

# QL3060 pASIC 3 FPGA Data Sheet



- 60,000 Usable PLD Gate pASIC 3 FPGA Combining High Performance and High Density

## Device Highlights

### High Performance & High Density

- 60,000 Usable PLD Gates with 316 I/Os
- 300 MHz, 16-bit Counters, 400 MHz Datapaths
- 0.35  $\mu\text{m}$  four-layer metal non-volatile CMOS process for smallest die sizes

### Easy to Use / Fast Development Cycles

- 100% routable with 100% utilization and complete pin-out stability
- Variable-grain logic cells provide high performance and 100% utilization
- Comprehensive design tools include high quality Verilog/VHDL synthesis

### Advanced I/O Capabilities

- Interfaces with both 3.3 V and 5.0 V devices
- PCI compliant with 3.3 V and 5.0 V buses for -1/-2/-3/-4 speed grades
- Full JTAG boundary scan
- I/O Cells with individually controlled Registered Input Path and Output Enables

### Total of 316 I/O Pins

- 308 bidirectional input/output pins, PCI-compliant for 5.0 V and 3.3 V buses for -1/-2/-3/-4 speed grades
- Eight high-drive input/distributed network pins

### Eight Low-Skew Distributed Networks

- Two array clock/control networks available to the logic cell flip-flop clock, set and reset inputs — each driven by an input-only pin
- Six global clock/control networks available to the logic cell F1, clock set, and reset inputs and the input and I/O register clock, reset, and enable inputs as well as the output enable control — each driven by an input-only or I/O pin, or any logic cell output or I/O cell feedback

### High Performance

- Input + logic cell + output total delays under 6 ns
- Data path speeds over 400 MHz
- Counter speeds over 300 MHz

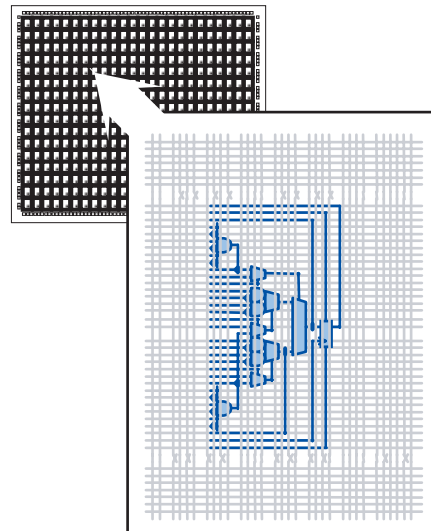


Figure 1: 1,584 pASIC 3 Logic Cells

## Architecture Overview

The QL3060 is a 60,000 usable PLD gate member of the pASIC 3 family of FPGAs. pASIC 3 FPGAs are fabricated on a 0.35  $\mu\text{m}$  four-layer metal process using QuickLogic<sup>®</sup>'s patented ViaLink<sup>®</sup> technology to provide a unique combination of high performance, high density, low cost, and extreme ease-of-use.

The QL3060 contains 1,584 logic cells. With a maximum of 316 I/Os, the QL3060 is available in 208-PQFP and 456-pin PBGA packages.

Software support for the complete pASIC 3 family, including the QL3060, is available through three basic packages. The turnkey QuickWorks<sup>®</sup> package provides the most complete FPGA software solution from design entry to logic synthesis, to place and route, to simulation. The QuickTools<sup>™</sup> for Workstations package provides a solution for designers who use Cadence<sup>®</sup>, Exemplar<sup>™</sup>, Mentor<sup>®</sup>, Synopsys<sup>®</sup>, Synplicity<sup>®</sup>, Viewlogic<sup>™</sup>, Aldec<sup>™</sup>,

[www.DataSheet4U.com](http://www.DataSheet4U.com) or other third-party tools for design entry, synthesis, or simulation.

## Electrical Specifications

### AC Characteristics at $V_{CC} = 3.3\text{ V}$ , $T_A = 25^\circ\text{C}$ ( $K = 1.00$ )

To calculate delays, multiply the appropriate K factor from **Table 7** by the numbers provided in **Table 1** through **Table 5**.

Table 1: Logic Cells

| Symbol      | Parameter                        | Propagation Delays (ns) Fanout <sup>a</sup> |     |     |     |     |
|-------------|----------------------------------|---|-----|-----|-----|-----|
|             |                                  | 1   | 2   | 3   | 4   | 8   |
| $t_{PD}$    | Combinatorial Delay <sup>b</sup> | 1.4   | 1.7 | 1.9 | 2.2 | 3.2 |
| $t_{SU}$    | Setup Time <sup>b</sup>          | 1.7   | 1.7 | 1.7 | 1.7 | 1.7 |
| $t_H$       | Hold Time                        | 0.0   | 0.0 | 0.0 | 0.0 | 0.0 |
| $t_{CLK}$   | Clock to Q Delay                 | 0.7   | 1.0 | 1.2 | 1.5 | 2.5 |
| $t_{CWHI}$  | Clock High Time                  | 1.2   | 1.2 | 1.2 | 1.2 | 1.2 |
| $t_{CWLO}$  | Clock Low Time                   | 1.2   | 1.2 | 1.2 | 1.2 | 1.2 |
| $t_{SET}$   | Set Delay                        | 1.0   | 1.3 | 1.5 | 1.8 | 2.8 |
| $t_{RESET}$ | Reset Delay                      | 0.8   | 1.1 | 1.3 | 1.6 | 2.6 |
| $t_{SW}$    | Set Width                        | 1.9   | 1.9 | 1.9 | 1.9 | 1.9 |
| $t_{RW}$    | Reset Width                      | 1.8   | 1.8 | 1.8 | 1.8 | 1.8 |

- a. Stated timing for worst case Propagation Delay over process variation at  $V_{CC} = 3.3\text{ V}$  and  $T_A = 25^\circ\text{C}$ . Multiply by the appropriate Delay Factor, K, for speed grade, voltage, and temperature settings as specified in **Table 7**.
- b. These limits are derived from a representative selection of the slowest paths through the pASIC 3 logic cell including typical net delays. Worst case delay values for specific paths should be determined from timing analysis of your particular design.

Table 2: Input-Only/Clock Cells

| Symbol     | Parameter                               | Propagation Delays (ns) Fanout <sup>a</sup> |     |     |     |     |     |     |
|------------|---|---|-----|-----|-----|-----|-----|-----|
|            |   | 1   | 2   | 3   | 4   | 8   | 12  | 24  |
| $t_{IN}$   | High Drive Input Delay                  | 1.5   | 1.6 | 1.8 | 1.9 | 2.4 | 2.9 | 4.4 |
| $t_{INI}$  | High Drive Input, Inverting Delay       | 1.6   | 1.7 | 1.9 | 2.0 | 2.5 | 3.0 | 4.5 |
| $t_{ISU}$  | Input Register Set-Up Time              | 3.1   | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| $t_{IH}$   | Input Register Hold Time                | 0.0   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $t_{ICLK}$ | Input Register Clock To Q               | 0.7   | 0.8 | 1.0 | 1.1 | 1.6 | 2.1 | 3.6 |
| $t_{IRST}$ | Input Register Reset Delay              | 0.6   | 0.7 | 0.9 | 1.0 | 1.5 | 2.0 | 3.5 |
| $t_{ESU}$  | Input Register clock Enable Set-Up Time | 2.3   | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| $t_{IEH}$  | Input Register Clock Enable Hold Time   | 0.0   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

- a. Stated timing for worst case Propagation Delay over process variation at  $V_{CC} = 3.3\text{ V}$  and  $T_A = 25^\circ\text{C}$ . Multiply by the appropriate Delay Factor, K, for speed grade, voltage, and temperature settings as specified in **Table 7**.

Table 3: Clock Cells

| Symbol            | Parameter                 | Propagation Delays (ns) Loads per Half Column <sup>a</sup> |     |     |     |     |     |     |
|-------------------|---------------------------|--|-----|-----|-----|-----|-----|-----|
|                   |                           | 1  | 2   | 3   | 4   | 8   | 10  | 11  |
| t <sub>ACK</sub>  | Array Clock Delay         | 1.2  | 1.2 | 1.3 | 1.3 | 1.5 | 1.6 | 1.7 |
| t <sub>GCKP</sub> | Global Clock Pin Delay    | 0.7  | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| t <sub>GCKB</sub> | Global Clock Buffer Delay | 0.8  | 0.8 | 0.9 | 0.9 | 1.1 | 1.2 | 1.3 |

a. The array distributed networks consist of 40 half columns and the global distributed networks consist of 44 half columns, each driven by an independent buffer. The number of half columns used does not affect clock buffer delay. The array clock has up to eight loads per half column. The global clock has up to 11 loads per half column.

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Table 4: Input-Only I/O Cells

| Symbol             | Parameter                               | Propagation Delays (ns) Fanout <sup>a</sup> |     |     |     |     |     |
|--------------------|---|---|-----|-----|-----|-----|-----|
|                    |   | 1   | 2   | 3   | 4   | 8   | 10  |
| t <sub>I/O</sub>   | Input Delay (bidirectional pad)         | 1.3   | 1.6 | 1.8 | 2.1 | 3.1 | 3.6 |
| t <sub>ISU</sub>   | Input Register Set-Up Time              | 3.1   | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| t <sub>IH</sub>    | Input Register Hold Time                | 0.0   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| t <sub>IOCLK</sub> | Input Register Clock To Q               | 0.7   | 1.0 | 1.2 | 1.5 | 2.5 | 3.0 |
| t <sub>IORST</sub> | Input Register Reset Delay              | 0.6   | 0.9 | 1.1 | 1.4 | 2.4 | 2.9 |
| t <sub>IESU</sub>  | Input Register clock Enable Set-Up Time | 2.3   | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| t <sub>IEH</sub>   | Input Register Clock Enable Hold Time   | 0.0   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

a. Stated timing for worst case Propagation Delay over process variation at V<sub>CC</sub> = 3.3 V and TA = 25°C. Multiply by the appropriate Delay Factor, K, for speed grade, voltage, and temperature settings as specified in **Table 7**.

Table 5: Output-Only I/O Cells

| Symbol      | Parameter                                   | Propagation Delays (ns) Output Load Capacitance (pF) |     |     |     |     |
|-------------|---|--|-----|-----|-----|-----|
|             |   | 30   | 50  | 75  | 100 | 150 |
| $t_{OUTLH}$ | Output Delay Low to High                    | 2.1  | 2.5 | 3.1 | 3.6 | 4.7 |
| $t_{OUTHl}$ | Output Delay High to Low                    | 2.2  | 2.6 | 3.2 | 3.7 | 4.8 |
| $t_{PZH}$   | Output Delay Tri-state to High              | 1.2  | 1.7 | 2.2 | 2.8 | 3.9 |
| $t_{PZL}$   | Output Delay Tri-state to Low               | 1.6  | 2.0 | 2.6 | 3.1 | 4.2 |
| $t_{PHZ}$   | Output Delay High to Tri-State <sup>a</sup> | 2.0  | -   | -   | -   | -   |
| $t_{PLZ}$   | Output Delay Low to Tri-State               | 1.2  | -   | -   | -   | -   |

www.DataSheet4U.com a. The loads presented in **Figure 2** are used for  $t_{PXZ}$ :

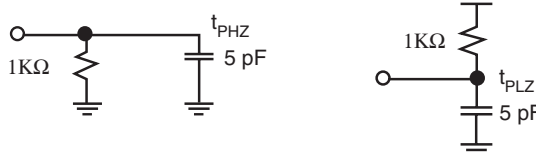


Figure 2: Loads used for  $t_{PXZ}$

## DC Characteristics

The DC specifications are provided in **Table 6** through **Table 8**.

Table 6: Absolute Maximum Ratings

| Parameter                 | Value                              | Parameter           | Value           |
|---------------------------|------------------------------------|---------------------|-----------------|
| V <sub>CC</sub> Voltage   | -0.5 V to 4.6 V                    | DC Input Current    | ±20 mA          |
| V <sub>CCIO</sub> Voltage | -0.5 V to 7.0 V                    | ESD Pad Protection  | ±2000 V         |
| Input Voltage             | -0.5 V to V <sub>CCIO</sub> +0.5 V | Storage Temperature | -65°C to +150°C |
| Latch-up Immunity         | ±200 mA                            | Lead Temperature    | 300°C           |

Table 7: Operating Range

| Symbol            | Parameter                   | Military       |      | Industrial |      | Commercial |      | Unit |     |
|-------------------|-----------------------------|----------------|------|------------|------|------------|------|------|-----|
|                   |                             | Min            | Max  | Min        | Max  | Min        | Max  |      |     |
| V <sub>CC</sub>   | Supply Voltage              | 3.0            | 3.6  | 3.0        | 3.6  | 3.0        | 3.6  | V    |     |
| V <sub>CCIO</sub> | I/O Input Tolerance Voltage | 3.0            | 5.5  | 3.0        | 5.5  | 3.0        | 5.25 | V    |     |
| TA                | Ambient Temperature         | -55            | -    | -40        | 85   | 0          | 70   | °C   |     |
| TC                | Case Temperature            | -              | 125  | -          | -    | -          | -    | °C   |     |
| K                 | Delay Factor                | -0 Speed Grade | -    | -          | 0.43 | 1.90       | 0.46 | 1.85 | n/a |
|                   |                             | -1 Speed Grade | 0.42 | 1.64       | 0.43 | 1.54       | 0.46 | 1.50 | n/a |
|                   |                             | -2 Speed Grade | 0.42 | 1.37       | 0.43 | 1.28       | 0.46 | 1.25 | n/a |
|                   |                             | -3 Speed Grade |      |            | 0.43 | 0.90       | 0.46 | 0.88 | n/a |
|                   |                             | -4 Speed Grade |      |            | 0.43 | 0.82       | 0.46 | 0.80 | n/a |

Table 8: DC Characteristics

| Symbol     | Parameter                                 | Conditions                      | Min          | Max            | Units         |
|------------|---|---------------------------------|--------------|----------------|---------------|
| $V_{IH}$   | Input HIGH Voltage                        |                                 | $0.5 V_{CC}$ | $V_{CCIO}+0.5$ | V             |
| $V_{IL}$   | Input LOW Voltage                         |                                 | -0.5         | $0.3 V_{CC}$   | V             |
| $V_{OH}$   | Output HIGH Voltage                       | $I_{OH} = -12 \text{ mA}$       | 2.4          |                | V             |
|            |   | $I_{OH} = -500 \mu\text{A}$     | $0.9 V_{CC}$ |                | V             |
| $V_{OL}$   | Output LOW Voltage                        | $I_{OL} = 16 \text{ mA}^a$      |              | 0.45           | V             |
|            |   | $I_{OL} = 1.5 \text{ mA}$       |              | $0.1 V_{CC}$   | V             |
| $I_I$      | I or I/O Input Leakage Current            | $V_I = V_{CCIO}$ or GND         | -10          | 10             | $\mu\text{A}$ |
| $I_{OZ}$   | 3-State Output Leakage Current            | $V_I = V_{CCIO}$ or GND         | -10          | 10             | $\mu\text{A}$ |
| $C_I$      | Input Capacitance <sup>b</sup>            |                                 |              | 10             | pF            |
| $I_{OS}$   | Output Short Circuit Current <sup>c</sup> | $V_O = \text{GND}$              | -15          | -180           | mA            |
|            |   | $V_O = V_{CC}$                  | 40           | 210            | mA            |
| $I_{CC}$   | D.C. Supply Current <sup>d</sup>          | $V_I, V_{IO} = V_{CCIO}$ or GND | 0.50 (typ)   | 2              | mA            |
| $I_{CCIO}$ | D.C. Supply Current on $V_{CCIO}$         |                                 | 0            | 100            | $\mu\text{A}$ |

- a. Applies only to -1/-2/-3/-4 commercial grade devices. These speed grades are also PCI-compliant. All other devices have 8 mA  $I_{OL}$  specifications.
- b. Capacitance is sample tested only. Clock pins are 12 pF maximum.
- c. Only one output at a time. Duration should not exceed 30 seconds.
- d. For -1/-2/-3/-4 commercial grade devices only. Maximum  $I_{CC}$  is 3 mA for -0 commercial grade and all industrial grade devices. and 5 mA for all military grade devices. For AC conditions, contact QuickLogic customer applications group (see [Contact Information](#)).

## Kv and Kt Graphs

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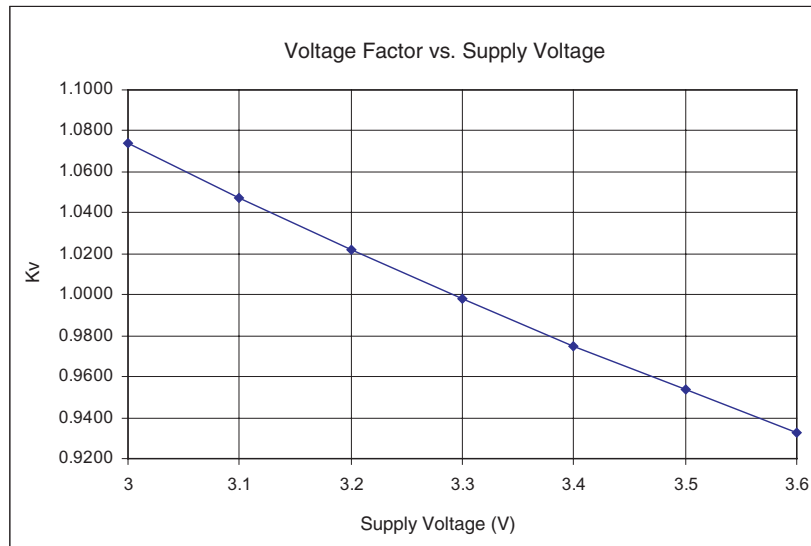


Figure 3: Voltage Factor vs. Supply Voltage

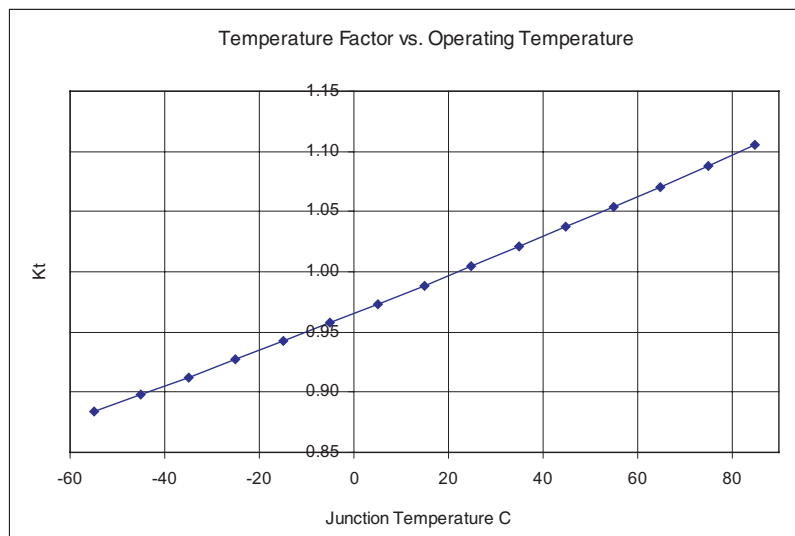
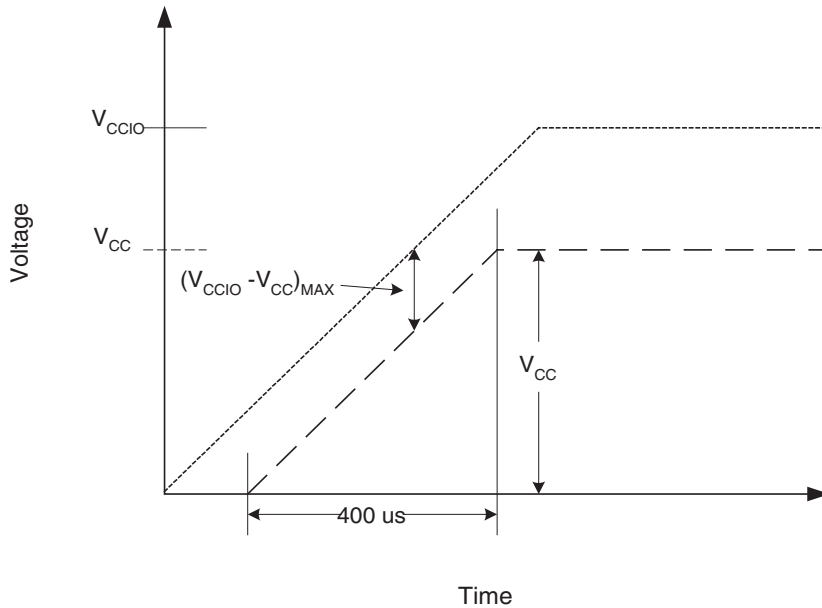


Figure 4: Temperature Factor vs. Operating Temperature



## Power-up Sequencing



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Figure 5: Power-up Requirements

The following requirements must be met when powering up the device (refer to **Figure 5**):

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

An internal diode is present in-between  $V_{CC}$  and  $V_{CCIO}$ , as shown in **Figure 6**.

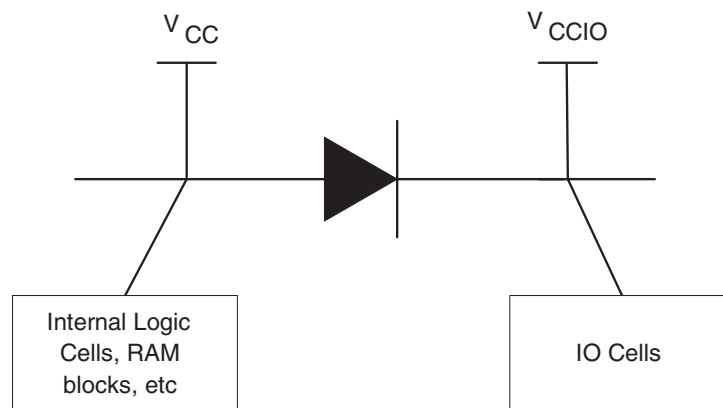


Figure 6: Internal Diode Between  $V_{CC}$  and  $V_{CCIO}$

## JTAG

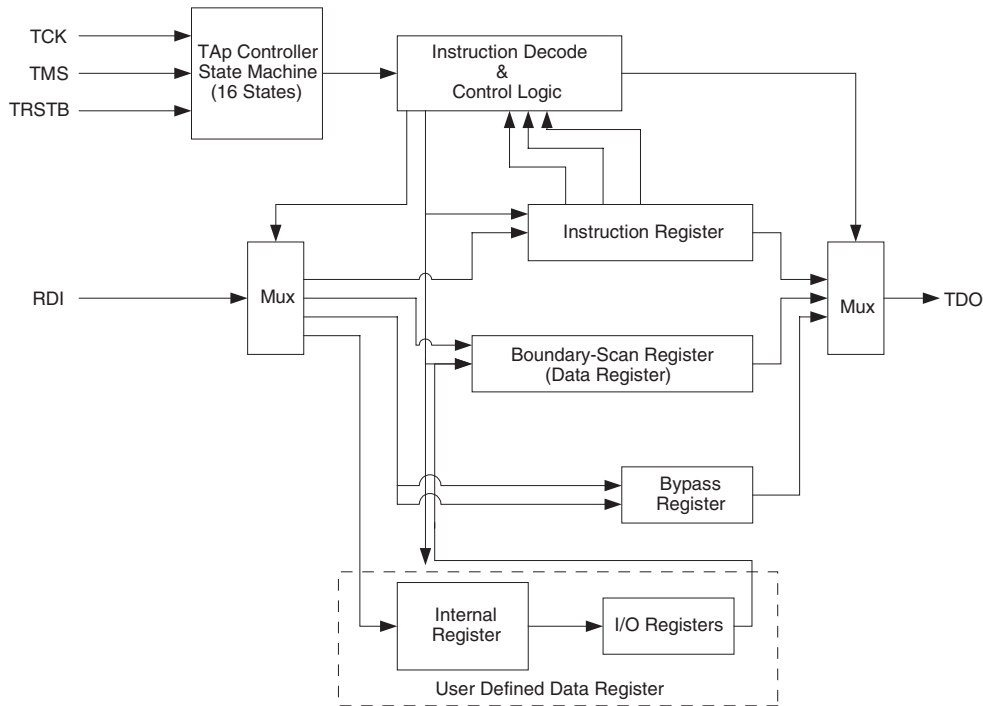


Figure 7: JTAG Block Diagram

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

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

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

The 1149.1 standard requires the following three tests:

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

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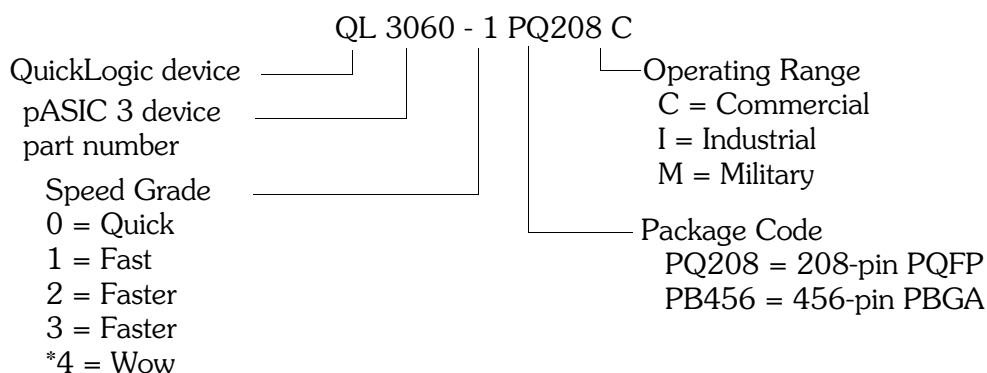
## Pin Descriptions

Table 9: Pin Descriptions

| Pin               | Function                                      | Description  |
|-------------------|---|--|
| TDI               | Test Data In for JTAG                         | Hold HIGH during normal operation. Connect to V <sub>CC</sub> if not used for JTAG.                  |
| TRSTB             | Active low Reset for JTAG                     | Hold LOW during normal operation. Connect to ground if not used for JTAG.                            |
| TMS               | Test Mode Select for JTAG                     | Hold HIGH during normal operation. Connect to V <sub>CC</sub> if not used for JTAG.                  |
| TCK               | Test Clock for JTAG                           | Hold HIGH or LOW during normal operation. Connect to V <sub>CC</sub> or ground if not used for JTAG. |
| TDO               | Test data out for JTAG                        | Output that must be left unconnected if not used for JTAG.   |
| STM               | Special Test Mode                             | Must be grounded during normal operation.  |
| I/ACLK            | High-drive input and/or array network driver  | Can be configured as either or both.   |
| I/GCLK            | High-drive input and/or global network driver | Can be configured as either or both.   |
| I                 | High-drive input                              | Use for input signals with high fanout.  |
| I/O               | Input/Output pin                              | Can be configured as an input and/or output.   |
| V <sub>CC</sub>   | Power supply pin                              | Connect to 3.3 V supply.   |
| V <sub>CCIO</sub> | Input voltage tolerance pin                   | Connect to 5.0 V supply if 5 V input tolerance is required, otherwise connect to 3.3 V supply.       |
| GND               | Ground pin                                    | Connect to ground.   |

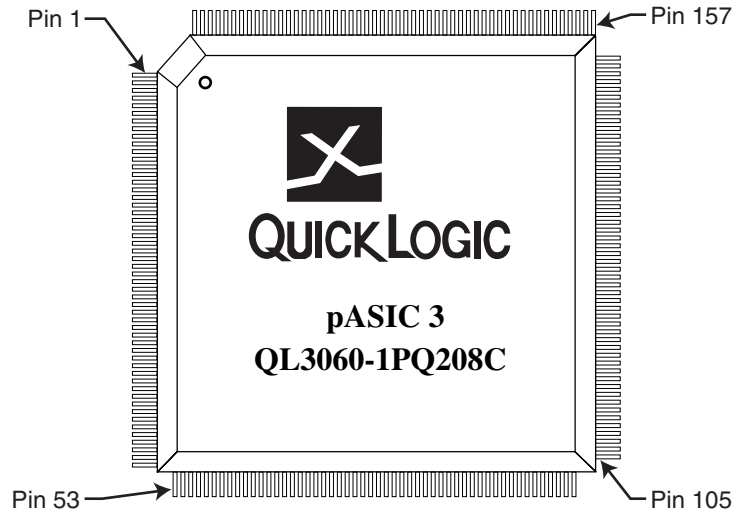
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## Ordering Information



\* Contact QuickLogic regarding availability (see [Contact Information](#))

## 208 PQFP Pinout Diagram



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Figure 8: Top View of 208 Pin PQFP

## 208 PQFP Pinout Table

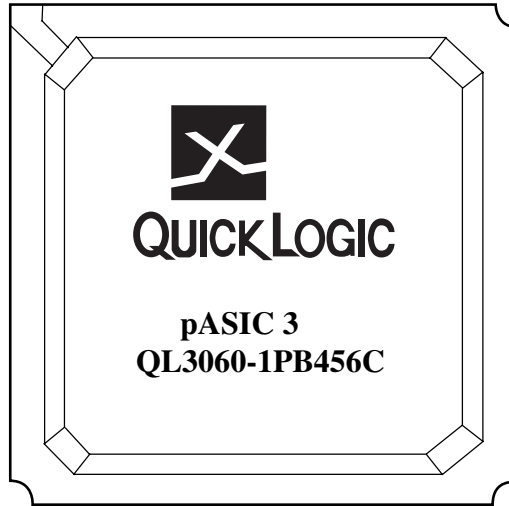
Table 10: 208 PQFP Pinout Table

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

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# 456 PBGA Pinout Diagram

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BOTTOM View

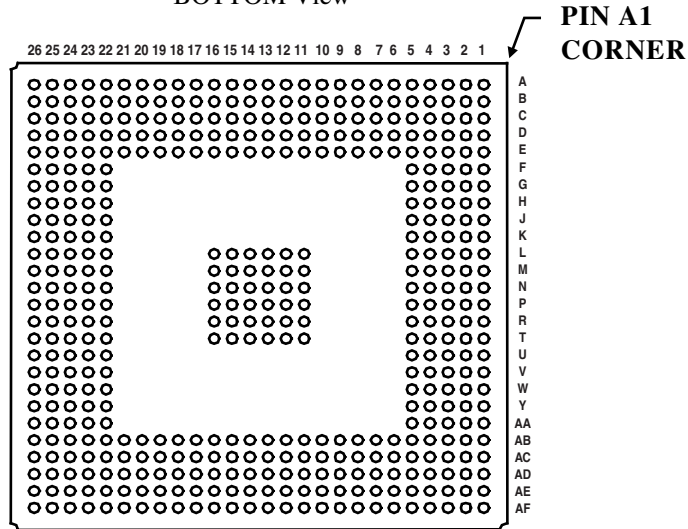


Figure 9: 456-Pin PBGA Pinout Diagram

# 456 PBGA Pinout Table

Table 11: 456 PBGA Pinout Table

| 456 | Function          | 456 | Function | 456 | Function        | 456 | Function        | 456 | Function        |
|-----|-------------------|-----|----------|-----|-----------------|-----|-----------------|-----|-----------------|
| A1  | I/O               | B26 | STM      | D25 | I/O             | H4  | I/O             | M14 | GND/THERM       |
| A2  | I/O               | C1  | I/O      | D26 | I/O             | H5  | NC              | M15 | GND/THERM       |
| A3  | I/O               | C2  | I/O      | E1  | I/O             | H22 | NC              | M16 | GND/THERM       |
| A4  | I/O               | C3  | I/O      | E2  | I/O             | H23 | I/O             | M22 | NC              |
| A5  | I/O               | C4  | TDO      | E3  | I/O             | H24 | I/O             | M23 | NC              |
| A6  | I/O               | C5  | I/O      | E4  | I/O             | H25 | I/O             | M24 | I/O             |
| A7  | I/O               | C6  | I/O      | E5  | GND             | H26 | I/O             | M25 | I/O             |
| A8  | I/O               | C7  | I/O      | E6  | V <sub>CC</sub> | J1  | I/O             | M26 | I/O             |
| A9  | I/O               | C8  | I/O      | E7  | GND             | J2  | I/O             | N1  | GCLK/I          |
| A10 | I/O               | C9  | I/O      | E8  | NC              | J3  | I/O             | N2  | I/O             |
| A11 | I/O               | C10 | I/O      | E9  | GND             | J4  | NC              | N3  | I/O             |
| A12 | V <sub>CCIO</sub> | C11 | I/O      | E10 | I/O             | J5  | GND             | N4  | GCLK/I          |
| A13 | I/O               | C12 | I/O      | E11 | GND             | J22 | NC              | N5  | V <sub>CC</sub> |
| A14 | I/O               | C13 | I/O      | E12 | GND             | J23 | NC              | N11 | GND/THERM       |
| A15 | I/O               | C14 | I/O      | E13 | V <sub>CC</sub> | J24 | I/O             | N12 | GND/THERM       |
| A16 | I/O               | C15 | I/O      | E14 | GND             | J25 | I/O             | N13 | GND/THERM       |
| A17 | I/O               | C16 | I/O      | E15 | GND             | J26 | I/O             | N14 | GND/THERM       |
| A18 | I/O               | C17 | I/O      | E16 | GND             | K1  | I/O             | N15 | GND/THERM       |
| A19 | I/O               | C18 | I/O      | E17 | NC              | K2  | I/O             | N16 | GND/THERM       |
| A20 | I/O               | C19 | I/O      | E18 | GND             | K3  | I/O             | N22 | GND             |
| A21 | I/O               | C20 | I/O      | E19 | NC              | K4  | I/O             | N23 | I/O             |
| A22 | I/O               | C21 | I/O      | E20 | GND             | K5  | V <sub>CC</sub> | N24 | I/O             |
| A23 | I/O               | C22 | I/O      | E21 | V <sub>CC</sub> | K22 | GND             | N25 | I/O             |
| A24 | I/O               | C23 | I/O      | E22 | GND             | K23 | I/O             | N26 | I/O             |
| A25 | I/O               | C24 | I/O      | E23 | I/O             | K24 | I/O             | P1  | I/O             |
| A26 | I/O               | C25 | TCK      | E24 | I/O             | K25 | I/O             | P2  | I/O             |
| B1  | I/O               | C26 | I/O      | E25 | I/O             | K26 | I/O             | P3  | I/O             |
| B2  | I/O               | D1  | I/O      | E26 | I/O             | L1  | I/O             | P4  | I/O             |
| B3  | I/O               | D2  | I/O      | F1  | I/O             | L2  | I/O             | P5  | NC              |
| B4  | I/O               | D3  | I/O      | F2  | I/O             | L3  | I/O             | P11 | GND/THERM       |
| B5  | I/O               | D4  | GND      | F3  | I/O             | L4  | I/O             | P12 | GND/THERM       |
| B6  | I/O               | D5  | I/O      | F4  | NC              | L5  | NC              | P13 | GND/THERM       |
| B7  | I/O               | D6  | NC       | F5  | V <sub>CC</sub> | L11 | GND/THERM       | P14 | GND/THERM       |
| B8  | I/O               | D7  | I/O      | F22 | V <sub>CC</sub> | L12 | GND/THERM       | P15 | GND/THERM       |
| B9  | I/O               | D8  | I/O      | F23 | NC              | L13 | GND/THERM       | P16 | GND/THERM       |
| B10 | I/O               | D9  | GND      | F24 | I/O             | L14 | GND/THERM       | P22 | NC              |
| B11 | I/O               | D10 | I/O      | F25 | I/O             | L15 | GND/THERM       | P23 | GCLK / I        |
| B12 | I/O               | D11 | I/O      | F26 | I/O             | L16 | GND/THERM       | P24 | GCLK / I        |
| B13 | I/O               | D12 | GND      | G1  | I/O             | L22 | NC              | P25 | I/O             |
| B14 | I/O               | D13 | I/O      | G2  | I/O             | L23 | I/O             | P26 | ACLK / I        |
| B15 | I/O               | D14 | I/O      | G3  | I/O             | L24 | I/O             | R1  | I/O             |
| B16 | I/O               | D15 | GND      | G4  | I/O             | L25 | I/O             | R2  | I/O             |
| B17 | I/O               | D16 | I/O      | G5  | NC              | L26 | I/O             | R3  | I/O             |
| B18 | I/O               | D17 | I/O      | G22 | GND             | M1  | ACLK / I        | R4  | NC              |
| B19 | I/O               | D18 | GND      | G23 | I/O             | M2  | GCLK/I          | R5  | NC              |
| B20 | I/O               | D19 | I/O      | G24 | I/O             | M3  | I/O             | R11 | GND/THERM       |
| B21 | I/O               | D20 | I/O      | G25 | I/O             | M4  | NC              | R12 | GND/THERM       |
| B22 | I/O               | D21 | NC       | G26 | I/O             | M5  | GND             | R13 | GND/THERM       |
| B23 | I/O               | D22 | I/O      | H1  | I/O             | M11 | GND/THERM       | R14 | GND/THERM       |
| B24 | I/O               | D23 | GND      | H2  | I/O             | M12 | GND/THERM       | R15 | GND/THERM       |
| B25 | I/O               | D24 | I/O      | H3  | I/O             | M13 | GND/THERM       | R16 | GND/THERM       |

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Table 11: 456 PBGA Pinout Table (Continued)

| 456 | Function        | 456  | Function        | 456  | Function          | 456  | Function | 456  | Function |
|-----|-----------------|------|-----------------|------|-------------------|------|----------|------|----------|
| R22 | V <sub>CC</sub> | W1   | I/O             | AB12 | NC                | AD1  | I/O      | AE16 | I/O      |
| R23 | NC              | W2   | I/O             | AB13 | I/O               | AD2  | NC       | AE17 | I/O      |
| R24 | I/O             | W3   | I/O             | AB14 | GND               | AD3  | I/O      | AE18 | I/O      |
| R25 | I/O             | W4   | I/O             | AB15 | V <sub>CC</sub>   | AD4  | I/O      | AE19 | I/O      |
| R26 | GCLK / I        | W5   | NC              | AB16 | I/O               | AD5  | I/O      | AE20 | I/O      |
| T1  | I/O             | W22  | NC              | AB17 | NC                | AD6  | I/O      | AE21 | I/O      |
| T2  | I/O             | W23  | I/O             | AB18 | V <sub>CC</sub>   | AD7  | I/O      | AE22 | I/O      |
| T3  | I/O             | W24  | I/O             | AB19 | GND               | AD8  | I/O      | AE23 | NC       |
| T4  | I/O             | W25  | I/O             | AB20 | NC                | AD9  | I/O      | AE24 | TMS      |
| T5  | V <sub>CC</sub> | W26  | I/O             | AB21 | V <sub>CC</sub>   | AD10 | I/O      | AE25 | I/O      |
| T11 | GND/THERMAL     | Y1   | I/O             | AB22 | GND               | AD11 | I/O      | AE26 | I/O      |
| T12 | GND/THERMAL     | Y2   | I/O             | AB23 | I/O               | AD12 | I/O      | AF1  | I/O      |
| T13 | GND/THERMAL     | Y3   | I/O             | AB24 | I/O               | AD13 | I/O      | AF2  | I/O      |
| T14 | GND/THERMAL     | Y4   | I/O             | AB25 | I/O               | AD14 | I/O      | AF3  | I/O      |
| T15 | GND/THERMAL     | Y5   | I/O             | AB26 | I/O               | AD15 | I/O      | AF4  | I/O      |
| T16 | GND/THERMAL     | Y22  | GND             | AC1  | I/O               | AD16 | I/O      | AF5  | I/O      |
| T22 | GND             | Y23  | I/O             | AC2  | I/O               | AD17 | I/O      | AF6  | I/O      |
| T23 | I/O             | Y24  | I/O             | AC3  | NC                | AD18 | I/O      | AF7  | I/O      |
| T24 | I/O             | Y25  | I/O             | AC4  | GND               | AD19 | I/O      | AF8  | I/O      |
| T25 | I/O             | Y26  | I/O             | AC5  | I/O               | AD20 | I/O      | AF9  | I/O      |
| T26 | I/O             | AA1  | I/O             | AC6  | NC                | AD21 | I/O      | AF10 | I/O      |
| U1  | I/O             | AA2  | I/O             | AC7  | I/O               | AD22 | I/O      | AF11 | I/O      |
| U2  | I/O             | AA3  | NC              | AC8  | I/O               | AD23 | TRSTB    | AF12 | I/O      |
| U3  | I/O             | AA4  | NC              | AC9  | NC                | AD24 | I/O      | AF13 | I/O      |
| U4  | I/O             | AA5  | V <sub>CC</sub> | AC10 | I/O               | AD25 | I/O      | AF14 | I/O      |
| U5  | GND             | AA22 | V <sub>CC</sub> | AC11 | I/O               | AD26 | I/O      | AF15 | I/O      |
| U22 | NC              | AA23 | NC              | AC12 | NC                | AE1  | TDI      | AF16 | I/O      |
| U23 | I/O             | AA24 | I/O             | AC13 | I/O               | AE2  | I/O      | AF17 | I/O      |
| U24 | I/O             | AA25 | I/O             | AC14 | V <sub>CCIO</sub> | AE3  | I/O      | AF18 | I/O      |
| U25 | I/O             | AA26 | I/O             | AC15 | NC                | AE4  | I/O      | AF19 | I/O      |
| U26 | I/O             | AB1  | I/O             | AC16 | I/O               | AE5  | I/O      | AF20 | I/O      |
| V1  | I/O             | AB2  | I/O             | AC17 | I/O               | AE6  | I/O      | AF21 | I/O      |
| V2  | I/O             | AB3  | I/O             | AC18 | NC                | AE7  | I/O      | AF22 | I/O      |
| V3  | I/O             | AB4  | I/O             | AC19 | I/O               | AE8  | I/O      | AF23 | I/O      |
| V4  | NC              | AB5  | GND             | AC20 | I/O               | AE9  | I/O      | AF24 | I/O      |
| V5  | NC              | AB6  | V <sub>CC</sub> | AC21 | I/O               | AE10 | I/O      | AF25 | I/O      |
| V22 | GND             | AB7  | NC              | AC22 | NC                | AE11 | I/O      | AF26 | I/O      |
| V23 | NC              | AB8  | NC              | AC23 | GND               | AE12 | I/O      |      |          |
| V24 | I/O             | AB9  | NC              | AC24 | I/O               | AE13 | I/O      |      |          |
| V25 | I/O             | AB10 | V <sub>CC</sub> | AC25 | I/O               | AE14 | I/O      |      |          |
| V26 | I/O             | AB11 | GND             | AC26 | I/O               | AE15 | I/O      |      |          |

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# 456 PBGA Mechanical Drawing

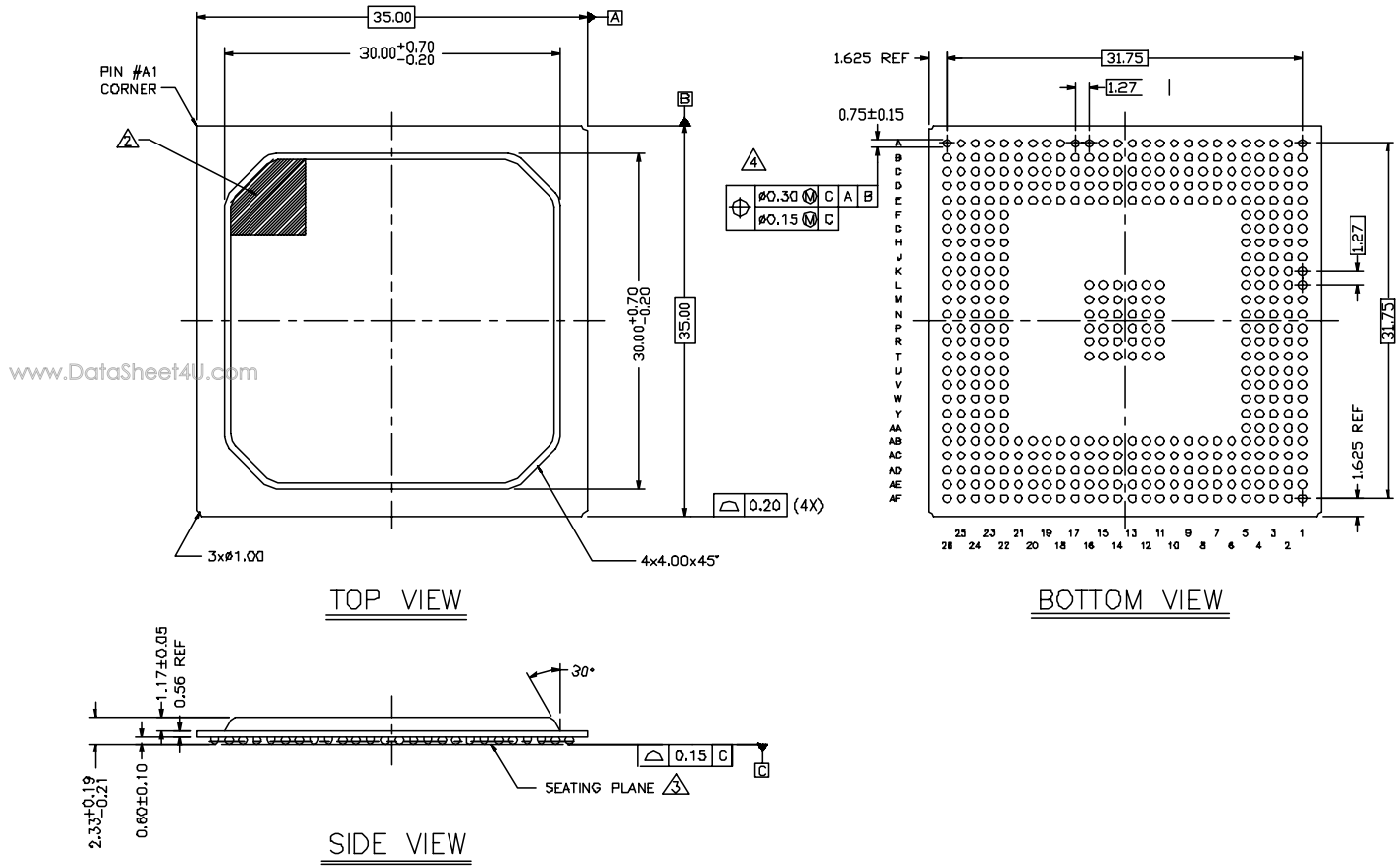


Figure 10: 456 PBGA Mechanical Drawing

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## Revision History

Table 12: Revision History

| Revision | Date       | Comments   |
|----------|------------|--|
| A        | not avail. | First release.   |
| B        | not avail. |  |
| C        | May 2001   | Update of AC/DC Specs and reformat   |
| D        | June 2002  | Added Kfactor, Power-up, JTAG and mechanical drawing information. Reformatted. |

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