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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           | 5 ns                                                                                                                                                                |
| Voltage Supply - Internal       | 1.65V ~ 1.95V                                                                                                                                                       |
| Number of Logic Elements/Blocks | 8                                                                                                                                                                   |
| Number of Macrocells            | 128                                                                                                                                                                 |
| Number of Gates                 | -                                                                                                                                                                   |
| Number of I/O                   | 64                                                                                                                                                                  |
| Operating Temperature           | 0°C ~ 90°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/lc4128c-5tn100c">https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4128c-5tn100c</a> |

**Table 2. ispMACH 4000Z Family Selection Guide**

|                                   | ispMACH 4032ZC      | ispMACH 4064ZC                               | ispMACH 4128ZC       | ispMACH 4256ZC                    |
|-----------------------------------|---------------------|----------------------------------------------|----------------------|-----------------------------------|
| Macrocells                        | 32                  | 64                                           | 128                  | 256                               |
| I/O + Dedicated Inputs            | 32+4/32+4           | 32+4/32+12/<br>64+10/64+10                   | 64+10/96+4           | 64+10/96+6/<br>128+4              |
| t <sub>PD</sub> (ns)              | 3.5                 | 3.7                                          | 4.2                  | 4.5                               |
| t <sub>S</sub> (ns)               | 2.2                 | 2.5                                          | 2.7                  | 2.9                               |
| t <sub>CO</sub> (ns)              | 3.0                 | 3.2                                          | 3.5                  | 3.8                               |
| f <sub>MAX</sub> (MHz)            | 267                 | 250                                          | 220                  | 200                               |
| Supply Voltage (V)                | 1.8                 | 1.8                                          | 1.8                  | 1.8                               |
| Max. Standby I <sub>CC</sub> (μA) | 20                  | 25                                           | 35                   | 55                                |
| Pins/Package                      | 48 TQFP<br>56 csBGA | 48 TQFP<br>56 csBGA<br>100 TQFP<br>132 csBGA | 100 TQFP<br>132csBGA | 100 TQFP<br>132 csBGA<br>176 TQFP |

## ispMACH 4000 Introduction

The high performance ispMACH 4000 family from Lattice offers a SuperFAST CPLD solution. The family is a blend of Lattice's two most popular architectures: the ispLSI® 2000 and ispMACH 4A. Retaining the best of both families, the ispMACH 4000 architecture focuses on significant innovations to combine the highest performance with low power in a flexible CPLD family.

The ispMACH 4000 combines high speed and low power with the flexibility needed for ease of design. With its robust Global Routing Pool and Output Routing Pool, this family delivers excellent First-Time-Fit, timing predictability, routing, pin-out retention and density migration.

The ispMACH 4000 family offers densities ranging from 32 to 512 macrocells. There are multiple density-I/O combinations in Thin Quad Flat Pack (TQFP), Chip Scale BGA (csBGA) and Fine Pitch Thin BGA (ftBGA) packages ranging from 44 to 256 pins/balls. Table 1 shows the macrocell, package and I/O options, along with other key parameters.

The ispMACH 4000 family has enhanced system integration capabilities. It supports 3.3V (4000V), 2.5V (4000B) and 1.8V (4000C/Z) supply voltages and 3.3V, 2.5V and 1.8V interface voltages. Additionally, inputs can be safely driven up to 5.5V when an I/O bank is configured for 3.3V operation, making this family 5V tolerant. The ispMACH 4000 also offers enhanced I/O features such as slew rate control, PCI compatibility, bus-keeper latches, pull-up resistors, pull-down resistors, open drain outputs and hot socketing. The ispMACH 4000 family members are 3.3V/2.5V/1.8V in-system programmable through the IEEE Standard 1532 interface. IEEE Standard 1149.1 boundary scan testing capability also allows product testing on automated test equipment. The 1532 interface signals TCK, TMS, TDI and TDO are referenced to V<sub>CC</sub> (logic core).

## Overview

The ispMACH 4000 devices consist of multiple 36-input, 16-macrocell Generic Logic Blocks (GLBs) interconnected by a Global Routing Pool (GRP). Output Routing Pools (ORPs) connect the GLBs to the I/O Blocks (IOBs), which contain multiple I/O cells. This architecture is shown in Figure 1.

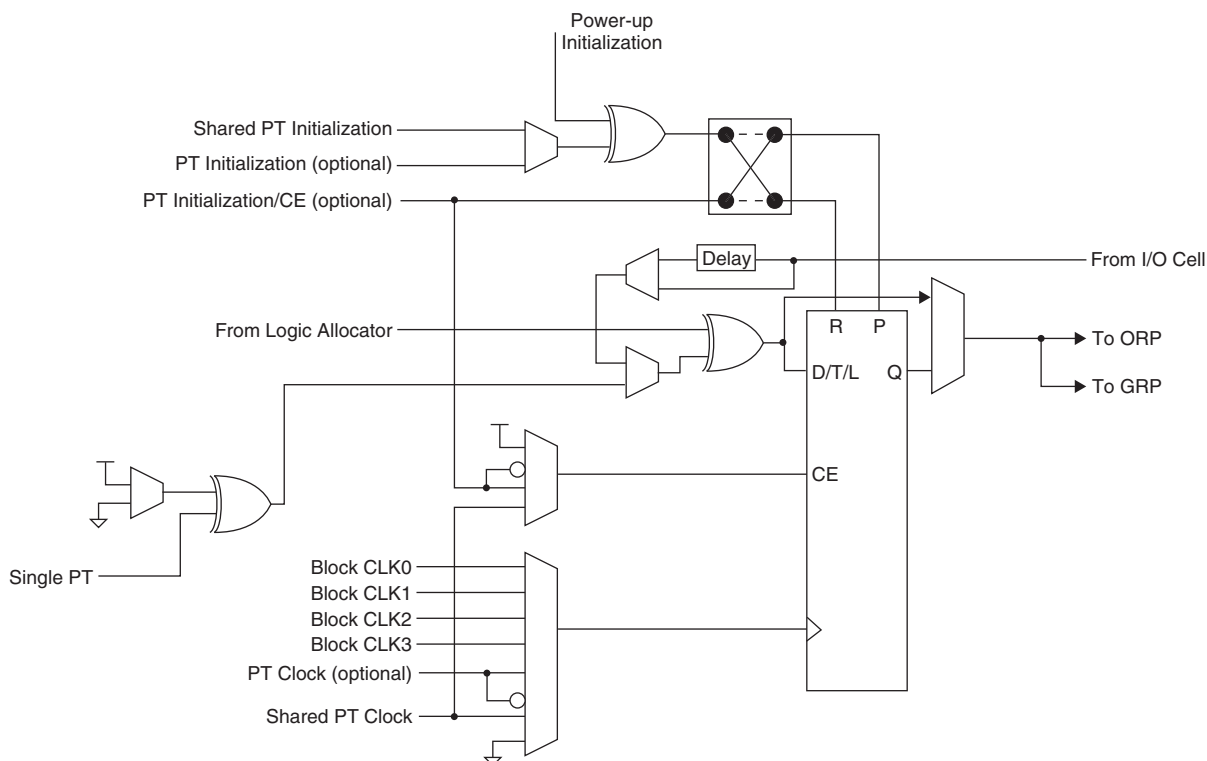
**Table 5. Product Term Expansion Capability**

| 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

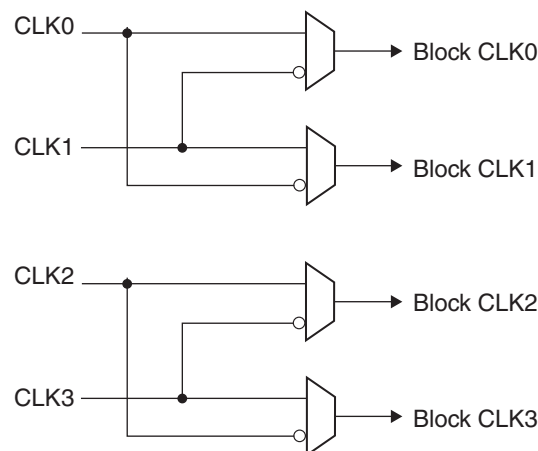
The ispMACH 4000 family architecture accommodates both block-level and macrocell-level set and reset capability. There is one block-level initialization term that is distributed to all macrocell registers in a GLB. At the macrocell level, two product terms can be “stolen” from the cluster associated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



**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 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    |

## 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    |

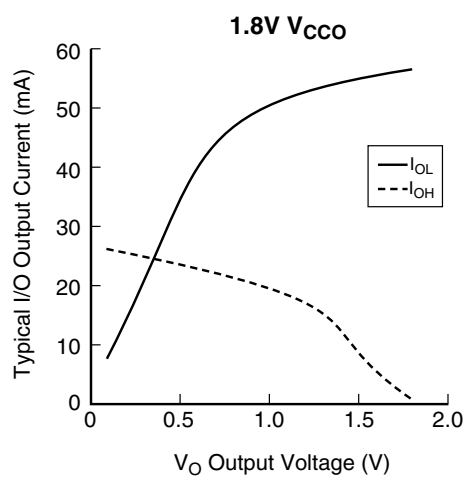
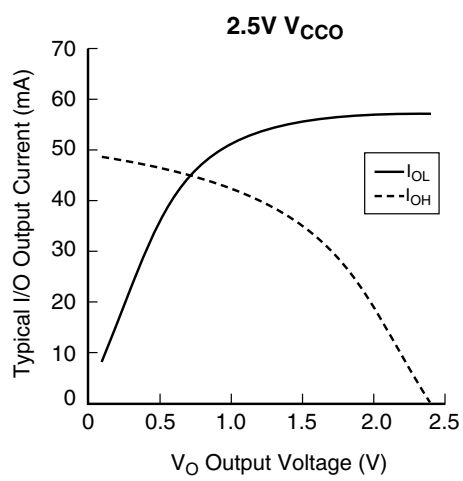
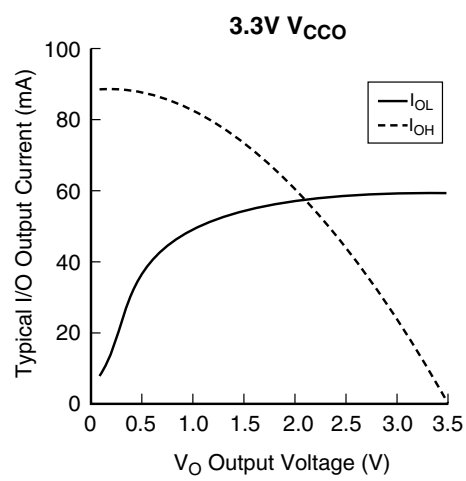
1. T<sub>A</sub> = 25°C, frequency = 1.0 MHz.

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 External Switching Characteristics (Cont.)****Over Recommended Operating Conditions**

| Parameter                     | Description <sup>1, 2, 3</sup>                                                    | -45  |      | -5   |      | -75  |      | Units |
|-------------------------------|-----------------------------------------------------------------------------------|------|------|------|------|------|------|-------|
|                               |                                                                                   | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>PD</sub>               | 5-PT bypass combinatorial propagation delay                                       | —    | 4.5  | —    | 5.0  | —    | 7.5  | ns    |
| t <sub>PD_MC</sub>            | 20-PT combinatorial propagation delay through macrocell                           | —    | 5.8  | —    | 6.0  | —    | 8.0  | ns    |
| t <sub>S</sub>                | GLB register setup time before clock                                              | 2.9  | —    | 3.0  | —    | 4.5  | —    | ns    |
| t <sub>ST</sub>               | GLB register setup time before clock with T-type register                         | 3.1  | —    | 3.2  | —    | 4.7  | —    | ns    |
| t <sub>SIR</sub>              | GLB register setup time before clock, input register path                         | 1.3  | —    | 1.3  | —    | 1.4  | —    | ns    |
| t <sub>SIRZ</sub>             | GLB register setup time before clock with zero hold                               | 2.6  | —    | 2.6  | —    | 2.7  | —    | ns    |
| t <sub>H</sub>                | GLB register hold time after clock                                                | 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  | —    | ns    |
| t <sub>HIR</sub>              | GLB register hold time after clock, input register path                           | 1.3  | —    | 1.3  | —    | 1.3  | —    | ns    |
| t <sub>HIRZ</sub>             | GLB register hold time after clock, input register path with zero hold            | 0.0  | —    | 0.0  | —    | 0.0  | —    | ns    |
| t <sub>CO</sub>               | GLB register clock-to-output delay                                                | —    | 3.8  | —    | 4.2  | —    | 4.5  | ns    |
| t <sub>R</sub>                | External reset pin to output delay                                                | —    | 7.5  | —    | 7.5  | —    | 9.0  | ns    |
| t <sub>RW</sub>               | External reset pulse duration                                                     | 2.0  | —    | 2.0  | —    | 4.0  | —    | ns    |
| t <sub>PTOE/DIS</sub>         | Input to output local product term output enable/disable                          | —    | 8.2  | —    | 8.5  | —    | 9.0  | ns    |
| t <sub>GPTOE/DIS</sub>        | Input to output global product term output enable/disable                         | —    | 10.0 | —    | 10.0 | —    | 10.5 | ns    |
| t <sub>GOE/DIS</sub>          | Global OE input to output enable/disable                                          | —    | 5.5  | —    | 6.0  | —    | 7.0  | ns    |
| t <sub>CW</sub>               | Global clock width, high or low                                                   | 1.8  | —    | 2.0  | —    | 2.8  | —    | ns    |
| t <sub>GW</sub>               | Global gate width low (for low transparent) or high (for high transparent)        | 1.8  | —    | 2.0  | —    | 2.8  | —    | ns    |
| t <sub>WIR</sub>              | Input register clock width, high or low                                           | 1.8  | —    | 2.0  | —    | 2.8  | —    | ns    |
| f <sub>MAX</sub> <sup>4</sup> | Clock frequency with internal feedback                                            | —    | 200  | —    | 200  | —    | 168  | MHz   |
| f <sub>MAX</sub> (Ext.)       | clock frequency with external feedback, [1 / (t <sub>S</sub> + t <sub>CO</sub> )] | —    | 150  | —    | 139  | —    | 111  | MHz   |

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

Timing v.2.2

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

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

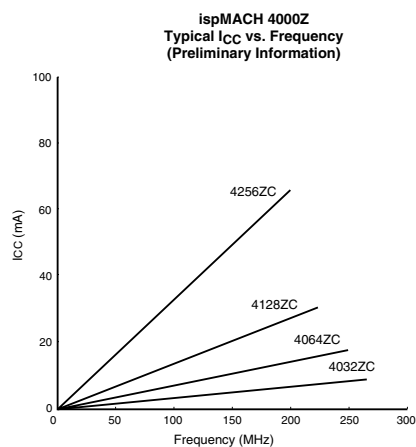
4. Standard 16-bit counter using GRP feedback.

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

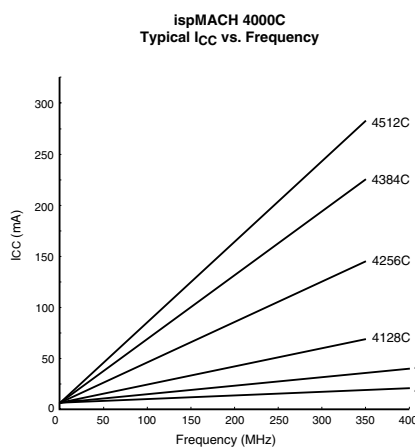
Over Recommended Operating Conditions

| Parameter             | Description                                      | -2.5 |      | -2.7 |      | -3   |      | -3.5 |      | Units |
|-----------------------|--------------------------------------------------|------|------|------|------|------|------|------|------|-------|
| In/Out Delays         |                                                  |      |      |      |      |      |      |      |      |       |
| t <sub>IN</sub>       | Input Buffer Delay                               | —    | 0.60 | —    | 0.60 | —    | 0.70 | —    | 0.70 | ns    |
| t <sub>GOE</sub>      | Global OE Pin Delay                              | —    | 2.04 | —    | 2.54 | —    | 3.04 | —    | 3.54 | ns    |
| t <sub>GCLK_IN</sub>  | Global Clock Input Buffer Delay                  | —    | 0.78 | —    | 1.28 | —    | 1.28 | —    | 1.28 | ns    |
| t <sub>BUF</sub>      | Delay through Output Buffer                      | —    | 0.85 | —    | 0.85 | —    | 0.85 | —    | 0.85 | ns    |
| t <sub>EN</sub>       | Output Enable Time                               | —    | 0.96 | —    | 0.96 | —    | 0.96 | —    | 0.96 | ns    |
| t <sub>DIS</sub>      | Output Disable Time                              | —    | 0.96 | —    | 0.96 | —    | 0.96 | —    | 0.96 | ns    |
| Routing/GLB Delays    |                                                  |      |      |      |      |      |      |      |      |       |
| t <sub>ROUTE</sub>    | Delay through GRP                                | —    | 0.61 | —    | 0.81 | —    | 1.01 | —    | 1.01 | ns    |
| t <sub>MCELL</sub>    | Macrocell Delay                                  | —    | 0.45 | —    | 0.55 | —    | 0.55 | —    | 0.65 | ns    |
| t <sub>INREG</sub>    | Input Buffer to Macrocell Register Delay         | —    | 0.11 | —    | 0.31 | —    | 0.31 | —    | 0.31 | ns    |
| t <sub>FBK</sub>      | Internal Feedback Delay                          | —    | 0.00 | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| t <sub>PDb</sub>      | 5-PT Bypass Propagation Delay                    | —    | 0.44 | —    | 0.44 | —    | 0.44 | —    | 0.94 | ns    |
| t <sub>PDi</sub>      | Macrocell Propagation Delay                      | —    | 0.64 | —    | 0.64 | —    | 0.64 | —    | 0.94 | ns    |
| Register/Latch Delays |                                                  |      |      |      |      |      |      |      |      |       |
| t <sub>S</sub>        | D-Register Setup Time (Global Clock)             | 0.92 | —    | 1.12 | —    | 1.02 | —    | 0.92 | —    | ns    |
| t <sub>S_PT</sub>     | D-Register Setup Time (Product Term Clock)       | 1.42 | —    | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>ST</sub>       | T-Register Setup Time (Global Clock)             | 1.12 | —    | 1.32 | —    | 1.22 | —    | 1.12 | —    | ns    |
| t <sub>ST_PT</sub>    | T-Register Setup Time (Product Term Clock)       | 1.42 | —    | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>H</sub>        | D-Register Hold Time                             | 0.88 | —    | 0.68 | —    | 0.98 | —    | 1.08 | —    | ns    |
| t <sub>HT</sub>       | T-Register Hold Time                             | 0.88 | —    | 0.68 | —    | 0.98 | —    | 1.08 | —    | ns    |
| t <sub>SIR</sub>      | D-Input Register Setup Time (Global Clock)       | 0.82 | —    | 1.37 | —    | 1.27 | —    | 1.27 | —    | ns    |
| t <sub>SIR_PT</sub>   | D-Input Register Setup Time (Product Term Clock) | 1.45 | —    | 1.45 | —    | 1.45 | —    | 1.45 | —    | ns    |
| t <sub>HIR</sub>      | D-Input Register Hold Time (Global Clock)        | 0.88 | —    | 0.63 | —    | 0.73 | —    | 0.73 | —    | ns    |
| t <sub>HIR_PT</sub>   | D-Input Register Hold Time (Product Term Clock)  | 0.88 | —    | 0.63 | —    | 0.73 | —    | 0.73 | —    | ns    |
| t <sub>COi</sub>      | Register Clock to Output/Feedback MUX Time       | —    | 0.52 | —    | 0.52 | —    | 0.52 | —    | 0.52 | ns    |
| t <sub>CES</sub>      | Clock Enable Setup Time                          | 2.25 | —    | 2.25 | —    | 2.25 | —    | 2.25 | —    | ns    |
| t <sub>CEH</sub>      | Clock Enable Hold Time                           | 1.88 | —    | 1.88 | —    | 1.88 | —    | 1.88 | —    | ns    |
| t <sub>SL</sub>       | Latch Setup Time (Global Clock)                  | 0.92 | —    | 1.12 | —    | 1.02 | —    | 0.92 | —    | ns    |
| t <sub>SL_PT</sub>    | Latch Setup Time (Product Term Clock)            | 1.42 | —    | 1.32 | —    | 1.32 | —    | 1.32 | —    | ns    |
| t <sub>HL</sub>       | Latch Hold Time                                  | 1.17 | —    | 1.17 | —    | 1.17 | —    | 1.17 | —    | ns    |
| t <sub>GOi</sub>      | Latch Gate to Output/Feedback MUX Time           | —    | 0.33 | —    | 0.33 | —    | 0.33 | —    | 0.33 | ns    |

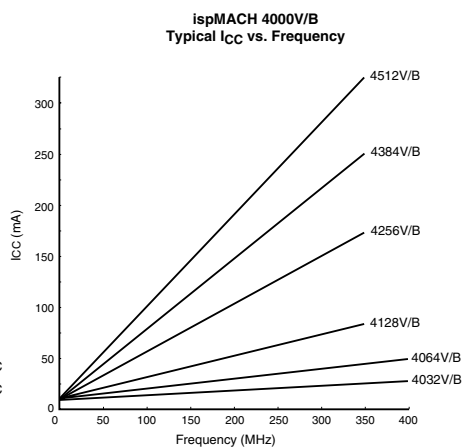
## Power Consumption



Note: The devices are configured with maximum number of 16-bit counters, typical current at 1.8V, 25°C.



Note: The devices are configured with maximum number of 16-bit counters, typical current at 1.8V, 25°C.



Note: The devices are configured with maximum number of 16-bit counters, typical current at 3.3V, 2.5V, 25°C.

## Power Estimation Coefficients<sup>1</sup>

| Device          | A     | B     |
|-----------------|-------|-------|
| ispMACH 4032V/B | 11.3  | 0.010 |
| ispMACH 4032C   | 1.3   | 0.010 |
| ispMACH 4064V/B | 11.5  | 0.010 |
| ispMACH 4064C   | 1.5   | 0.010 |
| ispMACH 4128V/B | 11.5  | 0.011 |
| ispMACH 4128C   | 1.5   | 0.011 |
| ispMACH 4256V/B | 12    | 0.011 |
| ispMACH 4256C   | 2     | 0.011 |
| ispMACH 4384V/B | 12.5  | 0.013 |
| ispMACH 4384C   | 2.5   | 0.013 |
| ispMACH 4512V/B | 13    | 0.013 |
| ispMACH 4512C   | 3     | 0.013 |
| ispMACH 4032ZC  | 0.010 | 0.010 |
| ispMACH 4064ZC  | 0.011 | 0.010 |
| ispMACH 4128ZC  | 0.012 | 0.010 |
| ispMACH 4256ZC  | 0.013 | 0.010 |

1. For further information about the use of these coefficients, refer to TN1005, [Power Estimation in ispMACH 4000V/B/C/Z Devices](#).

**ispMACH 4128V/B/C Logic Signal Connections: 128-Pin TQFP (Cont.)**

| Pin Number | Bank Number | ispMACH 4128V/B/C |                 |
|------------|-------------|-------------------|-----------------|
|            |             | GLB/MC/Pad        | ORP             |
| 62         | 1           | E10               | E <sup>8</sup>  |
| 63         | 1           | E12               | E <sup>9</sup>  |
| 64         | 1           | E14               | E <sup>11</sup> |
| 65         | 1           | GND               | -               |
| 66         | 1           | TMS               | -               |
| 67         | 1           | VCCO (Bank 1)     | -               |
| 68         | 1           | F0                | F <sup>0</sup>  |
| 69         | 1           | F1                | F <sup>1</sup>  |
| 70         | 1           | F2                | F <sup>2</sup>  |
| 71         | 1           | F4                | F <sup>3</sup>  |
| 72         | 1           | F5                | F <sup>4</sup>  |
| 73         | 1           | F6                | F <sup>5</sup>  |
| 74         | 1           | GND (Bank 1)      | -               |
| 75         | 1           | F8                | F <sup>6</sup>  |
| 76         | 1           | F9                | F <sup>7</sup>  |
| 77         | 1           | F10               | F <sup>8</sup>  |
| 78         | 1           | F12               | F <sup>9</sup>  |
| 79         | 1           | F13               | F <sup>10</sup> |
| 80         | 1           | F14               | F <sup>11</sup> |
| 81         | 1           | VCCO (Bank 1)     | -               |
| 82         | 1           | G14               | G <sup>11</sup> |
| 83         | 1           | G13               | G <sup>10</sup> |
| 84         | 1           | G12               | G <sup>9</sup>  |
| 85         | 1           | G10               | G <sup>8</sup>  |
| 86         | 1           | G9                | G <sup>7</sup>  |
| 87         | 1           | G8                | G <sup>6</sup>  |
| 88         | 1           | GND (Bank 1)      | -               |
| 89         | 1           | G6                | G <sup>5</sup>  |
| 90         | 1           | G5                | G <sup>4</sup>  |
| 91         | 1           | G4                | G <sup>3</sup>  |
| 92         | 1           | G2                | G <sup>2</sup>  |
| 93         | 1           | G0                | G <sup>0</sup>  |
| 94         | 1           | VCCO (Bank 1)     | -               |
| 95         | 1           | TDO               | -               |
| 96         | 1           | VCC               | -               |
| 97         | 1           | GND               | -               |
| 98         | 1           | H14               | H <sup>11</sup> |
| 99         | 1           | H13               | H <sup>10</sup> |
| 100        | 1           | H12               | H <sup>9</sup>  |
| 101        | 1           | H10               | H <sup>8</sup>  |
| 102        | 1           | H9                | H <sup>7</sup>  |
| 103        | 1           | H8                | H <sup>6</sup>  |
| 104        | 1           | GND (Bank 1)      | -               |

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

| 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              |
| 101        | 1           | GND (Bank 1)        | -               | GND (Bank 1)      | -                | GND (Bank 1)      | -                |
| 102        | 1           | L14                 | L <sup>14</sup> | AX14              | AX <sup>14</sup> | GX14              | GX <sup>14</sup> |
| 103        | 1           | L12                 | L <sup>12</sup> | AX12              | AX <sup>12</sup> | GX12              | GX <sup>12</sup> |
| 104        | 1           | L10                 | L <sup>10</sup> | AX10              | AX <sup>10</sup> | GX10              | GX <sup>10</sup> |
| 105        | 1           | L8                  | L <sup>8</sup>  | AX8               | AX <sup>8</sup>  | GX8               | GX <sup>8</sup>  |
| 106        | 1           | L6                  | L <sup>6</sup>  | AX6               | AX <sup>6</sup>  | GX6               | GX <sup>6</sup>  |
| 107        | 1           | L4                  | L <sup>4</sup>  | AX4               | AX <sup>4</sup>  | GX4               | GX <sup>4</sup>  |
| 108        | 1           | L2                  | L <sup>2</sup>  | AX2               | AX <sup>2</sup>  | GX2               | GX <sup>2</sup>  |
| 109        | 1           | L0                  | L <sup>0</sup>  | AX0               | AX <sup>0</sup>  | GX0               | GX <sup>0</sup>  |
| 110        | 1           | VCCO (Bank 1)       | -               | VCCO (Bank 1)     | -                | VCCO (Bank 1)     | -                |
| 111        | 1           | M0                  | M <sup>0</sup>  | DX0               | DX <sup>0</sup>  | JX0               | JX <sup>0</sup>  |
| 112        | 1           | M2                  | M <sup>2</sup>  | DX2               | DX <sup>2</sup>  | JX2               | JX <sup>2</sup>  |
| 113        | 1           | M4                  | M <sup>4</sup>  | DX4               | DX <sup>4</sup>  | JX4               | JX <sup>4</sup>  |
| 114        | 1           | M6                  | M <sup>6</sup>  | DX6               | DX <sup>6</sup>  | JX6               | JX <sup>6</sup>  |
| 115        | 1           | M8                  | M <sup>8</sup>  | DX8               | DX <sup>8</sup>  | JX8               | JX <sup>8</sup>  |
| 116        | 1           | M10                 | M <sup>10</sup> | DX10              | DX <sup>10</sup> | JX10              | JX <sup>10</sup> |
| 117        | 1           | M12                 | M <sup>12</sup> | DX12              | DX <sup>12</sup> | JX12              | JX <sup>12</sup> |
| 118        | 1           | M14                 | M <sup>14</sup> | DX14              | DX <sup>14</sup> | JX14              | JX <sup>14</sup> |
| 119        | 1           | GND (Bank 1)        | -               | GND (Bank 1)      | -                | GND (Bank 1)      | -                |
| 120        | 1           | N0                  | N <sup>0</sup>  | FX0               | FX <sup>0</sup>  | NX0               | NX <sup>0</sup>  |
| 121        | 1           | N2                  | N <sup>2</sup>  | FX2               | FX <sup>2</sup>  | NX2               | NX <sup>2</sup>  |
| 122        | 1           | N4                  | N <sup>4</sup>  | FX4               | FX <sup>4</sup>  | NX4               | NX <sup>4</sup>  |
| 123        | 1           | N6                  | N <sup>6</sup>  | FX6               | FX <sup>6</sup>  | NX6               | NX <sup>6</sup>  |
| 124        | 1           | N8                  | N <sup>8</sup>  | FX8               | FX <sup>8</sup>  | NX8               | NX <sup>8</sup>  |
| 125        | 1           | N10                 | N <sup>10</sup> | FX10              | FX <sup>10</sup> | NX10              | NX <sup>10</sup> |
| 126        | 1           | N12                 | N <sup>12</sup> | FX12              | FX <sup>12</sup> | NX12              | NX <sup>12</sup> |
| 127        | 1           | N14                 | N <sup>14</sup> | FX14              | FX <sup>14</sup> | NX14              | NX <sup>14</sup> |
| 128        | 1           | VCCO (Bank 1)       | -               | VCCO (Bank 1)     | -                | VCCO (Bank 1)     | -                |
| 129        | -           | TDO                 | -               | TDO               | -                | TDO               | -                |
| 130        | -           | VCC                 | -               | VCC               | -                | VCC               | -                |
| 131        | -           | NC                  | -               | NC                | -                | NC                | -                |
| 132        | -           | NC                  | -               | NC                | -                | NC                | -                |
| 133        | -           | NC                  | -               | NC                | -                | NC                | -                |
| 134        | -           | GND                 | -               | GND               | -                | GND               | -                |
| 135        | 1           | O14                 | O <sup>14</sup> | GX14              | GX <sup>14</sup> | OX14              | OX <sup>14</sup> |
| 136        | 1           | O12                 | O <sup>12</sup> | GX12              | GX <sup>12</sup> | OX12              | OX <sup>12</sup> |
| 137        | 1           | O10                 | O <sup>10</sup> | GX10              | GX <sup>10</sup> | OX10              | OX <sup>10</sup> |
| 138        | 1           | O8                  | O <sup>8</sup>  | GX8               | GX <sup>8</sup>  | OX8               | OX <sup>8</sup>  |
| 139        | 1           | O6                  | O <sup>6</sup>  | GX6               | GX <sup>6</sup>  | OX6               | OX <sup>6</sup>  |
| 140        | 1           | O4                  | O <sup>4</sup>  | GX4               | GX <sup>4</sup>  | OX4               | OX <sup>4</sup>  |
| 141        | 1           | O2                  | O <sup>2</sup>  | GX2               | GX <sup>2</sup>  | OX2               | OX <sup>2</sup>  |

**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            |
| E7          | 0        | NC                           | -              | B1                           | B <sup>1</sup> | F8                | F <sup>4</sup> | D12               | D <sup>3</sup> |
| A3          | 0        | B0                           | B <sup>0</sup> | B2                           | B <sup>2</sup> | B0                | B <sup>0</sup> | B0                | B <sup>0</sup> |
| F7          | 0        | B2                           | B <sup>1</sup> | B4                           | B <sup>3</sup> | B2                | B <sup>1</sup> | B2                | B <sup>1</sup> |
| B4          | 0        | B4                           | B <sup>2</sup> | B6                           | B <sup>4</sup> | B4                | B <sup>2</sup> | B4                | B <sup>2</sup> |
| C5          | 0        | B6                           | B <sup>3</sup> | B8                           | B <sup>5</sup> | B6                | B <sup>3</sup> | B6                | B <sup>3</sup> |
| A2          | 0        | B8                           | B <sup>4</sup> | B9                           | B <sup>6</sup> | B8                | B <sup>4</sup> | B8                | B <sup>4</sup> |
| E6          | 0        | B10                          | B <sup>5</sup> | B10                          | B <sup>7</sup> | B10               | B <sup>5</sup> | B10               | B <sup>5</sup> |
| B3          | 0        | B12                          | B <sup>6</sup> | B12                          | B <sup>8</sup> | B12               | B <sup>6</sup> | B12               | B <sup>6</sup> |
| C4          | 0        | B14                          | B <sup>7</sup> | B14                          | B <sup>9</sup> | B14               | B <sup>7</sup> | B14               | B <sup>7</sup> |
| D4          | 0        | NC                           | -              | NC                           | -              | D10               | D <sup>5</sup> | F0                | F <sup>0</sup> |
| E5          | 0        | NC                           | -              | NC                           | -              | D8                | D <sup>4</sup> | F2                | F <sup>1</sup> |
| -           | -        | VCC                          | -              | VCC                          | -              | VCC               | -              | VCC               | -              |
| -           | -        | -                            | -              | -                            | -              | GND               | -              | GND               | -              |
| -           | 0        | -                            | -              | -                            | -              | GND (Bank 0)      | -              | GND (Bank 0)      | -              |

Note: VCC, VCCO and GND are tied together to their respective common signal on the package substrate. See Power Supply and NC Connections table for VCC/ VCCO/GND pin definitions.

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

| Family  | Part Number                   | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-------------------------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4256V | LC4256V-5FT256AI              | 256        | 3.3     | 5               | ftBGA   | 256            | 128 | I     |
|         | LC4256V-75FT256AI             | 256        | 3.3     | 7.5             | ftBGA   | 256            | 128 | I     |
|         | LC4256V-10FT256AI             | 256        | 3.3     | 10              | ftBGA   | 256            | 128 | I     |
|         | LC4256V-5FT256BI              | 256        | 3.3     | 5               | ftBGA   | 256            | 160 | I     |
|         | LC4256V-75FT256BI             | 256        | 3.3     | 7.5             | ftBGA   | 256            | 160 | I     |
|         | LC4256V-10FT256BI             | 256        | 3.3     | 10              | ftBGA   | 256            | 160 | I     |
|         | LC4256V-5F256AI <sup>1</sup>  | 256        | 3.3     | 5               | fpBGA   | 256            | 128 | I     |
|         | LC4256V-75F256AI <sup>1</sup> | 256        | 3.3     | 7.5             | fpBGA   | 256            | 128 | I     |
|         | LC4256V-10F256AI <sup>1</sup> | 256        | 3.3     | 10              | fpBGA   | 256            | 128 | I     |
|         | LC4256V-5F256BI <sup>1</sup>  | 256        | 3.3     | 5               | fpBGA   | 256            | 160 | I     |
|         | LC4256V-75F256BI <sup>1</sup> | 256        | 3.3     | 7.5             | fpBGA   | 256            | 160 | I     |
|         | LC4256V-10F256BI <sup>1</sup> | 256        | 3.3     | 10              | fpBGA   | 256            | 160 | I     |
|         | LC4256V-5T176I                | 256        | 3.3     | 5               | TQFP    | 176            | 128 | I     |
|         | LC4256V-75T176I               | 256        | 3.3     | 7.5             | TQFP    | 176            | 128 | I     |
|         | LC4256V-10T176I               | 256        | 3.3     | 10              | TQFP    | 176            | 128 | I     |
|         | LC4256V-5T144I                | 256        | 3.3     | 5               | TQFP    | 144            | 96  | I     |
|         | LC4256V-75T144I               | 256        | 3.3     | 7.5             | TQFP    | 144            | 96  | I     |
|         | LC4256V-10T144I               | 256        | 3.3     | 10              | TQFP    | 144            | 96  | I     |
|         | LC4256V-5T100I                | 256        | 3.3     | 5               | TQFP    | 100            | 64  | I     |
|         | LC4256V-75T100I               | 256        | 3.3     | 7.5             | TQFP    | 100            | 64  | I     |
|         | LC4256V-10T100I               | 256        | 3.3     | 10              | TQFP    | 100            | 64  | I     |
| LC4384V | LC4384V-5FT256I               | 384        | 3.3     | 5               | ftBGA   | 256            | 192 | I     |
|         | LC4384V-75FT256I              | 384        | 3.3     | 7.5             | ftBGA   | 256            | 192 | I     |
|         | LC4384V-10FT256I              | 384        | 3.3     | 10              | ftBGA   | 256            | 192 | I     |
|         | LC4384V-5F256I <sup>1</sup>   | 384        | 3.3     | 5               | fpBGA   | 256            | 192 | I     |
|         | LC4384V-75F256I <sup>1</sup>  | 384        | 3.3     | 7.5             | fpBGA   | 256            | 192 | I     |
|         | LC4384V-10F256I <sup>1</sup>  | 384        | 3.3     | 10              | fpBGA   | 256            | 192 | I     |
|         | LC4384V-5T176I                | 384        | 3.3     | 5               | TQFP    | 176            | 128 | I     |
|         | LC4384V-75T176I               | 384        | 3.3     | 7.5             | TQFP    | 176            | 128 | I     |
|         | LC4384V-10T176I               | 384        | 3.3     | 10              | TQFP    | 176            | 128 | I     |
| LC4512V | LC4512V-5FT256I               | 512        | 3.3     | 5               | ftBGA   | 256            | 208 | I     |
|         | LC4512V-75FT256I              | 512        | 3.3     | 7.5             | ftBGA   | 256            | 208 | I     |
|         | LC4512V-10FT256I              | 512        | 3.3     | 10              | ftBGA   | 256            | 208 | I     |
|         | LC4512V-5F256I <sup>1</sup>   | 512        | 3.3     | 5               | fpBGA   | 256            | 208 | I     |
|         | LC4512V-75F256I <sup>1</sup>  | 512        | 3.3     | 7.5             | fpBGA   | 256            | 208 | I     |
|         | LC4512V-10F256I <sup>1</sup>  | 512        | 3.3     | 10              | fpBGA   | 256            | 208 | I     |
|         | LC4512V-5T176I                | 512        | 3.3     | 5               | TQFP    | 176            | 128 | I     |
|         | LC4512V-75T176I               | 512        | 3.3     | 7.5             | TQFP    | 176            | 128 | I     |
|         | LC4512V-10T176I               | 512        | 3.3     | 10              | TQFP    | 176            | 128 | I     |

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

## ispMACH 4000V (3.3V) Extended Temperature Devices

| Device  | Part Number     | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-----------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4032V | LC4032V-75T48E  | 32         | 3.3     | 7.5             | TQFP    | 48             | 32  | E     |
|         | LC4032V-75T44E  | 32         | 3.3     | 7.5             | TQFP    | 44             | 30  | E     |
| LC4064V | LC4064V-75T100E | 64         | 3.3     | 7.5             | TQFP    | 100            | 64  | E     |
|         | LC4064V-75T48E  | 64         | 3.3     | 7.5             | TQFP    | 48             | 32  | E     |
|         | LC4064V-75T44E  | 64         | 3.3     | 7.5             | TQFP    | 44             | 30  | E     |
| LC4128V | LC4128V-75T144E | 128        | 3.3     | 7.5             | TQFP    | 144            | 96  | E     |
|         | LC4128V-75T128E | 128        | 3.3     | 7.5             | TQFP    | 128            | 92  | E     |
|         | LC4128V-75T100E | 128        | 3.3     | 7.5             | TQFP    | 100            | 64  | E     |
| LC4256V | LC4256V-75T176E | 256        | 3.3     | 7.5             | TQFP    | 176            | 128 | E     |
|         | LC4256V-75T144E | 256        | 3.3     | 7.5             | TQFP    | 144            | 96  | E     |
|         | LC4256V-75T100E | 256        | 3.3     | 7.5             | TQFP    | 100            | 64  | E     |

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

| Device  | Part Number                    | Macrocells | Voltage | t <sub>PD</sub> | Package         | Pin/Ball Count | I/O | Grade |
|---------|--------------------------------|------------|---------|-----------------|-----------------|----------------|-----|-------|
| LC4256V | LC4256V-5FTN256AI              | 256        | 3.3     | 5               | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256V-75FTN256AI             | 256        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256V-10FTN256AI             | 256        | 3.3     | 10              | Lead-free ftBGA | 256            | 128 | I     |
|         | LC4256V-5FTN256BI              | 256        | 3.3     | 5               | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256V-75FTN256BI             | 256        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256V-10FTN256BI             | 256        | 3.3     | 10              | Lead-free ftBGA | 256            | 160 | I     |
|         | LC4256V-5FN256AI <sup>1</sup>  | 256        | 3.3     | 5               | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256V-75FN256AI <sup>1</sup> | 256        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256V-10FN256AI <sup>1</sup> | 256        | 3.3     | 10              | Lead-free fpBGA | 256            | 128 | I     |
|         | LC4256V-5FN256BI <sup>1</sup>  | 256        | 3.3     | 5               | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256V-75FN256BI <sup>1</sup> | 256        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256V-10FN256BI <sup>1</sup> | 256        | 3.3     | 10              | Lead-free fpBGA | 256            | 160 | I     |
|         | LC4256V-5TN176I                | 256        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256V-75TN176I               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256V-10TN176I               | 256        | 3.3     | 10              | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4256V-5TN144I                | 256        | 3.3     | 5               | Lead-free TQFP  | 144            | 96  | I     |
|         | LC4256V-75TN144I               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 144            | 96  | I     |
|         | LC4256V-10TN144I               | 256        | 3.3     | 10              | Lead-free TQFP  | 144            | 96  | I     |
|         | LC4256V-5TN100I                | 256        | 3.3     | 5               | Lead-free TQFP  | 100            | 64  | I     |
|         | LC4256V-75TN100I               | 256        | 3.3     | 7.5             | Lead-free TQFP  | 100            | 64  | I     |
|         | LC4256V-10TN100I               | 256        | 3.3     | 10              | Lead-free TQFP  | 100            | 64  | I     |
| LC4384V | LC4384V-5FTN256I               | 384        | 3.3     | 5               | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384V-75FTN256I              | 384        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384V-10FTN256I              | 384        | 3.3     | 10              | Lead-free ftBGA | 256            | 192 | I     |
|         | LC4384V-5FN256I <sup>1</sup>   | 384        | 3.3     | 5               | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384V-75FN256I <sup>1</sup>  | 384        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384V-10FN256I <sup>1</sup>  | 384        | 3.3     | 10              | Lead-free fpBGA | 256            | 192 | I     |
|         | LC4384V-5TN176I                | 384        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4384V-75TN176I               | 384        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4384V-10TN176I               | 384        | 3.3     | 10              | Lead-free TQFP  | 176            | 128 | I     |
| LC4512V | LC4512V-5FTN256I               | 512        | 3.3     | 5               | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512V-75FTN256I              | 512        | 3.3     | 7.5             | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512V-10FTN256I              | 512        | 3.3     | 10              | Lead-free ftBGA | 256            | 208 | I     |
|         | LC4512V-5FN256I <sup>1</sup>   | 512        | 3.3     | 5               | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512V-75FN256I <sup>1</sup>  | 512        | 3.3     | 7.5             | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512V-10FN256I <sup>1</sup>  | 512        | 3.3     | 10              | Lead-free fpBGA | 256            | 208 | I     |
|         | LC4512V-5TN176I                | 512        | 3.3     | 5               | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4512V-75TN176I               | 512        | 3.3     | 7.5             | Lead-free TQFP  | 176            | 128 | I     |
|         | LC4512V-10TN176I               | 512        | 3.3     | 10              | Lead-free TQFP  | 176            | 128 | I     |

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