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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       | 3V ~ 3.6V                                                                                                                                                           |
| Number of Logic Elements/Blocks | 8                                                                                                                                                                   |
| Number of Macrocells            | 128                                                                                                                                                                 |
| 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/lc4128v-75t100i">https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4128v-75t100i</a> |

**Figure 1. Functional Block Diagram**

The I/Os in the ispMACH 4000 are split into two banks. Each bank has a separate I/O power supply. Inputs can support a variety of standards independent of the chip or bank power supply. Outputs support the standards compatible with the power supply provided to the bank. Support for a variety of standards helps designers implement designs in mixed voltage environments. In addition, 5V tolerant inputs are specified within an I/O bank that is connected to  $V_{CC0}$  of 3.0V to 3.6V for LVCMOS 3.3, LVTTTL and PCI interfaces.

## ispMACH 4000 Architecture

There are a total of two GLBs in the ispMACH 4032, increasing to 32 GLBs in the ispMACH 4512. Each GLB has 36 inputs. All GLB inputs come from the GRP and all outputs from the GLB are brought back into the GRP to be connected to the inputs of any other GLB on the device. Even if feedback signals return to the same GLB, they still must go through the GRP. This mechanism ensures that GLBs communicate with each other with consistent and predictable delays. The outputs from the GLB are also sent to the ORP. The ORP then sends them to the associated I/O cells in the I/O block.

### Generic Logic Block

The ispMACH 4000 GLB consists of a programmable AND array, logic allocator, 16 macrocells and a GLB clock generator. Macrocells are decoupled from the product terms through the logic allocator and the I/O pins are decoupled from macrocells through the ORP. Figure 2 illustrates the GLB.

## Product Term Allocator

The product term allocator assigns product terms from a cluster to either logic or control applications as required by the design being implemented. Product terms that are used as logic are steered into a 5-input OR gate associated with the cluster. Product terms that used for control are steered either to the macrocell or I/O cell associated with the cluster. Table 3 shows the available functions for each of the five product terms in the cluster. The OR gate output connects to the associated I/O cell, providing a fast path for narrow combinatorial functions, and to the logic allocator.

**Table 3. Individual PT Steering**

| Product Term | Logic    | Control                                                                     |
|--------------|----------|-----------------------------------------------------------------------------|
| PT $n$       | Logic PT | Single PT for XOR/OR                                                        |
| PT $n+1$     | Logic PT | Individual Clock (PT Clock)                                                 |
| PT $n+2$     | Logic PT | Individual Initialization or Individual Clock Enable (PT Initialization/CE) |
| PT $n+3$     | Logic PT | Individual Initialization (PT Initialization)                               |
| PT $n+4$     | Logic PT | Individual OE (PTOE)                                                        |

## Cluster Allocator

The cluster allocator allows clusters to be steered to neighboring macrocells, thus allowing the creation of functions with more product terms. Table 4 shows which clusters can be steered to which macrocells. Used in this manner, the cluster allocator can be used to form functions of up to 20 product terms. Additionally, the cluster allocator accepts inputs from the wide steering logic. Using these inputs, functions up to 80 product terms can be created.

**Table 4. Available Clusters for Each Macrocell**

| Macrocell | Available Clusters |     |     |     |
|-----------|--------------------|-----|-----|-----|
| M0        | —                  | C0  | C1  | C2  |
| M1        | C0                 | C1  | C2  | C3  |
| M2        | C1                 | C2  | C3  | C4  |
| M3        | C2                 | C3  | C4  | C5  |
| M4        | C3                 | C4  | C5  | C6  |
| M5        | C4                 | C5  | C6  | C7  |
| M6        | C5                 | C6  | C7  | C8  |
| M7        | C6                 | C7  | C8  | C9  |
| M8        | C7                 | C8  | C9  | C10 |
| M9        | C8                 | C9  | C10 | C11 |
| M10       | C9                 | C10 | C11 | C12 |
| M11       | C10                | C11 | C12 | C13 |
| M12       | C11                | C12 | C13 | C14 |
| M13       | C12                | C13 | C14 | C15 |
| M14       | C13                | C14 | C15 | —   |
| M15       | C14                | C15 | —   | —   |

## Wide Steering Logic

The wide steering logic allows the output of the cluster allocator  $n$  to be connected to the input of the cluster allocator  $n+4$ . Thus, cluster chains can be formed with up to 80 product terms, supporting wide product term functions and allowing performance to be increased through a single GLB implementation. Table 5 shows the product term chains.

- 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

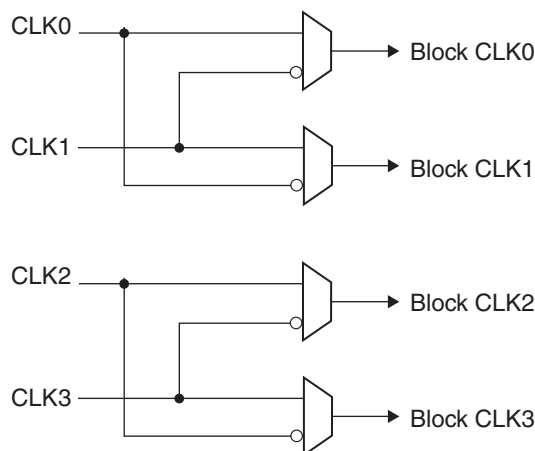
The ispMACH 4000 family architecture accommodates both block-level and macrocell-level set and reset capability. There is one block-level initialization term that is distributed to all macrocell registers in a GLB. At the macrocell level, two product terms can be “stolen” from the cluster associated 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**



**Table 10. ORP Combinations for I/O Blocks with 12 I/Os**

| I/O Cell | Available Macrocells                 |
|----------|--------------------------------------|
| I/O 0    | M0, M1, M2, M3, M4, M5, M6, M7       |
| I/O 1    | M1, M2, M3, M4, M5, M6, M7, M8       |
| I/O 2    | M2, M3, M4, M5, M6, M7, M8, M9       |
| I/O 3    | M4, M5, M6, M7, M8, M9, M10, M11     |
| I/O 4    | M5, M6, M7, M8, M9, M10, M11, M12    |
| I/O 5    | M6, M7, M8, M9, M10, M11, M12, M13   |
| I/O 6    | M8, M9, M10, M11, M12, M13, M14, M15 |
| I/O 7    | M9, M10, M11, M12, M13, M14, M15, M0 |
| I/O 8    | M10, M11, M12, M13, M14, M15, M0, M1 |
| I/O 9    | M12, M13, M14, M15, M0, M1, M2, M3   |
| I/O 10   | M13, M14, M15, M0, M1, M2, M3, M4    |
| I/O 11   | M14, M15, M0, M1, M2, M3, M4, M5     |

## ORP Bypass and Fast Output Multiplexers

The ORP bypass and fast-path output multiplexer is a 4:1 multiplexer and allows the 5-PT fast path to bypass the ORP and be connected directly to the pin with either the regular output or the inverted output. This multiplexer also allows the register output to bypass the ORP to achieve faster  $t_{CO}$ .

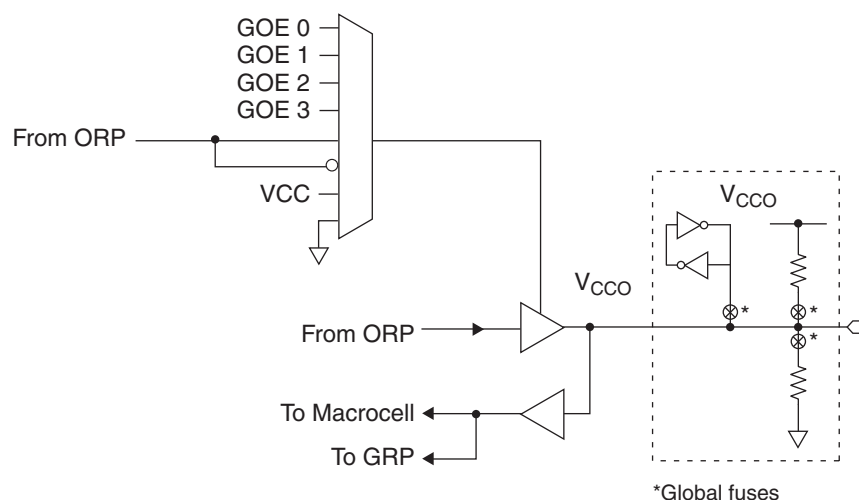
## Output Enable Routing Multiplexers

The OE Routing Pool provides the corresponding local output enable (OE) product term to the I/O cell.

## I/O Cell

The I/O cell contains the following programmable elements: output buffer, input buffer, OE multiplexer and bus maintenance circuitry. Figure 8 details the I/O cell.

**Figure 8. I/O Cell**



Each output supports a variety of output standards dependent on the  $V_{CCO}$  supplied to its I/O bank. Outputs can also be configured for open drain operation. Each input can be programmed to support a variety of standards, independent of the  $V_{CCO}$  supplied to its I/O bank. The I/O standards supported are:

## Supply Current, ispMACH 4000V/B/C (Cont.)

### Over Recommended Operating Conditions

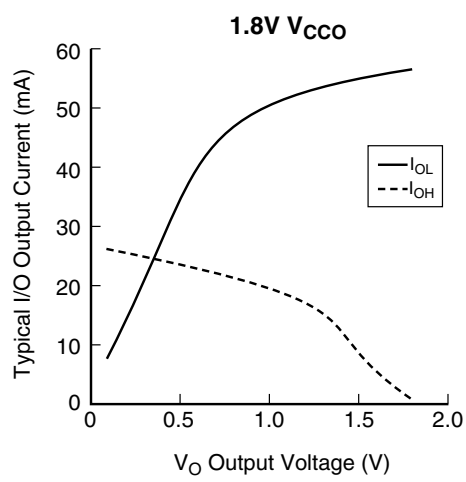
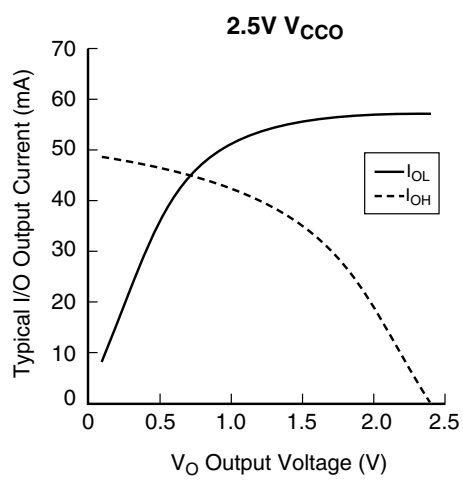
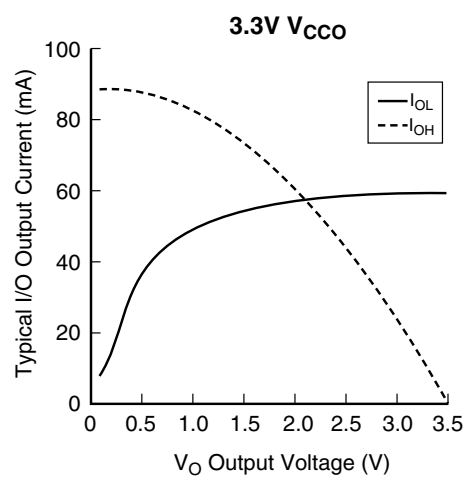
| Symbol       | Parameter                    | Condition       | Min. | Typ. | Max. | Units |
|--------------|------------------------------|-----------------|------|------|------|-------|
| $I_{CC}^{4}$ | Standby Power Supply Current | $V_{CC} = 3.3V$ | —    | 13   | —    | mA    |
|              |                              | $V_{CC} = 2.5V$ | —    | 13   | —    | mA    |
|              |                              | $V_{CC} = 1.8V$ | —    | 3    | —    | mA    |

1.  $T_A = 25^{\circ}C$ , frequency = 1.0 MHz.
2. Device configured with 16-bit counters.
3.  $I_{CC}$  varies with specific device configuration and operating frequency.
4.  $T_A = 25^{\circ}C$

## Supply Current, ispMACH 4000Z

### Over Recommended Operating Conditions

| Symbol                    | Parameter                      | Condition                          | Min. | Typ. | Max. | Units |
|---------------------------|--------------------------------|------------------------------------|------|------|------|-------|
| ispMACH 4032ZC            |                                |                                    |      |      |      |       |
| ICC <sup>1, 2, 3, 5</sup> | Operating Power Supply Current | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 50   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 58   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 60   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 70   | —    | μA    |
| ICC <sup>4, 5</sup>       | Standby Power Supply Current   | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 10   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 13   | 20   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 15   | 25   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 22   | —    | μA    |
| ispMACH 4064ZC            |                                |                                    |      |      |      |       |
| ICC <sup>1, 2, 3, 5</sup> | Operating Power Supply Current | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 80   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 89   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 92   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 109  | —    | μA    |
| ICC <sup>4, 5</sup>       | Standby Power Supply Current   | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 11   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 15   | 25   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 18   | 35   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 37   | —    | μA    |
| ispMACH 4128ZC            |                                |                                    |      |      |      |       |
| ICC <sup>1, 2, 3, 5</sup> | Operating Power Supply Current | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 168  | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 190  | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 195  | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 212  | —    | μA    |
| ICC <sup>4, 5</sup>       | Standby Power Supply Current   | Vcc = 1.8V, T <sub>A</sub> = 25°C  | —    | 12   | —    | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 70°C  | —    | 16   | 35   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 85°C  | —    | 19   | 50   | μA    |
|                           |                                | Vcc = 1.9V, T <sub>A</sub> = 125°C | —    | 42   | —    | μA    |



**ispMACH 4000V/B/C External Switching Characteristics (Cont.)****Over Recommended Operating Conditions**

| Parameter        | Description <sup>1, 2, 3</sup>                                             | -5   |      | -75  |      | -10  |      | Units |
|------------------|----------------------------------------------------------------------------|------|------|------|------|------|------|-------|
|                  |                                                                            | Min. | Max. | Min. | Max. | Min. | Max. |       |
| $t_{PD}$         | 5-PT bypass combinatorial propagation delay                                | —    | 5.0  | —    | 7.5  | —    | 10.0 | ns    |
| $t_{PD\_MC}$     | 20-PT combinatorial propagation delay through macrocell                    | —    | 5.5  | —    | 8.0  | —    | 10.5 | ns    |
| $t_S$            | GLB register setup time before clock                                       | 3.0  | —    | 4.5  | —    | 5.5  | —    | ns    |
| $t_{ST}$         | GLB register setup time before clock with T-type register                  | 3.2  | —    | 4.7  | —    | 5.5  | —    | ns    |
| $t_{SIR}$        | GLB register setup time before clock, input register path                  | 1.2  | —    | 1.7  | —    | 1.7  | —    | ns    |
| $t_{SIRZ}$       | GLB register setup time before clock with zero hold                        | 2.2  | —    | 2.7  | —    | 2.7  | —    | ns    |
| $t_H$            | GLB register hold time after clock                                         | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| $t_{HT}$         | GLB register hold time after clock with T-type register                    | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| $t_{HIR}$        | GLB register hold time after clock, input register path                    | 1.0  | —    | 1.0  | —    | 1.0  | —    | ns    |
| $t_{HIRZ}$       | GLB register hold time after clock, input register path with zero hold     | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| $t_{CO}$         | GLB register clock-to-output delay                                         | —    | 3.4  | —    | 4.5  | —    | 6.0  | ns    |
| $t_R$            | External reset pin to output delay                                         | —    | 6.3  | —    | 9.0  | —    | 10.5 | ns    |
| $t_{RW}$         | External reset pulse duration                                              | 2.0  | —    | 4.0  | —    | 4.0  | —    | ns    |
| $t_{PTOE/DIS}$   | Input to output local product term output enable/disable                   | —    | 7.0  | —    | 9.0  | —    | 10.5 | ns    |
| $t_{GPTOE/DIS}$  | Input to output global product term output enable/disable                  | —    | 9.0  | —    | 10.3 | —    | 12.0 | ns    |
| $t_{GOE/DIS}$    | Global OE input to output enable/disable                                   | —    | 5.0  | —    | 7.0  | —    | 8.0  | ns    |
| $t_{CW}$         | Global clock width, high or low                                            | 2.2  | —    | 2.8  | —    | 4.0  | —    | ns    |
| $t_{GW}$         | Global gate width low (for low transparent) or high (for high transparent) | 2.2  | —    | 2.8  | —    | 4.0  | —    | ns    |
| $t_{WIR}$        | Input register clock width, high or low                                    | 2.2  | —    | 2.8  | —    | 4.0  | —    | ns    |
| $f_{MAX}^4$      | Clock frequency with internal feedback                                     | —    | 227  | —    | 168  | —    | 125  | MHz   |
| $f_{MAX} (Ext.)$ | Clock frequency with external feedback, $[1/(t_S + t_{CO})]$               | —    | 156  | —    | 111  | —    | 86   | 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 4000V/B/C Internal Timing Parameters (Cont.)****Over Recommended Operating Conditions**

| Parameter             | Description                                                         | -2.5 |      | -2.7 |      | -3   |      | -3.5 |      | Units |
|-----------------------|---------------------------------------------------------------------|------|------|------|------|------|------|------|------|-------|
| $t_{PDLi}$            | Propagation Delay through Transparent Latch to Output/ Feedback MUX | —    | 0.25 | —    | 0.25 | —    | 0.25 | —    | 0.25 | ns    |
| $t_{SRi}$             | Asynchronous Reset or Set to Output/Feedback MUX Delay              | 0.28 | —    | 0.28 | —    | 0.28 | —    | 0.28 | —    | ns    |
| $t_{SRR}$             | Asynchronous Reset or Set Recovery Time                             | 1.67 | —    | 1.67 | —    | 1.67 | —    | 1.67 | —    | ns    |
| <b>Control Delays</b> |                                                                     |      |      |      |      |      |      |      |      |       |
| $t_{BCLK}$            | GLB PT Clock Delay                                                  | —    | 1.12 | —    | 1.12 | —    | 1.12 | —    | 1.12 | ns    |
| $t_{PTCLK}$           | Macrocell PT Clock Delay                                            | —    | 0.87 | —    | 0.87 | —    | 0.87 | —    | 0.87 | ns    |
| $t_{BSR}$             | Block PT Set/Reset Delay                                            | —    | 1.83 | —    | 1.83 | —    | 1.83 | —    | 1.83 | ns    |
| $t_{PTSR}$            | Macrocell PT Set/Reset Delay                                        | —    | 1.11 | —    | 1.41 | —    | 1.51 | —    | 1.61 | ns    |
| $t_{GPTOE}$           | Global PT OE Delay                                                  | —    | 2.83 | —    | 4.13 | —    | 5.33 | —    | 5.33 | ns    |
| $t_{PTOE}$            | Macrocell PT OE Delay                                               | —    | 1.83 | —    | 2.13 | —    | 2.33 | —    | 2.83 | ns    |

Timing v.3.2

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

## ispMACH 4000V/B/C Internal Timing Parameters

Over Recommended Operating Conditions

| Parameter             | Description                                                            | -5   |      | -75  |      | -10  |      | Units |
|-----------------------|------------------------------------------------------------------------|------|------|------|------|------|------|-------|
|                       |                                                                        | Min. | Max. | Min. | Max. | Min. | Max. |       |
| In/Out Delays         |                                                                        |      |      |      |      |      |      |       |
| t <sub>IN</sub>       | Input Buffer Delay                                                     | —    | 0.95 | —    | 1.50 | —    | 2.00 | ns    |
| t <sub>GOE</sub>      | Global OE Pin Delay                                                    | —    | 4.04 | —    | 6.04 | —    | 7.04 | ns    |
| t <sub>GCLK_IN</sub>  | Global Clock Input Buffer Delay                                        | —    | 1.83 | —    | 2.28 | —    | 3.28 | ns    |
| t <sub>BUF</sub>      | Delay through Output Buffer                                            | —    | 1.00 | —    | 1.50 | —    | 1.50 | ns    |
| t <sub>EN</sub>       | Output Enable Time                                                     | —    | 0.96 | —    | 0.96 | —    | 0.96 | ns    |
| t <sub>DIS</sub>      | Output Disable Time                                                    | —    | 0.96 | —    | 0.96 | —    | 0.96 | ns    |
| Routing/GLB Delays    |                                                                        |      |      |      |      |      |      |       |
| t <sub>ROUTE</sub>    | Delay through GRP                                                      | —    | 1.51 | —    | 2.26 | —    | 3.26 | ns    |
| t <sub>MCELL</sub>    | Macrocell Delay                                                        | —    | 1.05 | —    | 1.45 | —    | 1.95 | ns    |
| t <sub>INREG</sub>    | Input Buffer to Macrocell Register Delay                               | —    | 0.56 | —    | 0.96 | —    | 1.46 | ns    |
| t <sub>FBK</sub>      | Internal Feedback Delay                                                | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| t <sub>PDb</sub>      | 5-PT Bypass Propagation Delay                                          | —    | 1.54 | —    | 2.24 | —    | 3.24 | ns    |
| t <sub>PDi</sub>      | Macrocell Propagation Delay                                            | —    | 0.94 | —    | 1.24 | —    | 1.74 | ns    |
| Register/Latch Delays |                                                                        |      |      |      |      |      |      |       |
| t <sub>S</sub>        | D-Register Setup Time (Global Clock)                                   | 1.32 | —    | 1.57 | —    | 1.57 | —    | ns    |
| t <sub>S_PT</sub>     | D-Register Setup Time (Product Term Clock)                             | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>ST</sub>       | T-Register Setup Time (Global Clock)                                   | 1.52 | —    | 1.77 | —    | 1.77 | —    | ns    |
| t <sub>ST_PT</sub>    | T-Register Setup Time (Product Term Clock)                             | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>H</sub>        | D-Register Hold Time                                                   | 1.68 | —    | 2.93 | —    | 3.93 | —    | ns    |
| t <sub>HT</sub>       | T-Register Hold Time                                                   | 1.68 | —    | 2.93 | —    | 3.93 | —    | ns    |
| t <sub>SIR</sub>      | D-Input Register Setup Time (Global Clock)                             | 1.52 | —    | 1.57 | —    | 1.57 | —    | 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)                              | 0.68 | —    | 1.18 | —    | 1.18 | —    | ns    |
| t <sub>HIR_PT</sub>   | D-Input Register Hold Time (Product Term Clock)                        | 0.68 | —    | 1.18 | —    | 1.18 | —    | ns    |
| t <sub>COi</sub>      | Register Clock to Output/Feedback MUX Time                             | —    | 0.52 | —    | 0.67 | —    | 1.17 | ns    |
| t <sub>CES</sub>      | Clock Enable Setup Time                                                | 2.25 | —    | 2.25 | —    | 2.25 | —    | ns    |
| t <sub>CEH</sub>      | Clock Enable Hold Time                                                 | 1.88 | —    | 1.88 | —    | 1.88 | —    | ns    |
| t <sub>SL</sub>       | Latch Setup Time (Global Clock)                                        | 1.32 | —    | 1.57 | —    | 1.57 | —    | ns    |
| t <sub>SL_PT</sub>    | Latch Setup Time (Product Term Clock)                                  | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>HL</sub>       | Latch Hold Time                                                        | 1.17 | —    | 1.17 | —    | 1.17 | —    | ns    |
| t <sub>GOi</sub>      | Latch Gate to Output/Feedback MUX Time                                 | —    | 0.33 | —    | 0.33 | —    | 0.33 | ns    |
| t <sub>PDLi</sub>     | Propagation Delay through Transparent Latch to Output/<br>Feedback MUX | —    | 0.25 | —    | 0.25 | —    | 0.25 | ns    |
| t <sub>SRI</sub>      | Asynchronous Reset or Set to Output/Feedback MUX<br>Delay              | 0.28 | —    | 0.28 | —    | 0.28 | —    | ns    |
| t <sub>SRR</sub>      | Asynchronous Reset or Set Recovery Time                                | 1.67 | —    | 1.67 | —    | 1.67 | —    | ns    |
| Control Delays        |                                                                        |      |      |      |      |      |      |       |
| t <sub>BCLK</sub>     | GLB PT Clock Delay                                                     | —    | 1.12 | —    | 1.12 | —    | 0.62 | ns    |
| t <sub>PTCLK</sub>    | Macrocell PT Clock Delay                                               | —    | 0.87 | —    | 0.87 | —    | 0.87 | ns    |
| t <sub>BSR</sub>      | GLB PT Set/Reset Delay                                                 | —    | 1.83 | —    | 1.83 | —    | 1.83 | ns    |
| t <sub>PTSR</sub>     | Macrocell PT Set/Reset Delay                                           | —    | 2.51 | —    | 3.41 | —    | 3.41 | ns    |

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

| Parameter                    | Description           | -45  |      | -5   |      | -75  |      | Units |
|------------------------------|-----------------------|------|------|------|------|------|------|-------|
|                              |                       | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>P<sub>TOE</sub></sub> | Macrocell PT OE Delay | —    | 2.50 | —    | 2.70 | —    | 2.00 | 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 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             |
| H15         | 1        | M2                           | M <sup>1</sup> | M1                           | M <sup>1</sup> | DX2               | DX <sup>1</sup> | JX2               | JX <sup>1</sup> |
| H14         | 1        | M4                           | M <sup>2</sup> | M2                           | M <sup>2</sup> | DX4               | DX <sup>2</sup> | JX4               | JX <sup>2</sup> |
| H13         | 1        | M6                           | M <sup>3</sup> | M4                           | M <sup>3</sup> | DX6               | DX <sup>3</sup> | JX6               | JX <sup>3</sup> |
| G16         | 1        | M8                           | M <sup>4</sup> | M6                           | M <sup>4</sup> | DX8               | DX <sup>4</sup> | JX8               | JX <sup>4</sup> |
| H12         | 1        | M10                          | M <sup>5</sup> | M8                           | M <sup>5</sup> | DX10              | DX <sup>5</sup> | JX10              | JX <sup>5</sup> |
| G15         | 1        | M12                          | M <sup>6</sup> | M9                           | M <sup>6</sup> | DX12              | DX <sup>6</sup> | JX12              | JX <sup>6</sup> |
| H11         | 1        | M14                          | M <sup>7</sup> | M10                          | M <sup>7</sup> | DX14              | DX <sup>7</sup> | JX14              | JX <sup>7</sup> |
| F16         | 1        | NC                           | -              | M12                          | M <sup>8</sup> | CX0               | CX <sup>0</sup> | IX0               | IX <sup>0</sup> |
| G13         | 1        | NC                           | -              | M14                          | M <sup>9</sup> | CX2               | CX <sup>1</sup> | IX4               | IX <sup>1</sup> |
| G14         | 1        | NC                           | -              | NC                           | -              | EX14              | EX <sup>7</sup> | KX0               | KX <sup>0</sup> |
| F15         | 1        | NC                           | -              | NC                           | -              | EX12              | EX <sup>6</sup> | KX2               | KX <sup>1</sup> |
| E16         | 1        | NC                           | -              | NC                           | -              | NC                | -               | KX4               | KX <sup>2</sup> |
| -           | 1        | GND (Bank 1)                 | -              | GND (Bank 1)                 | -              | GND (Bank 1)      | -               | GND (Bank 1)      | -               |
| -           | 1        | -                            | -              | VCCO (Bank 1)                | -              | VCCO (Bank 1)     | -               | VCCO (Bank 1)     | -               |
| E15         | 1        | NC                           | -              | NC                           | -              | NC                | -               | KX6               | KX <sup>3</sup> |
| G12         | 1        | NC                           | -              | NC                           | -              | EX10              | EX <sup>5</sup> | KX8               | KX <sup>4</sup> |
| E13         | 1        | NC                           | -              | NC                           | -              | EX8               | EX <sup>4</sup> | KX10              | KX <sup>5</sup> |
| D16         | 1        | NC                           | -              | N0                           | N <sup>0</sup> | CX4               | CX <sup>2</sup> | IX8               | IX <sup>2</sup> |
| E14         | 1        | NC                           | -              | N1                           | N <sup>1</sup> | CX6               | CX <sup>3</sup> | IX12              | IX <sup>3</sup> |
| G11         | 1        | N0                           | N <sup>0</sup> | N2                           | N <sup>2</sup> | FX0               | FX <sup>0</sup> | NX0               | NX <sup>0</sup> |
| D15         | 1        | N2                           | N <sup>1</sup> | N4                           | N <sup>3</sup> | FX2               | FX <sup>1</sup> | NX2               | NX <sup>1</sup> |
| F11         | 1        | N4                           | N <sup>2</sup> | N6                           | N <sup>4</sup> | FX4               | FX <sup>2</sup> | NX4               | NX <sup>2</sup> |
| C16         | 1        | N6                           | N <sup>3</sup> | N8                           | N <sup>5</sup> | FX6               | FX <sup>3</sup> | NX6               | NX <sup>3</sup> |
| F12         | 1        | N8                           | N <sup>4</sup> | N9                           | N <sup>6</sup> | FX8               | FX <sup>4</sup> | NX8               | NX <sup>4</sup> |
| D14         | 1        | N10                          | N <sup>5</sup> | N10                          | N <sup>7</sup> | FX10              | FX <sup>5</sup> | NX10              | NX <sup>5</sup> |
| C15         | 1        | N12                          | N <sup>6</sup> | N12                          | N <sup>8</sup> | FX12              | FX <sup>6</sup> | NX12              | NX <sup>6</sup> |
| B16         | 1        | N14                          | N <sup>7</sup> | N14                          | N <sup>9</sup> | FX14              | FX <sup>7</sup> | NX14              | NX <sup>7</sup> |
| -           | 1        | VCCO (Bank 1)                | -              | VCCO (Bank 1)                | -              | VCCO (Bank 1)     | -               | VCCO (Bank 1)     | -               |
| C14         | -        | TDO                          | -              | TDO                          | -              | TDO               | -               | TDO               | -               |
| -           | -        | VCC                          | -              | VCC                          | -              | VCC               | -               | VCC               | -               |
| -           | -        | GND                          | -              | GND                          | -              | GND               | -               | GND               | -               |
| -           | 1        | -                            | -              | GND (Bank 1)                 | -              | GND (Bank 1)      | -               | GND (Bank 1)      | -               |
| A15         | 1        | NC                           | -              | NC                           | -              | EX6               | EX <sup>3</sup> | KX12              | KX <sup>6</sup> |
| B14         | 1        | NC                           | -              | NC                           | -              | EX4               | EX <sup>2</sup> | KX14              | KX <sup>7</sup> |
| E12         | 1        | O14                          | O <sup>7</sup> | O14                          | O <sup>9</sup> | GX14              | GX <sup>7</sup> | OX14              | OX <sup>7</sup> |
| A14         | 1        | O12                          | O <sup>6</sup> | O12                          | O <sup>8</sup> | GX12              | GX <sup>6</sup> | OX12              | OX <sup>6</sup> |
| C13         | 1        | O10                          | O <sup>5</sup> | O10                          | O <sup>7</sup> | GX10              | GX <sup>5</sup> | OX10              | OX <sup>5</sup> |
| D13         | 1        | O8                           | O <sup>4</sup> | O9                           | O <sup>6</sup> | GX8               | GX <sup>4</sup> | OX8               | OX <sup>4</sup> |
| E11         | 1        | O6                           | O <sup>3</sup> | O8                           | O <sup>5</sup> | GX6               | GX <sup>3</sup> | OX6               | OX <sup>3</sup> |
| B13         | 1        | O4                           | O <sup>2</sup> | O6                           | O <sup>4</sup> | GX4               | GX <sup>2</sup> | OX4               | OX <sup>2</sup> |
| F10         | 1        | O2                           | O <sup>1</sup> | O4                           | O <sup>3</sup> | GX2               | GX <sup>1</sup> | OX2               | OX <sup>1</sup> |

## 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 4000V (3.3V) Commercial Devices (Cont.)

| Device  | Part Number                   | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-------------------------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4128V | LC4128V-27T144C               | 128        | 3.3     | 2.7             | TQFP    | 144            | 96  | C     |
|         | LC4128V-5T144C                | 128        | 3.3     | 5               | TQFP    | 144            | 96  | C     |
|         | LC4128V-75T144C               | 128        | 3.3     | 7.5             | TQFP    | 144            | 96  | C     |
|         | LC4128V-27T128C               | 128        | 3.3     | 2.7             | TQFP    | 128            | 92  | C     |
|         | LC4128V-5T128C                | 128        | 3.3     | 5               | TQFP    | 128            | 92  | C     |
|         | LC4128V-75T128C               | 128        | 3.3     | 7.5             | TQFP    | 128            | 92  | C     |
|         | LC4128V-27T100C               | 128        | 3.3     | 2.7             | TQFP    | 100            | 64  | C     |
|         | LC4128V-5T100C                | 128        | 3.3     | 5               | TQFP    | 100            | 64  | C     |
|         | LC4128V-75T100C               | 128        | 3.3     | 7.5             | TQFP    | 100            | 64  | C     |
| LC4256V | LC4256V-3FT256AC              | 256        | 3.3     | 3               | ftBGA   | 256            | 128 | C     |
|         | LC4256V-5FT256AC              | 256        | 3.3     | 5               | ftBGA   | 256            | 128 | C     |
|         | LC4256V-75FT256AC             | 256        | 3.3     | 7.5             | ftBGA   | 256            | 128 | C     |
|         | LC4256V-3FT256BC              | 256        | 3.3     | 3               | ftBGA   | 256            | 160 | C     |
|         | LC4256V-5FT256BC              | 256        | 3.3     | 5               | ftBGA   | 256            | 160 | C     |
|         | LC4256V-75FT256BC             | 256        | 3.3     | 7.5             | ftBGA   | 256            | 160 | C     |
|         | LC4256V-3F256AC <sup>1</sup>  | 256        | 3.3     | 3               | fpBGA   | 256            | 128 | C     |
|         | LC4256V-5F256AC <sup>1</sup>  | 256        | 3.3     | 5               | fpBGA   | 256            | 128 | C     |
|         | LC4256V-75F256AC <sup>1</sup> | 256        | 3.3     | 7.5             | fpBGA   | 256            | 128 | C     |
|         | LC4256V-3F256BC <sup>1</sup>  | 256        | 3.3     | 3               | fpBGA   | 256            | 160 | C     |
|         | LC4256V-5F256BC <sup>1</sup>  | 256        | 3.3     | 5               | fpBGA   | 256            | 160 | C     |
|         | LC4256V-75F256BC <sup>1</sup> | 256        | 3.3     | 7.5             | fpBGA   | 256            | 160 | C     |
|         | LC4256V-3T176C                | 256        | 3.3     | 3               | TQFP    | 176            | 128 | C     |
|         | LC4256V-5T176C                | 256        | 3.3     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4256V-75T176C               | 256        | 3.3     | 7.5             | TQFP    | 176            | 128 | C     |
|         | LC4256V-3T144C                | 256        | 3.3     | 3               | TQFP    | 144            | 96  | C     |
|         | LC4256V-5T144C                | 256        | 3.3     | 5               | TQFP    | 144            | 96  | C     |
|         | LC4256V-75T144C               | 256        | 3.3     | 7.5             | TQFP    | 144            | 96  | C     |
|         | LC4256V-3T100C                | 256        | 3.3     | 3               | TQFP    | 100            | 64  | C     |
|         | LC4256V-5T100C                | 256        | 3.3     | 5               | TQFP    | 100            | 64  | C     |
|         | LC4256V-75T100C               | 256        | 3.3     | 7.5             | TQFP    | 100            | 64  | C     |
| LC4384V | LC4384V-35FT256C              | 384        | 3.3     | 3.5             | ftBGA   | 256            | 192 | C     |
|         | LC4384V-5FT256C               | 384        | 3.3     | 5               | ftBGA   | 256            | 192 | C     |
|         | LC4384V-75FT256C              | 384        | 3.3     | 7.5             | ftBGA   | 256            | 192 | C     |
|         | LC4384V-35F256C <sup>1</sup>  | 384        | 3.3     | 3.5             | fpBGA   | 256            | 192 | C     |
|         | LC4384V-5F256C <sup>1</sup>   | 384        | 3.3     | 5               | fpBGA   | 256            | 192 | C     |
|         | LC4384V-75F256C <sup>1</sup>  | 384        | 3.3     | 7.5             | fpBGA   | 256            | 192 | C     |
|         | LC4384V-35T176C               | 384        | 3.3     | 3.5             | TQFP    | 176            | 128 | C     |
|         | LC4384V-5T176C                | 384        | 3.3     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4384V-75T176C               | 384        | 3.3     | 7.5             | TQFP    | 176            | 128 | C     |

**ispMACH 4000Z (Zero Power, 1.8V) Lead-Free Industrial Devices (Cont.)**

| Device   | Part Number       | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|----------|-------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4064ZC | LC4064ZC-5MN132I  | 64         | 1.8     | 5               | Lead-free csBGA | 132            | 64  | I     |
|          | LC4064ZC-75MN132I | 64         | 1.8     | 7.5             | Lead-free csBGA | 132            | 64  | I     |
|          | LC4064ZC-5TN100I  | 64         | 1.8     | 5               | Lead-free TQFP  | 100            | 64  | I     |
|          | LC4064ZC-75TN100I | 64         | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | I     |
|          | LC4064ZC-5MN56I   | 64         | 1.8     | 5               | Lead-free csBGA | 56             | 32  | I     |
|          | LC4064ZC-75MN56I  | 64         | 1.8     | 7.5             | Lead-free csBGA | 56             | 32  | I     |
|          | LC4064ZC-5TN48I   | 64         | 1.8     | 5               | Lead-free TQFP  | 48             | 32  | I     |
|          | LC4064ZC-75TN48I  | 64         | 1.8     | 7.5             | Lead-free TQFP  | 48             | 32  | I     |
| LC4128ZC | LC4128ZC-75MN132I | 128        | 1.8     | 7.5             | Lead-free csBGA | 132            | 96  | I     |
|          | LC4128ZC-75TN100I | 128        | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | I     |
| LC4256ZC | LC4256ZC-75TN176I | 256        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|          | LC4256ZC-75MN132I | 256        | 1.8     | 7.5             | Lead-free csBGA | 132            | 96  | I     |
|          | LC4256ZC-75TN100I | 256        | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | I     |

**ispMACH 4000Z (Zero Power, 1.8V) Lead-Free Extended Temperature Devices**

| Device   | Part Number       | Macrocells | Voltage | t <sub>PD</sub> | Package        | Pin/Ball Count | I/O | Grade |
|----------|-------------------|------------|---------|-----------------|----------------|----------------|-----|-------|
| LC4032ZC | LC4032ZC-75TN48E  | 32         | 1.8     | 7.5             | Lead-free TQFP | 48             | 32  | E     |
| LC4064ZC | LC4064ZC-75TN100E | 64         | 1.8     | 7.5             | Lead-free TQFP | 100            | 64  | E     |
|          | LC4064ZC-75TN48E  | 64         | 1.8     | 7.5             | Lead-free TQFP | 48             | 32  | E     |
| LC4128ZC | LC4128ZC-75TN100E | 128        | 1.8     | 7.5             | Lead-free TQFP | 100            | 64  | E     |
| LC4256ZC | LC4256ZC-75TN176E | 256        | 1.8     | 7.5             | Lead-free TQFP | 176            | 128 | E     |
|          | LC4256ZC-75TN100E | 256        | 1.8     | 7.5             | Lead-free TQFP | 100            | 64  | E     |

**ispMACH 4000C (1.8V) Lead-Free Commercial Devices**

| Device  | Part Number     | Macrocells | Voltage | t <sub>PD</sub> | Package        | Pin/Ball Count | I/O | Grade |
|---------|-----------------|------------|---------|-----------------|----------------|----------------|-----|-------|
| LC4032C | LC4032C-25TN48C | 32         | 1.8     | 2.5             | Lead-free TQFP | 48             | 32  | C     |
|         | LC4032C-5TN48C  | 32         | 1.8     | 5               | Lead-free TQFP | 48             | 32  | C     |
|         | LC4032C-75TN48C | 32         | 1.8     | 7.5             | Lead-free TQFP | 48             | 32  | C     |
|         | LC4032C-25TN44C | 32         | 1.8     | 2.5             | Lead-free TQFP | 44             | 30  | C     |
|         | LC4032C-5TN44C  | 32         | 1.8     | 5               | Lead-free TQFP | 44             | 30  | C     |
|         | LC4032C-75TN44C | 32         | 1.8     | 7.5             | Lead-free TQFP | 44             | 30  | C     |

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

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4064C | LC4064C-25TN100C               | 64         | 1.8     | 2.5             | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4064C-5TN100C                | 64         | 1.8     | 5               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4064C-75TN100C               | 64         | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4064C-25TN48C                | 64         | 1.8     | 2.5             | Lead-free TQFP  | 48             | 32  | C     |
|         | LC4064C-5TN48C                 | 64         | 1.8     | 5               | Lead-free TQFP  | 48             | 32  | C     |
|         | LC4064C-75TN48C                | 64         | 1.8     | 7.5             | Lead-free TQFP  | 48             | 32  | C     |
|         | LC4064C-25TN44C                | 64         | 1.8     | 2.5             | Lead-free TQFP  | 44             | 30  | C     |
|         | LC4064C-5TN44C                 | 64         | 1.8     | 5               | Lead-free TQFP  | 44             | 30  | C     |
|         | LC4064C-75TN44C                | 64         | 1.8     | 7.5             | Lead-free TQFP  | 44             | 30  | C     |
| LC4128C | LC4128C-27TN128C               | 128        | 1.8     | 2.7             | Lead-free TQFP  | 128            | 92  | C     |
|         | LC4128C-5TN128C                | 128        | 1.8     | 5               | Lead-free TQFP  | 128            | 92  | C     |
|         | LC4128C-75TN128C               | 128        | 1.8     | 7.5             | Lead-free TQFP  | 128            | 92  | C     |
|         | LC4128C-27TN100C               | 128        | 1.8     | 2.7             | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4128C-5TN100C                | 128        | 1.8     | 5               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4128C-75TN100C               | 128        | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | C     |
| LC4256C | LC4256C-3FTN256AC              | 256        | 1.8     | 3               | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256C-5FTN256AC              | 256        | 1.8     | 5               | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256C-75FTN256AC             | 256        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 128 | C     |
|         | LC4256C-3FTN256BC              | 256        | 1.8     | 3               | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256C-5FTN256BC              | 256        | 1.8     | 5               | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256C-75FTN256BC             | 256        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 160 | C     |
|         | LC4256C-3FN256AC <sup>1</sup>  | 256        | 1.8     | 3               | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256C-5FN256AC <sup>1</sup>  | 256        | 1.8     | 5               | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256C-75FN256AC <sup>1</sup> | 256        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 128 | C     |
|         | LC4256C-3FN256BC <sup>1</sup>  | 256        | 1.8     | 3               | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256C-5FN256BC <sup>1</sup>  | 256        | 1.8     | 5               | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256C-75FN256BC <sup>1</sup> | 256        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 160 | C     |
|         | LC4256C-3TN176C                | 256        | 1.8     | 3               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256C-5TN176C                | 256        | 1.8     | 5               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256C-75TN176C               | 256        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4256C-3TN100C                | 256        | 1.8     | 3               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4256C-5TN100C                | 256        | 1.8     | 5               | Lead-free TQFP  | 100            | 64  | C     |
|         | LC4256C-75TN100C               | 256        | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | C     |
| LC4384C | LC4384C-35FTN256C              | 384        | 1.8     | 3.5             | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384C-5FTN256C               | 384        | 1.8     | 5               | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384C-75FTN256C              | 384        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 192 | C     |
|         | LC4384C-35FN256C <sup>1</sup>  | 384        | 1.8     | 3.5             | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384C-5FN256C <sup>1</sup>   | 384        | 1.8     | 5               | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384C-75FN256C <sup>1</sup>  | 384        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 192 | C     |
|         | LC4384C-35TN176C               | 384        | 1.8     | 3.5             | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4384C-5TN176C                | 384        | 1.8     | 5               | Lead-free TQFP  | 176            | 128 | C     |
|         | LC4384C-75TN176C               | 384        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | C     |

## ispMACH 4000C (1.8V) Lead-Free Industrial Devices (Cont.)

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4256C | LC4256C-5FTN256AI              | 256        | 1.8     | 5               | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256C-75FTN256AI             | 256        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256C-10FTN256AI             | 256        | 1.8     | 10              | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256C-5FTN256BI              | 256        | 1.8     | 5               | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256C-75FTN256BI             | 256        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256C-10FTN256BI             | 256        | 1.8     | 10              | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256C-5FN256AI <sup>1</sup>  | 256        | 1.8     | 5               | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256C-75FN256AI <sup>1</sup> | 256        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256C-10FN256AI <sup>1</sup> | 256        | 1.8     | 10              | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256C-5FN256BI <sup>1</sup>  | 256        | 1.8     | 5               | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256C-75FN256BI <sup>1</sup> | 256        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256C-10FN256BI <sup>1</sup> | 256        | 1.8     | 10              | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256C-5TN176I                | 256        | 1.8     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256C-75TN176I               | 256        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256C-10TN176I               | 256        | 1.8     | 10              | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256C-5TN100I                | 256        | 1.8     | 5               | Lead-free TQFP  | 100            | 64  | I     |
|         | LC4256C-75TN100I               | 256        | 1.8     | 7.5             | Lead-free TQFP  | 100            | 64  | I     |
|         | LC4256C-10TN100I               | 256        | 1.8     | 10              | Lead-free TQFP  | 100            | 64  | I     |
| LC4384C | LC4384C-5FTN256I               | 384        | 1.8     | 5               | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384C-75FTN256I              | 384        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384C-10FTN256I              | 384        | 1.8     | 10              | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384C-5FN256I <sup>1</sup>   | 384        | 1.8     | 5               | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384C-75FN256I <sup>1</sup>  | 384        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384C-10FN256I <sup>1</sup>  | 384        | 1.8     | 10              | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384C-5TN176I                | 384        | 1.8     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4384C-75TN176I               | 384        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4384C-10TN176I               | 384        | 1.8     | 10              | Lead-free TQFP  | 176            | 128 | I     |
| LC4512C | LC4512C-5FTN256I               | 512        | 1.8     | 5               | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512C-75FTN256I              | 512        | 1.8     | 7.5             | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512C-10FTN256I              | 512        | 1.8     | 10              | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512C-5FN256I <sup>1</sup>   | 512        | 1.8     | 5               | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512C-75FN256I <sup>1</sup>  | 512        | 1.8     | 7.5             | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512C-10FN256I <sup>1</sup>  | 512        | 1.8     | 10              | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512C-5TN176I                | 512        | 1.8     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4512C-75TN176I               | 512        | 1.8     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4512C-10TN176I               | 512        | 1.8     | 10              | Lead-free TQFP  | 176            | 128 | I     |

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

**ispMACH 4000B (2.5V) Lead-Free Commercial Devices (Cont.)**

| Device  | Part Number                   | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|-------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4384B | LC4384B-35FTN256C             | 384        | 2.5     | 3.5             | Lead-Free ftBGA | 256            | 192 | C     |
|         | LC4384B-5FTN256C              | 384        | 2.5     | 5               | Lead-Free ftBGA | 256            | 192 | C     |
|         | LC4384B-75FTN256C             | 384        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 192 | C     |
|         | LC4384B-35FN256C <sup>1</sup> | 384        | 2.5     | 3.5             | Lead-Free fpBGA | 256            | 192 | C     |
|         | LC4384B-5FN256C <sup>1</sup>  | 384        | 2.5     | 5               | Lead-Free fpBGA | 256            | 192 | C     |
|         | LC4384B-75FN256C <sup>1</sup> | 384        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 192 | C     |
|         | LC4384B-35TN176C              | 384        | 2.5     | 3.5             | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4384B-5TN176C               | 384        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4384B-75TN176C              | 384        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | C     |
| LC4512B | LC4512B-35FTN256C             | 512        | 2.5     | 3.5             | Lead-Free ftBGA | 256            | 208 | C     |
|         | LC4512B-5FTN256C              | 512        | 2.5     | 5               | Lead-Free ftBGA | 256            | 208 | C     |
|         | LC4512B-75FTN256C             | 512        | 2.5     | 7.5             | Lead-Free ftBGA | 256            | 208 | C     |
|         | LC4512B-35FN256C <sup>1</sup> | 512        | 2.5     | 3.5             | Lead-Free fpBGA | 256            | 208 | C     |
|         | LC4512B-5FN256C <sup>1</sup>  | 512        | 2.5     | 5               | Lead-Free fpBGA | 256            | 208 | C     |
|         | LC4512B-75FN256C <sup>1</sup> | 512        | 2.5     | 7.5             | Lead-Free fpBGA | 256            | 208 | C     |
|         | LC4512B-35TN176C              | 512        | 2.5     | 3.5             | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4512B-5TN176C               | 512        | 2.5     | 5               | Lead-Free TQFP  | 176            | 128 | C     |
|         | LC4512B-75TN176C              | 512        | 2.5     | 7.5             | Lead-Free TQFP  | 176            | 128 | C     |

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

**ispMACH 4000B (2.5V) Lead-Free Industrial Devices**

| Device  | Part Number      | Macrocells | Voltage | t <sub>PD</sub> | Package        | Pin/Ball Count | I/O | Grade |
|---------|------------------|------------|---------|-----------------|----------------|----------------|-----|-------|
| LC4032B | LC4032B-5TN48I   | 32         | 2.5     | 5               | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4032B-75TN48I  | 32         | 2.5     | 7.5             | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4032B-10TN48I  | 32         | 2.5     | 10              | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4032B-5TN44I   | 32         | 2.5     | 5               | Lead-Free TQFP | 44             | 30  | I     |
|         | LC4032B-75TN44I  | 32         | 2.5     | 7.5             | Lead-Free TQFP | 44             | 30  | I     |
|         | LC4032B-10TN44I  | 32         | 2.5     | 10              | Lead-Free TQFP | 44             | 30  | I     |
| LC4064B | LC4064B-5TN100I  | 64         | 2.5     | 5               | Lead-Free TQFP | 100            | 64  | I     |
|         | LC4064B-75TN100I | 64         | 2.5     | 7.5             | Lead-Free TQFP | 100            | 64  | I     |
|         | LC4064B-10TN100I | 64         | 2.5     | 10              | Lead-Free TQFP | 100            | 64  | I     |
|         | LC4064B-5TN48I   | 64         | 2.5     | 5               | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4064B-75TN48I  | 64         | 2.5     | 7.5             | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4064B-10TN48I  | 64         | 2.5     | 10              | Lead-Free TQFP | 48             | 32  | I     |
|         | LC4064B-5TN44I   | 64         | 2.5     | 5               | Lead-Free TQFP | 44             | 30  | I     |
|         | LC4064B-75TN44I  | 64         | 2.5     | 7.5             | Lead-Free TQFP | 44             | 30  | I     |
|         | LC4064B-10TN44I  | 64         | 2.5     | 10              | Lead-Free TQFP | 44             | 30  | I     |

**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                                                                                                                                   |

**Revision History (Cont.)**

| Date          | Version | Change Summary                                                                                                                        |
|---------------|---------|---------------------------------------------------------------------------------------------------------------------------------------|
| January 2004  | 20z     | ispMACH 4000Z data sheet status changed from preliminary to final. Documents production release of the ispMACH 4256Z device.          |
|               |         | Added new feature - ispMACH 4000Z supports operation down to 1.6V.                                                                    |
|               |         | Added lead-free packaging ordering part numbers for the ispMACH 4000Z/C/V devices.                                                    |
| April 2004    | 21z     | Updated $I_{PU}$ (I/O Weak Pull-up Resistor Current) max. specification for the ispMACH 4000V/B/C; -150 $\mu$ A to -200 $\mu$ A.      |
| November 2004 | 22z     | Added User Electronic Signature section.                                                                                              |
|               |         | Added ispMACH 4000B (2.5V) Lead-Free Ordering Part Numbers.                                                                           |
| December 2004 | 22z.1   | Updated Further Information section.                                                                                                  |
| February 2006 | 22z.2   | Clarification to ispMACH 4000Z Input Leakage ( $I_{IH}$ ) specification.                                                              |
| March 2007    | 22.3    | Updated ispMACH 4000 Introduction section.                                                                                            |
|               |         | Updated Signal Descriptions table.                                                                                                    |
| June 2007     | 22.4    | Updated Features bullets to include reference to “LA” automotive data sheet under the “Broad Device Offering” bullet.                 |
|               |         | Added footnote 1 to Part Number Description to reference the “LA” automotive data sheet.                                              |
|               |         | Changed device temperature references from ‘Automotive’ to “Extended Temperature” for non-AEC-Q100 qualified devices.                 |
| November 2007 | 23.0    | Added 256-ftBGA package Ordering Part Number information per PCN#14A-07.                                                              |
| May 2009      | 23.1    | Correction to $t_{CW}$ , $t_{GW}$ , $t_{WIR}$ and $f_{MAX}$ parameters in ispMACH 4000Z External Switching Characteristics table.     |
|               |         | Correction to $t_{CW}$ , $t_{GW}$ , $t_{WIR}$ and $f_{MAX}$ parameters in ispMACH 4000V/B/C External Switching Characteristics table. |