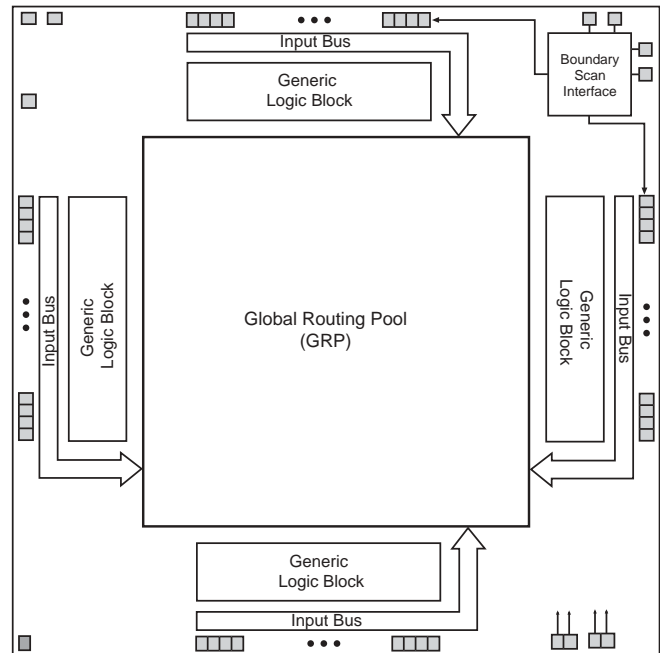


## Features

- **Second Generation SuperWIDE HIGH DENSITY IN-SYSTEM PROGRAMMABLE LOGIC DEVICE**
  - 3.3V Power Supply
  - User Selectable 3.3V/2.5V I/O
  - 6000 PLD Gates / 128 Macrocells
  - 96 I/O Pins Available
  - 128 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.
  - Interfaces with Standard 5V TTL Devices
- **HIGH PERFORMANCE E<sup>2</sup>CMOS<sup>®</sup> TECHNOLOGY**
  - $f_{max} = 180$  MHz Maximum Operating Frequency
  - $t_{pd} = 5.0$  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.

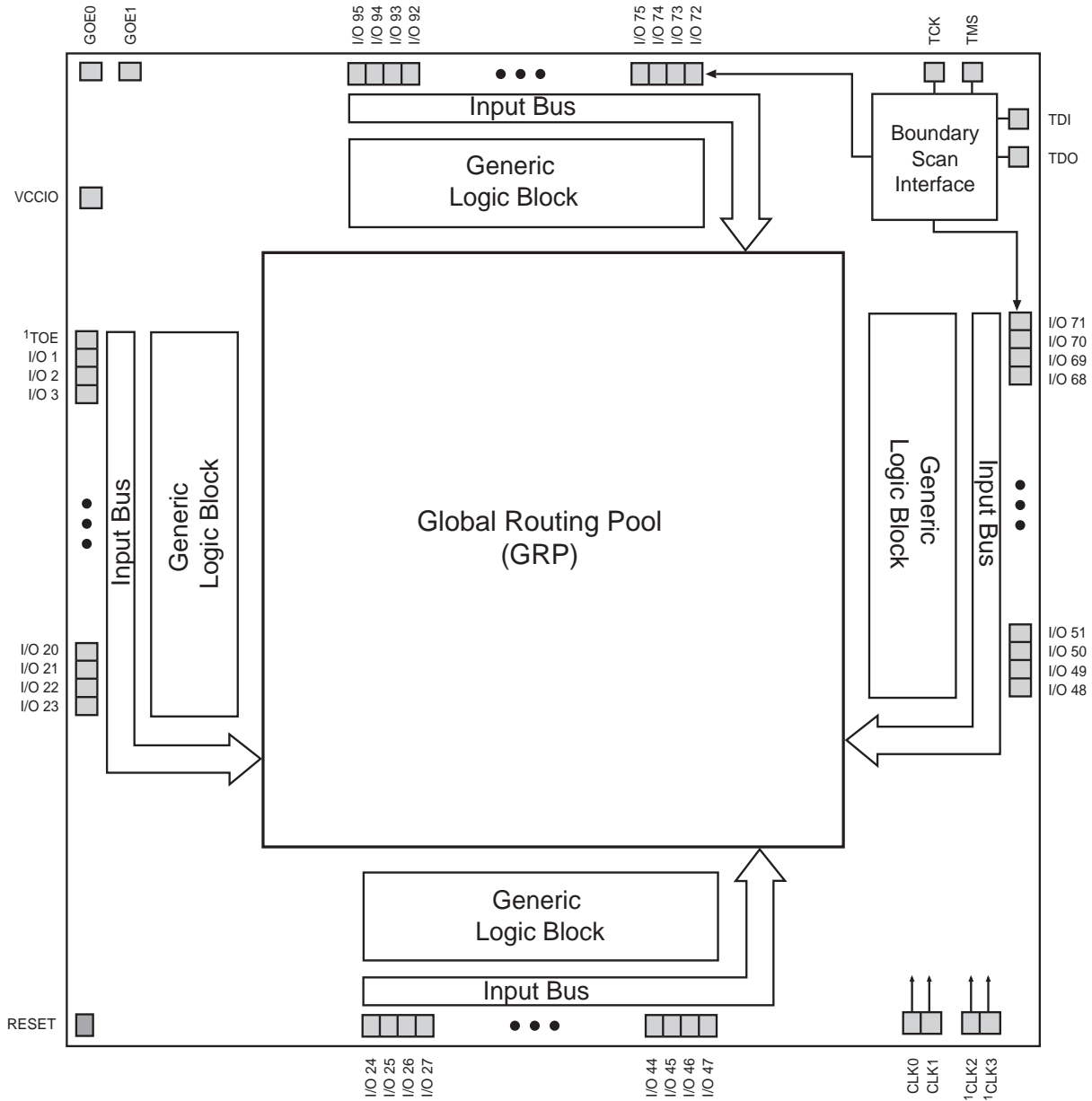
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January 2002

**Functional Block Diagram**

Figure 1. ispLSI 5128VE Functional Block Diagram (96-I/O)



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

| Package Type | Multiplexed Signals |               |             |
|--------------|---------------------|---------------|-------------|
| 128 TQFP     | I/O 59 / CLK2       | I/O 65 / 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 5128VE Block Diagram (96 I/O)

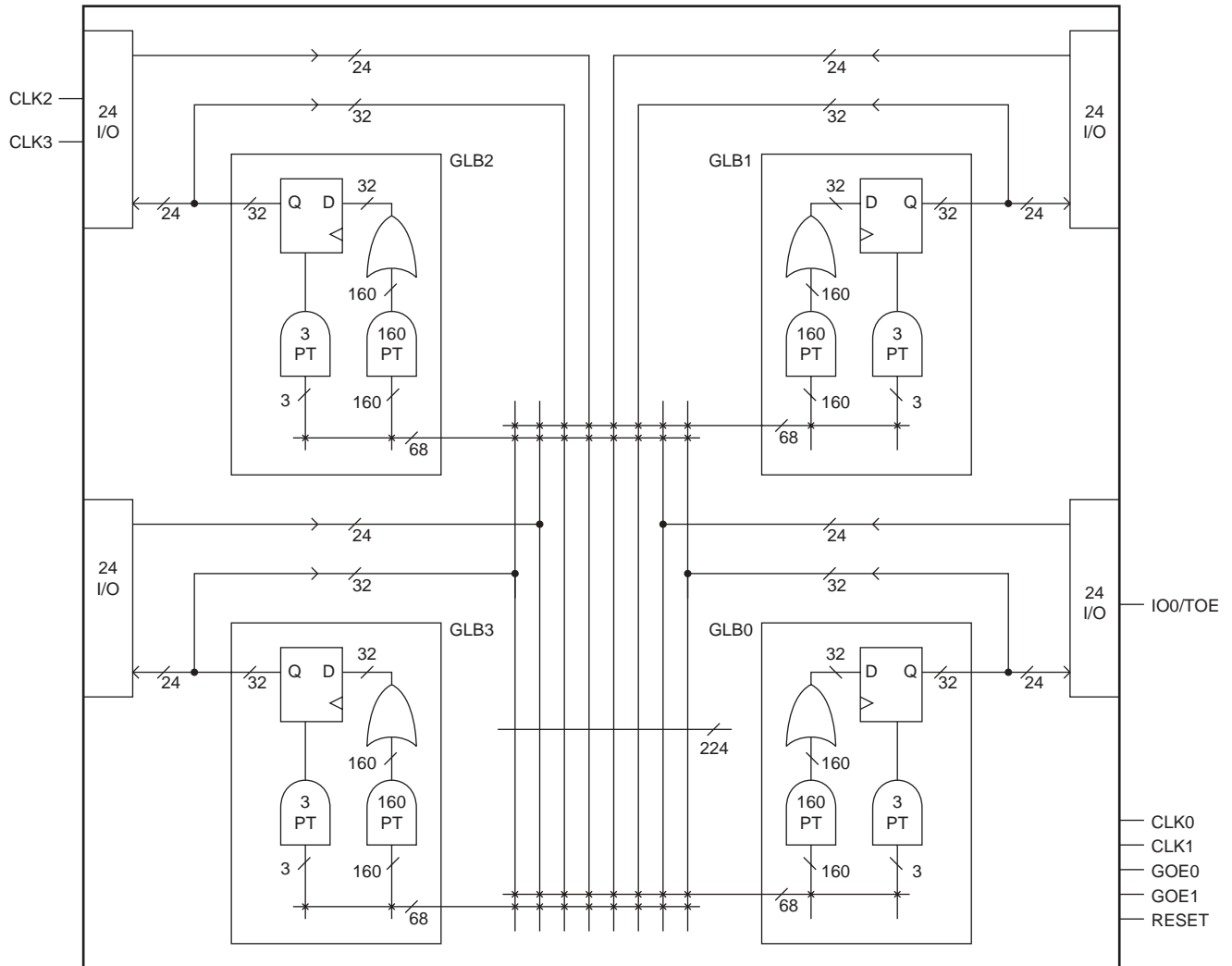


Figure 3. ispLSI 5000VE Generic Logic Block (GLB)

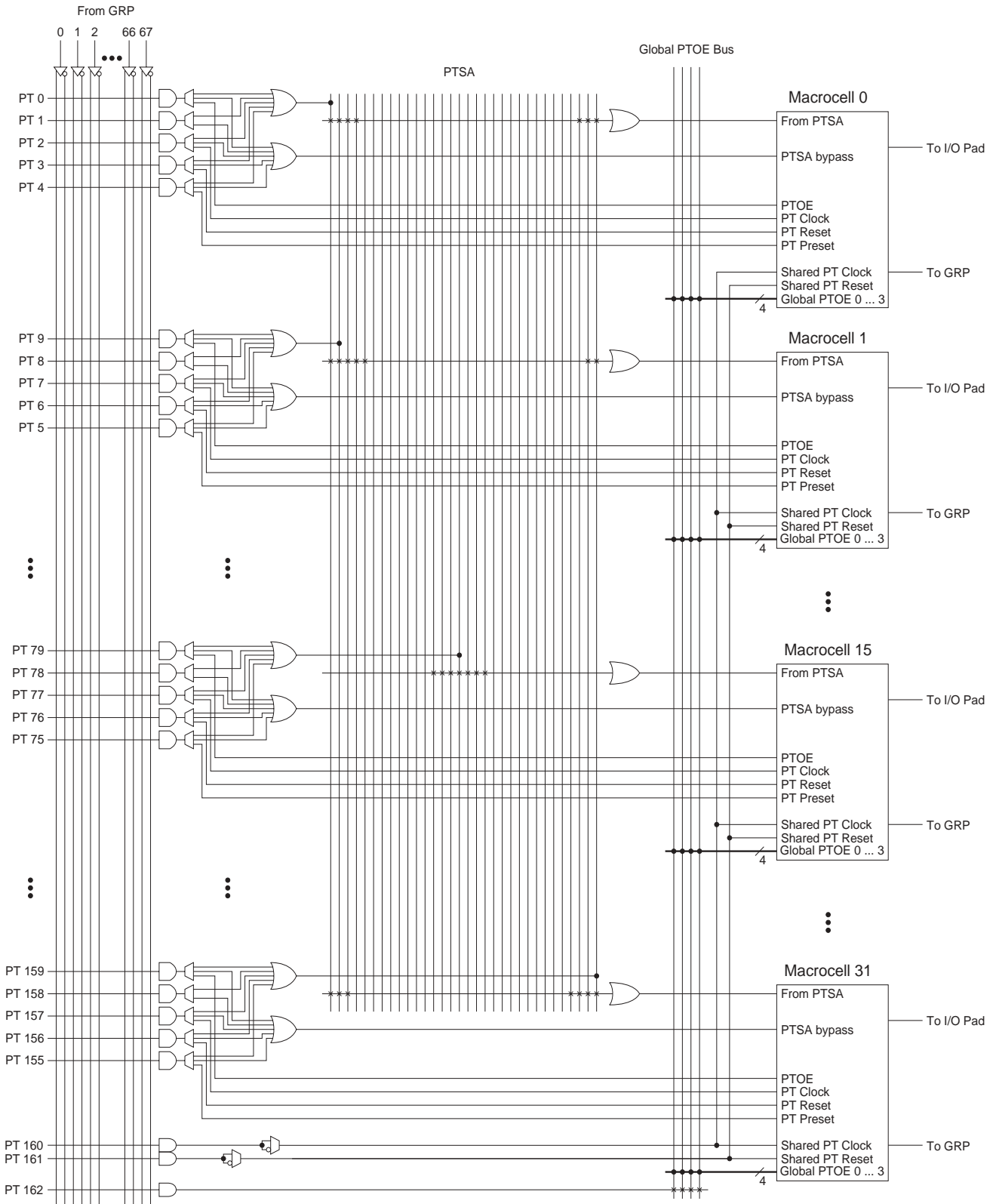
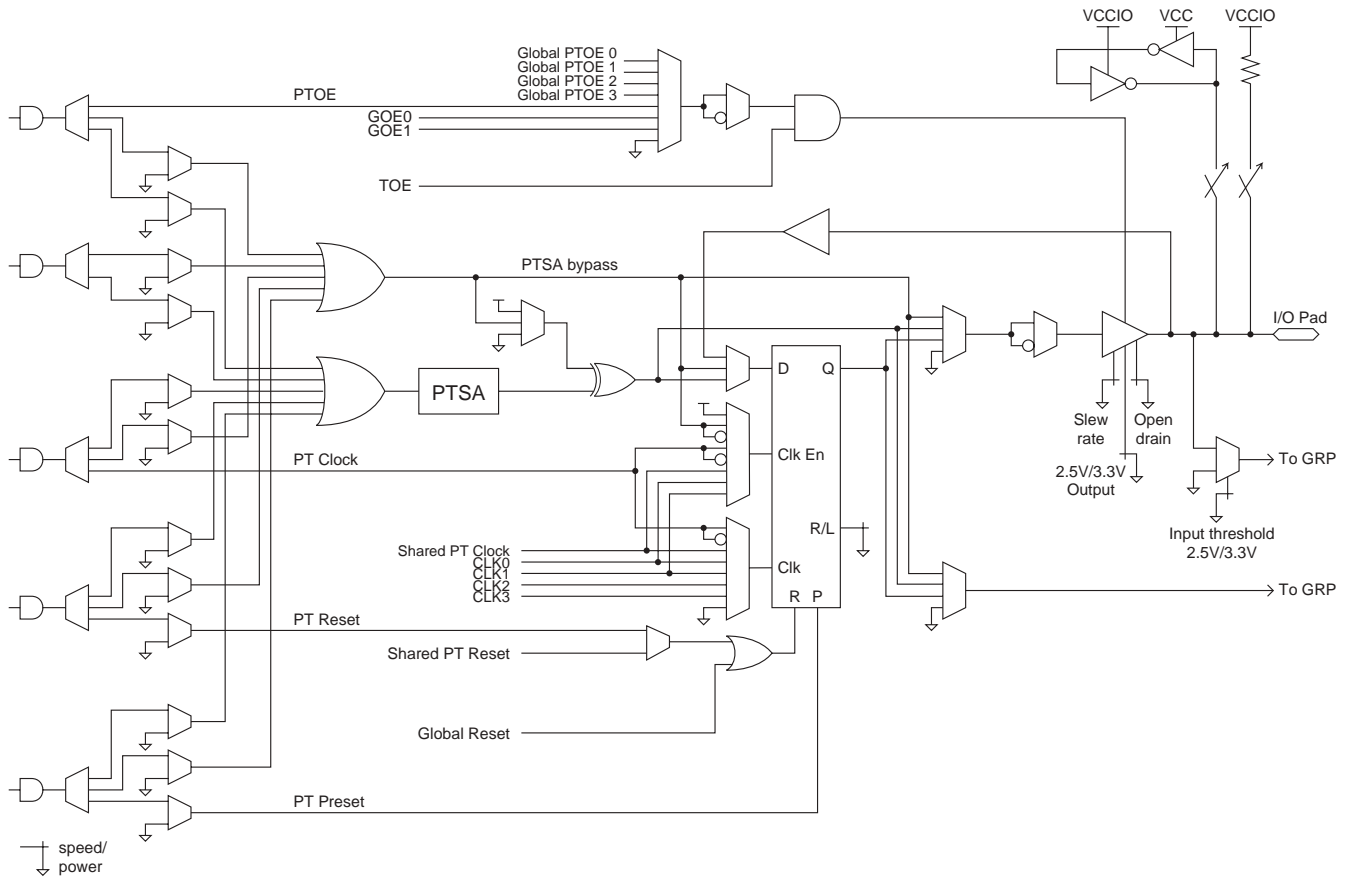


Figure 4. ispLSI 5000VE Macrocell



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**

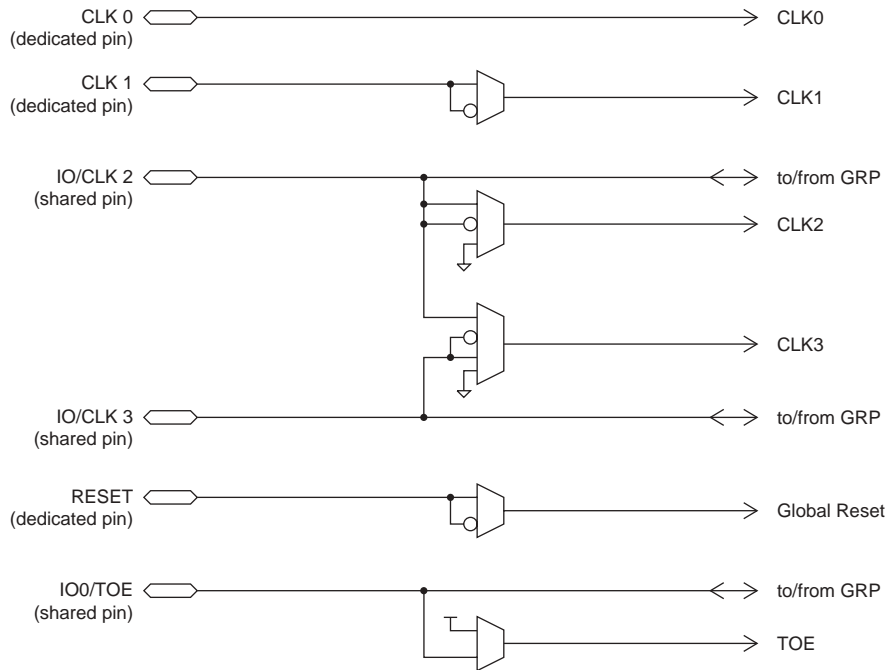


Figure 6. Boundary Scan Register Circuit for I/O Pins

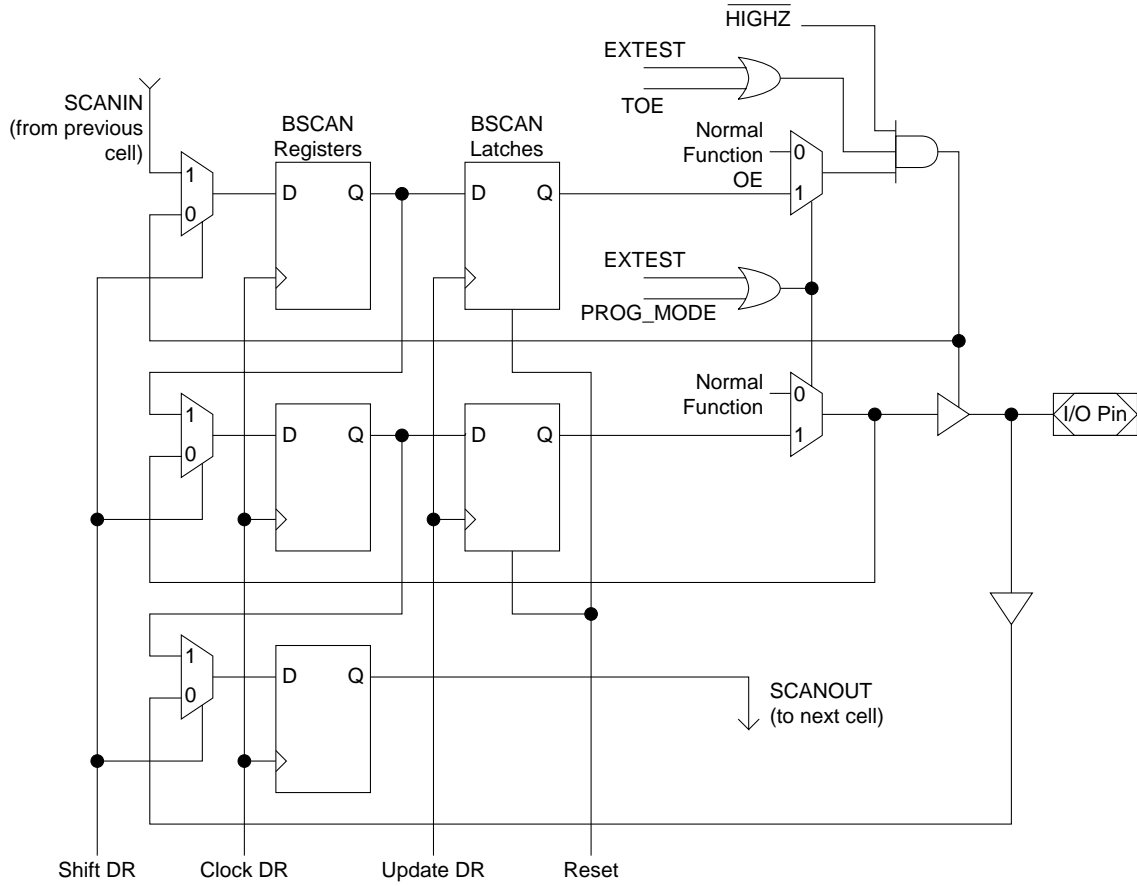


Figure 7. Boundary Scan Register Circuit for Input-Only Pins

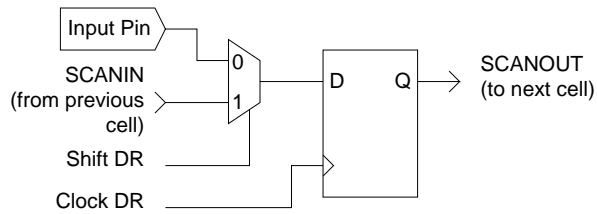
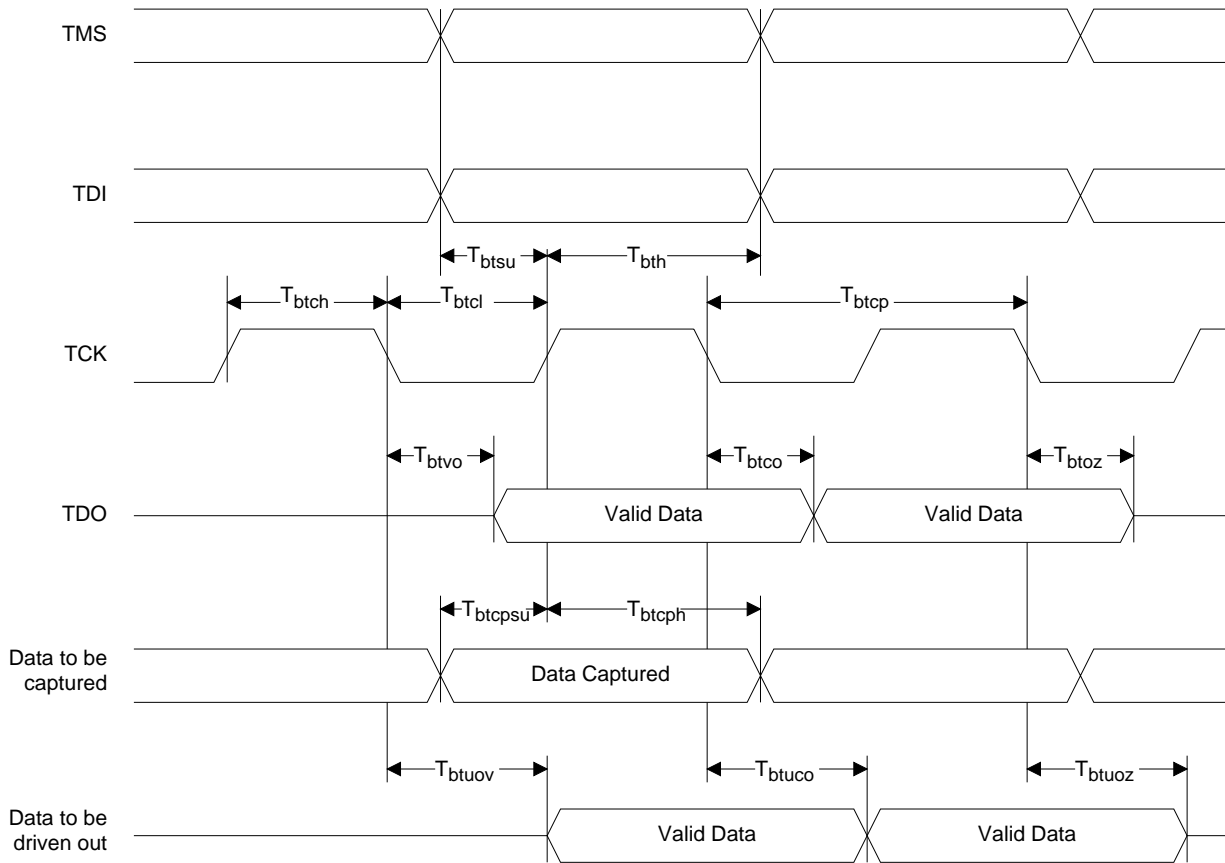




Figure 8. Boundary Scan Waveforms and Timing Specifications



| SYMBOL      | PARAMETER  | MIN  | MAX | UNITS |
|-------------|--|------|-----|-------|
| $t_{btcp}$  | TCK [BSCAN test] clock pulse width                             | 125  | –   | ns    |
| $t_{btch}$  | TCK [BSCAN test] pulse width high                              | 62.5 | –   | ns    |
| $t_{btcl}$  | TCK [BSCAN test] pulse width low                               | 62.5 | –   | ns    |
| $t_{btsu}$  | TCK [BSCAN test] setup time                                    | 25   | –   | ns    |
| $t_{bth}$   | TCK [BSCAN test] hold time                                     | 25   | –   | ns    |
| $t_{rf}$    | TCK [BSCAN test] rise and fall time                            | 50   | –   | mV/ns |
| $t_{btco}$  | TAP controller falling edge of clock to valid output           | –    | 25  | ns    |
| $t_{btoz}$  | TAP controller falling edge of clock to data output disable    | –    | 25  | ns    |
| $t_{btvo}$  | TAP controller falling edge of clock to data output enable     | –    | 25  | ns    |
| $t_{btcpu}$ | BSCAN test Capture register setup time                         | 25   | –   | ns    |
| $t_{btcpu}$ | BSCAN test Capture register hold time                          | 25   | –   | ns    |
| $t_{btuo}$  | BSCAN test Update reg, falling edge of clock to valid output   | –    | 50  | ns    |
| $t_{btuo}$  | BSCAN test Update reg, falling edge of clock to output disable | –    | 50  | ns    |
| $t_{btuo}$  | BSCAN test Update reg, falling edge of clock to output enable  | –    | 50  | ns    |

## 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.

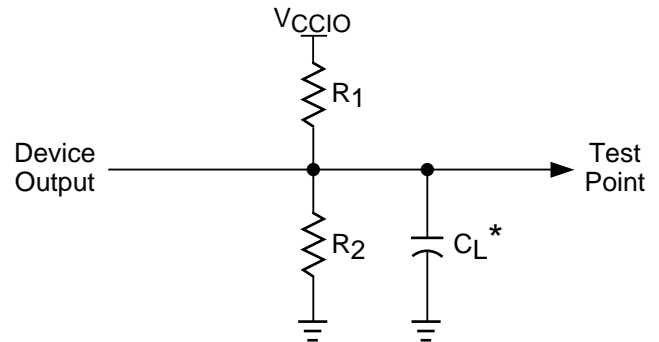
Table 2-0003/5KVE

**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 Range<sup>1</sup>**

**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 Range<sup>1</sup>

### Over Recommended Operating Conditions

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

1. I/O voltage configuration must be set to V<sub>CCIO</sub>.

2.5V/5128VE

## DC Electrical Characteristics

### Over Recommended Operating Conditions

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

1. Pullup is capable of pulling to a minimum voltage of V<sub>OH</sub> under no-load conditions.

DC Char\_5KVE

## External Switching Characteristics

### Over Recommended Operating Conditions

| PARAM.                              | TEST <sup>3</sup><br>COND. | DESCRIPTION <sup>4,5</sup>                          | -180 |      | -125 |      | UNITS |
|-------------------------------------|----------------------------|---|------|------|------|------|-------|
|                                     |                            |   | MIN. | MAX. | MIN. | MAX. |       |
| t <sub>pd1</sub> <sup>6</sup>       | A                          | Data Prop. Delay, 5PT Bypass                        | —    | 5.0  | —    | 7.5  | ns    |
| t <sub>pd2</sub> <sup>6</sup>       | A                          | Data Propagation Delay                              | —    | 7.0  | —    | 9.5  | ns    |
| f <sub>max</sub>                    | A                          | Clock Frequency with Internal Feedback <sup>1</sup> | 180  | —    | 125  | —    | MHz   |
| f <sub>max</sub> (Ext.)             | —                          | Clock Freq. with Ext. Feedback, 1/(tsu2 + tco1)     | 133  | —    | 87   | —    | MHz   |
| f <sub>max</sub> (Tog.)             | —                          | Clock Frequency, Max Toggle <sup>2</sup>            | 227  | —    | 167  | —    | MHz   |
| t <sub>su1</sub>                    | —                          | GLB Reg. Setup Time before Clk, 5PT bypass          | 3.5  | —    | 5.0  | —    | ns    |
| t <sub>co1</sub> <sup>6</sup>       | A                          | GLB Reg. Clock to Output Delay                      | —    | 3.0  | —    | 4.5  | ns    |
| t <sub>h1</sub>                     | —                          | GLB Reg. Hold Time after Clock, 5PT bypass          | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>su2</sub>                    | —                          | GLB Reg. Setup Time before Clock                    | 4.5  | —    | 7.0  | —    | ns    |
| t <sub>h2</sub>                     | —                          | GLB Reg. Hold Time after Clock                      | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>su3</sub>                    | —                          | GLB Reg. Setup Time before Clock, Input Reg. Path   | 2.5  | —    | 3.5  | —    | ns    |
| t <sub>h3</sub>                     | —                          | GLB Reg. Hold Time after Clock, Input Reg. Path     | 0.5  | —    | 0.5  | —    | ns    |
| t <sub>r1</sub>                     | A                          | Ext. Reset Pin to Output Delay                      | —    | 6.0  | —    | 10.0 | ns    |
| t <sub>rw1</sub> <sup>7</sup>       | —                          | Ext. Reset Pulse Duration                           | 3.5  | —    | 5.0  | —    | ns    |
| t <sub>pten/dis</sub> <sup>6</sup>  | B/C                        | Local Product Term Output Enable/Disable            | —    | 6.0  | —    | 8.5  | ns    |
| t <sub>gpten/dis</sub> <sup>6</sup> | B/C                        | Global Product Term Output Enable/Disable           | —    | 7.0  | —    | 14.0 | ns    |
| t <sub>gen/dis</sub> <sup>6</sup>   | B/C                        | Global OE Input to Output Enable/Disable            | —    | 3.5  | —    | 5.5  | ns    |
| t <sub>tten/dis</sub> <sup>6</sup>  | B/C                        | Test OE Input to Output Enable/Disable              | —    | 5.5  | —    | 10.5 | ns    |
| t <sub>wh</sub>                     | —                          | Ext. Sync. Clock Pulse Duration, High               | 2.2  | —    | 3.0  | —    | ns    |
| t <sub>wl</sub>                     | —                          | Ext. Sync. Clock Pulse Duration, Low                | 2.2  | —    | 3.0  | —    | ns    |

1. Standard 16-bit counter using GRP feedback.

2. f<sub>max</sub> (Toggle) may be less than 1/(t<sub>wh</sub> + t<sub>wl</sub>). 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<sub>cc</sub> as I/O voltage reference. An additional 0.5ns delay is incurred when V<sub>ccio</sub> is used as I/O voltage reference.

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

Timing Ext.5128ve1.eps

Timing v.2.0

## External Switching Characteristics

### Over Recommended Operating Conditions

| PARAM.                 | TEST <sup>3</sup><br>COND. | DESCRIPTION <sup>4,5</sup>                          | -100 |      | -80  |      | UNITS |
|------------------------|----------------------------|---|------|------|------|------|-------|
|                        |                            |   | MIN. | MAX. | MIN. | MAX. |       |
| tpd1 <sup>6</sup>      | A                          | Data Prop. Delay, 5PT Bypass                        | —    | 10.0 | —    | 12.0 | ns    |
| tpd2 <sup>6</sup>      | A                          | Data Propagation Delay                              | —    | 12.0 | —    | 15.0 | ns    |
| fmax                   | A                          | Clock Frequency with Internal Feedback <sup>1</sup> | 100  | —    | 80   | —    | MHz   |
| fmax (Ext.)            | —                          | Clock Freq. with Ext. Feedback, 1/(tsu2 + tco1)     | 67   | —    | 56   | —    | MHz   |
| fmax (Tog.)            | —                          | Clock Frequency, Max Toggle <sup>2</sup>            | 125  | —    | 100  | —    | MHz   |
| tsu1                   | —                          | GLB Reg. Setup Time before Clk, 5PT bypass          | 7.0  | —    | 8.0  | —    | ns    |
| tco1 <sup>6</sup>      | A                          | GLB Reg. Clock to Output Delay                      | —    | 6.0  | —    | 7.0  | ns    |
| th1                    | —                          | GLB Reg. Hold Time after Clock, 5PT bypass          | 0.0  | —    | 0.0  | —    | ns    |
| tsu2                   | —                          | GLB Reg. Setup Time before Clock                    | 9.0  | —    | 11.0 | —    | ns    |
| th2                    | —                          | GLB Reg. Hold Time after Clock                      | 0.0  | —    | 0.0  | —    | ns    |
| tsu3                   | —                          | GLB Reg. Setup Time before Clock, Input Reg. Path   | 4.5  | —    | 5.5  | —    | ns    |
| th3                    | —                          | GLB Reg. Hold Time after Clock, Input Reg. Path     | 1.0  | —    | 1.0  | —    | ns    |
| tr1                    | A                          | Ext. Reset Pin to Output Delay                      | —    | 11.5 | —    | 13.0 | ns    |
| trw1 <sup>7</sup>      | —                          | Ext. Reset Pulse Duration                           | 6.5  | —    | 8.0  | —    | ns    |
| tpden/dis <sup>6</sup> | B/C                        | Local Product Term Output Enable/Disable            | —    | 10.0 | —    | 12.0 | ns    |
| tgden/dis <sup>6</sup> | B/C                        | Global Product Term Output Enable/Disable           | —    | 15.5 | —    | 17.0 | ns    |
| tgen/dis <sup>6</sup>  | B/C                        | Global OE Input to Output Enable/Disable            | —    | 7.5  | —    | 9.0  | ns    |
| tten/dis <sup>6</sup>  | B/C                        | Test OE Input to Output Enable/Disable              | —    | 11.5 | —    | 12.5 | ns    |
| twh                    | —                          | Ext. Sync. Clock Pulse Duration, High               | 4.0  | —    | 5.0  | —    | ns    |
| twl                    | —                          | Ext. Sync. Clock Pulse Duration, Low                | 4.0  | —    | 5.0  | —    | ns    |

1. Standard 16-bit counter using GRP feedback.

2. fmax (Toggle) may be less than 1/(twh + twl). 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 Vcc as I/O voltage reference. An additional 0.5ns delay is incurred when Vccio is used as I/O reference.

7. Pulse widths less than minimum may cause unknown output behavior. used as I/O voltage reference.

Timing Ext.5128ve2.eps

Timing v.2.0

## Internal Timing Parameters

### Over Recommended Operating Conditions

| PARAMETER                    | DESCRIPTION                                | -180 |     | -125 |     | -100 |     | -80 |     | UNIT |
|------------------------------|--|------|-----|------|-----|------|-----|-----|-----|------|
|                              |  | MIN  | MAX | MIN  | MAX | MIN  | MAX | MIN | MAX |      |
| <b>In/Out Delays</b>         |  |      |     |      |     |      |     |     |     |      |
| <b>t<sub>in</sub></b>        | Input Buffer Delay                         | –    | 0.9 | –    | 1.3 | –    | 2.3 | –   | 2.3 | ns   |
| <b>t<sub>gclk_in</sub></b>   | Global Clock Buffer Input Delay (clk0)     | –    | 1.0 | –    | 1.3 | –    | 1.8 | –   | 1.8 | ns   |
| <b>trst</b>                  | Global Reset Pin Delay                     | –    | 4.4 | –    | 6.6 | –    | 7.1 | –   | 7.1 | ns   |
| <b>t<sub>goe</sub></b>       | Global OE Pin Delay                        | –    | 2.5 | –    | 3.9 | –    | 5.9 | –   | 7.4 | ns   |
| <b>t<sub>buf</sub></b>       | Output Buffer Delay                        | –    | 1.1 | –    | 2.2 | –    | 2.7 | –   | 3.7 | ns   |
| <b>t<sub>en</sub></b>        | Output Enable Delay                        | –    | 1.0 | –    | 1.6 | –    | 1.6 | –   | 1.6 | ns   |
| <b>t<sub>dis</sub></b>       | Output Disable Delay                       | –    | 1.0 | –    | 1.6 | –    | 1.6 | –   | 1.6 | ns   |
| <b>Routing/GLB Delays</b>    |  |      |     |      |     |      |     |     |     |      |
| <b>t<sub>route</sub></b>     | GRP and Logic Delay                        | –    | 2.7 | –    | 3.6 | –    | 4.0 | –   | 4.5 | ns   |
| <b>t<sub>ptdb</sub></b>      | 5-pt Bypass Propagation Delay              | –    | 0.3 | –    | 0.4 | –    | 1.0 | –   | 1.5 | ns   |
| <b>t<sub>pdi</sub></b>       | Combinatorial Propagation Delay            | –    | 1.0 | –    | 0.0 | –    | 0.0 | –   | 0.0 | ns   |
| <b>t<sub>ptsa</sub></b>      | Product Term Sharing Array                 | –    | 1.3 | –    | 2.4 | –    | 3.0 | –   | 4.5 | ns   |
| <b>t<sub>fbk</sub></b>       | Internal Feedback Delay                    | –    | 0.0 | –    | 0.0 | –    | 0.0 | –   | 0.5 | ns   |
| <b>t<sub>inreg</sub></b>     | Input Buffer to Macrocell Register Delay   | –    | 2.0 | –    | 2.5 | –    | 2.5 | –   | 3.5 | ns   |
| <b>Register/Latch Delays</b> |  |      |     |      |     |      |     |     |     |      |
| <b>t<sub>s</sub></b>         | Register Setup Time                        | 0.6  | –   | 1.0  | –   | 1.5  | –   | 1.5 | –   | ns   |
| <b>t<sub>s_pt</sub></b>      | Register Setup Time (Product Term Clock)   | 0.6  | –   | 1.0  | –   | 1.5  | –   | 1.5 | –   | ns   |
| <b>t<sub>h</sub></b>         | Register Hold Time                         | 2.4  | –   | 3.0  | –   | 4.0  | –   | 5.0 | –   | ns   |
| <b>t<sub>coi</sub></b>       | Register Clock to GLB Output Delay         | –    | 0.9 | –    | 1.0 | –    | 1.5 | –   | 1.5 | ns   |
| <b>t<sub>sl</sub></b>        | Latch Setup Time                           | 0.6  | –   | 1.0  | –   | 1.5  | –   | 1.5 | –   | ns   |
| <b>t<sub>hl</sub></b>        | Latch Hold Time                            | 2.4  | –   | 3.0  | –   | 4.0  | –   | 5.0 | –   | ns   |
| <b>t<sub>goi</sub></b>       | Latch Gate to GLB Output Delay             | –    | 0.9 | –    | 1.0 | –    | 1.5 | –   | 1.5 | ns   |
| <b>t<sub>pdl</sub></b>       | GLB Latch propagation Delay                | –    | 1.0 | –    | 1.5 | –    | 2.0 | –   | 2.5 | ns   |
| <b>t<sub>ces</sub></b>       | Clock Enable Setup Time                    | 4.1  | –   | 4.3  | –   | 5.3  | –   | 6.3 | –   | ns   |
| <b>t<sub>ceh</sub></b>       | Clock Enable Hold Time                     | 0.3  | –   | 1.7  | –   | 2.7  | –   | 3.7 | –   | ns   |
| <b>t<sub>sri</sub></b>       | Asynchronous Set/Reset to GLB Output Delay | –    | 0.5 | –    | 1.2 | –    | 1.7 | –   | 2.2 | ns   |
| <b>t<sub>srr</sub></b>       | Asynchronous Set/Reset Recovery Time       | 1.1  | –   | 1.2  | –   | 1.2  | –   | 2.2 | –   | ns   |
| <b>Control Delays</b>        |  |      |     |      |     |      |     |     |     |      |
| <b>t<sub>ptclk</sub></b>     | Macrocell PT Clock Delay                   | –    | 0.4 | –    | 0.4 | –    | 0.5 | –   | 0.5 | ns   |
| <b>t<sub>bclk</sub></b>      | Block PT Clock Delay                       | –    | 1.4 | –    | 1.9 | –    | 2.5 | –   | 2.5 | ns   |
| <b>t<sub>ptsr</sub></b>      | Macrocell PT Set/Reset Delay               | –    | 1.8 | –    | 3.7 | –    | 4.8 | –   | 4.8 | ns   |
| <b>t<sub>bsr</sub></b>       | Block PT Set/Reset Delay                   | –    | 2.8 | –    | 5.7 | –    | 6.8 | –   | 6.8 | ns   |
| <b>t<sub>ptoe</sub></b>      | Macrocell PT OE Delay                      | –    | 1.4 | –    | 2.0 | –    | 2.1 | –   | 3.6 | ns   |
| <b>t<sub>gptoe</sub></b>     | Global PT OE Delay                         | –    | 2.4 | –    | 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 5128VE Timing Parameters (continued)**

| ADDER TYPE                                  | BASE PARAMETER  | ADDER |      |      |     | UNITS |
|---|---|-------|------|------|-----|-------|
|   |   | -180  | -125 | -100 | -80 |       |
| <b>Routing Adders</b>                       |   |       |      |      |     |       |
| <b>t<sub>lp</sub></b>                       | <b>t<sub>route</sub></b>                                | 1.0   | 1.5  | 1.5  | 1.5 | ns    |
| <b>Tioi Input Adders</b>                    |   |       |      |      |     |       |
| clk1  | <b>t<sub>gclk_in</sub></b>                              | 0.9   | 1.7  | 1.7  | 1.7 | ns    |
| clk2  | <b>t<sub>gclk_in</sub></b>                              | 1.4   | 1.7  | 1.7  | 1.7 | ns    |
| clk3  | <b>t<sub>gclk_in</sub></b>                              | 1.4   | 1.7  | 1.7  | 1.7 | ns    |
| <b>Tioo Output Adders<sup>1</sup></b>       |   |       |      |      |     |       |
| Slow Slew I/O                               | <b>t<sub>buf</sub>, t<sub>en</sub></b>                  | 4.0   | 4.0  | 4.0  | 4.0 | ns    |
| LVTTTL_out                                  | <b>t<sub>buf</sub>, t<sub>en</sub>, t<sub>dis</sub></b> | 0.0   | 0.0  | 0.0  | 0.0 | ns    |
| LVC MOS25_out                               | <b>t<sub>buf</sub>, t<sub>en</sub>, t<sub>dis</sub></b> | 0.5   | 0.5  | 0.5  | 0.5 | ns    |
| LVC MOS33_out                               | <b>t<sub>buf</sub>, t<sub>en</sub>, t<sub>dis</sub></b> | 0.0   | 0.0  | 0.0  | 0.0 | ns    |
| <b>Tbla Additional Block Loading Adders</b> |   |       |      |      |     |       |
| 1   | <b>t<sub>route</sub></b>                                | 0.1   | 0.1  | 0.1  | 0.1 | ns    |
| 2   | <b>t<sub>route</sub></b>                                | 0.2   | 0.2  | 0.2  | 0.2 | ns    |
| 3   | <b>t<sub>route</sub></b>                                | 0.3   | 0.3  | 0.3  | 0.3 | ns    |

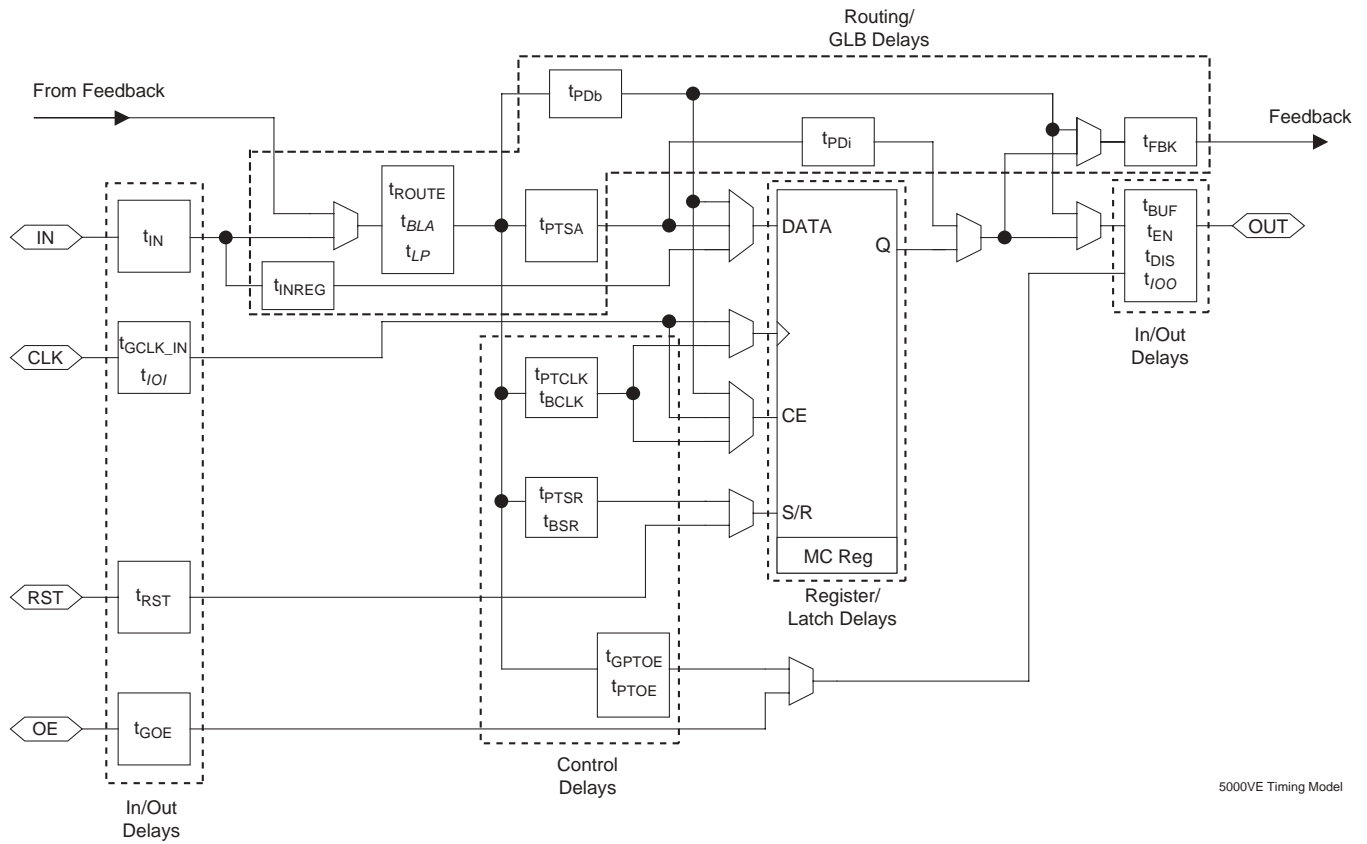
<sup>1</sup>Timing for open drain configurations is the same as non-open drain configurations.

Timing Table/5128VE  
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 5128VE Timing Model**



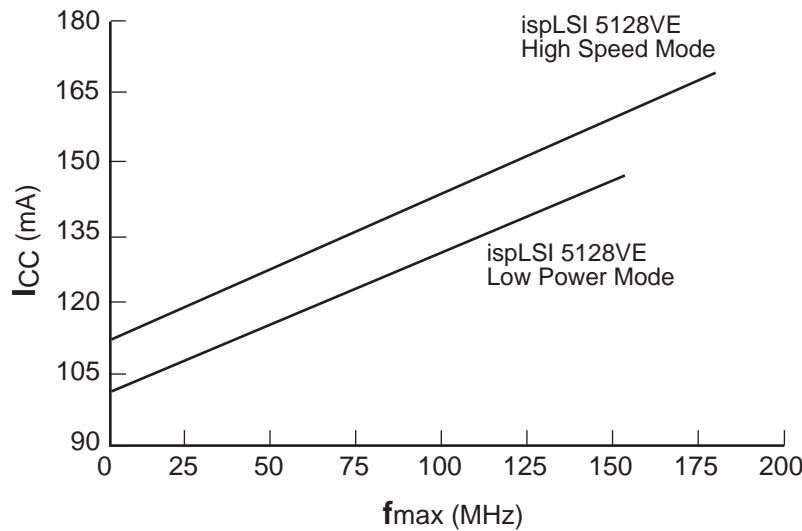
Note: Italicized parameters are delay adders above and beyond default conditions (i.e. GRP load of one GLB, CLK0, high-speed AND Array and VCC I/O option).

**Power Consumption**

Power consumption in the ispLSI 5128VE 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 8 16-bit Counters  
Typical Current at 3.3V, 25° C

ICC can be estimated for the ispLSI 5128VE using the following equation:

**High Speed Mode:**  $ICC = 12.4 + (\# \text{ of PTs} * 0.408) + (\# \text{ of nets} * Fmax * 0.00169)$

**Low Power Mode:**  $ICC = 12.4 + (\# \text{ of PTs} * 0.349) + (\# \text{ of nets} * Fmax * 0.00169)$

# 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.

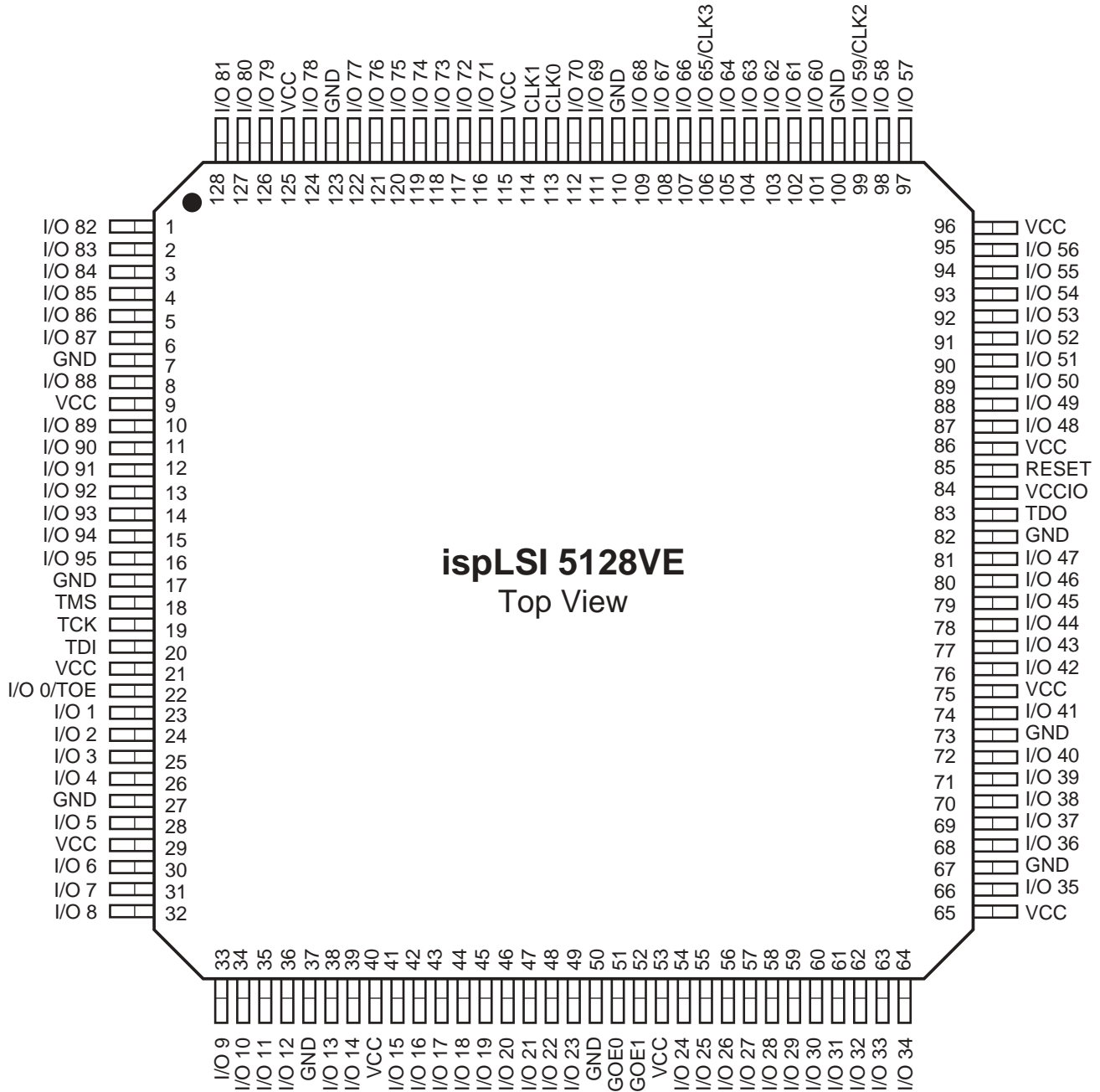
0127/5128VE

**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  |
| 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,<br>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. |

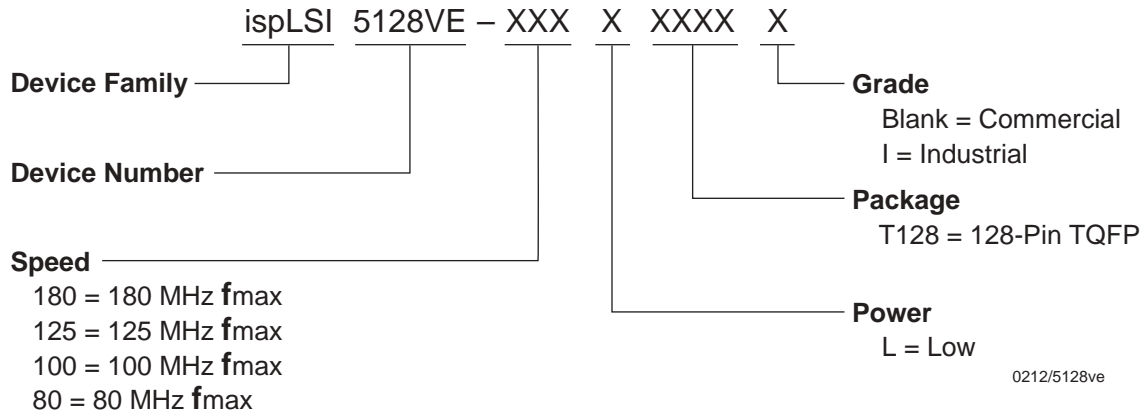
**Pin Configuration**

ispLSI 5128VE 128-Pin TQFP (0.4mm Lead Pitch / 14.0mm x 14.0mm Body Size)



128 TQFP/5128VE

**Part Number Description**



**Ordering Information**

**COMMERCIAL**

| FAMILY | fmax (MHz) | tpd (ns) | ORDERING NUMBER        | PACKAGE      |
|--------|------------|----------|------------------------|--------------|
| ispLSI | 180        | 5.0      | ispLSI 5128VE-180LT128 | 128-Pin TQFP |
|        | 125        | 7.5      | ispLSI 5128VE-125LT128 | 128-Pin TQFP |
|        | 100        | 10       | ispLSI 5128VE-100LT128 | 128-Pin TQFP |

Table 2-0041A/5128VE

**INDUSTRIAL**

| FAMILY | fmax (MHz) | tpd (ns) | ORDERING NUMBER         | PACKAGE      |
|--------|------------|----------|-------------------------|--------------|
| ispLSI | 125        | 7.5      | ispLSI 5128VE-125LT128I | 128-Pin TQFP |
|        | 100        | 10       | ispLSI 5128VE-100LT128I | 128-Pin TQFP |
|        | 80         | 12       | ispLSI 5128VE-80LT128I  | 128-Pin TQFP |

Table 2-0041B/5128VE

The ispLSI 5128VE is dual-marked with both Commercial and Industrial grades. The Commercial speed grade is faster (i.e. ispLSI 5128VE-180LT128) than the Industrial speed grade (i.e. ispLSI 5128VE-125LT128I).