2.90     | 2.74     | 3.27     | 6.58      | 6.43      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-52 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 2.73     | 0.19      | 0.85     | 0.66       | 2.78     | 2.21     | 2.25     | 2.31     | 6.31      | 5.74      | ns    |
| 6 mA           | Std.        | 0.97       | 2.31     | 0.19      | 0.85     | 0.66       | 2.36     | 1.84     | 2.50     | 2.76     | 5.89      | 5.37      | ns    |
| 8 mA           | Std.        | 0.97       | 2.31     | 0.19      | 0.85     | 0.66       | 2.36     | 1.84     | 2.50     | 2.76     | 5.89      | 5.37      | ns    |
| 12 mA          | Std.        | 0.97       | 2.09     | 0.19      | 0.85     | 0.66       | 2.13     | 1.67     | 2.67     | 3.04     | 5.66      | 5.20      | ns    |
| 16 mA          | Std.        | 0.97       | 2.05     | 0.19      | 0.85     | 0.66       | 2.09     | 1.63     | 2.70     | 3.12     | 5.62      | 5.16      | ns    |
| 24 mA          | Std.        | 0.97       | 2.07     | 0.19      | 0.85     | 0.66       | 2.11     | 1.59     | 2.75     | 3.41     | 5.64      | 5.12      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-53 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 3.94     | 0.19      | 0.85     | 0.66       | 4.01     | 3.45     | 1.98     | 2.02     | 7.54      | 6.98      | ns    |
| 6 mA           | Std.        | 0.97       | 3.24     | 0.19      | 0.85     | 0.66       | 3.30     | 2.98     | 2.20     | 2.42     | 6.83      | 6.51      | ns    |
| 8 mA           | Std.        | 0.97       | 3.24     | 0.19      | 0.85     | 0.66       | 3.30     | 2.98     | 2.20     | 2.42     | 6.83      | 6.51      | ns    |
| 12 mA          | Std.        | 0.97       | 2.76     | 0.19      | 0.85     | 0.66       | 2.81     | 2.62     | 2.36     | 2.68     | 6.35      | 6.15      | ns    |
| 16 mA          | Std.        | 0.97       | 2.76     | 0.19      | 0.85     | 0.66       | 2.81     | 2.62     | 2.36     | 2.68     | 6.35      | 6.15      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-54 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 2.32     | 0.19      | 0.85     | 0.66       | 2.36     | 1.89     | 1.98     | 2.13     | 5.89      | 5.42      | ns    |
| 6 mA           | Std.        | 0.97       | 1.94     | 0.19      | 0.85     | 0.66       | 1.98     | 1.56     | 2.20     | 2.53     | 5.51      | 5.09      | ns    |
| 8 mA           | Std.        | 0.97       | 1.94     | 0.19      | 0.85     | 0.66       | 1.98     | 1.56     | 2.20     | 2.53     | 5.51      | 5.09      | ns    |
| 12 mA          | Std.        | 0.97       | 1.75     | 0.19      | 0.85     | 0.66       | 1.78     | 1.39     | 2.36     | 2.79     | 5.31      | 4.92      | ns    |
| 16 mA          | Std.        | 0.97       | 1.75     | 0.19      | 0.85     | 0.66       | 1.78     | 1.39     | 2.36     | 2.79     | 5.31      | 4.92      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-55 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 3.80     | 0.19      | 0.83     | 0.66       | 3.87     | 3.40     | 1.74     | 1.78     | ns    |
| 4 mA           | Std.        | 0.97       | 3.80     | 0.19      | 0.83     | 0.66       | 3.87     | 3.40     | 1.74     | 1.78     | ns    |
| 6 mA           | Std.        | 0.97       | 3.15     | 0.19      | 0.83     | 0.66       | 3.20     | 2.93     | 1.96     | 2.17     | ns    |
| 8 mA           | Std.        | 0.97       | 3.15     | 0.19      | 0.83     | 0.66       | 3.20     | 2.93     | 1.96     | 2.17     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-56 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 2.19     | 0.19      | 0.83     | 0.66       | 2.23     | 1.79     | 1.74     | 1.87     | ns    |
| 4 mA           | Std.        | 0.97       | 2.19     | 0.19      | 0.83     | 0.66       | 2.23     | 1.79     | 1.74     | 1.87     | ns    |
| 6 mA           | Std.        | 0.97       | 1.85     | 0.19      | 0.83     | 0.66       | 1.88     | 1.45     | 1.96     | 2.26     | ns    |
| 8 mA           | Std.        | 0.97       | 1.85     | 0.19      | 0.83     | 0.66       | 1.88     | 1.45     | 1.96     | 2.26     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### Applies to 1.2 V DC Core Voltage

**Table 2-57 • 3.3 V LVTTL / 3.3 V LVCMOS Low Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 5.11     | 0.26      | 0.98     | 1.10       | 5.21     | 4.47     | 2.80     | 3.01     | 11.01     | 10.28     | ns    |
| 6 mA           | Std.        | 1.55       | 4.37     | 0.26      | 0.98     | 1.10       | 4.45     | 3.93     | 3.05     | 3.46     | 10.26     | 9.74      | ns    |
| 8 mA           | Std.        | 1.55       | 4.37     | 0.26      | 0.98     | 1.10       | 4.45     | 3.93     | 3.05     | 3.46     | 10.26     | 9.74      | ns    |
| 12 mA          | Std.        | 1.55       | 3.84     | 0.26      | 0.98     | 1.10       | 3.91     | 3.53     | 3.23     | 3.75     | 9.72      | 9.34      | ns    |
| 16 mA          | Std.        | 1.55       | 3.68     | 0.26      | 0.98     | 1.10       | 3.75     | 3.44     | 3.27     | 3.83     | 9.56      | 9.25      | ns    |
| 24 mA          | Std.        | 1.55       | 3.60     | 0.26      | 0.98     | 1.10       | 3.67     | 3.46     | 3.31     | 4.12     | 9.48      | 9.27      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-58 • 3.3 V LVTTL / 3.3 V LVCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 3.32     | 0.26      | 0.98     | 1.10       | 3.38     | 2.75     | 2.80     | 3.16     | 9.19      | 8.56      | ns    |
| 6 mA           | Std.        | 1.55       | 2.90     | 0.26      | 0.98     | 1.10       | 2.95     | 2.37     | 3.06     | 3.62     | 8.76      | 8.18      | ns    |
| 8 mA           | Std.        | 1.55       | 2.90     | 0.26      | 0.98     | 1.10       | 2.95     | 2.37     | 3.06     | 3.62     | 8.76      | 8.18      | ns    |
| 12 mA          | Std.        | 1.55       | 2.66     | 0.26      | 0.98     | 1.10       | 2.71     | 2.18     | 3.23     | 3.92     | 8.52      | 7.99      | ns    |
| 16 mA          | Std.        | 1.55       | 2.62     | 0.26      | 0.98     | 1.10       | 2.67     | 2.15     | 3.27     | 3.99     | 8.48      | 7.95      | ns    |
| 24 mA          | Std.        | 1.55       | 2.64     | 0.26      | 0.98     | 1.10       | 2.69     | 2.10     | 3.32     | 4.29     | 8.50      | 7.91      | ns    |

#### Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-59 • 3.3 V LVTTL / 3.3 V LVCMOS Low Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 4.55     | 0.26      | 0.97     | 1.10       | 4.64     | 3.98     | 2.52     | 2.81     | 10.44     | 9.79      | ns    |
| 6 mA           | Std.        | 1.55       | 3.83     | 0.26      | 0.97     | 1.10       | 3.90     | 3.50     | 2.75     | 3.22     | 9.71      | 9.31      | ns    |
| 8 mA           | Std.        | 1.55       | 3.83     | 0.26      | 0.97     | 1.10       | 3.90     | 3.50     | 2.75     | 3.22     | 9.71      | 9.31      | ns    |
| 12 mA          | Std.        | 1.55       | 3.34     | 0.26      | 0.97     | 1.10       | 3.40     | 3.13     | 2.92     | 3.49     | 9.21      | 8.94      | ns    |
| 16 mA          | Std.        | 1.55       | 3.34     | 0.26      | 0.97     | 1.10       | 3.40     | 3.13     | 2.92     | 3.49     | 9.21      | 8.94      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.



**Table 2-60 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 2.88     | 0.26      | 0.97     | 1.10       | 2.93     | 2.38     | 2.52     | 2.94     | 8.74      | 8.19      | ns    |
| 6 mA           | Std.        | 1.55       | 2.49     | 0.26      | 0.97     | 1.10       | 2.54     | 2.04     | 2.75     | 3.36     | 8.35      | 7.85      | ns    |
| 8 mA           | Std.        | 1.55       | 2.49     | 0.26      | 0.97     | 1.10       | 2.54     | 2.04     | 2.75     | 3.36     | 8.35      | 7.85      | ns    |
| 12 mA          | Std.        | 1.55       | 2.30     | 0.26      | 0.97     | 1.10       | 2.34     | 1.87     | 2.91     | 3.62     | 8.15      | 7.67      | ns    |
| 16 mA          | Std.        | 1.55       | 2.30     | 0.26      | 0.97     | 1.10       | 2.34     | 1.87     | 2.91     | 3.62     | 8.15      | 7.67      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-61 • 3.3 V LVTTTL / 3.3 V LVCMOS Low Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 4.38     | 0.26      | 0.94     | 1.10       | 4.46     | 3.91     | 2.16     | 2.43     | ns    |
| 4 mA           | Std.        | 1.55       | 4.38     | 0.26      | 0.94     | 1.10       | 4.46     | 3.91     | 2.16     | 2.43     | ns    |
| 6 mA           | Std.        | 1.55       | 3.71     | 0.26      | 0.94     | 1.10       | 3.78     | 3.43     | 2.39     | 2.83     | ns    |
| 8 mA           | Std.        | 1.55       | 3.71     | 0.26      | 0.94     | 1.10       | 3.78     | 3.43     | 2.39     | 2.83     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-62 • 3.3 V LVTTTL / 3.3 V LVCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 2.73     | 0.26      | 0.94     | 1.10       | 2.78     | 2.26     | 2.16     | 2.54     | ns    |
| 4 mA           | Std.        | 1.55       | 2.73     | 0.26      | 0.94     | 1.10       | 2.78     | 2.26     | 2.16     | 2.54     | ns    |
| 6 mA           | Std.        | 1.55       | 2.37     | 0.26      | 0.94     | 1.10       | 2.42     | 1.92     | 2.39     | 2.94     | ns    |
| 8 mA           | Std.        | 1.55       | 2.37     | 0.26      | 0.94     | 1.10       | 2.42     | 1.92     | 2.39     | 2.94     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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 2-63 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced I/O Banks

| 2.5 V LVCMOS   | $V_{IL}$ |         | $V_{IH}$ |         | $V_{OL}$ | $V_{OH}$ | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|----------------|----------|---------|----------|---------|----------|----------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive Strength | Min., V  | Max., V | Min., V  | Max., V | Max., V  | Min., V  | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 2        | 2        | 16                    | 18                    | 10        | 10        |
| 4 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 4        | 4        | 16                    | 18                    | 10        | 10        |
| 6 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 6        | 6        | 32                    | 37                    | 10        | 10        |
| 8 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 8        | 8        | 32                    | 37                    | 10        | 10        |
| 12 mA          | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 12       | 12       | 65                    | 74                    | 10        | 10        |
| 16 mA          | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 16       | 16       | 83                    | 87                    | 10        | 10        |
| 24 mA          | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 24       | 24       | 169                   | 124                   | 10        | 10        |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-64 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard Plus I/O Banks

| 2.5 V LVCMOS   | $V_{IL}$ |         | $V_{IH}$ |         | $V_{OL}$ | $V_{OH}$ | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|----------------|----------|---------|----------|---------|----------|----------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive Strength | Min., V  | Max., V | Min., V  | Max., V | Max., V  | Min., V  | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 2        | 2        | 16                    | 18                    | 10        | 10        |
| 4 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 4        | 4        | 16                    | 18                    | 10        | 10        |
| 6 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 6        | 6        | 32                    | 37                    | 10        | 10        |
| 8 mA           | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 8        | 8        | 32                    | 37                    | 10        | 10        |
| 12 mA          | −0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 12       | 12       | 65                    | 74                    | 10        | 10        |

**Notes:**

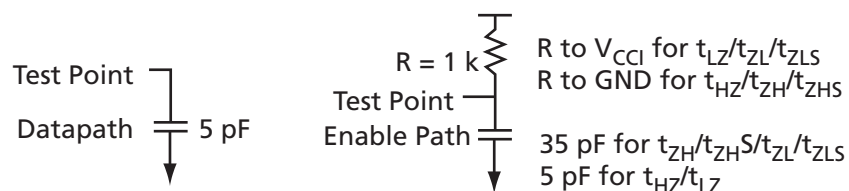
1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-65 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard I/O Banks

| 2.5 V<br>LVCMOS   | $V_{IL}$ |         | $V_{IH}$ |         | $V_{OL}$ | $V_{OH}$ | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|-------------------|----------|---------|----------|---------|----------|----------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive<br>Strength | Min., V  | Max., V | Min., V  | Max., V | Max., V  | Min., V  | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA              | -0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 2        | 2        | 16                    | 18                    | 10        | 10        |
| 4 mA              | -0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 4        | 4        | 16                    | 18                    | 10        | 10        |
| 6 mA              | -0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 6        | 6        | 32                    | 37                    | 10        | 10        |
| 8 mA              | -0.3     | 0.7     | 1.7      | 2.7     | 0.7      | 1.7      | 8        | 8        | 32                    | 37                    | 10        | 10        |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.



**Figure 2-8 • AC Loading**

**Table 2-66 • AC Waveforms, Measuring Points, and Capacitive Loads**

| Input LOW (V) | Input HIGH (V) | Measuring Point* (V) | C <sub>LOAD</sub> (pF) |
|---------------|----------------|----------------------|------------------------|
| 0             | 2.5            | 1.2                  | 5                      |

\* Measuring point =  $V_{trip}$ . See Table 2-28 on page 2-25 for a complete table of trip points.

## Timing Characteristics

*Applies to 1.5 V DC Core Voltage*

**Table 2-67 • 2.5 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 4.96     | 0.19      | 1.07     | 0.66       | 5.05     | 4.58     | 2.26     | 1.99     | 8.58      | 8.11      | ns    |
| 6 mA           | Std.        | 0.97       | 4.15     | 0.19      | 1.07     | 0.66       | 4.23     | 3.93     | 2.54     | 2.51     | 7.76      | 7.46      | ns    |
| 8 mA           | Std.        | 0.97       | 4.15     | 0.19      | 1.07     | 0.66       | 4.23     | 3.93     | 2.54     | 2.51     | 7.76      | 7.46      | ns    |
| 12 mA          | Std.        | 0.97       | 3.57     | 0.19      | 1.07     | 0.66       | 3.64     | 3.46     | 2.73     | 2.83     | 7.17      | 6.99      | ns    |
| 16 mA          | Std.        | 0.97       | 3.39     | 0.19      | 1.07     | 0.66       | 3.45     | 3.35     | 2.77     | 2.92     | 6.98      | 6.88      | ns    |
| 24 mA          | Std.        | 0.97       | 3.37     | 0.19      | 1.07     | 0.66       | 3.37     | 3.37     | 2.83     | 3.25     | 6.90      | 6.90      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-68 • 2.5 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 2.77     | 0.19      | 1.07     | 0.66       | 2.82     | 2.59     | 2.26     | 2.08     | 6.35      | 6.12      | ns    |
| 6 mA           | Std.        | 0.97       | 2.34     | 0.19      | 1.07     | 0.66       | 2.38     | 2.07     | 2.54     | 2.60     | 5.91      | 5.60      | ns    |
| 8 mA           | Std.        | 0.97       | 2.34     | 0.19      | 1.07     | 0.66       | 2.38     | 2.07     | 2.54     | 2.60     | 5.91      | 5.60      | ns    |
| 12 mA          | Std.        | 0.97       | 2.09     | 0.19      | 1.07     | 0.66       | 2.13     | 1.82     | 2.73     | 2.93     | 5.66      | 5.35      | ns    |
| 16 mA          | Std.        | 0.97       | 2.04     | 0.19      | 1.07     | 0.66       | 2.08     | 1.77     | 2.77     | 3.01     | 5.61      | 5.31      | ns    |
| 24 mA          | Std.        | 0.97       | 2.05     | 0.19      | 1.07     | 0.66       | 2.09     | 1.71     | 2.83     | 3.35     | 5.62      | 5.24      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-69 • 2.5 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 4.42     | 0.19      | 1.08     | 0.66       | 4.50     | 4.09     | 1.96     | 1.85     | 8.03      | 7.62      | ns    |
| 6 mA           | Std.        | 0.97       | 3.62     | 0.19      | 1.08     | 0.66       | 3.69     | 3.51     | 2.21     | 2.31     | 7.22      | 7.04      | ns    |
| 8 mA           | Std.        | 0.97       | 3.62     | 0.19      | 1.08     | 0.66       | 3.69     | 3.51     | 2.21     | 2.31     | 7.22      | 7.04      | ns    |
| 12 mA          | Std.        | 0.97       | 3.08     | 0.19      | 1.08     | 0.66       | 3.14     | 3.08     | 2.39     | 2.61     | 6.67      | 6.61      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-70 • 2.5 V LVC MOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 0.97       | 2.36     | 0.19      | 1.08     | 0.66       | 2.40     | 2.21     | 1.96     | 1.92     | 5.93      | 5.74      | ns    |
| 6 mA           | Std.        | 0.97       | 1.97     | 0.19      | 1.08     | 0.66       | 2.00     | 1.74     | 2.21     | 2.39     | 5.53      | 5.27      | ns    |
| 8 mA           | Std.        | 0.97       | 1.97     | 0.19      | 1.08     | 0.66       | 2.00     | 1.74     | 2.21     | 2.39     | 5.53      | 5.27      | ns    |
| 12 mA          | Std.        | 0.97       | 1.75     | 0.19      | 1.08     | 0.66       | 1.78     | 1.51     | 2.38     | 2.69     | 5.32      | 5.04      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-71 • 2.5 V LVC MOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 4.27     | 0.19      | 1.04     | 0.66       | 4.35     | 4.06     | 1.71     | 1.62     | ns    |
| 4 mA           | Std.        | 0.97       | 4.27     | 0.19      | 1.04     | 0.66       | 4.35     | 4.06     | 1.71     | 1.62     | ns    |
| 6 mA           | Std.        | 0.97       | 3.54     | 0.19      | 1.04     | 0.66       | 3.60     | 3.47     | 1.95     | 2.07     | ns    |
| 8 mA           | Std.        | 0.97       | 3.54     | 0.19      | 1.04     | 0.66       | 3.60     | 3.47     | 1.95     | 2.07     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-72 • 2.5 V LVC MOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 2.24     | 0.19      | 1.04     | 0.66       | 2.28     | 2.08     | 1.71     | 1.68     | ns    |
| 4 mA           | Std.        | 0.97       | 2.24     | 0.19      | 1.04     | 0.66       | 2.28     | 2.08     | 1.71     | 1.68     | ns    |
| 6 mA           | Std.        | 0.97       | 1.88     | 0.19      | 1.04     | 0.66       | 1.92     | 1.62     | 1.95     | 2.14     | ns    |
| 8 mA           | Std.        | 0.97       | 1.88     | 0.19      | 1.04     | 0.66       | 1.92     | 1.62     | 1.95     | 2.14     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### Applies to 1.2 V Core Voltage

**Table 2-73 • 2.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 5.58     | 0.26      | 1.20     | 1.10       | 5.68     | 5.14     | 2.80     | 2.78     | 11.49     | 10.95     | ns    |
| 6 mA           | Std.        | 1.55       | 4.75     | 0.26      | 1.20     | 1.10       | 4.84     | 4.47     | 3.09     | 3.31     | 10.65     | 10.28     | ns    |
| 8 mA           | Std.        | 1.55       | 4.75     | 0.26      | 1.20     | 1.10       | 4.84     | 4.47     | 3.09     | 3.31     | 10.65     | 10.28     | ns    |
| 12 mA          | Std.        | 1.55       | 4.15     | 0.26      | 1.20     | 1.10       | 4.23     | 3.99     | 3.28     | 3.65     | 10.04     | 9.80      | ns    |
| 16 mA          | Std.        | 1.55       | 3.97     | 0.26      | 1.20     | 1.10       | 4.04     | 3.88     | 3.33     | 3.74     | 9.85      | 9.69      | ns    |
| 24 mA          | Std.        | 1.55       | 3.90     | 0.26      | 1.20     | 1.10       | 3.96     | 3.90     | 3.38     | 4.07     | 9.77      | 9.71      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-74 • 2.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 3.32     | 0.26      | 1.20     | 1.10       | 3.38     | 3.09     | 2.80     | 2.89     | 9.19      | 8.90      | ns    |
| 6 mA           | Std.        | 1.55       | 2.88     | 0.26      | 1.20     | 1.10       | 2.93     | 2.56     | 3.09     | 3.43     | 8.74      | 8.37      | ns    |
| 8 mA           | Std.        | 1.55       | 2.88     | 0.26      | 1.20     | 1.10       | 2.93     | 2.56     | 3.09     | 3.43     | 8.74      | 8.37      | ns    |
| 12 mA          | Std.        | 1.55       | 2.63     | 0.26      | 1.20     | 1.10       | 2.68     | 2.30     | 3.28     | 3.77     | 8.48      | 8.10      | ns    |
| 16 mA          | Std.        | 1.55       | 2.58     | 0.26      | 1.20     | 1.10       | 2.63     | 2.25     | 3.33     | 3.86     | 8.44      | 8.06      | ns    |
| 24 mA          | Std.        | 1.55       | 2.59     | 0.26      | 1.20     | 1.10       | 2.64     | 2.19     | 3.39     | 4.21     | 8.45      | 8.00      | ns    |

#### Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-75 • 2.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 5.01     | 0.26      | 1.20     | 1.10       | 5.11     | 4.60     | 2.49     | 2.60     | 10.92     | 10.41     | ns    |
| 6 mA           | Std.        | 1.55       | 4.20     | 0.26      | 1.20     | 1.10       | 4.28     | 4.00     | 2.74     | 3.08     | 10.08     | 9.81      | ns    |
| 8 mA           | Std.        | 1.55       | 4.20     | 0.26      | 1.20     | 1.10       | 4.28     | 4.00     | 2.74     | 3.08     | 10.08     | 9.81      | ns    |
| 12 mA          | Std.        | 1.55       | 3.64     | 0.26      | 1.20     | 1.10       | 3.71     | 3.56     | 2.92     | 3.39     | 9.52      | 9.36      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-76 • 2.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 4 mA           | Std.        | 1.55       | 2.90     | 0.26      | 1.20     | 1.10       | 2.95     | 2.66     | 2.48     | 2.70     | 8.76      | 8.47      | ns    |
| 6 mA           | Std.        | 1.55       | 2.50     | 0.26      | 1.20     | 1.10       | 2.54     | 2.18     | 2.74     | 3.19     | 8.35      | 7.99      | ns    |
| 8 mA           | Std.        | 1.55       | 2.50     | 0.26      | 1.20     | 1.10       | 2.54     | 2.18     | 2.74     | 3.19     | 8.35      | 7.99      | ns    |
| 12 mA          | Std.        | 1.55       | 2.28     | 0.26      | 1.20     | 1.10       | 2.32     | 1.95     | 2.92     | 3.50     | 8.13      | 7.75      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-77 • 2.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 4.84     | 0.26      | 1.15     | 1.10       | 4.93     | 4.56     | 2.12     | 2.22     | ns    |
| 4 mA           | Std.        | 1.55       | 4.84     | 0.26      | 1.15     | 1.10       | 4.93     | 4.56     | 2.12     | 2.22     | ns    |
| 6 mA           | Std.        | 1.55       | 4.08     | 0.26      | 1.15     | 1.10       | 4.16     | 3.96     | 2.37     | 2.69     | ns    |
| 8 mA           | Std.        | 1.55       | 4.08     | 0.26      | 1.15     | 1.10       | 4.16     | 3.96     | 2.37     | 2.69     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-78 • 2.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 2.3\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 2.75     | 0.26      | 1.15     | 1.10       | 2.80     | 2.53     | 2.12     | 2.31     | ns    |
| 4 mA           | Std.        | 1.55       | 2.75     | 0.26      | 1.15     | 1.10       | 2.80     | 2.53     | 2.12     | 2.31     | ns    |
| 6 mA           | Std.        | 1.55       | 2.38     | 0.26      | 1.15     | 1.10       | 2.42     | 2.05     | 2.37     | 2.79     | ns    |
| 8 mA           | Std.        | 1.55       | 2.38     | 0.26      | 1.15     | 1.10       | 2.42     | 2.05     | 2.37     | 2.79     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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 2-79 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced I/O Banks

| 1.8 V LVCMOS   | $V_{IL}$ |                  | $V_{IH}$         |         | $V_{OL}$ | $V_{OH}$         | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|----------------|----------|------------------|------------------|---------|----------|------------------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive Strength | Min., V  | Max., V          | Min., V          | Max., V | Max., V  | Min., V          | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 2        | 2        | 9                     | 11                    | 10        | 10        |
| 4 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 4        | 4        | 17                    | 22                    | 10        | 10        |
| 6 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 6        | 6        | 35                    | 44                    | 10        | 10        |
| 8 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 8        | 8        | 45                    | 51                    | 10        | 10        |
| 12 mA          | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 12       | 12       | 91                    | 74                    | 10        | 10        |
| 16 mA          | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 16       | 16       | 91                    | 74                    | 10        | 10        |

### Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-80 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard Plus I/O Banks

| 1.8 V LVCMOS   | $V_{IL}$ |                  | $V_{IH}$         |         | $V_{OL}$ | $V_{OH}$         | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|----------------|----------|------------------|------------------|---------|----------|------------------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive Strength | Min., V  | Max., V          | Min., V          | Max., V | Max., V  | Min., V          | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 2        | 2        | 9                     | 11                    | 10        | 10        |
| 4 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 4        | 4        | 17                    | 22                    | 10        | 10        |
| 6 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 6        | 6        | 35                    | 44                    | 10        | 10        |
| 8 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 8        | 8        | 35                    | 44                    | 10        | 10        |

### Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

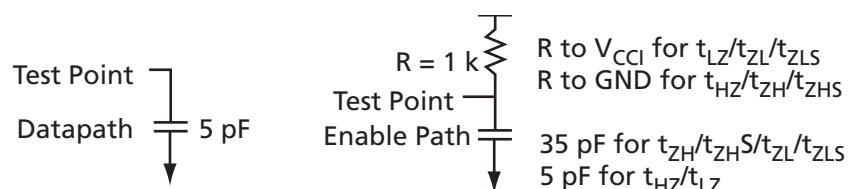


**Table 2-81 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard I/O Banks

| 1.8 V<br>LVCMOS   | $V_{IL}$ |                  | $V_{IH}$         |         | $V_{OL}$ | $V_{OH}$         | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$             | $I_{OSL}$             | $I_{IL}$  | $I_{IH}$  |
|-------------------|----------|------------------|------------------|---------|----------|------------------|----------|----------|-----------------------|-----------------------|-----------|-----------|
| Drive<br>Strength | Min., V  | Max., V          | Min., V          | Max., V | Max., V  | Min., V          | mA       | mA       | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| 2 mA              | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 2        | 2        | 9                     | 11                    | 10        | 10        |
| 4 mA              | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.9     | 0.45     | $V_{CCI} - 0.45$ | 4        | 4        | 17                    | 22                    | 10        | 10        |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.



**Figure 2-9 • AC Loading**

**Table 2-82 • 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 2-28 on page 2-25 for a complete table of trip points.

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-83 • 1.8 V LVC MOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 6.38     | 0.19      | 1.01     | 0.66       | 6.49     | 5.92     | 2.33     | 1.56     | 10.03     | 9.45      | ns    |
| 4 mA           | Std.        | 0.97       | 5.35     | 0.19      | 1.01     | 0.66       | 5.45     | 5.04     | 2.67     | 2.38     | 8.98      | 8.57      | ns    |
| 6 mA           | Std.        | 0.97       | 4.62     | 0.19      | 1.01     | 0.66       | 4.70     | 4.43     | 2.90     | 2.78     | 8.23      | 7.96      | ns    |
| 8 mA           | Std.        | 0.97       | 4.37     | 0.19      | 1.01     | 0.66       | 4.45     | 4.30     | 2.95     | 2.89     | 7.98      | 7.83      | ns    |
| 12 mA          | Std.        | 0.97       | 4.31     | 0.19      | 1.01     | 0.66       | 4.37     | 4.31     | 3.03     | 3.29     | 7.90      | 7.84      | ns    |
| 16 mA          | Std.        | 0.97       | 4.31     | 0.19      | 1.01     | 0.66       | 4.37     | 4.31     | 3.03     | 3.29     | 7.90      | 7.84      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-84 • 1.8 V LVC MOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 3.24     | 0.19      | 1.01     | 0.66       | 3.20     | 3.24     | 2.33     | 1.61     | 6.73      | 6.78      | ns    |
| 4 mA           | Std.        | 0.97       | 2.62     | 0.19      | 1.01     | 0.66       | 2.67     | 2.50     | 2.66     | 2.46     | 6.20      | 6.04      | ns    |
| 6 mA           | Std.        | 0.97       | 2.31     | 0.19      | 1.01     | 0.66       | 2.35     | 2.14     | 2.89     | 2.87     | 5.88      | 5.67      | ns    |
| 8 mA           | Std.        | 0.97       | 2.25     | 0.19      | 1.01     | 0.66       | 2.29     | 2.07     | 2.95     | 2.98     | 5.82      | 5.60      | ns    |
| 12 mA          | Std.        | 0.97       | 2.24     | 0.19      | 1.01     | 0.66       | 2.28     | 1.99     | 3.02     | 3.39     | 5.81      | 5.52      | ns    |
| 16 mA          | Std.        | 0.97       | 2.24     | 0.19      | 1.01     | 0.66       | 2.28     | 1.99     | 3.02     | 3.39     | 5.81      | 5.52      | ns    |

#### Notes:

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-85 • 1.8 V LVC MOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 5.78     | 0.19      | 1.01     | 0.66       | 5.89     | 5.31     | 1.95     | 1.46     | 9.42      | 8.84      | ns    |
| 4 mA           | Std.        | 0.97       | 4.75     | 0.19      | 1.01     | 0.66       | 4.84     | 4.53     | 2.25     | 2.21     | 8.37      | 8.06      | ns    |
| 6 mA           | Std.        | 0.97       | 4.07     | 0.19      | 1.01     | 0.66       | 4.14     | 3.97     | 2.46     | 2.57     | 7.67      | 7.50      | ns    |
| 8 mA           | Std.        | 0.97       | 4.07     | 0.19      | 1.01     | 0.66       | 4.14     | 3.97     | 2.46     | 2.57     | 7.67      | 7.50      | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-86 • 1.8 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 2.75     | 0.19      | 1.01     | 0.66       | 2.79     | 2.75     | 1.94     | 1.51     | 6.32      | 6.28      | ns    |
| 4 mA           | Std.        | 0.97       | 2.25     | 0.19      | 1.01     | 0.66       | 2.29     | 2.09     | 2.24     | 2.29     | 5.82      | 5.62      | ns    |
| 6 mA           | Std.        | 0.97       | 1.97     | 0.19      | 1.01     | 0.66       | 2.01     | 1.76     | 2.46     | 2.66     | 5.54      | 5.29      | ns    |
| 8 mA           | Std.        | 0.97       | 1.97     | 0.19      | 1.01     | 0.66       | 2.01     | 1.76     | 2.46     | 2.66     | 5.54      | 5.29      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-87 • 1.8 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 5.63     | 0.19      | 0.98     | 0.66       | 5.73     | 5.29     | 1.68     | 1.24     | ns    |
| 4 mA           | Std.        | 0.97       | 4.69     | 0.19      | 0.98     | 0.66       | 4.78     | 4.51     | 1.97     | 1.98     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-88 • 1.8 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 2.62     | 0.19      | 0.98     | 0.66       | 2.67     | 2.59     | 1.67     | 1.29     | ns    |
| 4 mA           | Std.        | 0.97       | 2.18     | 0.19      | 0.98     | 0.66       | 2.22     | 1.93     | 1.96     | 2.06     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-89 • 1.8 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 6.96     | 0.26      | 1.11     | 1.10       | 7.09     | 6.49     | 2.85     | 2.27     | 12.89     | 12.29     | ns    |
| 4 mA           | Std.        | 1.55       | 5.90     | 0.26      | 1.11     | 1.10       | 6.01     | 5.57     | 3.20     | 3.12     | 11.82     | 11.38     | ns    |
| 6 mA           | Std.        | 1.55       | 5.15     | 0.26      | 1.11     | 1.10       | 5.24     | 4.95     | 3.44     | 3.54     | 11.05     | 10.76     | ns    |
| 8 mA           | Std.        | 1.55       | 4.89     | 0.26      | 1.11     | 1.10       | 4.98     | 4.81     | 3.49     | 3.65     | 10.79     | 10.62     | ns    |
| 12 mA          | Std.        | 1.55       | 4.83     | 0.26      | 1.11     | 1.10       | 4.90     | 4.83     | 3.57     | 4.06     | 10.71     | 10.64     | ns    |
| 16 mA          | Std.        | 1.55       | 4.83     | 0.26      | 1.11     | 1.10       | 4.90     | 4.83     | 3.57     | 4.06     | 10.71     | 10.64     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-90 • 1.8 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 3.73     | 0.26      | 1.11     | 1.10       | 3.71     | 3.73     | 2.85     | 2.32     | 9.52      | 9.54      | ns    |
| 4 mA           | Std.        | 1.55       | 3.11     | 0.26      | 1.11     | 1.10       | 3.16     | 2.97     | 3.19     | 3.21     | 8.97      | 8.78      | ns    |
| 6 mA           | Std.        | 1.55       | 2.78     | 0.26      | 1.11     | 1.10       | 2.84     | 2.60     | 3.43     | 3.63     | 8.64      | 8.40      | ns    |
| 8 mA           | Std.        | 1.55       | 2.72     | 0.26      | 1.11     | 1.10       | 2.77     | 2.52     | 3.49     | 3.74     | 8.58      | 8.33      | ns    |
| 12 mA          | Std.        | 1.55       | 2.71     | 0.26      | 1.11     | 1.10       | 2.76     | 2.44     | 3.56     | 4.17     | 8.57      | 8.24      | ns    |
| 16 mA          | Std.        | 1.55       | 2.71     | 0.26      | 1.11     | 1.10       | 2.76     | 2.44     | 3.56     | 4.17     | 8.57      | 8.24      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-91 • 1.8 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 6.31     | 0.26      | 1.11     | 1.10       | 6.43     | 5.81     | 2.46     | 2.14     | 12.24     | 11.62     | ns    |
| 4 mA           | Std.        | 1.55       | 5.26     | 0.26      | 1.11     | 1.10       | 5.35     | 5.01     | 2.77     | 2.91     | 11.16     | 10.82     | ns    |
| 6 mA           | Std.        | 1.55       | 4.55     | 0.26      | 1.11     | 1.10       | 4.64     | 4.44     | 2.98     | 3.29     | 10.45     | 10.25     | ns    |
| 8 mA           | Std.        | 1.55       | 4.55     | 0.26      | 1.11     | 1.10       | 4.64     | 4.44     | 2.98     | 3.29     | 10.45     | 10.25     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-92 • 1.8 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 3.21     | 0.26      | 1.11     | 1.10       | 3.26     | 3.18     | 2.45     | 2.18     | 9.07      | 8.99      | ns    |
| 4 mA           | Std.        | 1.55       | 2.71     | 0.26      | 1.11     | 1.10       | 2.76     | 2.50     | 2.76     | 2.99     | 8.56      | 8.31      | ns    |
| 6 mA           | Std.        | 1.55       | 2.42     | 0.26      | 1.11     | 1.10       | 2.47     | 2.16     | 2.98     | 3.38     | 8.28      | 7.97      | ns    |
| 8 mA           | Std.        | 1.55       | 2.42     | 0.26      | 1.11     | 1.10       | 2.47     | 2.16     | 2.98     | 3.38     | 8.28      | 7.97      | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-93 • 1.8 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 6.13     | 0.26      | 1.08     | 1.10       | 6.24     | 5.79     | 2.07     | 1.77     | ns    |
| 4 mA           | Std.        | 1.55       | 5.16     | 0.26      | 1.08     | 1.10       | 5.26     | 4.99     | 2.37     | 2.53     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-94 • 1.8 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.7\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 3.05     | 0.26      | 1.08     | 1.10       | 3.11     | 3.01     | 2.07     | 1.81     | ns    |
| 4 mA           | Std.        | 1.55       | 2.60     | 0.26      | 1.08     | 1.10       | 2.64     | 2.33     | 2.37     | 2.61     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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 2-95 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced I/O Banks

| 1.5 V LVCMOS   | V <sub>IL</sub> |                         | V <sub>IH</sub>         |         | V <sub>OL</sub>         | V <sub>OH</sub>         | I <sub>OL</sub> | I <sub>OH</sub> | I <sub>OSH</sub>      | I <sub>OSL</sub>      | I <sub>IL</sub> | I <sub>IH</sub> |
|----------------|-----------------|-------------------------|-------------------------|---------|-------------------------|-------------------------|-----------------|-----------------|-----------------------|-----------------------|-----------------|-----------------|
| Drive Strength | Min., V         | Max., V                 | Min., V                 | Max., V | Max., V                 | Min., V                 | mA              | mA              | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | μA <sup>2</sup> | μA <sup>2</sup> |
| 2 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 2               | 2               | 13                    | 16                    | 10              | 10              |
| 4 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 4               | 4               | 25                    | 33                    | 10              | 10              |
| 6 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 6               | 6               | 32                    | 39                    | 10              | 10              |
| 8 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 8               | 8               | 66                    | 55                    | 10              | 10              |
| 12 mA          | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 12              | 12              | 66                    | 55                    | 10              | 10              |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-96 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard Plus I/O Banks

| 1.5 V LVCMOS   | V <sub>IL</sub> |                         | V <sub>IH</sub>         |         | V <sub>OL</sub>         | V <sub>OH</sub>         | I <sub>OL</sub> | I <sub>OH</sub> | I <sub>OSH</sub>      | I <sub>OSL</sub>      | I <sub>IL</sub> | I <sub>IH</sub> |
|----------------|-----------------|-------------------------|-------------------------|---------|-------------------------|-------------------------|-----------------|-----------------|-----------------------|-----------------------|-----------------|-----------------|
| Drive Strength | Min., V         | Max., V                 | Min., V                 | Max., V | Max., V                 | Min., V                 | mA              | mA              | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | μA <sup>2</sup> | μA <sup>2</sup> |
| 2 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 2               | 2               | 13                    | 16                    | 10              | 10              |
| 4 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 4               | 4               | 25                    | 33                    | 10              | 10              |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-97 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard I/O Banks

| 1.5 V LVCMOS   | V <sub>IL</sub> |                         | V <sub>IH</sub>         |         | V <sub>OL</sub>         | V <sub>OH</sub>         | I <sub>OL</sub> | I <sub>OH</sub> | I <sub>OSH</sub>      | I <sub>OSL</sub>      | I <sub>IL</sub> | I <sub>IH</sub> |
|----------------|-----------------|-------------------------|-------------------------|---------|-------------------------|-------------------------|-----------------|-----------------|-----------------------|-----------------------|-----------------|-----------------|
| Drive Strength | Min., V         | Max., V                 | Min., V                 | Max., V | Max., V                 | Min., V                 | mA              | mA              | Max., mA <sup>1</sup> | Max., mA <sup>1</sup> | μA <sup>2</sup> | μA <sup>2</sup> |
| 2 mA           | −0.3            | 0.35 * V <sub>CCI</sub> | 0.65 * V <sub>CCI</sub> | 1.575   | 0.25 * V <sub>CCI</sub> | 0.75 * V <sub>CCI</sub> | 2               | 2               | 13                    | 16                    | 10              | 10              |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

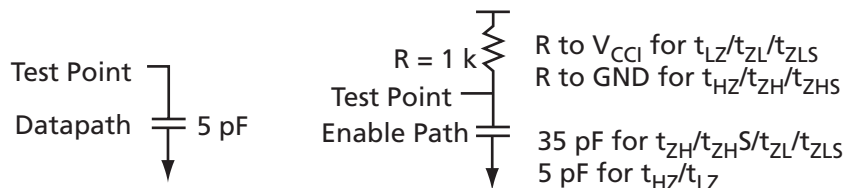


Figure 2-10 • AC Loading

Table 2-98 • AC Waveforms, Measuring Points, and Capacitive Loads

| Input LOW (V) | Input HIGH (V) | Measuring Point* (V) | C <sub>LOAD</sub> (pF) |
|---------------|----------------|----------------------|------------------------|
| 0             | 1.5            | 0.75                 | 5                      |

\* Measuring point =  $V_{trip}$ . See Table 2-28 on page 2-25 for a complete table of trip points.

### Timing Characteristics

#### 1.5 V DC Core Voltage

Table 2-99 • 1.5 V LVC MOS Low Slew – Applies to 1.5 V DC Core Voltage

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 6.62     | 0.19      | 1.17     | 0.66       | 6.74     | 6.05     | 2.79     | 2.31     | 10.28     | 9.58      | ns    |
| 4 mA           | Std.        | 0.97       | 5.74     | 0.19      | 1.17     | 0.66       | 5.85     | 5.33     | 3.06     | 2.78     | 9.38      | 8.86      | ns    |
| 6 mA           | Std.        | 0.97       | 5.43     | 0.19      | 1.17     | 0.66       | 5.53     | 5.18     | 3.12     | 2.90     | 9.06      | 8.71      | ns    |
| 8 mA           | Std.        | 0.97       | 5.35     | 0.19      | 1.17     | 0.66       | 5.45     | 5.19     | 3.21     | 3.36     | 8.98      | 8.72      | ns    |
| 12 mA          | Std.        | 0.97       | 5.35     | 0.19      | 1.17     | 0.66       | 5.45     | 5.19     | 3.21     | 3.36     | 8.98      | 8.72      | ns    |

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-100 • 1.5 V LVC MOS High Slew – Applies to 1.5 V DC Core Voltage

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 2.97     | 0.19      | 1.17     | 0.66       | 3.03     | 2.89     | 2.78     | 2.40     | 6.56      | 6.43      | ns    |
| 4 mA           | Std.        | 0.97       | 2.60     | 0.19      | 1.17     | 0.66       | 2.64     | 2.44     | 3.05     | 2.88     | 6.18      | 5.97      | ns    |
| 6 mA           | Std.        | 0.97       | 3.63     | 0.19      | 1.17     | 0.66       | 3.62     | 3.63     | 3.06     | 3.00     | 7.15      | 7.16      | ns    |
| 8 mA           | Std.        | 0.97       | 2.50     | 0.19      | 1.17     | 0.66       | 2.55     | 2.26     | 3.20     | 3.48     | 6.08      | 5.79      | ns    |
| 12 mA          | Std.        | 0.97       | 2.50     | 0.19      | 1.17     | 0.66       | 2.55     | 2.26     | 3.20     | 3.48     | 6.08      | 5.79      | ns    |

#### Notes:

- Software default selection highlighted in gray.
- For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

**Table 2-101 • 1.5 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 5.93     | 0.19      | 1.17     | 0.66       | 6.04     | 5.46     | 2.30     | 2.15     | 9.57      | 8.99      | ns    |
| 4 mA           | Std.        | 0.97       | 5.11     | 0.19      | 1.17     | 0.66       | 5.20     | 4.79     | 2.54     | 2.58     | 8.73      | 8.32      | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-102 • 1.5 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 0.97       | 2.58     | 0.19      | 1.17     | 0.66       | 2.63     | 2.40     | 2.29     | 2.24     | 6.16      | 5.94      | ns    |
| 4 mA           | Std.        | 0.97       | 2.25     | 0.19      | 1.17     | 0.66       | 2.29     | 1.99     | 2.53     | 2.68     | 5.82      | 5.52      | ns    |

*Notes:*

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-103 • 1.5 V LVCMOS Low Slew – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 5.88     | 0.19      | 1.13     | 0.66       | 5.99     | 5.45     | 1.99     | 1.93     | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-104 • 1.5 V LVCMOS High Slew – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 0.97       | 2.51     | 0.19      | 1.13     | 0.66       | 2.56     | 2.20     | 1.99     | 2.03     | ns    |

*Notes:*

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage



**Table 2-105 • 1.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 7.16     | 0.26      | 1.27     | 1.10       | 7.29     | 6.60     | 3.32     | 3.01     | 13.10     | 12.41     | ns    |
| 4 mA           | Std.        | 1.55       | 6.26     | 0.26      | 1.27     | 1.10       | 6.37     | 5.86     | 3.59     | 3.49     | 12.18     | 11.67     | ns    |
| 6 mA           | Std.        | 1.55       | 5.93     | 0.26      | 1.27     | 1.10       | 6.04     | 5.70     | 3.65     | 3.62     | 11.85     | 11.51     | ns    |
| 8 mA           | Std.        | 1.55       | 5.85     | 0.26      | 1.27     | 1.10       | 5.96     | 5.72     | 3.75     | 4.10     | 11.77     | 11.52     | ns    |
| 12 mA          | Std.        | 1.55       | 5.85     | 0.26      | 1.27     | 1.10       | 5.96     | 5.72     | 3.75     | 4.10     | 11.77     | 11.52     | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-106 • 1.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Advanced I/O Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 3.43     | 0.26      | 1.27     | 1.10       | 3.49     | 3.36     | 3.31     | 3.10     | 9.30      | 9.16      | ns    |
| 4 mA           | Std.        | 1.55       | 3.04     | 0.26      | 1.27     | 1.10       | 3.10     | 2.89     | 3.58     | 3.59     | 8.91      | 8.70      | ns    |
| 6 mA           | Std.        | 1.55       | 4.11     | 0.26      | 1.27     | 1.10       | 4.10     | 4.11     | 3.59     | 3.72     | 9.91      | 9.92      | ns    |
| 8 mA           | Std.        | 1.55       | 2.95     | 0.26      | 1.27     | 1.10       | 3.00     | 2.70     | 3.74     | 4.21     | 8.81      | 8.51      | ns    |
| 12 mA          | Std.        | 1.55       | 2.95     | 0.26      | 1.27     | 1.10       | 3.00     | 2.70     | 3.74     | 4.21     | 8.81      | 8.51      | ns    |

*Notes:*

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-107 • 1.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 6.42     | 0.26      | 1.27     | 1.10       | 6.54     | 5.95     | 2.81     | 2.81     | 12.35     | 11.76     | ns    |
| 4 mA           | Std.        | 1.55       | 5.58     | 0.26      | 1.27     | 1.10       | 5.68     | 5.27     | 3.06     | 3.25     | 11.49     | 11.08     | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-108 • 1.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Plus Banks

| Drive Strength | 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 |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-----------|-----------|-------|
| 2 mA           | Std.        | 1.55       | 3.01     | 0.26      | 1.27     | 1.10       | 3.07     | 2.81     | 2.80     | 2.90     | 8.88      | 8.62      | ns    |
| 4 mA           | Std.        | 1.55       | 2.67     | 0.26      | 1.27     | 1.10       | 2.72     | 2.39     | 3.05     | 3.36     | 8.53      | 8.20      | ns    |

*Notes:*

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-109 • 1.5 V LCMOS Low Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 6.35     | 0.26      | 1.22     | 1.10       | 6.46     | 5.93     | 2.39     | 2.45     | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-110 • 1.5 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$ 

Applicable to Standard Banks

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 2 mA           | Std.        | 1.55       | 2.91     | 0.26      | 1.22     | 1.10       | 2.96     | 2.60     | 2.39     | 2.54     | ns    |

*Notes:*

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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 2-111 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced I/O Banks

| 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    | $\mu A$    | $\mu A$    |
| 2 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.26    | $0.25 * V_{CCI}$ | $0.75 * V_{CCI}$ | 2        | 2        | TBD         | TBD         | 10         | 10         |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-112 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard Plus I/O Banks

| 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    | $\mu A$    | $\mu A$    |
| 2 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.26    | $0.25 * V_{CCI}$ | $0.75 * V_{CCI}$ | 2        | 2        | TBD         | TBD         | 10         | 10         |

**Notes:**

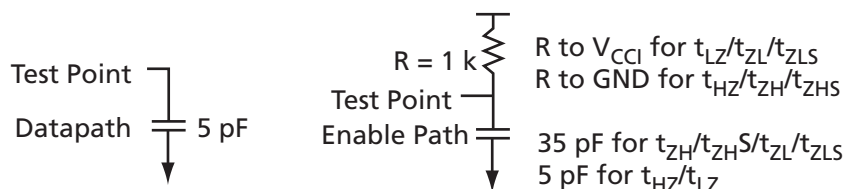
1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.

**Table 2-113 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Standard I/O Banks

| 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    | $\mu A$    | $\mu A$    |
| 1 mA           | -0.3     | $0.35 * V_{CCI}$ | $0.65 * V_{CCI}$ | 1.26    | $0.25 * V_{CCI}$ | $0.75 * V_{CCI}$ | 1        | 1        | TBD         | TBD         | 10         | 10         |

**Notes:**

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.
3. Software default selection highlighted in gray.



**Figure 2-11 • AC Loading**

**Table 2-114 • AC Waveforms, Measuring Points, and Capacitive Loads**

| Input LOW (V) | Input HIGH (V) | Measuring Point* (V) | C <sub>LOAD</sub> (pF) |
|---------------|----------------|----------------------|------------------------|
| 0             | 1.2            | 0.6                  | 5                      |

\* Measuring point =  $V_{trip}$ . See [Table 2-28 on page 2-25](#) for a complete table of trip points.

## Timing Characteristics

### 1.2 V DC Core Voltage

**Table 2-115 • 1.2 V LVC MOS Low Slew**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 1.4\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | Speed Grade | t <sub>DOUT</sub> | t <sub>DP</sub> | t <sub>DIN</sub> | t <sub>PY</sub> | t <sub>EOUT</sub> | t <sub>ZL</sub> | t <sub>ZH</sub> | t <sub>LZ</sub> | t <sub>HZ</sub> | t <sub>ZLS</sub> | t <sub>ZHS</sub> | Units |
|----------------|-------------|-------------------|-----------------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|-------|
| 2 mA           | Std.        | 0.97              | 6.62            | 0.19             | 1.17            | 0.66              | 6.74            | 6.05            | 2.79            | 2.31            | 10.28            | 9.58             | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-116 • 1.2 V LVC MOS High Slew**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.14\text{ V}$   
Applicable to Advanced I/O Banks

| Drive Strength | Speed Grade | t <sub>DOUT</sub> | t <sub>DP</sub> | t <sub>DIN</sub> | t <sub>PY</sub> | t <sub>EOUT</sub> | t <sub>ZL</sub> | t <sub>ZH</sub> | t <sub>LZ</sub> | t <sub>HZ</sub> | t <sub>ZLS</sub> | t <sub>ZHS</sub> | Units |
|----------------|-------------|-------------------|-----------------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|-------|
| 2 mA           | Std.        | 1.55              | 3.61            | 0.26             | 1.58            | 1.10              | 3.45            | 3.33            | 3.94            | 3.66            | 9.05             | 8.93             | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-117 • 1.2 V LVC MOS High Slew**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.14\text{ V}$   
Applicable to Standard Plus I/O Banks

| Drive Strength | Speed Grade | t <sub>DOUT</sub> | t <sub>DP</sub> | t <sub>DIN</sub> | t <sub>PY</sub> | t <sub>EOUT</sub> | t <sub>ZL</sub> | t <sub>ZH</sub> | t <sub>LZ</sub> | t <sub>HZ</sub> | t <sub>ZLS</sub> | t <sub>ZHS</sub> | Units |
|----------------|-------------|-------------------|-----------------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|-------|
| 2 mA           | Std.        | 1.55              | 7.60            | 0.26             | 1.58            | 1.10              | 7.27            | 6.52            | 3.31            | 3.36            | 12.86            | 12.12            | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-118 • 1.2 V LVC MOS High Slew**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.14\text{ V}$   
Applicable to Standard Plus I/O Banks

| Drive Strength | Speed Grade | t <sub>DOUT</sub> | t <sub>DP</sub> | t <sub>DIN</sub> | t <sub>PY</sub> | t <sub>EOUT</sub> | t <sub>ZL</sub> | t <sub>ZH</sub> | t <sub>LZ</sub> | t <sub>HZ</sub> | t <sub>ZLS</sub> | t <sub>ZHS</sub> | Units |
|----------------|-------------|-------------------|-----------------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|-------|
| 2 mA           | Std.        | 1.55              | 3.23            | 0.26             | 1.58            | 1.10              | 3.09            | 2.76            | 3.30            | 3.49            | 8.69             | 8.36             | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-119 • 1.2 V LVC MOS High Slew**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.14\text{ V}$   
Applicable to Standard Banks

| Drive Strength | Speed Grade | t <sub>DOUT</sub> | t <sub>DP</sub> | t <sub>DIN</sub> | t <sub>PY</sub> | t <sub>EOUT</sub> | t <sub>ZL</sub> | t <sub>ZH</sub> | t <sub>LZ</sub> | t <sub>HZ</sub> | Units |
|----------------|-------------|-------------------|-----------------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|-------|
| 1 mA           | Std.        | 1.55              | 8.58            | 0.26             | 1.52            | 1.10              | 8.21            | 7.36            | 2.52            | 2.40            | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-120 • 1.2 V LCMOS High Slew – Applies to 1.2 V DC Core Voltage**  
**Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 1.14\text{ V}$**   
**Applicable to Standard Banks**

| Drive Strength | Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | $t_{EOUT}$ | $t_{ZL}$ | $t_{ZH}$ | $t_{LZ}$ | $t_{HZ}$ | Units |
|----------------|-------------|------------|----------|-----------|----------|------------|----------|----------|----------|----------|-------|
| 1 mA           | Std.        | 1.55       | 3.60     | 0.26      | 1.52     | 1.10       | 3.45     | 3.04     | 2.52     | 2.50     | ns    |

**Notes:**

1. Software default selection highlighted in gray.
2. For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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.

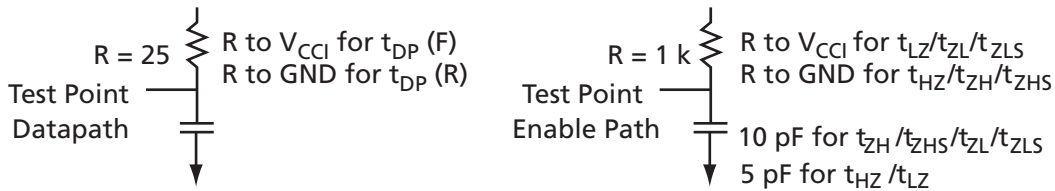
**Table 2-121 • Minimum and Maximum DC Input and Output Levels**  
Applicable to Advanced and Standard Plus I/Os

| 3.3 V PCI/PCI-X       | $V_{IL}$       |        | $V_{IH}$ |        | $V_{OL}$ | $V_{OH}$ | $I_{OL}$ | $I_{OH}$ | $I_{OSH}$            | $I_{OSL}$            | $I_{IL}$  | $I_{IH}$  |
|-----------------------|----------------|--------|----------|--------|----------|----------|----------|----------|----------------------|----------------------|-----------|-----------|
| Drive Strength        | Min, V         | Max, V | Min, V   | Max, V | Max, V   | Min, V   | mA       | mA       | Max, mA <sup>1</sup> | Max, mA <sup>1</sup> | $\mu A^2$ | $\mu A^2$ |
| Per PCI specification | Per PCI curves |        |          |        |          |          |          |          |                      |                      | 10        | 10        |

Notes:

1. Currents are measured at 100°C junction temperature and maximum voltage.
2. Currents are measured at 85°C junction temperature.

AC loadings are defined per the PCI/PCI-X specifications for the datapath; Actel loadings for enable path characterization are described in [Figure 2-12](#).



**Figure 2-12 • AC Loading**

AC loadings are defined per PCI/PCI-X specifications for the datapath; Actel loading for tristate is described in [Table 2-122](#).

**Table 2-122 • 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 $t_{DP(R)}$<br>0.615 * $V_{CC1}$ for $t_{DP(F)}$ | 10              |

\* Measuring point =  $V_{trip}$ . See [Table 2-28 on page 2-25](#) for a complete table of trip points.

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-123 • 3.3 V PCI/PCI-X**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| 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.        | 0.97       | 2.32     | 0.19      | 0.70     | 0.66       | 2.36     | 1.77     | 2.67     | 3.04     | 5.89      | 5.30      | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-124 • 3.3 V PCI/PCI-X**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus I/O Banks

| 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.        | 0.97       | 1.96     | 0.19      | 0.70     | 0.66       | 2.00     | 1.50     | 2.36     | 2.79     | 5.53      | 5.03      | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-125 • 3.3 V PCI/PCI-X**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Advanced I/O Banks

| 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.        | 1.55       | 2.90     | 0.25      | 0.86     | 1.10       | 2.95     | 2.29     | 3.23     | 3.92     | 8.76      | 8.10      | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-126 • 3.3 V PCI/PCI-X**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Plus I/O Banks

| 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.        | 1.55       | 2.52     | 0.25      | 0.85     | 1.10       | 2.57     | 1.98     | 2.91     | 3.62     | 8.37      | 7.78      | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) 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.

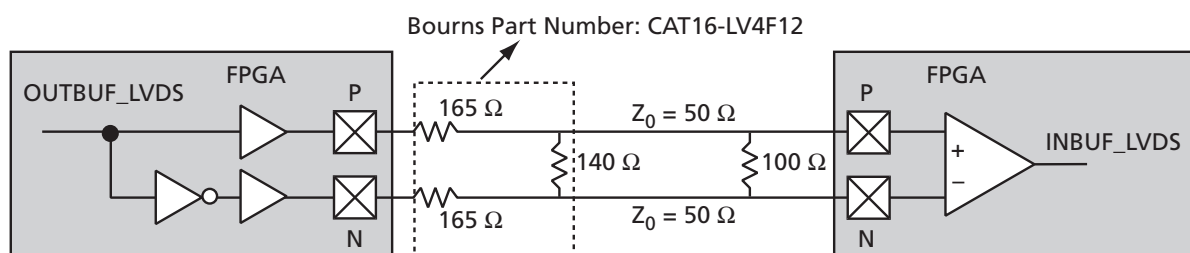
Differential I/Os can also be used in conjunction with the embedded Input Register (InReg), Output Register (OutReg), Enable Register (EnReg), and Double Data Rate (DDR). However, there is no support for bidirectional I/Os or tristates with the LVPECL standards.

### 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 2-13](#). 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, IGLOO also supports Bus LVDS structure and Multipoint LVDS (M-LVDS) configuration (up to 40 nodes).



**Figure 2-13 • LVDS Circuit Diagram and Board-Level Implementation**



**Table 2-127 • 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    | $\mu$ A |
| $I_{IL}^3$   | Input LOW Leakage Current   |       |       | 10    | $\mu$ 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 =  $\pm 350$  mV.
3. Currents are measured at 85°C junction temperature.
4.  $I_{OL}/I_{OH}$  is defined by  $V_{ODIFF}/(resistor\ network)$ .

**Table 2-128 • 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 2-28 on page 2-25 for a complete table of trip points.

**Timing Characteristics**
**1.5 V DC Core Voltage**
**Table 2-129 • LVDS – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425$  V, Worst-Case  $V_{CCI} = 2.3$  V  
Applicable to Standard Banks

| Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | Units |
|-------------|------------|----------|-----------|----------|-------|
| Std.        | 0.97       | 1.67     | 0.19      | 1.31     | ns    |

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 and Table 2-7 on page 2-7 for derating values.

**1.2 V DC Core Voltage**
**Table 2-130 • LVDS – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14$  V, Worst-Case  $V_{CCI} = 2.3$  V  
Applicable to Standard Banks

| Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | Units |
|-------------|------------|----------|-----------|----------|-------|
| Std.        | 1.55       | 2.19     | 0.25      | 1.52     | ns    |

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 and Table 2-7 on page 2-7 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 2-14. The input and output buffer delays are available in the LVDS section in Table 2-129 on page 2-65 and Table 2-130 on page 2-65.

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").

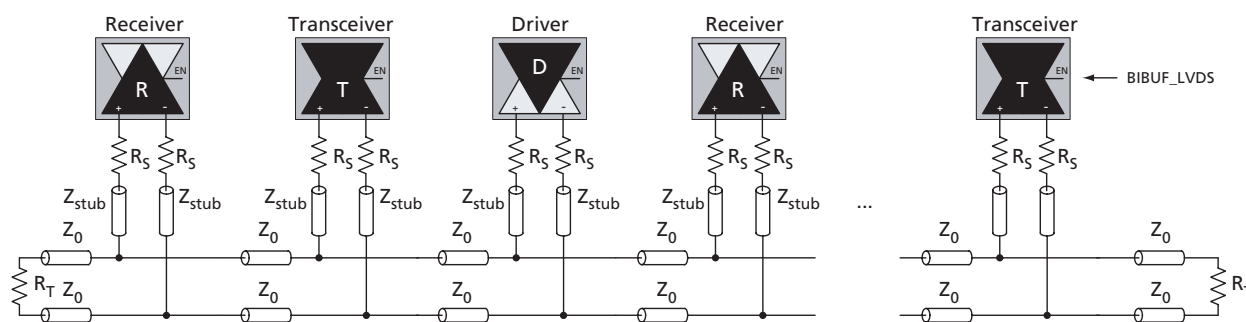


Figure 2-14 • B-LVDS/M-LVDS Multipoint Application Using LVDS I/O Buffers

## 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 2-15. 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.

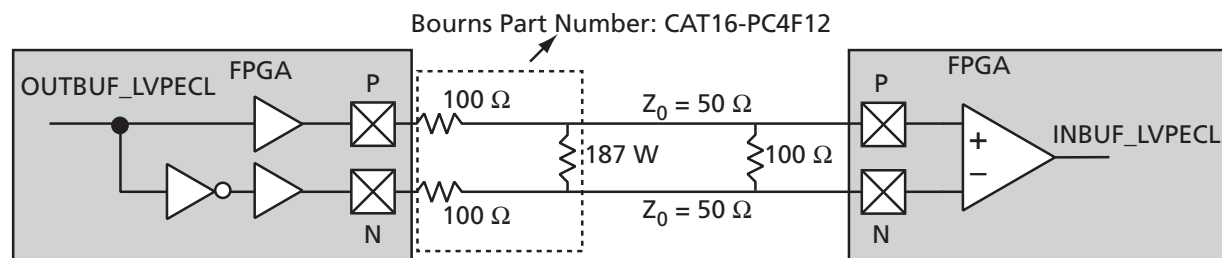


Figure 2-15 • LVPECL Circuit Diagram and Board-Level Implementation

**Table 2-131 • 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 2-132 • 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 2-28 on page 2-87](#) for a complete table of trip points.

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-133 • LVPECL – Applies to 1.5 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | Units |
|-------------|------------|----------|-----------|----------|-------|
| Std.        | 0.97       | 1.67     | 0.19      | 1.16     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-134 • LVPECL – Applies to 1.2 V DC Core Voltage**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ , Worst-Case  $V_{CCI} = 3.0\text{ V}$   
Applicable to Standard Banks

| Speed Grade | $t_{DOUT}$ | $t_{DP}$ | $t_{DIN}$ | $t_{PY}$ | Units |
|-------------|------------|----------|-----------|----------|-------|
| Std.        | 1.55       | 2.24     | 0.25      | 1.37     | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## I/O Register Specifications

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

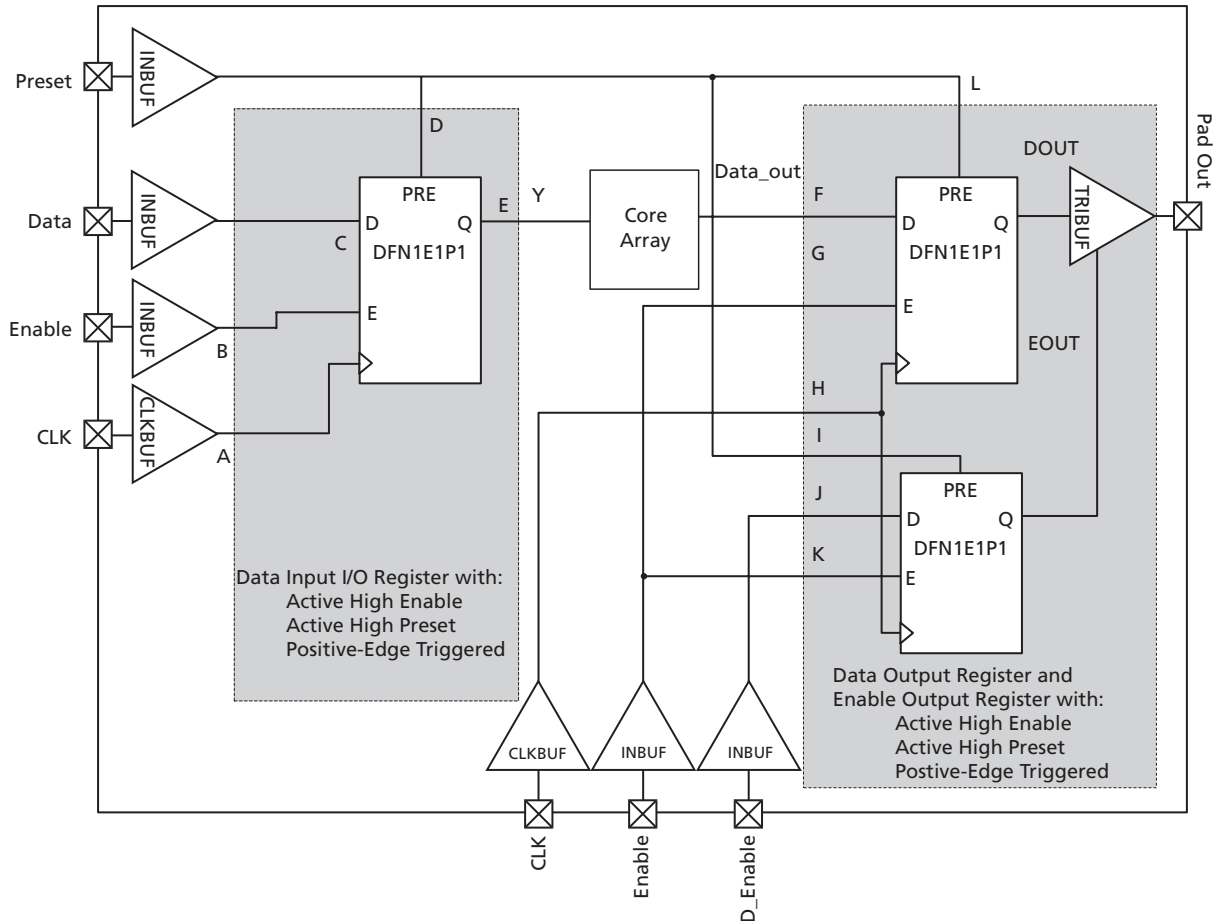


Figure 2-16 • Timing Model of Registered I/O Buffers with Synchronous Enable and Asynchronous Preset

**Table 2-135 • Parameter Definition and Measuring Nodes**

| Parameter Name       | Parameter Definition                                             | Measuring Nodes (from, to)* |
|----------------------|------------------------------------------------------------------|-----------------------------|
| t <sub>OCLKQ</sub>   | Clock-to-Q of the Output Data Register                           | H, DOUT                     |
| t <sub>OSUD</sub>    | Data Setup Time for the Output Data Register                     | F, H                        |
| t <sub>OHD</sub>     | Data Hold Time for the Output Data Register                      | F, H                        |
| t <sub>OSUE</sub>    | Enable Setup Time for the Output Data Register                   | G, H                        |
| t <sub>OHE</sub>     | Enable Hold Time for the Output Data Register                    | G, H                        |
| t <sub>OPRE2Q</sub>  | Asynchronous Preset-to-Q of the Output Data Register             | L, DOUT                     |
| t <sub>OEMPRE</sub>  | Asynchronous Preset Removal Time for the Output Data Register    | L, H                        |
| t <sub>ORECPRE</sub> | Asynchronous Preset Recovery Time for the Output Data Register   | L, H                        |
| t <sub>OCLKQ</sub>   | Clock-to-Q of the Output Enable Register                         | H, EOUT                     |
| t <sub>OESUD</sub>   | Data Setup Time for the Output Enable Register                   | J, H                        |
| t <sub>OEHd</sub>    | Data Hold Time for the Output Enable Register                    | J, H                        |
| t <sub>OESUE</sub>   | Enable Setup Time for the Output Enable Register                 | K, H                        |
| t <sub>OEHd</sub>    | Enable Hold Time for the Output Enable Register                  | K, H                        |
| t <sub>OEPRE2Q</sub> | Asynchronous Preset-to-Q of the Output Enable Register           | I, EOUT                     |
| t <sub>OEMPRE</sub>  | Asynchronous Preset Removal Time for the Output Enable Register  | I, H                        |
| t <sub>OERCPRE</sub> | Asynchronous Preset Recovery Time for the Output Enable Register | I, H                        |
| t <sub>ICLKQ</sub>   | Clock-to-Q of the Input Data Register                            | A, E                        |
| t <sub>ISUD</sub>    | Data Setup Time for the Input Data Register                      | C, A                        |
| t <sub>IHD</sub>     | Data Hold Time for the Input Data Register                       | C, A                        |
| t <sub>ISUE</sub>    | Enable Setup Time for the Input Data Register                    | B, A                        |
| t <sub>IHE</sub>     | Enable Hold Time for the Input Data Register                     | B, A                        |
| t <sub>IPRE2Q</sub>  | Asynchronous Preset-to-Q of the Input Data Register              | D, E                        |
| t <sub>IEMPRE</sub>  | Asynchronous Preset Removal Time for the Input Data Register     | D, A                        |
| t <sub>IRECPRE</sub> | Asynchronous Preset Recovery Time for the Input Data Register    | D, A                        |

\* See Figure 2-16 on page 2-68 for more information.

## Fully Registered I/O Buffers with Synchronous Enable and Asynchronous Clear

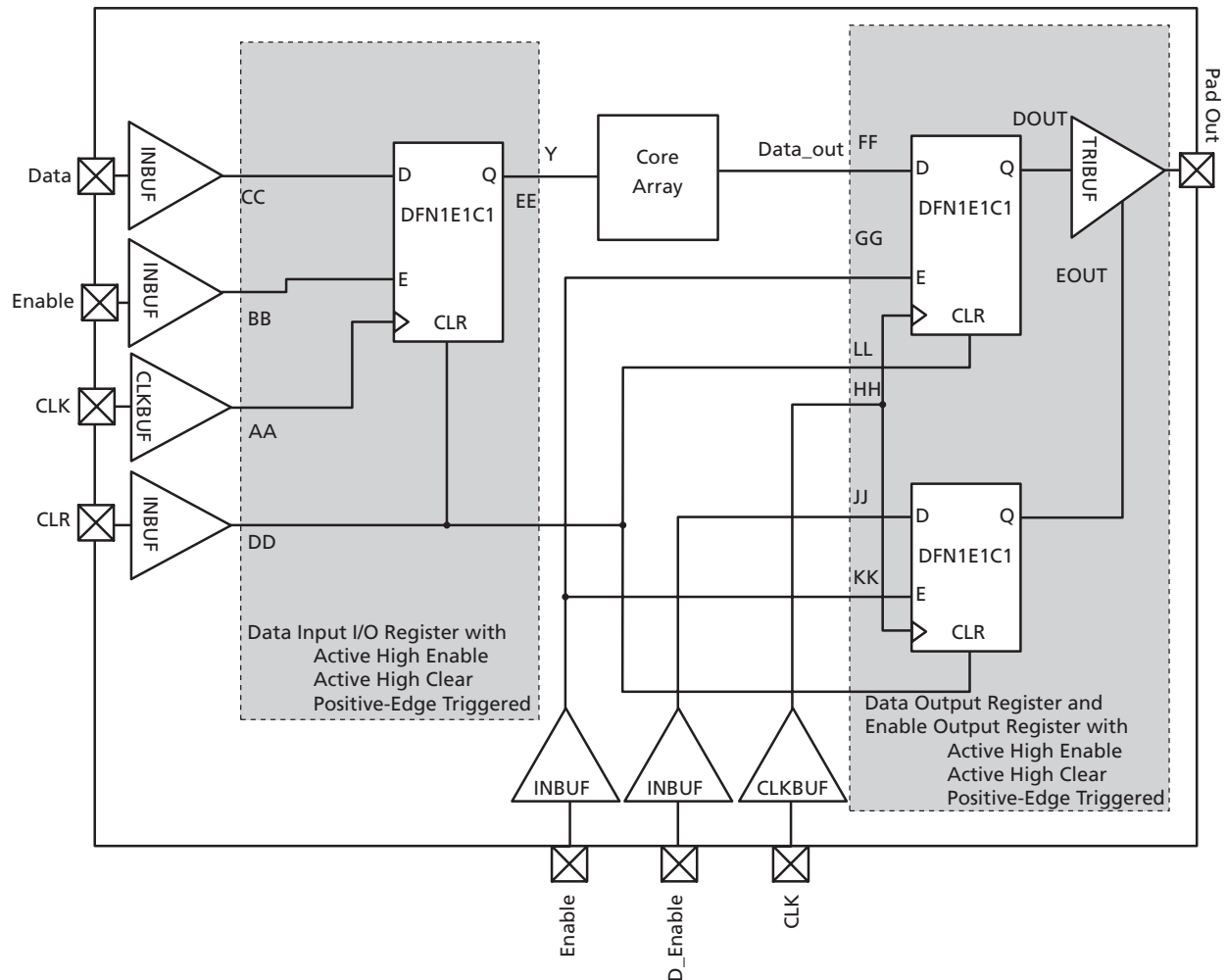


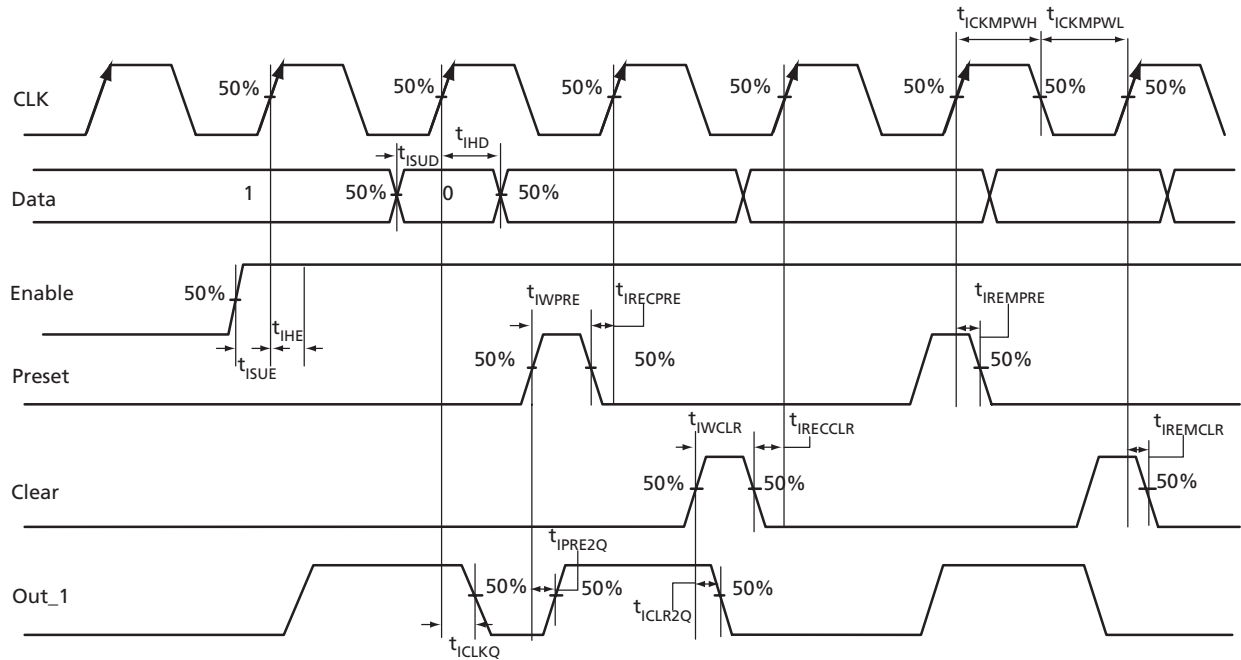
Figure 2-17 • Timing Model of the Registered I/O Buffers with Synchronous Enable and Asynchronous Clear

**Table 2-136 • Parameter Definition and Measuring Nodes**

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

\* See Figure 2-17 on page 2-70 for more information.

## Input Register



**Figure 2-18 • Input Register Timing Diagram**

### Timing Characteristics

#### 1.5 V DC Core Voltage

**Table 2-137 • Input Data Register Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Parameter            | Description                                                         | Std. | Units |
|----------------------|---------------------------------------------------------------------|------|-------|
| $t_{\text{CLKQ}}$    | Clock-to-Q of the Input Data Register                               | 0.42 | ns    |
| $t_{\text{ISUD}}$    | Data Setup Time for the Input Data Register                         | 0.47 | ns    |
| $t_{\text{IHD}}$     | Data Hold Time for the Input Data Register                          | 0.00 | ns    |
| $t_{\text{ISUE}}$    | Enable Setup Time for the Input Data Register                       | 0.67 | ns    |
| $t_{\text{IHE}}$     | Enable Hold Time for the Input Data Register                        | 0.00 | ns    |
| $t_{\text{ICLR2Q}}$  | Asynchronous Clear-to-Q of the Input Data Register                  | 0.79 | ns    |
| $t_{\text{IPRE2Q}}$  | Asynchronous Preset-to-Q of the Input Data Register                 | 0.79 | ns    |
| $t_{\text{IEMCLR}}$  | Asynchronous Clear Removal Time for the Input Data Register         | 0.00 | ns    |
| $t_{\text{IRECCLR}}$ | Asynchronous Clear Recovery Time for the Input Data Register        | 0.24 | ns    |
| $t_{\text{IEMPRE}}$  | Asynchronous Preset Removal Time for the Input Data Register        | 0.00 | ns    |
| $t_{\text{IRECPRE}}$ | Asynchronous Preset Recovery Time for the Input Data Register       | 0.24 | ns    |
| $t_{\text{IWCLR}}$   | Asynchronous Clear Minimum Pulse Width for the Input Data Register  | 0.19 | ns    |
| $t_{\text{IWPRE}}$   | Asynchronous Preset Minimum Pulse Width for the Input Data Register | 0.19 | ns    |
| $t_{\text{ICKMPWH}}$ | Clock Minimum Pulse Width HIGH for the Input Data Register          | 0.31 | ns    |
| $t_{\text{ICKMPWL}}$ | Clock Minimum Pulse Width LOW for the Input Data Register           | 0.28 | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.



**Table 2-138 • Input Data Register Propagation Delays**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**2-73**

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-139 • Output Data Register Propagation Delays**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Parameter            | Description                                                          | Std. | Units |
|----------------------|----------------------------------------------------------------------|------|-------|
| $t_{\text{CLKQ}}$    | Clock-to-Q of the Output Data Register                               | 1.00 | ns    |
| $t_{\text{OSUD}}$    | Data Setup Time for the Output Data Register                         | 0.51 | ns    |
| $t_{\text{OHD}}$     | Data Hold Time for the Output Data Register                          | 0.00 | ns    |
| $t_{\text{OSUE}}$    | Enable Setup Time for the Output Data Register                       | 0.70 | ns    |
| $t_{\text{OHE}}$     | Enable Hold Time for the Output Data Register                        | 0.00 | ns    |
| $t_{\text{OCLR2Q}}$  | Asynchronous Clear-to-Q of the Output Data Register                  | 1.34 | ns    |
| $t_{\text{OPRE2Q}}$  | Asynchronous Preset-to-Q of the Output Data Register                 | 1.34 | ns    |
| $t_{\text{OREMCLR}}$ | Asynchronous Clear Removal Time for the Output Data Register         | 0.00 | ns    |
| $t_{\text{ORECCLR}}$ | Asynchronous Clear Recovery Time for the Output Data Register        | 0.24 | ns    |
| $t_{\text{OREMPRE}}$ | Asynchronous Preset Removal Time for the Output Data Register        | 0.00 | ns    |
| $t_{\text{ORECPRE}}$ | Asynchronous Preset Recovery Time for the Output Data Register       | 0.24 | ns    |
| $t_{\text{OWCLR}}$   | Asynchronous Clear Minimum Pulse Width for the Output Data Register  | 0.19 | ns    |
| $t_{\text{OWPRE}}$   | Asynchronous Preset Minimum Pulse Width for the Output Data Register | 0.19 | ns    |
| $t_{\text{OCKMPWH}}$ | Clock Minimum Pulse Width HIGH for the Output Data Register          | 0.31 | ns    |
| $t_{\text{OCKMPWL}}$ | Clock Minimum Pulse Width LOW for the Output Data Register           | 0.28 | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-140 • Output Data Register Propagation Delays**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

| Parameter            | Description                                                          | Std. | Units |
|----------------------|----------------------------------------------------------------------|------|-------|
| $t_{\text{CLKQ}}$    | Clock-to-Q of the Output Data Register                               | 1.52 | ns    |
| $t_{\text{OSUD}}$    | Data Setup Time for the Output Data Register                         | 1.15 | ns    |
| $t_{\text{OHD}}$     | Data Hold Time for the Output Data Register                          | 0.00 | ns    |
| $t_{\text{OSUE}}$    | Enable Setup Time for the Output Data Register                       | 1.11 | ns    |
| $t_{\text{OHE}}$     | Enable Hold Time for the Output Data Register                        | 0.00 | ns    |
| $t_{\text{OCLR2Q}}$  | Asynchronous Clear-to-Q of the Output Data Register                  | 1.96 | ns    |
| $t_{\text{OPRE2Q}}$  | Asynchronous Preset-to-Q of the Output Data Register                 | 1.96 | ns    |
| $t_{\text{OREMCLR}}$ | Asynchronous Clear Removal Time for the Output Data Register         | 0.00 | ns    |
| $t_{\text{ORECCLR}}$ | Asynchronous Clear Recovery Time for the Output Data Register        | 0.24 | ns    |
| $t_{\text{OREMPRE}}$ | Asynchronous Preset Removal Time for the Output Data Register        | 0.00 | ns    |
| $t_{\text{ORECPRE}}$ | Asynchronous Preset Recovery Time for the Output Data Register       | 0.24 | ns    |
| $t_{\text{OWCLR}}$   | Asynchronous Clear Minimum Pulse Width for the Output Data Register  | 0.19 | ns    |
| $t_{\text{OWPRE}}$   | Asynchronous Preset Minimum Pulse Width for the Output Data Register | 0.19 | ns    |
| $t_{\text{OCKMPWH}}$ | Clock Minimum Pulse Width HIGH for the Output Data Register          | 0.31 | ns    |
| $t_{\text{OCKMPWL}}$ | Clock Minimum Pulse Width LOW for the Output Data Register           | 0.28 | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## Output Enable Register

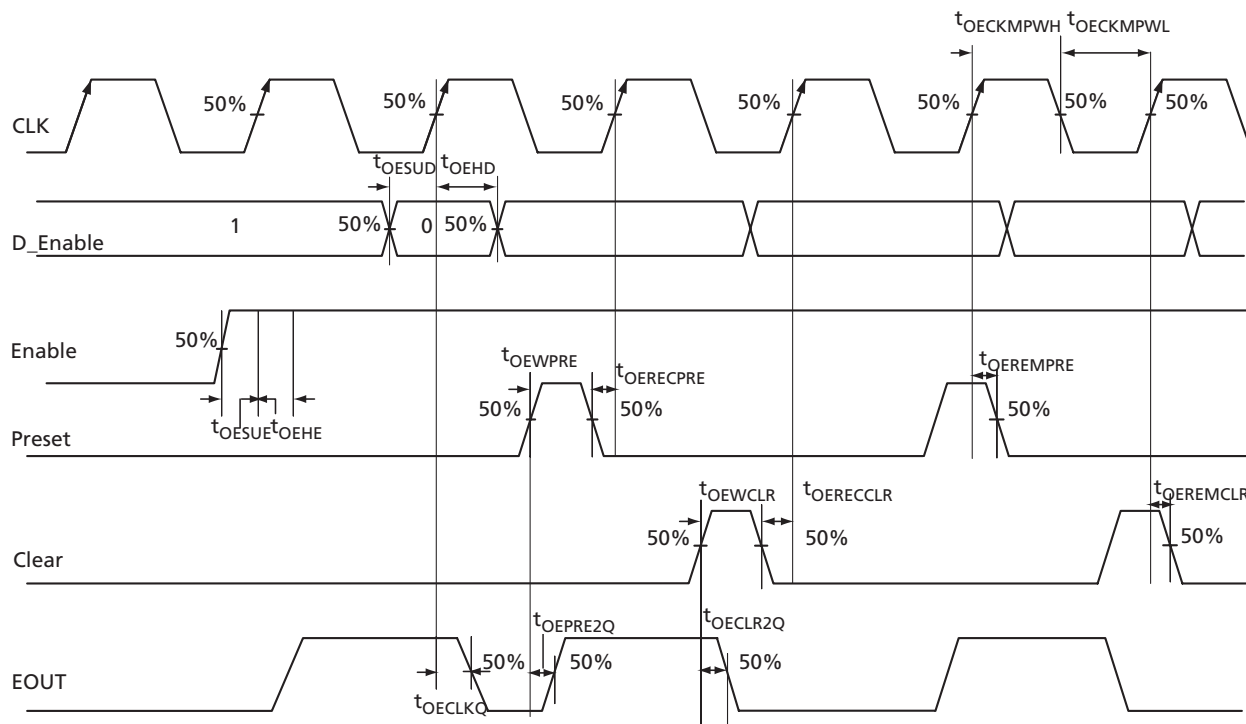


Figure 2-20 • Output Enable Register Timing Diagram

### Timing Characteristics

1.5 V DC Core Voltage

Table 2-141 • Output Enable Register Propagation Delays

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Parameter      | Description                                                            | Std. | Units |
|----------------|------------------------------------------------------------------------|------|-------|
| $t_{OECLKQ}$   | Clock-to-Q of the Output Enable Register                               | 0.75 | ns    |
| $t_{OESUD}$    | Data Setup Time for the Output Enable Register                         | 0.51 | ns    |
| $t_{OEHD}$     | Data Hold Time for the Output Enable Register                          | 0.00 | ns    |
| $t_{OESUE}$    | Enable Setup Time for the Output Enable Register                       | 0.73 | ns    |
| $t_{OEHE}$     | Enable Hold Time for the Output Enable Register                        | 0.00 | ns    |
| $t_{OECLR2Q}$  | Asynchronous Clear-to-Q of the Output Enable Register                  | 1.13 | ns    |
| $t_{OEPRE2Q}$  | Asynchronous Preset-to-Q of the Output Enable Register                 | 1.13 | ns    |
| $t_{OEREMCLR}$ | Asynchronous Clear Removal Time for the Output Enable Register         | 0.00 | ns    |
| $t_{OERECCLR}$ | Asynchronous Clear Recovery Time for the Output Enable Register        | 0.24 | ns    |
| $t_{OEREMPRE}$ | Asynchronous Preset Removal Time for the Output Enable Register        | 0.00 | ns    |
| $t_{OERECPRE}$ | Asynchronous Preset Recovery Time for the Output Enable Register       | 0.24 | ns    |
| $t_{OEWCCLR}$  | Asynchronous Clear Minimum Pulse Width for the Output Enable Register  | 0.19 | ns    |
| $t_{OEWPPE}$   | Asynchronous Preset Minimum Pulse Width for the Output Enable Register | 0.19 | ns    |
| $t_{OECKMPWH}$ | Clock Minimum Pulse Width HIGH for the Output Enable Register          | 0.31 | ns    |
| $t_{OECKMPWL}$ | Clock Minimum Pulse Width LOW for the Output Enable Register           | 0.28 | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

### 1.2 V DC Core Voltage

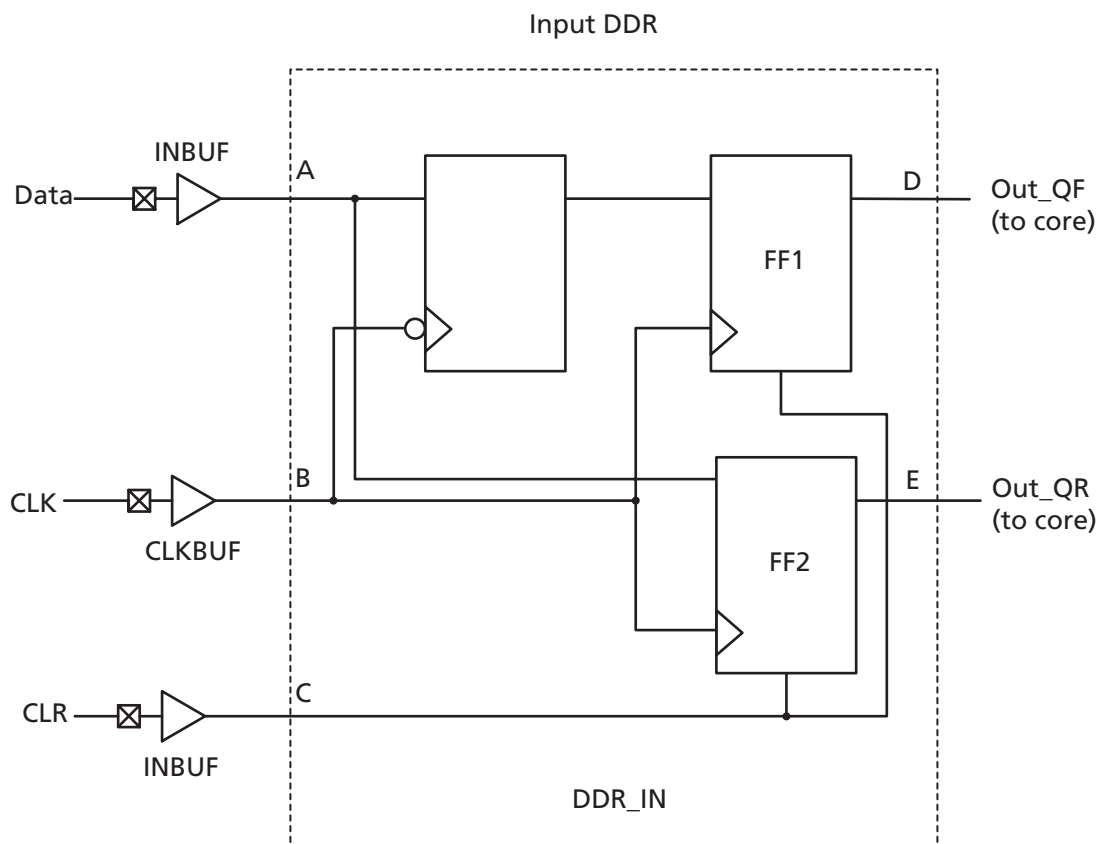
**Table 2-142 • Output Enable Register Propagation Delays**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

| Parameter      | Description                                                            | Std. | Units |
|----------------|------------------------------------------------------------------------|------|-------|
| $t_{OECLKQ}$   | Clock-to-Q of the Output Enable Register                               | 1.10 | ns    |
| $t_{OESUD}$    | Data Setup Time for the Output Enable Register                         | 1.15 | ns    |
| $t_{OEHD}$     | Data Hold Time for the Output Enable Register                          | 0.00 | ns    |
| $t_{OESUE}$    | Enable Setup Time for the Output Enable Register                       | 1.22 | ns    |
| $t_{OEHE}$     | Enable Hold Time for the Output Enable Register                        | 0.00 | ns    |
| $t_{OECLR2Q}$  | Asynchronous Clear-to-Q of the Output Enable Register                  | 1.65 | ns    |
| $t_{OEPRE2Q}$  | Asynchronous Preset-to-Q of the Output Enable Register                 | 1.65 | ns    |
| $t_{OEREMCLR}$ | Asynchronous Clear Removal Time for the Output Enable Register         | 0.00 | ns    |
| $t_{OERECCLR}$ | Asynchronous Clear Recovery Time for the Output Enable Register        | 0.24 | ns    |
| $t_{OEREMPRE}$ | Asynchronous Preset Removal Time for the Output Enable Register        | 0.00 | ns    |
| $t_{OERECPRE}$ | Asynchronous Preset Recovery Time for the Output Enable Register       | 0.24 | ns    |
| $t_{OEWCCLR}$  | Asynchronous Clear Minimum Pulse Width for the Output Enable Register  | 0.19 | ns    |
| $t_{OEWPPE}$   | Asynchronous Preset Minimum Pulse Width for the Output Enable Register | 0.19 | ns    |
| $t_{OECKMPWH}$ | Clock Minimum Pulse Width HIGH for the Output Enable Register          | 0.31 | ns    |
| $t_{OECKMPWL}$ | Clock Minimum Pulse Width LOW for the Output Enable Register           | 0.28 | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## DDR Module Specifications

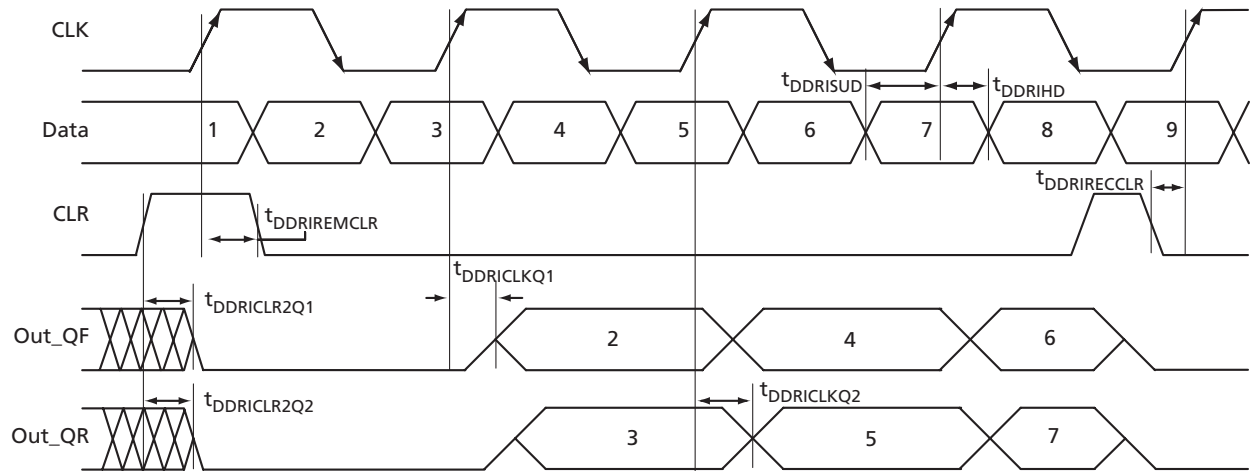
### Input DDR Module



**Figure 2-21 • Input DDR Timing Model**

**Table 2-143 • 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                       |
| $t_{DDRIHD}$     | 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 2-22 • Input DDR Timing Diagram**

### Timing Characteristics

#### 1.5 V DC Core Voltage

**Table 2-144 • Input DDR Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.25\text{ V}$ 

| Parameter              | Description                                          | Std. | Units |
|------------------------|------------------------------------------------------|------|-------|
| $t_{\text{DDRCLKQ1}}$  | Clock-to-Out Out_QR for Input DDR                    | 0.48 | ns    |
| $t_{\text{DDRCLKQ2}}$  | Clock-to-Out Out_QF for Input DDR                    | 0.65 | ns    |
| $t_{\text{DDRISUD1}}$  | Data Setup for Input DDR (negedge)                   | 0.50 | ns    |
| $t_{\text{DDRISUD2}}$  | Data Setup for Input DDR (posedge)                   | 0.40 | ns    |
| $t_{\text{DDRHD1}}$    | Data Hold for Input DDR (negedge)                    | 0.00 | ns    |
| $t_{\text{DDRHD2}}$    | Data Hold for Input DDR (posedge)                    | 0.00 | ns    |
| $t_{\text{DDRCLR2Q1}}$ | Asynchronous Clear-to-Out Out_QR for Input DDR       | 0.82 | ns    |
| $t_{\text{DDRCLR2Q2}}$ | Asynchronous Clear-to-Out Out_QF for Input DDR       | 0.98 | ns    |
| $t_{\text{DDRREMLR}}$  | Asynchronous Clear Removal Time for Input DDR        | 0.00 | ns    |
| $t_{\text{DDRRECLR}}$  | Asynchronous Clear Recovery Time for Input DDR       | 0.23 | ns    |
| $t_{\text{DDRWCCLR}}$  | Asynchronous Clear Minimum Pulse Width for Input DDR | 0.19 | ns    |
| $t_{\text{DDRCKMPWH}}$ | Clock Minimum Pulse Width HIGH for Input DDR         | 0.31 | ns    |
| $t_{\text{DDRCKMPWL}}$ | Clock Minimum Pulse Width LOW for Input DDR          | 0.28 | ns    |
| $F_{\text{DDRIMAX}}$   | Maximum Frequency for Input DDR                      | TBD  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

### 1.2 V DC Core Voltage

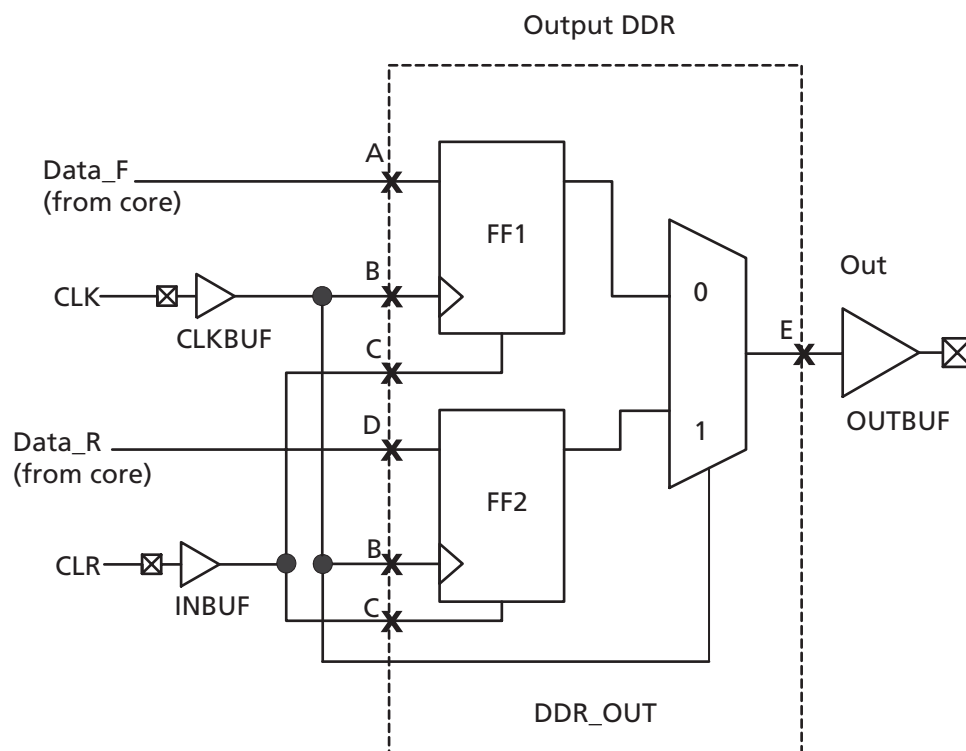
**Table 2-145 • Input DDR Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ 

| Parameter               | Description                                          | Std. | Units |
|-------------------------|------------------------------------------------------|------|-------|
| $t_{\text{DDRICKQ1}}$   | Clock-to-Out Out_QR for Input DDR                    | 0.76 | ns    |
| $t_{\text{DDRICKQ2}}$   | Clock-to-Out Out_QF for Input DDR                    | 0.94 | ns    |
| $t_{\text{DDRISUD1}}$   | Data Setup for Input DDR (negedge)                   | 0.93 | ns    |
| $t_{\text{DDRISUD2}}$   | Data Setup for Input DDR (posedge)                   | 0.84 | ns    |
| $t_{\text{DDRIRD1}}$    | Data Hold for Input DDR (negedge)                    | 0.00 | ns    |
| $t_{\text{DDRIRD2}}$    | Data Hold for Input DDR (posedge)                    | 0.00 | ns    |
| $t_{\text{DDRICLR2Q1}}$ | Asynchronous Clear-to-Out Out_QR for Input DDR       | 1.23 | ns    |
| $t_{\text{DDRICLR2Q2}}$ | Asynchronous Clear-to-Out Out_QF for Input DDR       | 1.42 | ns    |
| $t_{\text{DDRIRECLR}}$  | Asynchronous Clear Removal Time for Input DDR        | 0.00 | ns    |
| $t_{\text{DDRIRECLR}}$  | Asynchronous Clear Recovery Time for Input DDR       | 0.24 | ns    |
| $t_{\text{DDRIRWCLR}}$  | Asynchronous Clear Minimum Pulse Width for Input DDR | 0.19 | ns    |
| $t_{\text{DDRICKMPWH}}$ | Clock Minimum Pulse Width HIGH for Input DDR         | 0.31 | ns    |
| $t_{\text{DDRICKMPWL}}$ | Clock Minimum Pulse Width LOW for Input DDR          | 0.28 | ns    |
| $F_{\text{DDRIMAX}}$    | Maximum Frequency for Input DDR                      | TBD  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## Output DDR Module

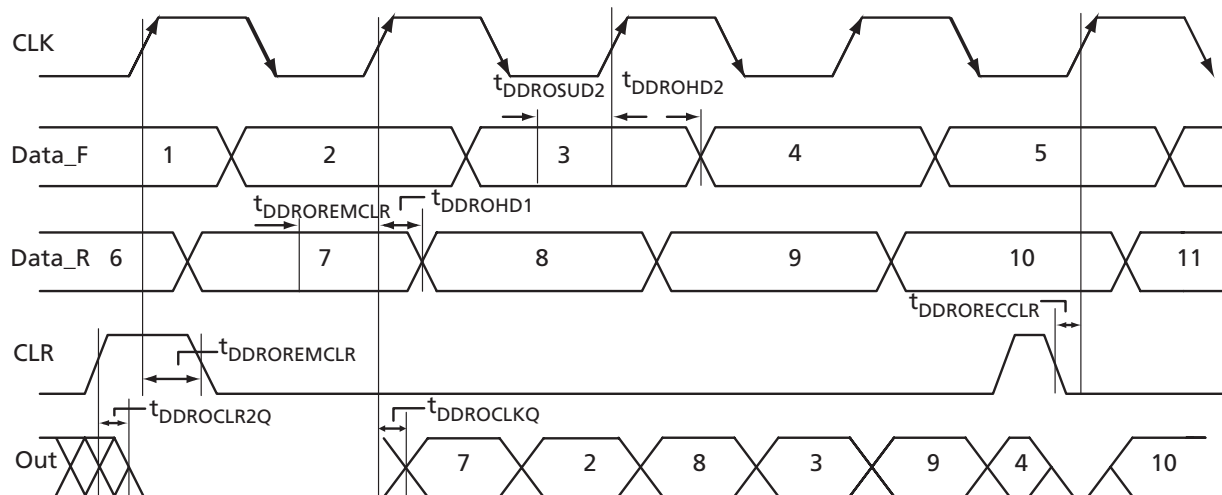


**Figure 2-23 • Output DDR Timing Model**

**Table 2-146 • Parameter Definitions**

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




**Figure 2-24 • Output DDR Timing Diagram**

### Timing Characteristics

1.5 V DC Core Voltage

**Table 2-147 • Output DDR Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

| Parameter        | Description                                           | Std. | Units |
|------------------|-------------------------------------------------------|------|-------|
| $t_{DDROCLKQ}$   | Clock-to-Out of DDR for Output DDR                    | 1.07 | ns    |
| $t_{DDROSUD1}$   | Data_F Data Setup for Output DDR                      | 0.67 | ns    |
| $t_{DDROSUD2}$   | Data_R Data Setup for Output DDR                      | 0.67 | ns    |
| $t_{DDROHD1}$    | Data_F Data Hold for Output DDR                       | 0.00 | ns    |
| $t_{DDROHD2}$    | Data_R Data Hold for Output DDR                       | 0.00 | ns    |
| $t_{DDROCLR2Q}$  | Asynchronous Clear-to-Out for Output DDR              | 1.38 | ns    |
| $t_{DDROEMCLR}$  | Asynchronous Clear Removal Time for Output DDR        | 0.00 | ns    |
| $t_{DDROECCLR}$  | Asynchronous Clear Recovery Time for Output DDR       | 0.23 | ns    |
| $t_{DDROWCLR1}$  | Asynchronous Clear Minimum Pulse Width for Output DDR | 0.19 | ns    |
| $t_{DDROCKMPWH}$ | Clock Minimum Pulse Width HIGH for the Output DDR     | 0.31 | ns    |
| $t_{DDROCKMPWL}$ | Clock Minimum Pulse Width LOW for the Output DDR      | 0.28 | ns    |
| $F_{DDOMAX}$     | Maximum Frequency for the Output DDR                  | TBD  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-148 • Output DDR Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ 

| Parameter               | Description                                           | Std. | Units |
|-------------------------|-------------------------------------------------------|------|-------|
| $t_{\text{DDROCLKQ}}$   | Clock-to-Out of DDR for Output DDR                    | 1.60 | ns    |
| $t_{\text{DDROSUD1}}$   | Data_F Data Setup for Output DDR                      | 1.09 | ns    |
| $t_{\text{DDROSUD2}}$   | Data_R Data Setup for Output DDR                      | 1.16 | ns    |
| $t_{\text{DDROHD1}}$    | Data_F Data Hold for Output DDR                       | 0.00 | ns    |
| $t_{\text{DDROHD2}}$    | Data_R Data Hold for Output DDR                       | 0.00 | ns    |
| $t_{\text{DDROCLR2Q}}$  | Asynchronous Clear-to-Out for Output DDR              | 1.99 | ns    |
| $t_{\text{DDROREMCLR}}$ | Asynchronous Clear Removal Time for Output DDR        | 0.00 | ns    |
| $t_{\text{DDRORECCLR}}$ | Asynchronous Clear Recovery Time for Output DDR       | 0.24 | ns    |
| $t_{\text{DDROWCLR1}}$  | Asynchronous Clear Minimum Pulse Width for Output DDR | 0.19 | ns    |
| $t_{\text{DDROCKMPWH}}$ | Clock Minimum Pulse Width HIGH for the Output DDR     | 0.31 | ns    |
| $t_{\text{DDROCKMPWL}}$ | Clock Minimum Pulse Width LOW for the Output DDR      | 0.28 | ns    |
| $F_{\text{DDOMAX}}$     | Maximum Frequency for the Output DDR                  | TBD  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## VersaTile Characteristics

### VersaTile Specifications as a Combinatorial Module

The IGLOO 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*.

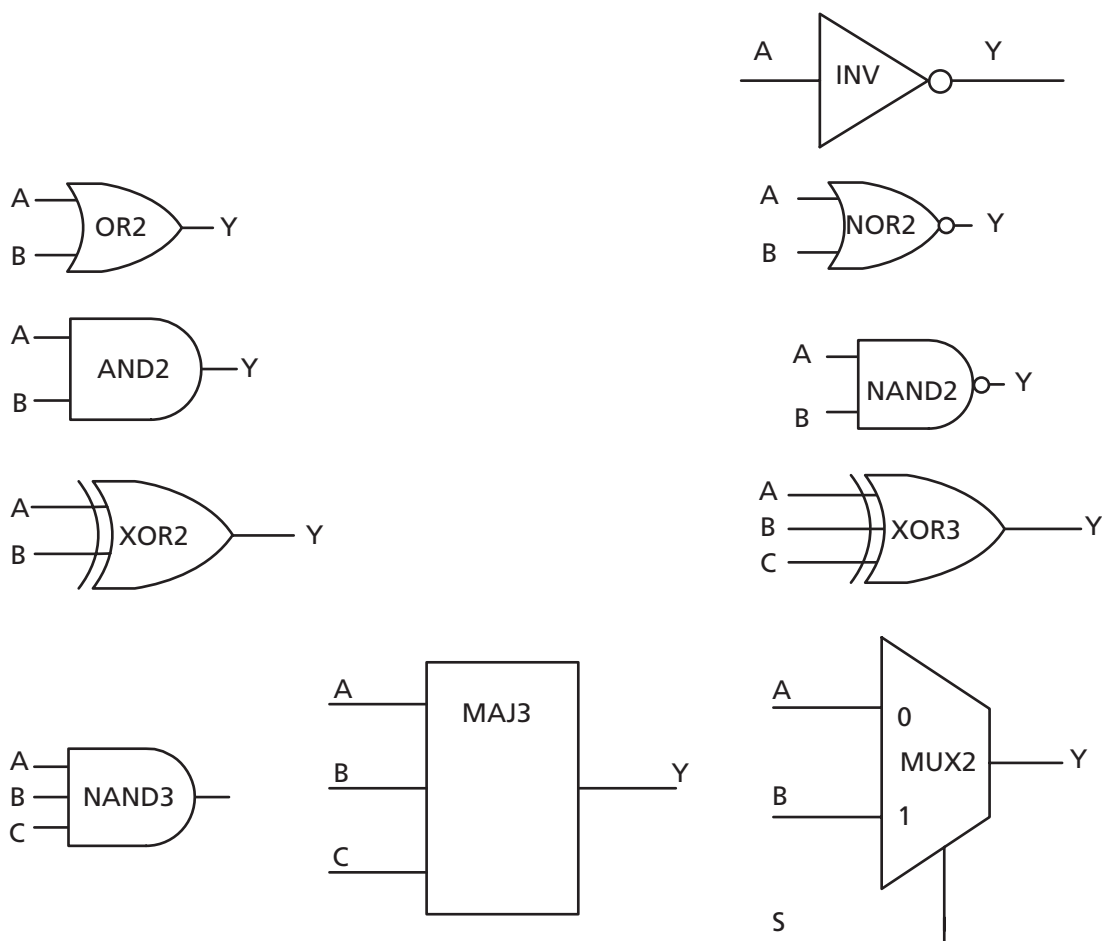


Figure 2-25 • Sample of Combinatorial Cells

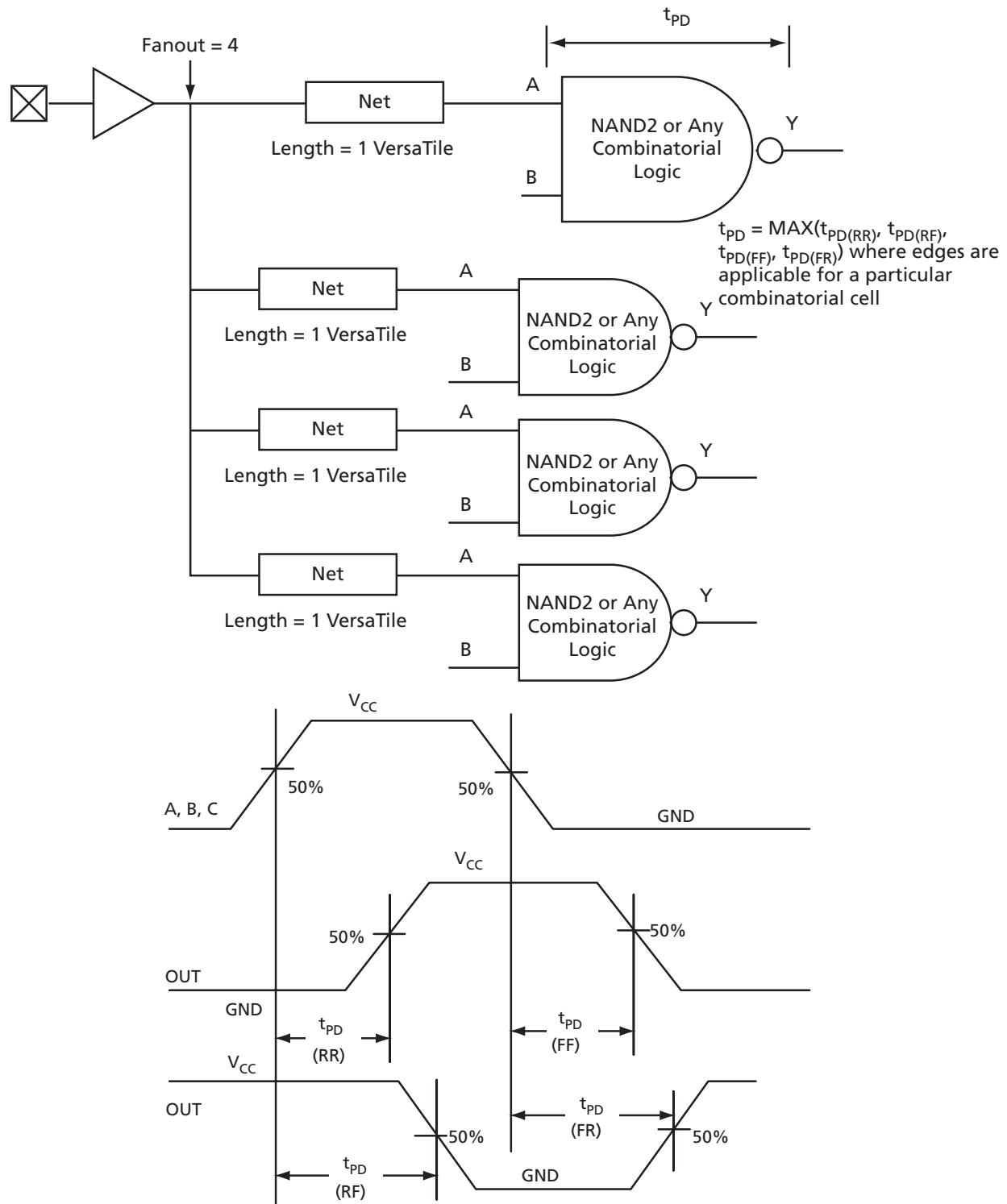


Figure 2-26 • Timing Model and Waveforms

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-149 • Combinatorial Cell Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Combinatorial Cell | Equation                          | Parameter | Std. | Units |
|--------------------|-----------------------------------|-----------|------|-------|
| INV                | $Y = !A$                          | $t_{PD}$  | 0.80 | ns    |
| AND2               | $Y = A \cdot B$                   | $t_{PD}$  | 0.84 | ns    |
| NAND2              | $Y = !(A \cdot B)$                | $t_{PD}$  | 0.90 | ns    |
| OR2                | $Y = A + B$                       | $t_{PD}$  | 1.19 | ns    |
| NOR2               | $Y = !(A + B)$                    | $t_{PD}$  | 1.10 | ns    |
| XOR2               | $Y = A \oplus B$                  | $t_{PD}$  | 1.37 | ns    |
| MAJ3               | $Y = \text{MAJ}(A, B, C)$         | $t_{PD}$  | 1.33 | ns    |
| XOR3               | $Y = A \oplus B \oplus C$         | $t_{PD}$  | 1.79 | ns    |
| MUX2               | $Y = A \text{ IS } + B \text{ S}$ | $t_{PD}$  | 1.48 | ns    |
| AND3               | $Y = A \cdot B \cdot C$           | $t_{PD}$  | 1.21 | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-150 • Combinatorial Cell Propagation Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

| Combinatorial Cell | Equation                          | Parameter | Std. | Units |
|--------------------|-----------------------------------|-----------|------|-------|
| INV                | $Y = !A$                          | $t_{PD}$  | 1.34 | ns    |
| AND2               | $Y = A \cdot B$                   | $t_{PD}$  | 1.43 | ns    |
| NAND2              | $Y = !(A \cdot B)$                | $t_{PD}$  | 1.59 | ns    |
| OR2                | $Y = A + B$                       | $t_{PD}$  | 2.30 | ns    |
| NOR2               | $Y = !(A + B)$                    | $t_{PD}$  | 2.07 | ns    |
| XOR2               | $Y = A \oplus B$                  | $t_{PD}$  | 2.46 | ns    |
| MAJ3               | $Y = \text{MAJ}(A, B, C)$         | $t_{PD}$  | 2.46 | ns    |
| XOR3               | $Y = A \oplus B \oplus C$         | $t_{PD}$  | 3.12 | ns    |
| MUX2               | $Y = A \text{ IS } + B \text{ S}$ | $t_{PD}$  | 2.83 | ns    |
| AND3               | $Y = A \cdot B \cdot C$           | $t_{PD}$  | 2.28 | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## VersaTile Specifications as a Sequential Module

The IGLOO 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*.

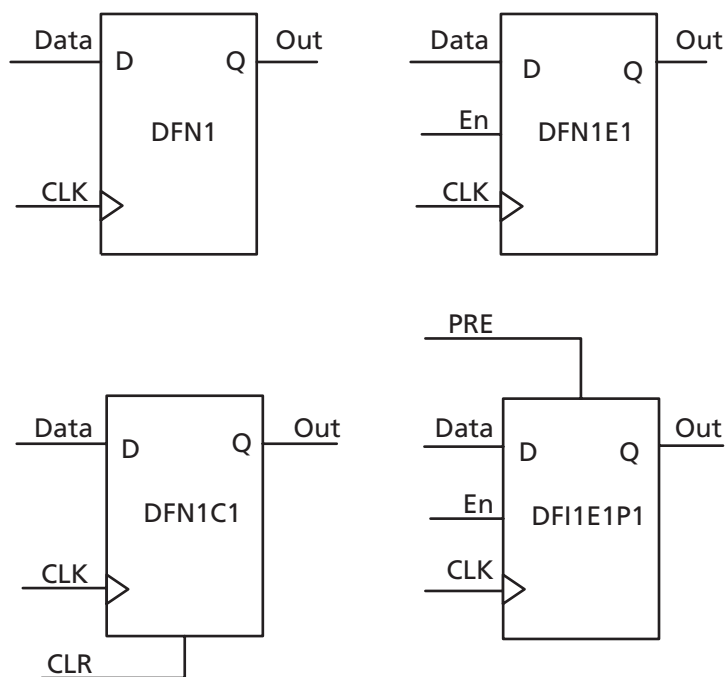
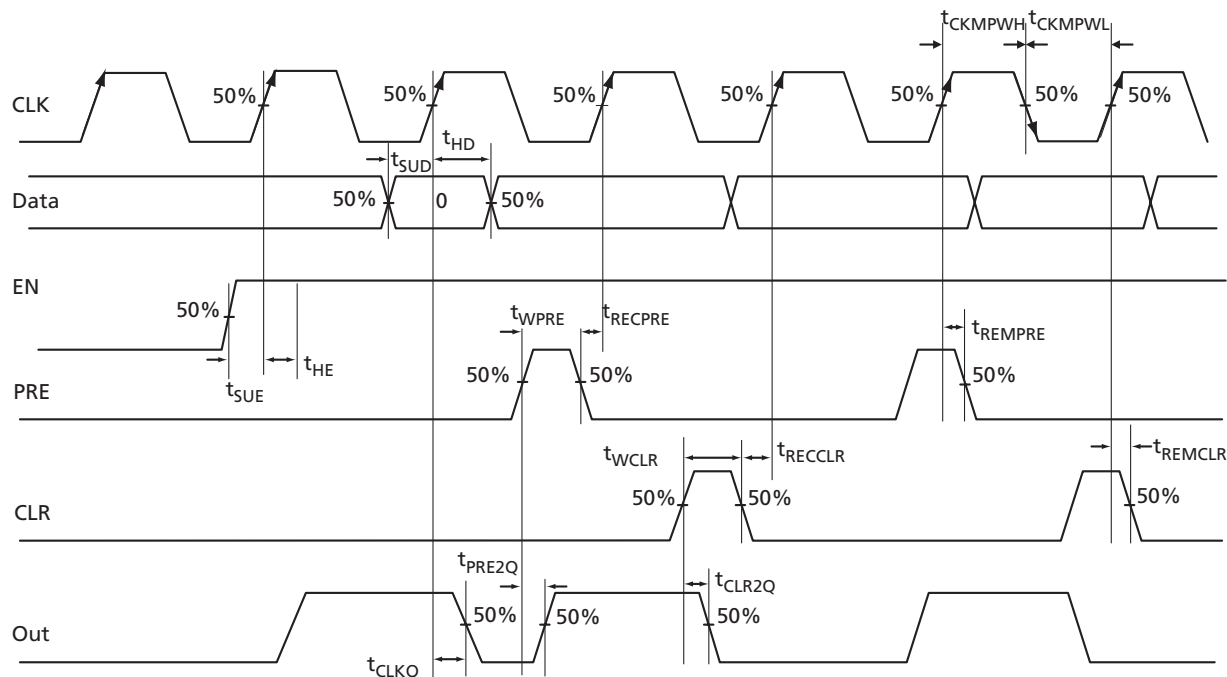


Figure 2-27 • Sample of Sequential Cells



**Figure 2-28 • Timing Model and Waveforms**

## Timing Characteristics

1.5 V DC Core Voltage

**Table 2-151 • Register Delays**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Parameter    | Description                                                   | Std. | Units |
|--------------|---------------------------------------------------------------|------|-------|
| $t_{CLKQ}$   | Clock-to-Q of the Core Register                               | 0.89 | ns    |
| $t_{SUD}$    | Data Setup Time for the Core Register                         | 0.81 | ns    |
| $t_{HD}$     | Data Hold Time for the Core Register                          | 0.00 | ns    |
| $t_{SUE}$    | Enable Setup Time for the Core Register                       | 0.73 | ns    |
| $t_{HE}$     | Enable Hold Time for the Core Register                        | 0.00 | ns    |
| $t_{CLR2Q}$  | Asynchronous Clear-to-Q of the Core Register                  | 0.60 | ns    |
| $t_{PRE2Q}$  | Asynchronous Preset-to-Q of the Core Register                 | 0.62 | ns    |
| $t_{REMCLR}$ | Asynchronous Clear Removal Time for the Core Register         | 0.00 | ns    |
| $t_{RECCLR}$ | Asynchronous Clear Recovery Time for the Core Register        | 0.24 | ns    |
| $t_{REMPRE}$ | Asynchronous Preset Removal Time for the Core Register        | 0.00 | ns    |
| $t_{RECPRE}$ | Asynchronous Preset Recovery Time for the Core Register       | 0.23 | ns    |
| $t_{WCLR}$   | Asynchronous Clear Minimum Pulse Width for the Core Register  | 0.30 | ns    |
| $t_{WPRE}$   | Asynchronous Preset Minimum Pulse Width for the Core Register | 0.30 | ns    |
| $t_{CKMPWH}$ | Clock Minimum Pulse Width HIGH for the Core Register          | 0.56 | ns    |
| $t_{CKMPWL}$ | Clock Minimum Pulse Width LOW for the Core Register           | 0.56 | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

## 1.2 V DC Core Voltage

**Table 2-152 • Register Delays**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ 

| Parameter    | Description                                                   | Std. | Units |
|--------------|---------------------------------------------------------------|------|-------|
| $t_{CLKQ}$   | Clock-to-Q of the Core Register                               | 1.61 | ns    |
| $t_{SUD}$    | Data Setup Time for the Core Register                         | 1.17 | ns    |
| $t_{HD}$     | Data Hold Time for the Core Register                          | 0.00 | ns    |
| $t_{SUE}$    | Enable Setup Time for the Core Register                       | 1.29 | ns    |
| $t_{HE}$     | Enable Hold Time for the Core Register                        | 0.00 | ns    |
| $t_{CLR2Q}$  | Asynchronous Clear-to-Q of the Core Register                  | 0.87 | ns    |
| $t_{PRE2Q}$  | Asynchronous Preset-to-Q of the Core Register                 | 0.89 | ns    |
| $t_{REMCLR}$ | Asynchronous Clear Removal Time for the Core Register         | 0.00 | ns    |
| $t_{RECCLR}$ | Asynchronous Clear Recovery Time for the Core Register        | 0.24 | ns    |
| $t_{REMPRE}$ | Asynchronous Preset Removal Time for the Core Register        | 0.00 | ns    |
| $t_{RECPRE}$ | Asynchronous Preset Recovery Time for the Core Register       | 0.24 | ns    |
| $t_{WCLR}$   | Asynchronous Clear Minimum Pulse Width for the Core Register  | 0.46 | ns    |
| $t_{WPRE}$   | Asynchronous Preset Minimum Pulse Width for the Core Register | 0.46 | ns    |
| $t_{CKMPWH}$ | Clock Minimum Pulse Width HIGH for the Core Register          | 0.95 | ns    |
| $t_{CKMPWL}$ | Clock Minimum Pulse Width LOW for the Core Register           | 0.95 | ns    |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.



## Global Resource Characteristics

### AGL250 Clock Tree Topology

Clock delays are device-specific. Figure 2-29 is an example of a global tree used for clock routing. The global tree presented in Figure 2-29 is driven by a CCC located on the west side of the AGL250 device. It is used to drive all D-flip-flops in the device.

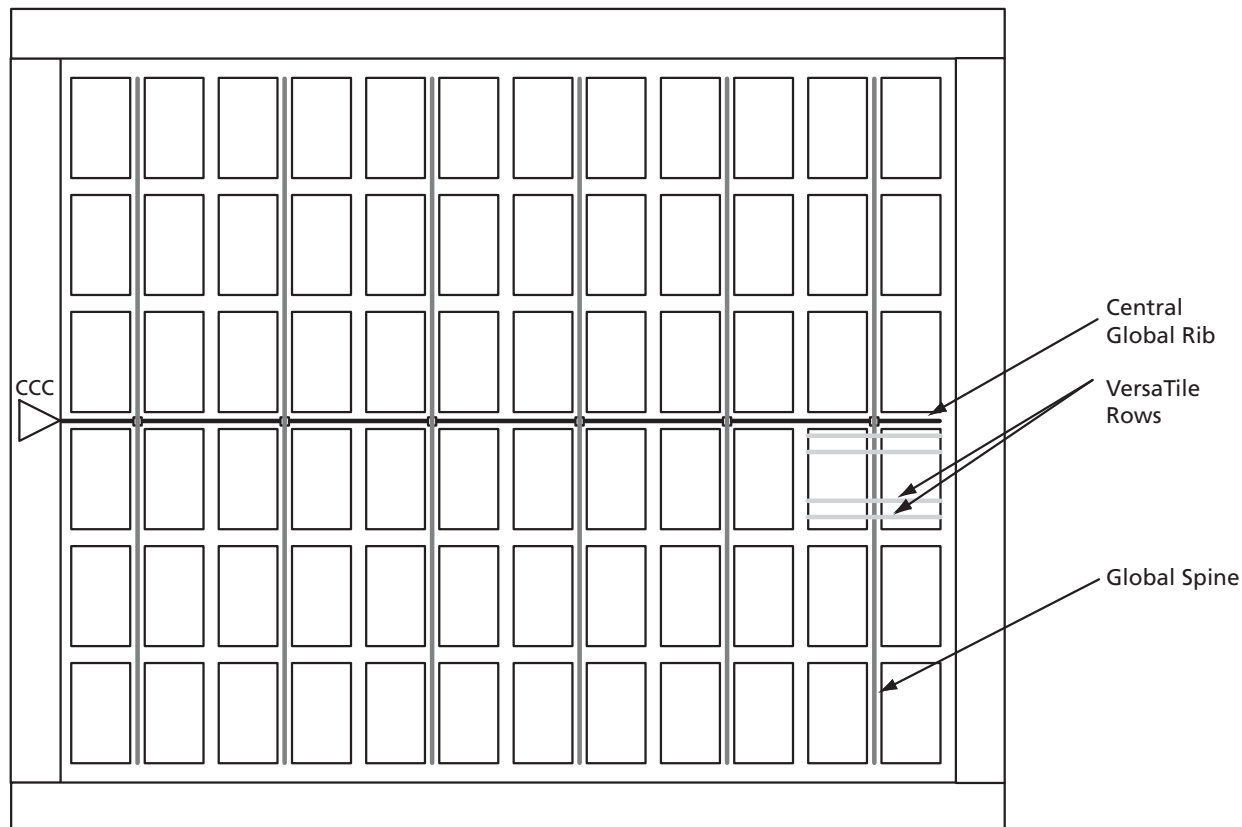


Figure 2-29 • Example of Global Tree Use in an AGL250 Device for Clock Routing

## 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 2-98](#). [Table 2-153](#) to [Table 2-168 on page 2-97](#) present minimum and maximum global clock delays within each device. Minimum and maximum delays are measured with minimum and maximum loading.

### Timing Characteristics

#### 1.5 V DC Core Voltage

**Table 2-153 • AGL015 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$

| Parameter            | Description                               | Std.              |                   | Units |
|----------------------|-------------------------------------------|-------------------|-------------------|-------|
|                      |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{\text{RCKL}}$    | Input LOW Delay for Global Clock          | 1.21              | 1.42              | ns    |
| $t_{\text{RCKH}}$    | Input HIGH Delay for Global Clock         | 1.23              | 1.49              | ns    |
| $t_{\text{RCKMPWH}}$ | Minimum Pulse Width HIGH for Global Clock |                   |                   | ns    |
| $t_{\text{RCKMPWL}}$ | Minimum Pulse Width LOW for Global Clock  |                   |                   | ns    |
| $t_{\text{RCKSW}}$   | Maximum Skew for Global Clock             |                   | 0.27              | ns    |
| $F_{\text{RMAX}}$    | 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 2-6 on page 2-6](#) for derating values.

**Table 2-154 • AGL030 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$

| Parameter            | Description                               | Std.              |                   | Units |
|----------------------|-------------------------------------------|-------------------|-------------------|-------|
|                      |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{\text{RCKL}}$    | Input LOW Delay for Global Clock          | 1.21              | 1.42              | ns    |
| $t_{\text{RCKH}}$    | Input HIGH Delay for Global Clock         | 1.23              | 1.49              | ns    |
| $t_{\text{RCKMPWH}}$ | Minimum Pulse Width HIGH for Global Clock |                   |                   | ns    |
| $t_{\text{RCKMPWL}}$ | Minimum Pulse Width LOW for Global Clock  |                   |                   | ns    |
| $t_{\text{RCKSW}}$   | Maximum Skew for Global Clock             |                   | 0.27              | ns    |
| $F_{\text{RMAX}}$    | 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 2-6 on page 2-6](#) for derating values.

**Table 2-155 • AGL060 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.33              | 1.55              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.35              | 1.62              | 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              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-156 • AGL125 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.36              | 1.71              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.39              | 1.82              | 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             |                   | 0.43              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-157 • AGL250 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.39              | 1.73              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.41              | 1.84              | 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             |                   | 0.43              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-158 • AGL400 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input Low Delay for Global Clock          | 1.45              | 1.79              | ns    |
| $t_{RCKH}$    | Input High Delay for Global Clock         | 1.48              | 1.91              | 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             |                   | 0.43              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-159 • AGL600 Global Resource**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.48              | 1.82              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.52              | 1.94              | 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             |                   | 0.42              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-160 • AGL1000 Global Resource**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.55              | 1.89              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.60              | 2.02              | 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             |                   | 0.42              | 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 2-6 on page 2-6](#) for derating values.

### 1.2 V DC Core Voltage

**Table 2-161 • AGL015 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.79              | 2.09              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.87              | 2.26              | 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             |                   | 0.39              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-162 • AGL030 Global Resource**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 1.80              | 2.09              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 1.88              | 2.27              | 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             |                   | 0.39              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-163 • AGL060 Global Resource**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$

| Parameter            | Description                               | Std.              |                   | Units |
|----------------------|-------------------------------------------|-------------------|-------------------|-------|
|                      |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{\text{RCKL}}$    | Input LOW Delay for Global Clock          | 2.04              | 2.33              | ns    |
| $t_{\text{RCKH}}$    | Input HIGH Delay for Global Clock         | 2.10              | 2.51              | ns    |
| $t_{\text{RCKMPWH}}$ | Minimum Pulse Width HIGH for Global Clock |                   |                   | ns    |
| $t_{\text{RCKMPWL}}$ | Minimum Pulse Width LOW for Global Clock  |                   |                   | ns    |
| $t_{\text{RCKSW}}$   | Maximum Skew for Global Clock             |                   | 0.40              | ns    |
| $F_{\text{RMAX}}$    | 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 2-6 on page 2-6](#) for derating values.

**Table 2-164 • AGL125 Global Resource**  
Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$

| Parameter            | Description                               | Std.              |                   | Units |
|----------------------|-------------------------------------------|-------------------|-------------------|-------|
|                      |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{\text{RCKL}}$    | Input LOW Delay for Global Clock          | 2.08              | 2.54              | ns    |
| $t_{\text{RCKH}}$    | Input HIGH Delay for Global Clock         | 2.15              | 2.77              | ns    |
| $t_{\text{RCKMPWH}}$ | Minimum Pulse Width HIGH for Global Clock |                   |                   | ns    |
| $t_{\text{RCKMPWL}}$ | Minimum Pulse Width LOW for Global Clock  |                   |                   | ns    |
| $t_{\text{RCKSW}}$   | Maximum Skew for Global Clock             |                   | 0.62              | ns    |
| $F_{\text{RMAX}}$    | 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 2-6 on page 2-6](#) for derating values.

**Table 2-165 • AGL250 Global Resource**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.14\text{ V}$

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 2.11              | 2.57              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 2.19              | 2.81              | 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             |                   | 0.62              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-166 • AGL400 Global Resource**  
Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.14\text{ V}$

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 2.18              | 2.64              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 2.27              | 2.89              | 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             |                   | 0.62              | 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 2-6 on page 2-6](#) for derating values.



**Table 2-167 • AGL600 Global Resource**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 2.22              | 2.67              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 2.32              | 2.93              | 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             |                   | 0.61              | 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 2-6 on page 2-6](#) for derating values.

**Table 2-168 • AGL1000 Global Resource**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                               | Std.              |                   | Units |
|---------------|-------------------------------------------|-------------------|-------------------|-------|
|               |                                           | Min. <sup>1</sup> | Max. <sup>2</sup> |       |
| $t_{RCKL}$    | Input LOW Delay for Global Clock          | 2.31              | 2.76              | ns    |
| $t_{RCKH}$    | Input HIGH Delay for Global Clock         | 2.42              | 3.03              | 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             |                   | 0.61              | 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 2-6 on page 2-6](#) for derating values.

## Clock Conditioning Circuits

### CCC Electrical Specifications

#### Timing Characteristics

**Table 2-169 • IGLOO CCC/PLL Specification**  
For IGLOO V2 or V5 Devices, 1.5 V DC Core Supply 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 <sup>1, 2</sup>  |                                    | 360              |                        | ps    |
| Number of Programmable Values in Each Programmable Delay Block |                                    |                  | 32                     |       |
| Serial Clock (SCLK) for Dynamic PLL <sup>3</sup>               |                                    |                  | 100                    | ns    |
| Input Cycle-to-Cycle Jitter (peak magnitude)                   |                                    |                  | 1                      | ns    |
| CCC Output Peak-to-Peak Period Jitter $F_{CCC\_OUT}$           | Maximum 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                                                |                                    |                  | 2.5                    | ns    |
| LockControl = 1                                                |                                    |                  | 1.5                    | ns    |
| Output Duty Cycle                                              | 48.5                               |                  | 51.5                   | %     |
| Delay Range in Block: Programmable Delay 1 <sup>1, 2, 4</sup>  | 1.25                               |                  | 15.65                  | ns    |
| Delay Range in Block: Programmable Delay 2 <sup>1, 2, 4</sup>  | 0.025                              |                  | 15.65                  | ns    |
| Delay Range in Block: Fixed Delay <sup>1, 2, 4</sup>           |                                    | 3.5              |                        | ns    |

#### Notes:

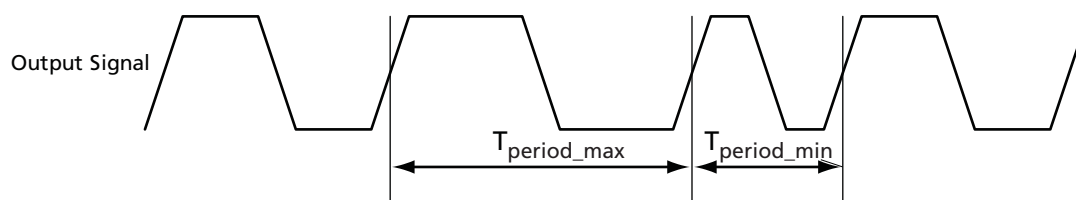
1. This delay is a function of voltage and temperature. See [Table 2-6 on page 2-6](#) and [Table 2-7 on page 2-7](#) for deratings.
2.  $T_J = 25^\circ\text{C}$ ,  $V_{CC} = 1.5\text{ V}$
3. Maximum value obtained for a Std. speed grade device in Worst-Case Commercial Conditions. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.
4. For the definitions of Type 1 and Type 2, refer to the PLL Block Diagram in the [Clock Conditioning Circuits in IGLOO and ProASIC3 Devices](#) chapter of the handbook.
5. The AGL030 device does not support PLL.
6. Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to the PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by the period jitter parameter.

**Table 2-170 • IGLOO CCC/PLL Specification**  
For IGLOO V2 Devices, 1.2 V DC Core Supply Voltage

| Parameter                                                      | Min.                               | Typ.             | Max.                   | Units |
|----------------------------------------------------------------|------------------------------------|------------------|------------------------|-------|
| Clock Conditioning Circuitry Input Frequency $f_{IN\_CCC}$     | 1.5                                |                  | 160                    | MHz   |
| Clock Conditioning Circuitry Output Frequency $f_{OUT\_CCC}$   | 0.75                               |                  | 160                    | MHz   |
| Delay Increments in Programmable Delay Blocks <sup>1, 2</sup>  |                                    | 580              |                        | ps    |
| Number of Programmable Values in Each Programmable Delay Block |                                    |                  | 32                     |       |
| Serial Clock (SCLK) for Dynamic PLL <sup>3</sup>               |                                    |                  | 60                     | ns    |
| Input Cycle-to-Cycle Jitter (peak magnitude)                   |                                    |                  | 0.25                   | ns    |
| CCC Output Peak-to-Peak Period Jitter $F_{CCC\_OUT}$           | Maximum 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 160 MHz                                             | 2.50%                              | 3.75%            | 2.75%                  |       |
| Acquisition Time                                               |                                    |                  |                        |       |
| LockControl = 0                                                |                                    |                  | 300                    | μs    |
| LockControl = 1                                                |                                    |                  | 6.0                    | ms    |
| Tracking Jitter                                                |                                    |                  |                        |       |
| LockControl = 0                                                |                                    |                  | 4                      | ns    |
| LockControl = 1                                                |                                    |                  | 3                      | ns    |
| Output Duty Cycle                                              | 48.5                               |                  | 51.5                   | %     |
| Delay Range in Block: Programmable Delay 1 <sup>1, 2, 4</sup>  | 2.3                                |                  | 20.86                  | ns    |
| Delay Range in Block: Programmable Delay 2 <sup>1, 2, 4</sup>  | 0.025                              |                  | 20.86                  | ns    |
| Delay Range in Block: Fixed Delay <sup>1, 2, 4</sup>           |                                    | 5.7              |                        | ns    |

**Notes:**

1. This delay is a function of voltage and temperature. See [Table 2-6 on page 2-6](#) and [Table 2-7 on page 2-7](#) 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 Commercial Conditions. For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.
4. For the definitions of Type 1 and Type 2, refer to the PLL Block Diagram in the [Clock Conditioning Circuits in IGLOO and ProASIC3 Devices](#) chapter of the handbook.
5. The AGL030 device does not support PLL.
6. Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to the PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by the period jitter parameter.



*Note:* Peak-to-peak jitter measurements are defined by  $T_{\text{peak-to-peak}} = T_{\text{period\_max}} - T_{\text{period\_min}}$ .

**Figure 2-30 • Peak-to-Peak Jitter Definition**

# Embedded SRAM and FIFO Characteristics

## SRAM

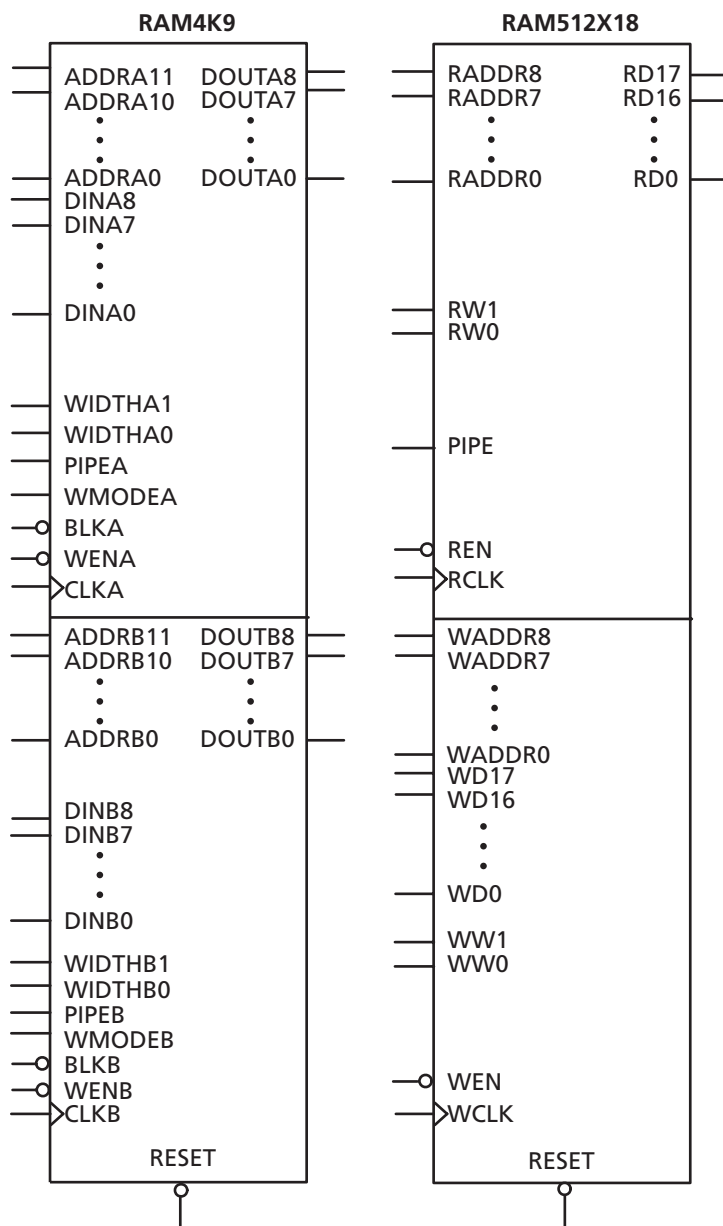


Figure 2-31 • RAM Models

## Timing Waveforms

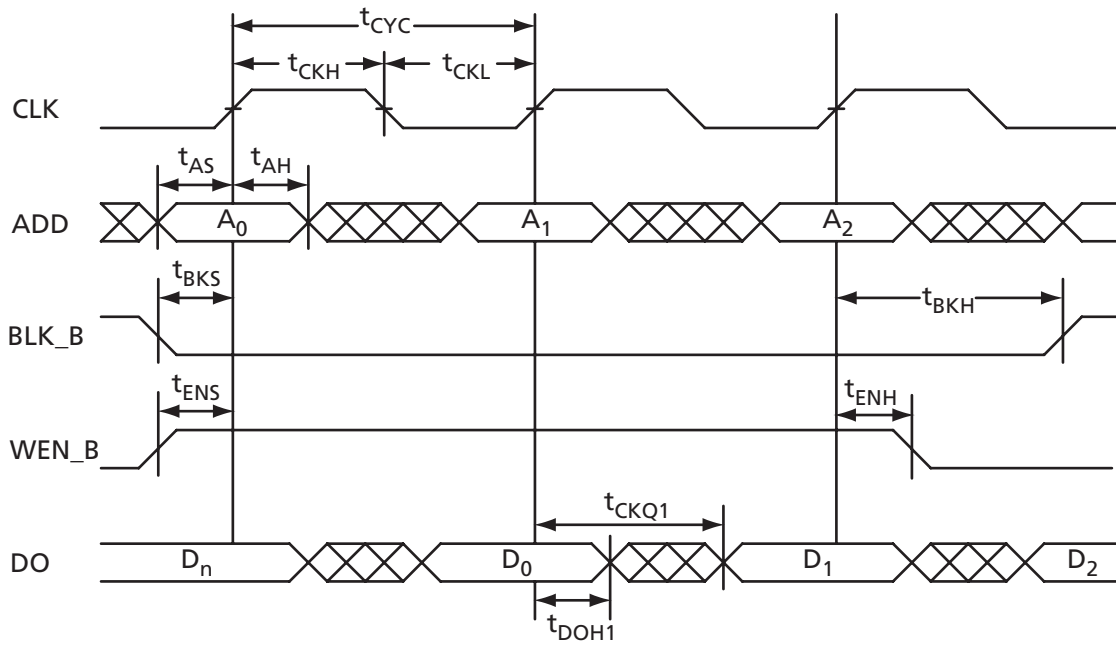


Figure 2-32 • RAM Read for Pass-Through Output

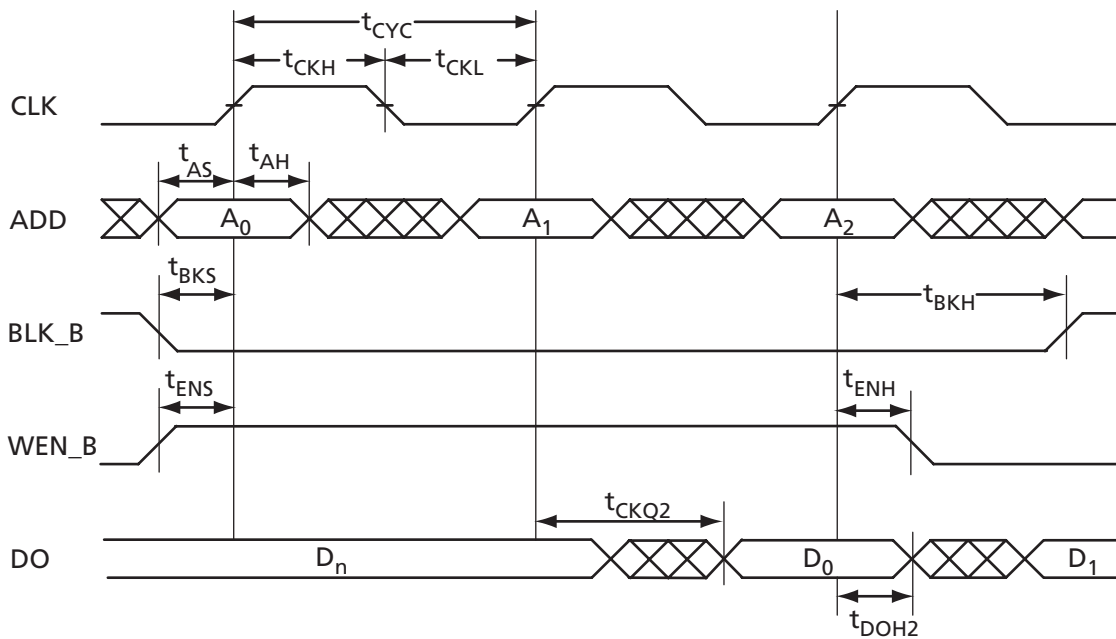


Figure 2-33 • RAM Read for Pipelined Output

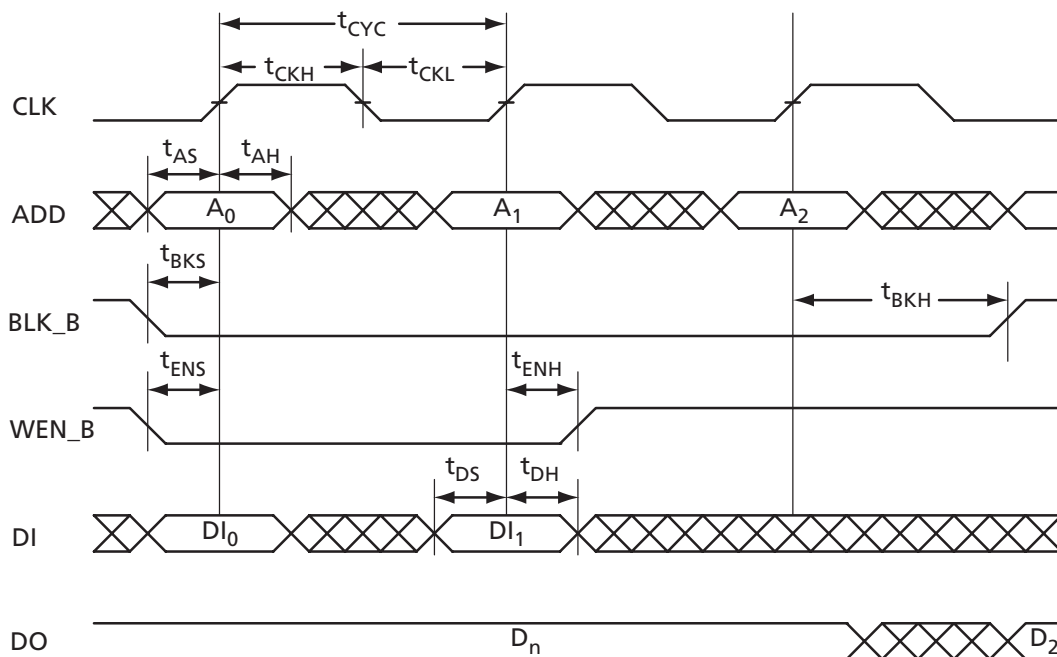


Figure 2-34 • RAM Write, Output Retained (WMODE = 0)

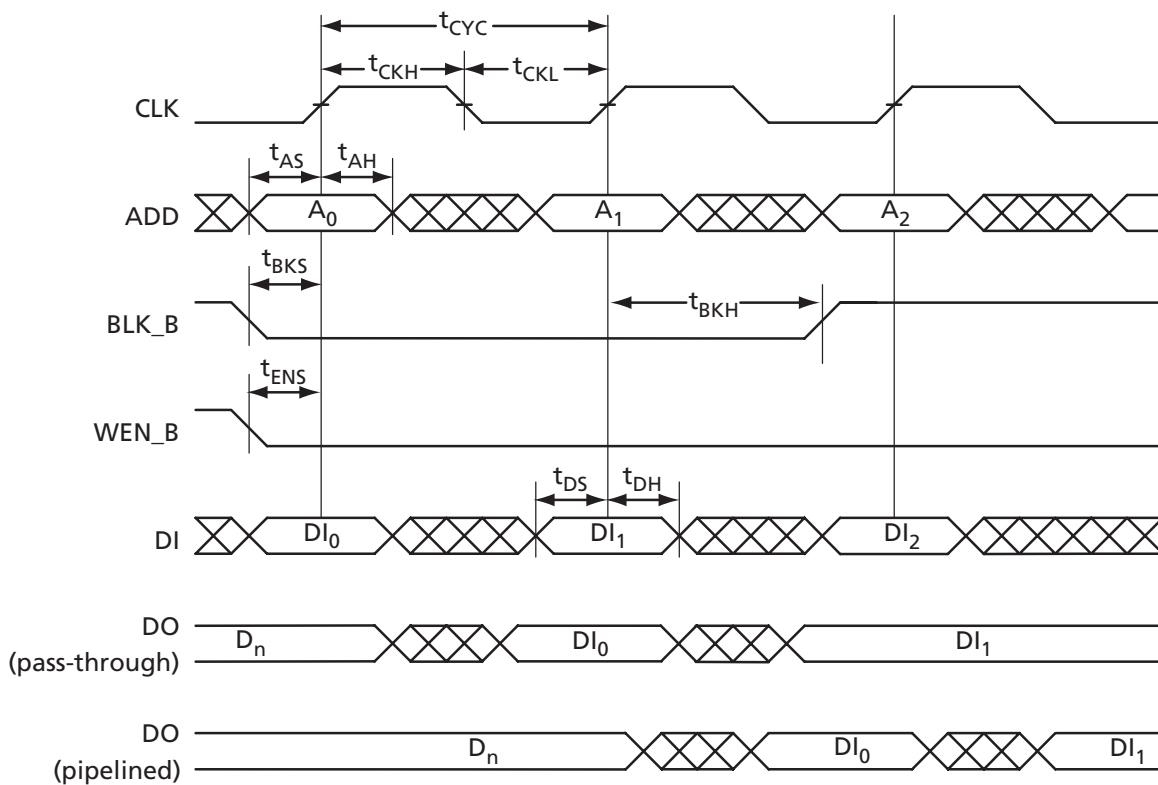


Figure 2-35 • RAM Write, Output as Write Data (WMODE = 1)

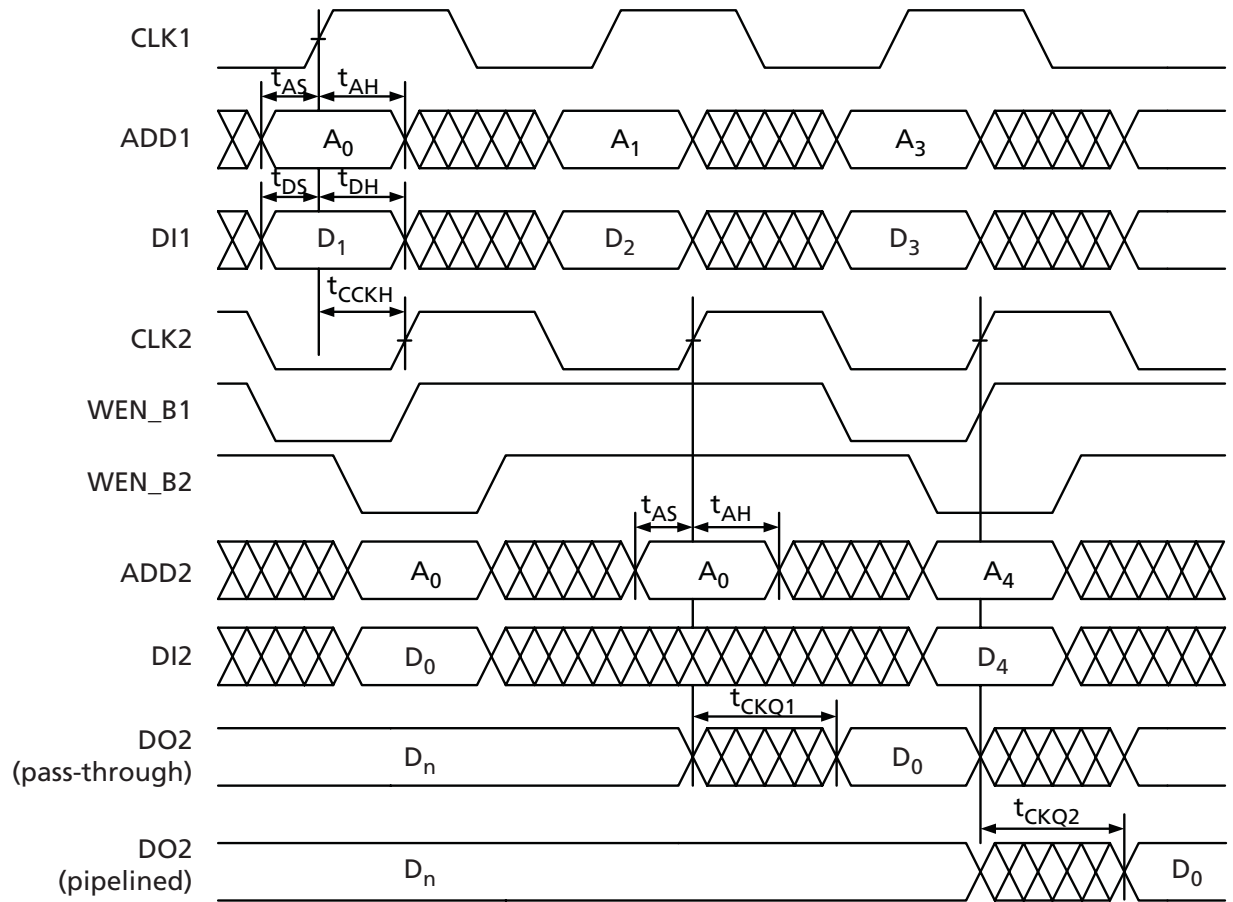


Figure 2-36 • Write Access after Write onto Same Address



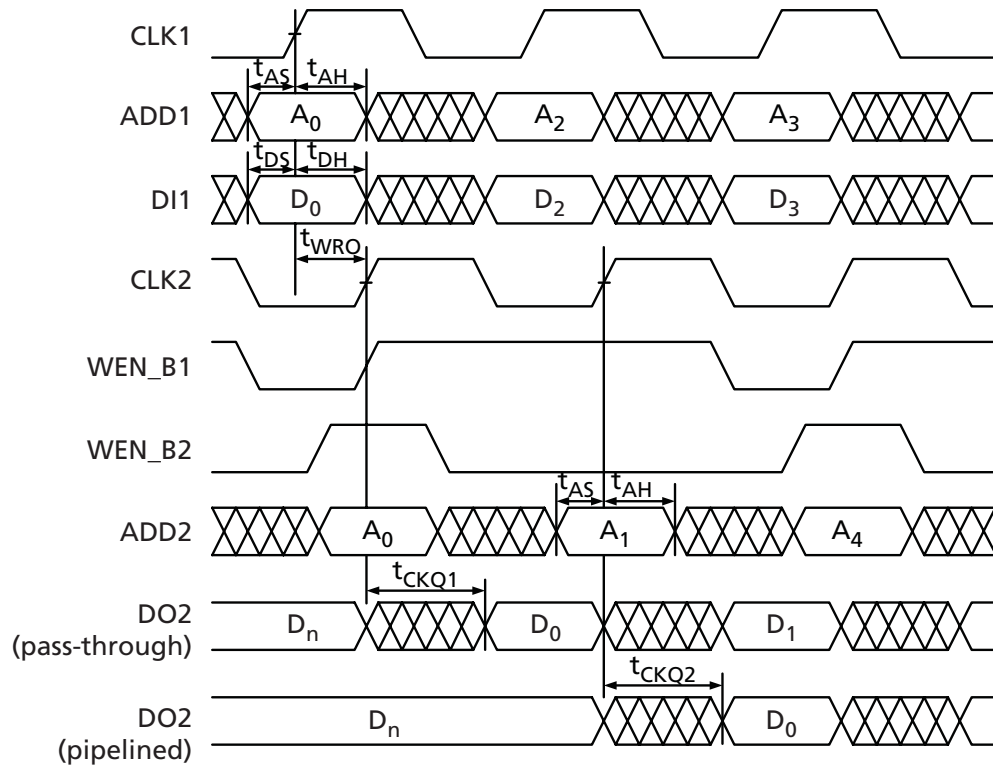
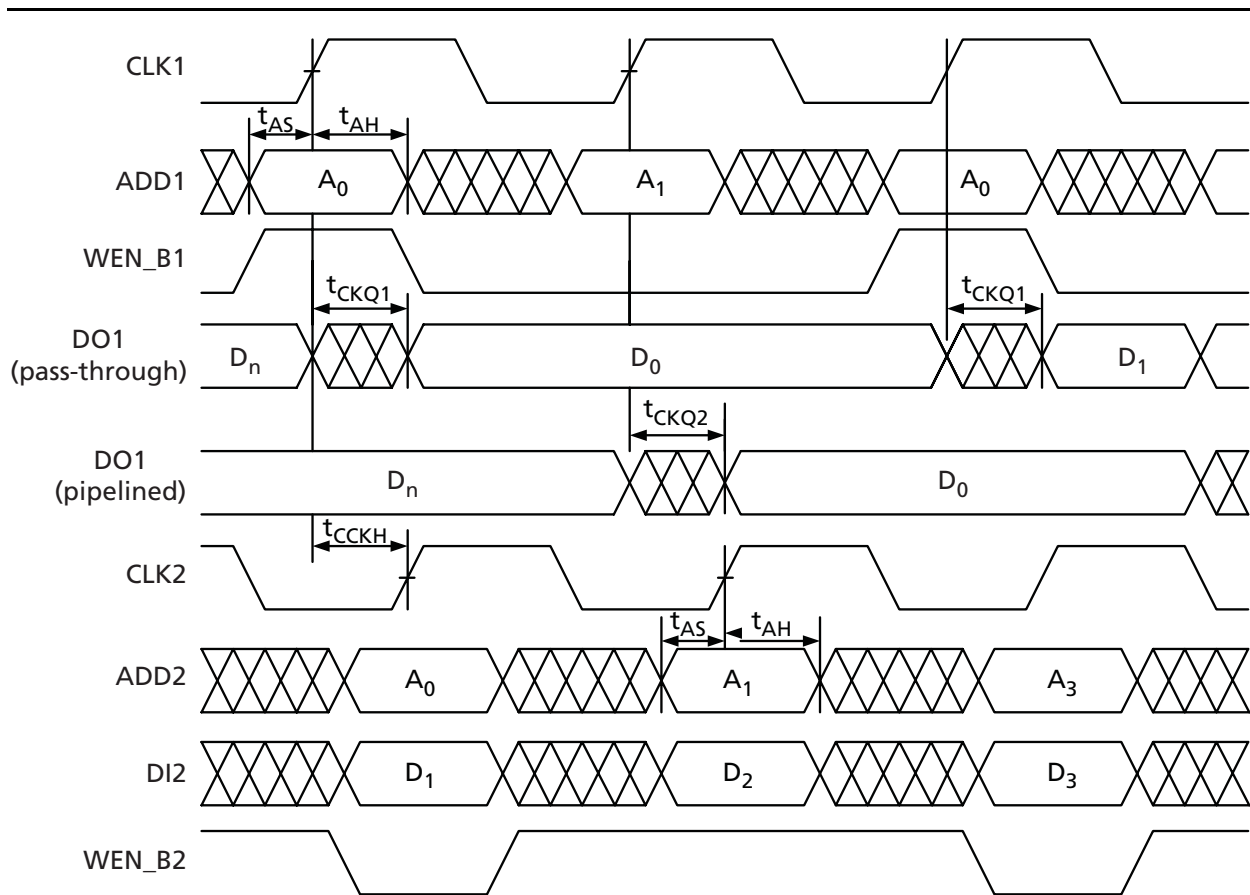
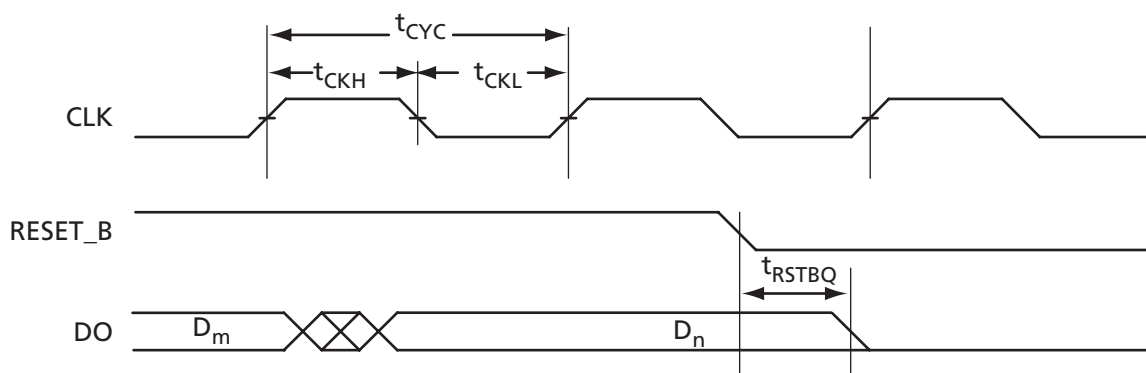


Figure 2-37 • Read Access after Write onto Same Address



**Figure 2-38 • Write Access after Read onto Same Address**



**Figure 2-39 • RAM Reset**

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-171 • RAM4K9**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                                                                                   | Std. | Units |
|---------------|-----------------------------------------------------------------------------------------------|------|-------|
| $t_{AS}$      | Address setup time                                                                            | 0.83 | ns    |
| $t_{AH}$      | Address hold time                                                                             | 0.16 | ns    |
| $t_{ENS}$     | REN_B, WEN_B setup time                                                                       | 0.81 | ns    |
| $t_{ENH}$     | REN_B, WEN_B hold time                                                                        | 0.16 | ns    |
| $t_{BKS}$     | BLK_B setup time                                                                              | 1.65 | ns    |
| $t_{BKH}$     | BLK_B hold time                                                                               | 0.16 | ns    |
| $t_{DS}$      | Input data (DI) setup time                                                                    | 0.71 | ns    |
| $t_{DH}$      | Input data (DI) hold time                                                                     | 0.36 | ns    |
| $t_{CKQ1}$    | Clock HIGH to new data valid on DO (output retained, WMODE = 0)                               | 3.53 | ns    |
|               | Clock HIGH to new data valid on DO (flow-through, WMODE = 1)                                  | 3.06 | ns    |
| $t_{CKQ2}$    | Clock HIGH to new data valid on DO (pipelined)                                                | 1.81 | ns    |
| $t_{WRO}$     | Address collision clk-to-clk delay for reliable read access after write on same address       | TBD  | ns    |
| $t_{CCKH}$    | Address collision clk-to-clk delay for reliable write access after write/read on same address | TBD  | ns    |
| $t_{RSTBQ}$   | RESET_B LOW to data out LOW on DO (flow-through)                                              | 2.06 | ns    |
|               | RESET_B LOW to data out LOW on DO (pipelined)                                                 | 2.06 | ns    |
| $t_{REMRSTB}$ | RESET_B removal                                                                               | 0.61 | ns    |
| $t_{RECRSTB}$ | RESET_B recovery                                                                              | 3.21 | ns    |
| $t_{MPWRSTB}$ | RESET_B minimum pulse width                                                                   | 0.68 | ns    |
| $t_{CYC}$     | Clock cycle time                                                                              | 6.24 | ns    |
| $f_{MAX}$     | Maximum frequency                                                                             | 160  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

**Table 2-172 • RAM512X18**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$ 

| Parameter     | Description                                                                                   | Std. | Units |
|---------------|-----------------------------------------------------------------------------------------------|------|-------|
| $t_{AS}$      | Address setup time                                                                            | 0.83 | ns    |
| $t_{AH}$      | Address hold time                                                                             | 0.16 | ns    |
| $t_{ENS}$     | REN_B, WEN_B setup time                                                                       | 0.73 | ns    |
| $t_{ENH}$     | REN_B, WEN_B hold time                                                                        | 0.08 | ns    |
| $t_{DS}$      | Input data (DI) setup time                                                                    | 0.71 | ns    |
| $t_{DH}$      | Input data (DI) hold time                                                                     | 0.36 | ns    |
| $t_{CKQ1}$    | Clock HIGH to new data valid on DO (output retained, WMODE = 0)                               | 4.21 | ns    |
| $t_{CKQ2}$    | Clock HIGH to new data valid on DO (pipelined)                                                | 1.71 | ns    |
| $t_{WRO}$     | Address collision clk-to-clk delay for reliable read access after write on same address       | TBD  | ns    |
| $t_{CCKH}$    | Address collision clk-to-clk delay for reliable write access after write/read on same address | TBD  | ns    |
| $t_{RSTBQ}$   | RESET_B LOW to data out LOW on DO (flow-through)                                              | 2.06 | ns    |
|               | RESET_B LOW to data out LOW on DO (pipelined)                                                 | 2.06 | ns    |
| $t_{REMRSTB}$ | RESET_B removal                                                                               | 0.61 | ns    |
| $t_{RECRSTB}$ | RESET_B recovery                                                                              | 3.21 | ns    |
| $t_{MPWRSTB}$ | RESET_B minimum pulse width                                                                   | 0.68 | ns    |
| $t_{CYC}$     | Clock cycle time                                                                              | 6.24 | ns    |
| $F_{MAX}$     | Maximum frequency                                                                             | 160  | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

## 1.2 V DC Core Voltage

**Table 2-173 • RAM4K9**

Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                                                                                   | Std.  | Units |
|---------------|-----------------------------------------------------------------------------------------------|-------|-------|
| $t_{AS}$      | Address setup time                                                                            | 1.53  | ns    |
| $t_{AH}$      | Address hold time                                                                             | 0.29  | ns    |
| $t_{ENS}$     | REN_B, WEN_B setup time                                                                       | 1.50  | ns    |
| $t_{ENH}$     | REN_B, WEN_B hold time                                                                        | 0.29  | ns    |
| $t_{BKS}$     | BLK_B setup time                                                                              | 3.05  | ns    |
| $t_{BKH}$     | BLK_B hold time                                                                               | 0.29  | ns    |
| $t_{DS}$      | Input data (DI) setup time                                                                    | 1.33  | ns    |
| $t_{DH}$      | Input data (DI) hold time                                                                     | 0.66  | ns    |
| $t_{CKQ1}$    | Clock HIGH to new data valid on DO (output retained, WMODE = 0)                               | 6.61  | ns    |
|               | Clock HIGH to new data valid on DO (flow-through, WMODE = 1)                                  | 5.72  | ns    |
| $t_{CKQ2}$    | Clock HIGH to new data valid on DO (pipelined)                                                | 3.38  | ns    |
| $t_{WRO}$     | Address collision clk-to-clk delay for reliable read access after write on same address       | TBD   | ns    |
| $t_{CCKH}$    | Address collision clk-to-clk delay for reliable write access after write/read on same address | TBD   | ns    |
| $t_{RSTBQ}$   | RESET_B LOW to data out LOW on DO (flow-through)                                              | 3.86  | ns    |
|               | RESET_B LOW to data out LOW on DO (pipelined)                                                 | 3.86  | ns    |
| $t_{REMRSTB}$ | RESET_B removal                                                                               | 1.12  | ns    |
| $t_{RECRSTB}$ | RESET_B recovery                                                                              | 5.93  | ns    |
| $t_{MPWRSTB}$ | RESET_B minimum pulse width                                                                   | 1.18  | ns    |
| $t_{CYC}$     | Clock cycle time                                                                              | 10.90 | ns    |
| $F_{MAX}$     | Maximum frequency                                                                             | 92    | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

**Table 2-174 • RAM512X18**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$ 

| Parameter     | Description                                                                                   | Std.  | Units |
|---------------|-----------------------------------------------------------------------------------------------|-------|-------|
| $t_{AS}$      | Address setup time                                                                            | 1.53  | ns    |
| $t_{AH}$      | Address hold time                                                                             | 0.29  | ns    |
| $t_{ENS}$     | REN_B, WEN_B setup time                                                                       | 1.36  | ns    |
| $t_{ENH}$     | REN_B, WEN_B hold time                                                                        | 0.15  | ns    |
| $t_{DS}$      | Input data (DI) setup time                                                                    | 1.33  | ns    |
| $t_{DH}$      | Input data (DI) hold time                                                                     | 0.66  | ns    |
| $t_{CKQ1}$    | Clock HIGH to new data valid on DO (output retained, WMODE = 0)                               | 7.88  | ns    |
| $t_{CKQ2}$    | Clock HIGH to new data valid on DO (pipelined)                                                | 3.20  | ns    |
| $t_{WRO}$     | Address collision clk-to-clk delay for reliable read access after write on same address       | TBD   | ns    |
| $t_{CCKH}$    | Address collision clk-to-clk delay for reliable write access after write/read on same address | TBD   | ns    |
| $t_{RSTBQ}$   | RESET_B LOW to data out LOW on DO (flow through)                                              | 3.86  | ns    |
|               | RESET_B LOW to data out LOW on DO (pipelined)                                                 | 3.86  | ns    |
| $t_{REMRSTB}$ | RESET_B removal                                                                               | 1.12  | ns    |
| $t_{RECRSTB}$ | RESET_B recovery                                                                              | 5.93  | ns    |
| $t_{MPWRSTB}$ | RESET_B minimum pulse width                                                                   | 1.18  | ns    |
| $t_{CYC}$     | Clock cycle time                                                                              | 10.90 | ns    |
| $F_{MAX}$     | Maximum frequency                                                                             | 92    | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## FIFO

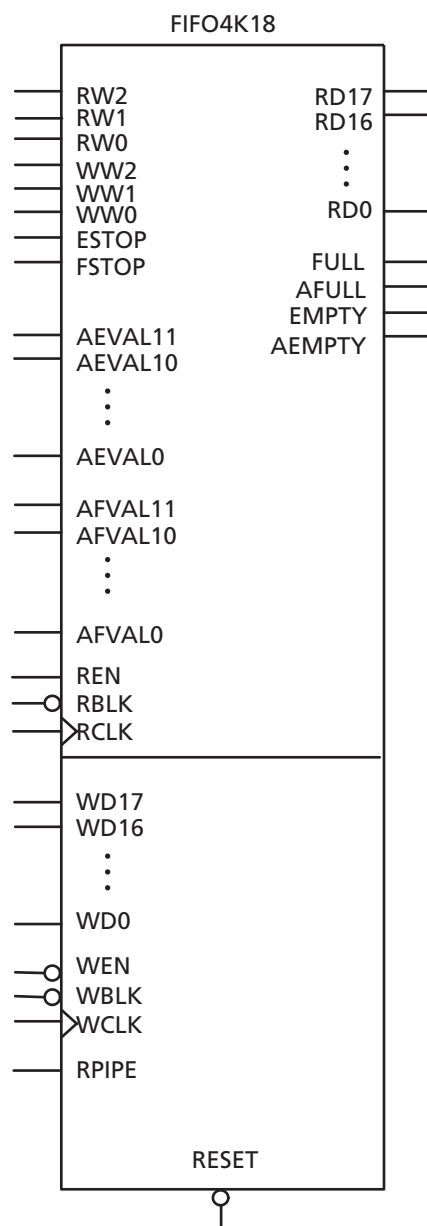


Figure 2-40 • FIFO Model

## Timing Waveforms

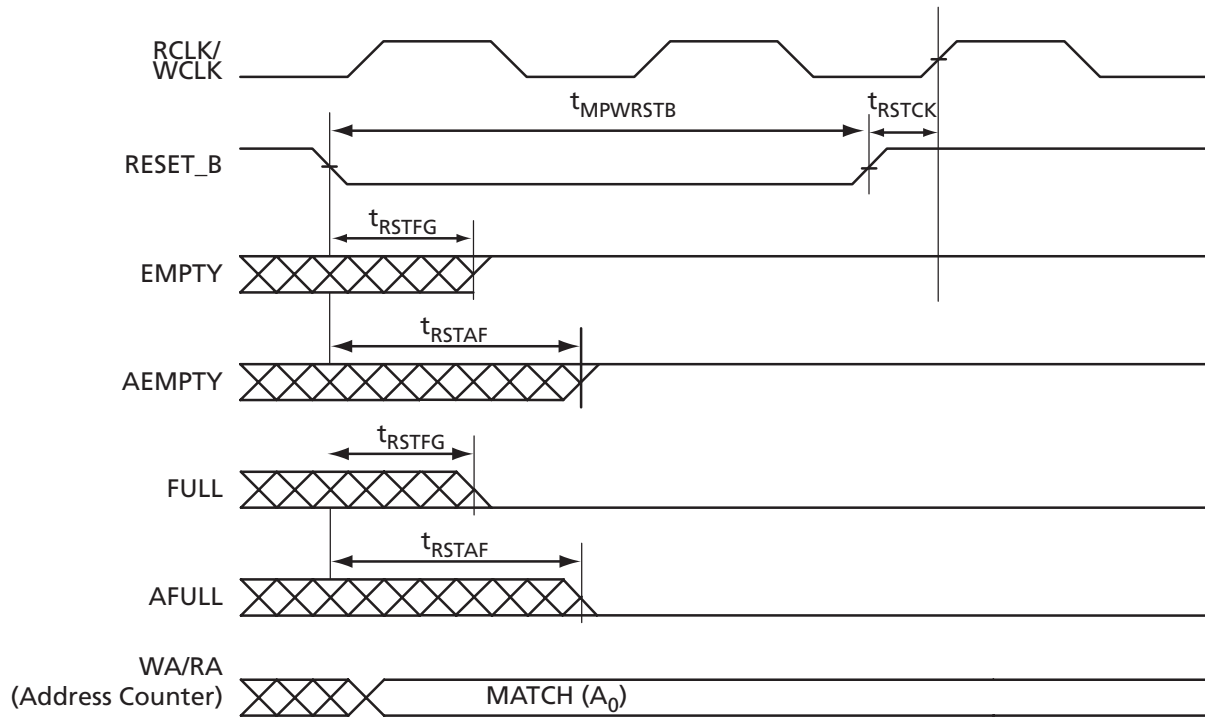


Figure 2-41 • FIFO Reset

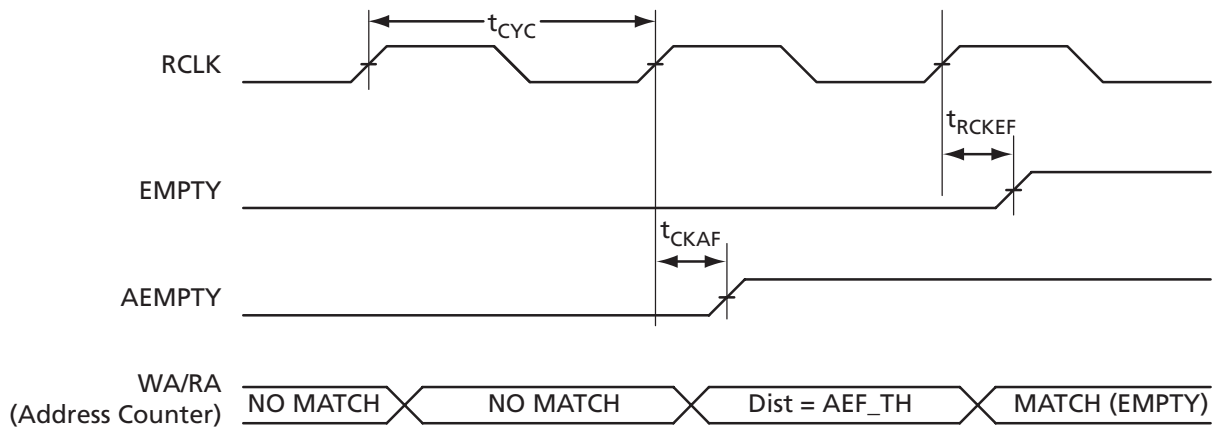


Figure 2-42 • FIFO EMPTY Flag and AEMPTY Flag Assertion



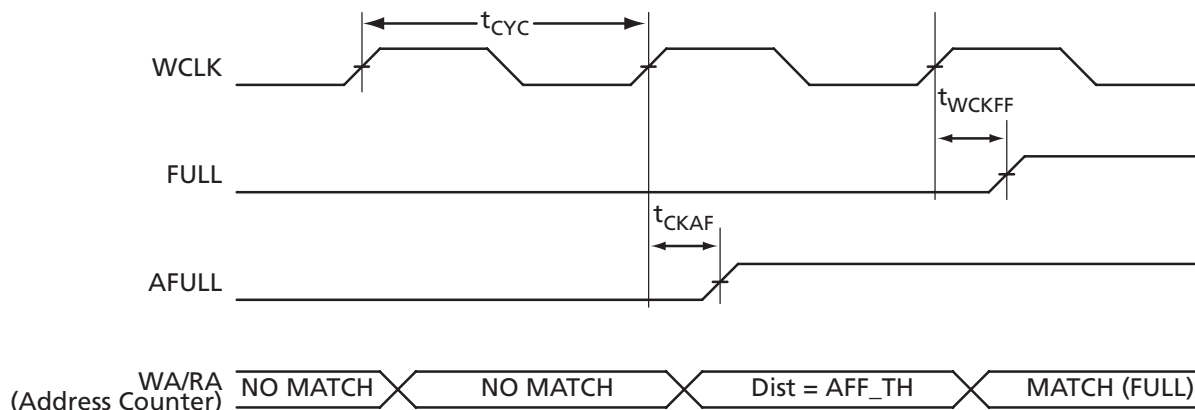


Figure 2-43 • FIFO FULL Flag and AFULL Flag Assertion

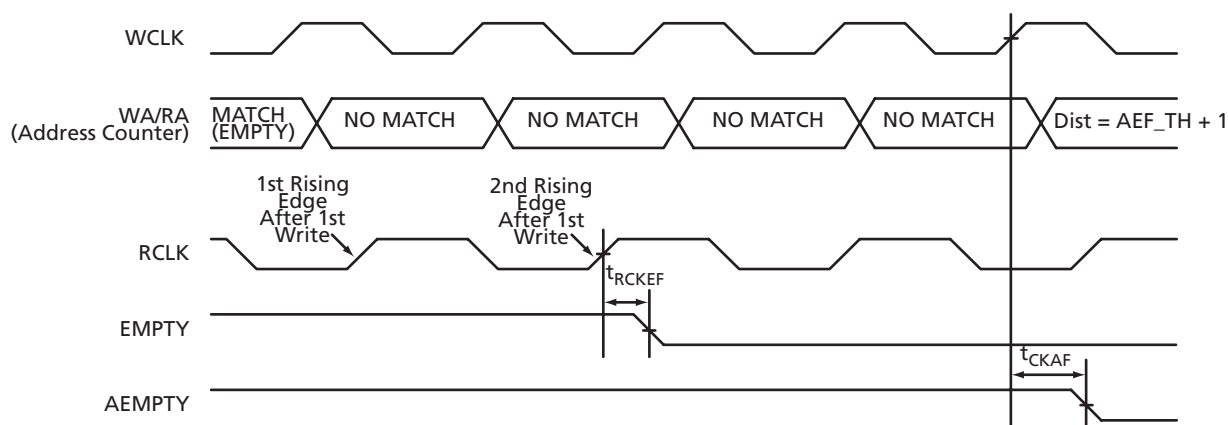


Figure 2-44 • FIFO EMPTY Flag and AEMPTY Flag Deassertion

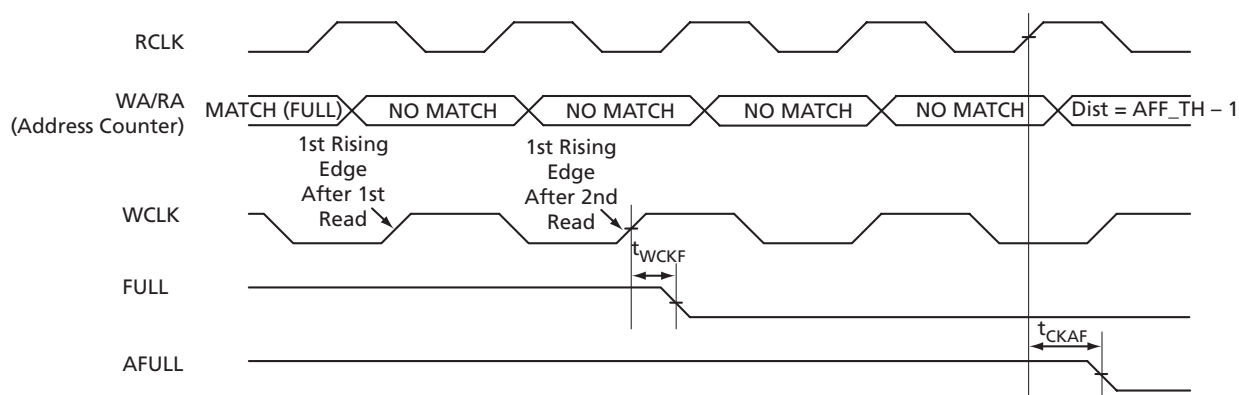


Figure 2-45 • FIFO FULL Flag and AFULL Flag Deassertion

## Timing Characteristics

### 1.5 V DC Core Voltage

**Table 2-175 • FIFO**
**Worst Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.425\text{ V}$** 

| Parameter     | Description                                       | Std.  | Units |
|---------------|---------------------------------------------------|-------|-------|
| $t_{ENS}$     | REN_B, WEN_B Setup Time                           | 1.99  | ns    |
| $t_{ENH}$     | REN_B, WEN_B Hold Time                            | 0.16  | ns    |
| $t_{BKS}$     | BLK_B Setup Time                                  | 0.30  | ns    |
| $t_{BKH}$     | BLK_B Hold Time                                   | 0.00  | ns    |
| $t_{DS}$      | Input Data (DI) Setup Time                        | 0.76  | ns    |
| $t_{DH}$      | Input Data (DI) Hold Time                         | 0.25  | ns    |
| $t_{CKQ1}$    | Clock HIGH to New Data Valid on DO (flow-through) | 3.33  | ns    |
| $t_{CKQ2}$    | Clock HIGH to New Data Valid on DO (pipelined)    | 1.80  | ns    |
| $t_{RCKEF}$   | RCLK HIGH to Empty Flag Valid                     | 3.53  | ns    |
| $t_{WCKFF}$   | WCLK HIGH to Full Flag Valid                      | 3.35  | ns    |
| $t_{CKAF}$    | Clock HIGH to Almost Empty/Full Flag Valid        | 12.85 | ns    |
| $t_{RSTFG}$   | RESET_B LOW to Empty/Full Flag Valid              | 3.48  | ns    |
| $t_{RSTAF}$   | RESET_B LOW to Almost Empty/Full Flag Valid       | 12.72 | ns    |
| $t_{RSTBQ}$   | RESET_B LOW to Data Out LOW on DO (flow-through)  | 2.02  | ns    |
|               | RESET_B LOW to Data Out LOW on DO (pipelined)     | 2.02  | ns    |
| $t_{REMRSTB}$ | RESET_B Removal                                   | 0.61  | ns    |
| $t_{RECRSTB}$ | RESET_B Recovery                                  | 3.21  | ns    |
| $t_{MPWRSTB}$ | RESET_B Minimum Pulse Width                       | 0.68  | ns    |
| $t_{CYC}$     | Clock Cycle Time                                  | 6.24  | ns    |
| $F_{MAX}$     | Maximum Frequency for FIFO                        | 160   | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-6 on page 2-6](#) for derating values.

## 1.2 V DC Core Voltage

**Table 2-176 • FIFO**

Worst Commercial-Case Conditions:  $T_J = 70^{\circ}\text{C}$ ,  $V_{CC} = 1.14\text{ V}$ 

| Parameter            | Description                                       | Std.  | Units |
|----------------------|---------------------------------------------------|-------|-------|
| $t_{\text{ENS}}$     | REN_B, WEN_B Setup Time                           | 4.13  | ns    |
| $t_{\text{ENH}}$     | REN_B, WEN_B Hold Time                            | 0.31  | ns    |
| $t_{\text{BKS}}$     | BLK_B Setup Time                                  | 0.47  | ns    |
| $t_{\text{BKH}}$     | BLK_B Hold Time                                   | 0.00  | ns    |
| $t_{\text{DS}}$      | Input Data (DI) Setup Time                        | 1.56  | ns    |
| $t_{\text{DH}}$      | Input Data (DI) Hold Time                         | 0.49  | ns    |
| $t_{\text{CKQ1}}$    | Clock HIGH to New Data Valid on DO (flow-through) | 6.80  | ns    |
| $t_{\text{CKQ2}}$    | Clock HIGH to New Data Valid on DO (pipelined)    | 3.62  | ns    |
| $t_{\text{RCKEF}}$   | RCLK HIGH to Empty Flag Valid                     | 7.23  | ns    |
| $t_{\text{WCKFF}}$   | WCLK HIGH to Full Flag Valid                      | 6.85  | ns    |
| $t_{\text{CKAF}}$    | Clock HIGH to Almost Empty/Full Flag Valid        | 26.61 | ns    |
| $t_{\text{RSTFG}}$   | RESET_B LOW to Empty/Full Flag Valid              | 7.12  | ns    |
| $t_{\text{RSTAF}}$   | RESET_B LOW to Almost Empty/Full Flag Valid       | 26.33 | ns    |
| $t_{\text{RSTBQ}}$   | RESET_B LOW to Data Out LOW on DO (flow-through)  | 4.09  | ns    |
|                      | RESET_B LOW to Data Out LOW on DO (pipelined)     | 4.09  | ns    |
| $t_{\text{REMRSTB}}$ | RESET_B Removal                                   | 1.23  | ns    |
| $t_{\text{RECRSTB}}$ | RESET_B Recovery                                  | 6.58  | ns    |
| $t_{\text{MPWRSTB}}$ | RESET_B Minimum Pulse Width                       | 1.18  | ns    |
| $t_{\text{CYC}}$     | Clock Cycle Time                                  | 10.90 | ns    |
| $F_{\text{MAX}}$     | Maximum Frequency for FIFO                        | 92    | MHz   |

**Note:** For specific junction temperature and voltage supply levels, refer to [Table 2-7 on page 2-7](#) for derating values.

## Embedded FlashROM Characteristics

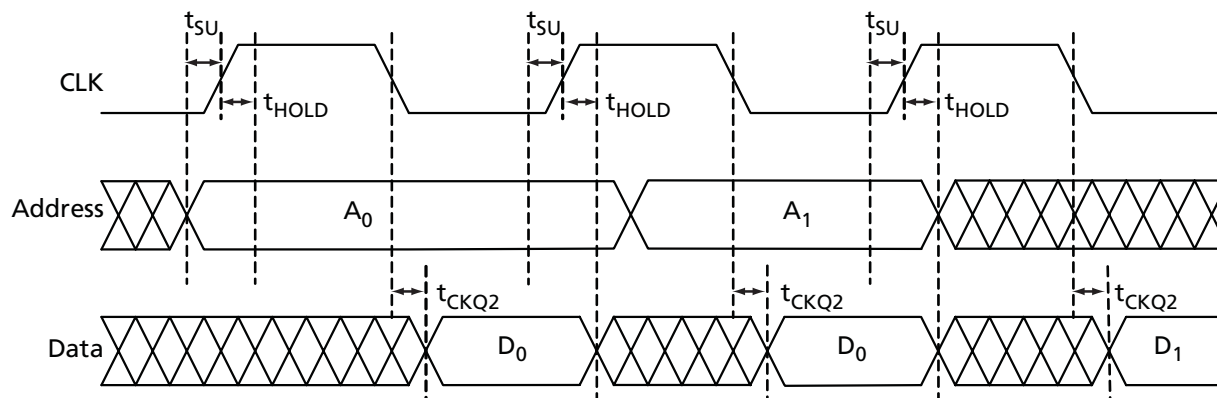


Figure 2-46 • Timing Diagram

### Timing Characteristics

#### 1.5 V DC Core Voltage

Table 2-177 • Embedded FlashROM Access Time

Worst Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.425\text{ V}$

| Parameter  | Description             | Std.  | Units |
|------------|-------------------------|-------|-------|
| $t_{SU}$   | Address Setup Time      | 0.57  | ns    |
| $t_{HOLD}$ | Address Hold Time       | 0.00  | ns    |
| $t_{CK2Q}$ | Clock to Out            | 34.14 | ns    |
| $F_{MAX}$  | Maximum Clock Frequency | 15    | MHz   |

#### 1.2 V DC Core Voltage

Table 2-178 • Embedded FlashROM Access Time

Worst Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ ,  $V_{CC} = 1.14\text{ V}$

| Parameter  | Description             | Std.  | Units |
|------------|-------------------------|-------|-------|
| $t_{SU}$   | Address Setup Time      | 0.59  | ns    |
| $t_{HOLD}$ | Address Hold Time       | 0.00  | ns    |
| $t_{CK2Q}$ | Clock to Out            | 52.90 | ns    |
| $F_{MAX}$  | Maximum Clock Frequency | 10    | MHz   |

## 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 2-19 for more details.

### Timing Characteristics

**Table 2-179 • JTAG 1532**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.425\text{ V}$

| Parameter     | Description                 | Std.  | Units |
|---------------|-----------------------------|-------|-------|
| $t_{DISU}$    | Test Data Input Setup Time  | 1.00  | ns    |
| $t_{DIHD}$    | Test Data Input Hold Time   | 2.00  | ns    |
| $t_{TMSSU}$   | Test Mode Select Setup Time | 1.00  | ns    |
| $t_{TMDHD}$   | Test Mode Select Hold Time  | 2.00  | ns    |
| $t_{TCK2Q}$   | Clock to Q (data out)       | 8.00  | ns    |
| $t_{RSTB2Q}$  | Reset to Q (data out)       | 25.00 | ns    |
| $F_{TCKMAX}$  | TCK Maximum Frequency       | 15    | MHz   |
| $t_{TRSTREM}$ | ResetB Removal Time         | 0.58  | ns    |
| $t_{TRSTREC}$ | ResetB Recovery Time        | 0.00  | ns    |
| $t_{TRSTMPW}$ | ResetB Minimum Pulse        | TBD   | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

**Table 2-180 • JTAG 1532**

Commercial-Case Conditions:  $T_J = 70^\circ\text{C}$ , Worst-Case  $V_{CC} = 1.14\text{ V}$

| Parameter     | Description                 | Std.  | Units |
|---------------|-----------------------------|-------|-------|
| $t_{DISU}$    | Test Data Input Setup Time  | 1.50  | ns    |
| $t_{DIHD}$    | Test Data Input Hold Time   | 3.00  | ns    |
| $t_{TMSSU}$   | Test Mode Select Setup Time | 1.50  | ns    |
| $t_{TMDHD}$   | Test Mode Select Hold Time  | 3.00  | ns    |
| $t_{TCK2Q}$   | Clock to Q (data out)       | 11.00 | ns    |
| $t_{RSTB2Q}$  | Reset to Q (data out)       | 30.00 | ns    |
| $F_{TCKMAX}$  | TCK Maximum Frequency       | 9.00  | MHz   |
| $t_{TRSTREM}$ | ResetB Removal Time         | 1.18  | ns    |
| $t_{TRSTREC}$ | ResetB Recovery Time        | 0.00  | ns    |
| $t_{TRSTMPW}$ | ResetB Minimum Pulse        | TBD   | ns    |

*Note:* For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

## Part Number and Revision Date

Part Number 51700095-002-5

Revised April 2009

## List of Changes

The following table lists critical changes that were made in the current version of the chapter.

| Previous Version               | Changes in Current Version (Advance v0.6)                                                                                                                                                                                                                                                                                                                                                                                                        | Page         |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Advance v0.5<br>(October 2008) | Reference to the –F speed grade was removed from this document, since it is no longer offered for IGLOO devices.                                                                                                                                                                                                                                                                                                                                 | 2-1          |
| Advance v0.4<br>(August 2008)  | The tables in the "Quiescent Supply Current" section were updated with values for AGL400.                                                                                                                                                                                                                                                                                                                                                        | 2-7          |
|                                | The tables in the "Power Consumption of Various Internal Resources" section were updated with values for AGL400.                                                                                                                                                                                                                                                                                                                                 | 2-12         |
|                                | Table 2-158 · AGL400 Global Resource is new.                                                                                                                                                                                                                                                                                                                                                                                                     | 2-92         |
| Advance v0.3<br>(July 2008)    | 3.0 V LVC MOS wide range support data was added to Table 2-2 · Recommended Operating Conditions <sup>4</sup> .                                                                                                                                                                                                                                                                                                                                   | 2-2          |
|                                | 3.3 V LVC MOS wide range support data was added to Table 2-24 · Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings to Table 2-26 · Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings.                                                                                   | 2-23 to 2-24 |
|                                | 3.3 V LVC MOS wide range support data was added to Table 2-27 · Summary of Maximum and Minimum DC Input Levels.                                                                                                                                                                                                                                                                                                                                  | 2-24         |
|                                | 3.3 V LVC MOS wide range support text was added to Table 2-49 · Minimum and Maximum DC Input and Output Levels for LVC MOS 3.3 V Wide Range.                                                                                                                                                                                                                                                                                                     | 2-37         |
|                                | Table 2-49 · Minimum and Maximum DC Input and Output Levels for LVC MOS 3.3 V Wide Range is new.                                                                                                                                                                                                                                                                                                                                                 | 2-37         |
| Advance v0.2<br>(July 2008)    | As a result of the Libero IDE v8.4 release, Actel now offers a wide range of core voltage support. The document was updated to change 1.2 V / 1.5 V to 1.2 V to 1.5 V.                                                                                                                                                                                                                                                                           | N/A          |
| Advance v0.1<br>(January 2008) | Tables have been updated to reflect default values in the software. The default I/O capacitance is 5 pF. Tables have been updated to include the LVC MOS 1.2 V I/O set.<br><br>DDR Tables have two additional data points added to reflect both edges for Input DDR setup and hold time.<br><br>The power data table has been updated to match SmartPower data rather than simulation values.<br><br>AGL015 global clock delays have been added. | N/A          |
|                                | Table 2-1 · Absolute Maximum Ratings was updated to combine the V <sub>CCI</sub> and VMV parameters in one row. The word "output" from the parameter description for V <sub>CCI</sub> and VMV, and table note 3 was added.                                                                                                                                                                                                                       | 2-1          |

| Previous Version               | Changes in Current Version (Advance v0.6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Page                   |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Advance v0.1<br>(January 2008) | Table 2-2 · Recommended Operating Conditions <sup>4</sup> was updated to add references to tables notes 4, 6, 7, and 8. VMV was added to the V <sub>CCI</sub> parameter row, and table note 9 was added.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2-2                    |
|                                | In Table 2-3 · Flash Programming Limits – Retention, Storage, and Operating Temperature <sup>1</sup> , the maximum operating junction temperature was changed from 110° to 100°.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2-2                    |
|                                | VMV was removed from Table 2-4 · Overshoot and Undershoot Limits 1. The table title was modified to remove "as measured on quiet I/Os." Table note 2 was revised to remove "estimated SSO density over cycles." Table note 3 was revised to remove "refers only to overshoot/undershoot limits for simultaneous switching I/Os."                                                                                                                                                                                                                                                                                                                                                                               | 2-3                    |
|                                | The "PLL Behavior at Brownout Condition" section is new.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2-4                    |
|                                | Figure 2-2 · V2 Devices – I/O State as a Function of V <sub>CCI</sub> and V <sub>CC</sub> Voltage Levels is new.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2-5                    |
|                                | EQ 2-2 was updated. The temperature was changed to 100°C, and therefore the end result changed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2-6                    |
|                                | The table notes for Table 2-8 · Quiescent Supply Current (I <sub>DD</sub> ) Characteristics, IGLOO Flash*Freeze Mode*, Table 2-9 · Quiescent Supply Current (I <sub>DD</sub> ) Characteristics, IGLOO Sleep Mode (V <sub>CC</sub> = 0 V)*, and Table 2-10 · Quiescent Supply Current (I <sub>DD</sub> ) Characteristics, IGLOO Shutdown Mode (V <sub>CC</sub> , V <sub>CCI</sub> = 0 V)* were updated to remove VMV and include P <sub>DC6</sub> and P <sub>DC7</sub> . V <sub>CCI</sub> and V <sub>JTAG</sub> were removed from the statement about I <sub>DD</sub> in the table note for Table 2-9 · Quiescent Supply Current (I <sub>DD</sub> ) Characteristics, IGLOO Sleep Mode (V <sub>CC</sub> = 0 V)*. | 2-7                    |
|                                | Note 2 of Table 2-11 · Quiescent Supply Current (I <sub>DD</sub> ), No IGLOO Flash*Freeze Mode <sup>1</sup> was updated to include V <sub>CCPLL</sub> . Note 4 was updated to include P <sub>DC6</sub> and P <sub>DC7</sub> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2-8                    |
|                                | Table 2-12 · Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings, Table 2-13 · Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings, Table 2-14 · Summary of I/O Input Buffer Power (per pin) – Default I/O Software Settings, and Table 2-15 · Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings <sup>1</sup> were updated to change P <sub>DC2</sub> to P <sub>DC6</sub> and P <sub>DC3</sub> to P <sub>DC7</sub> . The table notes were updated to reflect that power was measured on V <sub>CCI</sub> .                                                                                                                          | 2-9<br>through<br>2-10 |
|                                | Table 2-19 · Different Components Contributing to the Static Power Consumption in IGLOO Devices and Table 2-21 · Different Components Contributing to the Static Power Consumption in IGLOO Device were updated to add P <sub>DC6</sub> and P <sub>DC7</sub> , and to change the definition for P <sub>DC5</sub> to bank quiescent power. Subtitles were added to indicate type of devices and core supply voltage.                                                                                                                                                                                                                                                                                            | 2-13,<br>2-15          |
|                                | The "Total Static Power Consumption—P <sub>STAT</sub> " section was updated to revise the calculation of P <sub>STAT</sub> including P <sub>DC6</sub> and P <sub>DC7</sub> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2-16                   |
|                                | In Table 2-18 · Different Components Contributing to Dynamic Power Consumption in IGLOO Devices, the description for P <sub>AC13</sub> was changed from Static to Dynamic.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2-12                   |
|                                | Footnote 1 was updated to include information about P <sub>AC13</sub> . The PLL Contribution equation was changed from: P <sub>PLL</sub> = P <sub>AC13</sub> + P <sub>AC14</sub> * F <sub>CLKOUT</sub> to P <sub>PLL</sub> = P <sub>DC4</sub> + P <sub>AC13</sub> * F <sub>CLKOUT</sub> .                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-17                   |

| Previous Version                | Changes in Current Version (Advance v0.6)                                                                                                                                                            | Page          |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Advance v0.6<br>(November 2007) | The "Timing Model" was updated to be consistent with the revised timing numbers.                                                                                                                     | 2-19          |
|                                 | In Table 2-26 • Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions—Software Default Settings, $T_J$ was changed to $T_A$ in notes 1 and 2. | 2-24          |
|                                 | All AC Loading figures for single-ended I/O standards were changed from Datapaths at 35 pF to 5 pF.                                                                                                  | N/A           |
|                                 | The "1.2 V LVCMOS (JESD8-12A)" section is new.                                                                                                                                                       | 2-59          |
|                                 | This document was previously in datasheet Advance v0.7. As a result of moving to the handbook format, Actel has restarted the version numbers. The new version number is Advance v0.1.               | N/A           |
| Advance v0.6<br>(continued)     | Table 2-4 • IGLOO CCC/PLL Specification and Table 2-5 • IGLOO CCC/PLL Specification were updated.                                                                                                    | 2-19,<br>2-20 |
|                                 | The former Table 2-16 • Maximum I/O Frequency for Single-Ended and Differential I/Os in All Banks in IGLOO Devices (maximum drive strength and high slew selected) was removed.                      | N/A           |
|                                 | The "During Flash*Freeze Mode" section was updated to include information about the output of the I/O to the FPGA core.                                                                              | 2-57          |
|                                 | Table 2-31 • Flash*Freeze Pin Location in IGLOO Family Packages (device-independent) was updated to add UC81 and CS281. Flash*Freeze pins were assigned for CS81, CS121, and CS196.                  | 2-61          |
|                                 | Figure 2-40 • Flash*Freeze Mode Type 2 – Timing Diagram was updated to modify the LSICC Signal.                                                                                                      | 2-55          |
|                                 | Information regarding calculation of the quiescent supply current was added to the "Quiescent Supply Current" section.                                                                               | 3-6           |
|                                 | Table 3-8 • Quiescent Supply Current ( $I_{DD}$ ) Characteristics, IGLOO Flash*Freeze Mode <sup>†</sup> was updated.                                                                                 | 3-6           |
|                                 | Table 3-9 • Quiescent Supply Current ( $I_{DD}$ ) Characteristics, IGLOO Sleep Mode ( $V_{CC} = 0\text{ V}$ ) <sup>†</sup> was updated.                                                              | 3-6           |
|                                 | Table 3-11 • Quiescent Supply Current ( $I_{DD}$ ), No IGLOO Flash*Freeze Mode <sup>1</sup> was updated.                                                                                             | 3-7           |
|                                 | Table 3-115 • Minimum and Maximum DC Input and Output Levels was updated.                                                                                                                            | 3-58          |
|                                 | Table 3-156 • JTAG 1532 was updated and Table 3-155 • JTAG 1532 is new.                                                                                                                              | 3-104         |
| Advance v0.3<br>(August 2007)   | The "Power Conservation Techniques" section was updated to recommend that unused I/O signals be left floating.                                                                                       | 2-51          |
| Advance v0.2<br>(July 2007)     | The CS81 and CS121 packages were added to Table 2-31 • Flash*Freeze Pin Location in IGLOO Family Packages (device-independent).                                                                      | 2-61          |
| Advance v0.1                    | The $T_J$ parameter in Table 3-2 • Recommended Operating Conditions was changed to $T_A$ , ambient temperature, and table notes 4–6 were added.                                                      | 3-2           |



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

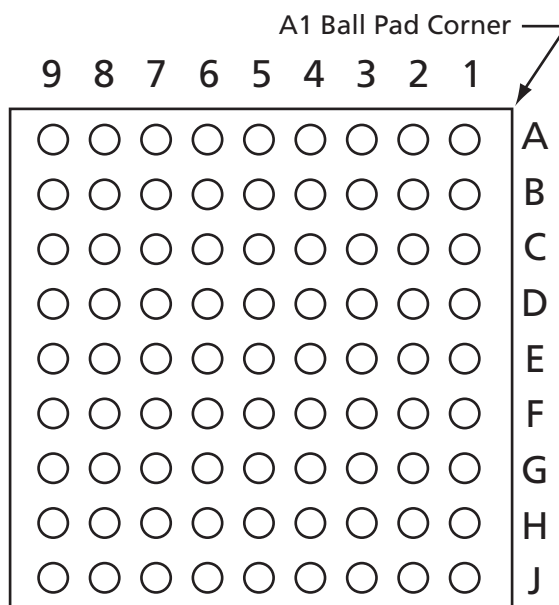
The Actel products described in this advance status datasheet may not have completed Actel's qualification process. Actel may amend or enhance products during the product introduction and qualification process, resulting in changes in device functionality or performance. It is the responsibility of each 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](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.





## 3 – Package Pin Assignments

### 81-Pin $\mu$ CSP



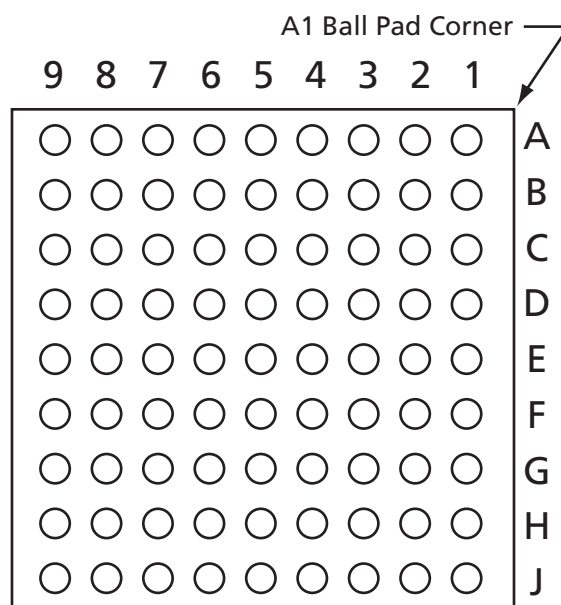
*Note:* This is the bottom view of the package.

#### **Note**

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

| 81-Pin $\mu$ CSP |                    | 81-Pin $\mu$ CSP |                    | 81-Pin $\mu$ CSP |                   |
|------------------|--------------------|------------------|--------------------|------------------|-------------------|
| Pin Number       | AGL030 Function    | Pin Number       | AGL030 Function    | Pin Number       | AGL030 Function   |
| A1               | IO00RSB0           | E1               | GEB0/IO71RSB1      | J1               | IO63RSB1          |
| A2               | IO02RSB0           | E2               | GEA0/IO72RSB1      | J2               | IO61RSB1          |
| A3               | IO06RSB0           | E3               | GEC0/IO73RSB1      | J3               | IO59RSB1          |
| A4               | IO11RSB0           | E4               | V <sub>CC</sub> B1 | J4               | IO56RSB1          |
| A5               | IO16RSB0           | E5               | V <sub>CC</sub>    | J5               | IO52RSB1          |
| A6               | IO19RSB0           | E6               | V <sub>CC</sub> B0 | J6               | IO44RSB1          |
| A7               | IO22RSB0           | E7               | GDC0/IO32RSB0      | J7               | TCK               |
| A8               | IO24RSB0           | E8               | GDA0/IO33RSB0      | J8               | TMS               |
| A9               | IO26RSB0           | E9               | GDB0/IO34RSB0      | J9               | V <sub>PUMP</sub> |
| B1               | IO81RSB1           | F1               | IO68RSB1           |                  |                   |
| B2               | IO04RSB0           | F2               | IO67RSB1           |                  |                   |
| B3               | IO10RSB0           | F3               | IO64RSB1           |                  |                   |
| B4               | IO13RSB0           | F4               | GND                |                  |                   |
| B5               | IO15RSB0           | F5               | V <sub>CC</sub> B1 |                  |                   |
| B6               | IO20RSB0           | F6               | IO47RSB1           |                  |                   |
| B7               | IO21RSB0           | F7               | IO36RSB0           |                  |                   |
| B8               | IO28RSB0           | F8               | IO38RSB0           |                  |                   |
| B9               | IO25RSB0           | F9               | IO40RSB0           |                  |                   |
| C1               | IO79RSB1           | G1               | IO65RSB1           |                  |                   |
| C2               | IO80RSB1           | G2               | IO66RSB1           |                  |                   |
| C3               | IO08RSB0           | G3               | IO57RSB1           |                  |                   |
| C4               | IO12RSB0           | G4               | IO53RSB1           |                  |                   |
| C5               | IO17RSB0           | G5               | IO49RSB1           |                  |                   |
| C6               | IO14RSB0           | G6               | IO45RSB1           |                  |                   |
| C7               | IO18RSB0           | G7               | IO46RSB1           |                  |                   |
| C8               | IO29RSB0           | G8               | V <sub>JTAG</sub>  |                  |                   |
| C9               | IO27RSB0           | G9               | TRST               |                  |                   |
| D1               | IO74RSB1           | H1               | IO62RSB1           |                  |                   |
| D2               | IO76RSB1           | H2               | FF/IO60RSB1        |                  |                   |
| D3               | IO77RSB1           | H3               | IO58RSB1           |                  |                   |
| D4               | V <sub>CC</sub>    | H4               | IO54RSB1           |                  |                   |
| D5               | V <sub>CC</sub> B0 | H5               | IO48RSB1           |                  |                   |
| D6               | GND                | H6               | IO43RSB1           |                  |                   |
| D7               | IO23RSB0           | H7               | IO42RSB1           |                  |                   |
| D8               | IO31RSB0           | H8               | TDI                |                  |                   |
| D9               | IO30RSB0           | H9               | TDO                |                  |                   |

## 81-Pin CSP



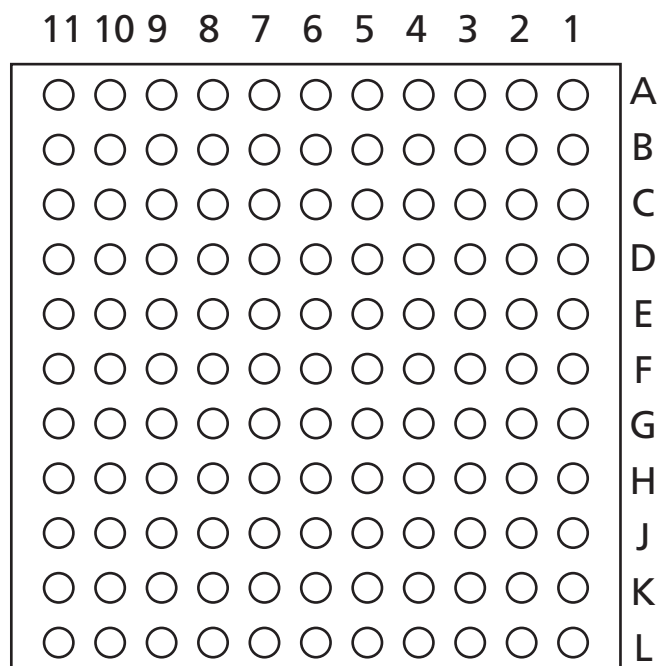
*Note:* This is the bottom view of the package.

### **Note**

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| 81-Pin CSP |                     | 81-Pin CSP |                     | 81-Pin CSP |                   |
|------------|---------------------|------------|---------------------|------------|-------------------|
| Pin Number | AGL030 Function     | Pin Number | AGL030 Function     | Pin Number | AGL030 Function   |
| A1         | IO00RSB0            | E1         | GEB0/IO71RSB1       | J1         | IO63RSB1          |
| A2         | IO02RSB0            | E2         | GEA0/IO72RSB1       | J2         | IO61RSB1          |
| A3         | IO06RSB0            | E3         | GEC0/IO73RSB1       | J3         | IO59RSB1          |
| A4         | IO11RSB0            | E4         | V <sub>CCI</sub> B1 | J4         | IO56RSB1          |
| A5         | IO16RSB0            | E5         | V <sub>CC</sub>     | J5         | IO52RSB1          |
| A6         | IO19RSB0            | E6         | V <sub>CCI</sub> B0 | J6         | IO45RSB1          |
| A7         | IO22RSB0            | E7         | GDC0/IO32RSB0       | J7         | TCK               |
| A8         | IO24RSB0            | E8         | GDA0/IO33RSB0       | J8         | TMS               |
| A9         | IO26RSB0            | E9         | GDB0/IO34RSB0       | J9         | V <sub>PUMP</sub> |
| B1         | IO81RSB1            | F1         | IO68RSB1            |            |                   |
| B2         | IO04RSB0            | F2         | IO67RSB1            |            |                   |
| B3         | IO10RSB0            | F3         | IO64RSB1            |            |                   |
| B4         | IO13RSB0            | F4         | GND                 |            |                   |
| B5         | IO15RSB0            | F5         | V <sub>CCI</sub> B1 |            |                   |
| B6         | IO20RSB0            | F6         | IO47RSB1            |            |                   |
| B7         | IO21RSB0            | F7         | IO36RSB0            |            |                   |
| B8         | IO28RSB0            | F8         | IO38RSB0            |            |                   |
| B9         | IO25RSB0            | F9         | IO40RSB0            |            |                   |
| C1         | IO79RSB1            | G1         | IO65RSB1            |            |                   |
| C2         | IO80RSB1            | G2         | IO66RSB1            |            |                   |
| C3         | IO08RSB0            | G3         | IO57RSB1            |            |                   |
| C4         | IO12RSB0            | G4         | IO53RSB1            |            |                   |
| C5         | IO17RSB0            | G5         | IO49RSB1            |            |                   |
| C6         | IO14RSB0            | G6         | IO44RSB1            |            |                   |
| C7         | IO18RSB0            | G7         | IO46RSB1            |            |                   |
| C8         | IO29RSB0            | G8         | V <sub>JTAG</sub>   |            |                   |
| C9         | IO27RSB0            | G9         | TRST                |            |                   |
| D1         | IO74RSB1            | H1         | IO62RSB1            |            |                   |
| D2         | IO76RSB1            | H2         | FF/IO60RSB1         |            |                   |
| D3         | IO77RSB1            | H3         | IO58RSB1            |            |                   |
| D4         | V <sub>CC</sub>     | H4         | IO54RSB1            |            |                   |
| D5         | V <sub>CCI</sub> B0 | H5         | IO48RSB1            |            |                   |
| D6         | GND                 | H6         | IO43RSB1            |            |                   |
| D7         | IO23RSB0            | H7         | IO42RSB1            |            |                   |
| D8         | IO31RSB0            | H8         | TDI                 |            |                   |
| D9         | IO30RSB0            | H9         | TDO                 |            |                   |

## 121-Pin CSP



*Note:* This is the bottom view of the package.

### Note

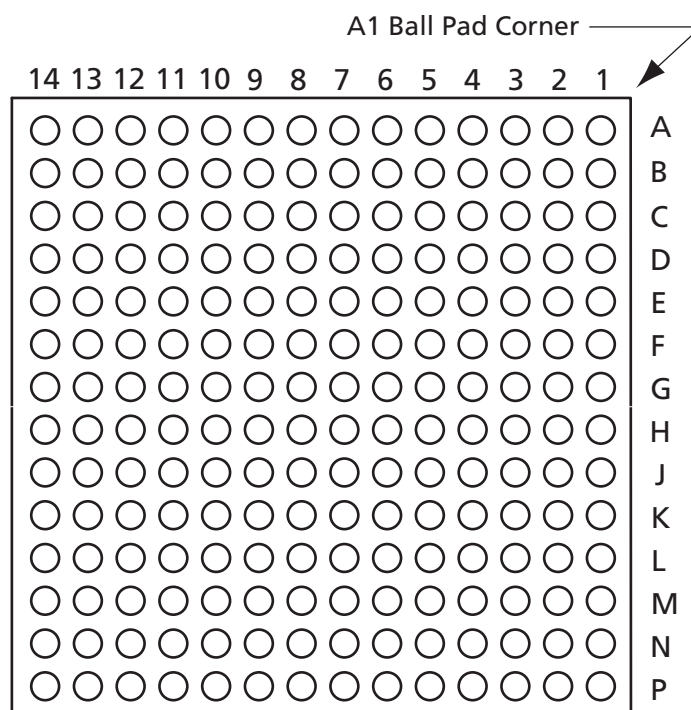
For Package Manufacturing and Environmental information, visit the Resource Center at <http://www.actel.com/products/solutions/package/docs.aspx>.

| 121-Pin CSP |                 | 121-Pin CSP |                     | 121-Pin CSP |                   |
|-------------|-----------------|-------------|---------------------|-------------|-------------------|
| Pin Number  | AGL060 Function | Pin Number  | AGL060 Function     | Pin Number  | AGL060 Function   |
| A1          | GNDQ            | D9          | GCA2/IO41RSB0       | H6          | GEC2/IO66RSB1     |
| A2          | IO01RSB0        | D10         | IO30RSB0            | H7          | IO54RSB1          |
| A3          | GAA1/IO03RSB0   | D11         | IO33RSB0            | H8          | GDC2/IO53RSB1     |
| A4          | GAC1/IO07RSB0   | E1          | IO87RSB1            | H9          | V <sub>JTAG</sub> |
| A5          | IO15RSB0        | E2          | GFC0/IO85RSB1       | H10         | TRST              |
| A6          | IO13RSB0        | E3          | IO92RSB1            | H11         | IO44RSB0          |
| A7          | IO17RSB0        | E4          | IO94RSB1            | J1          | GEC1/IO74RSB1     |
| A8          | GBB1/IO22RSB0   | E5          | V <sub>CC</sub>     | J2          | GEC0/IO73RSB1     |
| A9          | GBA1/IO24RSB0   | E6          | V <sub>CC</sub> B0  | J3          | GEB1/IO72RSB1     |
| A10         | GNDQ            | E7          | GND                 | J4          | GEA0/IO69RSB1     |
| A11         | VMV0            | E8          | GCC0/IO36RSB0       | J5          | FF/GEB2/IO67RSB1  |
| B1          | GAA2/IO95RSB1   | E9          | IO34RSB0            | J6          | IO62RSB1          |
| B2          | IO00RSB0        | E10         | GCB1/IO37RSB0       | J7          | GDA2/IO51RSB1     |
| B3          | GAA0/IO02RSB0   | E11         | GCC1/IO35RSB0       | J8          | GDB2/IO52RSB1     |
| B4          | GAC0/IO06RSB0   | F1*         | V <sub>COMPLF</sub> | J9          | TDI               |
| B5          | IO08RSB0        | F2          | GFB0/IO83RSB1       | J10         | TDO               |
| B6          | IO12RSB0        | F3          | GFA0/IO82RSB1       | J11         | GDC1/IO45RSB0     |
| B7          | IO16RSB0        | F4          | GFC1/IO86RSB1       | K1          | GEB0/IO71RSB1     |
| B8          | GBC1/IO20RSB0   | F5          | V <sub>CC</sub> B1  | K2          | GEA1/IO70RSB1     |
| B9          | GBB0/IO21RSB0   | F6          | V <sub>CC</sub>     | K3          | GEA2/IO68RSB1     |
| B10         | GBB2/IO27RSB0   | F7          | V <sub>CC</sub> B0  | K4          | IO64RSB1          |
| B11         | GBA2/IO25RSB0   | F8          | GCB2/IO42RSB0       | K5          | IO60RSB1          |
| C1          | IO89RSB1        | F9          | GCC2/IO43RSB0       | K6          | IO59RSB1          |
| C2          | GAC2/IO91RSB1   | F10         | GCB0/IO38RSB0       | K7          | IO56RSB1          |
| C3          | GAB1/IO05RSB0   | F11         | GCA1/IO39RSB0       | K8          | TCK               |
| C4          | GAB0/IO04RSB0   | G1*         | V <sub>CCPLF</sub>  | K9          | TMS               |
| C5          | IO09RSB0        | G2          | GFB2/IO79RSB1       | K10         | V <sub>PUMP</sub> |
| C6          | IO14RSB0        | G3          | GFA1/IO81RSB1       | K11         | GDB1/IO47RSB0     |
| C7          | GBA0/IO23RSB0   | G4          | GFB1/IO84RSB1       | L1          | VMV1              |
| C8          | GBC0/IO19RSB0   | G5          | GND                 | L2          | GNDQ              |
| C9          | IO26RSB0        | G6          | V <sub>CC</sub> B1  | L3          | IO65RSB1          |
| C10         | IO28RSB0        | G7          | V <sub>CC</sub>     | L4          | IO63RSB1          |
| C11         | GBC2/IO29RSB0   | G8          | GDC0/IO46RSB0       | L5          | IO61RSB1          |
| D1          | IO88RSB1        | G9          | GDA1/IO49RSB0       | L6          | IO58RSB1          |
| D2          | IO90RSB1        | G10         | GDB0/IO48RSB0       | L7          | IO57RSB1          |
| D3          | GAB2/IO93RSB1   | G11         | GCA0/IO40RSB0       | L8          | IO55RSB1          |
| D4          | IO10RSB0        | H1          | IO75RSB1            | L9          | GNDQ              |
| D5          | IO11RSB0        | H2          | IO76RSB1            | L10         | GDA0/IO50RSB0     |
| D6          | IO18RSB0        | H3          | GFC2/IO78RSB1       | L11         | VMV1              |
| D7          | IO32RSB0        | H4          | GFA2/IO80RSB1       |             |                   |
| D8          | IO31RSB0        | H5          | IO77RSB1            |             |                   |

\* Pin numbers F1 and G1 must be connected to ground because a PLL is not supported for AGL060-CS/G121.



## 196-Pin CSP



*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>.

| 196-Pin CSP |                    | 196-Pin CSP |                    | 196-Pin CSP |                     |
|-------------|--------------------|-------------|--------------------|-------------|---------------------|
| Pin Number  | AGL125 Function    | Pin Number  | AGL125 Function    | Pin Number  | AGL125 Function     |
| A1          | GND                | C9          | IO23RSB0           | F3          | IO113RSB1           |
| A2          | GAA0/IO00RSB0      | C10         | IO29RSB0           | F4          | IO112RSB1           |
| A3          | GAC0/IO04RSB0      | C11         | V <sub>CCIB0</sub> | F5          | IO111RSB1           |
| A4          | GAC1/IO05RSB0      | C12         | IO42RSB0           | F6          | NC                  |
| A5          | IO09RSB0           | C13         | GNDQ               | F7          | V <sub>CC</sub>     |
| A6          | IO15RSB0           | C14         | IO44RSB0           | F8          | V <sub>CC</sub>     |
| A7          | IO18RSB0           | D1          | IO127RSB1          | F9          | NC                  |
| A8          | IO22RSB0           | D2          | IO129RSB1          | F10         | IO07RSB0            |
| A9          | IO27RSB0           | D3          | GAA2/IO132RSB1     | F11         | IO25RSB0            |
| A10         | GBC0/IO35RSB0      | D4          | IO126RSB1          | F12         | IO10RSB0            |
| A11         | GBB0/IO37RSB0      | D5          | IO06RSB0           | F13         | IO33RSB0            |
| A12         | GBB1/IO38RSB0      | D6          | IO13RSB0           | F14         | IO47RSB0            |
| A13         | GBA1/IO40RSB0      | D7          | IO19RSB0           | G1          | GFB1/IO121RSB1      |
| A14         | GND                | D8          | IO21RSB0           | G2          | GFA0/IO119RSB1      |
| B1          | V <sub>CCIB1</sub> | D9          | IO26RSB0           | G3          | GFA2/IO117RSB1      |
| B2          | VMV0               | D10         | IO31RSB0           | G4          | V <sub>COMPLF</sub> |
| B3          | GAA1/IO01RSB0      | D11         | IO30RSB0           | G5          | GFC0/IO122RSB1      |
| B4          | GAB1/IO03RSB0      | D12         | VMV0               | G6          | V <sub>CC</sub>     |
| B5          | GND                | D13         | IO46RSB0           | G7          | GND                 |
| B6          | IO16RSB0           | D14         | GBC2/IO45RSB0      | G8          | GND                 |
| B7          | IO20RSB0           | E1          | IO125RSB1          | G9          | V <sub>CC</sub>     |
| B8          | IO24RSB0           | E2          | GND                | G10         | GCC0/IO52RSB0       |
| B9          | IO28RSB0           | E3          | IO131RSB1          | G11         | GCB1/IO53RSB0       |
| B10         | GND                | E4          | V <sub>CCIB1</sub> | G12         | GCA0/IO56RSB0       |
| B11         | GBC1/IO36RSB0      | E5          | NC                 | G13         | IO48RSB0            |
| B12         | GBA0/IO39RSB0      | E6          | IO08RSB0           | G14         | GCC2/IO59RSB0       |
| B13         | GBA2/IO41RSB0      | E7          | IO17RSB0           | H1          | GFB0/IO120RSB1      |
| B14         | GBB2/IO43RSB0      | E8          | IO12RSB0           | H2          | GFA1/IO118RSB1      |
| C1          | GAC2/IO128RSB1     | E9          | IO11RSB0           | H3          | V <sub>CCPLF</sub>  |
| C2          | GAB2/IO130RSB1     | E10         | NC                 | H4          | GFB2/IO116RSB1      |
| C3          | GNDQ               | E11         | V <sub>CCIB0</sub> | H5          | GFC1/IO123RSB1      |
| C4          | V <sub>CCIB0</sub> | E12         | IO32RSB0           | H6          | V <sub>CC</sub>     |
| C5          | GAB0/IO02RSB0      | E13         | GND                | H7          | GND                 |
| C6          | IO14RSB0           | E14         | IO34RSB0           | H8          | GND                 |
| C7          | V <sub>CCIB0</sub> | F1          | IO124RSB1          | H9          | V <sub>CC</sub>     |
| C8          | NC                 | F2          | IO114RSB1          | H10         | GCC1/IO51RSB0       |

| 196-Pin CSP |                    | 196-Pin CSP |                    | 196-Pin CSP |                   |
|-------------|--------------------|-------------|--------------------|-------------|-------------------|
| Pin Number  | AGL125 Function    | Pin Number  | AGL125 Function    | Pin Number  | AGL125 Function   |
| H11         | GCB0/IO54RSB0      | L5          | IO91RSB1           | N13         | GNDQ              |
| H12         | GCA1/IO55RSB0      | L6          | IO90RSB1           | N14         | TDO               |
| H13         | IO49RSB0           | L7          | IO83RSB1           | P1          | GND               |
| H14         | GCA2/IO57RSB0      | L8          | IO81RSB1           | P2          | GEA2/IO103RSB1    |
| J1          | GFC2/IO115RSB1     | L9          | IO71RSB1           | P3          | FF/GEB2/IO102RSB1 |
| J2          | IO110RSB1          | L10         | IO70RSB1           | P4          | IO98RSB1          |
| J3          | IO94RSB1           | L11         | V <sub>PUMP</sub>  | P5          | IO97RSB1          |
| J4          | IO93RSB1           | L12         | V <sub>JTAG</sub>  | P6          | IO85RSB1          |
| J5          | IO89RSB1           | L13         | GDA0/IO66RSB0      | P7          | IO84RSB1          |
| J6          | NC                 | L14         | GDB0/IO64RSB0      | P8          | IO79RSB1          |
| J7          | V <sub>CC</sub>    | M1          | GEB0/IO106RSB1     | P9          | IO77RSB1          |
| J8          | V <sub>CC</sub>    | M2          | GEA1/IO105RSB1     | P10         | IO75RSB1          |
| J9          | NC                 | M3          | GNDQ               | P11         | GDC2/IO69RSB1     |
| J10         | IO60RSB0           | M4          | V <sub>CCIB1</sub> | P12         | GDA2/IO67RSB1     |
| J11         | GCB2/IO58RSB0      | M5          | IO92RSB1           | P13         | TMS               |
| J12         | IO50RSB0           | M6          | IO88RSB1           | P14         | GND               |
| J13         | GDC1/IO61RSB0      | M7          | NC                 |             |                   |
| J14         | GDC0/IO62RSB0      | M8          | V <sub>CCIB1</sub> |             |                   |
| K1          | IO99RSB1           | M9          | IO76RSB1           |             |                   |
| K2          | GND                | M10         | GDB2/IO68RSB1      |             |                   |
| K3          | IO95RSB1           | M11         | V <sub>CCIB1</sub> |             |                   |
| K4          | V <sub>CCIB1</sub> | M12         | VMV1               |             |                   |
| K5          | NC                 | M13         | TRST               |             |                   |
| K6          | IO86RSB1           | M14         | V <sub>CCIB0</sub> |             |                   |
| K7          | IO80RSB1           | N1          | GEA0/IO104RSB1     |             |                   |
| K8          | IO74RSB1           | N2          | VMV1               |             |                   |
| K9          | IO72RSB1           | N3          | GEC2/IO101RSB1     |             |                   |
| K10         | NC                 | N4          | IO100RSB1          |             |                   |
| K11         | V <sub>CCIB0</sub> | N5          | GND                |             |                   |
| K12         | GDA1/IO65RSB0      | N6          | IO87RSB1           |             |                   |
| K13         | GND                | N7          | IO82RSB1           |             |                   |
| K14         | GDB1/IO63RSB0      | N8          | IO78RSB1           |             |                   |
| L1          | GEB1/IO107RSB1     | N9          | IO73RSB1           |             |                   |
| L2          | GEC1/IO109RSB1     | N10         | GND                |             |                   |
| L3          | GEC0/IO108RSB1     | N11         | TCK                |             |                   |
| L4          | IO96RSB1           | N12         | TDI                |             |                   |

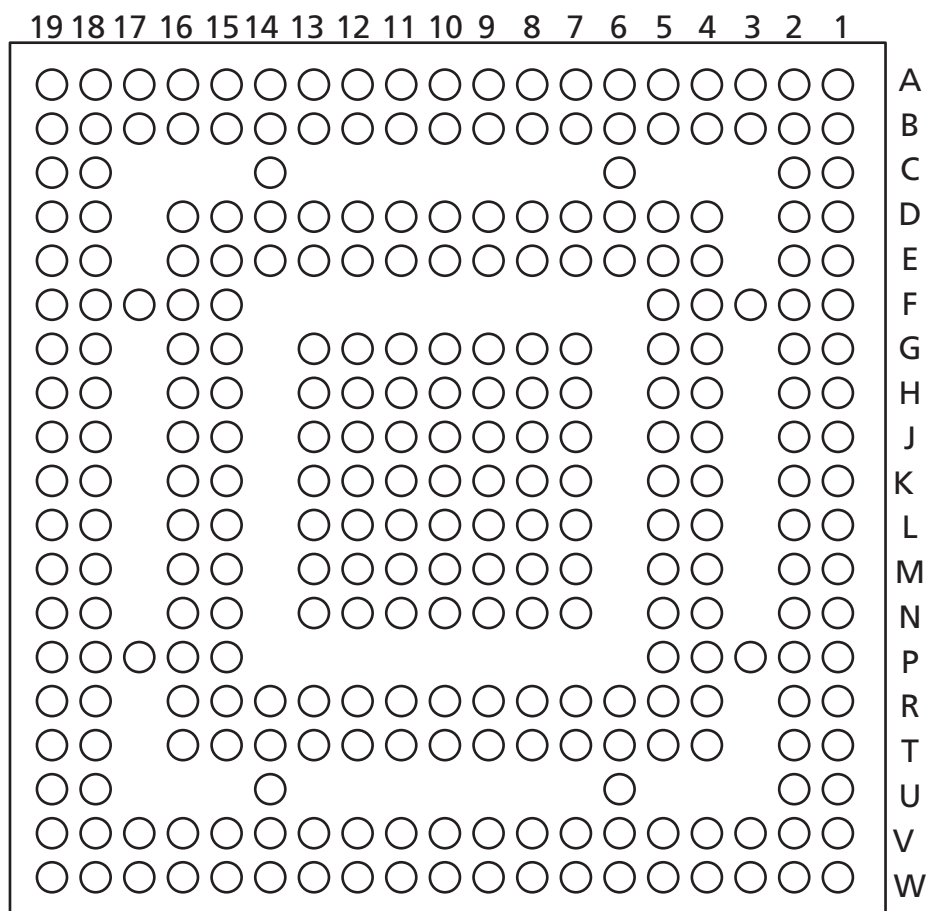
| 196-Pin CSP |                     | 196-Pin CSP |                     | 196-Pin CSP |                     |
|-------------|---------------------|-------------|---------------------|-------------|---------------------|
| Pin Number  | AGL250 Function     | Pin Number  | AGL250 Function     | Pin Number  | AGL250 Function     |
| A1          | GND                 | C9          | IO30RSB0            | F3          | IO111PDB3           |
| A2          | GAA0/IO00RSB0       | C10         | IO33RSB0            | F4          | IO111NDB3           |
| A3          | GAC0/IO04RSB0       | C11         | V <sub>CCI</sub> B0 | F5          | IO113NPB3           |
| A4          | GAC1/IO05RSB0       | C12         | IO41NPB1            | F6          | IO06RSB0            |
| A5          | IO10RSB0            | C13         | GNDQ                | F7          | V <sub>CC</sub>     |
| A6          | IO13RSB0            | C14         | IO42NDB1            | F8          | V <sub>CC</sub>     |
| A7          | IO17RSB0            | D1          | IO116VDB3           | F9          | IO28RSB0            |
| A8          | IO19RSB0            | D2          | IO117VDB3           | F10         | IO54PDB1            |
| A9          | IO23RSB0            | D3          | GAA2/IO118UDB3      | F11         | IO54NDB1            |
| A10         | GBC0/IO35RSB0       | D4          | IO113PPB3           | F12         | IO47NDB1            |
| A11         | GBB0/IO37RSB0       | D5          | IO08RSB0            | F13         | IO47PDB1            |
| A12         | GBB1/IO38RSB0       | D6          | IO14RSB0            | F14         | IO45NDB1            |
| A13         | GBA1/IO40RSB0       | D7          | IO15RSB0            | G1          | GFB1/IO109PDB3      |
| A14         | GND                 | D8          | IO18RSB0            | G2          | GFA0/IO108NDB3      |
| B1          | V <sub>CCI</sub> B3 | D9          | IO25RSB0            | G3          | GFA2/IO107PPB3      |
| B2          | VMV0                | D10         | IO32RSB0            | G4          | V <sub>COMPLF</sub> |
| B3          | GAA1/IO01RSB0       | D11         | IO44PPB1            | G5          | GFC0/IO110NDB3      |
| B4          | GAB1/IO03RSB0       | D12         | VMV1                | G6          | V <sub>CC</sub>     |
| B5          | GND                 | D13         | IO43NDB1            | G7          | GND                 |
| B6          | IO12RSB0            | D14         | GBC2/IO43PDB1       | G8          | GND                 |
| B7          | IO16RSB0            | E1          | IO112PDB3           | G9          | V <sub>CC</sub>     |
| B8          | IO22RSB0            | E2          | GND                 | G10         | GCC0/IO48NDB1       |
| B9          | IO24RSB0            | E3          | IO118VDB3           | G11         | GCB1/IO49PDB1       |
| B10         | GND                 | E4          | V <sub>CCI</sub> B3 | G12         | GCA0/IO50NDB1       |
| B11         | GBC1/IO36RSB0       | E5          | IO114USB3           | G13         | IO53NDB1            |
| B12         | GBA0/IO39RSB0       | E6          | IO07RSB0            | G14         | GCC2/IO53PDB1       |
| B13         | GBA2/IO41PPB1       | E7          | IO09RSB0            | H1          | GFB0/IO109NDB3      |
| B14         | GBB2/IO42PDB1       | E8          | IO21RSB0            | H2          | GFA1/IO108PDB3      |
| C1          | GAC2/IO116UDB3      | E9          | IO31RSB0            | H3          | V <sub>CCPLF</sub>  |
| C2          | GAB2/IO117UDB3      | E10         | IO34RSB0            | H4          | GFB2/IO106PPB3      |
| C3          | GNDQ                | E11         | V <sub>CCI</sub> B1 | H5          | GFC1/IO110PDB3      |
| C4          | V <sub>CCI</sub> B0 | E12         | IO44NPB1            | H6          | V <sub>CC</sub>     |
| C5          | GAB0/IO02RSB0       | E13         | GND                 | H7          | GND                 |
| C6          | IO11RSB0            | E14         | IO45PDB1            | H8          | GND                 |
| C7          | V <sub>CCI</sub> B0 | F1          | IO112NDB3           | H9          | V <sub>CC</sub>     |
| C8          | IO20RSB0            | F2          | IO107NPB3           | H10         | GCC1/IO48PDB1       |

| 196-Pin CSP |                     | 196-Pin CSP |                     | 196-Pin CSP |                 |
|-------------|---------------------|-------------|---------------------|-------------|-----------------|
| Pin Number  | AGL250 Function     | Pin Number  | AGL250 Function     | Pin Number  | AGL250 Function |
| H11         | GCB0/IO49NDB1       | L5          | IO89RSB2            | N13         | GNDQ            |
| H12         | GCA1/IO50PDB1       | L6          | IO92RSB2            | N14         | TDO             |
| H13         | IO51NDB1            | L7          | IO75RSB2            | P1          | GND             |
| H14         | GCA2/IO51PDB1       | L8          | IO66RSB2            | P2          | GEA2/IO97RSB2   |
| J1          | GFC2/IO105PDB3      | L9          | IO65RSB2            | P3          | GEB2/IO96RSB2   |
| J2          | IO104PPB3           | L10         | IO71RSB2            | P4          | IO90RSB2        |
| J3          | IO106NPB3           | L11         | V <sub>PUMP</sub>   | P5          | IO85RSB2        |
| J4          | IO103PDB3           | L12         | V <sub>JTAG</sub>   | P6          | IO83RSB2        |
| J5          | IO103NDB3           | L13         | GDA0/IO60VPB1       | P7          | IO79RSB2        |
| J6          | IO80RSB2            | L14         | GDB0/IO59VDB1       | P8          | IO76RSB2        |
| J7          | V <sub>CC</sub>     | M1          | GEB0/IO99NDB3       | P9          | IO72RSB2        |
| J8          | V <sub>CC</sub>     | M2          | GEA1/IO98PPB3       | P10         | IO68RSB2        |
| J9          | IO64RSB2            | M3          | GNDQ                | P11         | GDC2/IO63RSB2   |
| J10         | IO56PDB1            | M4          | V <sub>CCI</sub> B2 | P12         | GDA2/IO61RSB2   |
| J11         | GCB2/IO52PDB1       | M5          | IO88RSB2            | P13         | TMS             |
| J12         | IO52NDB1            | M6          | IO87RSB2            | P14         | GND             |
| J13         | GDC1/IO58UDB1       | M7          | IO82RSB2            |             |                 |
| J14         | GDC0/IO58VDB1       | M8          | V <sub>CCI</sub> B2 |             |                 |
| K1          | IO105NDB3           | M9          | IO67RSB2            |             |                 |
| K2          | GND                 | M10         | GDB2/IO62RSB2       |             |                 |
| K3          | IO104NPB3           | M11         | V <sub>CCI</sub> B2 |             |                 |
| K4          | V <sub>CCI</sub> B3 | M12         | VMV2                |             |                 |
| K5          | IO101PPB3           | M13         | TRST                |             |                 |
| K6          | IO91RSB2            | M14         | V <sub>CCI</sub> B1 |             |                 |
| K7          | IO81RSB2            | N1          | GEA0/IO98NPB3       |             |                 |
| K8          | IO73RSB2            | N2          | VMV3                |             |                 |
| K9          | IO77RSB2            | N3          | GEC2/IO95RSB2       |             |                 |
| K10         | IO56NDB1            | N4          | IO94RSB2            |             |                 |
| K11         | V <sub>CCI</sub> B1 | N5          | GND                 |             |                 |
| K12         | GDA1/IO60UPB1       | N6          | IO86RSB2            |             |                 |
| K13         | GND                 | N7          | IO78RSB2            |             |                 |
| K14         | GDB1/IO59UDB1       | N8          | IO74RSB2            |             |                 |
| L1          | GEB1/IO99PDB3       | N9          | IO69RSB2            |             |                 |
| L2          | GEC1/IO100PDB3      | N10         | GND                 |             |                 |
| L3          | GEC0/IO100NDB3      | N11         | TCK                 |             |                 |
| L4          | IO101NPB3           | N12         | TDI                 |             |                 |

| 196-pin CSP |                    | 196-pin CSP |                    | 196-pin CSP |                     |
|-------------|--------------------|-------------|--------------------|-------------|---------------------|
| Pin Number  | AGL400 Function    | Pin Number  | AGL400 Function    | Pin Number  | AGL400 Function     |
| A1          | GND                | C8          | IO31RSB0           | F2          | IO144NPB3           |
| A2          | GAA0/IO00RSB0      | C9          | IO44RSB0           | F3          | IO148PDB3           |
| A3          | GAC0/IO04RSB0      | C10         | IO49RSB0           | F4          | IO148NDB3           |
| A4          | GAC1/IO05RSB0      | C11         | V <sub>CC</sub> B0 | F5          | IO150NPB3           |
| A5          | IO14RSB0           | C12         | IO60NPB1           | F6          | IO07RSB0            |
| A6          | IO18RSB0           | C13         | GNDQ               | F7          | V <sub>CC</sub>     |
| A7          | IO26RSB0           | C14         | IO61NDB1           | F8          | V <sub>CC</sub>     |
| A8          | IO29RSB0           | D1          | IO153VDB3          | F9          | IO43RSB0            |
| A9          | IO36RSB0           | D2          | IO154VDB3          | F10         | IO73PDB1            |
| A10         | GBC0/IO54RSB0      | D3          | GAA2/IO155UDB3     | F11         | IO73NDB1            |
| A11         | GBB0/IO56RSB0      | D4          | IO150PPB3          | F12         | IO66NDB1            |
| A12         | GBB1/IO57RSB0      | D5          | IO11RSB0           | F13         | IO66PDB1            |
| A13         | GBA1/IO59RSB0      | D6          | IO20RSB0           | F14         | IO64NDB1            |
| A14         | GND                | D7          | IO23RSB0           | G1          | GFB1/IO146PDB3      |
| B1          | V <sub>CC</sub> B3 | D8          | IO28RSB0           | G2          | GFA0/IO145NDB3      |
| B2          | VMV0               | D9          | IO41RSB0           | G3          | GFA2/IO144PPB3      |
| B2          | VMV0               | D10         | IO47RSB0           | G4          | V <sub>COMPLF</sub> |
| B3          | GAA1/IO01RSB0      | D11         | IO63PPB1           | G5          | GFC0/IO147NDB3      |
| B4          | GAB1/IO03RSB0      | D12         | VMV1               | G6          | V <sub>CC</sub>     |
| B5          | GND                | D13         | IO62NDB1           | G7          | GND                 |
| B6          | IO17RSB0           | D14         | GBC2/IO62PDB1      | G8          | GND                 |
| B7          | IO25RSB0           | E1          | IO149PDB3          | G9          | V <sub>CC</sub>     |
| B8          | IO34RSB0           | E2          | GND                | G10         | GCC0/IO67NDB1       |
| B9          | IO39RSB0           | E3          | IO155VDB3          | G11         | GCB1/IO68PDB1       |
| B10         | GND                | E4          | V <sub>CC</sub> B3 | G12         | GCA0/IO69NDB1       |
| B11         | GBC1/IO55RSB0      | E5          | IO151USB3          | G13         | IO72NDB1            |
| B12         | GBA0/IO58RSB0      | E6          | IO09RSB0           | G14         | GCC2/IO72PDB1       |
| B13         | GBA2/IO60PPB1      | E7          | IO12RSB0           | H1          | GFB0/IO146NDB3      |
| B14         | GBB2/IO61PDB1      | E8          | IO32RSB0           | H2          | GFA1/IO145PDB3      |
| C1          | GAC2/IO153UDB3     | E9          | IO46RSB0           | H3          | V <sub>CCPLF</sub>  |
| C2          | GAB2/IO154UDB3     | E10         | IO51RSB0           | H4          | GFB2/IO143PPB3      |
| C3          | GNDQ               | E11         | V <sub>CC</sub> B1 | H5          | GFC1/IO147PDB3      |
| C4          | V <sub>CC</sub> B0 | E12         | IO63NPB1           | H6          | V <sub>CC</sub>     |
| C5          | GAB0/IO02RSB0      | E13         | GND                | H7          | GND                 |
| C6          | IO15RSB0           | E14         | IO64PDB1           | H8          | GND                 |
| C7          | V <sub>CC</sub> B0 | F1          | IO149NDB3          | H9          | V <sub>CC</sub>     |

| 196-pin CSP |                    | 196-pin CSP |                    | 196-pin CSP |                   |
|-------------|--------------------|-------------|--------------------|-------------|-------------------|
| Pin Number  | AGL400 Function    | Pin Number  | AGL400 Function    | Pin Number  | AGL400 Function   |
| H10         | GCC1/IO67PDB1      | L4          | IO138NPB3          | N11         | TCK               |
| H11         | GCB0/IO68NDB1      | L5          | IO122RSB2          | N12         | TDI               |
| H12         | GCA1/IO69PDB1      | L6          | IO128RSB2          | N13         | GNDQ              |
| H13         | IO70NDB1           | L7          | IO101RSB2          | N14         | TDO               |
| H14         | GCA2/IO70PDB1      | L8          | IO88RSB2           | P1          | GND               |
| J1          | GFC2/IO142PDB3     | L9          | IO86RSB2           | P2          | GEA2/IO134RSB2    |
| J2          | IO141PPB3          | L10         | IO94RSB2           | P3          | FF/GEB2/IO133RSB2 |
| J3          | IO143NPB3          | L11         | V <sub>PUMP</sub>  | P4          | IO123RSB2         |
| J4          | IO140PDB3          | L12         | V <sub>JTAG</sub>  | P5          | IO116RSB2         |
| J5          | IO140NDB3          | L13         | GDA0/IO79VPB1      | P6          | IO114RSB2         |
| J6          | IO109RSB2          | L14         | GDB0/IO78VDB1      | P7          | IO107RSB2         |
| J7          | V <sub>CC</sub>    | M1          | GEB0/IO136NDB3     | P8          | IO103RSB2         |
| J8          | V <sub>CC</sub>    | M2          | GEA1/IO135PPB3     | P9          | IO95RSB2          |
| J9          | IO84RSB2           | M3          | GNDQ               | P10         | IO91RSB2          |
| J10         | IO75PDB1           | M4          | V <sub>CC</sub> B2 | P11         | GDC2/IO82RSB2     |
| J11         | GCB2/IO71PDB1      | M5          | IO120RSB2          | P12         | GDA2/IO80RSB2     |
| J12         | IO71NDB1           | M6          | IO119RSB2          | P13         | TMS               |
| J13         | GDC1/IO77UDB1      | M7          | IO112RSB2          | P14         | GND               |
| J14         | GDC0/IO77VDB1      | M8          | V <sub>CC</sub> B2 |             |                   |
| K1          | IO142NDB3          | M9          | IO89RSB2           |             |                   |
| K2          | GND                | M10         | GDB2/IO81RSB2      |             |                   |
| K3          | IO141NPB3          | M11         | V <sub>CC</sub> B2 |             |                   |
| K4          | V <sub>CC</sub> B3 | M12         | VMV2               |             |                   |
| K5          | IO138PPB3          | M12         | VMV2               |             |                   |
| K6          | IO125RSB2          | M13         | TRST               |             |                   |
| K7          | IO110RSB2          | M14         | V <sub>CC</sub> B1 |             |                   |
| K8          | IO98RSB2           | N1          | GEA0/IO135NPB3     |             |                   |
| K9          | IO104RSB2          | N2          | VMV3               |             |                   |
| K10         | IO75NDB1           | N3          | GEC2/IO132RSB2     |             |                   |
| K11         | V <sub>CC</sub> B1 | N4          | IO130RSB2          |             |                   |
| K12         | GDA1/IO79UPB1      | N5          | GND                |             |                   |
| K13         | GND                | N6          | IO117RSB2          |             |                   |
| K14         | GDB1/IO78UDB1      | N7          | IO106RSB2          |             |                   |
| L1          | GEB1/IO136PDB3     | N8          | IO100RSB2          |             |                   |
| L2          | GEC1/IO137PDB3     | N9          | IO92RSB2           |             |                   |
| L3          | GEC0/IO137NDB3     | N10         | GND                |             |                   |

## 281-Pin CSP



*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>.



| 281-Pin CSP |                      | 281-Pin CSP |                      | 281-Pin CSP |                      |
|-------------|----------------------|-------------|----------------------|-------------|----------------------|
| Pin Number  | AGL600 Function      | Pin Number  | AGL600 Function      | Pin Number  | AGL600 Function      |
| A1          | GND                  | B18         | V <sub>CC</sub> I B1 | E13         | IO46RSB0             |
| A2          | GAB0/IO02RSB0        | B19         | IO61NDB1             | E14         | GBB1/IO57RSB0        |
| A3          | GAC1/IO05RSB0        | C1          | GAB2/IO173PPB3       | E15         | IO62NPB1             |
| A4          | IO07RSB0             | C2          | IO174NPB3            | E16         | IO63PPB1             |
| A5          | IO10RSB0             | C6          | IO12RSB0             | E18         | IO64PPB1             |
| A6          | IO14RSB0             | C14         | IO50RSB0             | E19         | IO65NPB1             |
| A7          | IO18RSB0             | C18         | IO60NPB1             | F1          | IO168NPB3            |
| A8          | IO21RSB0             | C19         | GBB2/IO61PDB1        | F2          | GND                  |
| A9          | IO22RSB0             | D1          | IO170PPB3            | F3          | IO169PPB3            |
| A10         | V <sub>CC</sub> I B0 | D2          | IO172NPB3            | F4          | IO170NPB3            |
| A11         | IO33RSB0             | D4          | GAA0/IO00RSB0        | F5          | IO173NPB3            |
| A12         | IO40RSB0             | D5          | GAA1/IO01RSB0        | F15         | IO63NPB1             |
| A13         | IO37RSB0             | D6          | IO09RSB0             | F16         | IO65PPB1             |
| A14         | IO48RSB0             | D7          | IO16RSB0             | F17         | IO64NPB1             |
| A15         | IO51RSB0             | D8          | IO19RSB0             | F18         | GND                  |
| A16         | IO53RSB0             | D9          | IO26RSB0             | F19         | IO68PPB1             |
| A17         | GBC1/IO55RSB0        | D10         | GND                  | G1          | IO167NPB3            |
| A18         | GBA0/IO58RSB0        | D11         | IO34RSB0             | G2          | IO165NDB3            |
| A19         | GND                  | D12         | IO45RSB0             | G4          | IO168PPB3            |
| B1          | GAA2/IO174PPB3       | D13         | IO49RSB0             | G5          | IO167PPB3            |
| B2          | V <sub>CC</sub> I B0 | D14         | IO47RSB0             | G7          | GAC2/IO172PPB3       |
| B3          | GAB1/IO03RSB0        | D15         | GBB0/IO56RSB0        | G8          | VCCIB0               |
| B4          | GAC0/IO04RSB0        | D16         | GBA2/IO60PPB1        | G9          | IO28RSB0             |
| B5          | IO06RSB0             | D18         | GBC2/IO62PPB1        | G10         | IO32RSB0             |
| B6          | GND                  | D19         | IO66NPB1             | G11         | IO43RSB0             |
| B7          | IO15RSB0             | E1          | IO169NPB3            | G12         | VCCIB0               |
| B8          | IO20RSB0             | E2          | IO171PPB3            | G13         | IO66PPB1             |
| B9          | IO23RSB0             | E4          | IO171NPB3            | G15         | IO67NDB1             |
| B10         | IO24RSB0             | E5          | IO08RSB0             | G16         | IO67PDB1             |
| B11         | IO36RSB0             | E6          | IO11RSB0             | G18         | GCC0/IO69NPB1        |
| B12         | IO35RSB0             | E7          | IO13RSB0             | G19         | GCB1/IO70PPB1        |
| B13         | IO44RSB0             | E8          | IO17RSB0             | H1          | GFB0/IO163NPB3       |
| B14         | GND                  | E9          | IO25RSB0             | H2          | IO165PDB3            |
| B15         | IO52RSB0             | E10         | IO30RSB0             | H4          | GFC1/IO164PPB3       |
| B16         | GBC0/IO54RSB0        | E11         | IO41RSB0             | H5          | GFB1/IO163PPB3       |
| B17         | GBA1/IO59RSB0        | E12         | IO42RSB0             | H7          | V <sub>CC</sub> I B3 |

| 281-Pin CSP |                     | 281-Pin CSP |                     | 281-Pin CSP |                   |
|-------------|---------------------|-------------|---------------------|-------------|-------------------|
| Pin Number  | AGL600 Function     | Pin Number  | AGL600 Function     | Pin Number  | AGL600 Function   |
| H8          | V <sub>CC</sub>     | K15         | IO73NPB1            | N4          | IO150PPB3         |
| H9          | V <sub>CCI</sub> B0 | K16         | GND                 | N5          | IO148NPB3         |
| H10         | V <sub>CC</sub>     | K18         | IO74NPB1            | N7          | GEA2/IO143RSB2    |
| H11         | V <sub>CCI</sub> B0 | K19         | V <sub>CCI</sub> B1 | N8          | VCCIB2            |
| H12         | V <sub>CC</sub>     | L1          | GFB2/IO160PDB3      | N9          | IO117RSB2         |
| H13         | V <sub>CCI</sub> B1 | L2          | IO160NDB3           | N10         | IO115RSB2         |
| H15         | IO68NPB1            | L4          | GFC2/IO159PPB3      | N11         | IO114RSB2         |
| H16         | GCB0/IO70NPB1       | L5          | IO153PPB3           | N12         | VCCIB2            |
| H18         | GCA1/IO71PPB1       | L7          | IO153NPB3           | N13         | V <sub>PUMP</sub> |
| H19         | GCA2/IO72PPB1       | L8          | V <sub>CCI</sub> B3 | N15         | IO82PPB1          |
| J1          | V <sub>COMPLF</sub> | L9          | GND                 | N16         | IO85PPB1          |
| J2          | GFA0/IO162NDB3      | L10         | GND                 | N18         | IO82NPB1          |
| J4          | V <sub>CCPLF</sub>  | L11         | GND                 | N19         | IO81PPB1          |
| J5          | GFC0/IO164NPB3      | L12         | V <sub>CCI</sub> B1 | P1          | IO151PDB3         |
| J7          | GFA2/IO161PDB3      | L13         | IO76PPB1            | P2          | GND               |
| J8          | V <sub>CCI</sub> B3 | L15         | IO76NPB1            | P3          | IO151NDB3         |
| J9          | GND                 | L16         | IO77PPB1            | P4          | IO149PPB3         |
| J10         | GND                 | L18         | IO78NPB1            | P5          | GEA0/IO144NPB3    |
| J11         | GND                 | L19         | IO77NPB1            | P15         | IO83NDB1          |
| J12         | V <sub>CCI</sub> B1 | M1          | IO158PDB3           | P16         | IO83PDB1          |
| J13         | GCC1/IO69PPB1       | M2          | IO158NDB3           | P17         | GDC1/IO86PPB1     |
| J15         | GCA0/IO71NPB1       | M4          | IO154NPB3           | P18         | GND               |
| J16         | GCB2/IO73PPB1       | M5          | IO152PPB3           | P19         | IO85NPB1          |
| J18         | IO72NPB1            | M7          | V <sub>CCI</sub> B3 | R1          | IO150NPB3         |
| J19         | IO75PSB1            | M8          | V <sub>CC</sub>     | R2          | IO149NPB3         |
| K1          | V <sub>CCI</sub> B3 | M9          | V <sub>CCI</sub> B2 | R4          | GEC1/IO146PPB3    |
| K2          | GFA1/IO162PDB3      | M10         | V <sub>CC</sub>     | R5          | GEB1/IO145PPB3    |
| K4          | GND                 | M11         | V <sub>CCI</sub> B2 | R6          | IO138RSB2         |
| K5          | IO159NPB3           | M12         | V <sub>CC</sub>     | R7          | IO127RSB2         |
| K7          | IO161NDB3           | M13         | VCCIB1              | R8          | IO123RSB2         |
| K8          | V <sub>CC</sub>     | M15         | IO79NPB1            | R9          | IO118RSB2         |
| K9          | GND                 | M16         | IO81NPB1            | R10         | IO111RSB2         |
| K10         | GND                 | M18         | IO79PPB1            | R11         | IO106RSB2         |
| K11         | GND                 | M19         | IO78PPB1            | R12         | IO103RSB2         |
| K12         | V <sub>CC</sub>     | N1          | IO154PPB3           | R13         | IO97RSB2          |
| K13         | GCC2/IO74PPB1       | N2          | IO152NPB3           | R14         | IO95RSB2          |

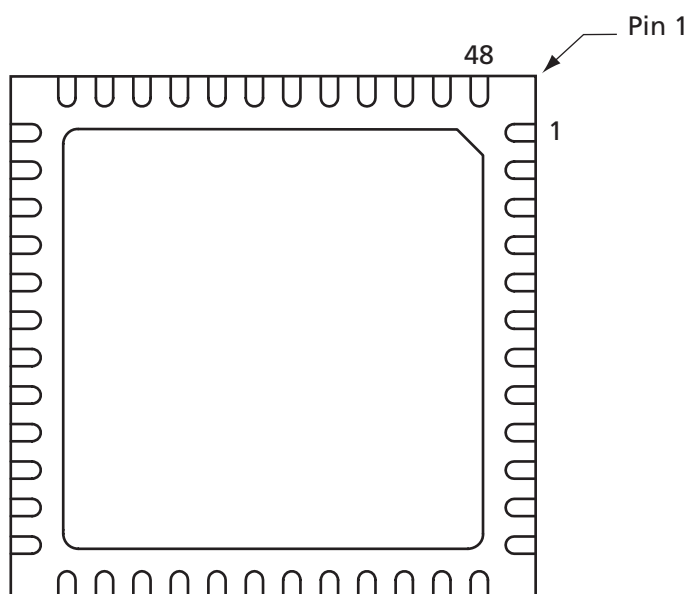
| 281-Pin CSP |                    | 281-Pin CSP |                    |
|-------------|--------------------|-------------|--------------------|
| Pin Number  | AGL600 Function    | Pin Number  | AGL600 Function    |
| R15         | IO94RSB2           | V10         | IO112RSB2          |
| R16         | GDA1/IO88PPB1      | V11         | IO110RSB2          |
| R18         | GDB0/IO87NPB1      | V12         | IO108RSB2          |
| R19         | GDC0/IO86NPB1      | V13         | IO102RSB2          |
| T1          | IO148PPB3          | V14         | GND                |
| T2          | GEC0/IO146NPB3     | V15         | IO93RSB2           |
| T4          | GEB0/IO145NPB3     | V16         | GDA2/IO89RSB2      |
| T5          | IO132RSB2          | V17         | TDI                |
| T6          | IO136RSB2          | V18         | V <sub>CC</sub> B2 |
| T7          | IO130RSB2          | V19         | TDO                |
| T8          | IO126RSB2          | W1          | GND                |
| T9          | IO120RSB2          | W2          | FF/GEB2/IO142RSB2  |
| T10         | GND                | W3          | IO139RSB2          |
| T11         | IO113RSB2          | W4          | IO137RSB2          |
| T12         | IO104RSB2          | W5          | IO134RSB2          |
| T13         | IO101RSB2          | W6          | IO133RSB2          |
| T14         | IO98RSB2           | W7          | IO128RSB2          |
| T15         | GDC2/IO91RSB2      | W8          | IO124RSB2          |
| T16         | TMS                | W9          | IO119RSB2          |
| T18         | V <sub>JTAG</sub>  | W10         | V <sub>CC</sub> B2 |
| T19         | GDB1/IO87PPB1      | W11         | IO109RSB2          |
| U1          | IO147PDB3          | W12         | IO107RSB2          |
| U2          | GEA1/IO144PPB3     | W13         | IO105RSB2          |
| U6          | IO131RSB2          | W14         | IO100RSB2          |
| U14         | IO99RSB2           | W15         | IO96RSB2           |
| U18         | TRST               | W16         | IO92RSB2           |
| U19         | GDA0/IO88NPB1      | W17         | GDB2/IO90RSB2      |
| V1          | IO147NDB3          | W18         | TCK                |
| V2          | V <sub>CC</sub> B3 | W19         | GND                |
| V3          | GEC2/IO141RSB2     |             |                    |
| V4          | IO140RSB2          |             |                    |
| V5          | IO135RSB2          |             |                    |
| V6          | GND                |             |                    |
| V7          | IO125RSB2          |             |                    |
| V8          | IO122RSB2          |             |                    |
| V9          | IO116RSB2          |             |                    |

| 281-Pin CSP |                    | 281-Pin CSP |                    | 281-Pin CSP |                    |
|-------------|--------------------|-------------|--------------------|-------------|--------------------|
| Pin Number  | AGL1000 Function   | Pin Number  | AGL1000 Function   | Pin Number  | AGL1000 Function   |
| A1          | GND                | B18         | V <sub>CC</sub> B1 | E13         | IO53RSB0           |
| A2          | GAB0/IO02RSB0      | B19         | IO79NDB1           | E14         | GBB1/IO75RSB0      |
| A3          | GAC1/IO05RSB0      | C1          | GAB2/IO224PPB3     | E15         | IO80NPB1           |
| A4          | IO13RSB0           | C2          | IO225NPB3          | E16         | IO85PPB1           |
| A5          | IO11RSB0           | C6          | IO18RSB0           | E18         | IO83PPB1           |
| A6          | IO16RSB0           | C14         | IO63RSB0           | E19         | IO84NPB1           |
| A7          | IO20RSB0           | C18         | IO78NPB1           | F1          | IO214NPB3          |
| A8          | IO24RSB0           | C19         | GBB2/IO79PDB1      | F2          | GND                |
| A9          | IO29RSB0           | D1          | IO219PPB3          | F3          | IO217PPB3          |
| A10         | V <sub>CC</sub> B0 | D2          | IO223NPB3          | F4          | IO219NPB3          |
| A11         | IO39RSB0           | D4          | GAA0/IO00RSB0      | F5          | IO224NPB3          |
| A12         | IO45RSB0           | D5          | GAA1/IO01RSB0      | F15         | IO85NPB1           |
| A13         | IO48RSB0           | D6          | IO15RSB0           | F16         | IO84PPB1           |
| A14         | IO58RSB0           | D7          | IO19RSB0           | F17         | IO83NPB1           |
| A15         | IO61RSB0           | D8          | IO27RSB0           | F18         | GND                |
| A16         | IO62RSB0           | D9          | IO32RSB0           | F19         | IO90PPB1           |
| A17         | GBC1/IO73RSB0      | D10         | GND                | G1          | IO212NPB3          |
| A18         | GBA0/IO76RSB0      | D11         | IO38RSB0           | G2          | IO211NDB3          |
| A19         | GND                | D12         | IO44RSB0           | G4          | IO214PPB3          |
| B1          | GAA2/IO225PPB3     | D13         | IO47RSB0           | G5          | IO212PPB3          |
| B2          | V <sub>CC</sub> B0 | D14         | IO60RSB0           | G7          | GAC2/IO223PPB3     |
| B3          | GAB1/IO03RSB0      | D15         | GBB0/IO74RSB0      | G8          | V <sub>CC</sub> B0 |
| B4          | GAC0/IO04RSB0      | D16         | GBA2/IO78PPB1      | G9          | IO30RSB0           |
| B5          | IO12RSB0           | D18         | GBC2/IO80PPB1      | G10         | IO37RSB0           |
| B6          | GND                | D19         | IO88NPB1           | G11         | IO43RSB0           |
| B7          | IO21RSB0           | E1          | IO217NPB3          | G12         | V <sub>CC</sub> B0 |
| B8          | IO26RSB0           | E2          | IO221PPB3          | G13         | IO88PPB1           |
| B9          | IO34RSB0           | E4          | IO221NPB3          | G15         | IO89NDB1           |
| B10         | IO35RSB0           | E5          | IO10RSB0           | G16         | IO89PDB1           |
| B11         | IO36RSB0           | E6          | IO14RSB0           | G18         | GCC0/IO91NPB1      |
| B12         | IO46RSB0           | E7          | IO25RSB0           | G19         | GCB1/IO92PPB1      |
| B13         | IO52RSB0           | E8          | IO28RSB0           | H1          | GFB0/IO208NPB3     |
| B14         | GND                | E9          | IO31RSB0           | H2          | IO211PDB3          |
| B15         | IO59RSB0           | E10         | IO33RSB0           | H4          | GFC1/IO209PPB3     |
| B16         | GBC0/IO72RSB0      | E11         | IO42RSB0           | H5          | GFB1/IO208PPB3     |
| B17         | GBA1/IO77RSB0      | E12         | IO49RSB0           | H7          | V <sub>CC</sub> B3 |

| 281-Pin CSP |                     | 281-Pin CSP |                    | 281-Pin CSP |                    |
|-------------|---------------------|-------------|--------------------|-------------|--------------------|
| Pin Number  | AGL1000 Function    | Pin Number  | AGL1000 Function   | Pin Number  | AGL1000 Function   |
| H8          | V <sub>CC</sub>     | K15         | IO95NPB1           | N4          | IO196PPB3          |
| H9          | V <sub>CC</sub> B0  | K16         | GND                | N5          | IO197NPB3          |
| H10         | V <sub>CC</sub>     | K18         | IO96NPB1           | N7          | GEA2/IO187RSB2     |
| H11         | V <sub>CC</sub> B0  | K19         | V <sub>CC</sub> B1 | N8          | V <sub>CC</sub> B2 |
| H12         | V <sub>CC</sub>     | L1          | GFB2/IO205PDB3     | N9          | IO155RSB2          |
| H13         | V <sub>CC</sub> B1  | L2          | IO205NDB3          | N10         | IO154RSB2          |
| H15         | IO90NPB1            | L4          | GFC2/IO204PPB3     | N11         | IO150RSB2          |
| H16         | GCB0/IO92NPB1       | L5          | IO203PPB3          | N12         | V <sub>CC</sub> B2 |
| H18         | GCA1/IO93PPB1       | L7          | IO203NPB3          | N13         | V <sub>PUMP</sub>  |
| H19         | GCA2/IO94PPB1       | L8          | V <sub>CC</sub> B3 | N15         | IO107PPB1          |
| J1          | V <sub>COMPLF</sub> | L9          | GND                | N16         | IO105PPB1          |
| J2          | GFA0/IO207NDB3      | L10         | GND                | N18         | IO107NPB1          |
| J4          | V <sub>CC</sub> PLF | L11         | GND                | N19         | IO100PPB1          |
| J5          | GFC0/IO209NPB3      | L12         | V <sub>CC</sub> B1 | P1          | IO195PDB3          |
| J7          | GFA2/IO206PDB3      | L13         | IO103PPB1          | P2          | GND                |
| J8          | V <sub>CC</sub> B3  | L15         | IO103NPB1          | P3          | IO195NDB3          |
| J9          | GND                 | L16         | IO97PPB1           | P4          | IO194PPB3          |
| J10         | GND                 | L18         | IO98NPB1           | P5          | GEA0/IO188NPB3     |
| J11         | GND                 | L19         | IO97NPB1           | P15         | IO108NDB1          |
| J12         | V <sub>CC</sub> B1  | M1          | IO202PDB3          | P16         | IO108PDB1          |
| J13         | GCC1/IO91PPB1       | M2          | IO202NDB3          | P17         | GDC1/IO111PPB1     |
| J15         | GCA0/IO93NPB1       | M4          | IO201NPB3          | P18         | GND                |
| J16         | GCB2/IO95PPB1       | M5          | IO198PPB3          | P19         | IO105NPB1          |
| J18         | IO94NPB1            | M7          | V <sub>CC</sub> B3 | R1          | IO196NPB3          |
| J19         | IO102PSB1           | M8          | V <sub>CC</sub>    | R2          | IO194NPB3          |
| K1          | V <sub>CC</sub> B3  | M9          | V <sub>CC</sub> B2 | R4          | GEC1/IO190PPB3     |
| K2          | GFA1/IO207PDB3      | M10         | V <sub>CC</sub>    | R5          | GEB1/IO189PPB3     |
| K4          | GND                 | M11         | V <sub>CC</sub> B2 | R6          | IO184RSB2          |
| K5          | IO204NPB3           | M12         | V <sub>CC</sub>    | R7          | IO173RSB2          |
| K7          | IO206NDB3           | M13         | V <sub>CC</sub> B1 | R8          | IO168RSB2          |
| K8          | V <sub>CC</sub>     | M15         | IO104NPB1          | R9          | IO160RSB2          |
| K9          | GND                 | M16         | IO100NPB1          | R10         | IO151RSB2          |
| K10         | GND                 | M18         | IO104PPB1          | R11         | IO141RSB2          |
| K11         | GND                 | M19         | IO98PPB1           | R12         | IO136RSB2          |
| K12         | V <sub>CC</sub>     | N1          | IO201PPB3          | R13         | IO127RSB2          |
| K13         | GCC2/IO96PPB1       | N2          | IO198NPB3          | R14         | IO124RSB2          |

| 281-Pin CSP |                      | 281-Pin CSP |                      |
|-------------|----------------------|-------------|----------------------|
| Pin Number  | AGL1000 Function     | Pin Number  | AGL1000 Function     |
| R15         | IO122RSB2            | V10         | IO145RSB2            |
| R16         | GDA1/IO113PPB1       | V11         | IO144RSB2            |
| R18         | GDB0/IO112NPB1       | V12         | IO134RSB2            |
| R19         | GDC0/IO111NPB1       | V13         | IO133RSB2            |
| T1          | IO197PPB3            | V14         | GND                  |
| T2          | GEC0/IO190NPB3       | V15         | IO119RSB2            |
| T4          | GEB0/IO189NPB3       | V16         | GDA2/IO114RSB2       |
| T5          | IO181RSB2            | V17         | TDI                  |
| T6          | IO172RSB2            | V18         | V <sub>CC</sub> I B2 |
| T7          | IO171RSB2            | V19         | TDO                  |
| T8          | IO156RSB2            | W1          | GND                  |
| T9          | IO159RSB2            | W2          | FF/GEB2/IO186RSB2    |
| T10         | GND                  | W3          | IO183RSB2            |
| T11         | IO139RSB2            | W4          | IO176RSB2            |
| T12         | IO138RSB2            | W5          | IO170RSB2            |
| T13         | IO129RSB2            | W6          | IO162RSB2            |
| T14         | IO123RSB2            | W7          | IO157RSB2            |
| T15         | GDC2/IO116RSB2       | W8          | IO152RSB2            |
| T16         | TMS                  | W9          | IO149RSB2            |
| T18         | V <sub>JTAG</sub>    | W10         | V <sub>CC</sub> I B2 |
| T19         | GDB1/IO112PPB1       | W11         | IO140RSB2            |
| U1          | IO193PDB3            | W12         | IO135RSB2            |
| U2          | GEA1/IO188PPB3       | W13         | IO130RSB2            |
| U6          | IO167RSB2            | W14         | IO125RSB2            |
| U14         | IO128RSB2            | W15         | IO120RSB2            |
| U18         | TRST                 | W16         | IO118RSB2            |
| U19         | GDA0/IO113NPB1       | W17         | GDB2/IO115RSB2       |
| V1          | IO193NDB3            | W18         | TCK                  |
| V2          | V <sub>CC</sub> I B3 | W19         | GND                  |
| V3          | GEC2/IO185RSB2       |             |                      |
| V4          | IO182RSB2            |             |                      |
| V5          | IO175RSB2            |             |                      |
| V6          | GND                  |             |                      |
| V7          | IO161RSB2            |             |                      |
| V8          | IO143RSB2            |             |                      |
| V9          | IO146RSB2            |             |                      |

## 48-Pin QFN



### Notes:

1. This is the bottom view of the package.
2. The die attach paddle center of the package is tied to ground (GND).

### Note

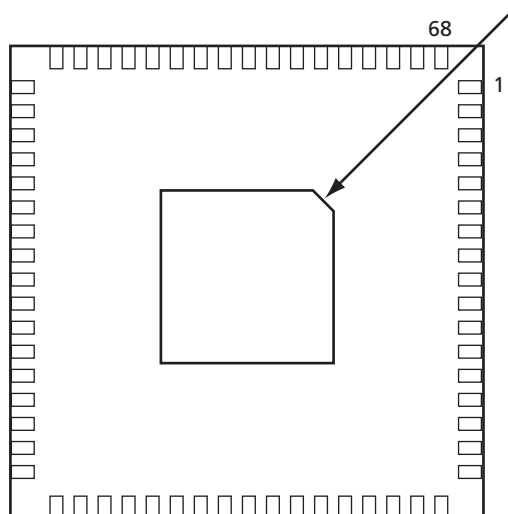
For Package Manufacturing and Environmental information, visit the Resource Center at <http://www.actel.com/products/solutions/package/docs.aspx>.

| 48-Pin QFP |                    |
|------------|--------------------|
| Pin Number | AGL030 Function    |
| 1          | IO82RSB1           |
| 2          | GEC0/IO73RSB1      |
| 3          | GEA0/IO72RSB1      |
| 4          | GEB0/IO71RSB1      |
| 5          | GND                |
| 6          | V <sub>CC</sub> B1 |
| 7          | IO68RSB1           |
| 8          | IO67RSB1           |
| 9          | IO66RSB1           |
| 10         | IO65RSB1           |
| 11         | IO64RSB1           |
| 12         | IO62RSB1           |
| 13         | IO61RSB1           |
| 14         | FF/IO60RSB1        |
| 15         | IO57RSB1           |
| 16         | IO55RSB1           |
| 17         | IO53RSB1           |
| 18         | V <sub>CC</sub>    |
| 19         | V <sub>CC</sub> B1 |
| 20         | IO46RSB1           |
| 21         | IO42RSB1           |
| 22         | TCK                |
| 23         | TDI                |
| 24         | TMS                |
| 25         | V <sub>PUMP</sub>  |
| 26         | TDO                |
| 27         | TRST               |
| 28         | V <sub>JTAG</sub>  |
| 29         | IO38RSB0           |
| 30         | GDB0/IO34RSB0      |
| 31         | GDA0/IO33RSB0      |
| 32         | GDC0/IO32RSB0      |
| 33         | V <sub>CC</sub> B0 |
| 34         | GND                |
| 35         | V <sub>CC</sub>    |
| 36         | IO25RSB0           |

| 48-Pin QFP |                 |
|------------|-----------------|
| Pin Number | AGL030 Function |
| 37         | IO24RSB0        |
| 38         | IO22RSB0        |
| 39         | IO20RSB0        |
| 40         | IO18RSB0        |
| 41         | IO16RSB0        |
| 42         | IO14RSB0        |
| 43         | IO10RSB0        |
| 44         | IO08RSB0        |
| 45         | IO06RSB0        |
| 46         | IO04RSB0        |
| 47         | IO02RSB0        |
| 48         | IO00RSB0        |



## 68-Pin QFN



### Notes:

1. This is the bottom view of the package.
2. The die attach paddle center of the package is tied to ground (GND).

### Note

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

| 68-Pin QFN |                    |
|------------|--------------------|
| Pin Number | AGL015 Function    |
| 1          | IO82RSB1           |
| 2          | IO80RSB1           |
| 3          | IO78RSB1           |
| 4          | IO76RSB1           |
| 5          | GEC0/IO73RSB1      |
| 6          | GEA0/IO72RSB1      |
| 7          | GEB0/IO71RSB1      |
| 8          | V <sub>CC</sub>    |
| 9          | GND                |
| 10         | V <sub>CC</sub> B1 |
| 11         | IO68RSB1           |
| 12         | IO67RSB1           |
| 13         | IO66RSB1           |
| 14         | IO65RSB1           |
| 15         | IO64RSB1           |
| 16         | IO63RSB1           |
| 17         | IO62RSB1           |
| 18         | FF/IO60RSB1        |
| 19         | IO58RSB1           |
| 20         | IO56RSB1           |
| 21         | IO54RSB1           |
| 22         | IO52RSB1           |
| 23         | IO51RSB1           |
| 24         | V <sub>CC</sub>    |
| 25         | GND                |
| 26         | V <sub>CC</sub> B1 |
| 27         | IO50RSB1           |
| 28         | IO48RSB1           |
| 29         | IO46RSB1           |
| 30         | IO44RSB1           |
| 31         | IO42RSB1           |
| 32         | TCK                |
| 33         | TDI                |
| 34         | TMS                |
| 35         | V <sub>PUMP</sub>  |
| 36         | TDO                |

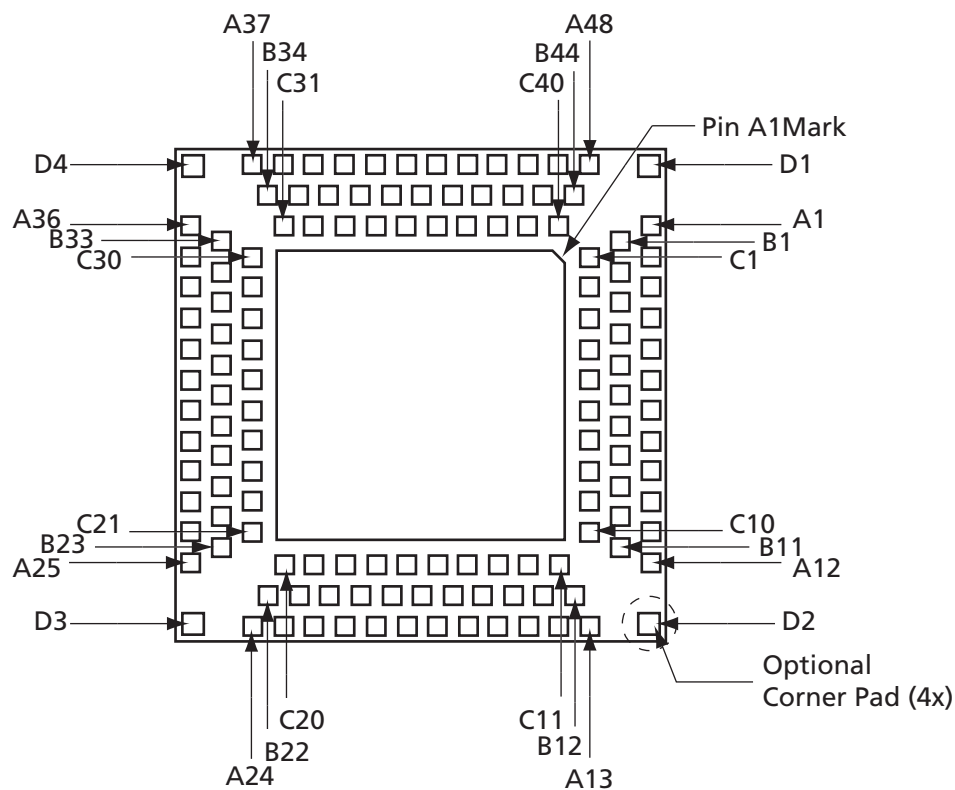
| 68-Pin QFN |                    |
|------------|--------------------|
| Pin Number | AGL015 Function    |
| 37         | TRST               |
| 38         | V <sub>JTAG</sub>  |
| 39         | IO40RSB0           |
| 40         | IO37RSB0           |
| 41         | GDB0/IO34RSB0      |
| 42         | GDA0/IO33RSB0      |
| 43         | GDC0/IO32RSB0      |
| 44         | V <sub>CC</sub> B0 |
| 45         | GND                |
| 46         | V <sub>CC</sub>    |
| 47         | IO31RSB0           |
| 48         | IO29RSB0           |
| 49         | IO28RSB0           |
| 50         | IO27RSB0           |
| 51         | IO25RSB0           |
| 52         | IO24RSB0           |
| 53         | IO22RSB0           |
| 54         | IO21RSB0           |
| 55         | IO19RSB0           |
| 56         | IO17RSB0           |
| 57         | IO15RSB0           |
| 58         | IO14RSB0           |
| 59         | V <sub>CC</sub> B0 |
| 60         | GND                |
| 61         | V <sub>CC</sub>    |
| 62         | IO12RSB0           |
| 63         | IO10RSB0           |
| 64         | IO08RSB0           |
| 65         | IO06RSB0           |
| 66         | IO04RSB0           |
| 67         | IO02RSB0           |
| 68         | IO00RSB0           |

| 68-Pin QFN |                     | 68-Pin QFN |                     |
|------------|---------------------|------------|---------------------|
| Pin Number | AGL015 Function     | Pin Number | AGL015 Function     |
| 1          | IO82RSB1            | 37         | TRST                |
| 2          | IO80RSB1            | 38         | V <sub>JTAG</sub>   |
| 3          | IO78RSB1            | 39         | IO40RSB0            |
| 4          | IO76RSB1            | 40         | IO37RSB0            |
| 5          | GEC0/IO73RSB1       | 41         | GDB0/IO34RSB0       |
| 6          | GEA0/IO72RSB1       | 42         | GDA0/IO33RSB0       |
| 7          | GEB0/IO71RSB1       | 43         | GDC0/IO32RSB0       |
| 8          | V <sub>CC</sub>     | 44         | V <sub>CCI</sub> B0 |
| 9          | GND                 | 45         | GND                 |
| 10         | V <sub>CCI</sub> B1 | 46         | V <sub>CC</sub>     |
| 11         | IO68RSB1            | 47         | IO31RSB0            |
| 12         | IO67RSB1            | 48         | IO29RSB0            |
| 13         | IO66RSB1            | 49         | IO28RSB0            |
| 14         | IO65RSB1            | 50         | IO27RSB0            |
| 15         | IO64RSB1            | 51         | IO25RSB0            |
| 16         | IO63RSB1            | 52         | IO24RSB0            |
| 17         | IO62RSB1            | 53         | IO22RSB0            |
| 18         | FF/IO60RSB1         | 54         | IO21RSB0            |
| 19         | IO58RSB1            | 55         | IO19RSB0            |
| 20         | IO56RSB1            | 56         | IO17RSB0            |
| 21         | IO54RSB1            | 57         | IO15RSB0            |
| 22         | IO52RSB1            | 58         | IO14RSB0            |
| 23         | IO51RSB1            | 59         | V <sub>CCI</sub> B0 |
| 24         | V <sub>CC</sub>     | 60         | GND                 |
| 25         | GND                 | 61         | V <sub>CC</sub>     |
| 26         | V <sub>CCI</sub> B1 | 62         | IO12RSB0            |
| 27         | IO50RSB1            | 63         | IO10RSB0            |
| 28         | IO48RSB1            | 64         | IO08RSB0            |
| 29         | IO46RSB1            | 65         | IO06RSB0            |
| 30         | IO44RSB1            | 66         | IO04RSB0            |
| 31         | IO42RSB1            | 67         | IO02RSB0            |
| 32         | TCK                 | 68         | IO00RSB0            |
| 33         | TDI                 |            |                     |
| 34         | TMS                 |            |                     |
| 35         | V <sub>PUMP</sub>   |            |                     |
| 36         | TDO                 |            |                     |

| 68-Pin QFN |                    |
|------------|--------------------|
| Pin Number | AGL030 Function    |
| 1          | IO82RSB1           |
| 2          | IO80RSB1           |
| 3          | IO78RSB1           |
| 4          | IO76RSB1           |
| 5          | GEC0/IO73RSB1      |
| 6          | GEA0/IO72RSB1      |
| 7          | GEB0/IO71RSB1      |
| 8          | V <sub>CC</sub>    |
| 9          | GND                |
| 10         | V <sub>CC</sub> B1 |
| 11         | IO68RSB1           |
| 12         | IO67RSB1           |
| 13         | IO66RSB1           |
| 14         | IO65RSB1           |
| 15         | IO64RSB1           |
| 16         | IO63RSB1           |
| 17         | IO62RSB1           |
| 18         | FF/IO60RSB1        |
| 19         | IO58RSB1           |
| 20         | IO56RSB1           |
| 21         | IO54RSB1           |
| 22         | IO52RSB1           |
| 23         | IO51RSB1           |
| 24         | V <sub>CC</sub>    |
| 25         | GND                |
| 26         | V <sub>CC</sub> B1 |
| 27         | IO50RSB1           |
| 28         | IO48RSB1           |
| 29         | IO46RSB1           |
| 30         | IO44RSB1           |
| 31         | IO42RSB1           |
| 32         | TCK                |
| 33         | TDI                |
| 34         | TMS                |
| 35         | V <sub>PUMP</sub>  |
| 36         | TDO                |

| 68-Pin QFN |                    |
|------------|--------------------|
| Pin Number | AGL030 Function    |
| 37         | TRST               |
| 38         | V <sub>JTAG</sub>  |
| 39         | IO40RSB0           |
| 40         | IO37RSB0           |
| 41         | GDB0/IO34RSB0      |
| 42         | GDA0/IO33RSB0      |
| 43         | GDC0/IO32RSB0      |
| 44         | V <sub>CC</sub> B0 |
| 45         | GND                |
| 46         | V <sub>CC</sub>    |
| 47         | IO31RSB0           |
| 48         | IO29RSB0           |
| 49         | IO28RSB0           |
| 50         | IO27RSB0           |
| 51         | IO25RSB0           |
| 52         | IO24RSB0           |
| 53         | IO22RSB0           |
| 54         | IO21RSB0           |
| 55         | IO19RSB0           |
| 56         | IO17RSB0           |
| 57         | IO15RSB0           |
| 58         | IO14RSB0           |
| 59         | V <sub>CC</sub> B0 |
| 60         | GND                |
| 61         | V <sub>CC</sub>    |
| 62         | IO12RSB0           |
| 63         | IO10RSB0           |
| 64         | IO08RSB0           |
| 65         | IO06RSB0           |
| 66         | IO04RSB0           |
| 67         | IO02RSB0           |
| 68         | IO00RSB0           |

## 132-Pin QFN



### Notes:

1. This is the bottom view of the package.
2. The die attach paddle center of the package is tied to ground (GND).

### Note

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

| 132-Pin QFN |                 | 132-Pin QFN |                 | 132-Pin QFN |                    |
|-------------|-----------------|-------------|-----------------|-------------|--------------------|
| Pin Number  | AGL030 Function | Pin Number  | AGL030 Function | Pin Number  | AGL030 Function    |
| A1          | IO80RSB1        | A37         | IO22RSB0        | B25         | GND                |
| A2          | IO77RSB1        | A38         | IO19RSB0        | B26         | NC                 |
| A3          | NC              | A39         | NC              | B27         | IO37RSB0           |
| A4          | IO76RSB1        | A40         | IO18RSB0        | B28         | GND                |
| A5          | GEC0/IO73RSB1   | A41         | IO16RSB0        | B29         | GDA0/IO33RSB0      |
| A6          | NC              | A42         | IO14RSB0        | B30         | NC                 |
| A7          | GEB0/IO71RSB1   | A43         | V <sub>CC</sub> | B31         | GND                |
| A8          | IO69RSB1        | A44         | IO11RSB0        | B32         | IO29RSB0           |
| A9          | NC              | A45         | IO08RSB0        | B33         | IO26RSB0           |
| A10         | V <sub>CC</sub> | A46         | IO06RSB0        | B34         | IO23RSB0           |
| A11         | IO67RSB1        | A47         | IO05RSB0        | B35         | IO20RSB0           |
| A12         | IO64RSB1        | A48         | IO02RSB0        | B36         | GND                |
| A13         | IO59RSB1        | B1          | IO81RSB1        | B37         | IO17RSB0           |
| A14         | IO56RSB1        | B2          | IO78RSB1        | B38         | IO15RSB0           |
| A15         | NC              | B3          | GND             | B39         | GND                |
| A16         | IO55RSB1        | B4          | IO75RSB1        | B40         | IO12RSB0           |
| A17         | IO53RSB1        | B5          | NC              | B41         | IO09RSB0           |
| A18         | V <sub>CC</sub> | B6          | GND             | B42         | GND                |
| A19         | IO50RSB1        | B7          | IO70RSB1        | B43         | IO04RSB0           |
| A20         | IO48RSB1        | B8          | NC              | B44         | IO01RSB0           |
| A21         | IO45RSB1        | B9          | GND             | C1          | IO82RSB1           |
| A22         | IO44RSB1        | B10         | IO66RSB1        | C2          | IO79RSB1           |
| A23         | IO43RSB1        | B11         | IO63RSB1        | C3          | NC                 |
| A24         | TDI             | B12         | FF/IO60RSB1     | C4          | IO74RSB1           |
| A25         | TRST            | B13         | IO57RSB1        | C5          | GEA0/IO72RSB1      |
| A26         | IO40RSB0        | B14         | GND             | C6          | NC                 |
| A27         | NC              | B15         | IO54RSB1        | C7          | NC                 |
| A28         | IO39RSB0        | B16         | IO52RSB1        | C8          | V <sub>CC</sub> B1 |
| A29         | IO38RSB0        | B17         | GND             | C9          | IO65RSB1           |
| A30         | IO36RSB0        | B18         | IO49RSB1        | C10         | IO62RSB1           |
| A31         | IO35RSB0        | B19         | IO46RSB1        | C11         | IO61RSB1           |
| A32         | GDC0/IO32RSB0   | B20         | GND             | C12         | IO58RSB1           |
| A33         | NC              | B21         | IO42RSB1        | C13         | NC                 |
| A34         | V <sub>CC</sub> | B22         | TMS             | C14         | NC                 |
| A35         | IO30RSB0        | B23         | TDO             | C15         | IO51RSB1           |
| A36         | IO27RSB0        | B24         | IO41RSB0        | C16         | V <sub>CC</sub> B1 |

| 132-Pin QFN |                     |
|-------------|---------------------|
| Pin Number  | AGL030 Function     |
| C17         | IO47RSB1            |
| C18         | NC                  |
| C19         | TCK                 |
| C20         | NC                  |
| C21         | V <sub>PUMP</sub>   |
| C22         | V <sub>JTAG</sub>   |
| C23         | NC                  |
| C24         | NC                  |
| C25         | NC                  |
| C26         | GDB0/IO34RSB0       |
| C27         | NC                  |
| C28         | V <sub>CC1</sub> B0 |
| C29         | IO28RSB0            |
| C30         | IO25RSB0            |
| C31         | IO24RSB0            |
| C32         | IO21RSB0            |
| C33         | NC                  |
| C34         | NC                  |
| C35         | V <sub>CC1</sub> B0 |
| C36         | IO13RSB0            |
| C37         | IO10RSB0            |
| C38         | IO07RSB0            |
| C39         | IO03RSB0            |
| C40         | IO00RSB0            |
| D1          | GND                 |
| D2          | GND                 |
| D3          | GND                 |
| D4          | GND                 |

| 132-Pin QFN |                                 | 132-Pin QFN |                                 | 132-Pin QFN |                                 |
|-------------|---------------------------------|-------------|---------------------------------|-------------|---------------------------------|
| Pin Number  | AGL060 Function                 | Pin Number  | AGL060 Function                 | Pin Number  | AGL060 Function                 |
| A1          | GAB2/IO00RSB1                   | A37         | GBB1/IO25RSB0                   | B25         | GND                             |
| A2          | IO93RSB1                        | A38         | GBC0/IO22RSB0                   | B26         | NC                              |
| A3          | V <sub>CC</sub> I <sub>B1</sub> | A39         | V <sub>CC</sub> I <sub>B0</sub> | B27         | GCB2/IO45RSB0                   |
| A4          | GFC1/IO89RSB1                   | A40         | IO21RSB0                        | B28         | GND                             |
| A5          | GFB0/IO86RSB1                   | A41         | IO18RSB0                        | B29         | GCB0/IO41RSB0                   |
| A6          | V <sub>CC</sub> PLF             | A42         | IO15RSB0                        | B30         | GCC1/IO38RSB0                   |
| A7          | GFA1/IO84RSB1                   | A43         | IO14RSB0                        | B31         | GND                             |
| A8          | GFC2/IO81RSB1                   | A44         | IO11RSB0                        | B32         | GBB2/IO30RSB0                   |
| A9          | IO78RSB1                        | A45         | GAB1/IO08RSB0                   | B33         | VMV0                            |
| A10         | V <sub>CC</sub>                 | A46         | NC                              | B34         | GBA0/IO26RSB0                   |
| A11         | GEB1/IO75RSB1                   | A47         | GAB0/IO07RSB0                   | B35         | GBC1/IO23RSB0                   |
| A12         | GEO0/IO72RSB1                   | A48         | IO04RSB0                        | B36         | GND                             |
| A13         | GEC2/IO69RSB1                   | B1          | IO01RSB1                        | B37         | IO20RSB0                        |
| A14         | IO65RSB1                        | B2          | GAC2/IO94RSB1                   | B38         | IO17RSB0                        |
| A15         | V <sub>CC</sub>                 | B3          | GND                             | B39         | GND                             |
| A16         | IO64RSB1                        | B4          | GFC0/IO88RSB1                   | B40         | IO12RSB0                        |
| A17         | IO63RSB1                        | B5          | V <sub>CC</sub> OMPLF           | B41         | GAC0/IO09RSB0                   |
| A18         | IO62RSB1                        | B6          | GND                             | B42         | GND                             |
| A19         | IO61RSB1                        | B7          | GFB2/IO82RSB1                   | B43         | GAA1/IO06RSB0                   |
| A20         | IO58RSB1                        | B8          | IO79RSB1                        | B44         | GNDQ                            |
| A21         | GDB2/IO55RSB1                   | B9          | GND                             | C1          | GAA2/IO02RSB1                   |
| A22         | NC                              | B10         | GEB0/IO74RSB1                   | C2          | IO95RSB1                        |
| A23         | GDA2/IO54RSB1                   | B11         | VMV1                            | C3          | V <sub>CC</sub>                 |
| A24         | TDI                             | B12         | FF/GEB2/IO70RSB1                | C4          | GFB1/IO87RSB1                   |
| A25         | TRST                            | B13         | IO67RSB1                        | C5          | GFA0/IO85RSB1                   |
| A26         | GDC1/IO48RSB0                   | B14         | GND                             | C6          | GFA2/IO83RSB1                   |
| A27         | V <sub>CC</sub>                 | B15         | NC                              | C7          | IO80RSB1                        |
| A28         | IO47RSB0                        | B16         | NC                              | C8          | V <sub>CC</sub> I <sub>B1</sub> |
| A29         | GCC2/IO46RSB0                   | B17         | GND                             | C9          | GEO1/IO73RSB1                   |
| A30         | GCA2/IO44RSB0                   | B18         | IO59RSB1                        | C10         | GNDQ                            |
| A31         | GCA0/IO43RSB0                   | B19         | GDC2/IO56RSB1                   | C11         | GEO2/IO71RSB1                   |
| A32         | GCB1/IO40RSB0                   | B20         | GND                             | C12         | IO68RSB1                        |
| A33         | IO36RSB0                        | B21         | GNDQ                            | C13         | V <sub>CC</sub> I <sub>B1</sub> |
| A34         | V <sub>CC</sub>                 | B22         | TMS                             | C14         | NC                              |
| A35         | IO31RSB0                        | B23         | TDO                             | C15         | NC                              |
| A36         | GBA2/IO28RSB0                   | B24         | GDC0/IO49RSB0                   | C16         | IO60RSB1                        |

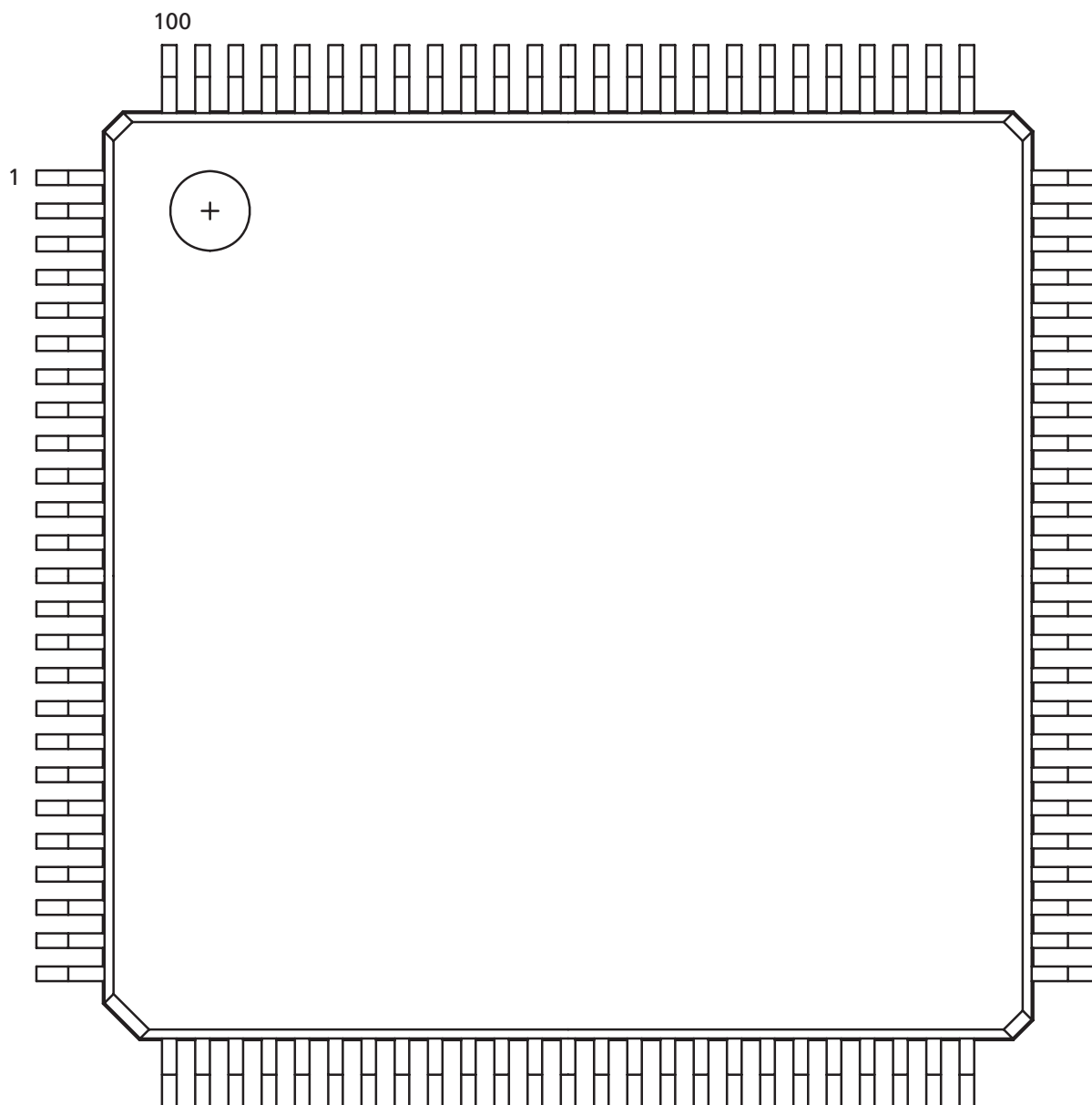


| 132-Pin QFN |                     |
|-------------|---------------------|
| Pin Number  | AGL060 Function     |
| C17         | IO57RSB1            |
| C18         | NC                  |
| C19         | TCK                 |
| C20         | VMV1                |
| C21         | V <sub>PUMP</sub>   |
| C22         | V <sub>JTAG</sub>   |
| C23         | V <sub>CC1</sub> B0 |
| C24         | NC                  |
| C25         | NC                  |
| C26         | GCA1/IO42RSB0       |
| C27         | GCC0/IO39RSB0       |
| C28         | V <sub>CC1</sub> B0 |
| C29         | IO29RSB0            |
| C30         | GNDQ                |
| C31         | GBA1/IO27RSB0       |
| C32         | GBB0/IO24RSB0       |
| C33         | V <sub>CC</sub>     |
| C34         | IO19RSB0            |
| C35         | IO16RSB0            |
| C36         | IO13RSB0            |
| C37         | GAC1/IO10RSB0       |
| C38         | NC                  |
| C39         | GAA0/IO05RSB0       |
| C40         | VMV0                |
| D1          | GND                 |
| D2          | GND                 |
| D3          | GND                 |
| D4          | GND                 |

| 132-Pin QFN |                     | 132-Pin QFN |                     | 132-Pin QFN |                     |
|-------------|---------------------|-------------|---------------------|-------------|---------------------|
| Pin Number  | AGL125 Function     | Pin Number  | AGL125 Function     | Pin Number  | AGL125 Function     |
| A1          | GAB2/IO69RSB1       | A37         | GBB1/IO38RSB0       | B25         | GND                 |
| A2          | IO130RSB1           | A38         | GBC0/IO35RSB0       | B26         | NC                  |
| A3          | V <sub>CCI</sub> B1 | A39         | V <sub>CCI</sub> B0 | B27         | GCB2/IO58RSB0       |
| A4          | GFC1/IO126RSB1      | A40         | IO28RSB0            | B28         | GND                 |
| A5          | GFB0/IO123RSB1      | A41         | IO22RSB0            | B29         | GCB0/IO54RSB0       |
| A6          | V <sub>CCPLF</sub>  | A42         | IO18RSB0            | B30         | GCC1/IO51RSB0       |
| A7          | GFA1/IO121RSB1      | A43         | IO14RSB0            | B31         | GND                 |
| A8          | GFC2/IO118RSB1      | A44         | IO11RSB0            | B32         | GBB2/IO43RSB0       |
| A9          | IO115RSB1           | A45         | IO07RSB0            | B33         | VMV0                |
| A10         | V <sub>CC</sub>     | A46         | V <sub>CC</sub>     | B34         | GBA0/IO39RSB0       |
| A11         | GEB1/IO110RSB1      | A47         | GAC1/IO05RSB0       | B35         | GBC1/IO36RSB0       |
| A12         | GEA0/IO107RSB1      | A48         | GAB0/IO02RSB0       | B36         | GND                 |
| A13         | GEC2/IO104RSB1      | B1          | IO68RSB1            | B37         | IO26RSB0            |
| A14         | IO100RSB1           | B2          | GAC2/IO131RSB1      | B38         | IO21RSB0            |
| A15         | V <sub>CC</sub>     | B3          | GND                 | B39         | GND                 |
| A16         | IO99RSB1            | B4          | GFC0/IO125RSB1      | B40         | IO13RSB0            |
| A17         | IO96RSB1            | B5          | V <sub>COMPLF</sub> | B41         | IO08RSB0            |
| A18         | IO94RSB1            | B6          | GND                 | B42         | GND                 |
| A19         | IO91RSB1            | B7          | GFB2/IO119RSB1      | B43         | GAC0/IO04RSB0       |
| A20         | IO85RSB1            | B8          | IO116RSB1           | B44         | GNDQ                |
| A21         | IO79RSB1            | B9          | GND                 | C1          | GAA2/IO67RSB1       |
| A22         | V <sub>CC</sub>     | B10         | GEB0/IO109RSB1      | C2          | IO132RSB1           |
| A23         | GDB2/IO71RSB1       | B11         | VMV1                | C3          | V <sub>CC</sub>     |
| A24         | TDI                 | B12         | FF/GEB2/IO105RSB1   | C4          | GFB1/IO124RSB1      |
| A25         | TRST                | B13         | IO101RSB1           | C5          | GFA0/IO122RSB1      |
| A26         | GDC1/IO61RSB0       | B14         | GND                 | C6          | GFA2/IO120RSB1      |
| A27         | V <sub>CC</sub>     | B15         | IO98RSB1            | C7          | IO117RSB1           |
| A28         | IO60RSB0            | B16         | IO95RSB1            | C8          | V <sub>CCI</sub> B1 |
| A29         | GCC2/IO59RSB0       | B17         | GND                 | C9          | GEA1/IO108RSB1      |
| A30         | GCA2/IO57RSB0       | B18         | IO87RSB1            | C10         | GNDQ                |
| A31         | GCA0/IO56RSB0       | B19         | IO81RSB1            | C11         | GEA2/IO106RSB1      |
| A32         | GCB1/IO53RSB0       | B20         | GND                 | C12         | IO103RSB1           |
| A33         | IO49RSB0            | B21         | GNDQ                | C13         | V <sub>CCI</sub> B1 |
| A34         | V <sub>CC</sub>     | B22         | TMS                 | C14         | IO97RSB1            |
| A35         | IO44RSB0            | B23         | TDO                 | C15         | IO93RSB1            |
| A36         | GBA2/IO41RSB0       | B24         | GDC0/IO62RSB0       | C16         | IO89RSB1            |

| 132-Pin QFN |                     |
|-------------|---------------------|
| Pin Number  | AGL125 Function     |
| C17         | IO83RSB1            |
| C18         | V <sub>CCI</sub> B1 |
| C19         | TCK                 |
| C20         | VMV1                |
| C21         | V <sub>PUMP</sub>   |
| C22         | V <sub>JTAG</sub>   |
| C23         | V <sub>CCI</sub> B0 |
| C24         | NC                  |
| C25         | NC                  |
| C26         | GCA1/IO55RSB0       |
| C27         | GCC0/IO52RSB0       |
| C28         | V <sub>CCI</sub> B0 |
| C29         | IO42RSB0            |
| C30         | GNDQ                |
| C31         | GBA1/IO40RSB0       |
| C32         | GBB0/IO37RSB0       |
| C33         | V <sub>CC</sub>     |
| C34         | IO24RSB0            |
| C35         | IO19RSB0            |
| C36         | IO16RSB0            |
| C37         | IO10RSB0            |
| C38         | V <sub>CCI</sub> B0 |
| C39         | GAB1/IO03RSB0       |
| C40         | VMV0                |
| D1          | GND                 |
| D2          | GND                 |
| D3          | GND                 |
| D4          | GND                 |

## 100-Pin VQFP



*Note:* This is the top 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>.

| 100-Pin VQFP |                     | 100-Pin VQFP |                     | 100-Pin VQFP |                     |
|--------------|---------------------|--------------|---------------------|--------------|---------------------|
| Pin Number   | AGL030 Function     | Pin Number   | AGL030 Function     | Pin Number   | AGL030 Function     |
| 1            | GND                 | 37           | V <sub>CC</sub>     | 73           | IO27RSB0            |
| 2            | IO82RSB1            | 38           | GND                 | 74           | IO26RSB0            |
| 3            | IO81RSB1            | 39           | V <sub>CCI</sub> B1 | 75           | IO25RSB0            |
| 4            | IO80RSB1            | 40           | IO49RSB1            | 76           | IO24RSB0            |
| 5            | IO79RSB1            | 41           | IO47RSB1            | 77           | IO23RSB0            |
| 6            | IO78RSB1            | 42           | IO46RSB1            | 78           | IO22RSB0            |
| 7            | IO77RSB1            | 43           | IO45RSB1            | 79           | IO21RSB0            |
| 8            | IO76RSB1            | 44           | IO44RSB1            | 80           | IO20RSB0            |
| 9            | GND                 | 45           | IO43RSB1            | 81           | IO19RSB0            |
| 10           | IO75RSB1            | 46           | IO42RSB1            | 82           | IO18RSB0            |
| 11           | IO74RSB1            | 47           | TCK                 | 83           | IO17RSB0            |
| 12           | GEC0/IO73RSB1       | 48           | TDI                 | 84           | IO16RSB0            |
| 13           | GEA0/IO72RSB1       | 49           | TMS                 | 85           | IO15RSB0            |
| 14           | GEB0/IO71RSB1       | 50           | NC                  | 86           | IO14RSB0            |
| 15           | IO70RSB1            | 51           | GND                 | 87           | V <sub>CCI</sub> B0 |
| 16           | IO69RSB1            | 52           | V <sub>PUMP</sub>   | 88           | GND                 |
| 17           | V <sub>CC</sub>     | 53           | NC                  | 89           | V <sub>CC</sub>     |
| 18           | V <sub>CCI</sub> B1 | 54           | TDO                 | 90           | IO12RSB0            |
| 19           | IO68RSB1            | 55           | TRST                | 91           | IO10RSB0            |
| 20           | IO67RSB1            | 56           | V <sub>JTAG</sub>   | 92           | IO08RSB0            |
| 21           | IO66RSB1            | 57           | IO41RSB0            | 93           | IO07RSB0            |
| 22           | IO65RSB1            | 58           | IO40RSB0            | 94           | IO06RSB0            |
| 23           | IO64RSB1            | 59           | IO39RSB0            | 95           | IO05RSB0            |
| 24           | IO63RSB1            | 60           | IO38RSB0            | 96           | IO04RSB0            |
| 25           | IO62RSB1            | 61           | IO37RSB0            | 97           | IO03RSB0            |
| 26           | IO61RSB1            | 62           | IO36RSB0            | 98           | IO02RSB0            |
| 27           | FF/IO60RSB1         | 63           | GDB0/IO34RSB0       | 99           | IO01RSB0            |
| 28           | IO59RSB1            | 64           | GDA0/IO33RSB0       | 100          | IO00RSB0            |
| 29           | IO58RSB1            | 65           | GDC0/IO32RSB0       |              |                     |
| 30           | IO57RSB1            | 66           | V <sub>CCI</sub> B0 |              |                     |
| 31           | IO56RSB1            | 67           | GND                 |              |                     |
| 32           | IO55RSB1            | 68           | V <sub>CC</sub>     |              |                     |
| 33           | IO54RSB1            | 69           | IO31RSB0            |              |                     |
| 34           | IO53RSB1            | 70           | IO30RSB0            |              |                     |
| 35           | IO52RSB1            | 71           | IO29RSB0            |              |                     |
| 36           | IO51RSB1            | 72           | IO28RSB0            |              |                     |

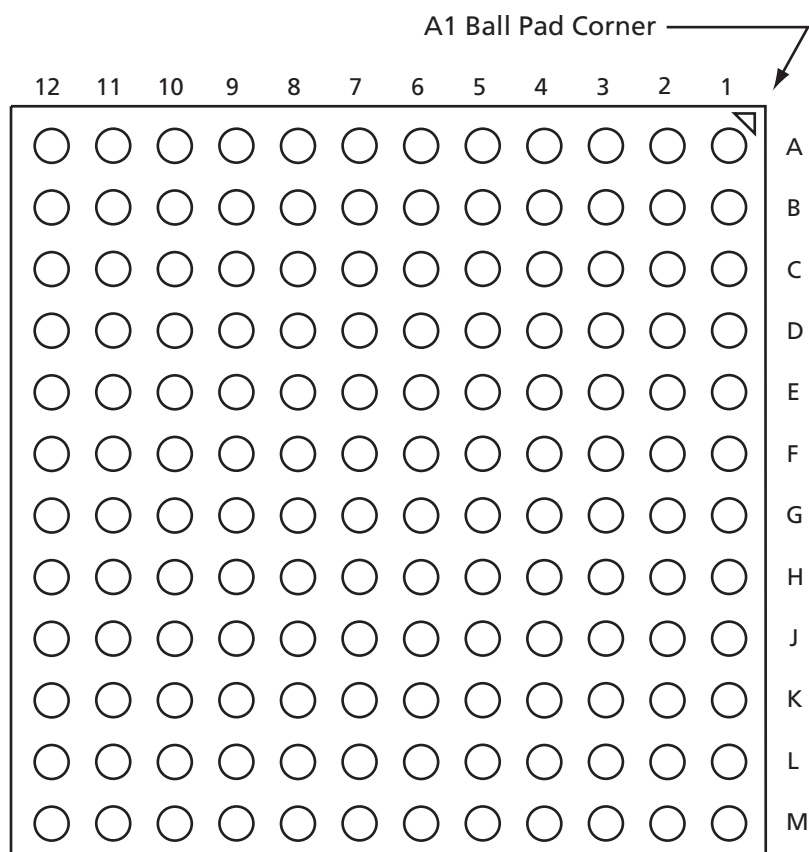
| 100-Pin VQFP |                     | 100-Pin VQFP |                    | 100-Pin VQFP |                    |
|--------------|---------------------|--------------|--------------------|--------------|--------------------|
| Pin Number   | AGL060 Function     | Pin Number   | AGL060 Function    | Pin Number   | AGL060 Function    |
| 1            | GND                 | 37           | V <sub>CC</sub>    | 73           | GBA2/IO25RSB0      |
| 2            | GAA2/IO51RSB1       | 38           | GND                | 74           | VMV0               |
| 3            | IO52RSB1            | 39           | V <sub>CC</sub> B1 | 75           | GNDQ               |
| 4            | GAB2/IO53RSB1       | 40           | IO60RSB1           | 76           | GBA1/IO24RSB0      |
| 5            | IO95RSB1            | 41           | IO59RSB1           | 77           | GBA0/IO23RSB0      |
| 6            | GAC2/IO94RSB1       | 42           | IO58RSB1           | 78           | GBB1/IO22RSB0      |
| 7            | IO93RSB1            | 43           | IO57RSB1           | 79           | GBB0/IO21RSB0      |
| 8            | IO92RSB1            | 44           | GDC2/IO56RSB1      | 80           | GBC1/IO20RSB0      |
| 9            | GND                 | 45           | GDB2/IO55RSB1      | 81           | GBC0/IO19RSB0      |
| 10           | GFB1/IO87RSB1       | 46           | GDA2/IO54RSB1      | 82           | IO18RSB0           |
| 11           | GFB0/IO86RSB1       | 47           | TCK                | 83           | IO17RSB0           |
| 12           | V <sub>COMPLF</sub> | 48           | TDI                | 84           | IO15RSB0           |
| 13           | GFA0/IO85RSB1       | 49           | TMS                | 85           | IO13RSB0           |
| 14           | V <sub>CC</sub> PLF | 50           | VMV1               | 86           | IO11RSB0           |
| 15           | GFA1/IO84RSB1       | 51           | GND                | 87           | V <sub>CC</sub> B0 |
| 16           | GFA2/IO83RSB1       | 52           | V <sub>PUMP</sub>  | 88           | GND                |
| 17           | V <sub>CC</sub>     | 53           | NC                 | 89           | V <sub>CC</sub>    |
| 18           | V <sub>CC</sub> B1  | 54           | TDO                | 90           | IO10RSB0           |
| 19           | GEC1/IO77RSB1       | 55           | TRST               | 91           | IO09RSB0           |
| 20           | GEB1/IO75RSB1       | 56           | V <sub>JTAG</sub>  | 92           | IO08RSB0           |
| 21           | GEB0/IO74RSB1       | 57           | GDA1/IO49RSB0      | 93           | GAC1/IO07RSB0      |
| 22           | GEA1/IO73RSB1       | 58           | GDC0/IO46RSB0      | 94           | GAC0/IO06RSB0      |
| 23           | GEA0/IO72RSB1       | 59           | GDC1/IO45RSB0      | 95           | GAB1/IO05RSB0      |
| 24           | VMV1                | 60           | GCC2/IO43RSB0      | 96           | GAB0/IO04RSB0      |
| 25           | GNDQ                | 61           | GCB2/IO42RSB0      | 97           | GAA1/IO03RSB0      |
| 26           | GEA2/IO71RSB1       | 62           | GCA0/IO40RSB0      | 98           | GAA0/IO02RSB0      |
| 27           | FF/GEB2/IO70RSB1    | 63           | GCA1/IO39RSB0      | 99           | IO01RSB0           |
| 28           | GEC2/IO69RSB1       | 64           | GCC0/IO36RSB0      | 100          | IO00RSB0           |
| 29           | IO68RSB1            | 65           | GCC1/IO35RSB0      |              |                    |
| 30           | IO67RSB1            | 66           | V <sub>CC</sub> B0 |              |                    |
| 31           | IO66RSB1            | 67           | GND                |              |                    |
| 32           | IO65RSB1            | 68           | V <sub>CC</sub>    |              |                    |
| 33           | IO64RSB1            | 69           | IO31RSB0           |              |                    |
| 34           | IO63RSB1            | 70           | GBC2/IO29RSB0      |              |                    |
| 35           | IO62RSB1            | 71           | GBB2/IO27RSB0      |              |                    |
| 36           | IO61RSB1            | 72           | IO26RSB0           |              |                    |

| 100-Pin VQFP |                     | 100-Pin VQFP |                    | 100-Pin VQFP |                    |
|--------------|---------------------|--------------|--------------------|--------------|--------------------|
| Pin Number   | AGL125 Function     | Pin Number   | AGL125 Function    | Pin Number   | AGL125 Function    |
| 1            | GND                 | 37           | V <sub>CC</sub>    | 73           | GBA2/IO41RSB0      |
| 2            | GAA2/IO67RSB1       | 38           | GND                | 74           | VMV0               |
| 3            | IO68RSB1            | 39           | V <sub>CC</sub> B1 | 75           | GNDQ               |
| 4            | GAB2/IO69RSB1       | 40           | IO87RSB1           | 76           | GBA1/IO40RSB0      |
| 5            | IO132RSB1           | 41           | IO84RSB1           | 77           | GBA0/IO39RSB0      |
| 6            | GAC2/IO131RSB1      | 42           | IO81RSB1           | 78           | GBB1/IO38RSB0      |
| 7            | IO130RSB1           | 43           | IO75RSB1           | 79           | GBB0/IO37RSB0      |
| 8            | IO129RSB1           | 44           | GDC2/IO72RSB1      | 80           | GBC1/IO36RSB0      |
| 9            | GND                 | 45           | GDB2/IO71RSB1      | 81           | GBC0/IO35RSB0      |
| 10           | GFB1/IO124RSB1      | 46           | GDA2/IO70RSB1      | 82           | IO32RSB0           |
| 11           | GFB0/IO123RSB1      | 47           | TCK                | 83           | IO28RSB0           |
| 12           | V <sub>COMPLF</sub> | 48           | TDI                | 84           | IO25RSB0           |
| 13           | GFA0/IO122RSB1      | 49           | TMS                | 85           | IO22RSB0           |
| 14           | V <sub>CCPLF</sub>  | 50           | VMV1               | 86           | IO19RSB0           |
| 15           | GFA1/IO121RSB1      | 51           | GND                | 87           | V <sub>CC</sub> B0 |
| 16           | GFA2/IO120RSB1      | 52           | V <sub>PUMP</sub>  | 88           | GND                |
| 17           | V <sub>CC</sub>     | 53           | NC                 | 89           | V <sub>CC</sub>    |
| 18           | V <sub>CC</sub> B1  | 54           | TDO                | 90           | IO15RSB0           |
| 19           | GEC0/IO111RSB1      | 55           | TRST               | 91           | IO13RSB0           |
| 20           | GEB1/IO110RSB1      | 56           | V <sub>JTAG</sub>  | 92           | IO11RSB0           |
| 21           | GEB0/IO109RSB1      | 57           | GDA1/IO65RSB0      | 93           | IO09RSB0           |
| 22           | GEA1/IO108RSB1      | 58           | GDC0/IO62RSB0      | 94           | IO07RSB0           |
| 23           | GEA0/IO107RSB1      | 59           | GDC1/IO61RSB0      | 95           | GAC1/IO05RSB0      |
| 24           | VMV1                | 60           | GCC2/IO59RSB0      | 96           | GAC0/IO04RSB0      |
| 25           | GNDQ                | 61           | GCB2/IO58RSB0      | 97           | GAB1/IO03RSB0      |
| 26           | GEA2/IO106RSB1      | 62           | GCA0/IO56RSB0      | 98           | GAB0/IO02RSB0      |
| 27           | FF/GEB2/IO105RSB1   | 63           | GCA1/IO55RSB0      | 99           | GAA1/IO01RSB0      |
| 28           | GEC2/IO104RSB1      | 64           | GCC0/IO52RSB0      | 100          | GAA0/IO00RSB0      |
| 29           | IO102RSB1           | 65           | GCC1/IO51RSB0      |              |                    |
| 30           | IO100RSB1           | 66           | V <sub>CC</sub> B0 |              |                    |
| 31           | IO99RSB1            | 67           | GND                |              |                    |
| 32           | IO97RSB1            | 68           | V <sub>CC</sub>    |              |                    |
| 33           | IO96RSB1            | 69           | IO47RSB0           |              |                    |
| 34           | IO95RSB1            | 70           | GBC2/IO45RSB0      |              |                    |
| 35           | IO94RSB1            | 71           | GBB2/IO43RSB0      |              |                    |
| 36           | IO93RSB1            | 72           | IO42RSB0           |              |                    |

| 100-Pin VQFP |                     | 100-Pin VQFP |                    | 100-Pin VQFP |                    |
|--------------|---------------------|--------------|--------------------|--------------|--------------------|
| Pin Number   | AGL250 Function     | Pin Number   | AGL250 Function    | Pin Number   | AGL250 Function    |
| 1            | GND                 | 37           | V <sub>CC</sub>    | 73           | GBA2/IO41PDB1      |
| 2            | GAA2/IO118UDB3      | 38           | GND                | 74           | VMV1               |
| 3            | IO118VDB3           | 39           | V <sub>CC</sub> B2 | 75           | GNDQ               |
| 4            | GAB2/IO117UDB3      | 40           | IO77RSB2           | 76           | GBA1/IO40RSB0      |
| 5            | IO117VDB3           | 41           | IO74RSB2           | 77           | GBA0/IO39RSB0      |
| 6            | GAC2/IO116UDB3      | 42           | IO71RSB2           | 78           | GBB1/IO38RSB0      |
| 7            | IO116VDB3           | 43           | GDC2/IO63RSB2      | 79           | GBB0/IO37RSB0      |
| 8            | IO112PSB3           | 44           | GDB2/IO62RSB2      | 80           | GBC1/IO36RSB0      |
| 9            | GND                 | 45           | GDA2/IO61RSB2      | 81           | GBC0/IO35RSB0      |
| 10           | GFB1/IO109PDB3      | 46           | GNDQ               | 82           | IO29RSB0           |
| 11           | GFB0/IO109NDB3      | 47           | TCK                | 83           | IO27RSB0           |
| 12           | V <sub>COMPLF</sub> | 48           | TDI                | 84           | IO25RSB0           |
| 13           | GFA0/IO108NPB3      | 49           | TMS                | 85           | IO23RSB0           |
| 14           | V <sub>CCPLF</sub>  | 50           | VMV2               | 86           | IO21RSB0           |
| 15           | GFA1/IO108PPB3      | 51           | GND                | 87           | V <sub>CC</sub> B0 |
| 16           | GFA2/IO107PSB3      | 52           | V <sub>PUMP</sub>  | 88           | GND                |
| 17           | V <sub>CC</sub>     | 53           | NC                 | 89           | V <sub>CC</sub>    |
| 18           | V <sub>CC</sub> B3  | 54           | TDO                | 90           | IO15RSB0           |
| 19           | GFC2/IO105PSB3      | 55           | TRST               | 91           | IO13RSB0           |
| 20           | GEC1/IO100PDB3      | 56           | V <sub>JTAG</sub>  | 92           | IO11RSB0           |
| 21           | GEC0/IO100NDB3      | 57           | GDA1/IO60USB1      | 93           | GAC1/IO05RSB0      |
| 22           | GEA1/IO98PDB3       | 58           | GDC0/IO58VDB1      | 94           | GAC0/IO04RSB0      |
| 23           | GEA0/IO98NDB3       | 59           | GDC1/IO58UDB1      | 95           | GAB1/IO03RSB0      |
| 24           | VMV3                | 60           | IO52NDB1           | 96           | GAB0/IO02RSB0      |
| 25           | GNDQ                | 61           | GCB2/IO52PDB1      | 97           | GAA1/IO01RSB0      |
| 26           | GEA2/IO97RSB2       | 62           | GCA1/IO50PDB1      | 98           | GAA0/IO00RSB0      |
| 27           | FF/GE2/IO96RSB2     | 63           | GCA0/IO50NDB1      | 99           | GNDQ               |
| 28           | GEC2/IO95RSB2       | 64           | GCC0/IO48NDB1      | 100          | VMV0               |
| 29           | IO93RSB2            | 65           | GCC1/IO48PDB1      |              |                    |
| 30           | IO92RSB2            | 66           | V <sub>CC</sub> B1 |              |                    |
| 31           | IO91RSB2            | 67           | GND                |              |                    |
| 32           | IO90RSB2            | 68           | V <sub>CC</sub>    |              |                    |
| 33           | IO88RSB2            | 69           | IO43NDB1           |              |                    |
| 34           | IO86RSB2            | 70           | GBC2/IO43PDB1      |              |                    |
| 35           | IO85RSB2            | 71           | GBB2/IO42PSB1      |              |                    |
| 36           | IO84RSB2            | 72           | IO41NDB1           |              |                    |



## 144-Pin FBGA



*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>.

| 144-Pin FBGA |                 |
|--------------|-----------------|
| Pin Number   | AGL125 Function |
| A1           | GNDQ            |
| A2           | VMV0            |
| A3           | GAB0/IO02RSB0   |
| A4           | GAB1/IO03RSB0   |
| A5           | IO11RSB0        |
| A6           | GND             |
| A7           | IO18RSB0        |
| A8           | V <sub>CC</sub> |
| A9           | IO25RSB0        |
| A10          | GBA0/IO39RSB0   |
| A11          | GBA1/IO40RSB0   |
| A12          | GNDQ            |
| B1           | GAB2/IO69RSB1   |
| B2           | GND             |
| B3           | GAA0/IO00RSB0   |
| B4           | GAA1/IO01RSB0   |
| B5           | IO08RSB0        |
| B6           | IO14RSB0        |
| B7           | IO19RSB0        |
| B8           | IO22RSB0        |
| B9           | GBB0/IO37RSB0   |
| B10          | GBB1/IO38RSB0   |
| B11          | GND             |
| B12          | VMV0            |
| C1           | IO132RSB1       |
| C2           | GFA2/IO120RSB1  |
| C3           | GAC2/IO131RSB1  |
| C4           | V <sub>CC</sub> |
| C5           | IO10RSB0        |
| C6           | IO12RSB0        |
| C7           | IO21RSB0        |
| C8           | IO24RSB0        |
| C9           | IO27RSB0        |
| C10          | GBA2/IO41RSB0   |
| C11          | IO42RSB0        |
| C12          | GBC2/IO45RSB0   |

| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL125 Function     |
| D1           | IO128RSB1           |
| D2           | IO129RSB1           |
| D3           | IO130RSB1           |
| D4           | GAA2/IO67RSB1       |
| D5           | GAC0/IO04RSB0       |
| D6           | GAC1/IO05RSB0       |
| D7           | GBC0/IO35RSB0       |
| D8           | GBC1/IO36RSB0       |
| D9           | GBB2/IO43RSB0       |
| D10          | IO28RSB0            |
| D11          | IO44RSB0            |
| D12          | GCB1/IO53RSB0       |
| E1           | V <sub>CC</sub>     |
| E2           | GFC0/IO125RSB1      |
| E3           | GFC1/IO126RSB1      |
| E4           | V <sub>CC</sub> B1  |
| E5           | IO68RSB1            |
| E6           | V <sub>CC</sub> B0  |
| E7           | V <sub>CC</sub> B0  |
| E8           | GCC1/IO51RSB0       |
| E9           | V <sub>CC</sub> B0  |
| E10          | V <sub>CC</sub>     |
| E11          | GCA0/IO56RSB0       |
| E12          | IO46RSB0            |
| F1           | GFB0/IO123RSB1      |
| F2           | V <sub>COMPLF</sub> |
| F3           | GFB1/IO124RSB1      |
| F4           | IO127RSB1           |
| F5           | GND                 |
| F6           | GND                 |
| F7           | GND                 |
| F8           | GCC0/IO52RSB0       |
| F9           | GCB0/IO54RSB0       |
| F10          | GND                 |
| F11          | GCA1/IO55RSB0       |
| F12          | GCA2/IO57RSB0       |

| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL125 Function     |
| G1           | GFA1/IO121RSB1      |
| G2           | GND                 |
| G3           | V <sub>CC</sub> PLF |
| G4           | GFA0/IO122RSB1      |
| G5           | GND                 |
| G6           | GND                 |
| G7           | GND                 |
| G8           | GDC1/IO61RSB0       |
| G9           | IO48RSB0            |
| G10          | GCC2/IO59RSB0       |
| G11          | IO47RSB0            |
| G12          | GCB2/IO58RSB0       |
| H1           | V <sub>CC</sub>     |
| H2           | GFB2/IO119RSB1      |
| H3           | GFC2/IO118RSB1      |
| H4           | GEC1/IO112RSB1      |
| H5           | V <sub>CC</sub>     |
| H6           | IO50RSB0            |
| H7           | IO60RSB0            |
| H8           | GDB2/IO71RSB1       |
| H9           | GDC0/IO62RSB0       |
| H10          | V <sub>CC</sub> B0  |
| H11          | IO49RSB0            |
| H12          | V <sub>CC</sub>     |
| J1           | GEB1/IO110RSB1      |
| J2           | IO115RSB1           |
| J3           | V <sub>CC</sub> B1  |
| J4           | GEC0/IO111RSB1      |
| J5           | IO116RSB1           |
| J6           | IO117RSB1           |
| J7           | V <sub>CC</sub>     |
| J8           | TCK                 |
| J9           | GDA2/IO70RSB1       |
| J10          | TDO                 |
| J11          | GDA1/IO65RSB0       |
| J12          | GDB1/IO63RSB0       |

| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL125 Function     |
| K1           | GEB0/IO109RSB1      |
| K2           | GEA1/IO108RSB1      |
| K3           | GEA0/IO107RSB1      |
| K4           | GEA2/IO106RSB1      |
| K5           | IO100RSB1           |
| K6           | IO98RSB1            |
| K7           | GND                 |
| K8           | IO73RSB1            |
| K9           | GDC2/IO72RSB1       |
| K10          | GND                 |
| K11          | GDA0/IO66RSB0       |
| K12          | GDB0/IO64RSB0       |
| L1           | GND                 |
| L2           | VMV1                |
| L3           | FF/GEB2/IO105RSB1   |
| L4           | IO102RSB1           |
| L5           | V <sub>CCI</sub> B1 |
| L6           | IO95RSB1            |
| L7           | IO85RSB1            |
| L8           | IO74RSB1            |
| L9           | TMS                 |
| L10          | V <sub>JTAG</sub>   |
| L11          | VMV1                |
| L12          | TRST                |
| M1           | GNDQ                |
| M2           | GEC2/IO104RSB1      |
| M3           | IO103RSB1           |
| M4           | IO101RSB1           |
| M5           | IO97RSB1            |
| M6           | IO94RSB1            |
| M7           | IO86RSB1            |
| M8           | IO75RSB1            |
| M9           | TDI                 |
| M10          | V <sub>CCI</sub> B1 |
| M11          | V <sub>PUMP</sub>   |
| M12          | GNDQ                |

| 144-Pin FBGA |                 | 144-Pin FBGA |                     | 144-Pin FBGA |                    |
|--------------|-----------------|--------------|---------------------|--------------|--------------------|
| Pin Number   | AGL250 Function | Pin Number   | AGL250 Function     | Pin Number   | AGL250 Function    |
| A1           | GNDQ            | D1           | IO112NDB3           | G1           | GFA1/IO108PPB3     |
| A2           | VMV0            | D2           | IO112PDB3           | G2           | GND                |
| A3           | GAB0/IO02RSB0   | D3           | IO116VDB3           | G3           | V <sub>CCPLF</sub> |
| A4           | GAB1/IO03RSB0   | D4           | GAA2/IO118UPB3      | G4           | GFA0/IO108NPB3     |
| A5           | IO16RSB0        | D5           | GAC0/IO04RSB0       | G5           | GND                |
| A6           | GND             | D6           | GAC1/IO05RSB0       | G6           | GND                |
| A7           | IO29RSB0        | D7           | GBC0/IO35RSB0       | G7           | GND                |
| A8           | V <sub>CC</sub> | D8           | GBC1/IO36RSB0       | G8           | GDC1/IO58UPB1      |
| A9           | IO33RSB0        | D9           | GBB2/IO42PDB1       | G9           | IO53NDB1           |
| A10          | GBA0/IO39RSB0   | D10          | IO42NDB1            | G10          | GCC2/IO53PDB1      |
| A11          | GBA1/IO40RSB0   | D11          | IO43NPB1            | G11          | IO52NDB1           |
| A12          | GNDQ            | D12          | GCB1/IO49PPB1       | G12          | GCB2/IO52PDB1      |
| B1           | GAB2/IO117UDB3  | E1           | V <sub>CC</sub>     | H1           | V <sub>CC</sub>    |
| B2           | GND             | E2           | GFC0/IO110NDB3      | H2           | GFB2/IO106PDB3     |
| B3           | GAA0/IO00RSB0   | E3           | GFC1/IO110PDB3      | H3           | GFC2/IO105PSB3     |
| B4           | GAA1/IO01RSB0   | E4           | V <sub>CC</sub> B3  | H4           | GEC1/IO100PDB3     |
| B5           | IO14RSB0        | E5           | IO118VPB3           | H5           | V <sub>CC</sub>    |
| B6           | IO19RSB0        | E6           | V <sub>CC</sub> B0  | H6           | IO79RSB2           |
| B7           | IO22RSB0        | E7           | V <sub>CC</sub> B0  | H7           | IO65RSB2           |
| B8           | IO30RSB0        | E8           | GCC1/IO48PDB1       | H8           | GDB2/IO62RSB2      |
| B9           | GBB0/IO37RSB0   | E9           | V <sub>CC</sub> B1  | H9           | GDC0/IO58VPB1      |
| B10          | GBB1/IO38RSB0   | E10          | V <sub>CC</sub>     | H10          | V <sub>CC</sub> B1 |
| B11          | GND             | E11          | GCA0/IO50NDB1       | H11          | IO54PSB1           |
| B12          | VMV1            | E12          | IO51NDB1            | H12          | V <sub>CC</sub>    |
| C1           | IO117VDB3       | F1           | GFB0/IO109NPB3      | J1           | GEB1/IO99PDB3      |
| C2           | GFA2/IO107PPB3  | F2           | V <sub>COMPLF</sub> | J2           | IO106NDB3          |
| C3           | GAC2/IO116UDB3  | F3           | GFB1/IO109PPB3      | J3           | V <sub>CC</sub> B3 |
| C4           | V <sub>CC</sub> | F4           | IO107NPB3           | J4           | GEC0/IO100NDB3     |
| C5           | IO12RSB0        | F5           | GND                 | J5           | IO88RSB2           |
| C6           | IO17RSB0        | F6           | GND                 | J6           | IO81RSB2           |
| C7           | IO24RSB0        | F7           | GND                 | J7           | V <sub>CC</sub>    |
| C8           | IO31RSB0        | F8           | GCC0/IO48NDB1       | J8           | TCK                |
| C9           | IO34RSB0        | F9           | GCB0/IO49NPB1       | J9           | GDA2/IO61RSB2      |
| C10          | GBA2/IO41PDB1   | F10          | GND                 | J10          | TDO                |
| C11          | IO41NDB1        | F11          | GCA1/IO50PDB1       | J11          | GDA1/IO60UDB1      |
| C12          | GBC2/IO43PPB1   | F12          | GCA2/IO51PDB1       | J12          | GDB1/IO59UDB1      |

| 144-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL250 Function    |
| K1           | GEB0/IO99NDB3      |
| K2           | GEA1/IO98PDB3      |
| K3           | GEA0/IO98NDB3      |
| K4           | GEA2/IO97RSB2      |
| K5           | IO90RSB2           |
| K6           | IO84RSB2           |
| K7           | GND                |
| K8           | IO66RSB2           |
| K9           | GDC2/IO63RSB2      |
| K10          | GND                |
| K11          | GDA0/IO60VDB1      |
| K12          | GDB0/IO59VDB1      |
| L1           | GND                |
| L2           | VMV3               |
| L3           | FF/GEB2/IO96RSB2   |
| L4           | IO91RSB2           |
| L5           | V <sub>CC</sub> B2 |
| L6           | IO82RSB2           |
| L7           | IO80RSB2           |
| L8           | IO72RSB2           |
| L9           | TMS                |
| L10          | V <sub>JTAG</sub>  |
| L11          | VMV2               |
| L12          | TRST               |
| M1           | GNDQ               |
| M2           | GEC2/IO95RSB2      |
| M3           | IO92RSB2           |
| M4           | IO89RSB2           |
| M5           | IO87RSB2           |
| M6           | IO85RSB2           |
| M7           | IO78RSB2           |
| M8           | IO76RSB2           |
| M9           | TDI                |
| M10          | V <sub>CC</sub> B2 |
| M11          | V <sub>PUMP</sub>  |
| M12          | GNDQ               |

| 144-pin FBGA |                 | 144-pin FBGA |                        | 144-pin FBGA |                    |
|--------------|-----------------|--------------|------------------------|--------------|--------------------|
| Pin Number   | AGL400 Function | Pin Number   | AGL400 Function        | Pin Number   | AGL400 Function    |
| A1           | GNDQ            | D1           | IO149NDB3              | G1           | GFA1/IO145PPB3     |
| A2           | VMV0            | D2           | IO149PDB3              | G2           | GND                |
| A3           | GAB0/IO02RSB0   | D3           | IO153VDB3              | G3           | V <sub>CCPLF</sub> |
| A4           | GAB1/IO03RSB0   | D4           | GAA2/IO155UPB3         | G4           | GFA0/IO145NPB3     |
| A5           | IO16RSB0        | D5           | GAC0/IO04RSB0          | G5           | GND                |
| A6           | GND             | D6           | GAC1/IO05RSB0          | G6           | GND                |
| A7           | IO30RSB0        | D7           | GBC0/IO54RSB0          | G7           | GND                |
| A8           | V <sub>CC</sub> | D8           | GBC1/IO55RSB0          | G8           | GDC1/IO77UPB1      |
| A9           | IO34RSB0        | D9           | GBB2/IO61PDB1          | G9           | IO72NDB1           |
| A10          | GBA0/IO58RSB0   | D10          | IO61NDB1               | G10          | GCC2/IO72PDB1      |
| A11          | GBA1/IO59RSB0   | D11          | IO62NPB1               | G11          | IO71NDB1           |
| A12          | GNDQ            | D12          | GCB1/IO68PPB1          | G12          | GCB2/IO71PDB1      |
| B1           | GAB2/IO154UDB3  | E1           | V <sub>CC</sub>        | H1           | V <sub>CC</sub>    |
| B2           | GND             | E2           | GFC0/IO147NDB3         | H2           | GFB2/IO143PDB3     |
| B3           | GAA0/IO00RSB0   | E3           | GFC1/IO147PDB3         | H3           | GFC2/IO142PSB3     |
| B4           | GAA1/IO01RSB0   | E4           | V <sub>CC</sub> B3     | H4           | GEC1/IO137PDB3     |
| B5           | IO14RSB0        | E5           | IO155VPB3              | H5           | V <sub>CC</sub>    |
| B6           | IO19RSB0        | E6           | V <sub>CC</sub> B0     | H6           | IO75PDB1           |
| B7           | IO23RSB0        | E7           | V <sub>CC</sub> B0     | H7           | IO75NDB1           |
| B8           | IO31RSB0        | E8           | GCC1/IO67PDB1          | H8           | GDB2/IO81RSB2      |
| B9           | GBB0/IO56RSB0   | E9           | V <sub>CC</sub> B1     | H9           | GDC0/IO77VPB1      |
| B10          | GBB1/IO57RSB0   | E10          | V <sub>CC</sub>        | H10          | V <sub>CC</sub> B1 |
| B11          | GND             | E11          | GCA0/IO69NDB1          | H11          | IO73PSB1           |
| B12          | VMV1            | E12          | IO70NDB1               | H12          | V <sub>CC</sub>    |
| C1           | IO154VDB3       | F1           | GFB0/IO146NPB3         | J1           | GEB1/IO136PDB3     |
| C2           | GFA2/IO144PPB3  | F2           | V <sub>CC</sub> COMPLF | J2           | IO143NDB3          |
| C3           | GAC2/IO153UDB3  | F3           | GFB1/IO146PPB3         | J3           | V <sub>CC</sub> B3 |
| C4           | V <sub>CC</sub> | F4           | IO144NPB3              | J4           | GEC0/IO137NDB3     |
| C5           | IO12RSB0        | F5           | GND                    | J5           | IO125RSB2          |
| C6           | IO17RSB0        | F6           | GND                    | J6           | IO116RSB2          |
| C7           | IO25RSB0        | F7           | GND                    | J7           | V <sub>CC</sub>    |
| C8           | IO32RSB0        | F8           | GCC0/IO67NDB1          | J8           | TCK                |
| C9           | IO53RSB0        | F9           | GCB0/IO68NPB1          | J9           | GDA2/IO80RSB2      |
| C10          | GBA2/IO60PDB1   | F10          | GND                    | J10          | TDO                |
| C11          | IO60NDB1        | F11          | GCA1/IO69PDB1          | J11          | GDA1/IO79UDB1      |
| C12          | GBC2/IO62PPB1   | F12          | GCA2/IO70PDB1          | J12          | GDB1/IO78UDB1      |

| 144-pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL400 Function    |
| K1           | GEB0/IO136NDB3     |
| K2           | GEA1/IO135PDB3     |
| K3           | GEA0/IO135NDB3     |
| K4           | GEA2/IO134RSB2     |
| K5           | IO127RSB2          |
| K6           | IO121RSB2          |
| K7           | GND                |
| K8           | IO104RSB2          |
| K9           | GDC2/IO82RSB2      |
| K10          | GND                |
| K11          | GDA0/IO79VDB1      |
| K12          | GDB0/IO78VDB1      |
| L1           | GND                |
| L2           | VMV3               |
| L3           | FF/GEB2/IO133RSB2  |
| L4           | IO128RSB2          |
| L5           | V <sub>CC</sub> B2 |
| L6           | IO119RSB2          |
| L7           | IO114RSB2          |
| L8           | IO110RSB2          |
| L9           | TMS                |
| L10          | V <sub>JTAG</sub>  |
| L11          | VMV2               |
| L12          | TRST               |
| M1           | GNDQ               |
| M2           | GEC2/IO132RSB2     |
| M3           | IO129RSB2          |
| M4           | IO126RSB2          |
| M5           | IO124RSB2          |
| M6           | IO122RSB2          |
| M7           | IO117RSB2          |
| M8           | IO115RSB2          |
| M9           | TDI                |
| M10          | V <sub>CC</sub> B2 |
| M11          | V <sub>PUMP</sub>  |
| M12          | GNDQ               |

| 144-Pin FBGA |                 |
|--------------|-----------------|
| Pin Number   | AGL600 Function |
| A1           | GNDQ            |
| A2           | VMV0            |
| A3           | GAB0/IO02RSB0   |
| A4           | GAB1/IO03RSB0   |
| A5           | IO10RSB0        |
| A6           | GND             |
| A7           | IO34RSB0        |
| A8           | V <sub>CC</sub> |
| A9           | IO50RSB0        |
| A10          | GBA0/IO58RSB0   |
| A11          | GBA1/IO59RSB0   |
| A12          | GNDQ            |
| B1           | GAB2/IO173PDB3  |
| B2           | GND             |
| B3           | GAA0/IO00RSB0   |
| B4           | GAA1/IO01RSB0   |
| B5           | IO13RSB0        |
| B6           | IO19RSB0        |
| B7           | IO31RSB0        |
| B8           | IO39RSB0        |
| B9           | GBB0/IO56RSB0   |
| B10          | GBB1/IO57RSB0   |
| B11          | GND             |
| B12          | VMV1            |
| C1           | IO173NDB3       |
| C2           | GFA2/IO161PPB3  |
| C3           | GAC2/IO172PDB3  |
| C4           | V <sub>CC</sub> |
| C5           | IO16RSB0        |
| C6           | IO25RSB0        |
| C7           | IO28RSB0        |
| C8           | IO42RSB0        |
| C9           | IO45RSB0        |
| C10          | GBA2/IO60PDB1   |
| C11          | IO60NDB1        |
| C12          | GBC2/IO62PPB1   |

| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL600 Function     |
| D1           | IO169PDB3           |
| D2           | IO169NDB3           |
| D3           | IO172NDB3           |
| D4           | GAA2/IO174PPB3      |
| D5           | GAC0/IO04RSB0       |
| D6           | GAC1/IO05RSB0       |
| D7           | GBC0/IO54RSB0       |
| D8           | GBC1/IO55RSB0       |
| D9           | GBB2/IO61PDB1       |
| D10          | IO61NDB1            |
| D11          | IO62NPB1            |
| D12          | GCB1/IO70PPB1       |
| E1           | V <sub>CC</sub>     |
| E2           | GFC0/IO164NDB3      |
| E3           | GFC1/IO164PDB3      |
| E4           | V <sub>CC</sub> B3  |
| E5           | IO174NPB3           |
| E6           | V <sub>CC</sub> B0  |
| E7           | V <sub>CC</sub> B0  |
| E8           | GCC1/IO69PDB1       |
| E9           | V <sub>CC</sub> B1  |
| E10          | V <sub>CC</sub>     |
| E11          | GCA0/IO71NDB1       |
| E12          | IO72NDB1            |
| F1           | GFB0/IO163NPB3      |
| F2           | V <sub>COMPLF</sub> |
| F3           | GFB1/IO163PPB3      |
| F4           | IO161NPB3           |
| F5           | GND                 |
| F6           | GND                 |
| F7           | GND                 |
| F8           | GCC0/IO69NDB1       |
| F9           | GCB0/IO70NPB1       |
| F10          | GND                 |
| F11          | GCA1/IO71PDB1       |
| F12          | GCA2/IO72PDB1       |

| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL600 Function     |
| G1           | GFA1/IO162PPB3      |
| G2           | GND                 |
| G3           | V <sub>CC</sub> PLF |
| G4           | GFA0/IO162NPB3      |
| G5           | GND                 |
| G6           | GND                 |
| G7           | GND                 |
| G8           | GDC1/IO86PPB1       |
| G9           | IO74NDB1            |
| G10          | GCC2/IO74PDB1       |
| G11          | IO73NDB1            |
| G12          | GCB2/IO73PDB1       |
| H1           | V <sub>CC</sub>     |
| H2           | GFB2/IO160PDB3      |
| H3           | GFC2/IO159PSB3      |
| H4           | GEC1/IO146PDB3      |
| H5           | V <sub>CC</sub>     |
| H6           | IO80PDB1            |
| H7           | IO80NDB1            |
| H8           | GDB2/IO90RSB2       |
| H9           | GDC0/IO86NPB1       |
| H10          | V <sub>CC</sub> B1  |
| H11          | IO84PSB1            |
| H12          | V <sub>CC</sub>     |
| J1           | GEB1/IO145PDB3      |
| J2           | IO160NDB3           |
| J3           | V <sub>CC</sub> B3  |
| J4           | GEC0/IO146NDB3      |
| J5           | IO129RSB2           |
| J6           | IO131RSB2           |
| J7           | V <sub>CC</sub>     |
| J8           | TCK                 |
| J9           | GDA2/IO89RSB2       |
| J10          | TDO                 |
| J11          | GDA1/IO88PDB1       |
| J12          | GDB1/IO87PDB1       |

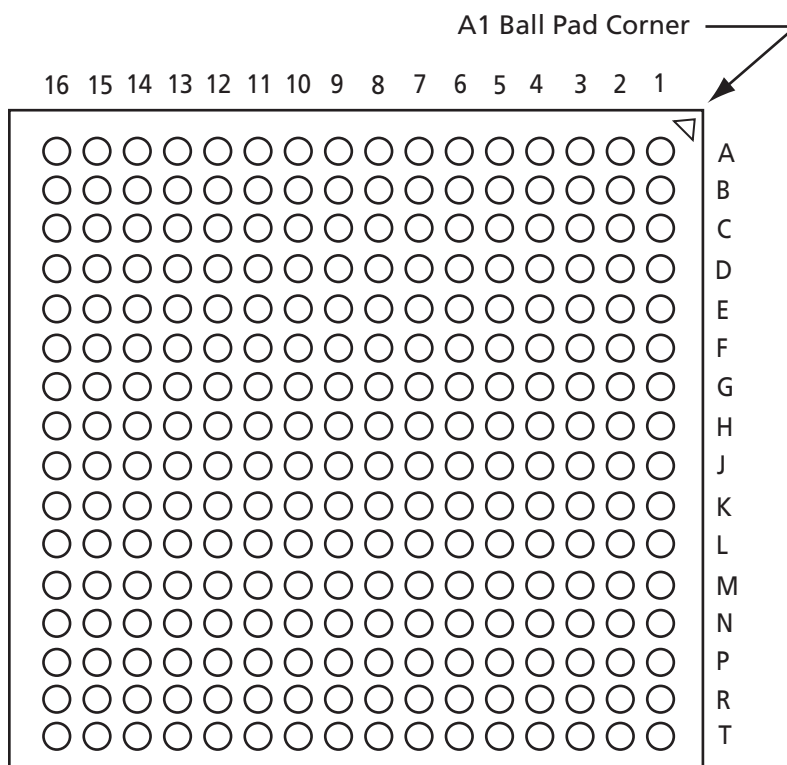


| 144-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL600 Function     |
| K1           | GEB0/IO145NDB3      |
| K2           | GEA1/IO144PDB3      |
| K3           | GEA0/IO144NDB3      |
| K4           | GEA2/IO143RSB2      |
| K5           | IO119RSB2           |
| K6           | IO111RSB2           |
| K7           | GND                 |
| K8           | IO94RSB2            |
| K9           | GDC2/IO91RSB2       |
| K10          | GND                 |
| K11          | GDA0/IO88NDB1       |
| K12          | GDB0/IO87NDB1       |
| L1           | GND                 |
| L2           | VMV3                |
| L3           | FF/GEB2/IO142RSB2   |
| L4           | IO136RSB2           |
| L5           | V <sub>CCI</sub> B2 |
| L6           | IO115RSB2           |
| L7           | IO103RSB2           |
| L8           | IO97RSB2            |
| L9           | TMS                 |
| L10          | V <sub>JTAG</sub>   |
| L11          | VMV2                |
| L12          | TRST                |
| M1           | GNDQ                |
| M2           | GEC2/IO141RSB2      |
| M3           | IO138RSB2           |
| M4           | IO123RSB2           |
| M5           | IO126RSB2           |
| M6           | IO134RSB2           |
| M7           | IO108RSB2           |
| M8           | IO99RSB2            |
| M9           | TDI                 |
| M10          | V <sub>CCI</sub> B2 |
| M11          | V <sub>PUMP</sub>   |
| M12          | GNDQ                |

| 144-Pin FBGA |                  | 144-Pin FBGA |                     | 144-Pin FBGA |                    |
|--------------|------------------|--------------|---------------------|--------------|--------------------|
| Pin Number   | AGL1000 Function | Pin Number   | AGL1000 Function    | Pin Number   | AGL1000 Function   |
| A1           | GNDQ             | D1           | IO213PDB3           | G1           | GFA1/IO207PPB3     |
| A2           | VMV0             | D2           | IO213NDB3           | G2           | GND                |
| A3           | GAB0/IO02RSB0    | D3           | IO223NDB3           | G3           | V <sub>CCPLF</sub> |
| A4           | GAB1/IO03RSB0    | D4           | GAA2/IO225PPB3      | G4           | GFA0/IO207NPB3     |
| A5           | IO10RSB0         | D5           | GAC0/IO04RSB0       | G5           | GND                |
| A6           | GND              | D6           | GAC1/IO05RSB0       | G6           | GND                |
| A7           | IO44RSB0         | D7           | GBC0/IO72RSB0       | G7           | GND                |
| A8           | V <sub>CC</sub>  | D8           | GBC1/IO73RSB0       | G8           | GDC1/IO111PPB1     |
| A9           | IO69RSB0         | D9           | GBB2/IO79PDB1       | G9           | IO96NDB1           |
| A10          | GBA0/IO76RSB0    | D10          | IO79NDB1            | G10          | GCC2/IO96PDB1      |
| A11          | GBA1/IO77RSB0    | D11          | IO80NPB1            | G11          | IO95NDB1           |
| A12          | GNDQ             | D12          | GCB1/IO92PPB1       | G12          | GCB2/IO95PDB1      |
| B1           | GAB2/IO224PDB3   | E1           | V <sub>CC</sub>     | H1           | V <sub>CC</sub>    |
| B2           | GND              | E2           | GFC0/IO209NDB3      | H2           | GFB2/IO205PDB3     |
| B3           | GAA0/IO00RSB0    | E3           | GFC1/IO209PDB3      | H3           | GFC2/IO204PSB3     |
| B4           | GAA1/IO01RSB0    | E4           | V <sub>CC</sub> B3  | H4           | GEC1/IO190PDB3     |
| B5           | IO13RSB0         | E5           | IO225NPB3           | H5           | V <sub>CC</sub>    |
| B6           | IO26RSB0         | E6           | V <sub>CC</sub> B0  | H6           | IO105PDB1          |
| B7           | IO35RSB0         | E7           | V <sub>CC</sub> B0  | H7           | IO105NDB1          |
| B8           | IO60RSB0         | E8           | GCC1/IO91PDB1       | H8           | GDB2/IO115RSB2     |
| B9           | GBB0/IO74RSB0    | E9           | V <sub>CC</sub> B1  | H9           | GDC0/IO111NPB1     |
| B10          | GBB1/IO75RSB0    | E10          | V <sub>CC</sub>     | H10          | V <sub>CC</sub> B1 |
| B11          | GND              | E11          | GCA0/IO93NDB1       | H11          | IO101PSB1          |
| B12          | VMV1             | E12          | IO94NDB1            | H12          | V <sub>CC</sub>    |
| C1           | IO224NDB3        | F1           | GFB0/IO208NPB3      | J1           | GEB1/IO189PDB3     |
| C2           | GFA2/IO206PPB3   | F2           | V <sub>COMPLF</sub> | J2           | IO205NDB3          |
| C3           | GAC2/IO223PDB3   | F3           | GFB1/IO208PPB3      | J3           | V <sub>CC</sub> B3 |
| C4           | V <sub>CC</sub>  | F4           | IO206NPB3           | J4           | GEC0/IO190NDB3     |
| C5           | IO16RSB0         | F5           | GND                 | J5           | IO160RSB2          |
| C6           | IO29RSB0         | F6           | GND                 | J6           | IO157RSB2          |
| C7           | IO32RSB0         | F7           | GND                 | J7           | V <sub>CC</sub>    |
| C8           | IO63RSB0         | F8           | GCC0/IO91NDB1       | J8           | TCK                |
| C9           | IO66RSB0         | F9           | GCB0/IO92NPB1       | J9           | GDA2/IO114RSB2     |
| C10          | GBA2/IO78PDB1    | F10          | GND                 | J10          | TDO                |
| C11          | IO78NDB1         | F11          | GCA1/IO93PDB1       | J11          | GDA1/IO113PDB1     |
| C12          | GBC2/IO80PPB1    | F12          | GCA2/IO94PDB1       | J12          | GDB1/IO112PDB1     |

| 144-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL1000 Function   |
| K1           | GEB0/IO189NDB3     |
| K2           | GEA1/IO188PDB3     |
| K3           | GEA0/IO188NDB3     |
| K4           | GEA2/IO187RSB2     |
| K5           | IO169RSB2          |
| K6           | IO152RSB2          |
| K7           | GND                |
| K8           | IO117RSB2          |
| K9           | GDC2/IO116RSB2     |
| K10          | GND                |
| K11          | GDA0/IO113NDB1     |
| K12          | GDB0/IO112NDB1     |
| L1           | GND                |
| L2           | VMV3               |
| L3           | FF/GEB2/IO186RSB2  |
| L4           | IO172RSB2          |
| L5           | V <sub>CC</sub> B2 |
| L6           | IO153RSB2          |
| L7           | IO144RSB2          |
| L8           | IO140RSB2          |
| L9           | TMS                |
| L10          | V <sub>JTAG</sub>  |
| L11          | VMV2               |
| L12          | TRST               |
| M1           | GNDQ               |
| M2           | GEC2/IO185RSB2     |
| M3           | IO173RSB2          |
| M4           | IO168RSB2          |
| M5           | IO161RSB2          |
| M6           | IO156RSB2          |
| M7           | IO145RSB2          |
| M8           | IO141RSB2          |
| M9           | TDI                |
| M10          | V <sub>CC</sub> B2 |
| M11          | V <sub>PUMP</sub>  |
| M12          | GNDQ               |

## 256-Pin FBGA



*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>.

| 256-Pin FBGA |                 |
|--------------|-----------------|
| Pin Number   | AGL400 Function |
| A1           | GND             |
| A2           | GAA0/IO00RSB0   |
| A3           | GAA1/IO01RSB0   |
| A4           | GAB0/IO02RSB0   |
| A5           | IO16RSB0        |
| A6           | IO17RSB0        |
| A7           | IO22RSB0        |
| A8           | IO28RSB0        |
| A9           | IO34RSB0        |
| A10          | IO37RSB0        |
| A11          | IO41RSB0        |
| A12          | IO43RSB0        |
| A13          | GBB1/IO57RSB0   |
| A14          | GBA0/IO58RSB0   |
| A15          | GBA1/IO59RSB0   |
| A16          | GND             |
| B1           | GAB2/IO154UDB3  |
| B2           | GAA2/IO155UDB3  |
| B3           | IO12RSB0        |
| B4           | GAB1/IO03RSB0   |
| B5           | IO13RSB0        |
| B6           | IO14RSB0        |
| B7           | IO21RSB0        |
| B8           | IO27RSB0        |
| B9           | IO32RSB0        |
| B10          | IO38RSB0        |
| B11          | IO42RSB0        |
| B12          | GBC1/IO55RSB0   |
| B13          | GBB0/IO56RSB0   |
| B14          | IO44RSB0        |
| B15          | GBA2/IO60PDB1   |
| B16          | IO60NDB1        |
| C1           | IO154VDB3       |
| C2           | IO155VDB3       |
| C3           | IO11RSB0        |
| C4           | IO07RSB0        |

| 256-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL400 Function    |
| C5           | GAC0/IO04RSB0      |
| C6           | GAC1/IO05RSB0      |
| C7           | IO20RSB0           |
| C8           | IO24RSB0           |
| C9           | IO33RSB0           |
| C10          | IO39RSB0           |
| C11          | IO45RSB0           |
| C12          | GBC0/IO54RSB0      |
| C13          | IO48RSB0           |
| C14          | VMV0               |
| C15          | IO61NPB1           |
| C16          | IO63PDB1           |
| D1           | IO151VDB3          |
| D2           | IO151UDB3          |
| D3           | GAC2/IO153UDB3     |
| D4           | IO06RSB0           |
| D5           | GNDQ               |
| D6           | IO10RSB0           |
| D7           | IO19RSB0           |
| D8           | IO26RSB0           |
| D9           | IO30RSB0           |
| D10          | IO40RSB0           |
| D11          | IO46RSB0           |
| D12          | GNDQ               |
| D13          | IO47RSB0           |
| D14          | GBB2/IO61PPB1      |
| D15          | IO53RSB0           |
| D16          | IO63NDB1           |
| E1           | IO150PDB3          |
| E2           | IO08RSB0           |
| E3           | IO153VDB3          |
| E4           | IO152VDB3          |
| E5           | VMV0               |
| E6           | V <sub>CC</sub> B0 |
| E7           | V <sub>CC</sub> B0 |
| E8           | IO25RSB0           |

| 256-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL400 Function    |
| E9           | IO31RSB0           |
| E10          | V <sub>CC</sub> B0 |
| E11          | V <sub>CC</sub> B0 |
| E12          | VMV1               |
| E13          | GBC2/IO62PDB1      |
| E14          | IO65RSB1           |
| E15          | IO52RSB0           |
| E16          | IO66PDB1           |
| F1           | IO150NDB3          |
| F2           | IO149NPB3          |
| F3           | IO09RSB0           |
| F4           | IO152UDB3          |
| F5           | V <sub>CC</sub> B3 |
| F6           | GND                |
| F7           | V <sub>CC</sub>    |
| F8           | V <sub>CC</sub>    |
| F9           | V <sub>CC</sub>    |
| F10          | V <sub>CC</sub>    |
| F11          | GND                |
| F12          | V <sub>CC</sub> B1 |
| F13          | IO62NDB1           |
| F14          | IO49RSB0           |
| F15          | IO64PPB1           |
| F16          | IO66NDB1           |
| G1           | IO148NDB3          |
| G2           | IO148PDB3          |
| G3           | IO149PPB3          |
| G4           | GFC1/IO147PPB3     |
| G5           | V <sub>CC</sub> B3 |
| G6           | V <sub>CC</sub>    |
| G7           | GND                |
| G8           | GND                |
| G9           | GND                |
| G10          | GND                |
| G11          | V <sub>CC</sub>    |
| G12          | V <sub>CC</sub> B1 |

| 256-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL400 Function     |
| G13          | GCC1/IO67PPB1       |
| G14          | IO64NPB1            |
| G15          | IO73PDB1            |
| G16          | IO73NDB1            |
| H1           | GFB0/IO146NPB3      |
| H2           | GFA0/IO145NDB3      |
| H3           | GFB1/IO146PPB3      |
| H4           | V <sub>COMPLF</sub> |
| H5           | GFC0/IO147NPB3      |
| H6           | V <sub>CC</sub>     |
| H7           | GND                 |
| H8           | GND                 |
| H9           | GND                 |
| H10          | GND                 |
| H11          | V <sub>CC</sub>     |
| H12          | GCC0/IO67NPB1       |
| H13          | GCB1/IO68PPB1       |
| H14          | GCA0/IO69NPB1       |
| H15          | NC                  |
| H16          | GCB0/IO68NPB1       |
| J1           | GFA2/IO144PPB3      |
| J2           | GFA1/IO145PDB3      |
| J3           | V <sub>CCPLF</sub>  |
| J4           | IO143NDB3           |
| J5           | GFB2/IO143PDB3      |
| J6           | V <sub>CC</sub>     |
| J7           | GND                 |
| J8           | GND                 |
| J9           | GND                 |
| J10          | GND                 |
| J11          | V <sub>CC</sub>     |
| J12          | GCB2/IO71PPB1       |
| J13          | GCA1/IO69PPB1       |
| J14          | GCC2/IO72PPB1       |
| J15          | NC                  |
| J16          | GCA2/IO70PDB1       |

| 256-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL400 Function    |
| K1           | GFC2/IO142PDB3     |
| K2           | IO144NPB3          |
| K3           | IO141PPB3          |
| K4           | IO120RSB2          |
| K5           | V <sub>CC</sub> B3 |
| K6           | V <sub>CC</sub>    |
| K7           | GND                |
| K8           | GND                |
| K9           | GND                |
| K10          | GND                |
| K11          | V <sub>CC</sub>    |
| K12          | V <sub>CC</sub> B1 |
| K13          | IO71NPB1           |
| K14          | IO74RSB1           |
| K15          | IO72NPB1           |
| K16          | IO70NDB1           |
| L1           | IO142NDB3          |
| L2           | IO141NPB3          |
| L3           | IO125RSB2          |
| L4           | IO139RSB3          |
| L5           | V <sub>CC</sub> B3 |
| L6           | GND                |
| L7           | V <sub>CC</sub>    |
| L8           | V <sub>CC</sub>    |
| L9           | V <sub>CC</sub>    |
| L10          | V <sub>CC</sub>    |
| L11          | GND                |
| L12          | V <sub>CC</sub> B1 |
| L13          | GDB0/IO78VPB1      |
| L14          | IO76VDB1           |
| L15          | IO76UDB1           |
| L16          | IO75PDB1           |
| M1           | IO140PDB3          |
| M2           | IO130RSB2          |
| M3           | IO138NPB3          |
| M4           | GEC0/IO137NPB3     |

| 256-Pin FBGA |                    |
|--------------|--------------------|
| Pin Number   | AGL400 Function    |
| M5           | VMV3               |
| M6           | V <sub>CC</sub> B2 |
| M7           | V <sub>CC</sub> B2 |
| M8           | IO108RSB2          |
| M9           | IO101RSB2          |
| M10          | V <sub>CC</sub> B2 |
| M11          | V <sub>CC</sub> B2 |
| M12          | VMV2               |
| M13          | IO83RSB2           |
| M14          | GDB1/IO78UPB1      |
| M15          | GDC1/IO77UDB1      |
| M16          | IO75NDB1           |
| N1           | IO140NDB3          |
| N2           | IO138PPB3          |
| N3           | GEC1/IO137PPB3     |
| N4           | IO131RSB2          |
| N5           | GNDQ               |
| N6           | GEA2/IO134RSB2     |
| N7           | IO117RSB2          |
| N8           | IO111RSB2          |
| N9           | IO99RSB2           |
| N10          | IO94RSB2           |
| N11          | IO87RSB2           |
| N12          | GNDQ               |
| N13          | IO93RSB2           |
| N14          | V <sub>JTAG</sub>  |
| N15          | GDC0/IO77VDB1      |
| N16          | GDA1/IO79UDB1      |
| P1           | GEB1/IO136PDB3     |
| P2           | GEB0/IO136NDB3     |
| P3           | VMV2               |
| P4           | IO129RSB2          |
| P5           | IO128RSB2          |
| P6           | IO122RSB2          |
| P7           | IO115RSB2          |
| P8           | IO110RSB2          |

| 256-Pin FBGA |                       |
|--------------|-----------------------|
| Pin Number   | AGL400 Function       |
| P9           | IO98RSB2              |
| P10          | IO95RSB2              |
| P11          | IO88RSB2              |
| P12          | IO84RSB2              |
| P13          | TCK                   |
| P14          | V <sub>PUMP</sub>     |
| P15          | TRST                  |
| P16          | GDA0/IO79VDB1         |
| R1           | GEA1/IO135PDB3        |
| R2           | GEA0/IO135NDB3        |
| R3           | IO127RSB2             |
| R4           | GEC2/IO132RSB2        |
| R5           | IO123RSB2             |
| R6           | IO118RSB2             |
| R7           | IO112RSB2             |
| R8           | IO106RSB2             |
| R9           | IO100RSB2             |
| R10          | IO96RSB2              |
| R11          | IO89RSB2              |
| R12          | IO85RSB2              |
| R13          | GDB2/IO81RSB2         |
| R14          | TDI                   |
| R15          | NC                    |
| R16          | TDO                   |
| T1           | GND                   |
| T2           | IO126RSB2             |
| T3           | FF/GEB2/IO133RSB<br>2 |
| T4           | IO124RSB2             |
| T5           | IO116RSB2             |
| T6           | IO113RSB2             |
| T7           | IO107RSB2             |
| T8           | IO105RSB2             |
| T9           | IO102RSB2             |
| T10          | IO97RSB2              |
| T11          | IO92RSB2              |

| 256-Pin FBGA |                 |
|--------------|-----------------|
| Pin Number   | AGL400 Function |
| T12          | GDC2/IO82RSB2   |
| T13          | IO86RSB2        |
| T14          | GDA2/IO80RSB2   |
| T15          | TMS             |
| T16          | GND             |

| 256-Pin FBGA |                 | 256-Pin FBGA |                     | 256-Pin FBGA |                     |
|--------------|-----------------|--------------|---------------------|--------------|---------------------|
| Pin Number   | AGL600 Function | Pin Number   | AGL600 Function     | Pin Number   | AGL600 Function     |
| A1           | GND             | C7           | IO20RSB0            | E13          | GBC2/IO62PDB1       |
| A2           | GAA0/IO00RSB0   | C8           | IO24RSB0            | E14          | IO67PPB1            |
| A3           | GAA1/IO01RSB0   | C9           | IO33RSB0            | E15          | IO64PPB1            |
| A4           | GAB0/IO02RSB0   | C10          | IO39RSB0            | E16          | IO66PDB1            |
| A5           | IO11RSB0        | C11          | IO44RSB0            | F1           | IO166NDB3           |
| A6           | IO16RSB0        | C12          | GBC0/IO54RSB0       | F2           | IO168NPB3           |
| A7           | IO18RSB0        | C13          | IO51RSB0            | F3           | IO167PPB3           |
| A8           | IO28RSB0        | C14          | VMV0                | F4           | IO169PDB3           |
| A9           | IO34RSB0        | C15          | IO61NPB1            | F5           | V <sub>CCI</sub> B3 |
| A10          | IO37RSB0        | C16          | IO63PDB1            | F6           | GND                 |
| A11          | IO41RSB0        | D1           | IO171NDB3           | F7           | V <sub>CC</sub>     |
| A12          | IO43RSB0        | D2           | IO171PDB3           | F8           | V <sub>CC</sub>     |
| A13          | GBB1/IO57RSB0   | D3           | GAC2/IO172PDB3      | F9           | V <sub>CC</sub>     |
| A14          | GBA0/IO58RSB0   | D4           | IO06RSB0            | F10          | V <sub>CC</sub>     |
| A15          | GBA1/IO59RSB0   | D5           | GNDQ                | F11          | GND                 |
| A16          | GND             | D6           | IO10RSB0            | F12          | V <sub>CCI</sub> B1 |
| B1           | GAB2/IO173PDB3  | D7           | IO19RSB0            | F13          | IO62NDB1            |
| B2           | GAA2/IO174PDB3  | D8           | IO26RSB0            | F14          | IO64NPB1            |
| B3           | GNDQ            | D9           | IO30RSB0            | F15          | IO65PPB1            |
| B4           | GAB1/IO03RSB0   | D10          | IO40RSB0            | F16          | IO66NDB1            |
| B5           | IO13RSB0        | D11          | IO45RSB0            | G1           | IO165NDB3           |
| B6           | IO14RSB0        | D12          | GNDQ                | G2           | IO165PDB3           |
| B7           | IO21RSB0        | D13          | IO50RSB0            | G3           | IO168PPB3           |
| B8           | IO27RSB0        | D14          | GBB2/IO61PPB1       | G4           | GFC1/IO164PPB3      |
| B9           | IO32RSB0        | D15          | IO53RSB0            | G5           | V <sub>CCI</sub> B3 |
| B10          | IO38RSB0        | D16          | IO63NDB1            | G6           | V <sub>CC</sub>     |
| B11          | IO42RSB0        | E1           | IO166PDB3           | G7           | GND                 |
| B12          | GBC1/IO55RSB0   | E2           | IO167NPB3           | G8           | GND                 |
| B13          | GBB0/IO56RSB0   | E3           | IO172NDB3           | G9           | GND                 |
| B14          | IO52RSB0        | E4           | IO169NDB3           | G10          | GND                 |
| B15          | GBA2/IO60PDB1   | E5           | VMV0                | G11          | V <sub>CC</sub>     |
| B16          | IO60NDB1        | E6           | V <sub>CCI</sub> B0 | G12          | V <sub>CCI</sub> B1 |
| C1           | IO173NDB3       | E7           | V <sub>CCI</sub> B0 | G13          | GCC1/IO69PPB1       |
| C2           | IO174NDB3       | E8           | IO25RSB0            | G14          | IO65NPB1            |
| C3           | VMV3            | E9           | IO31RSB0            | G15          | IO75PDB1            |
| C4           | IO07RSB0        | E10          | V <sub>CCI</sub> B0 | G16          | IO75NDB1            |
| C5           | GAC0/IO04RSB0   | E11          | V <sub>CCI</sub> B0 | H1           | GFB0/IO163NPB3      |
| C6           | GAC1/IO05RSB0   | E12          | VMV1                | H2           | GFA0/IO162NDB3      |



| 256-Pin FBGA |                     | 256-Pin FBGA |                    | 256-Pin FBGA |                   |
|--------------|---------------------|--------------|--------------------|--------------|-------------------|
| Pin Number   | AGL600 Function     | Pin Number   | AGL600 Function    | Pin Number   | AGL600 Function   |
| H3           | GFB1/IO163PPB3      | K9           | GND                | M15          | GDC1/IO86PDB1     |
| H4           | V <sub>COMPLF</sub> | K10          | GND                | M16          | IO84NDB1          |
| H5           | GFC0/IO164NPB3      | K11          | V <sub>CC</sub>    | N1           | IO150NDB3         |
| H6           | V <sub>CC</sub>     | K12          | V <sub>CC</sub> B1 | N2           | IO147PPB3         |
| H7           | GND                 | K13          | IO73NPB1           | N3           | GEC1/IO146PPB3    |
| H8           | GND                 | K14          | IO80NPB1           | N4           | IO140RSB2         |
| H9           | GND                 | K15          | IO74NPB1           | N5           | GNDQ              |
| H10          | GND                 | K16          | IO72NDB1           | N6           | GEA2/IO143RSB2    |
| H11          | V <sub>CC</sub>     | L1           | IO159NDB3          | N7           | IO126RSB2         |
| H12          | GCC0/IO69NPB1       | L2           | IO156NPB3          | N8           | IO120RSB2         |
| H13          | GCB1/IO70PPB1       | L3           | IO151PPB3          | N9           | IO108RSB2         |
| H14          | GCA0/IO71NPB1       | L4           | IO158PSB3          | N10          | IO103RSB2         |
| H15          | IO67NPB1            | L5           | V <sub>CC</sub> B3 | N11          | IO99RSB2          |
| H16          | GCB0/IO70NPB1       | L6           | GND                | N12          | GNDQ              |
| J1           | GFA2/IO161PPB3      | L7           | V <sub>CC</sub>    | N13          | IO92RSB2          |
| J2           | GFA1/IO162PDB3      | L8           | V <sub>CC</sub>    | N14          | V <sub>JTAG</sub> |
| J3           | VCCPLF              | L9           | V <sub>CC</sub>    | N15          | GDC0/IO86NDB1     |
| J4           | IO160NDB3           | L10          | V <sub>CC</sub>    | N16          | GDA1/IO88PDB1     |
| J5           | GFB2/IO160PDB3      | L11          | GND                | P1           | GEB1/IO145PDB3    |
| J6           | V <sub>CC</sub>     | L12          | V <sub>CC</sub> B1 | P2           | GEB0/IO145NDB3    |
| J7           | GND                 | L13          | GDB0/IO87NPB1      | P3           | VMV2              |
| J8           | GND                 | L14          | IO85NDB1           | P4           | IO138RSB2         |
| J9           | GND                 | L15          | IO85PDB1           | P5           | IO136RSB2         |
| J10          | GND                 | L16          | IO84PDB1           | P6           | IO131RSB2         |
| J11          | V <sub>CC</sub>     | M1           | IO150PDB3          | P7           | IO124RSB2         |
| J12          | GCB2/IO73PPB1       | M2           | IO151NPB3          | P8           | IO119RSB2         |
| J13          | GCA1/IO71PPB1       | M3           | IO147NPB3          | P9           | IO107RSB2         |
| J14          | GCC2/IO74PPB1       | M4           | GEC0/IO146NPB3     | P10          | IO104RSB2         |
| J15          | IO80PPB1            | M5           | VMV3               | P11          | IO97RSB2          |
| J16          | GCA2/IO72PDB1       | M6           | V <sub>CC</sub> B2 | P12          | VMV1              |
| K1           | GFC2/IO159PDB3      | M7           | V <sub>CC</sub> B2 | P13          | TCK               |
| K2           | IO161NPB3           | M8           | IO117RSB2          | P14          | VPUMP             |
| K3           | IO156PPB3           | M9           | IO110RSB2          | P15          | TRST              |
| K4           | IO129RSB2           | M10          | V <sub>CC</sub> B2 | P16          | GDA0/IO88NDB1     |
| K5           | V <sub>CC</sub> B3  | M11          | V <sub>CC</sub> B2 | R1           | GEA1/IO144PDB3    |
| K6           | V <sub>CC</sub>     | M12          | VMV2               | R2           | GEA0/IO144NDB3    |
| K7           | GND                 | M13          | IO94RSB2           | R3           | IO139RSB2         |
| K8           | GND                 | M14          | GDB1/IO87PPB1      | R4           | GEC2/IO141RSB2    |

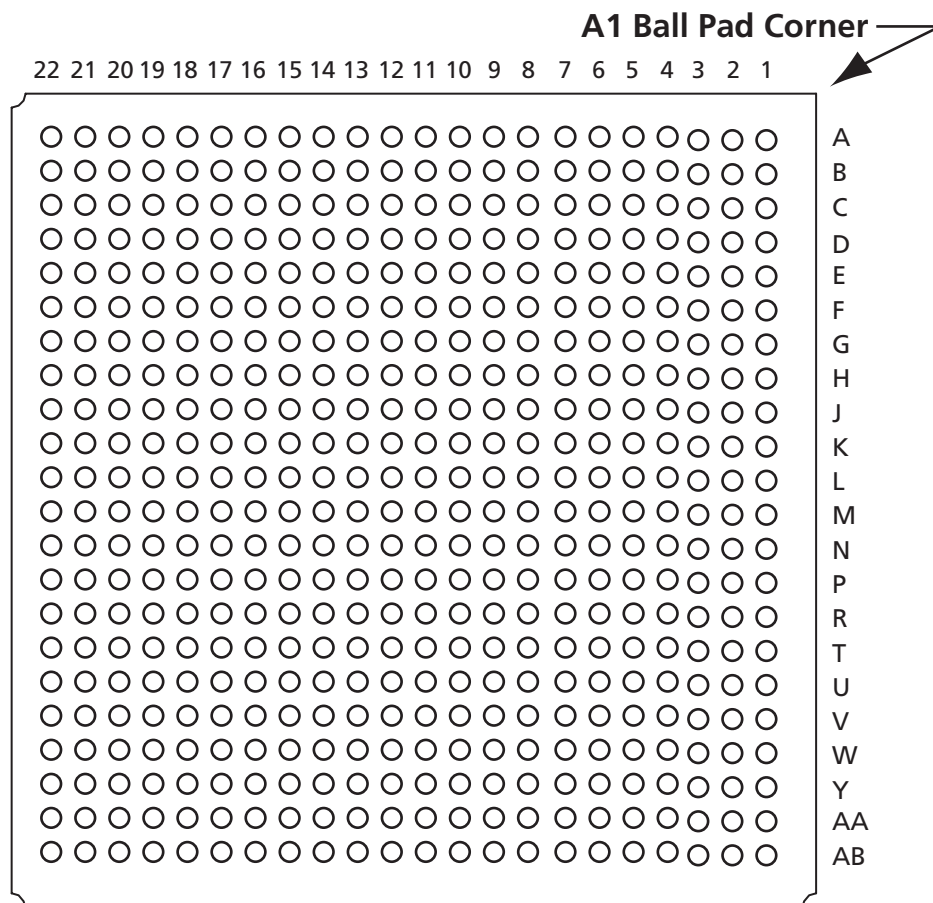
| 256-Pin FBGA |                   |
|--------------|-------------------|
| Pin Number   | AGL600 Function   |
| R5           | IO132RSB2         |
| R6           | IO127RSB2         |
| R7           | IO121RSB2         |
| R8           | IO114RSB2         |
| R9           | IO109RSB2         |
| R10          | IO105RSB2         |
| R11          | IO98RSB2          |
| R12          | IO96RSB2          |
| R13          | GDB2/IO90RSB2     |
| R14          | TDI               |
| R15          | GNDQ              |
| R16          | TDO               |
| T1           | GND               |
| T2           | IO137RSB2         |
| T3           | FF/GEB2/IO142RSB2 |
| T4           | IO134RSB2         |
| T5           | IO125RSB2         |
| T6           | IO123RSB2         |
| T7           | IO118RSB2         |
| T8           | IO115RSB2         |
| T9           | IO111RSB2         |
| T10          | IO106RSB2         |
| T11          | IO102RSB2         |
| T12          | GDC2/IO91RSB2     |
| T13          | IO93RSB2          |
| T14          | GDA2/IO89RSB2     |
| T15          | TMS               |
| T16          | GND               |

| 256-Pin FBGA |                  | 256-Pin FBGA |                    | 256-Pin FBGA |                    |
|--------------|------------------|--------------|--------------------|--------------|--------------------|
| Pin Number   | AGL1000 Function | Pin Number   | AGL1000 Function   | Pin Number   | AGL1000 Function   |
| A1           | GND              | C7           | IO25RSB0           | E13          | GBC2/IO80PDB1      |
| A2           | GAA0/IO00RSB0    | C8           | IO36RSB0           | E14          | IO83PPB1           |
| A3           | GAA1/IO01RSB0    | C9           | IO42RSB0           | E15          | IO86PPB1           |
| A4           | GAB0/IO02RSB0    | C10          | IO49RSB0           | E16          | IO87PDB1           |
| A5           | IO16RSB0         | C11          | IO56RSB0           | F1           | IO217NDB3          |
| A6           | IO22RSB0         | C12          | GBC0/IO72RSB0      | F2           | IO218NDB3          |
| A7           | IO28RSB0         | C13          | IO62RSB0           | F3           | IO216PDB3          |
| A8           | IO35RSB0         | C14          | VMV0               | F4           | IO216NDB3          |
| A9           | IO45RSB0         | C15          | IO78NDB1           | F5           | V <sub>CC</sub> B3 |
| A10          | IO50RSB0         | C16          | IO81NDB1           | F6           | GND                |
| A11          | IO55RSB0         | D1           | IO222NDB3          | F7           | V <sub>CC</sub>    |
| A12          | IO61RSB0         | D2           | IO222PDB3          | F8           | V <sub>CC</sub>    |
| A13          | GBB1/IO75RSB0    | D3           | GAC2/IO223PDB3     | F9           | V <sub>CC</sub>    |
| A14          | GBA0/IO76RSB0    | D4           | IO223NDB3          | F10          | V <sub>CC</sub>    |
| A15          | GBA1/IO77RSB0    | D5           | GNDQ               | F11          | GND                |
| A16          | GND              | D6           | IO23RSB0           | F12          | V <sub>CC</sub> B1 |
| B1           | GAB2/IO224PDB3   | D7           | IO29RSB0           | F13          | IO83NPB1           |
| B2           | GAA2/IO225PDB3   | D8           | IO33RSB0           | F14          | IO86NPB1           |
| B3           | GNDQ             | D9           | IO46RSB0           | F15          | IO90PPB1           |
| B4           | GAB1/IO03RSB0    | D10          | IO52RSB0           | F16          | IO87NDB1           |
| B5           | IO17RSB0         | D11          | IO60RSB0           | G1           | IO210PSB3          |
| B6           | IO21RSB0         | D12          | GNDQ               | G2           | IO213NDB3          |
| B7           | IO27RSB0         | D13          | IO80NDB1           | G3           | IO213PDB3          |
| B8           | IO34RSB0         | D14          | GBB2/IO79PDB1      | G4           | GFC1/IO209PPB3     |
| B9           | IO44RSB0         | D15          | IO79NDB1           | G5           | V <sub>CC</sub> B3 |
| B10          | IO51RSB0         | D16          | IO82NSB1           | G6           | V <sub>CC</sub>    |
| B11          | IO57RSB0         | E1           | IO217PDB3          | G7           | GND                |
| B12          | GBC1/IO73RSB0    | E2           | IO218PDB3          | G8           | GND                |
| B13          | GBB0/IO74RSB0    | E3           | IO221NDB3          | G9           | GND                |
| B14          | IO71RSB0         | E4           | IO221PDB3          | G10          | GND                |
| B15          | GBA2/IO78PDB1    | E5           | VMV0               | G11          | V <sub>CC</sub>    |
| B16          | IO81PDB1         | E6           | V <sub>CC</sub> B0 | G12          | V <sub>CC</sub> B1 |
| C1           | IO224NDB3        | E7           | V <sub>CC</sub> B0 | G13          | GCC1/IO91PPB1      |
| C2           | IO225NDB3        | E8           | IO38RSB0           | G14          | IO90NPB1           |
| C3           | VMV3             | E9           | IO47RSB0           | G15          | IO88PDB1           |
| C4           | IO11RSB0         | E10          | V <sub>CC</sub> B0 | G16          | IO88NDB1           |
| C5           | GAC0/IO04RSB0    | E11          | V <sub>CC</sub> B0 | H1           | GFB0/IO208NPB3     |
| C6           | GAC1/IO05RSB0    | E12          | VMV1               | H2           | GFA0/IO207NDB3     |

| 256-Pin FBGA |                     | 256-Pin FBGA |                    | 256-Pin FBGA |                   |
|--------------|---------------------|--------------|--------------------|--------------|-------------------|
| Pin Number   | AGL1000 Function    | Pin Number   | AGL1000 Function   | Pin Number   | AGL1000 Function  |
| H3           | GFB1/IO208PPB3      | K9           | GND                | M15          | GDC1/IO111PDB1    |
| H4           | V <sub>COMPLF</sub> | K10          | GND                | M16          | IO107NDB1         |
| H5           | GFC0/IO209NPB3      | K11          | V <sub>CC</sub>    | N1           | IO194PSB3         |
| H6           | V <sub>CC</sub>     | K12          | V <sub>CC</sub> B1 | N2           | IO192PPB3         |
| H7           | GND                 | K13          | IO95NPB1           | N3           | GEC1/IO190PPB3    |
| H8           | GND                 | K14          | IO100NPB1          | N4           | IO192NPB3         |
| H9           | GND                 | K15          | IO102NDB1          | N5           | GNDQ              |
| H10          | GND                 | K16          | IO102PDB1          | N6           | GEA2/IO187RSB2    |
| H11          | V <sub>CC</sub>     | L1           | IO202NDB3          | N7           | IO161RSB2         |
| H12          | GCC0/IO91NPB1       | L2           | IO202PDB3          | N8           | IO155RSB2         |
| H13          | GCB1/IO92PPB1       | L3           | IO196PPB3          | N9           | IO141RSB2         |
| H14          | GCA0/IO93NPB1       | L4           | IO193PPB3          | N10          | IO129RSB2         |
| H15          | IO96NPB1            | L5           | V <sub>CC</sub> B3 | N11          | IO124RSB2         |
| H16          | GCB0/IO92NPB1       | L6           | GND                | N12          | GNDQ              |
| J1           | GFA2/IO206PSB3      | L7           | V <sub>CC</sub>    | N13          | IO110PDB1         |
| J2           | GFA1/IO207PDB3      | L8           | V <sub>CC</sub>    | N14          | V <sub>JTAG</sub> |
| J3           | V <sub>CCPLF</sub>  | L9           | V <sub>CC</sub>    | N15          | GDC0/IO111NDB1    |
| J4           | IO205NDB3           | L10          | V <sub>CC</sub>    | N16          | GDA1/IO113PDB1    |
| J5           | GFB2/IO205PDB3      | L11          | GND                | P1           | GEB1/IO189PDB3    |
| J6           | V <sub>CC</sub>     | L12          | V <sub>CC</sub> B1 | P2           | GEB0/IO189NDB3    |
| J7           | GND                 | L13          | GDB0/IO112NPB1     | P3           | VMV2              |
| J8           | GND                 | L14          | IO106NDB1          | P4           | IO179RSB2         |
| J9           | GND                 | L15          | IO106PDB1          | P5           | IO171RSB2         |
| J10          | GND                 | L16          | IO107PDB1          | P6           | IO165RSB2         |
| J11          | V <sub>CC</sub>     | M1           | IO197NSB3          | P7           | IO159RSB2         |
| J12          | GCB2/IO95PPB1       | M2           | IO196NPB3          | P8           | IO151RSB2         |
| J13          | GCA1/IO93PPB1       | M3           | IO193NPB3          | P9           | IO137RSB2         |
| J14          | GCC2/IO96PPB1       | M4           | GEC0/IO190NPB3     | P10          | IO134RSB2         |
| J15          | IO100PPB1           | M5           | VMV3               | P11          | IO128RSB2         |
| J16          | GCA2/IO94PSB1       | M6           | V <sub>CC</sub> B2 | P12          | VMV1              |
| K1           | GFC2/IO204PDB3      | M7           | V <sub>CC</sub> B2 | P13          | TCK               |
| K2           | IO204NDB3           | M8           | IO147RSB2          | P14          | V <sub>PUMP</sub> |
| K3           | IO203NDB3           | M9           | IO136RSB2          | P15          | TRST              |
| K4           | IO203PDB3           | M10          | V <sub>CC</sub> B2 | P16          | GDA0/IO113NDB1    |
| K5           | V <sub>CC</sub> B3  | M11          | V <sub>CC</sub> B2 | R1           | GEA1/IO188PDB3    |
| K6           | V <sub>CC</sub>     | M12          | VMV2               | R2           | GEA0/IO188NDB3    |
| K7           | GND                 | M13          | IO110NDB1          | R3           | IO184RSB2         |
| K8           | GND                 | M14          | GDB1/IO112PPB1     | R4           | GEC2/IO185RSB2    |

| 256-Pin FBGA |                   |
|--------------|-------------------|
| Pin Number   | AGL1000 Function  |
| R5           | IO168RSB2         |
| R6           | IO163RSB2         |
| R7           | IO157RSB2         |
| R8           | IO149RSB2         |
| R9           | IO143RSB2         |
| R10          | IO138RSB2         |
| R11          | IO131RSB2         |
| R12          | IO125RSB2         |
| R13          | GDB2/IO115RSB2    |
| R14          | TDI               |
| R15          | GNDQ              |
| R16          | TDO               |
| T1           | GND               |
| T2           | IO183RSB2         |
| T3           | FF/GEB2/IO186RSB2 |
| T4           | IO172RSB2         |
| T5           | IO170RSB2         |
| T6           | IO164RSB2         |
| T7           | IO158RSB2         |
| T8           | IO153RSB2         |
| T9           | IO142RSB2         |
| T10          | IO135RSB2         |
| T11          | IO130RSB2         |
| T12          | GDC2/IO116RSB2    |
| T13          | IO120RSB2         |
| T14          | GDA2/IO114RSB2    |
| T15          | TMS               |
| T16          | GND               |

## 484-Pin FBGA



*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 FBGA |                      | 484-Pin FBGA |                      | 484-Pin FBGA |                      |
|--------------|----------------------|--------------|----------------------|--------------|----------------------|
| Pin Number   | AGL400 Function      | Pin Number   | AGL400 Function      | Pin Number   | AGL400 Function      |
| A1           | GND                  | AA15         | NC                   | B7           | NC                   |
| A2           | GND                  | AA16         | NC                   | B8           | NC                   |
| A3           | V <sub>CC</sub> I B0 | AA17         | NC                   | B9           | NC                   |
| A4           | NC                   | AA18         | NC                   | B10          | NC                   |
| A5           | NC                   | AA19         | NC                   | B11          | NC                   |
| A6           | IO15RSB0             | AA20         | NC                   | B12          | NC                   |
| A7           | IO18RSB0             | AA21         | V <sub>CC</sub> I B1 | B13          | NC                   |
| A8           | NC                   | AA22         | GND                  | B14          | NC                   |
| A9           | NC                   | AB1          | GND                  | B15          | NC                   |
| A10          | IO23RSB0             | AB2          | GND                  | B16          | NC                   |
| A11          | IO29RSB0             | AB3          | V <sub>CC</sub> I B2 | B17          | NC                   |
| A12          | IO35RSB0             | AB4          | NC                   | B18          | NC                   |
| A13          | IO36RSB0             | AB5          | NC                   | B19          | NC                   |
| A14          | NC                   | AB6          | IO121RSB2            | B20          | NC                   |
| A15          | NC                   | AB7          | IO119RSB2            | B21          | V <sub>CC</sub> I B1 |
| A16          | IO50RSB0             | AB8          | IO114RSB2            | B22          | GND                  |
| A17          | IO51RSB0             | AB9          | IO109RSB2            | C1           | V <sub>CC</sub> I B3 |
| A18          | NC                   | AB10         | NC                   | C2           | NC                   |
| A19          | NC                   | AB11         | NC                   | C3           | NC                   |
| A20          | V <sub>CC</sub> I B0 | AB12         | IO104RSB2            | C4           | NC                   |
| A21          | GND                  | AB13         | IO103RSB2            | C5           | GND                  |
| A22          | GND                  | AB14         | NC                   | C6           | NC                   |
| AA1          | GND                  | AB15         | NC                   | C7           | NC                   |
| AA2          | V <sub>CC</sub> I B3 | AB16         | IO91RSB2             | C8           | V <sub>CC</sub>      |
| AA3          | NC                   | AB17         | IO90RSB2             | C9           | V <sub>CC</sub>      |
| AA4          | NC                   | AB18         | NC                   | C10          | NC                   |
| AA5          | NC                   | AB19         | NC                   | C11          | NC                   |
| AA6          | NC                   | AB20         | V <sub>CC</sub> I B2 | C12          | NC                   |
| AA7          | NC                   | AB21         | GND                  | C13          | NC                   |
| AA8          | NC                   | AB22         | GND                  | C14          | V <sub>CC</sub>      |
| AA9          | NC                   | B1           | GND                  | C15          | V <sub>CC</sub>      |
| AA10         | NC                   | B2           | V <sub>CC</sub> I B3 | C16          | NC                   |
| AA11         | NC                   | B3           | NC                   | C17          | NC                   |
| AA12         | NC                   | B4           | NC                   | C18          | GND                  |
| AA13         | NC                   | B5           | NC                   | C19          | NC                   |
| AA14         | NC                   | B6           | NC                   | C20          | NC                   |

| 484-Pin FBGA |                    | 484-Pin FBGA |                 | 484-Pin FBGA |                    |
|--------------|--------------------|--------------|-----------------|--------------|--------------------|
| Pin Number   | AGL400 Function    | Pin Number   | AGL400 Function | Pin Number   | AGL400 Function    |
| C21          | NC                 | E13          | IO38RSB0        | G5           | IO151UDB3          |
| C22          | V <sub>CC</sub> B1 | E14          | IO42RSB0        | G6           | GAC2/IO153UDB3     |
| D1           | NC                 | E15          | GBC1/IO55RSB0   | G7           | IO06RSB0           |
| D2           | NC                 | E16          | GBB0/IO56RSB0   | G8           | GNDQ               |
| D3           | NC                 | E17          | IO44RSB0        | G9           | IO10RSB0           |
| D4           | GND                | E18          | GBA2/IO60PDB1   | G10          | IO19RSB0           |
| D5           | GAA0/IO00RSB0      | E19          | IO60NDB1        | G11          | IO26RSB0           |
| D6           | GAA1/IO01RSB0      | E20          | GND             | G12          | IO30RSB0           |
| D7           | GAB0/IO02RSB0      | E21          | NC              | G13          | IO40RSB0           |
| D8           | IO16RSB0           | E22          | NC              | G14          | IO46RSB0           |
| D9           | IO17RSB0           | F1           | NC              | G15          | GNDQ               |
| D10          | IO22RSB0           | F2           | NC              | G16          | IO47RSB0           |
| D11          | IO28RSB0           | F3           | NC              | G17          | GBB2/IO61PPB1      |
| D12          | IO34RSB0           | F4           | IO154VDB3       | G18          | IO53RSB0           |
| D13          | IO37RSB0           | F5           | IO155VDB3       | G19          | IO63NDB1           |
| D14          | IO41RSB0           | F6           | IO11RSB0        | G20          | NC                 |
| D15          | IO43RSB0           | F7           | IO07RSB0        | G21          | NC                 |
| D16          | GBB1/IO57RSB0      | F8           | GAC0/IO04RSB0   | G22          | NC                 |
| D17          | GBA0/IO58RSB0      | F9           | GAC1/IO05RSB0   | H1           | NC                 |
| D18          | GBA1/IO59RSB0      | F10          | IO20RSB0        | H2           | NC                 |
| D19          | GND                | F11          | IO24RSB0        | H3           | V <sub>CC</sub>    |
| D20          | NC                 | F12          | IO33RSB0        | H4           | IO150PDB3          |
| D21          | NC                 | F13          | IO39RSB0        | H5           | IO08RSB0           |
| D22          | NC                 | F14          | IO45RSB0        | H6           | IO153VDB3          |
| E1           | NC                 | F15          | GBC0/IO54RSB0   | H7           | IO152VDB3          |
| E2           | NC                 | F16          | IO48RSB0        | H8           | VMV0               |
| E3           | GND                | F17          | VMV0            | H9           | V <sub>CC</sub> B0 |
| E4           | GAB2/IO154UDB3     | F18          | IO61NPB1        | H10          | V <sub>CC</sub> B0 |
| E5           | GAA2/IO155UDB3     | F19          | IO63PDB1        | H11          | IO25RSB0           |
| E6           | IO12RSB0           | F20          | NC              | H12          | IO31RSB0           |
| E7           | GAB1/IO03RSB0      | F21          | NC              | H13          | V <sub>CC</sub> B0 |
| E8           | IO13RSB0           | F22          | NC              | H14          | V <sub>CC</sub> B0 |
| E9           | IO14RSB0           | G1           | NC              | H15          | VMV1               |
| E10          | IO21RSB0           | G2           | NC              | H16          | GBC2/IO62PDB1      |
| E11          | IO27RSB0           | G3           | NC              | H17          | IO65RSB1           |
| E12          | IO32RSB0           | G4           | IO151VDB3       | H18          | IO52RSB0           |



| 484-Pin FBGA |                    | 484-Pin FBGA |                     | 484-Pin FBGA |                    |
|--------------|--------------------|--------------|---------------------|--------------|--------------------|
| Pin Number   | AGL400 Function    | Pin Number   | AGL400 Function     | Pin Number   | AGL400 Function    |
| H19          | IO66PDB1           | K11          | GND                 | M3           | NC                 |
| H20          | V <sub>CC</sub>    | K12          | GND                 | M4           | GFA2/IO144PPB3     |
| H21          | NC                 | K13          | GND                 | M5           | GFA1/IO145PDB3     |
| H22          | NC                 | K14          | V <sub>CC</sub>     | M6           | V <sub>CCPLF</sub> |
| J1           | NC                 | K15          | V <sub>CC</sub> B1  | M7           | IO143NDB3          |
| J2           | NC                 | K16          | GCC1/IO67PPB1       | M8           | GFB2/IO143PDB3     |
| J3           | NC                 | K17          | IO64NPB1            | M9           | V <sub>CC</sub>    |
| J4           | IO150NDB3          | K18          | IO73PDB1            | M10          | GND                |
| J5           | IO149NPB3          | K19          | IO73NDB1            | M11          | GND                |
| J6           | IO09RSB0           | K20          | NC                  | M12          | GND                |
| J7           | IO152UDB3          | K21          | NC                  | M13          | GND                |
| J8           | V <sub>CC</sub> B3 | K22          | NC                  | M14          | V <sub>CC</sub>    |
| J9           | GND                | L1           | NC                  | M15          | GCB2/IO71PPB1      |
| J10          | V <sub>CC</sub>    | L2           | NC                  | M16          | GCA1/IO69PPB1      |
| J11          | V <sub>CC</sub>    | L3           | NC                  | M17          | GCC2/IO72PPB1      |
| J12          | V <sub>CC</sub>    | L4           | GFB0/IO146NPB3      | M18          | NC                 |
| J13          | V <sub>CC</sub>    | L5           | GFA0/IO145NDB3      | M19          | GCA2/IO70PDB1      |
| J14          | GND                | L6           | GFB1/IO146PPB3      | M20          | NC                 |
| J15          | V <sub>CC</sub> B1 | L7           | V <sub>COMPLF</sub> | M21          | NC                 |
| J16          | IO62NDB1           | L8           | GFC0/IO147NPB3      | M22          | NC                 |
| J17          | IO49RSB0           | L9           | V <sub>CC</sub>     | N1           | NC                 |
| J18          | IO64PPB1           | L10          | GND                 | N2           | NC                 |
| J19          | IO66NDB1           | L11          | GND                 | N3           | NC                 |
| J20          | NC                 | L12          | GND                 | N4           | GFC2/IO142PDB3     |
| J21          | NC                 | L13          | GND                 | N5           | IO144NPB3          |
| J22          | NC                 | L14          | V <sub>CC</sub>     | N6           | IO141PPB3          |
| K1           | NC                 | L15          | GCC0/IO67NPB1       | N7           | IO120RSB2          |
| K2           | NC                 | L16          | GCB1/IO68PPB1       | N8           | V <sub>CC</sub> B3 |
| K3           | NC                 | L17          | GCA0/IO69NPB1       | N9           | V <sub>CC</sub>    |
| K4           | IO148NDB3          | L18          | NC                  | N10          | GND                |
| K5           | IO148PDB3          | L19          | GCB0/IO68NPB1       | N11          | GND                |
| K6           | IO149PPB3          | L20          | NC                  | N12          | GND                |
| K7           | GFC1/IO147PPB3     | L21          | NC                  | N13          | GND                |
| K8           | V <sub>CC</sub> B3 | L22          | NC                  | N14          | V <sub>CC</sub>    |
| K9           | V <sub>CC</sub>    | M1           | NC                  | N15          | V <sub>CC</sub> B1 |
| K10          | GND                | M2           | NC                  | N16          | IO71NPB1           |

| 484-Pin FBGA |                    | 484-Pin FBGA |                    | 484-Pin FBGA |                   |
|--------------|--------------------|--------------|--------------------|--------------|-------------------|
| Pin Number   | AGL400 Function    | Pin Number   | AGL400 Function    | Pin Number   | AGL400 Function   |
| N17          | IO74RSB1           | R9           | V <sub>CC</sub> B2 | U1           | NC                |
| N18          | IO72NPB1           | R10          | V <sub>CC</sub> B2 | U2           | NC                |
| N19          | IO70NDB1           | R11          | IO108RSB2          | U3           | NC                |
| N20          | NC                 | R12          | IO101RSB2          | U4           | GEB1/IO136PDB3    |
| N21          | NC                 | R13          | V <sub>CC</sub> B2 | U5           | GEB0/IO136NDB3    |
| N22          | NC                 | R14          | V <sub>CC</sub> B2 | U6           | VMV2              |
| P1           | NC                 | R15          | VMV2               | U7           | IO129RSB2         |
| P2           | NC                 | R16          | IO83RSB2           | U8           | IO128RSB2         |
| P3           | NC                 | R17          | GDB1/IO78UPB1      | U9           | IO122RSB2         |
| P4           | IO142NDB3          | R18          | GDC1/IO77UDB1      | U10          | IO115RSB2         |
| P5           | IO141NPB3          | R19          | IO75NDB1           | U11          | IO110RSB2         |
| P6           | IO125RSB2          | R20          | V <sub>CC</sub>    | U12          | IO98RSB2          |
| P7           | IO139RSB3          | R21          | NC                 | U13          | IO95RSB2          |
| P8           | V <sub>CC</sub> B3 | R22          | NC                 | U14          | IO88RSB2          |
| P9           | GND                | T1           | NC                 | U15          | IO84RSB2          |
| P10          | V <sub>CC</sub>    | T2           | NC                 | U16          | TCK               |
| P11          | V <sub>CC</sub>    | T3           | NC                 | U17          | V <sub>PUMP</sub> |
| P12          | V <sub>CC</sub>    | T4           | IO140NDB3          | U18          | TRST              |
| P13          | V <sub>CC</sub>    | T5           | IO138PPB3          | U19          | GDA0/IO79VDB1     |
| P14          | GND                | T6           | GEC1/IO137PPB3     | U20          | NC                |
| P15          | V <sub>CC</sub> B1 | T7           | IO131RSB2          | U21          | NC                |
| P16          | GDB0/IO78VPB1      | T8           | GNDQ               | U22          | NC                |
| P17          | IO76VDB1           | T9           | GEA2/IO134RSB2     | V1           | NC                |
| P18          | IO76UDB1           | T10          | IO117RSB2          | V2           | NC                |
| P19          | IO75PDB1           | T11          | IO111RSB2          | V3           | GND               |
| P20          | NC                 | T12          | IO99RSB2           | V4           | GEA1/IO135PDB3    |
| P21          | NC                 | T13          | IO94RSB2           | V5           | GEA0/IO135NDB3    |
| P22          | NC                 | T14          | IO87RSB2           | V6           | IO127RSB2         |
| R1           | NC                 | T15          | GNDQ               | V7           | GEC2/IO132RSB2    |
| R2           | NC                 | T16          | IO93RSB2           | V8           | IO123RSB2         |
| R3           | V <sub>CC</sub>    | T17          | V <sub>JTAG</sub>  | V9           | IO118RSB2         |
| R4           | IO140PDB3          | T18          | GDC0/IO77VDB1      | V10          | IO112RSB2         |
| R5           | IO130RSB2          | T19          | GDA1/IO79UDB1      | V11          | IO106RSB2         |
| R6           | IO138NPB3          | T20          | NC                 | V12          | IO100RSB2         |
| R7           | GEC0/IO137NPB3     | T21          | NC                 | V13          | IO96RSB2          |
| R8           | VMV3               | T22          | NC                 | V14          | IO89RSB2          |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL400 Function     |
| V15          | IO85RSB2            |
| V16          | GDB2/IO81RSB2       |
| V17          | TDI                 |
| V18          | NC                  |
| V19          | TDO                 |
| V20          | GND                 |
| V21          | NC                  |
| V22          | NC                  |
| W1           | NC                  |
| W2           | NC                  |
| W3           | NC                  |
| W4           | GND                 |
| W5           | IO126RSB2           |
| W6           | FF/GEB2/IO133RSB2   |
| W7           | IO124RSB2           |
| W8           | IO116RSB2           |
| W9           | IO113RSB2           |
| W10          | IO107RSB2           |
| W11          | IO105RSB2           |
| W12          | IO102RSB2           |
| W13          | IO97RSB2            |
| W14          | IO92RSB2            |
| W15          | GDC2/IO82RSB2       |
| W16          | IO86RSB2            |
| W17          | GDA2/IO80RSB2       |
| W18          | TMS                 |
| W19          | GND                 |
| W20          | NC                  |
| W21          | NC                  |
| W22          | NC                  |
| Y1           | V <sub>CCI</sub> B3 |
| Y2           | NC                  |
| Y3           | NC                  |
| Y4           | NC                  |
| Y5           | GND                 |
| Y6           | NC                  |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL400 Function     |
| Y7           | NC                  |
| Y8           | V <sub>CC</sub>     |
| Y9           | V <sub>CC</sub>     |
| Y10          | NC                  |
| Y11          | NC                  |
| Y12          | NC                  |
| Y13          | NC                  |
| Y14          | V <sub>CC</sub>     |
| Y15          | V <sub>CC</sub>     |
| Y16          | NC                  |
| Y17          | NC                  |
| Y18          | GND                 |
| Y19          | NC                  |
| Y20          | NC                  |
| Y21          | NC                  |
| Y22          | V <sub>CCI</sub> B1 |

| 484-Pin FBGA |                      | 484-Pin FBGA |                      | 484-Pin FBGA |                      |
|--------------|----------------------|--------------|----------------------|--------------|----------------------|
| Pin Number   | AGL600 Function      | Pin Number   | AGL600 Function      | Pin Number   | AGL600 Function      |
| A1           | GND                  | AA15         | NC                   | B7           | IO12RSB0             |
| A2           | GND                  | AA16         | IO101RSB2            | B8           | NC                   |
| A3           | V <sub>CC</sub> I B0 | AA17         | NC                   | B9           | NC                   |
| A4           | NC                   | AA18         | NC                   | B10          | IO17RSB0             |
| A5           | NC                   | AA19         | NC                   | B11          | NC                   |
| A6           | IO09RSB0             | AA20         | NC                   | B12          | NC                   |
| A7           | IO15RSB0             | AA21         | V <sub>CC</sub> I B1 | B13          | IO36RSB0             |
| A8           | NC                   | AA22         | GND                  | B14          | NC                   |
| A9           | NC                   | AB1          | GND                  | B15          | NC                   |
| A10          | IO22RSB0             | AB2          | GND                  | B16          | IO47RSB0             |
| A11          | IO23RSB0             | AB3          | V <sub>CC</sub> I B2 | B17          | IO49RSB0             |
| A12          | IO29RSB0             | AB4          | NC                   | B18          | NC                   |
| A13          | IO35RSB0             | AB5          | NC                   | B19          | NC                   |
| A14          | NC                   | AB6          | IO130RSB2            | B20          | NC                   |
| A15          | NC                   | AB7          | IO128RSB2            | B21          | V <sub>CC</sub> I B1 |
| A16          | IO46RSB0             | AB8          | IO122RSB2            | B22          | GND                  |
| A17          | IO48RSB0             | AB9          | IO116RSB2            | C1           | V <sub>CC</sub> I B3 |
| A18          | NC                   | AB10         | NC                   | C2           | NC                   |
| A19          | NC                   | AB11         | NC                   | C3           | NC                   |
| A20          | V <sub>CC</sub> I B0 | AB12         | IO113RSB2            | C4           | NC                   |
| A21          | GND                  | AB13         | IO112RSB2            | C5           | GND                  |
| A22          | GND                  | AB14         | NC                   | C6           | NC                   |
| AA1          | GND                  | AB15         | NC                   | C7           | NC                   |
| AA2          | V <sub>CC</sub> I B3 | AB16         | IO100RSB2            | C8           | V <sub>CC</sub>      |
| AA3          | NC                   | AB17         | IO95RSB2             | C9           | V <sub>CC</sub>      |
| AA4          | NC                   | AB18         | NC                   | C10          | NC                   |
| AA5          | NC                   | AB19         | NC                   | C11          | NC                   |
| AA6          | IO135RSB2            | AB20         | V <sub>CC</sub> I B2 | C12          | NC                   |
| AA7          | IO133RSB2            | AB21         | GND                  | C13          | NC                   |
| AA8          | NC                   | AB22         | GND                  | C14          | V <sub>CC</sub>      |
| AA9          | NC                   | B1           | GND                  | C15          | V <sub>CC</sub>      |
| AA10         | NC                   | B2           | V <sub>CC</sub> I B3 | C16          | NC                   |
| AA11         | NC                   | B3           | NC                   | C17          | NC                   |
| AA12         | NC                   | B4           | NC                   | C18          | GND                  |
| AA13         | NC                   | B5           | NC                   | C19          | NC                   |
| AA14         | NC                   | B6           | IO08RSB0             | C20          | NC                   |

| 484-Pin FBGA |                     | 484-Pin FBGA |                 | 484-Pin FBGA |                     |
|--------------|---------------------|--------------|-----------------|--------------|---------------------|
| Pin Number   | AGL600 Function     | Pin Number   | AGL600 Function | Pin Number   | AGL600 Function     |
| C21          | NC                  | E13          | IO38RSB0        | G5           | IO171PDB3           |
| C22          | V <sub>CCI</sub> B1 | E14          | IO42RSB0        | G6           | GAC2/IO172PDB3      |
| D1           | NC                  | E15          | GBC1/IO55RSB0   | G7           | IO06RSB0            |
| D2           | NC                  | E16          | GBB0/IO56RSB0   | G8           | GNDQ                |
| D3           | NC                  | E17          | IO52RSB0        | G9           | IO10RSB0            |
| D4           | GND                 | E18          | GBA2/IO60PDB1   | G10          | IO19RSB0            |
| D5           | GAA0/IO00RSB0       | E19          | IO60NDB1        | G11          | IO26RSB0            |
| D6           | GAA1/IO01RSB0       | E20          | GND             | G12          | IO30RSB0            |
| D7           | GAB0/IO02RSB0       | E21          | NC              | G13          | IO40RSB0            |
| D8           | IO11RSB0            | E22          | NC              | G14          | IO45RSB0            |
| D9           | IO16RSB0            | F1           | NC              | G15          | GNDQ                |
| D10          | IO18RSB0            | F2           | NC              | G16          | IO50RSB0            |
| D11          | IO28RSB0            | F3           | NC              | G17          | GBB2/IO61PPB1       |
| D12          | IO34RSB0            | F4           | IO173NDB3       | G18          | IO53RSB0            |
| D13          | IO37RSB0            | F5           | IO174NDB3       | G19          | IO63NDB1            |
| D14          | IO41RSB0            | F6           | VMV3            | G20          | NC                  |
| D15          | IO43RSB0            | F7           | IO07RSB0        | G21          | NC                  |
| D16          | GBB1/IO57RSB0       | F8           | GAC0/IO04RSB0   | G22          | NC                  |
| D17          | GBA0/IO58RSB0       | F9           | GAC1/IO05RSB0   | H1           | NC                  |
| D18          | GBA1/IO59RSB0       | F10          | IO20RSB0        | H2           | NC                  |
| D19          | GND                 | F11          | IO24RSB0        | H3           | V <sub>CC</sub>     |
| D20          | NC                  | F12          | IO33RSB0        | H4           | IO166PDB3           |
| D21          | NC                  | F13          | IO39RSB0        | H5           | IO167NPB3           |
| D22          | NC                  | F14          | IO44RSB0        | H6           | IO172NDB3           |
| E1           | NC                  | F15          | GBC0/IO54RSB0   | H7           | IO169NDB3           |
| E2           | NC                  | F16          | IO51RSB0        | H8           | VMV0                |
| E3           | GND                 | F17          | VMV0            | H9           | V <sub>CCI</sub> B0 |
| E4           | GAB2/IO173PDB3      | F18          | IO61NPB1        | H10          | V <sub>CCI</sub> B0 |
| E5           | GAA2/IO174PDB3      | F19          | IO63PDB1        | H11          | IO25RSB0            |
| E6           | GNDQ                | F20          | NC              | H12          | IO31RSB0            |
| E7           | GAB1/IO03RSB0       | F21          | NC              | H13          | V <sub>CCI</sub> B0 |
| E8           | IO13RSB0            | F22          | NC              | H14          | V <sub>CCI</sub> B0 |
| E9           | IO14RSB0            | G1           | IO170NDB3       | H15          | VMV1                |
| E10          | IO21RSB0            | G2           | IO170PDB3       | H16          | GBC2/IO62PDB1       |
| E11          | IO27RSB0            | G3           | NC              | H17          | IO67PPB1            |
| E12          | IO32RSB0            | G4           | IO171NDB3       | H18          | IO64PPB1            |

| 484-Pin FBGA |                    | 484-Pin FBGA |                     | 484-Pin FBGA |                    |
|--------------|--------------------|--------------|---------------------|--------------|--------------------|
| Pin Number   | AGL600 Function    | Pin Number   | AGL600 Function     | Pin Number   | AGL600 Function    |
| H19          | IO66PDB1           | K11          | GND                 | M3           | IO158NPB3          |
| H20          | V <sub>CC</sub>    | K12          | GND                 | M4           | GFA2/IO161PPB3     |
| H21          | NC                 | K13          | GND                 | M5           | GFA1/IO162PDB3     |
| H22          | NC                 | K14          | V <sub>CC</sub>     | M6           | V <sub>CCPLF</sub> |
| J1           | NC                 | K15          | V <sub>CC</sub> B1  | M7           | IO160NDB3          |
| J2           | NC                 | K16          | GCC1/IO69PPB1       | M8           | GFB2/IO160PDB3     |
| J3           | NC                 | K17          | IO65NPB1            | M9           | V <sub>CC</sub>    |
| J4           | IO166NDB3          | K18          | IO75PDB1            | M10          | GND                |
| J5           | IO168NPB3          | K19          | IO75NDB1            | M11          | GND                |
| J6           | IO167PPB3          | K20          | NC                  | M12          | GND                |
| J7           | IO169PDB3          | K21          | IO76NDB1            | M13          | GND                |
| J8           | V <sub>CC</sub> B3 | K22          | IO76PDB1            | M14          | V <sub>CC</sub>    |
| J9           | GND                | L1           | NC                  | M15          | GCB2/IO73PPB1      |
| J10          | V <sub>CC</sub>    | L2           | IO155PDB3           | M16          | GCA1/IO71PPB1      |
| J11          | V <sub>CC</sub>    | L3           | NC                  | M17          | GCC2/IO74PPB1      |
| J12          | V <sub>CC</sub>    | L4           | GFB0/IO163NPB3      | M18          | IO80PPB1           |
| J13          | V <sub>CC</sub>    | L5           | GFA0/IO162NDB3      | M19          | GCA2/IO72PDB1      |
| J14          | GND                | L6           | GFB1/IO163PPB3      | M20          | IO79PPB1           |
| J15          | V <sub>CC</sub> B1 | L7           | V <sub>COMPLF</sub> | M21          | IO78PPB1           |
| J16          | IO62NDB1           | L8           | GFC0/IO164NPB3      | M22          | NC                 |
| J17          | IO64NPB1           | L9           | V <sub>CC</sub>     | N1           | IO154NDB3          |
| J18          | IO65PPB1           | L10          | GND                 | N2           | IO154PDB3          |
| J19          | IO66NDB1           | L11          | GND                 | N3           | NC                 |
| J20          | NC                 | L12          | GND                 | N4           | GFC2/IO159PDB3     |
| J21          | IO68PDB1           | L13          | GND                 | N5           | IO161NPB3          |
| J22          | IO68NDB1           | L14          | V <sub>CC</sub>     | N6           | IO156PPB3          |
| K1           | IO157PDB3          | L15          | GCC0/IO69NPB1       | N7           | IO129RSB2          |
| K2           | IO157NDB3          | L16          | GCB1/IO70PPB1       | N8           | V <sub>CC</sub> B3 |
| K3           | NC                 | L17          | GCA0/IO71NPB1       | N9           | V <sub>CC</sub>    |
| K4           | IO165NDB3          | L18          | IO67NPB1            | N10          | GND                |
| K5           | IO165PDB3          | L19          | GCB0/IO70NPB1       | N11          | GND                |
| K6           | IO168PPB3          | L20          | IO77PDB1            | N12          | GND                |
| K7           | GFC1/IO164PPB3     | L21          | IO77NDB1            | N13          | GND                |
| K8           | V <sub>CC</sub> B3 | L22          | IO78NPB1            | N14          | V <sub>CC</sub>    |
| K9           | V <sub>CC</sub>    | M1           | NC                  | N15          | V <sub>CC</sub> B1 |
| K10          | GND                | M2           | IO155NDB3           | N16          | IO73NPB1           |

| 484-Pin FBGA |                    | 484-Pin FBGA |                    | 484-Pin FBGA |                   |
|--------------|--------------------|--------------|--------------------|--------------|-------------------|
| Pin Number   | AGL600 Function    | Pin Number   | AGL600 Function    | Pin Number   | AGL600 Function   |
| N17          | IO80NPB1           | R9           | V <sub>CC</sub> B2 | U1           | IO149PDB3         |
| N18          | IO74NPB1           | R10          | V <sub>CC</sub> B2 | U2           | IO149NDB3         |
| N19          | IO72NDB1           | R11          | IO117RSB2          | U3           | NC                |
| N20          | NC                 | R12          | IO110RSB2          | U4           | GEB1/IO145PDB3    |
| N21          | IO79NPB1           | R13          | V <sub>CC</sub> B2 | U5           | GEB0/IO145NDB3    |
| N22          | NC                 | R14          | V <sub>CC</sub> B2 | U6           | VMV2              |
| P1           | NC                 | R15          | VMV2               | U7           | IO138RSB2         |
| P2           | IO153PDB3          | R16          | IO94RSB2           | U8           | IO136RSB2         |
| P3           | IO153NDB3          | R17          | GDB1/IO87PPB1      | U9           | IO131RSB2         |
| P4           | IO159NDB3          | R18          | GDC1/IO86PDB1      | U10          | IO124RSB2         |
| P5           | IO156NPB3          | R19          | IO84NDB1           | U11          | IO119RSB2         |
| P6           | IO151PPB3          | R20          | V <sub>CC</sub>    | U12          | IO107RSB2         |
| P7           | IO158PPB3          | R21          | IO81NDB1           | U13          | IO104RSB2         |
| P8           | V <sub>CC</sub> B3 | R22          | IO82PDB1           | U14          | IO97RSB2          |
| P9           | GND                | T1           | IO152PDB3          | U15          | VMV1              |
| P10          | V <sub>CC</sub>    | T2           | IO152NDB3          | U16          | TCK               |
| P11          | V <sub>CC</sub>    | T3           | NC                 | U17          | V <sub>PUMP</sub> |
| P12          | V <sub>CC</sub>    | T4           | IO150NDB3          | U18          | TRST              |
| P13          | V <sub>CC</sub>    | T5           | IO147PPB3          | U19          | GDA0/IO88NDB1     |
| P14          | GND                | T6           | GEC1/IO146PPB3     | U20          | NC                |
| P15          | V <sub>CC</sub> B1 | T7           | IO140RSB2          | U21          | IO83NDB1          |
| P16          | GDB0/IO87NPB1      | T8           | GNDQ               | U22          | NC                |
| P17          | IO85NDB1           | T9           | GEA2/IO143RSB2     | V1           | NC                |
| P18          | IO85PDB1           | T10          | IO126RSB2          | V2           | NC                |
| P19          | IO84PDB1           | T11          | IO120RSB2          | V3           | GND               |
| P20          | NC                 | T12          | IO108RSB2          | V4           | GEA1/IO144PDB3    |
| P21          | IO81PDB1           | T13          | IO103RSB2          | V5           | GEA0/IO144NDB3    |
| P22          | NC                 | T14          | IO99RSB2           | V6           | IO139RSB2         |
| R1           | NC                 | T15          | GNDQ               | V7           | GEC2/IO141RSB2    |
| R2           | NC                 | T16          | IO92RSB2           | V8           | IO132RSB2         |
| R3           | V <sub>CC</sub>    | T17          | V <sub>JTAG</sub>  | V9           | IO127RSB2         |
| R4           | IO150PDB3          | T18          | GDC0/IO86NDB1      | V10          | IO121RSB2         |
| R5           | IO151NPB3          | T19          | GDA1/IO88PDB1      | V11          | IO114RSB2         |
| R6           | IO147NPB3          | T20          | NC                 | V12          | IO109RSB2         |
| R7           | GEC0/IO146NPB3     | T21          | IO83PDB1           | V13          | IO105RSB2         |
| R8           | VMV3               | T22          | IO82NDB1           | V14          | IO98RSB2          |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL600 Function     |
| V15          | IO96RSB2            |
| V16          | GDB2/IO90RSB2       |
| V17          | TDI                 |
| V18          | GNDQ                |
| V19          | TDO                 |
| V20          | GND                 |
| V21          | NC                  |
| V22          | NC                  |
| W1           | NC                  |
| W2           | IO148PDB3           |
| W3           | NC                  |
| W4           | GND                 |
| W5           | IO137RSB2           |
| W6           | FF/GEB2/IO142RSB2   |
| W7           | IO134RSB2           |
| W8           | IO125RSB2           |
| W9           | IO123RSB2           |
| W10          | IO118RSB2           |
| W11          | IO115RSB2           |
| W12          | IO111RSB2           |
| W13          | IO106RSB2           |
| W14          | IO102RSB2           |
| W15          | GDC2/IO91RSB2       |
| W16          | IO93RSB2            |
| W17          | GDA2/IO89RSB2       |
| W18          | TMS                 |
| W19          | GND                 |
| W20          | NC                  |
| W21          | NC                  |
| W22          | NC                  |
| Y1           | V <sub>CCI</sub> B3 |
| Y2           | IO148NDB3           |
| Y3           | NC                  |
| Y4           | NC                  |
| Y5           | GND                 |
| Y6           | NC                  |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL600 Function     |
| Y7           | NC                  |
| Y8           | V <sub>CC</sub>     |
| Y9           | V <sub>CC</sub>     |
| Y10          | NC                  |
| Y11          | NC                  |
| Y12          | NC                  |
| Y13          | NC                  |
| Y14          | V <sub>CC</sub>     |
| Y15          | V <sub>CC</sub>     |
| Y16          | NC                  |
| Y17          | NC                  |
| Y18          | GND                 |
| Y19          | NC                  |
| Y20          | NC                  |
| Y21          | NC                  |
| Y22          | V <sub>CCI</sub> B1 |



| 484-Pin FBGA |                      | 484-Pin FBGA |                      | 484-Pin FBGA |                      |
|--------------|----------------------|--------------|----------------------|--------------|----------------------|
| Pin Number   | AGL1000 Function     | Pin Number   | AGL1000 Function     | Pin Number   | AGL1000 Function     |
| A1           | GND                  | AA15         | NC                   | B7           | IO15RSB0             |
| A2           | GND                  | AA16         | IO122RSB2            | B8           | IO19RSB0             |
| A3           | V <sub>CC</sub> I B0 | AA17         | IO119RSB2            | B9           | IO24RSB0             |
| A4           | IO07RSB0             | AA18         | IO117RSB2            | B10          | IO31RSB0             |
| A5           | IO09RSB0             | AA19         | NC                   | B11          | IO39RSB0             |
| A6           | IO13RSB0             | AA20         | NC                   | B12          | IO48RSB0             |
| A7           | IO18RSB0             | AA21         | V <sub>CC</sub> I B1 | B13          | IO54RSB0             |
| A8           | IO20RSB0             | AA22         | GND                  | B14          | IO58RSB0             |
| A9           | IO26RSB0             | AB1          | GND                  | B15          | IO63RSB0             |
| A10          | IO32RSB0             | AB2          | GND                  | B16          | IO66RSB0             |
| A11          | IO40RSB0             | AB3          | V <sub>CC</sub> I B2 | B17          | IO68RSB0             |
| A12          | IO41RSB0             | AB4          | IO180RSB2            | B18          | IO70RSB0             |
| A13          | IO53RSB0             | AB5          | IO176RSB2            | B19          | NC                   |
| A14          | IO59RSB0             | AB6          | IO173RSB2            | B20          | NC                   |
| A15          | IO64RSB0             | AB7          | IO167RSB2            | B21          | V <sub>CC</sub> I B1 |
| A16          | IO65RSB0             | AB8          | IO162RSB2            | B22          | GND                  |
| A17          | IO67RSB0             | AB9          | IO156RSB2            | C1           | V <sub>CC</sub> I B3 |
| A18          | IO69RSB0             | AB10         | IO150RSB2            | C2           | IO220PDB3            |
| A19          | NC                   | AB11         | IO145RSB2            | C3           | NC                   |
| A20          | V <sub>CC</sub> I B0 | AB12         | IO144RSB2            | C4           | NC                   |
| A21          | GND                  | AB13         | IO132RSB2            | C5           | GND                  |
| A22          | GND                  | AB14         | IO127RSB2            | C6           | IO10RSB0             |
| AA1          | GND                  | AB15         | IO126RSB2            | C7           | IO14RSB0             |
| AA2          | V <sub>CC</sub> I B3 | AB16         | IO123RSB2            | C8           | V <sub>CC</sub>      |
| AA3          | NC                   | AB17         | IO121RSB2            | C9           | V <sub>CC</sub>      |
| AA4          | IO181RSB2            | AB18         | IO118RSB2            | C10          | IO30RSB0             |
| AA5          | IO178RSB2            | AB19         | NC                   | C11          | IO37RSB0             |
| AA6          | IO175RSB2            | AB20         | V <sub>CC</sub> I B2 | C12          | IO43RSB0             |
| AA7          | IO169RSB2            | AB21         | GND                  | C13          | NC                   |
| AA8          | IO166RSB2            | AB22         | GND                  | C14          | V <sub>CC</sub>      |
| AA9          | IO160RSB2            | B1           | GND                  | C15          | V <sub>CC</sub>      |
| AA10         | IO152RSB2            | B2           | V <sub>CC</sub> I B3 | C16          | NC                   |
| AA11         | IO146RSB2            | B3           | NC                   | C17          | NC                   |
| AA12         | IO139RSB2            | B4           | IO06RSB0             | C18          | GND                  |
| AA13         | IO133RSB2            | B5           | IO08RSB0             | C19          | NC                   |
| AA14         | NC                   | B6           | IO12RSB0             | C20          | NC                   |

| 484-Pin FBGA |                     | 484-Pin FBGA |                  | 484-Pin FBGA |                     |
|--------------|---------------------|--------------|------------------|--------------|---------------------|
| Pin Number   | AGL1000 Function    | Pin Number   | AGL1000 Function | Pin Number   | AGL1000 Function    |
| C21          | NC                  | E13          | IO51RSB0         | G5           | IO222PDB3           |
| C22          | V <sub>CCI</sub> B1 | E14          | IO57RSB0         | G6           | GAC2/IO223PDB3      |
| D1           | IO219PDB3           | E15          | GBC1/IO73RSB0    | G7           | IO223NDB3           |
| D2           | IO220NDB3           | E16          | GGB0/IO74RSB0    | G8           | GNDQ                |
| D3           | NC                  | E17          | IO71RSB0         | G9           | IO23RSB0            |
| D4           | GND                 | E18          | GBA2/IO78PDB1    | G10          | IO29RSB0            |
| D5           | GAA0/IO00RSB0       | E19          | IO81PDB1         | G11          | IO33RSB0            |
| D6           | GAA1/IO01RSB0       | E20          | GND              | G12          | IO46RSB0            |
| D7           | GAB0/IO02RSB0       | E21          | NC               | G13          | IO52RSB0            |
| D8           | IO16RSB0            | E22          | IO84PDB1         | G14          | IO60RSB0            |
| D9           | IO22RSB0            | F1           | NC               | G15          | GNDQ                |
| D10          | IO28RSB0            | F2           | IO215PDB3        | G16          | IO80NDB1            |
| D11          | IO35RSB0            | F3           | IO215NDB3        | G17          | GGB2/IO79PDB1       |
| D12          | IO45RSB0            | F4           | IO224NDB3        | G18          | IO79NDB1            |
| D13          | IO50RSB0            | F5           | IO225NDB3        | G19          | IO82NPB1            |
| D14          | IO55RSB0            | F6           | VMV3             | G20          | IO85PDB1            |
| D15          | IO61RSB0            | F7           | IO11RSB0         | G21          | IO85NDB1            |
| D16          | GGB1/IO75RSB0       | F8           | GAC0/IO04RSB0    | G22          | NC                  |
| D17          | GBA0/IO76RSB0       | F9           | GAC1/IO05RSB0    | H1           | NC                  |
| D18          | GBA1/IO77RSB0       | F10          | IO25RSB0         | H2           | NC                  |
| D19          | GND                 | F11          | IO36RSB0         | H3           | V <sub>CC</sub>     |
| D20          | NC                  | F12          | IO42RSB0         | H4           | IO217PDB3           |
| D21          | NC                  | F13          | IO49RSB0         | H5           | IO218PDB3           |
| D22          | NC                  | F14          | IO56RSB0         | H6           | IO221NDB3           |
| E1           | IO219NDB3           | F15          | GBC0/IO72RSB0    | H7           | IO221PDB3           |
| E2           | NC                  | F16          | IO62RSB0         | H8           | VMV0                |
| E3           | GND                 | F17          | VMV0             | H9           | V <sub>CCI</sub> B0 |
| E4           | GAB2/IO224PDB3      | F18          | IO78NDB1         | H10          | V <sub>CCI</sub> B0 |
| E5           | GAA2/IO225PDB3      | F19          | IO81NDB1         | H11          | IO38RSB0            |
| E6           | GNDQ                | F20          | IO82PPB1         | H12          | IO47RSB0            |
| E7           | GAB1/IO03RSB0       | F21          | NC               | H13          | V <sub>CCI</sub> B0 |
| E8           | IO17RSB0            | F22          | IO84NDB1         | H14          | V <sub>CCI</sub> B0 |
| E9           | IO21RSB0            | G1           | IO214NDB3        | H15          | VMV1                |
| E10          | IO27RSB0            | G2           | IO214PDB3        | H16          | GBC2/IO80PDB1       |
| E11          | IO34RSB0            | G3           | NC               | H17          | IO83PPB1            |
| E12          | IO44RSB0            | G4           | IO222NDB3        | H18          | IO86PPB1            |

| 484-Pin FBGA |                    | 484-Pin FBGA |                     | 484-Pin FBGA |                    |
|--------------|--------------------|--------------|---------------------|--------------|--------------------|
| Pin Number   | AGL1000 Function   | Pin Number   | AGL1000 Function    | Pin Number   | AGL1000 Function   |
| H19          | IO87PDB1           | K11          | GND                 | M3           | IO206NDB3          |
| H20          | V <sub>CC</sub>    | K12          | GND                 | M4           | GFA2/IO206PDB3     |
| H21          | NC                 | K13          | GND                 | M5           | GFA1/IO207PDB3     |
| H22          | NC                 | K14          | V <sub>CC</sub>     | M6           | V <sub>CCPLF</sub> |
| J1           | IO212NDB3          | K15          | V <sub>CC</sub> B1  | M7           | IO205NDB3          |
| J2           | IO212PDB3          | K16          | GCC1/IO91PPB1       | M8           | GFB2/IO205PDB3     |
| J3           | NC                 | K17          | IO90NPB1            | M9           | V <sub>CC</sub>    |
| J4           | IO217NDB3          | K18          | IO88PDB1            | M10          | GND                |
| J5           | IO218NDB3          | K19          | IO88NDB1            | M11          | GND                |
| J6           | IO216PDB3          | K20          | IO94NPB1            | M12          | GND                |
| J7           | IO216NDB3          | K21          | IO98NDB1            | M13          | GND                |
| J8           | V <sub>CC</sub> B3 | K22          | IO98PDB1            | M14          | V <sub>CC</sub>    |
| J9           | GND                | L1           | NC                  | M15          | GCB2/IO95PPB1      |
| J10          | V <sub>CC</sub>    | L2           | IO200PDB3           | M16          | GCA1/IO93PPB1      |
| J11          | V <sub>CC</sub>    | L3           | IO210NPB3           | M17          | GCC2/IO96PPB1      |
| J12          | V <sub>CC</sub>    | L4           | GFB0/IO208NPB3      | M18          | IO100PPB1          |
| J13          | V <sub>CC</sub>    | L5           | GFA0/IO207NDB3      | M19          | GCA2/IO94PPB1      |
| J14          | GND                | L6           | GFB1/IO208PPB3      | M20          | IO101PPB1          |
| J15          | V <sub>CC</sub> B1 | L7           | V <sub>COMPLF</sub> | M21          | IO99PPB1           |
| J16          | IO83NPB1           | L8           | GFC0/IO209NPB3      | M22          | NC                 |
| J17          | IO86NPB1           | L9           | V <sub>CC</sub>     | N1           | IO201NDB3          |
| J18          | IO90PPB1           | L10          | GND                 | N2           | IO201PDB3          |
| J19          | IO87NDB1           | L11          | GND                 | N3           | NC                 |
| J20          | NC                 | L12          | GND                 | N4           | GFC2/IO204PDB3     |
| J21          | IO89PDB1           | L13          | GND                 | N5           | IO204NDB3          |
| J22          | IO89NDB1           | L14          | V <sub>CC</sub>     | N6           | IO203NDB3          |
| K1           | IO211PDB3          | L15          | GCC0/IO91NPB1       | N7           | IO203PDB3          |
| K2           | IO211NDB3          | L16          | GCB1/IO92PPB1       | N8           | V <sub>CC</sub> B3 |
| K3           | NC                 | L17          | GCA0/IO93NPB1       | N9           | V <sub>CC</sub>    |
| K4           | IO210PPB3          | L18          | IO96NPB1            | N10          | GND                |
| K5           | IO213NDB3          | L19          | GCB0/IO92NPB1       | N11          | GND                |
| K6           | IO213PDB3          | L20          | IO97PDB1            | N12          | GND                |
| K7           | GFC1/IO209PPB3     | L21          | IO97NDB1            | N13          | GND                |
| K8           | V <sub>CC</sub> B3 | L22          | IO99NPB1            | N14          | V <sub>CC</sub>    |
| K9           | V <sub>CC</sub>    | M1           | NC                  | N15          | V <sub>CC</sub> B1 |
| K10          | GND                | M2           | IO200NDB3           | N16          | IO95NPB1           |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL1000 Function    |
| N17          | IO100NPB1           |
| N18          | IO102NDB1           |
| N19          | IO102PDB1           |
| N20          | NC                  |
| N21          | IO101NPB1           |
| N22          | IO103PDB1           |
| P1           | NC                  |
| P2           | IO199PDB3           |
| P3           | IO199NDB3           |
| P4           | IO202NDB3           |
| P5           | IO202PDB3           |
| P6           | IO196PPB3           |
| P7           | IO193PPB3           |
| P8           | V <sub>CCI</sub> B3 |
| P9           | GND                 |
| P10          | V <sub>CC</sub>     |
| P11          | V <sub>CC</sub>     |
| P12          | V <sub>CC</sub>     |
| P13          | V <sub>CC</sub>     |
| P14          | GND                 |
| P15          | V <sub>CCI</sub> B1 |
| P16          | GDB0/IO112NPB1      |
| P17          | IO106NDB1           |
| P18          | IO106PDB1           |
| P19          | IO107PDB1           |
| P20          | NC                  |
| P21          | IO104PDB1           |
| P22          | IO103NDB1           |
| R1           | NC                  |
| R2           | IO197PPB3           |
| R3           | V <sub>CC</sub>     |
| R4           | IO197NPB3           |
| R5           | IO196NPB3           |
| R6           | IO193NPB3           |
| R7           | GEC0/IO190NPB3      |
| R8           | VMV3                |

| 484-Pin FBGA |                     |
|--------------|---------------------|
| Pin Number   | AGL1000 Function    |
| R9           | V <sub>CCI</sub> B2 |
| R10          | V <sub>CCI</sub> B2 |
| R11          | IO147RSB2           |
| R12          | IO136RSB2           |
| R13          | V <sub>CCI</sub> B2 |
| R14          | V <sub>CCI</sub> B2 |
| R15          | VMV2                |
| R16          | IO110NDB1           |
| R17          | GDB1/IO112PPB1      |
| R18          | GDC1/IO111PDB1      |
| R19          | IO107NDB1           |
| R20          | V <sub>CC</sub>     |
| R21          | IO104NDB1           |
| R22          | IO105PDB1           |
| T1           | IO198PDB3           |
| T2           | IO198NDB3           |
| T3           | NC                  |
| T4           | IO194PPB3           |
| T5           | IO192PPB3           |
| T6           | GEC1/IO190PPB3      |
| T7           | IO192NPB3           |
| T8           | GNDQ                |
| T9           | GEA2/IO187RSB2      |
| T10          | IO161RSB2           |
| T11          | IO155RSB2           |
| T12          | IO141RSB2           |
| T13          | IO129RSB2           |
| T14          | IO124RSB2           |
| T15          | GNDQ                |
| T16          | IO110PDB1           |
| T17          | V <sub>JTAG</sub>   |
| T18          | GDC0/IO111NDB1      |
| T19          | GDA1/IO113PDB1      |
| T20          | NC                  |
| T21          | IO108PDB1           |
| T22          | IO105NDB1           |

| 484-Pin FBGA |                   | 484-Pin FBGA |                    | 484-Pin FBGA |                    |
|--------------|-------------------|--------------|--------------------|--------------|--------------------|
| Pin Number   | AGL1000 Function  | Pin Number   | AGL1000 Function   | Pin Number   | AGL1000 Function   |
| U1           | IO195PDB3         | V15          | IO125RSB2          | Y7           | IO174RSB2          |
| U2           | IO195NDB3         | V16          | GDB2/IO115RSB2     | Y8           | V <sub>CC</sub>    |
| U3           | IO194NPB3         | V17          | TDI                | Y9           | V <sub>CC</sub>    |
| U4           | GEB1/IO189PDB3    | V18          | GNDQ               | Y10          | IO154RSB2          |
| U5           | GEB0/IO189NDB3    | V19          | TDO                | Y11          | IO148RSB2          |
| U6           | VMV2              | V20          | GND                | Y12          | IO140RSB2          |
| U7           | IO179RSB2         | V21          | NC                 | Y13          | NC                 |
| U8           | IO171RSB2         | V22          | IO109NDB1          | Y14          | V <sub>CC</sub>    |
| U9           | IO165RSB2         | W1           | NC                 | Y15          | V <sub>CC</sub>    |
| U10          | IO159RSB2         | W2           | IO191PDB3          | Y16          | NC                 |
| U11          | IO151RSB2         | W3           | NC                 | Y17          | NC                 |
| U12          | IO137RSB2         | W4           | GND                | Y18          | GND                |
| U13          | IO134RSB2         | W5           | IO183RSB2          | Y19          | NC                 |
| U14          | IO128RSB2         | W6           | FF/GEB2/IO186RSB2  | Y20          | NC                 |
| U15          | VMV1              | W7           | IO172RSB2          | Y21          | NC                 |
| U16          | TCK               | W8           | IO170RSB2          | Y22          | V <sub>CC</sub> B1 |
| U17          | V <sub>PUMP</sub> | W9           | IO164RSB2          |              |                    |
| U18          | TRST              | W10          | IO158RSB2          |              |                    |
| U19          | GDA0/IO113NDB1    | W11          | IO153RSB2          |              |                    |
| U20          | NC                | W12          | IO142RSB2          |              |                    |
| U21          | IO108NDB1         | W13          | IO135RSB2          |              |                    |
| U22          | IO109PDB1         | W14          | IO130RSB2          |              |                    |
| V1           | NC                | W15          | GDC2/IO116RSB2     |              |                    |
| V2           | NC                | W16          | IO120RSB2          |              |                    |
| V3           | GND               | W17          | GDA2/IO114RSB2     |              |                    |
| V4           | GEA1/IO188PDB3    | W18          | TMS                |              |                    |
| V5           | GEA0/IO188NDB3    | W19          | GND                |              |                    |
| V6           | IO184RSB2         | W20          | NC                 |              |                    |
| V7           | GEC2/IO185RSB2    | W21          | NC                 |              |                    |
| V8           | IO168RSB2         | W22          | NC                 |              |                    |
| V9           | IO163RSB2         | Y1           | V <sub>CC</sub> B3 |              |                    |
| V10          | IO157RSB2         | Y2           | IO191NDB3          |              |                    |
| V11          | IO149RSB2         | Y3           | NC                 |              |                    |
| V12          | IO143RSB2         | Y4           | IO182RSB2          |              |                    |
| V13          | IO138RSB2         | Y5           | GND                |              |                    |
| V14          | IO131RSB2         | Y6           | IO177RSB2          |              |                    |

## Part Number and Revision Date

Part Number 51700095-003-9

Revised February 2009

## List of Changes

The following table lists critical changes that were made in the current version of the chapter.

| Previous Version                | Changes in Current Version (v1.9)                                                                                                                                              | Page |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| v1.8<br>(January 2009)          | The "132-Pin QFN" pin table for the AGL060 device is new.                                                                                                                      | 3-30 |
| v1.7<br>(December 2008)         | The "121-Pin CSP" pin table was revised to add a note regarding pins F1 and G1.                                                                                                | 3-6  |
| v1.6<br>(October 2008)          | The "48-Pin QFP" pin diagram and pin table are new.                                                                                                                            | 3-22 |
|                                 | The "68-Pin QFN" pin table is new.                                                                                                                                             | 3-26 |
|                                 | The AGL600 Function for pin K15 in the "484-Pin FBGA" table was changed to $V_{CC}B1$ .                                                                                        | 3-66 |
| v1.5<br>(June 2008)             | The "196-pin CSP" table for the AGL400 device is new.                                                                                                                          | 3-12 |
|                                 | The "144-Pin FBGA" table for the AGL400 device is new.                                                                                                                         | 3-46 |
|                                 | The "256-Pin FBGA" table for the AGL400 device is new.                                                                                                                         | 3-57 |
|                                 | The "484-Pin FBGA" table for the AGL400 device is new.                                                                                                                         | 3-66 |
| v1.4<br>(June 2008)             | Pin numbers were added to the "68-Pin QFN" package diagram. Note 2 was added below the diagram.                                                                                | 3-23 |
|                                 | The "132-Pin QFN" package diagram was updated to include D1 to D4. In addition, note 1 was changed from top view to bottom view, and note 2 is new.                            | 3-27 |
| v1.3<br>(February 2008)         | The "68-Pin QFN" package drawing was updated to include numbers on pins 1 and 68.                                                                                              | 3-23 |
|                                 | The "281-Pin CSP" package and pin table was added for AGL1000.                                                                                                                 | 3-18 |
| v1.2<br>(February 2008)         | The "196-Pin CSP" package and pin table was added for AGL250.                                                                                                                  | 3-10 |
| v1.1<br>(January 2008)          | The "68-Pin QFN" section is new.                                                                                                                                               | 3-23 |
| v1.0<br>(January 2008)          | The "196-Pin CSP" package and pin table was added for AGL125.                                                                                                                  | 3-7  |
| Advance v0.7<br>(November 2007) | This document was previously in datasheet Advance v0.7. As a result of moving to the handbook format, Actel has restarted the version numbers. The new version number is v1.0. | N/A  |

| Previous Version                 | Changes in Current Version (v1.9)                                                                                                       | Page     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------|
| Advance v0.6<br>(November 2007)  | The "121-Pin CSP" and "281-Pin CSP" packages are new.                                                                                   | 4-5, 4-7 |
|                                  | The "81-Pin CSP" table for the AGL030 device was updated to change the G6 pin function to IO44RSB1 and the JG pin function to IO45RSB1. | 4-4      |
|                                  | The "121-Pin CSP" table for the AGL060 device is new.                                                                                   | 4-6      |
|                                  | The "256-Pin FBGA" table for the AGL1000 device is new.                                                                                 | 4-34     |
|                                  | The "281-Pin CSP" table for the AGL 600 device is new.                                                                                  | 4-8      |
|                                  | The "100-Pin VQFP" table for the AGL060 device is new.                                                                                  | 4-18     |
|                                  | The "144-Pin FBGA" table for the AGL250 device is new.                                                                                  | 4-24     |
|                                  | The "144-Pin FBGA" table for the AGL1000 device is new.                                                                                 | 4-28     |
|                                  | The "484-Pin FBGA" table for the AGL600 device is new.                                                                                  | 4-38     |
|                                  | The "484-Pin FBGA" table for the AGL1000 device is new.                                                                                 | 4-43     |
| Advance v0.5<br>(September 2007) | The "81-Pin $\mu$ CSP" table for the AGL030 device is new.                                                                              | 4-3      |
|                                  | The "81-Pin CSP" table for the AGL030 device is new.                                                                                    | 4-1      |

## 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 definitions 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)

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