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## Understanding [Embedded - CPLDs \(Complex Programmable Logic Devices\)](#)

Embedded - CPLDs, or Complex Programmable Logic Devices, are highly versatile digital logic devices used in electronic systems. These programmable components are designed to perform complex logical operations and can be customized for specific applications. Unlike fixed-function ICs, CPLDs offer the flexibility to reprogram their configuration, making them an ideal choice for various embedded systems. They consist of a set of logic gates and programmable interconnects, allowing designers to implement complex logic circuits without needing custom hardware.

## Applications of Embedded - CPLDs

### Details

|                                 |                                                                                                                                                                       |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status                  | Obsolete                                                                                                                                                              |
| Programmable Type               | In System Programmable                                                                                                                                                |
| Delay Time tpd(1) Max           | 7.5 ns                                                                                                                                                                |
| Voltage Supply - Internal       | 1.7V ~ 1.9V                                                                                                                                                           |
| Number of Logic Elements/Blocks | 16                                                                                                                                                                    |
| Number of Macrocells            | 256                                                                                                                                                                   |
| Number of Gates                 | -                                                                                                                                                                     |
| Number of I/O                   | 64                                                                                                                                                                    |
| Operating Temperature           | -40°C ~ 105°C (TJ)                                                                                                                                                    |
| Mounting Type                   | Surface Mount                                                                                                                                                         |
| Package / Case                  | 100-LQFP                                                                                                                                                              |
| Supplier Device Package         | 100-TQFP (14x14)                                                                                                                                                      |
| Purchase URL                    | <a href="https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4256zc-75t100i">https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4256zc-75t100i</a> |

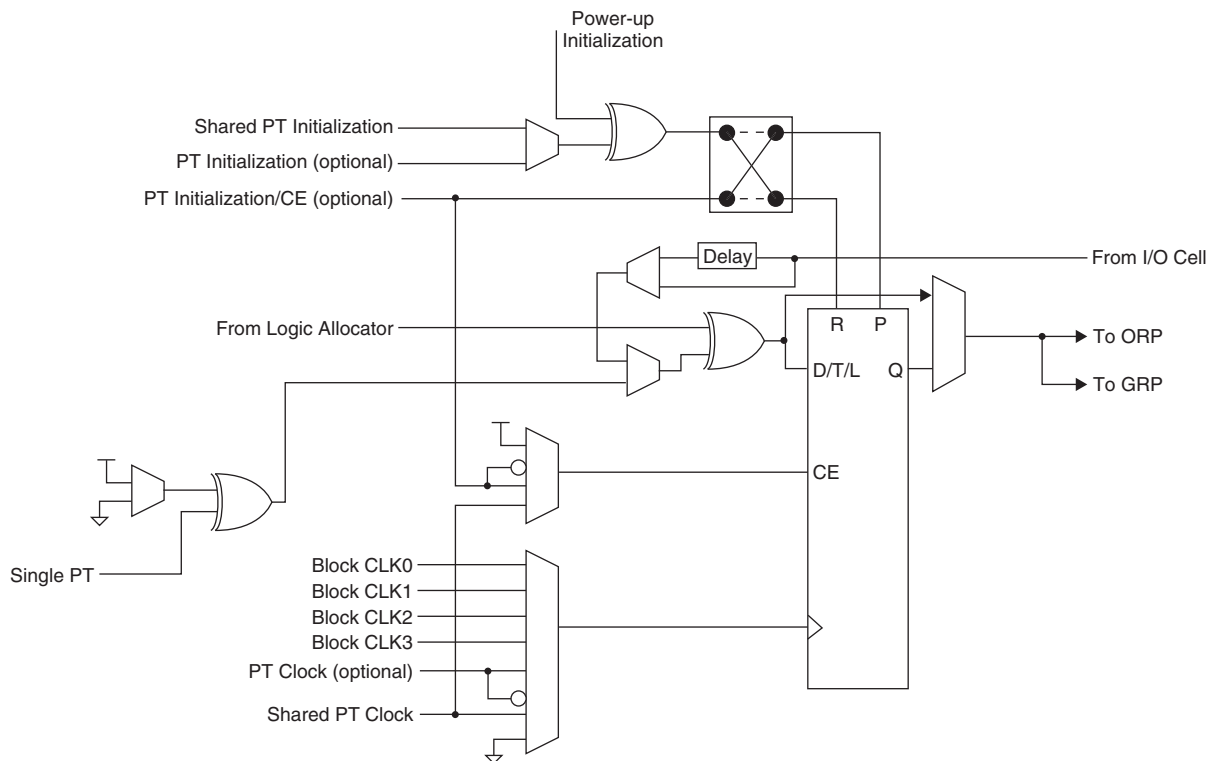
**Table 5. Product Term Expansion Capability**

| Expansion Chains | Macrocells Associated with Expansion Chain (with Wrap Around) | Max PT/Macrocell |
|------------------|---------------------------------------------------------------|------------------|
| Chain-0          | M0 M4 M8 M12 M0                                               | 75               |
| Chain-1          | M1 M5 M9 M13 M1                                               | 80               |
| Chain-2          | M2 M6 M10 M14 M2                                              | 75               |
| Chain-3          | M3 M7 M11 M15 M3                                              | 70               |

Every time the super cluster allocator is used, there is an incremental delay of  $t_{EXP}$ . When the super cluster allocator is used, all destinations other than the one being steered to, are given the value of ground (i.e., if the super cluster is steered to M (n+4), then M (n) is ground).

## Macrocell

The 16 macrocells in the GLB are driven by the 16 outputs from the logic allocator. Each macrocell contains a programmable XOR gate, a programmable register/latch, along with routing for the logic and control functions. Figure 5 shows a graphical representation of the macrocell. The macrocells feed the ORP and GRP. A direct input from the I/O cell allows designers to use the macrocell to construct high-speed input registers. A programmable delay in this path allows designers to choose between the fastest possible set-up time and zero hold time.

**Figure 5. Macrocell**

## Enhanced Clock Multiplexer

The clock input to the flip-flop can select any of the four block clocks along with the shared PT clock, and true and complement forms of the optional individual term clock. An 8:1 multiplexer structure is used to select the clock. The eight sources for the clock multiplexer are as follows:

- Block CLK0
- Block CLK1

- Block CLK2
- Block CLK3
- PT Clock
- PT Clock Inverted
- Shared PT Clock
- Ground

### Clock Enable Multiplexer

Each macrocell has a 4:1 clock enable multiplexer. This allows the clock enable signal to be selected from the following four sources:

- PT Initialization/CE
- PT Initialization/CE Inverted
- Shared PT Clock
- Logic High

### Initialization Control

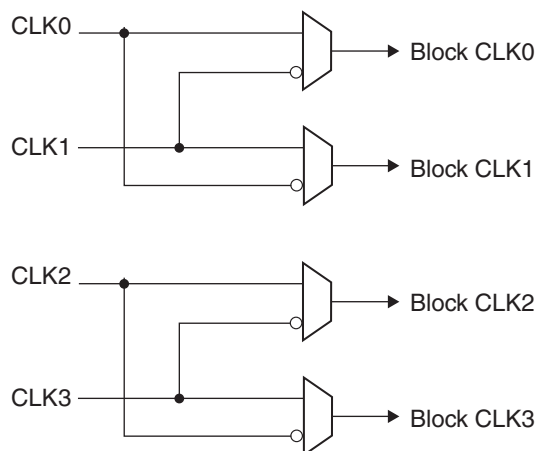
The ispMACH 4000 family architecture accommodates both block-level and macrocell-level set and reset capability. There is one block-level initialization term that is distributed to all macrocell registers in a GLB. At the macrocell level, two product terms can be “stolen” from the cluster associated with a macrocell to be used for set/reset functionality. A reset/preset swapping feature in each macrocell allows for reset and preset to be exchanged, providing flexibility.

Note that the reset/preset swapping selection feature affects power-up reset as well. All flip-flops power up to a known state for predictable system initialization. If a macrocell is configured to SET on a signal from the block-level initialization, then that macrocell will be SET during device power-up. If a macrocell is configured to RESET on a signal from the block-level initialization or is not configured for set/reset, then that macrocell will RESET on power-up. To guarantee initialization values, the  $V_{CC}$  rise must be monotonic, and the clock must be inactive until the reset delay time has elapsed.

### GLB Clock Generator

Each ispMACH 4000 device has up to four clock pins that are also routed to the GRP to be used as inputs. These pins drive a clock generator in each GLB, as shown in Figure 6. The clock generator provides four clock signals that can be used anywhere in the GLB. These four GLB clock signals can consist of a number of combinations of the true and complement edges of the global clock signals.

**Figure 6. GLB Clock Generator**



- LVTTTL
- LVCMOS 1.8
- LVCMOS 3.3
- 3.3V PCI Compatible
- LVCMOS 2.5

All of the I/Os and dedicated inputs have the capability to provide a bus-keeper latch, Pull-up Resistor or Pull-down Resistor. A fourth option is to provide none of these. The selection is done on a global basis. The default in both hardware and software is such that when the device is erased or if the user does not specify, the input structure is configured to be a Pull-up Resistor.

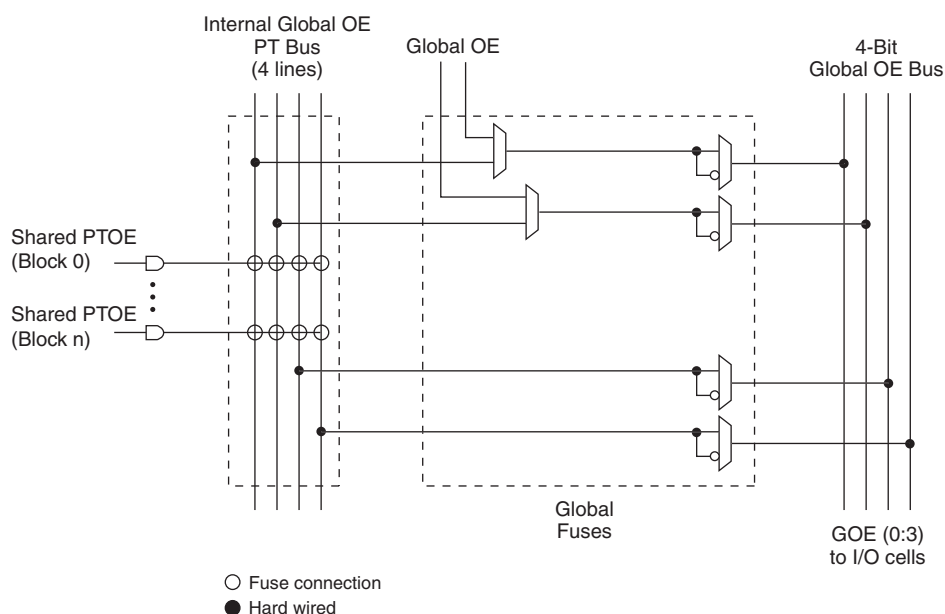
Each ispMACH 4000 device I/O has an individually programmable output slew rate control bit. Each output can be individually configured for fast slew or slow slew. The typical edge rate difference between fast and slow slew setting is 20%. For high-speed designs with long, unterminated traces, the slow-slew rate will introduce fewer reflections, less noise and keep ground bounce to a minimum. For designs with short traces or well terminated lines, the fast slew rate can be used to achieve the highest speed.

## Global OE Generation

Most ispMACH 4000 family devices have a 4-bit wide Global OE Bus, except the ispMACH 4032 device that has a 2-bit wide Global OE Bus. This bus is derived from a 4-bit internal global OE PT bus and two dual purpose I/O or GOE pins. Each signal that drives the bus can optionally be inverted.

Each GLB has a block-level OE PT that connects to all bits of the Global OE PT bus with four fuses. Hence, for a 256-macrocell device (with 16 blocks), each line of the bus is driven from 16 OE product terms. Figures 9 and 10 show a graphical representation of the global OE generation.

**Figure 9. Global OE Generation for All Devices Except ispMACH 4032**



**Absolute Maximum Ratings**<sup>1, 2, 3</sup>

|                                                       | ispMACH 4000C/Z<br>(1.8V) | ispMACH 4000B<br>(2.5V) | ispMACH 4000V<br>(3.3V) |
|-------------------------------------------------------|---------------------------|-------------------------|-------------------------|
| Supply Voltage ( $V_{CC}$ )                           | -0.5 to 2.5V              | -0.5 to 5.5V            | -0.5 to 5.5V            |
| Output Supply Voltage ( $V_{CCO}$ )                   | -0.5 to 4.5V              | -0.5 to 4.5V            | -0.5 to 4.5V            |
| Input or I/O Tristate Voltage Applied <sup>4, 5</sup> | -0.5 to 5.5V              | -0.5 to 5.5V            | -0.5 to 5.5V            |
| Storage Temperature                                   | -65 to 150°C              | -65 to 150°C            | -65 to 150°C            |
| Junction Temperature ( $T_j$ ) with Power Applied     | -55 to 150°C              | -55 to 150°C            | -55 to 150°C            |

1. Stress above those listed under the “Absolute Maximum Ratings” may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.
2. Compliance with Lattice [Thermal Management](#) document is required.
3. All voltages referenced to GND.
4. Undershoot of -2V and overshoot of ( $V_{IH}$  (MAX) + 2V), up to a total pin voltage of 6.0V, is permitted for a duration of < 20ns.
5. Maximum of 64 I/Os per device with  $V_{IN} > 3.6V$  is allowed.

**Recommended Operating Conditions**

| Symbol          | Parameter                         |                                                      | Min.                | Max. | Units |
|-----------------|-----------------------------------|------------------------------------------------------|---------------------|------|-------|
| V <sub>CC</sub> | Supply Voltage for 1.8V Devices   | ispMACH 4000C                                        | 1.65                | 1.95 | V     |
|                 |                                   | ispMACH 4000Z                                        | 1.7                 | 1.9  | V     |
|                 |                                   | ispMACH 4000Z, Extended Functional Voltage Operation | 1.6 <sup>1, 2</sup> | 1.9  | V     |
|                 | Supply Voltage for 2.5V Devices   |                                                      | 2.3                 | 2.7  | V     |
|                 | Supply Voltage for 3.3V Devices   |                                                      | 3.0                 | 3.6  | V     |
| T <sub>j</sub>  | Junction Temperature (Commercial) |                                                      | 0                   | 90   | C     |
|                 | Junction Temperature (Industrial) |                                                      | -40                 | 105  | C     |
|                 | Junction Temperature (Extended)   |                                                      | -40                 | 130  | C     |

1. Devices operating at 1.6V can expect performance degradation up to 35%.
2. Applicable for devices with 2004 date codes and later. Contact factory for ordering instructions.

**Erase Reprogram Specifications**

| Parameter             | Min.  | Max. | Units  |
|-----------------------|-------|------|--------|
| Erase/Reprogram Cycle | 1,000 | —    | Cycles |

Note: Valid over commercial temperature range.

**Hot Socketing Characteristics**<sup>1,2,3</sup>

| Symbol   | Parameter                    | Condition                                       | Min. | Typ.     | Max.      | Units   |
|----------|------------------------------|-------------------------------------------------|------|----------|-----------|---------|
| $I_{DK}$ | Input or I/O Leakage Current | $0 \leq V_{IN} \leq 3.0V$ , $T_j = 105^\circ C$ | —    | $\pm 30$ | $\pm 150$ | $\mu A$ |
|          |                              | $0 \leq V_{IN} \leq 3.0V$ , $T_j = 130^\circ C$ | —    | $\pm 30$ | $\pm 200$ | $\mu A$ |

1. Insensitive to sequence of  $V_{CC}$  or  $V_{CCO}$ . However, assumes monotonic rise/fall rates for  $V_{CC}$  and  $V_{CCO}$ , provided  $(V_{IN} - V_{CCO}) \leq 3.6V$ .
2.  $0 < V_{CC} < V_{CC} (MAX)$ ,  $0 < V_{CCO} < V_{CCO} (MAX)$ .
3.  $I_{DK}$  is additive to  $I_{PU}$ ,  $I_{PD}$  or  $I_{BH}$ . Device defaults to pull-up until fuse circuitry is active.

## Supply Current, ispMACH 4000Z (Cont.)

### Over Recommended Operating Conditions

| Symbol                    | Parameter                      | Condition                                      | Min. | Typ. | Max. | Units |
|---------------------------|--------------------------------|------------------------------------------------|------|------|------|-------|
| <b>ispMACH 4256ZC</b>     |                                |                                                |      |      |      |       |
| ICC <sup>1, 2, 3, 5</sup> | Operating Power Supply Current | V <sub>CC</sub> = 1.8V, T <sub>A</sub> = 25°C  | —    | 341  | —    | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 70°C  | —    | 361  | —    | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 85°C  | —    | 372  | —    | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 125°C | —    | 468  | —    | μA    |
| ICC <sup>4, 5</sup>       | Standby Power Supply Current   | V <sub>CC</sub> = 1.8V, T <sub>A</sub> = 25°C  | —    | 13   | —    | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 70°C  | —    | 32   | 55   | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 85°C  | —    | 43   | 90   | μA    |
|                           |                                | V <sub>CC</sub> = 1.9V, T <sub>A</sub> = 125°C | —    | 135  | —    | μA    |

1. T<sub>A</sub> = 25°C, frequency = 1.0 MHz.

2. Device configured with 16-bit counters.

3. I<sub>CC</sub> varies with specific device configuration and operating frequency.

4. V<sub>CCO</sub> = 3.6V, V<sub>IN</sub> = 0V or V<sub>CCO</sub>, bus maintenance turned off. V<sub>IN</sub> above V<sub>CCO</sub> will add transient current above the specified standby I<sub>CC</sub>.

5. Includes V<sub>CCO</sub> current without output loading.

## ispMACH 4000V/B/C External Switching Characteristics

Over Recommended Operating Conditions

| Parameter                     | Description <sup>1, 2, 3</sup>                                                   | -25  |      | -27  |      | -3   |      | -35  |      | Units |
|-------------------------------|----------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|-------|
|                               |                                                                                  | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>PD</sub>               | 5-PT bypass combinatorial propagation delay                                      | —    | 2.5  | —    | 2.7  | —    | 3.0  | —    | 3.5  | ns    |
| t <sub>PD_MC</sub>            | 20-PT combinatorial propagation delay through macrocell                          | —    | 3.2  | —    | 3.5  | —    | 3.8  | —    | 4.2  | ns    |
| t <sub>S</sub>                | GLB register setup time before clock                                             | 1.8  | —    | 1.8  | —    | 2.0  | —    | 2.0  | —    | ns    |
| t <sub>ST</sub>               | GLB register setup time before clock with T-type register                        | 2.0  | —    | 2.0  | —    | 2.2  | —    | 2.2  | —    | ns    |
| t <sub>SIR</sub>              | GLB register setup time before clock, input register path                        | 0.7  | —    | 1.0  | —    | 1.0  | —    | 1.0  | —    | ns    |
| t <sub>SIRZ</sub>             | GLB register setup time before clock with zero hold                              | 1.7  | —    | 2.0  | —    | 2.0  | —    | 2.0  | —    | ns    |
| t <sub>H</sub>                | GLB register hold time after clock                                               | 0.0  | —    | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>HT</sub>               | GLB register hold time after clock with T-type register                          | 0.0  | —    | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>HIR</sub>              | GLB register hold time after clock, input register path                          | 0.9  | —    | 1.0  | —    | 1.0  | —    | 1.0  | —    | ns    |
| t <sub>HIRZ</sub>             | GLB register hold time after clock, input register path with zero hold           | 0.0  | —    | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>CO</sub>               | GLB register clock-to-output delay                                               | —    | 2.2  | —    | 2.7  | —    | 2.7  | —    | 2.7  | ns    |
| t <sub>R</sub>                | External reset pin to output delay                                               | —    | 3.5  | —    | 4.0  | —    | 4.4  | —    | 4.5  | ns    |
| t <sub>RW</sub>               | External reset pulse duration                                                    | 1.5  | —    | 1.5  | —    | 1.5  | —    | 1.5  | -    | ns    |
| t <sub>PTOE/DIS</sub>         | Input to output local product term output enable/disable                         | —    | 4.0  | —    | 4.5  | —    | 5.0  | —    | 5.5  | ns    |
| t <sub>GPTOE/DIS</sub>        | Input to output global product term output enable/disable                        | —    | 5.0  | —    | 6.5  | —    | 8.0  | —    | 8.0  | ns    |
| t <sub>GOE/DIS</sub>          | Global OE input to output enable/disable                                         | —    | 3.0  | —    | 3.5  | —    | 4.0  | —    | 4.5  | ns    |
| t <sub>CW</sub>               | Global clock width, high or low                                                  | 1.1  | —    | 1.3  | —    | 1.3  | —    | 1.3  | —    | ns    |
| t <sub>GW</sub>               | Global gate width low (for low transparent) or high (for high transparent)       | 1.1  | —    | 1.3  | —    | 1.3  | —    | 1.3  | —    | ns    |
| t <sub>WIR</sub>              | Input register clock width, high or low                                          | 1.1  | —    | 1.3  | —    | 1.3  | —    | 1.3  | —    | ns    |
| f <sub>MAX</sub> <sup>4</sup> | Clock frequency with internal feedback                                           | —    | 400  | —    | 333  | —    | 322  | —    | 322  | MHz   |
| f <sub>MAX</sub> (Ext.)       | Clock frequency with external feedback, [1/ (t <sub>S</sub> + t <sub>CO</sub> )] | —    | 250  | —    | 222  | —    | 212  | —    | 212  | MHz   |

1. Timing numbers are based on default LVCMOS 1.8 I/O buffers. Use timing adjusters provided to calculate other standards.

Timing v.3.2

2. Measured using standard switching circuit, assuming GRP loading of 1 and 1 output switching.

3. Pulse widths and clock widths less than minimum will cause unknown behavior.

4. Standard 16-bit counter using GRP feedback.

## ispMACH 4000Z Internal Timing Parameters

Over Recommended Operating Conditions

| Parameter             | Description                                                        | -35  |      | -37  |      | -42  |      | Units |
|-----------------------|--------------------------------------------------------------------|------|------|------|------|------|------|-------|
|                       |                                                                    | Min. | Max. | Min. | Max. | Min. | Max. |       |
| In/Out Delays         |                                                                    |      |      |      |      |      |      |       |
| t <sub>IN</sub>       | Input Buffer Delay                                                 | —    | 0.75 | —    | 0.80 | —    | 0.75 | ns    |
| t <sub>GOE</sub>      | Global OE Pin Delay                                                | —    | 2.25 | —    | 2.25 | —    | 2.30 | ns    |
| t <sub>GCLK_IN</sub>  | Global Clock Input Buffer Delay                                    | —    | 1.60 | —    | 1.60 | —    | 1.95 | ns    |
| t <sub>BUF</sub>      | Delay through Output Buffer                                        | —    | 0.75 | —    | 0.90 | —    | 0.90 | ns    |
| t <sub>EN</sub>       | Output Enable Time                                                 | —    | 2.25 | —    | 2.25 | —    | 2.50 | ns    |
| t <sub>DIS</sub>      | Output Disable Time                                                | —    | 1.35 | —    | 1.35 | —    | 2.50 | ns    |
| Routing/GLB Delays    |                                                                    |      |      |      |      |      |      |       |
| t <sub>ROUTE</sub>    | Delay through GRP                                                  | —    | 1.60 | —    | 1.60 | —    | 2.15 | ns    |
| t <sub>MCELL</sub>    | Macrocell Delay                                                    | —    | 0.65 | —    | 0.75 | —    | 0.85 | ns    |
| t <sub>INREG</sub>    | Input Buffer to Macrocell Register Delay                           | —    | 0.91 | —    | 1.00 | —    | 1.00 | ns    |
| t <sub>FBK</sub>      | Internal Feedback Delay                                            | —    | 0.05 | —    | 0.00 | —    | 0.00 | ns    |
| t <sub>PDb</sub>      | 5-PT Bypass Propagation Delay                                      | —    | 0.40 | —    | 0.40 | —    | 0.40 | ns    |
| t <sub>PDi</sub>      | Macrocell Propagation Delay                                        | —    | 0.25 | —    | 0.25 | —    | 0.65 | ns    |
| Register/Latch Delays |                                                                    |      |      |      |      |      |      |       |
| t <sub>S</sub>        | D-Register Setup Time (Global Clock)                               | 0.80 | —    | 0.95 | —    | 0.90 | —    | ns    |
| t <sub>S_PT</sub>     | D-Register Setup Time (Product Term Clock)                         | 1.35 | —    | 1.95 | —    | 1.90 | —    | ns    |
| t <sub>ST</sub>       | T-Register Setup Time (Global Clock)                               | 1.00 | —    | 1.15 | —    | 1.10 | —    | ns    |
| t <sub>ST_PT</sub>    | T-register Setup Time (Product Term Clock)                         | 1.55 | —    | 1.75 | —    | 2.10 | —    | ns    |
| t <sub>H</sub>        | D-Register Hold Time                                               | 1.40 | —    | 1.55 | —    | 1.80 | —    | ns    |
| t <sub>HT</sub>       | T-Resister Hold Time                                               | 1.40 | —    | 1.55 | —    | 1.80 | —    | ns    |
| t <sub>SIR</sub>      | D-Input Register Setup Time (Global Clock)                         | 0.94 | —    | 0.90 | —    | 1.50 | —    | ns    |
| t <sub>SIR_PT</sub>   | D-Input Register Setup Time (Product Term Clock)                   | 1.45 | —    | 1.45 | —    | 1.45 | —    | ns    |
| t <sub>HIR</sub>      | D-Input Register Hold Time (Global Clock)                          | 1.06 | —    | 1.20 | —    | 1.10 | —    | ns    |
| t <sub>HIR_PT</sub>   | D-Input Register Hold Time (Product Term Clock)                    | 0.88 | —    | 1.00 | —    | 1.00 | —    | ns    |
| t <sub>COi</sub>      | Register Clock to Output/Feedback MUX Time                         | —    | 0.65 | —    | 0.70 | —    | 0.65 | ns    |
| t <sub>CES</sub>      | Clock Enable Setup Time                                            | 1.00 | —    | 2.00 | —    | 2.00 | —    | ns    |
| t <sub>CEH</sub>      | Clock Enable Hold Time                                             | 0.00 | —    | 0.00 | —    | 0.00 | —    | ns    |
| t <sub>SL</sub>       | Latch Setup Time (Global Clock)                                    | 0.80 | —    | 0.95 | —    | 0.90 | —    | ns    |
| t <sub>SL_PT</sub>    | Latch Setup Time (Product Term Clock)                              | 1.55 | —    | 1.95 | —    | 1.90 | —    | ns    |
| t <sub>HL</sub>       | Latch Hold Time                                                    | 1.40 | —    | 1.80 | —    | 1.80 | —    | ns    |
| t <sub>GOi</sub>      | Latch Gate to Output/Feedback MUX Time                             | —    | 0.40 | —    | 0.33 | —    | 0.33 | ns    |
| t <sub>PDLi</sub>     | Propagation Delay through Transparent Latch to Output/Feedback MUX | —    | 0.30 | —    | 0.25 | —    | 0.25 | ns    |
| t <sub>SRI</sub>      | Asynchronous Reset or Set to Output/Feedback MUX Delay             | —    | 0.28 | —    | 0.28 | —    | 1.27 | ns    |
| t <sub>SRR</sub>      | Asynchronous Reset or Set Recovery Delay                           | —    | 2.00 | —    | 1.67 | —    | 1.80 | ns    |
| Control Delays        |                                                                    |      |      |      |      |      |      |       |
| t <sub>BCLK</sub>     | GLB PT Clock Delay                                                 | —    | 1.30 | —    | 1.50 | —    | 1.55 | ns    |
| t <sub>PTCLK</sub>    | Macrocell PT Clock Delay                                           | —    | 1.50 | —    | 1.70 | —    | 1.55 | ns    |
| t <sub>BSR</sub>      | GLB PT Set/Reset Delay                                             | —    | 1.10 | —    | 1.83 | —    | 1.83 | ns    |
| t <sub>PTSR</sub>     | Macrocell PT Set/Reset Delay                                       | —    | 1.22 | —    | 2.02 | —    | 1.83 | ns    |

**ispMACH 4000Z Internal Timing Parameters (Cont.)****Over Recommended Operating Conditions**

| Parameter          | Description           | -35  |      | -37  |      | -42  |      | Units |
|--------------------|-----------------------|------|------|------|------|------|------|-------|
|                    |                       | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>GPTOE</sub> | Global PT OE Delay    | —    | 1.9  | —    | 2.35 | —    | 2.60 | ns    |
| t <sub>PPTOE</sub> | Macrocell PT OE Delay | —    | 2.4  | —    | 3.35 | —    | 2.60 | ns    |

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

Timing v.2.2

**ispMACH 4000V/B/C Timing Adders<sup>1</sup>**

| Adder Type                        | Base Parameter                                            | Description                                | -25  |      | -27  |      | -3   |      | -35  |      | Units |
|-----------------------------------|-----------------------------------------------------------|--------------------------------------------|------|------|------|------|------|------|------|------|-------|
|                                   |                                                           |                                            | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |       |
| Optional Delay Adders             |                                                           |                                            |      |      |      |      |      |      |      |      |       |
| t <sub>INDIO</sub>                | t <sub>INREG</sub>                                        | Input register delay                       | —    | 0.95 | —    | 1.00 | —    | 1.00 | —    | 1.00 | ns    |
| t <sub>EXP</sub>                  | t <sub>MCELL</sub>                                        | Product term expander delay                | —    | 0.33 | —    | 0.33 | —    | 0.33 | —    | 0.33 | ns    |
| t <sub>ORP</sub>                  | —                                                         | Output routing pool delay                  | —    | 0.05 | —    | 0.05 | —    | 0.05 | —    | 0.05 | ns    |
| t <sub>BLA</sub>                  | t <sub>ROUTE</sub>                                        | Additional block loading adder             | —    | 0.03 | —    | 0.05 | —    | 0.05 | —    | 0.05 | ns    |
| t <sub>IOI</sub> Input Adjusters  |                                                           |                                            |      |      |      |      |      |      |      |      |       |
| LVTTL_in                          | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVTTL standard                       | —    | 0.60 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS33_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 3.3 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS25_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 2.5 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS18_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 1.8 standard                 | —    | 0.00 | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_in                            | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using PCI compatible input                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| t <sub>IOO</sub> Output Adjusters |                                                           |                                            |      |      |      |      |      |      |      |      |       |
| LVTTL_out                         | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as TTL buffer            | —    | 0.20 | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS33_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 3.3V buffer           | —    | 0.20 | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS25_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 2.5V buffer           | —    | 0.10 | —    | 0.10 | —    | 0.10 | —    | 0.10 | ns    |
| LVC MOS18_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 1.8V buffer           | —    | 0.00 | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_out                           | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as PCI compatible buffer | —    | 0.20 | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| Slow Slew                         | t <sub>BUF</sub> , t <sub>EN</sub>                        | Output configured for slow slew rate       | —    | 1.00 | —    | 1.00 | —    | 1.00 | —    | 1.00 | ns    |

Note: Open drain timing is the same as corresponding LVC MOS timing.

Timing v.3.2

1. Refer to TN1004, [ispMACH 4000 Timing Model Design and Usage Guidelines](#) for information regarding use of these adders.

**ispMACH 4000Z Timing Adders (Cont.)<sup>1</sup>**

| Adder Type                        | Base Parameter                                            | Description                                | -45  |      | -5   |      | -75  |      | Units |
|-----------------------------------|-----------------------------------------------------------|--------------------------------------------|------|------|------|------|------|------|-------|
|                                   |                                                           |                                            | Min. | Max. | Min. | Max. | Min. | Max. |       |
| Optional Delay Adders             |                                                           |                                            |      |      |      |      |      |      |       |
| t <sub>INDIO</sub>                | t <sub>INREG</sub>                                        | Input register delay                       | —    | 1.30 | —    | 1.30 | —    | 1.30 | ns    |
| t <sub>EXP</sub>                  | t <sub>MCELL</sub>                                        | Product term expander delay                | —    | 0.45 | —    | 0.45 | —    | 0.50 | ns    |
| t <sub>ORP</sub>                  | —                                                         | Output routing pool delay                  | —    | 0.40 | —    | 0.40 | —    | 0.40 | ns    |
| t <sub>BLA</sub>                  | t <sub>ROUTE</sub>                                        | Additional block load-ing adder            | —    | 0.05 | —    | 0.05 | —    | 0.05 | ns    |
| t <sub>IOI</sub> Input Adjusters  |                                                           |                                            |      |      |      |      |      |      |       |
| LVTTTL_in                         | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVTTTL standard                      | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS33_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 3.3 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS25_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 2.5 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS18_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 1.8 standard                 | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_in                            | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using PCI compatible input                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| t <sub>IOO</sub> Output Adjusters |                                                           |                                            |      |      |      |      |      |      |       |
| LVTTTL_out                        | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as TTL buffer            | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS33_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 3.3V buffer           | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS25_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 2.5V buffer           | —    | 0.10 | —    | 0.10 | —    | 0.10 | ns    |
| LVC MOS18_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 1.8V buffer           | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_out                           | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as PCI compatible buffer | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| Slow Slew                         | t <sub>BUF</sub> , t <sub>EN</sub>                        | Output configured for slow slew rate       | —    | 1.00 | —    | 1.00 | —    | 1.00 | ns    |

Note: Open drain timing is the same as corresponding LVC MOS timing.

Timing v.2.2

1. Refer to TN1004, [ispMACH 4000 Timing Model Design and Usage Guidelines](#) for information regarding use of these adders.

**ispMACH 4000V/B/C/Z Power Supply and NC Connections<sup>1</sup>**

| Signal                 | 44-pin TQFP <sup>2</sup> | 48-pin TQFP <sup>2</sup> | 56-ball csBGA <sup>3</sup>                        | 100-pin TQFP <sup>2</sup> | 128-pin TQFP <sup>2</sup> |
|------------------------|--------------------------|--------------------------|---------------------------------------------------|---------------------------|---------------------------|
| VCC                    | 11, 33                   | 12, 36                   | K2, A9                                            | 25, 40, 75, 90            | 32, 51, 96, 115           |
| VCCO0<br>VCCO (Bank 0) | 6                        | 6                        | F3                                                | 13, 33, 95                | 3, 17, 30, 41, 122        |
| VCCO1<br>VCCO (Bank 1) | 28                       | 30                       | E8                                                | 45, 63, 83                | 58, 67, 81, 94, 105       |
| GND                    | 12, 34                   | 13, 37                   | H3, C8                                            | 1, 26, 51, 76             | 1, 33, 65, 97             |
| GND (Bank 0)           | 5                        | 5                        | D3                                                | 7, 18, 32, 96             | 10, 24, 40, 113, 123      |
| GND (Bank 1)           | 27                       | 29                       | G8                                                | 46, 57, 68, 82            | 49, 59, 74, 88, 104       |
| NC                     | —                        | —                        | <b>4032Z:</b> A8, B10, E1,<br>E3, F8, F10, J1, K3 | —                         | —                         |

1. All grounds must be electrically connected at the board level. However, for the purposes of I/O current loading, grounds are associated with the bank shown.
2. Pin orientation follows the conventional order from pin 1 marking of the top side view and counter-clockwise.
3. Pin orientation A1 starts from the upper left corner of the top side view with alphabetical order ascending vertically and numerical order ascending horizontally.

**ispMACH 4032V/B/C/Z and 4064V/B/C/Z Logic Signal Connections:  
48-Pin TQFP (Cont.)**

| Pin Number | Bank Number | ispMACH 4032V/B/C/Z |                 | ispMACH 4064V/B/C |                | ispMACH 4064Z |                |
|------------|-------------|---------------------|-----------------|-------------------|----------------|---------------|----------------|
|            |             | GLB/MC/Pad          | ORP             | GLB/MC/Pad        | ORP            | GLB/MC/Pad    | ORP            |
| 33         | 1           | B10                 | B <sup>10</sup> | D4                | D <sup>2</sup> | D10           | D <sup>5</sup> |
| 34         | 1           | B11                 | B <sup>11</sup> | D6                | D <sup>3</sup> | D8            | D <sup>4</sup> |
| 35         | -           | TDO                 | -               | TDO               | -              | TDO           | -              |
| 36         | -           | VCC                 | -               | VCC               | -              | VCC           | -              |
| 37         | -           | GND                 | -               | GND               | -              | GND           | -              |
| 38         | 1           | B12                 | B <sup>12</sup> | D8                | D <sup>4</sup> | D6            | D <sup>3</sup> |
| 39         | 1           | B13                 | B <sup>13</sup> | D10               | D <sup>5</sup> | D4            | D <sup>2</sup> |
| 40         | 1           | B14                 | B <sup>14</sup> | D12               | D <sup>6</sup> | D2            | D <sup>1</sup> |
| 41         | 1           | B15/GOE1            | B <sup>15</sup> | D14/GOE1          | D <sup>7</sup> | D0/GOE1       | D <sup>0</sup> |
| 42         | 1           | CLK3/I              | -               | CLK3/I            | -              | CLK3/I        | -              |
| 43         | 0           | CLK0/I              | -               | CLK0/I            | -              | CLK0/I        | -              |
| 44         | 0           | A0/GOE0             | A <sup>0</sup>  | A0/GOE0           | A <sup>0</sup> | A0/GOE0       | A <sup>0</sup> |
| 45         | 0           | A1                  | A <sup>1</sup>  | A2                | A <sup>1</sup> | A1            | A <sup>1</sup> |
| 46         | 0           | A2                  | A <sup>2</sup>  | A4                | A <sup>2</sup> | A2            | A <sup>2</sup> |
| 47         | 0           | A3                  | A <sup>3</sup>  | A6                | A <sup>3</sup> | A4            | A <sup>3</sup> |
| 48         | 0           | A4                  | A <sup>4</sup>  | A8                | A <sup>4</sup> | A6            | A <sup>4</sup> |

**ispMACH 4032Z and 4064Z Logic Signal Connections: 56-Ball csBGA**

| Ball Number | Bank Number | ispMACH 4032Z   |                 | ispMACH 4064Z  |                |
|-------------|-------------|-----------------|-----------------|----------------|----------------|
|             |             | GLB/MC/Pad      | ORP             | GLB/MC/Pad     | ORP            |
| B1          | -           | TDI             | -               | TDI            | -              |
| C3          | 0           | A5              | A <sup>5</sup>  | A8             | A <sup>5</sup> |
| C1          | 0           | A6              | A <sup>6</sup>  | A10            | A <sup>6</sup> |
| D1          | 0           | A7              | A <sup>7</sup>  | A11            | A <sup>7</sup> |
| D3          | 0           | GND (Bank 0)    | -               | GND (Bank 0)   | -              |
| E3          | 0           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| E1          | 0           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| F3          | 0           | VCCO (Bank 0)   | -               | VCCO (Bank 0)  | -              |
| F1          | 0           | A8              | A <sup>8</sup>  | B15            | B <sup>7</sup> |
| G3          | 0           | A9              | A <sup>9</sup>  | B12            | B <sup>6</sup> |
| G1          | 0           | A10             | A <sup>10</sup> | B10            | B <sup>5</sup> |
| H1          | 0           | A11             | A <sup>11</sup> | B8             | B <sup>4</sup> |
| J1          | 0           | NC              | -               | I              | -              |
| K1          | -           | TCK             | -               | TCK            | -              |
| K2          | -           | VCC             | -               | VCC            | -              |
| H3          | -           | GND             | -               | GND            | -              |
| K3          | -           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| K4          | 0           | A12             | A <sup>12</sup> | B6             | B <sup>3</sup> |
| H4          | 0           | A13             | A <sup>13</sup> | B4             | B <sup>2</sup> |
| H5          | 0           | A14             | A <sup>14</sup> | B2             | B <sup>1</sup> |

**ispMACH 4128V and 4256V Logic Signal Connections: 144-Pin TQFP (Cont.)**

| Pin Number | Bank Number | ispMACH 4128V   |      | ispMACH 4256V  |     |
|------------|-------------|-----------------|------|----------------|-----|
|            |             | GLB/MC/Pad      | ORP  | GLB/MC/Pad     | ORP |
| 129        | -           | VCC             | -    | VCC            | -   |
| 130        | 0           | A0/GOE0         | A^0  | A2/GOE0        | A^1 |
| 131        | 0           | A1              | A^1  | A4             | A^2 |
| 132        | 0           | A2              | A^2  | A6             | A^3 |
| 133        | 0           | A4              | A^3  | A8             | A^4 |
| 134        | 0           | A5              | A^4  | A10            | A^5 |
| 135        | 0           | A6              | A^5  | A12            | A^6 |
| 136        | 0           | VCCO (Bank 0)   | -    | VCCO (Bank 0)  | -   |
| 137        | 0           | GND (Bank 0)    | -    | GND (Bank 0)   | -   |
| 138        | 0           | A8              | A^6  | B2             | B^1 |
| 139        | 0           | A9              | A^7  | B4             | B^2 |
| 140        | 0           | A10             | A^8  | B6             | B^3 |
| 141        | 0           | A12             | A^9  | B8             | B^4 |
| 142        | 0           | A13             | A^10 | B10            | B^5 |
| 143        | 0           | A14             | A^11 | B12            | B^6 |
| 144        | 0           | NC <sup>2</sup> | -    | I <sup>2</sup> | -   |

1. For device migration considerations, these NC pins are GND pins for I/O banks in ispMACH 4128V devices.

2. For device migration considerations, these NC pins are input signal pins in ispMACH 4256V devices.

**ispMACH 4256V/B/C/Z, 4384V/B/C, 4512V/B/C, Logic Signal Connections: 176-Pin TQFP**

| Pin Number | Bank Number | ispMACH 4256V/B/C/Z |     | ispMACH 4384V/B/C |     | ispMACH 4512V/B/C |     |
|------------|-------------|---------------------|-----|-------------------|-----|-------------------|-----|
|            |             | GLB/MC/Pad          | ORP | GLB/MC/Pad        | ORP | GLB/MC/Pad        | ORP |
| 1          | -           | NC                  | -   | NC                | -   | NC                | -   |
| 2          | -           | GND                 | -   | GND               | -   | GND               | -   |
| 3          | -           | TDI                 | -   | TDI               | -   | TDI               | -   |
| 4          | 0           | VCCO (Bank 0)       | -   | VCCO (Bank 0)     | -   | VCCO (Bank 0)     | -   |
| 5          | 0           | C14                 | C^7 | C14               | C^7 | C14               | C^7 |
| 6          | 0           | C12                 | C^6 | C12               | C^6 | C12               | C^6 |
| 7          | 0           | C10                 | C^5 | C10               | C^5 | C10               | C^5 |
| 8          | 0           | C8                  | C^4 | C8                | C^4 | C8                | C^4 |
| 9          | 0           | C6                  | C^3 | C6                | C^3 | C6                | C^3 |
| 10         | 0           | C4                  | C^2 | C4                | C^2 | C4                | C^2 |
| 11         | 0           | C2                  | C^1 | C2                | C^1 | C2                | C^1 |
| 12         | 0           | C0                  | C^0 | C0                | C^0 | C0                | C^0 |
| 13         | 0           | GND (Bank 0)        | -   | GND (Bank 0)      | -   | GND (Bank 0)      | -   |
| 14         | 0           | D14                 | D^7 | E14               | E^7 | G14               | G^7 |
| 15         | 0           | D12                 | D^6 | E12               | E^6 | G12               | G^6 |
| 16         | 0           | D10                 | D^5 | E10               | E^5 | G10               | G^5 |
| 17         | 0           | D8                  | D^4 | E8                | E^4 | G8                | G^4 |
| 18         | 0           | D6                  | D^3 | E6                | E^3 | G6                | G^3 |

**ispMACH 4256V/B/C, 4384V/B/C, 4512V/B/C Logic Signal Connections:  
256-Ball ftBGA/fpBGA (Cont.)**

| Ball Number | I/O Bank | ispMACH 4256V/B/C<br>128-I/O |                | ispMACH 4256V/B/C<br>160-I/O |                | ispMACH 4384V/B/C |                 | ispMACH 4512V/B/C |                 |
|-------------|----------|------------------------------|----------------|------------------------------|----------------|-------------------|-----------------|-------------------|-----------------|
|             |          | GLB/MC/Pad                   | ORP            | GLB/MC/Pad                   | ORP            | GLB/MC/Pad        | ORP             | GLB/MC/Pad        | ORP             |
| R14         | 1        | J10                          | J <sup>5</sup> | J10                          | J <sup>7</sup> | N10               | N <sup>5</sup>  | BX10              | BX <sup>5</sup> |
| P13         | 1        | J12                          | J <sup>6</sup> | J12                          | J <sup>8</sup> | N12               | N <sup>6</sup>  | BX12              | BX <sup>6</sup> |
| N13         | 1        | J14                          | J <sup>7</sup> | J14                          | J <sup>9</sup> | N14               | N <sup>7</sup>  | BX14              | BX <sup>7</sup> |
| M12         | 1        | NC                           | -              | NC                           | -              | P4                | P <sup>2</sup>  | FX0               | FX <sup>0</sup> |
| T15         | 1        | NC                           | -              | NC                           | -              | P6                | P <sup>3</sup>  | FX2               | FX <sup>1</sup> |
| -           | -        | VCC                          | -              | VCC                          | -              | VCC               | -               | VCC               | -               |
| -           | -        | GND                          | -              | GND                          | -              | GND               | -               | GND               | -               |
| -           | 1        | -                            | -              | GND (Bank 1)                 | -              | GND (Bank 1)      | -               | GND (Bank 1)      | -               |
| P14         | -        | TMS                          | -              | TMS                          | -              | TMS               | -               | TMS               | -               |
| -           | 1        | VCCO (Bank 1)                | -              | VCCO (Bank 1)                | -              | VCCO (Bank 1)     | -               | VCCO (Bank 1)     | -               |
| L12         | 1        | NC                           | -              | NC                           | -              | NC                | -               | FX4               | FX <sup>2</sup> |
| R16         | 1        | NC                           | -              | NC                           | -              | P8                | P <sup>4</sup>  | FX6               | FX <sup>3</sup> |
| N14         | 1        | NC                           | -              | NC                           | -              | P10               | P <sup>5</sup>  | FX8               | FX <sup>4</sup> |
| P15         | 1        | K14                          | K <sup>7</sup> | K14                          | K <sup>9</sup> | O14               | O <sup>7</sup>  | CX14              | CX <sup>7</sup> |
| L11         | 1        | K12                          | K <sup>6</sup> | K12                          | K <sup>8</sup> | O12               | O <sup>6</sup>  | CX12              | CX <sup>6</sup> |
| P16         | 1        | K10                          | K <sup>5</sup> | K10                          | K <sup>7</sup> | O10               | O <sup>5</sup>  | CX10              | CX <sup>5</sup> |
| K11         | 1        | K8                           | K <sup>4</sup> | K9                           | K <sup>6</sup> | O8                | O <sup>4</sup>  | CX8               | CX <sup>4</sup> |
| M14         | 1        | K6                           | K <sup>3</sup> | K8                           | K <sup>5</sup> | O6                | O <sup>3</sup>  | CX6               | CX <sup>3</sup> |
| K12         | 1        | K4                           | K <sup>2</sup> | K6                           | K <sup>4</sup> | O4                | O <sup>2</sup>  | CX4               | CX <sup>2</sup> |
| N15         | 1        | K2                           | K <sup>1</sup> | K4                           | K <sup>3</sup> | O2                | O <sup>1</sup>  | CX2               | CX <sup>1</sup> |
| N16         | 1        | K0                           | K <sup>0</sup> | K2                           | K <sup>2</sup> | O0                | O <sup>0</sup>  | CX0               | CX <sup>0</sup> |
| M15         | 1        | NC                           | -              | K1                           | K <sup>1</sup> | BX6               | BX <sup>3</sup> | HX0               | HX <sup>0</sup> |
| M13         | 1        | NC                           | -              | K0                           | K <sup>0</sup> | BX4               | BX <sup>2</sup> | HX4               | HX <sup>1</sup> |
| -           | 1        | -                            | -              | VCCO (Bank 1)                | -              | VCCO (Bank 1)     | -               | VCCO (Bank 1)     | -               |
| -           | 1        | GND (Bank 1)                 | -              | GND (Bank 1)                 | -              | GND (Bank 1)      | -               | GND (Bank 1)      | -               |
| M16         | 1        | NC                           | -              | NC                           | -              | NC                | -               | FX10              | FX <sup>5</sup> |
| L15         | 1        | NC                           | -              | NC                           | -              | P12               | P <sup>6</sup>  | FX12              | FX <sup>6</sup> |
| L16         | 1        | NC                           | -              | NC                           | -              | P14               | P <sup>7</sup>  | FX14              | FX <sup>7</sup> |
| J11         | 1        | NC                           | -              | L14                          | L <sup>9</sup> | BX2               | BX <sup>1</sup> | HX8               | HX <sup>2</sup> |
| K15         | 1        | NC                           | -              | L12                          | L <sup>8</sup> | BX0               | BX <sup>0</sup> | HX12              | HX <sup>3</sup> |
| J12         | 1        | L14                          | L <sup>7</sup> | L10                          | L <sup>7</sup> | AX14              | AX <sup>7</sup> | GX14              | GX <sup>7</sup> |
| K13         | 1        | L12                          | L <sup>6</sup> | L9                           | L <sup>6</sup> | AX12              | AX <sup>6</sup> | GX12              | GX <sup>6</sup> |
| K14         | 1        | L10                          | L <sup>5</sup> | L8                           | L <sup>5</sup> | AX10              | AX <sup>5</sup> | GX10              | GX <sup>5</sup> |
| K16         | 1        | L8                           | L <sup>4</sup> | L6                           | L <sup>4</sup> | AX8               | AX <sup>4</sup> | GX8               | GX <sup>4</sup> |
| J16         | 1        | L6                           | L <sup>3</sup> | L4                           | L <sup>3</sup> | AX6               | AX <sup>3</sup> | GX6               | GX <sup>3</sup> |
| J15         | 1        | L4                           | L <sup>2</sup> | L2                           | L <sup>2</sup> | AX4               | AX <sup>2</sup> | GX4               | GX <sup>2</sup> |
| H16         | 1        | L2                           | L <sup>1</sup> | L1                           | L <sup>1</sup> | AX2               | AX <sup>1</sup> | GX2               | GX <sup>1</sup> |
| J13         | 1        | L0                           | L <sup>0</sup> | L0                           | L <sup>0</sup> | AX0               | AX <sup>0</sup> | GX0               | GX <sup>0</sup> |
| -           | 1        | VCCO (Bank 1)                | -              | VCCO (Bank 1)                | -              | VCCO (Bank 1)     | -               | VCCO (Bank 1)     | -               |
| -           | 1        | -                            | -              | GND (Bank 1)                 | -              | GND (Bank 1)      | -               | GND (Bank 1)      | -               |
| J14         | 1        | M0                           | M <sup>0</sup> | M0                           | M <sup>0</sup> | DX0               | DX <sup>0</sup> | JX0               | JX <sup>0</sup> |

## ispMACH 4000C (1.8V) Commercial Devices (Cont.)

| Device  | Part Number                   | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-------------------------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4128C | LC4128C-27T128C               | 128        | 1.8     | 2.7             | TQFP    | 128            | 92  | C     |
|         | LC4128C-5T128C                | 128        | 1.8     | 5               | TQFP    | 128            | 92  | C     |
|         | LC4128C-75T128C               | 128        | 1.8     | 7.5             | TQFP    | 128            | 92  | C     |
|         | LC4128C-27T100C               | 128        | 1.8     | 2.7             | TQFP    | 100            | 64  | C     |
|         | LC4128C-5T100C                | 128        | 1.8     | 5               | TQFP    | 100            | 64  | C     |
|         | LC4128C-75T100C               | 128        | 1.8     | 7.5             | TQFP    | 100            | 64  | C     |
| LC4256C | LC4256C-3FT256AC              | 256        | 1.8     | 3               | ftBGA   | 256            | 128 | C     |
|         | LC4256C-5FT256AC              | 256        | 1.8     | 5               | ftBGA   | 256            | 128 | C     |
|         | LC4256C-75FT256AC             | 256        | 1.8     | 7.5             | ftBGA   | 256            | 128 | C     |
|         | LC4256C-3FT256BC              | 256        | 1.8     | 3               | ftBGA   | 256            | 160 | C     |
|         | LC4256C-5FT256BC              | 256        | 1.8     | 5               | ftBGA   | 256            | 160 | C     |
|         | LC4256C-75FT256BC             | 256        | 1.8     | 7.5             | ftBGA   | 256            | 160 | C     |
|         | LC4256C-3F256AC <sup>1</sup>  | 256        | 1.8     | 3               | fpBGA   | 256            | 128 | C     |
|         | LC4256C-5F256AC <sup>1</sup>  | 256        | 1.8     | 5               | fpBGA   | 256            | 128 | C     |
|         | LC4256C-75F256AC <sup>1</sup> | 256        | 1.8     | 7.5             | fpBGA   | 256            | 128 | C     |
|         | LC4256C-3F256BC <sup>1</sup>  | 256        | 1.8     | 3               | fpBGA   | 256            | 160 | C     |
|         | LC4256C-5F256BC <sup>1</sup>  | 256        | 1.8     | 5               | fpBGA   | 256            | 160 | C     |
|         | LC4256C-75F256BC <sup>1</sup> | 256        | 1.8     | 7.5             | fpBGA   | 256            | 160 | C     |
|         | LC4256C-3T176C                | 256        | 1.8     | 3               | TQFP    | 176            | 128 | C     |
|         | LC4256C-5T176C                | 256        | 1.8     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4256C-75T176C               | 256        | 1.8     | 7.5             | TQFP    | 176            | 128 | C     |
|         | LC4256C-3T100C                | 256        | 1.8     | 3               | TQFP    | 100            | 64  | C     |
|         | LC4256C-5T100C                | 256        | 1.8     | 5               | TQFP    | 100            | 64  | C     |
|         | LC4256C-75T100C               | 256        | 1.8     | 7.5             | TQFP    | 100            | 64  | C     |
| LC4384C | LC4384C-35FT256C              | 384        | 1.8     | 3.5             | ftBGA   | 256            | 192 | C     |
|         | LC4384C-5FT256C               | 384        | 1.8     | 5               | ftBGA   | 256            | 192 | C     |
|         | LC4384C-75FT256C              | 384        | 1.8     | 7.5             | ftBGA   | 256            | 192 | C     |
|         | LC4384C-35F256C <sup>1</sup>  | 384        | 1.8     | 3.5             | fpBGA   | 256            | 192 | C     |
|         | LC4384C-5F256C <sup>1</sup>   | 384        | 1.8     | 5               | fpBGA   | 256            | 192 | C     |
|         | LC4384C-75F256C <sup>1</sup>  | 384        | 1.8     | 7.5             | fpBGA   | 256            | 192 | C     |
|         | LC4384C-35T176C               | 384        | 1.8     | 3.5             | TQFP    | 176            | 128 | C     |
|         | LC4384C-5T176C                | 384        | 1.8     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4384C-75T176C               | 384        | 1.8     | 7.5             | TQFP    | 176            | 128 | C     |
| LC4512C | LC4512C-35FT256C              | 512        | 1.8     | 3.5             | ftBGA   | 256            | 208 | C     |
|         | LC4512C-5FT256C               | 512        | 1.8     | 5               | ftBGA   | 256            | 208 | C     |
|         | LC4512C-75FT256C              | 512        | 1.8     | 7.5             | ftBGA   | 256            | 208 | C     |
|         | LC4512C-35F256C <sup>1</sup>  | 512        | 1.8     | 3.5             | fpBGA   | 256            | 208 | C     |
|         | LC4512C-5F256C <sup>1</sup>   | 512        | 1.8     | 5               | fpBGA   | 256            | 208 | C     |
|         | LC4512C-75F256C <sup>1</sup>  | 512        | 1.8     | 7.5             | fpBGA   | 256            | 208 | C     |
|         | LC4512C-35T176C               | 512        | 1.8     | 3.5             | TQFP    | 176            | 128 | C     |
|         | LC4512C-5T176C                | 512        | 1.8     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4512C-75T176C               | 512        | 1.8     | 7.5             | TQFP    | 176            | 128 | C     |

1. Use ftBGA package. fpBGA package devices have been discontinued via PCN#14A-07.

## ispMACH 4000B (2.5V) Industrial Devices (Cont.)

| Family  | Part Number                  | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|------------------------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4384B | LC4384B-5FT256I              | 384        | 2.5     | 5               | ftBGA   | 256            | 192 | I     |
|         | LC4384B-75FT256I             | 384        | 2.5     | 7.5             | ftBGA   | 256            | 192 | I     |
|         | LC4384B-10FT256I             | 384        | 2.5     | 10              | ftBGA   | 256            | 192 | I     |
|         | LC4384B-5F256I <sup>1</sup>  | 384        | 2.5     | 5               | fpBGA   | 256            | 192 | I     |
|         | LC4384B-75F256I <sup>1</sup> | 384        | 2.5     | 7.5             | fpBGA   | 256            | 192 | I     |
|         | LC4384B-10F256I <sup>1</sup> | 384        | 2.5     | 10              | fpBGA   | 256            | 192 | I     |
|         | LC4384B-5T176I               | 384        | 2.5     | 5               | TQFP    | 176            | 128 | I     |
|         | LC4384B-75T176I              | 384        | 2.5     | 7.5             | TQFP    | 176            | 128 | I     |
|         | LC4384B-10T176I              | 384        | 2.5     | 10              | TQFP    | 176            | 128 | I     |
| LC4512B | LC4512B-5FT256I              | 512        | 2.5     | 5               | ftBGA   | 256            | 208 | I     |
|         | LC4512B-75FT256I             | 512        | 2.5     | 7.5             | ftBGA   | 256            | 208 | I     |
|         | LC4512B-10FT256I             | 512        | 2.5     | 10              | ftBGA   | 256            | 208 | I     |
|         | LC4512B-5F256I <sup>1</sup>  | 512        | 2.5     | 5               | fpBGA   | 256            | 208 | I     |
|         | LC4512B-75F256I <sup>1</sup> | 512        | 2.5     | 7.5             | fpBGA   | 256            | 208 | I     |
|         | LC4512B-10F256I <sup>1</sup> | 512        | 2.5     | 10              | fpBGA   | 256            | 208 | I     |
|         | LC4512B-5T176I               | 512        | 2.5     | 5               | TQFP    | 176            | 128 | I     |
|         | LC4512B-75T176I              | 512        | 2.5     | 7.5             | TQFP    | 176            | 128 | I     |
|         | LC4512B-10T176I              | 512        | 2.5     | 10              | TQFP    | 176            | 128 | I     |

1. Use ftBGA package. fpBGA package devices have been discontinued via PCN#14A-07.

## ispMACH 4000V (3.3V) Commercial Devices

| Device  | Part Number     | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-----------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4032V | LC4032V-25T48C  | 32         | 3.3     | 2.5             | TQFP    | 48             | 32  | C     |
|         | LC4032V-5T48C   | 32         | 3.3     | 5               | TQFP    | 48             | 32  | C     |
|         | LC4032V-75T48C  | 32         | 3.3     | 7.5             | TQFP    | 48             | 32  | C     |
|         | LC4032V-25T44C  | 32         | 3.3     | 2.5             | TQFP    | 44             | 30  | C     |
|         | LC4032V-5T44C   | 32         | 3.3     | 5               | TQFP    | 44             | 30  | C     |
|         | LC4032V-75T44C  | 32         | 3.3     | 7.5             | TQFP    | 44             | 30  | C     |
| LC4064V | LC4064V-25T100C | 64         | 3.3     | 2.5             | TQFP    | 100            | 64  | C     |
|         | LC4064V-5T100C  | 64         | 3.3     | 5               | TQFP    | 100            | 64  | C     |
|         | LC4064V-75T100C | 64         | 3.3     | 7.5             | TQFP    | 100            | 64  | C     |
|         | LC4064V-25T48C  | 64         | 3.3     | 2.5             | TQFP    | 48             | 32  | C     |
|         | LC4064V-5T48C   | 64         | 3.3     | 5               | TQFP    | 48             | 32  | C     |
|         | LC4064V-75T48C  | 64         | 3.3     | 7.5             | TQFP    | 48             | 32  | C     |
|         | LC4064V-25T44C  | 64         | 3.3     | 2.5             | TQFP    | 44             | 30  | C     |
|         | LC4064V-5T44C   | 64         | 3.3     | 5               | TQFP    | 44             | 30  | C     |
|         | LC4064V-75T44C  | 64         | 3.3     | 7.5             | TQFP    | 44             | 30  | C     |

## ispMACH 4000B (2.5V) Lead-Free Commercial Devices

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4032B | LC4032B-25TN48C                | 32         | 2.5     | 2.5             | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4032B-5TN48C                 | 32         | 2.5     | 5               | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4032B-75TN48C                | 32         | 2.5     | 7.5             | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4032B-25TN44C                | 32         | 2.5     | 2.5             | Lead-Free TQFP  | 44             | 30  | C     |
|         | LC4032B-5TN44C                 | 32         | 2.5     | 5               | Lead-Free TQFP  | 44             | 30  | C     |
|         | LC4032B-75TN44C                | 32         | 2.5     | 7.5             | Lead-Free TQFP  | 44             | 30  | C     |
| LC4064B | LC4064B-25TN100C               | 64         | 2.5     | 2.5             | Lead-Free TQFP  | 100            | 64  | C     |
|         | LC4064B-5TN100C                | 64         | 2.5     | 5               | Lead-Free TQFP  | 100            | 64  | C     |
|         | LC4064B-75TN100C               | 64         | 2.5     | 7.5             | Lead-Free TQFP  | 100            | 64  | C     |
|         | LC4064B-25TN48C                | 64         | 2.5     | 2.5             | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4064B-5TN48C                 | 64         | 2.5     | 5               | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4064B-75TN48C                | 64         | 2.5     | 7.5             | Lead-Free TQFP  | 48             | 32  | C     |
|         | LC4064B-25TN44C                | 64         | 2.5     | 2.5             | Lead-Free TQFP  | 44             | 30  | C     |
|         | LC4064B-5TN44C                 | 64         | 2.5     | 5               | Lead-Free TQFP  | 44             | 30  | C     |
|         | LC4064B-75TN44C                | 64         | 2.5     | 7.5             | Lead-Free TQFP  | 44             | 30  | C     |
| LC4128B | LC4128B-27TN128C               | 128        | 2.5     | 2.7             | Lead-Free TQFP  | 128            | 92  | C     |
|         | LC4128B-5TN128C                | 128        | 2.5     | 5               | Lead-Free TQFP  | 128            | 92  | C     |
|         | LC4128B-75TN128C               | 128        | 2.5     | 7.5             | Lead-Free TQFP  | 128            | 92  | C     |
|         | LC4128B-27TN100C               | 128        | 2.5     | 2.7             | Lead-Free TQFP  | 100            | 92  | C     |
|         | LC4128B-5TN100C                | 128        | 2.5     | 5               | Lead-Free TQFP  | 100            | 92  | C     |
|         | LC4128B-75TN100C               | 128        | 2.5     | 7.5             | Lead-Free TQFP  | 100            | 92  | C     |
| LC4256B | LC4256B-3FTN256AC              | 256        | 2.5     | 3               | Lead-Free ftBGA | 256            | 128 | C     |
|         | LC4256B-5FTN256AC              | 256        | 2.5     | 5               | Lead-Free ftBGA | 256            | 128 | C     |
|         | LC4256B-75FTN256AC             | 256        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 128 | C     |
|         | LC4256B-3FTN256BC              | 256        | 2.5     | 3               | Lead-Free ftBGA | 256            | 160 | C     |
|         | LC4256B-5FTN256BC              | 256        | 2.5     | 5               | Lead-Free ftBGA | 256            | 160 | C     |
|         | LC4256B-75FTN256BC             | 256        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 160 | C     |
|         | LC4256B-3FN256AC <sup>1</sup>  | 256        | 2.5     | 3               | Lead-Free fpBGA | 256            | 128 | C     |
|         | LC4256B-5FN256AC <sup>1</sup>  | 256        | 2.5     | 5               | Lead-Free fpBGA | 256            | 128 | C     |
|         | LC4256B-75FN256AC <sup>1</sup> | 256        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 128 | C     |
|         | LC4256B-3FN256BC <sup>1</sup>  | 256        | 2.5     | 3               | Lead-Free fpBGA | 256            | 160 | C     |
|         | LC4256B-5FN256BC <sup>1</sup>  | 256        | 2.5     | 5               | Lead-Free fpBGA | 256            | 160 | C     |
|         | LC4256B-75FN256BC <sup>1</sup> | 256        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 160 | C     |
|         | LC4256B-3TN176C                | 256        | 2.5     | 3               | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4256B-5TN176C                | 256        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4256B-75TN176C               | 256        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4256B-3TN100C                | 256        | 2.5     | 3               | Lead-Free TQFP  | 100            | 64  | C     |
|         | LC4256B-5TN100C                | 256        | 2.5     | 5               | Lead-Free TQFP  | 100            | 64  | C     |
|         | LC4256B-75TN100C               | 256        | 2.5     | 7.5             | Lead-Free TQFP  | 100            | 64  | C     |

## ispMACH 4000B (2.5V) Lead-Free Industrial Devices (Cont.)

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4128B | LC4128B-5TN128I                | 128        | 2.5     | 5               | Lead-Free TQFP  | 128            | 92  | I     |
|         | LC4128B-75TN128I               | 128        | 2.5     | 7.5             | Lead-Free TQFP  | 128            | 92  | I     |
|         | LC4128B-10TN128I               | 128        | 2.5     | 10              | Lead-Free TQFP  | 128            | 92  | I     |
|         | LC4128B-5TN100I                | 128        | 2.5     | 5               | Lead-Free TQFP  | 100            | 64  | I     |
|         | LC4128B-75TN100I               | 128        | 2.5     | 7.5             | Lead-Free TQFP  | 100            | 64  | I     |
|         | LC4128B-10TN100I               | 128        | 2.5     | 10              | Lead-Free TQFP  | 100            | 64  | I     |
| LC4256B | LC4256B-5FTN256AI              | 256        | 2.5     | 5               | Lead-Free ftBGA | 256            | 128 | I     |
|         | LC4256B-75FTN256AI             | 256        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 128 | I     |
|         | LC4256B-10FTN256AI             | 256        | 2.5     | 10              | Lead-Free ftBGA | 256            | 128 | I     |
|         | LC4256B-5FTN256BI              | 256        | 2.5     | 5               | Lead-Free ftBGA | 256            | 160 | I     |
|         | LC4256B-75FTN256BI             | 256        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 160 | I     |
|         | LC4256B-10FTN256BI             | 256        | 2.5     | 10              | Lead-Free ftBGA | 256            | 160 | I     |
|         | LC4256B-5FN256AI <sup>1</sup>  | 256        | 2.5     | 5               | Lead-Free fpBGA | 256            | 128 | I     |
|         | LC4256B-75FN256AI <sup>1</sup> | 256        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 128 | I     |
|         | LC4256B-10FN256AI <sup>1</sup> | 256        | 2.5     | 10              | Lead-Free fpBGA | 256            | 128 | I     |
|         | LC4256B-5FN256BI <sup>1</sup>  | 256        | 2.5     | 5               | Lead-Free fpBGA | 256            | 160 | I     |
|         | LC4256B-75FN256BI <sup>1</sup> | 256        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 160 | I     |
|         | LC4256B-10FN256BI <sup>1</sup> | 256        | 2.5     | 10              | Lead-Free fpBGA | 256            | 160 | I     |
|         | LC4256B-5TN176I                | 256        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4256B-75TN176I               | 256        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4256B-10TN176I               | 256        | 2.5     | 10              | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4256B-5TN100I                | 256        | 2.5     | 5               | Lead-Free TQFP  | 100            | 64  | I     |
|         | LC4256B-75TN100I               | 256        | 2.5     | 7.5             | Lead-Free TQFP  | 100            | 64  | I     |
|         | LC4256B-10TN100I               | 256        | 2.5     | 10              | Lead-Free TQFP  | 100            | 64  | I     |
| LC4384B | LC4384B-5FTN256I               | 384        | 2.5     | 5               | Lead-Free ftBGA | 256            | 192 | I     |
|         | LC4384B-75FTN256I              | 384        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 192 | I     |
|         | LC4384B-10FTN256I              | 384        | 2.5     | 10              | Lead-Free ftBGA | 256            | 192 | I     |
|         | LC4384B-5FN256I <sup>1</sup>   | 384        | 2.5     | 5               | Lead-Free fpBGA | 256            | 192 | I     |
|         | LC4384B-75FN256I <sup>1</sup>  | 384        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 192 | I     |
|         | LC4384B-10FN256I <sup>1</sup>  | 384        | 2.5     | 10              | Lead-Free fpBGA | 256            | 192 | I     |
|         | LC4384B-5TN176I                | 384        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4384B-75TN176I               | 384        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4384B-10TN176I               | 384        | 2.5     | 10              | Lead-Free TQFP  | 176            | 128 | I     |
| LC4512B | LC4512B-5FTN256I               | 512        | 2.5     | 5               | Lead-Free ftBGA | 256            | 208 | I     |
|         | LC4512B-75FTN256I              | 512        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 208 | I     |
|         | LC4512B-10FTN256I              | 512        | 2.5     | 10              | Lead-Free ftBGA | 256            | 208 | I     |
|         | LC4512B-5FN256I <sup>1</sup>   | 512        | 2.5     | 5               | Lead-Free fpBGA | 256            | 208 | I     |
|         | LC4512B-75FN256I <sup>1</sup>  | 512        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 208 | I     |
|         | LC4512B-10FN256I <sup>1</sup>  | 512        | 2.5     | 10              | Lead-Free fpBGA | 256            | 208 | I     |
|         | LC4512B-5TN176I                | 512        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4512B-75TN176I               | 512        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | I     |
|         | LC4512B-10TN176I               | 512        | 2.5     | 10              | Lead-Free TQFP  | 176            | 128 | I     |

1. Use ftBGA package. fpBGA package devices have been discontinued via PCN#14A-07.

## ispMACH 4000V (3.3V) Lead-Free Commercial Devices (Cont.)

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4256V | LC4256V-3FTN256AC              | 256        | 3.3     | 3               | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256V-5FTN256AC              | 256        | 3.3     | 5               | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256V-75FTN256AC             | 256        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256V-3FTN256BC              | 256        | 3.3     | 3               | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256V-5FTN256BC              | 256        | 3.3     | 5               | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256V-75FTN256BC             | 256        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256V-3FN256AC <sup>1</sup>  | 256        | 3.3     | 3               | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256V-5FN256AC <sup>1</sup>  | 256        | 3.3     | 5               | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256V-75FN256AC <sup>1</sup> | 256        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256V-3FN256BC <sup>1</sup>  | 256        | 3.3     | 3               | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256V-5FN256BC <sup>1</sup>  | 256        | 3.3     | 5               | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256V-75FN256BC <sup>1</sup> | 256        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256V-3TN176C                | 256        | 3.3     | 3               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256V-5TN176C                | 256        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256V-75TN176C               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256V-3TN144C                | 256        | 3.3     | 3               | Lead-free TQFP  | 144            | 96  | C     |
|         | LC4256V-5TN144C                | 256        | 3.3     | 5               | Lead-free TQFP  | 144            | 96  | C     |
|         | LC4256V-75TN144C               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 144            | 96  | C     |
|         | LC4256V-3TN100C                | 256        | 3.3     | 3               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4256V-5TN100C                | 256        | 3.3     | 5               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4256V-75TN100C               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 100            | 64  | C     |
| LC4384V | LC4384V-35FTN256C              | 384        | 3.3     | 3.5             | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384V-5FTN256C               | 384        | 3.3     | 5               | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384V-75FTN256C              | 384        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384V-35FN256C <sup>1</sup>  | 384        | 3.3     | 3.5             | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384V-5FN256C <sup>1</sup>   | 384        | 3.3     | 5               | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384V-75FN256C <sup>1</sup>  | 384        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384V-35TN176C               | 384        | 3.3     | 3.5             | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4384V-5TN176C                | 384        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4384V-75TN176C               | 384        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | C     |
| LC4512V | LC4512V-35FTN256C              | 512        | 3.3     | 3.5             | Lead-free ftBGA | 256            | 208 | C     |
|         | LC4512V-5FTN256C               | 512        | 3.3     | 5               | Lead-free ftBGA | 256            | 208 | C     |
|         | LC4512V-75FTN256C              | 512        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 208 | C     |
|         | LC4512V-35FN256C <sup>1</sup>  | 512        | 3.3     | 3.5             | Lead-free fpBGA | 256            | 208 | C     |
|         | LC4512V-5FN256C <sup>1</sup>   | 512        | 3.3     | 5               | Lead-free fpBGA | 256            | 208 | C     |
|         | LC4512V-75FN256C <sup>1</sup>  | 512        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 208 | C     |
|         | LC4512V-35TN176C               | 512        | 3.3     | 3.5             | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4512V-5TN176C                | 512        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4512V-75TN176C               | 512        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | C     |

1. Use ftBGA package. fpBGA package devices have been discontinued via PCN#14A-07.

**ispMACH 4000V (3.3V) Lead-Free Extended Temperature Devices**

| Device  | Part Number      | Macrocells | Voltage | t <sub>PD</sub> | Package        | Pin/Ball Count | I/O | Grade |
|---------|------------------|------------|---------|-----------------|----------------|----------------|-----|-------|
| LC4032V | LC4032V-75TN48E  | 32         | 3.3     | 7.5             | Lead-free TQFP | 48             | 32  | E     |
|         | LC4032V-75TN44E  | 32         | 3.3     | 7.5             | Lead-free TQFP | 44             | 30  | E     |
| LC4064V | LC4064V-75TN100E | 64         | 3.3     | 7.5             | Lead-free TQFP | 100            | 64  | E     |
|         | LC4064V-75TN48E  | 64         | 3.3     | 7.5             | Lead-free TQFP | 48             | 32  | E     |
|         | LC4064V-75TN44E  | 64         | 3.3     | 7.5             | Lead-free TQFP | 44             | 30  | E     |
| LC4128V | LC4128V-75TN144E | 128        | 3.3     | 7.5             | Lead-free TQFP | 144            | 96  | E     |
|         | LC4128V-75TN128E | 128        | 3.3     | 7.5             | Lead-free TQFP | 128            | 92  | E     |
|         | LC4128V-75TN100E | 128        | 3.3     | 7.5             | Lead-free TQFP | 100            | 64  | E     |
| LC4256V | LC4256V-75TN176E | 256        | 3.3     | 7.5             | Lead-free TQFP | 176            | 128 | E     |
|         | LC4256V-75TN144E | 256        | 3.3     | 7.5             | Lead-free TQFP | 144            | 96  | E     |
|         | LC4256V-75TN100E | 256        | 3.3     | 7.5             | Lead-free TQFP | 100            | 64  | E     |

**For Further Information**

In addition to this data sheet, the following technical notes may be helpful when designing with the ispMACH 4000V/B/C/Z family:

- TN1004, [ispMACH 4000 Timing Model Design and Usage Guidelines](#)
- TN1005, [Power Estimation in ispMACH 4000V/B/C/Z Devices](#)

**Revision History**

| Date          | Version | Change Summary                                                                                                                                                                                              |
|---------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| —             | —       | Previous Lattice releases.                                                                                                                                                                                  |
| July 2003     | 17z     | Changed device status for LC4064ZC and LC4128ZC to production release and updated/added AC and DC parameters as well as ordering part numbers for LC4064ZC and LC4128ZC devices.                            |
|               |         | Improved leakage current specifications for ispMACH 4000Z. For ispMACH 4000V/B/C IIL, IIH condition now includes 0V and 3.6V end points ( $0 \leq V_{IN} \leq 3.6V$ ).                                      |
|               |         | Added 132-ball chip scale BGA power supply and NC connections.                                                                                                                                              |
|               |         | Added 132-ball chip scale BGA logic signal connections for LC4064ZC, LC4128ZC and LC4256ZC devices.                                                                                                         |
|               |         | Added lead-free package designators.                                                                                                                                                                        |
| October 2003  | 18z     | Hot socketing characteristics footnote 1. has been enhanced; Insensitive to sequence of VCC or VCCO. However, assumes monotonic rise/fall rates for Vcc and Vcco, provided $(V_{IN} - V_{CCO}) \leq 3.6V$ . |
|               |         | Improved LC4064ZC t <sub>S</sub> to 2.5ns, t <sub>ST</sub> to 2.7ns and f <sub>MAX</sub> (Ext.) to 175MHz, LC4128ZC t <sub>CO</sub> to 3.5ns and f <sub>MAX</sub> (Ext.) to 161MHz (version v.2.1).         |
|               |         | Improved associated internal timing numbers and timing adders (version v.2.1).                                                                                                                              |
|               |         | Added ispMACH 4000V/B/C/Z ORP Reference Tables.                                                                                                                                                             |
|               |         | Enhanced ORP information in device pinout tables consistent with the ORP Combinations for I/O Blocks tables (table 6, 7, 8 and 9 in page 9-11).                                                             |
|               |         | Corrected GLB/MC/Pad information in the 256-fpBGA pinouts for the LC4256V/B/C 160-I/O version.                                                                                                              |
|               |         | Added the ispMACH 4000 Family Speed Grade Offering table.                                                                                                                                                   |
|               |         | Added the ispMACH 4128ZC Industrial and Automotive Device OPNs                                                                                                                                              |
| December 2003 | 19z     | Added the ispMACH 4032ZC and 4064ZC Industrial and Automotive Device OPNs                                                                                                                                   |