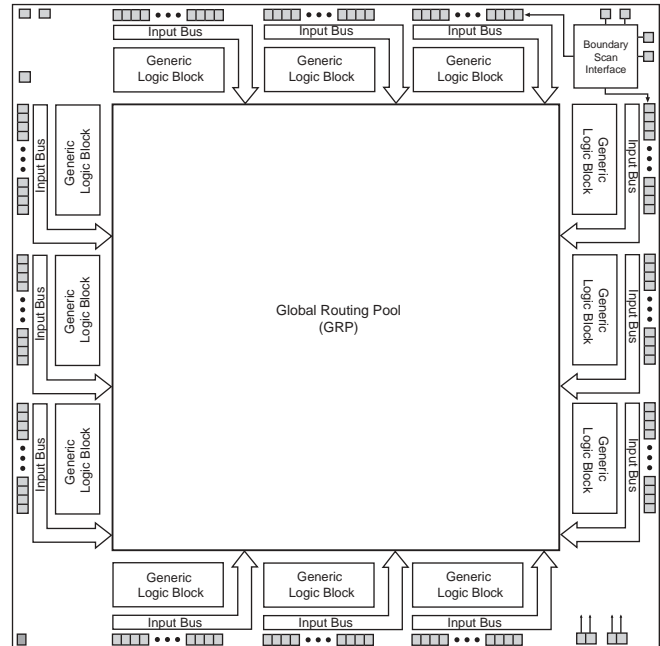


Features

- **Second Generation SuperWIDE HIGH DENSITY IN-SYSTEM PROGRAMMABLE LOGIC DEVICE**
 - 3.3V Power Supply
 - User Selectable 3.3V/2.5V I/O
 - 18000 PLD Gates / 384 Macrocells
 - Up to 192 I/O Pins
 - 384 Registers
 - High-Speed Global Interconnect
 - SuperWIDE Generic Logic Block (32 Macrocells) for Optimum Performance
 - SuperWIDE Input Gating (68 Inputs) for Fast Counters, State Machines, Address Decoders, etc.
 - PCB Efficient Ball Grid Array (BGA) Package Options
 - Interfaces with Standard 5V TTL Devices
- **HIGH PERFORMANCE E²CMOS[®] TECHNOLOGY**
 - $f_{max} = 165$ MHz Maximum Operating Frequency
 - $t_{pd} = 6.0$ ns Propagation Delay
 - TTL/3.3V/2.5V Compatible Input Thresholds and Output Levels
 - Electrically Erasable and Reprogrammable
 - Non-Volatile
 - Programmable Speed/Power Logic Path Optimization
- **IN-SYSTEM PROGRAMMABLE**
 - Increased Manufacturing Yields, Reduced Time-to-Market, and Improved Product Quality
 - Reprogram Soldered Devices for Faster Debugging
- **100% IEEE 1149.1 BOUNDARY SCAN TESTABLE AND 3.3V IN-SYSTEM PROGRAMMABLE**
- **ARCHITECTURE FEATURES**
 - Enhanced Pin-Locking Architecture with Single-Level Global Routing Pool and SuperWIDE GLBs
 - Wrap Around Product Term Sharing Array Supports up to 35 Product Terms Per Macrocell
 - Macrocells Support Concurrent Combinatorial and Registered Functions
 - Macrocell Registers Feature Multiple Control Options Including Set, Reset and Clock Enable
 - Four Dedicated Clock Input Pins Plus Macrocell Product Term Clocks
 - Programmable I/O Supports Programmable Bus Hold, Pull-up, Open Drain and Slew Rate Options
 - Four Global Product Term Output Enables, Two Global OE Pins and One Product Term OE per Macrocell

Functional Block Diagram



ispLSI 5000VE Description

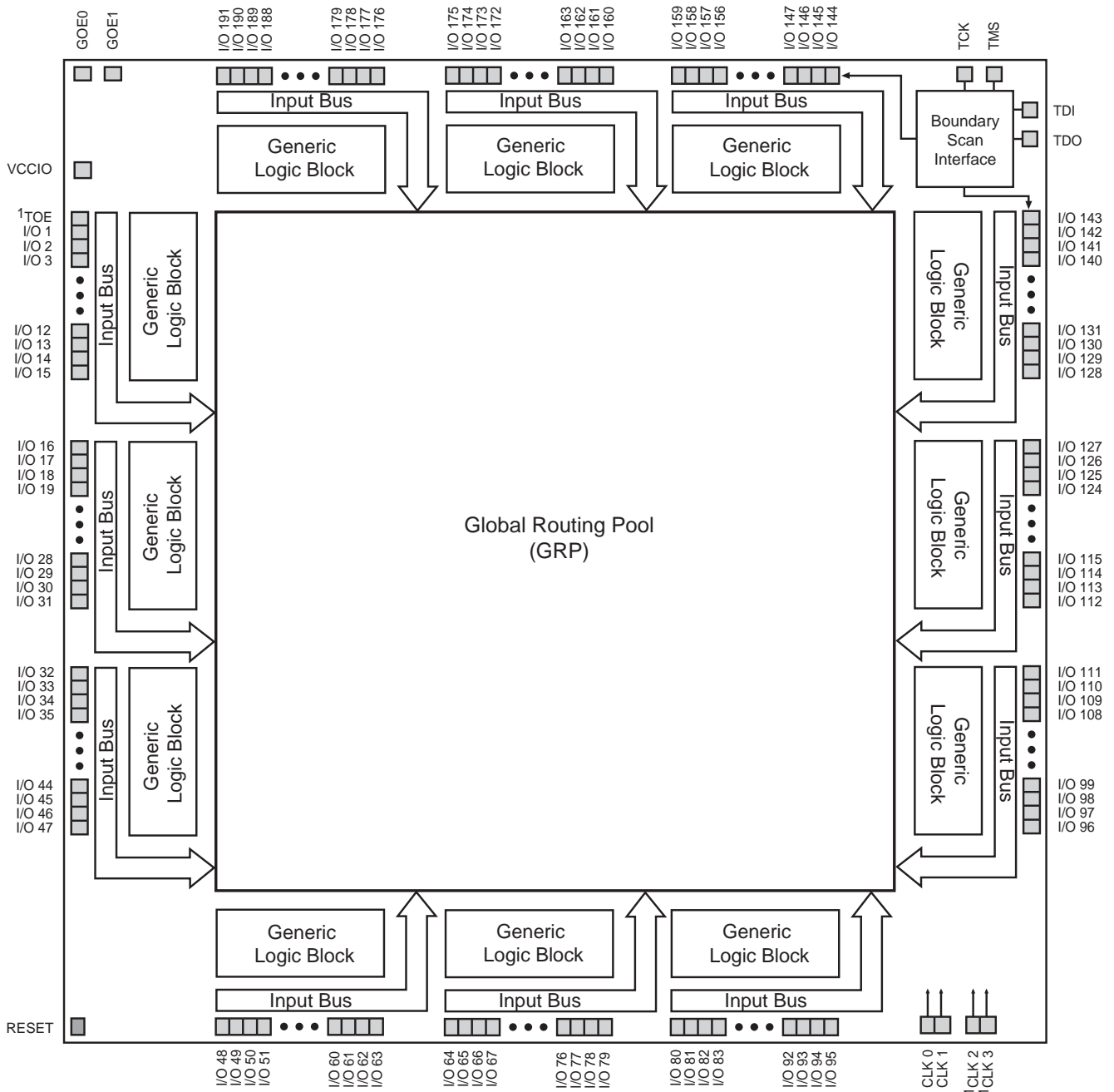
The ispLSI 5000VE Family of In-System Programmable High Density Logic Devices is based on Generic Logic Blocks (GLBs) of 32 registered macrocells and a single Global Routing Pool (GRP) structure interconnecting the GLBs.

Outputs from the GLBs drive the Global Routing Pool (GRP) between the GLBs. Switching resources are provided to allow signals in the Global Routing Pool to drive any or all the GLBs in the device. This mechanism allows fast, efficient connections across the entire device.

Each GLB contains 32 macrocells and a fully populated, programmable AND-array with 160 logic product terms and three extra control product terms. The GLB has 68 inputs from the Global Routing Pool which are available in both true and complement form for every product term. The 160 product terms are grouped in 32 sets of five and sent into a Product Term Sharing Array (PTSA) which allows sharing up to a maximum of 35 product terms for a single function. Alternatively, the PTSA can be bypassed for functions of five product terms or less. The three extra product terms are used for shared controls: reset, clock, clock enable and output enable.

Functional Block Diagram

Figure 1. ispLSI 5384VE Functional Block Diagram (192-I/O Option)



1. CLK2, CLK3 and TOE signals are multiplexed with I/O signals. Use the table below to determine which I/O is shared by package type.

| Package Type | Multiplexed Signals | | |
|--------------|---------------------|----------------|-------------|
| 256 fpBGA | I/O 119 / CLK2 | I/O 131 / CLK3 | I/O 0 / TOE |
| 272 BGA | I/O 119 / CLK2 | I/O 131 / CLK3 | I/O 0 / TOE |

ispLSI 5000VE Description (Continued)

The 32 registered macrocells in the GLB are driven by the 32 outputs from the PTSA or the PTSA bypass. Each macrocell contains a programmable XOR gate, a programmable register/latch and the necessary clocks and control logic to allow combinatorial or registered operation. The macrocells each have two outputs, combinatorial and registered. This dual output capability from the macrocell allows efficient use of the hardware resources. One output can be a registered function for example, while the other output can be an unrelated combinatorial function. A direct register input from the I/O pad facilitates efficient use of this feature to construct high-speed input registers.

Macrocell registers can be clocked from one of several global or product term clocks available on the device. A global and product term clock enable is also available to each register, eliminating the need to gate the clock to the macrocell registers. Reset for the macrocell register is provided from the global signal, its polarity is user-selectable. The macrocell register can be programmed to operate as a D-type register or a D-type latch.

The 32 outputs from the GLB can drive both the Global Routing Pool and the device I/O cells. The Global Routing Pool contains one input from each macrocell output and one input from each I/O pin.

The input buffer threshold has programmable TTL/3.3V/2.5V compatible levels. The output driver can source 4mA and sink 8mA in 3.3V mode. The output drivers have a separate VCCIO reference input which is independent of the main VCC supply for the device. This feature allows individual output drivers to drive either 3.3V (from the device VCC) or 2.5V (from the VCCIO pin) output levels while the device logic and the output current drive are powered from device supply (VCC). The output drivers also provide individually programmable edge rates and open drain capability. A programmable pullup resistor is provided to tie off unused inputs. Additionally, a programmable bus-hold latch is available to hold tristate outputs in their last valid state until the bus is driven again by some device.

Table 1. ispLSI 5000VE Family

| Device | GLBs | Macrocells | Package Type | | | | | |
|---------------|------|------------|--------------|----------|-----------|---------|-----------|---------|
| | | | 100 TQFP | 128 TQFP | 256 fpBGA | 272 BGA | 388 fpBGA | 388 BGA |
| ispLSI 5128VE | 4 | 128 | — | 96 I/O | — | — | — | — |
| ispLSI 5256VE | 8 | 256 | 72 I/O | 96 I/O | 144 I/O | 144 I/O | — | — |
| ispLSI 5384VE | 12 | 384 | — | — | 192 I/O | 192 I/O | — | — |
| ispLSI 5512VE | 16 | 512 | — | — | 192 I/O | 192 I/O | 256 I/O | 256 I/O |

The ispLSI 5000VE Family features 3.3V, non-volatile in-system programmability for both the logic and the interconnect structures, providing the means to develop truly reconfigurable systems. Programming is achieved through the industry standard IEEE 1149.1-compliant Boundary Scan interface. Boundary Scan test is also supported through the same interface.

An enhanced, multiple cell security scheme is provided that prevents reading of the JEDEC programming file when secured. After the device has been secured using this mechanism, the only way to clear the security is to execute a bulk-erase instruction.

ispLSI 5000VE Family Members

The ispLSI 5000VE Family ranges from 128 macrocells to 512 macrocells and operates from a 3.3V power supply. All family members will be available with multiple package options. The ispLSI 5000VE Family device matrix showing the various bondout options is shown in the table below.

The interconnect structure (GRP) is very similar to Lattice's existing ispLSI 1000, 2000 and 3000 families, but with an enhanced interconnect structure for optimal pin locking and logic routing. This eliminates the need for registered I/O cells or an Output Routing Pool.

The ispLSI 5000VE encompasses the innovative features of the ispLSI 5000VA family with several enhancements. The macrocell is optimized and the T-type flip flop option is removed. To improve the efficiency of design fits, the Product Term Reset Logic is simplified and the polarity option as well as the Global Preset function are removed. The programmable output-delay feature (skew option) is also removed. As a result, the ispLSI 5000VE is not JEDEC compatible with the ispLSI 5000VA. ispLSI 5000VA and 5000VE pinouts may differ in the same package, however all programming and power/ground pins are located in the same locations.

Figure 2. ispLSI 5384VE Block Diagram (192 I/O Version)

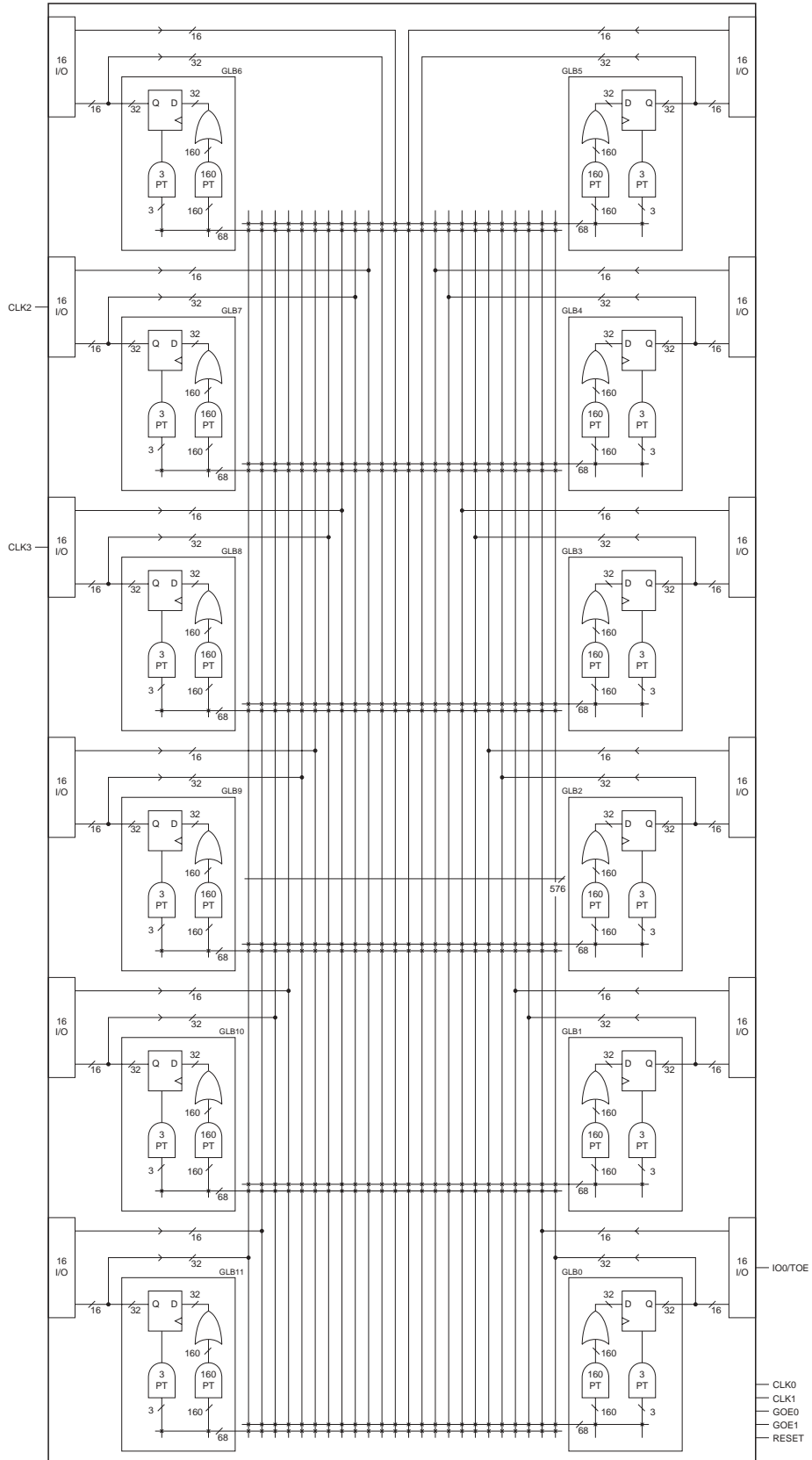
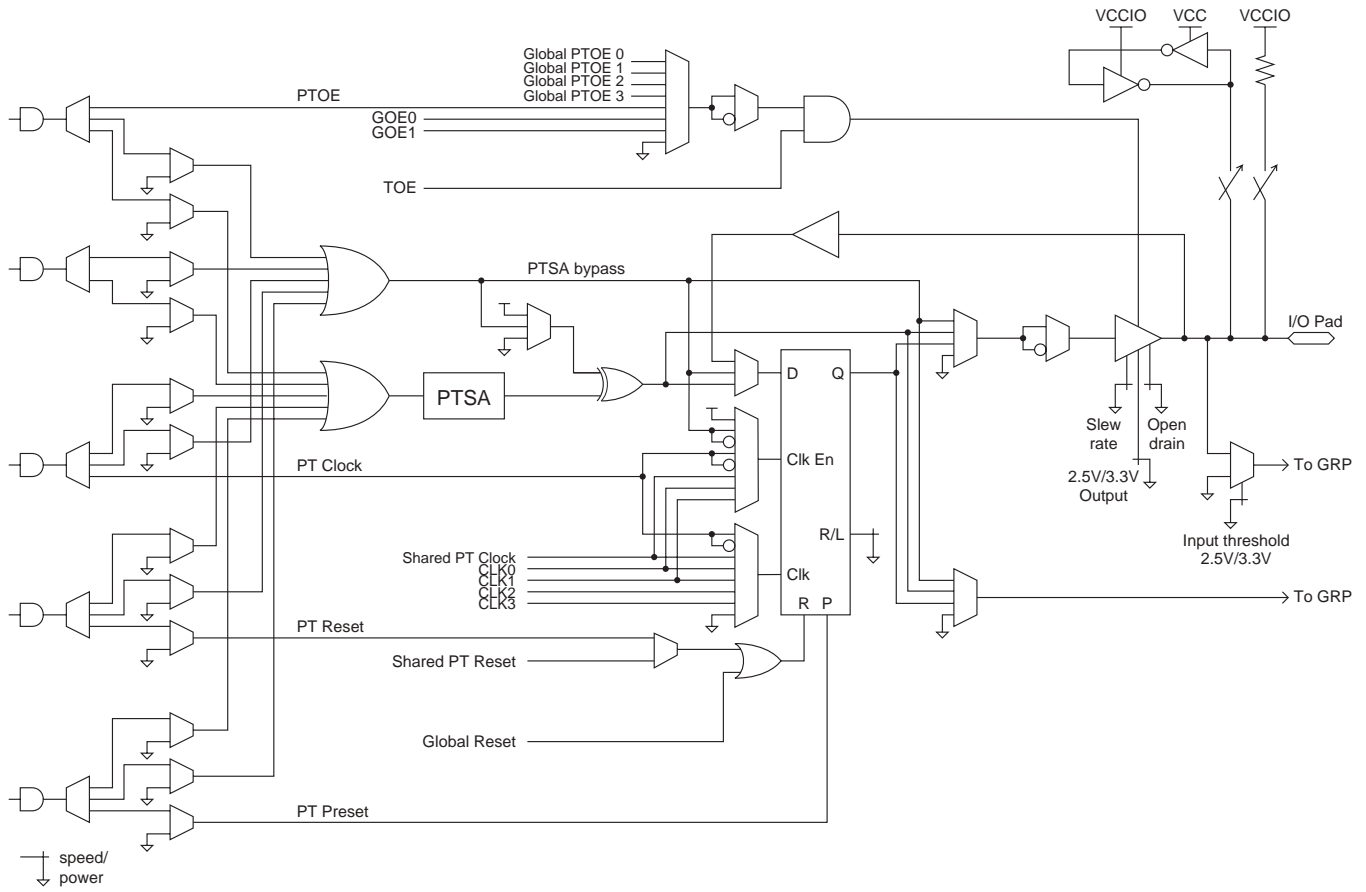


Figure 4. ispLSI 5000VE Macrocell



Note: Not all macrocells have I/O pads.

Global Clock Distribution

The ispLSI 5000VE Family has four dedicated clock input pins: CLK0 - CLK3. CLK0 input is used as the dedicated master clock that has the lowest internal clock skew with no clock inversion to maintain the fastest internal clock

speed. The clock inversion is available on the remaining CLK1 - CLK3 signals. By sharing the pins with the I/O pins, CLK2 and CLK3 can not only be inverted but are also available for logic implementation through GRP signal routing. Figure 5 shows these different clock distribution options.

Figure 5. ispLSI 5000VE Global Clock Structure

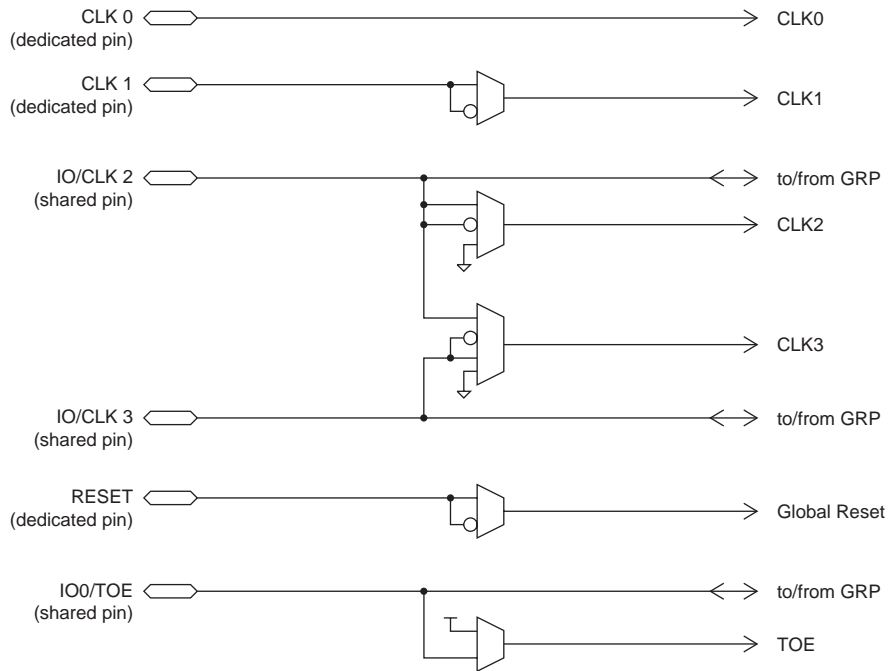


Figure 6. Boundary Scan Register Circuit for I/O Pins

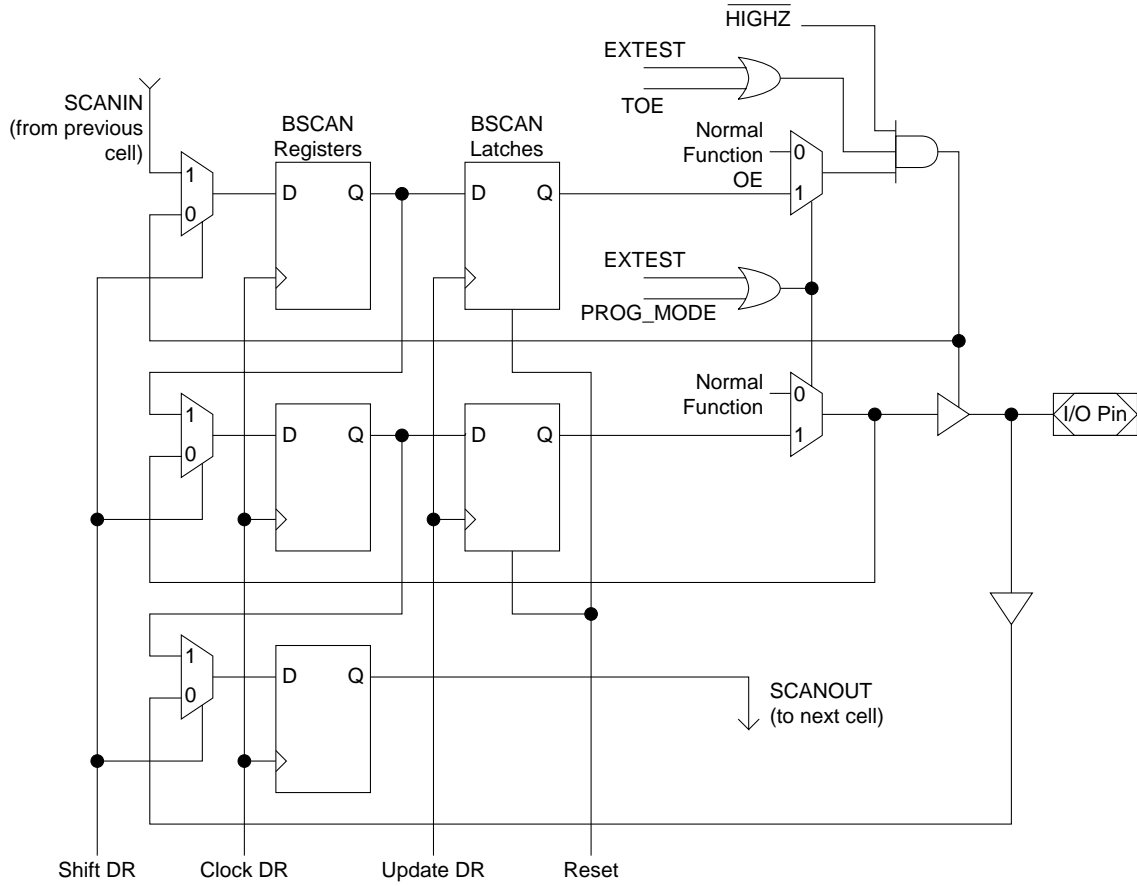
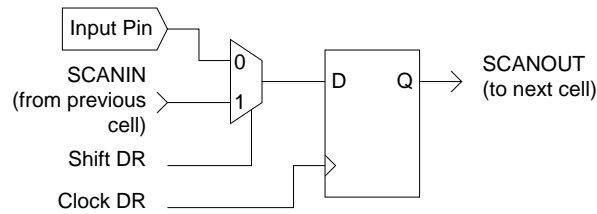


Figure 7. Boundary Scan Register Circuit for Input-Only Pins



Absolute Maximum Ratings ^{1, 2}

- Supply Voltage V_{CC} -0.5 to +5.4V
- Input Voltage Applied -0.5 to +5.6V
- Tri-Stated Output Voltage Applied -0.5 to +5.6V
- Storage Temperature -65 to 150°C
- Case Temp. with Power Applied -55 to 125°C
- Max. Junction Temp. (T_J) with Power Applied ... 150°C

1. Stresses above those listed under the “Absolute Maximum Ratings” may cause permanent damage to the device. Functional operation of the device at these or at any other conditions above those indicated in the operational sections of this specification is not implied (while programming, follow the programming specifications).
2. Compliance with the Thermal Management section of the Lattice Semiconductor Data Book or CD-ROM is a requirement.

DC Recommended Operating Condition

| SYMBOL | PARAMETER | MIN. | MAX. | UNITS | |
|------------|-----------------------|---|------|-------|---|
| V_{CC} | Supply Voltage | Commercial $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$ | 3.00 | 3.60 | V |
| | | Industrial $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ | 3.00 | 3.60 | V |
| V_{CCIO} | I/O Reference Voltage | 2.3 | 3.60 | V | |

Table 2-0005/5KVE

Capacitance ($T_A=25^\circ\text{C}, f=1.0\text{ MHz}$)

| SYMBOL | PARAMETER | TYPICAL | UNITS | TEST CONDITIONS |
|--------|--------------------------|---------|-------|---|
| C_1 | I/O Capacitance | 10 | pf | $V_{CC} = 3.3\text{V}, V_{I/O} = 0.0\text{V}$ |
| C_2 | Clock Capacitance | 10 | pf | $V_{CC} = 3.3\text{V}, V_{CK} = 0.0\text{V}$ |
| C_3 | Global Input Capacitance | 10 | pf | $V_{CC} = 3.3\text{V}, V_G = 0.0\text{V}$ |

Table 2-0006/5KVE

Erase Reprogram Specification

| PARAMETER | MINIMUM | MAXIMUM | UNITS |
|-------------------------------|---------|---------|--------|
| ispLSI Erase/Reprogram Cycles | 10000 | – | Cycles |

Table 2-0008/5KVE

Switching Test Conditions

| | |
|--------------------------------|-------------------------|
| Input Pulse Levels | GND to $V_{CCIO_{min}}$ |
| Input Rise and Fall Time | $\leq 1.5ns$ 10% to 90% |
| Input Timing Reference Levels | 1.5V |
| Output Timing Reference Levels | 1.5V |
| Output Load | See Figure 9 |

3-state levels are measured 0.5V from steady-state active level.

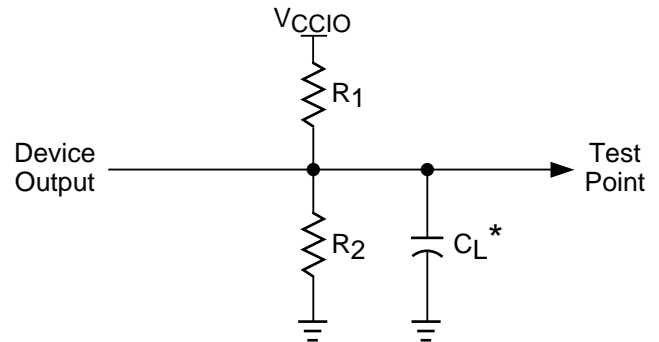
Table 2-0003/5KVE

Output Load Conditions (See Figure 9)

| TEST CONDITION | 3.3V | | 2.5V | | CL | |
|----------------|-----------------------------------|------|------|------|------|------|
| | R1 | R2 | R1 | R2 | | |
| A | 316Ω | 348Ω | 511Ω | 475Ω | 35pF | |
| B | Active High | ∞ | 348Ω | ∞ | 475Ω | 35pF |
| | Active Low | 316Ω | ∞ | 511Ω | ∞ | 35pF |
| C | Active High to Z at $V_{OH}-0.5V$ | ∞ | 348Ω | ∞ | 475Ω | 5pF |
| | Active Low to Z at $V_{OL}+0.5V$ | 316Ω | ∞ | 511Ω | ∞ | 5pF |
| D | Slow Slew | ∞ | ∞ | ∞ | ∞ | 35pF |

Table 2-0004A/5KVE

Figure 9. Test Load



* C_L includes Test Fixture and Probe Capacitance.

0213D

DC Electrical Characteristics for 3.3V Range¹

Over Recommended Operating Conditions

| SYMBOL | PARAMETER | CONDITION | MIN. | TYP. | MAX. | UNITS |
|------------|-----------------------|--|------|------|------|-------|
| V_{CCIO} | I/O Reference Voltage | | 3.0 | – | 3.6 | V |
| V_{IL} | Input Low Voltage | | -0.3 | – | 0.8 | V |
| V_{IH} | Input High Voltage | | 2.0 | – | 5.25 | V |
| V_{OL} | Output Low Voltage | $V_{CCIO} = \min, I_{OL} = 8\text{ mA}$ | – | – | 0.4 | V |
| V_{OH} | Output High Voltage | $V_{CCIO} = \min, I_{OH} = -4\text{ mA}$ | 2.4 | – | – | V |

Table 2-0007/5KVE

1. I/O voltage configuration must be set to VCC.

DC Electrical Characteristics for 2.5V Range¹

Over Recommended Operating Conditions

| SYMBOL | PARAMETER | CONDITION | MIN. | TYP. | MAX. | UNITS |
|-------------------|-----------------------|--|------|------|------|-------|
| V _{CCIO} | I/O Reference Voltage | | 2.3 | – | 2.7 | V |
| V _{IL} | Input Low Voltage | | -0.3 | – | 0.7 | V |
| V _{IH} | Input High Voltage | | 1.7 | – | 5.25 | V |
| V _{OL} | Output Low Voltage | V _{CCIO} =min, I _{OL} = 100μA | – | – | 0.2 | V |
| | | V _{CCIO} =min, I _{OL} = 2mA | – | – | 0.6 | V |
| V _{OH} | Output High Voltage | V _{CCIO} =min, I _{OH} = -100μA | 2.1 | – | – | V |
| | | V _{CCIO} =min, I _{OH} = -2mA | 1.8 | – | – | V |

1. I/O voltage configuration must be set to V_{CCIO}.

2.5V/5KVE

DC Electrical Characteristics

Over Recommended Operating Conditions

| SYMBOL | PARAMETER | CONDITION | MIN. | TYP. | MAX. | UNITS |
|------------------------------|--|---|-----------------|------|-----------------|-------|
| I _{IL} | Input or I/O Low Leakage Current | 0V ≤ V _{IN} ≤ V _{IL} (Max.) | – | – | -10 | μA |
| I _{IH} | Input or I/O High Leakage Current | (V _{CCIO} -0.2)V ≤ V _{IN} ≤ V _{CCIO} | – | – | 10 | μA |
| | | V _{CCIO} ≤ V _{IN} ≤ 5.25V | – | – | 50 | μA |
| I _{PU} ¹ | I/O Active Pullup Current | 0V ≤ V _{IN} ≤ V _{IL} | – | – | -200 | μA |
| I _{BHL} | Bus Hold Low Sustaining Current | V _{IN} = V _{IL} (max) | 40 | – | – | μA |
| I _{BHH} | Bus Hold High Sustaining Current | V _{IN} = V _{IH} (min) | -40 | – | – | μA |
| I _{BHLO} | Bus Hold Low Overdrive Current | 0V ≤ V _{IN} ≤ V _{CCIO} | – | – | 550 | μA |
| I _{BHLH} | Bus Hold High Overdrive Current | 0V ≤ V _{IN} ≤ V _{CCIO} | – | – | -550 | μA |
| I _{BHT} | Bus Hold Trip Points | | V _{IL} | – | V _{IH} | V |
| I _{VCCIO} | Current Needed for V _{CCIO} Pin | All I/Os Pulled-up, (Total I/Os * I _{PU} max) | – | – | 30 | mA |

1. Pullup is capable of pulling to a minimum voltage of V_{OH} under no-load conditions.

DC Char_5KVE

External Switching Characteristics

Over Recommended Operating Conditions

| PARAM. | TEST ³ COND. | DESCRIPTION ^{4,5} | -165 | | -125 | | UNITS |
|-------------------------------------|-------------------------|--|------|------|------|------|-------|
| | | | MIN. | MAX. | MIN. | MAX. | |
| t _{pd1} ⁶ | A | Data Prop. Delay, 5PT Bypass | — | 6.0 | — | 7.5 | ns |
| t _{pd2} ⁶ | A | Data Propagation Delay | — | 7.5 | — | 9.5 | ns |
| f _{max} | A | Clock Frequency with Internal Feedback ¹ | 165 | — | 125 | — | MHz |
| f _{max} (Ext.) | — | Clock Freq. with Ext. Feedback, 1/(t _{su2} + t _{co1}) | 118 | — | 87 | — | MHz |
| f _{max} (Tog.) | — | Clock Frequency, Max Toggle ² | 200 | — | 167 | — | MHz |
| t _{su1} | — | GLB Reg. Setup Time before Clk, 5PT bypass | 4.0 | — | 5.0 | — | ns |
| t _{co1} ⁶ | A | GLB Reg. Clock to Output Delay | — | 3.0 | — | 4.5 | ns |
| t _{h1} | — | GLB Reg. Hold Time after Clock, 5PT bypass | 0.0 | — | 0.0 | — | ns |
| t _{su2} | — | GLB Reg. Setup Time before Clock | 5.5 | — | 7.0 | — | ns |
| t _{h2} | — | GLB Reg. Hold Time after Clock | 0.0 | — | 0.0 | — | ns |
| t _{su3} | — | GLB Reg. Setup Time before Clock, Input Reg. Path | 3.0 | — | 3.5 | — | ns |
| t _{h3} | — | GLB Reg. Hold Time after Clock, Input Reg. Path | 0.5 | — | 0.5 | — | ns |
| t _{r1} | A | Ext. Reset Pin to Output Delay | — | 8.0 | — | 10.0 | ns |
| t _{rw1} ⁷ | — | Ext. Reset Pulse Duration | 4.0 | — | 5.0 | — | ns |
| t _{pten/dis} ⁶ | B/C | Local Product Term Output Enable/Disable | — | 7.0 | — | 8.5 | ns |
| t _{gpten/dis} ⁶ | B/C | Global Product Term Output Enable/Disable | — | 12.0 | — | 14.0 | ns |
| t _{gen/dis} ⁶ | B/C | Global OE Input to Output Enable/Disable | — | 4.5 | — | 5.5 | ns |
| t _{tten/dis} ⁶ | B/C | Test OE Input to Output Enable/Disable | — | 8.5 | — | 10.5 | ns |
| t _{wh} | — | Ext. Sync. Clock Pulse Duration, High | 2.5 | — | 3.0 | — | ns |
| t _{wl} | — | Ext. Sync. Clock Pulse Duration, Low | 2.5 | — | 3.0 | — | ns |

1. Standard 16-bit counter using GRP feedback.

5384ve1.eps Timing v.2.0

2. f_{max} (Toggle) may be less than 1/(t_{wh} + t_{wl}). This is to allow for a clock duty cycle of other than 50%.

3. Reference Switching Test Conditions section.

4. Unless noted otherwise, all timing numbers are taken with worst case PTSA fanout, a GRP load of 1 GLB, CLK0, and high-speed AND array.

5. Timing parameters measured using normal active output driver.

6. The delay parameters are measured with V_{cc} as I/O voltage reference. An additional 0.5ns delay is incurred when V_{ccio} is used as I/O voltage reference.

7. Pulse widths less than minimum may cause unknown output behavior.

External Switching Characteristics

Over Recommended Operating Conditions

| PARAM. | TEST ³ COND. | DESCRIPTION ^{4,5} | -100 | | -80 | | UNITS |
|---|----------------------------|---|------|------|------|------|-------|
| | | | MIN. | MAX. | MIN. | MAX. | |
| t _{pd1} ⁶ | A | Data Prop. Delay, 5PT Bypass | — | 10.0 | — | 12.0 | ns |
| t _{pd2} ⁶ | A | Data Propagation Delay | — | 12.0 | — | 15.0 | ns |
| f _{max} | A | Clock Frequency with Internal Feedback ¹ | 100 | — | 80 | — | MHz |
| f _{max} (Ext.) | — | Clock Freq. with Ext. Feedback, 1/(tsu2 + tco1) | 67 | — | 56 | — | MHz |
| f _{max} (Tog.) | — | Clock Frequency, Max Toggle ² | 125 | — | 100 | — | MHz |
| t _{su1} | — | GLB Reg. Setup Time before Clk, 5PT bypass | 7.0 | — | 8.0 | — | ns |
| t _{co1} ⁶ | A | GLB Reg. Clock to Output Delay | — | 6.0 | — | 7.0 | ns |
| t _{h1} | — | GLB Reg. Hold Time after Clock, 5PT bypass | 0.0 | — | 0.0 | — | ns |
| t _{su2} | — | GLB Reg. Setup Time before Clock | 9.0 | — | 11.0 | — | ns |
| t _{h2} | — | GLB Reg. Hold Time after Clock | 0.0 | — | 0.0 | — | ns |
| t _{su3} | — | GLB Reg. Setup Time before Clock, Input Reg. Path | 4.5 | — | 5.5 | — | ns |
| t _{h3} | — | GLB Reg. Hold Time after Clock, Input Reg. Path | 1.0 | — | 1.0 | — | ns |
| t _{r1} | A | Ext. Reset Pin to Output Delay | — | 11.5 | — | 13.0 | ns |
| t _{rw1} ⁷ | — | Ext. Reset Pulse Duration | 6.5 | — | 8.0 | — | ns |
| t _{p_{ten}/dis} ⁶ | B/C | Local Product Term Output Enable/Disable | — | 10.0 | — | 12.0 | ns |
| t _{g_{p_{ten}/dis}} ⁶ | B/C | Global Product Term Output Enable/Disable | — | 15.5 | — | 17.0 | ns |
| t _{g_{en}/dis} ⁶ | B/C | Global OE Input to Output Enable/Disable | — | 7.5 | — | 9.0 | ns |
| t _{t_{en}/dis} ⁶ | B/C | Test OE Input to Output Enable/Disable | — | 11.5 | — | 12.5 | ns |
| t _{wh} | — | Ext. Sync. Clock Pulse Duration, High | 4.0 | — | 5.0 | — | ns |
| t _{wl} | — | Ext. Sync. Clock Pulse Duration, Low | 4.0 | — | 5.0 | — | ns |

1. Standard 16-bit counter using GRP feedback.

5384ve2.eps Timing v.2.0

2. f_{max} (Toggle) may be less than 1/(t_{wh} + t_{wl}). This is to allow for a clock duty cycle of other than 50%.

3. Reference Switching Test Conditions section.

4. Unless noted otherwise, all timing numbers are taken with worst case PTSA fanout, a GRP load of 1 GLB, CLK0, and high-speed AND array.

5. Timing parameters measured using normal active output driver.

6. The delay parameters are measured with V_{cc} as I/O voltage reference. An additional 0.5ns delay is incurred when V_{ccio} is used as I/O reference.

7. Pulse widths less than minimum may cause unknown output behavior.

Internal Timing Parameters

Over Recommended Operating Conditions

| PARAMETER | DESCRIPTION | -165 | | -125 | | -100 | | -80 | | UNIT |
|------------------------------|--|------|-----|------|-----|------|-----|-----|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| In/Out Delays | | | | | | | | | | |
| t _{in} | Input Buffer Delay | – | 0.6 | – | 1.3 | – | 2.3 | – | 2.3 | ns |
| t _{gclk_in} | Global Clock Buffer Input Delay (clk0) | – | 0.7 | – | 1.3 | – | 1.8 | – | 1.8 | ns |
| t _{rst} | Global Reset Pin Delay | – | 4.9 | – | 6.6 | – | 7.1 | – | 7.1 | ns |
| t _{goe} | Global OE Pin Delay | – | 3.2 | – | 3.9 | – | 5.9 | – | 7.4 | ns |
| t _{buf} | Output Buffer Delay | – | 1.9 | – | 2.2 | – | 2.7 | – | 3.7 | ns |
| t _{en} | Output Enable Delay | – | 1.3 | – | 1.6 | – | 1.6 | – | 1.6 | ns |
| t _{dis} | Output Disable Delay | – | 1.3 | – | 1.6 | – | 1.6 | – | 1.6 | ns |
| Routing/GLB Delays | | | | | | | | | | |
| t _{route} | GRP and Logic Delay | – | 3.2 | – | 3.6 | – | 4.0 | – | 4.5 | ns |
| t _{ptdb} | 5-pt Bypass Propagation Delay | – | 0.3 | – | 0.4 | – | 1.0 | – | 1.5 | ns |
| t _{pdi} | Combinatorial Propagation Delay | – | 0.0 | – | 0.0 | – | 0.0 | – | 0.0 | ns |
| t _{ptsa} | Product Term Sharing Array | – | 1.8 | – | 2.4 | – | 3.0 | – | 4.5 | ns |
| t _{fbk} | Internal Feedback Delay | – | 0.0 | – | 0.0 | – | 0.0 | – | 0.5 | ns |
| t _{inreg} | Input Buffer to Macrocell Register Delay | – | 2.5 | – | 2.5 | – | 2.5 | – | 3.5 | ns |
| Register/Latch Delays | | | | | | | | | | |
| t _s | Register Setup Time | 0.6 | – | 1.0 | – | 1.5 | – | 1.5 | – | ns |
| t _{s_pt} | Register Setup Time (Product Term Clock) | 0.6 | – | 1.0 | – | 1.5 | – | 1.5 | – | ns |
| t _h | Register Hold Time | 2.9 | – | 3.0 | – | 4.0 | – | 5.0 | – | ns |
| t _{coi} | Register Clock to GLB Output Delay | – | 0.4 | – | 1.0 | – | 1.5 | – | 1.5 | ns |
| t _{sl} | Latch Setup Time | 0.6 | – | 1.0 | – | 1.5 | – | 1.5 | – | ns |
| t _{hl} | Latch Hold Time | 2.9 | – | 3.0 | – | 4.0 | – | 5.0 | – | ns |
| t _{goi} | Latch Gate to GLB Output Delay | – | 0.4 | – | 1.0 | – | 1.5 | – | 1.5 | ns |
| t _{pqli} | GLB Latch propagation Delay | – | 1.0 | – | 1.5 | – | 2.0 | – | 2.5 | ns |
| t _{ces} | Clock Enable Setup Time | 4.1 | – | 4.3 | – | 5.3 | – | 6.3 | – | ns |
| t _{ceh} | Clock Enable Hold Time | 0.9 | – | 1.7 | – | 2.7 | – | 3.7 | – | ns |
| t _{sri} | Asynchronous Set/Reset to GLB Output Delay | – | 1.2 | – | 1.2 | – | 1.7 | – | 2.2 | ns |
| t _{srr} | Asynchronous Set/Reset Recovery Time | 0.8 | – | 1.2 | – | 1.2 | – | 2.2 | – | ns |
| Control Delays | | | | | | | | | | |
| t _{ptclk} | Macrocell PT Clock Delay | – | 0.4 | – | 0.4 | – | 0.5 | – | 0.5 | ns |
| t _{bclk} | Block PT Clock Delay | – | 1.4 | – | 1.9 | – | 2.5 | – | 2.5 | ns |
| t _{ptsr} | Macrocell PT Set/Reset Delay | – | 2.1 | – | 3.7 | – | 4.8 | – | 4.8 | ns |
| t _{bsr} | Block PT Set/Reset Delay | – | 3.1 | – | 5.7 | – | 6.8 | – | 6.8 | ns |
| t _{ptoe} | Macrocell PT OE Delay | – | 1.9 | – | 2.0 | – | 2.1 | – | 3.6 | ns |
| t _{gptoe} | Global PT OE Delay | – | 6.9 | – | 7.5 | – | 7.6 | – | 8.6 | ns |

Note: Internal Timing Parameters are not tested and are for reference only. Refer to Timing Model in this data sheet for further details. Timing v 2.0

ispLSI 5384VE Timing Parameters (continued)

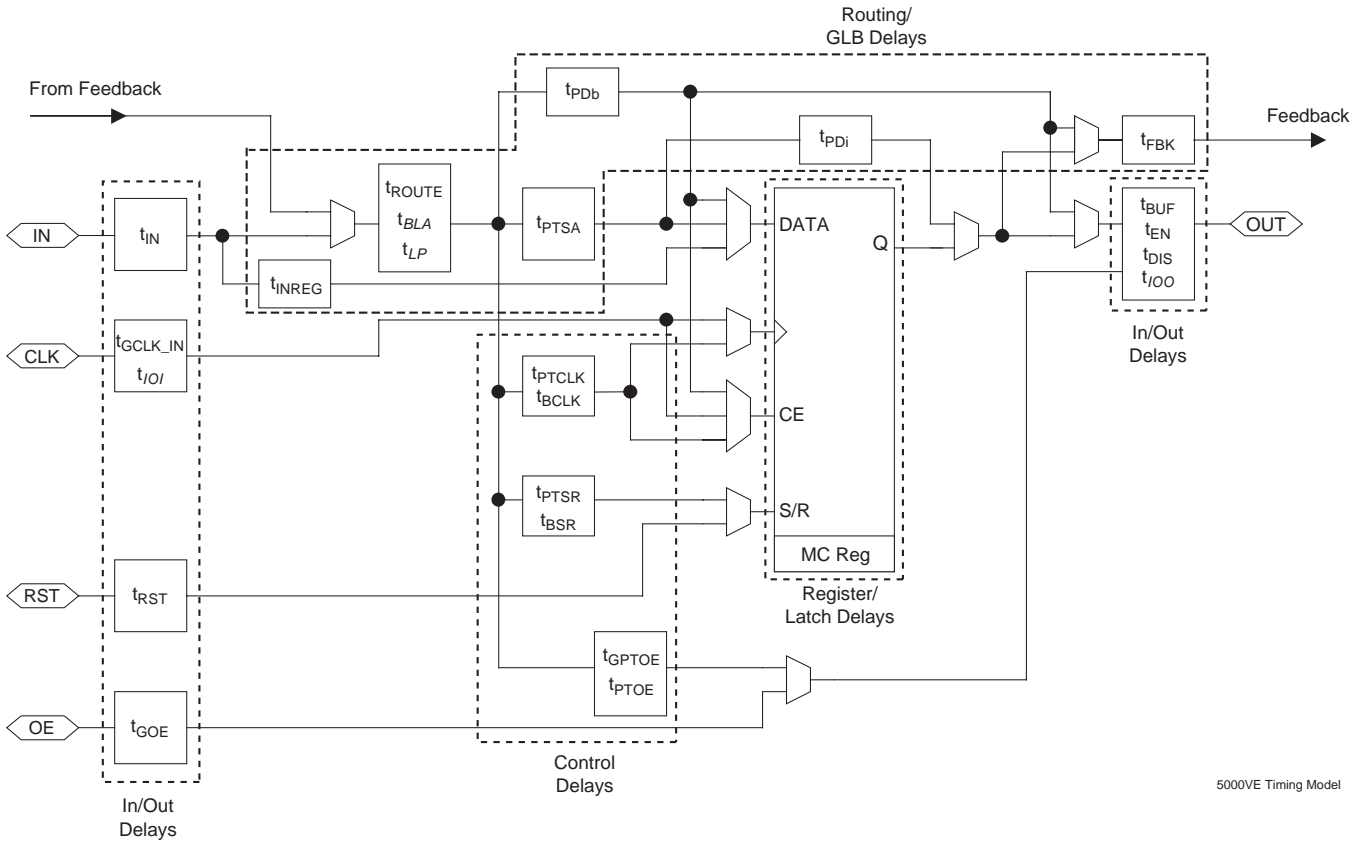
| ADDER TYPE | BASE PARAMETER | ADDER | | | | UNITS |
|---|---|-------|------|------|-----|-------|
| | | -165 | -125 | -100 | -80 | |
| Routing Adders | | | | | | |
| t_{tp} | t_{route} | 1.0 | 1.5 | 1.5 | 1.5 | ns |
| Tioi Input Adders | | | | | | |
| clk1 | t_{gclk_in} | 1.4 | 1.7 | 1.7 | 1.7 | ns |
| clk2 | t_{gclk_in} | 1.4 | 1.7 | 1.7 | 1.7 | ns |
| clk3 | t_{gclk_in} | 1.4 | 1.7 | 1.7 | 1.7 | ns |
| Tioo Output Adders¹ | | | | | | |
| Slow Slew I/O | t_{buf}, t_{en} | 4.0 | 4.0 | 4.0 | 4.0 | ns |
| LVTTL_out | t_{buf}, t_{en}, t_{dis} | 0.0 | 0.0 | 0.0 | 0.0 | ns |
| LVC MOS25_out | t_{buf}, t_{en}, t_{dis} | 0.5 | 0.5 | 0.5 | 0.5 | ns |
| LVC MOS33_out | t_{buf}, t_{en}, t_{dis} | 0.0 | 0.0 | 0.0 | 0.0 | ns |
| Tbla Additional Block Loading Adders | | | | | | |
| 1 | t_{route} | 0.1 | 0.1 | 0.1 | 0.1 | ns |
| 2 | t_{route} | 0.1 | 0.2 | 0.2 | 0.2 | ns |
| 3 | t_{route} | 0.2 | 0.3 | 0.3 | 0.3 | ns |
| 4 | t_{route} | 0.3 | 0.4 | 0.4 | 0.4 | ns |
| 5 | t_{route} | 0.4 | 0.5 | 0.5 | 0.5 | ns |
| 6 | t_{route} | 0.4 | 0.6 | 0.6 | 0.6 | ns |
| 7 | t_{route} | 0.5 | 0.7 | 0.7 | 0.7 | ns |
| 8 | t_{route} | 0.6 | 0.8 | 0.8 | 0.8 | ns |
| 9 | t_{route} | 0.6 | 0.9 | 0.9 | 0.9 | ns |
| 10 | t_{route} | 0.7 | 1.0 | 1.0 | 1.0 | ns |
| 11 | t_{route} | 0.8 | 1.1 | 1.1 | 1.1 | ns |

¹Timing for open drain configurations is the same as non-open drain configurations.

Timing Table/5384VE
Timing v.2.0

Note: Internal Timing Parameters are not tested and are for reference only. Refer to Timing Model in this data sheet for details.

ispLSI 5384VE Timing Model



5000VE Timing Model

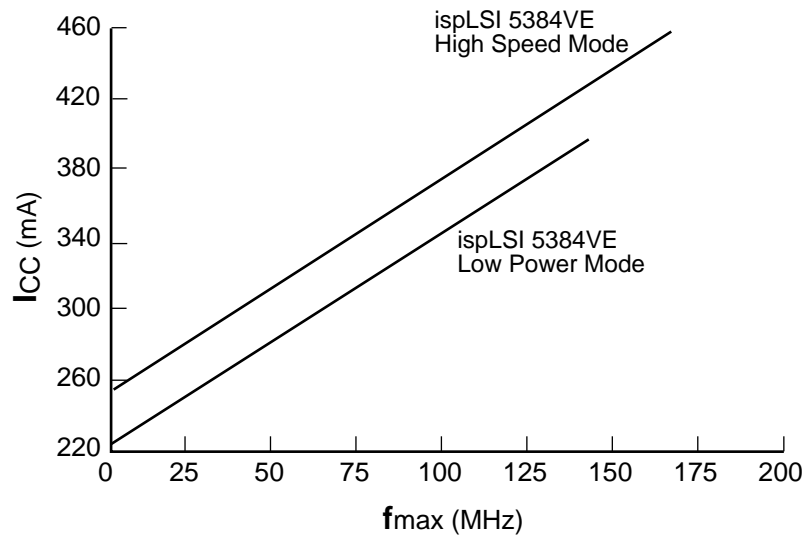
Note: Italicized parameters are delay adders above and beyond default conditions (i.e. GRP load of one GLB, CLK0, high-speed AND Array and VCC I/O option).

Power Consumption

Power consumption in the ispLSI 5384VE device depends on two primary factors: the speed at which the device is operating and the number of product terms used. The product terms have a fuse-selectable speed/power tradeoff setting. Each group of five product terms has a single speed/power tradeoff control fuse that acts on the complete group of five. The fast “high-speed”

setting operates product terms at their normal full power consumption. For portions of the logic that can tolerate longer propagation delays, selecting the slower “low-power” setting will reduce the power dissipation for these product terms. Figure 10 shows the relationship between power and operating frequency.

Figure 10. Typical Device Power Consumption vs fmax



Notes: Configuration of 24 16-bit Counters
Typical Current at 3.3V, 25° C

ICC can be estimated for the ispLSI 5384VE using the following equation:

High Speed Mode: $ICC = 22 + (\# \text{ of PTs} * 0.314) + (\# \text{ of nets} * F_{max} * 0.00317)$

Low Power Mode: $ICC = 22 + (\# \text{ of PTs} * 0.271) + (\# \text{ of nets} * F_{max} * 0.00317)$

of PTs = Number of Product Terms used in design

of nets = Number of Signals used in device

Fmax = Highest Clock Frequency to the device

The ICC estimate is based on typical conditions (VCC = 3.3V, room temperature) and an assumption of one GLB load on average exists. These values are for estimates only. Since the value of ICC is sensitive to operating conditions and the program in the device, the actual ICC should be verified.

0127/5384VE

Signal Descriptions

| Signal Name | Description |
|---------------------------|---|
| TMS | Input - This pin is the Test Mode Select input, which is used to control the JTAG state machine. |
| TCK | Input - This pin is the Test Clock input pin used to clock through the JTAG state machine. |
| TDI | Input - This pin is the JTAG Test Data In pin used to load data. |
| TDO | Output - This pin is the JTAG Test Data Out pin used to shift data out. |
| TOE / I/O0 | Input/Output - This pin functions as either the Test Output Enable pin or an I/O pin based upon customer's design. TOE tristates all I/O pins when a logic low is driven. |
| GOE0, GOE1 | Input - These two pins are the Global Output Enable input pins. |
| RESET | Dedicated Reset Input - This pin resets all registers in the device. The global polarity (active high or low input) for this pin is selectable. |
| I/O | Input/Output – These are the general purpose I/O used by the logic array. |
| GND | Ground |
| NC ¹ | No connect. |
| VCC | Vcc |
| CLK0, CLK1 | Dedicated clock inputs for all registers. Both clocks are muxed before being used as the clock input to all registers in the device. |
| CLK2 / I/O, CLK3 / I/O | Input/Output - These pins share functionality. They can be used as dedicated clock inputs for all registers, as well as I/O pins. |
| VCCIO | Input - This pin is used for optional 2.5V outputs. Every I/O can independently select either 3.3V or the optional voltage as its output level. If the optional output voltage is not required, this pin must be connected to the Vcc supply. Programmable pull-up resistors and bus-hold latches only draw current from this supply. |

1. NC pins are not to be connected to any active signals, VCC or GND.

Signal Configuration

ispLSI 5384VE 256-Ball fpBGA (1.0mm Ball Pitch / 17.0mm x 17.0mm Body Size)

| | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |
|---|---------|-----------------|-----------------|------------------|---------|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------|---|
| A | I/O 113 | I/O 116 | I/O 121 | I/O 125 | I/O 126 | I/O 131/ CLK3 | I/O 133 | I/O 139 | I/O 140 | CLK0 | I/O 145 | I/O 147 | I/O 151 | I/O 152 | I/O 153 | I/O 165 | A |
| B | I/O 108 | I/O 115 | I/O 117 | I/O 119/ CLK2 | I/O 124 | I/O 129 | I/O 132 | I/O 136 | CLK1 | I/O 144 | I/O 149 | I/O 156 | I/O 157 | I/O 163 | I/O 164 | I/O 168 | B |
| C | I/O 106 | I/O 114 | NC ¹ | I/O 120 | I/O 123 | I/O 128 | I/O 135 | I/O 138 | I/O 141 | I/O 143 | I/O 148 | I/O 155 | I/O 159 | I/O 160 | I/O 161 | I/O 172 | C |
| D | I/O 105 | I/O 109 | I/O 111 | GND | GND | VCC | GND | VCC | GND | GND | VCC | GND | VCC | I/O 169 | I/O 167 | I/O 175 | D |
| E | I/O 104 | NC ¹ | I/O 101 | VCC | I/O 112 | I/O 122 | I/O 127 | I/O 134 | I/O 142 | I/O 150 | I/O 158 | I/O 166 | GND | I/O 173 | I/O 171 | I/O 177 | E |
| F | I/O 100 | I/O 102 | I/O 97 | GND | I/O 110 | I/O 118 | I/O 130 | I/O 137 | I/O 146 | I/O 154 | I/O 162 | I/O 174 | VCC | I/O 181 | I/O 176 | I/O 179 | F |
| G | I/O 96 | I/O 98 | TDO | VCC | I/O 103 | I/O 107 | VCC | GND | GND | VCC | I/O 170 | I/O 178 | GND | I/O 185 | I/O 180 | I/O 187 | G |
| H | I/O 94 | VCCIO | RESET | GND | I/O 95 | I/O 99 | GND | VCC | VCC | GND | I/O 182 | I/O 186 | VCC | I/O 184 | I/O 183 | I/O 188 | H |
| J | I/O 93 | I/O 92 | I/O 90 | GND | I/O 91 | I/O 87 | GND | VCC | VCC | GND | I/O 189 | I/O 3 | GND | I/O 191 | I/O 190 | TMS | J |
| K | I/O 89 | I/O 88 | I/O 86 | VCC | I/O 83 | I/O 79 | VCC | GND | GND | VCC | I/O 10 | I/O 7 | VCC | TDI | TCK | I/O 0/ TOE | K |
| L | I/O 85 | I/O 84 | I/O 82 | GND | I/O 75 | I/O 68 | I/O 59 | I/O 51 | I/O 39 | I/O 31 | I/O 23 | I/O 15 | GND | I/O 4 | I/O 1 | I/O 2 | L |
| M | I/O 81 | I/O 80 | I/O 77 | GND | I/O 71 | I/O 63 | I/O 55 | I/O 47 | I/O 43 | I/O 35 | I/O 27 | I/O 19 | VCC | I/O 8 | I/O 6 | I/O 5 | M |
| N | I/O 78 | I/O 74 | I/O 76 | VCC | GND | VCC | GND | VCC | GND | GND | VCC | GND | GND | I/O 11 | I/O 12 | I/O 9 | N |
| P | I/O 73 | I/O 70 | I/O 65 | I/O 66 | I/O 57 | I/O 56 | GOE1 | GOE0 | I/O 41 | I/O 42 | I/O 36 | I/O 26 | I/O 22 | I/O 20 | I/O 13 | I/O 14 | P |
| R | I/O 72 | I/O 69 | I/O 62 | I/O 67 | I/O 64 | I/O 58 | I/O 48 | I/O 46 | I/O 40 | I/O 34 | I/O 29 | I/O 25 | I/O 24 | I/O 18 | I/O 17 | I/O 16 | R |
| T | I/O 61 | I/O 60 | I/O 54 | I/O 53 | I/O 52 | I/O 50 | I/O 49 | I/O 45 | I/O 44 | I/O 38 | I/O 37 | I/O 33 | I/O 32 | I/O 30 | I/O 28 | I/O 21 | T |
| | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |

ispLSI 5384VE

Bottom View

1. NCs are not to be connected to any active signals, VCC or GND.

Note: Ball A1 indicator dot on top side of package.

Signal Configuration

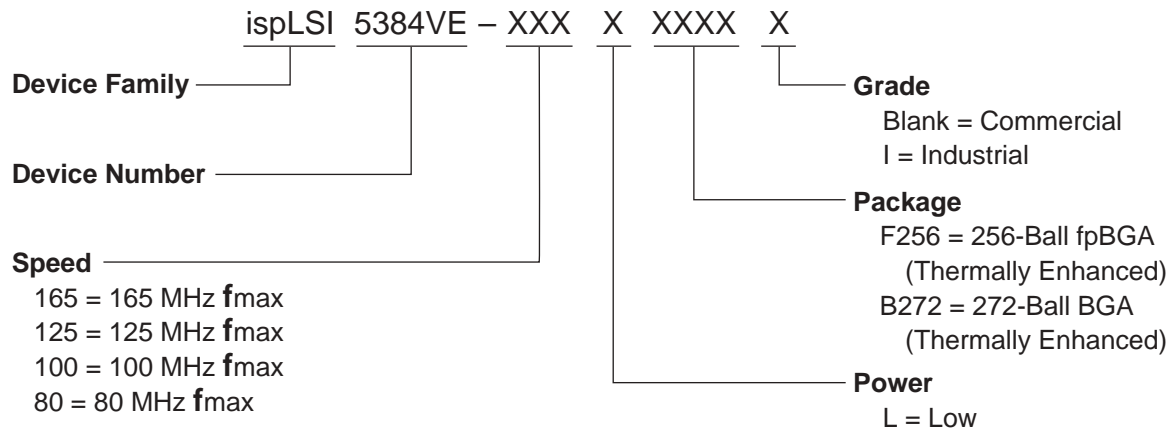
ispLSI 5384VE 272-Ball BGA (1.27mm Ball Pitch / 27.0mm x 27.0mm Body Size)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----|-----------------|-----------------|-----------------|-----------------|---|-----------------|-----------|--------------|-----------------|---------|---------|---------|---------|---------|---------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|---------|-----------------|---------|--|
| | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | | | | | | | | | | | | | | | | | |
| A | I/O 114 | I/O 115 | I/O 119/CLK2 | NC ¹ | I/O 122 | I/O 126 | I/O 129 | I/O 132 | I/O 136 | I/O 139 | I/O 140 | I/O 142 | I/O 146 | I/O 149 | I/O 151 | I/O 154 | I/O 158 | I/O 160 | I/O 164 | GND | | | | | | | | | | | | | | | | | |
| B | NC ¹ | NC ¹ | NC ¹ | I/O 116 | I/O 121 | I/O 125 | I/O 128 | I/O 131/CLK3 | I/O 135 | I/O 137 | I/O 141 | I/O 143 | I/O 147 | I/O 150 | I/O 153 | I/O 157 | I/O 159 | NC ¹ | I/O 163 | I/O 165 | | | | | | | | | | | | | | | | | |
| C | I/O 111 | NC ¹ | NC ¹ | I/O 117 | I/O 120 | I/O 123 | I/O 127 | I/O 130 | I/O 134 | I/O 138 | CLK0 | I/O 144 | I/O 148 | I/O 152 | I/O 156 | NC ¹ | I/O 162 | NC ¹ | I/O 166 | I/O 169 | | | | | | | | | | | | | | | | | |
| D | I/O 109 | NC ¹ | I/O 113 | GND | I/O 118 | VCC | I/O 124 | GND | I/O 133 | VCC | CLK1 | I/O 145 | GND | I/O 155 | VCC | I/O 161 | GND | NC ¹ | I/O 167 | I/O 170 | | | | | | | | | | | | | | | | | |
| E | I/O 105 | I/O 108 | I/O 110 | I/O 112 | ispLSI 5384VE Bottom View <table border="1" style="margin: 10px auto;"> <tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr> <tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr> <tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr> <tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr> </table> | | | | | | | | | | | | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | I/O 168 | I/O 171 | NC ¹ | I/O 172 | |
| GND | GND | GND | GND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GND | GND | GND | GND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GND | GND | GND | GND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GND | GND | GND | GND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | I/O 102 | I/O 104 | I/O 107 | VCC | | | | | | | | | | | | | VCC | I/O 173 | I/O 175 | I/O 176 | | | | | | | | | | | | | | | | | |
| G | I/O 100 | I/O 101 | I/O 103 | I/O 106 | | | | | | | | | | | | | I/O 174 | I/O 177 | I/O 178 | I/O 179 | | | | | | | | | | | | | | | | | |
| H | I/O 97 | I/O 98 | I/O 99 | GND | | | | | | | | | | | | | GND | I/O 180 | I/O 181 | I/O 182 | | | | | | | | | | | | | | | | | |
| J | TDO | VCCIO | RESET | I/O 96 | | | | | | | | | | | | | I/O 183 | I/O 184 | I/O 185 | I/O 186 | | | | | | | | | | | | | | | | | |
| K | I/O 92 | I/O 93 | I/O 94 | I/O 95 | | | | | | | | | | | | | VCC | I/O 188 | I/O 187 | I/O 189 | | | | | | | | | | | | | | | | | |
| L | I/O 91 | I/O 89 | I/O 90 | VCC | TCK | TMS | I/O 191 | I/O 190 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| M | I/O 88 | I/O 87 | I/O 86 | I/O 85 | I/O 2 | I/O 1 | I/O 0/TOE | TDI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| N | I/O 84 | I/O 83 | I/O 82 | GND | GND | I/O 5 | I/O 4 | I/O 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P | I/O 81 | NC ¹ | I/O 80 | I/O 77 | I/O 12 | I/O 9 | I/O 7 | I/O 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| R | I/O 79 | I/O 78 | I/O 76 | VCC | VCC | NC ¹ | I/O 10 | I/O 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| T | NC ¹ | I/O 75 | I/O 74 | NC ¹ | NC ¹ | I/O 14 | I/O 13 | I/O 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | I/O 73 | I/O 70 | I/O 71 | GND | I/O 64 | VCC | I/O 58 | GND | I/O 48 | GOE1 | VCC | I/O 37 | GND | I/O 28 | VCC | I/O 21 | GND | NC ¹ | NC ¹ | NC ¹ | | | | | | | | | | | | | | | | | |
| V | I/O 72 | I/O 69 | I/O 68 | I/O 65 | I/O 62 | I/O 59 | I/O 55 | I/O 51 | I/O 47 | GOE0 | I/O 42 | I/O 38 | I/O 34 | I/O 31 | I/O 27 | I/O 24 | I/O 20 | I/O 17 | I/O 16 | I/O 15 | | | | | | | | | | | | | | | | | |
| W | NC ¹ | NC ¹ | I/O 66 | NC ¹ | I/O 60 | I/O 56 | I/O 53 | I/O 50 | I/O 46 | I/O 45 | I/O 41 | I/O 39 | I/O 35 | I/O 32 | I/O 29 | I/O 25 | NC ¹ | I/O 19 | NC ¹ | NC ¹ | | | | | | | | | | | | | | | | | |
| Y | NC ¹ | I/O 67 | I/O 63 | I/O 61 | I/O 57 | I/O 54 | I/O 52 | I/O 49 | NC ¹ | I/O 44 | I/O 43 | I/O 40 | I/O 36 | I/O 33 | I/O 30 | I/O 26 | I/O 23 | I/O 22 | NC ¹ | I/O 18 | | | | | | | | | | | | | | | | | |
| | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | | | | | | | | | | | | | | | | | |

1. NCs are not to be connected to any active signals, Vcc or GND.

Note: Ball A1 indicator dot on top side of package.

Part Number Description



0212/5384ve

Ordering Information

COMMERCIAL

| FAMILY | f_{max} (MHz) | tpd (ns) | ORDERING NUMBER | PACKAGE |
|--------|-----------------|----------|------------------------|----------------|
| ispLSI | 165 | 6.0 | ispLSI 5384VE-165LF256 | 256-Ball fpBGA |
| | 165 | 6.0 | ispLSI 5384VE-165LB272 | 272-Ball BGA |
| | 125 | 7.5 | ispLSI 5384VE-125LF256 | 256-Ball fpBGA |
| | 125 | 7.5 | ispLSI 5384VE-125LB272 | 272-Ball BGA |
| | 100 | 10 | ispLSI 5384VE-100LF256 | 256-Ball fpBGA |
| | 100 | 10 | ispLSI 5384VE-100LB272 | 272-Ball BGA |

Table 2-0041A/5384VE

INDUSTRIAL

| FAMILY | f_{max} (MHz) | tpd (ns) | ORDERING NUMBER | PACKAGE |
|--------|-----------------|----------|-------------------------|----------------|
| ispLSI | 125 | 7.5 | ispLSI 5384VE-125LF256I | 256-Ball fpBGA |
| | 125 | 7.5 | ispLSI 5384VE-125LB272I | 272-Ball BGA |
| | 100 | 10 | ispLSI 5384VE-100LF256I | 256-Ball fpBGA |
| | 100 | 10 | ispLSI 5384VE-100LB272I | 272-Ball BGA |
| | 80 | 12 | ispLSI 5384VE-80LF256I | 256-Ball fpBGA |
| | 80 | 12 | ispLSI 5384VE-80LB272I | 272-Ball BGA |

The ispLSI 5384VE is dual-marked with both Commercial and Industrial grades. The Commercial speed grade is faster (i.e. ispLSI 5384VE-165LF256) than the Industrial speed grade (i.e. ispLSI 5384VE-125LF256I).

Table 2-0041B/5384VE