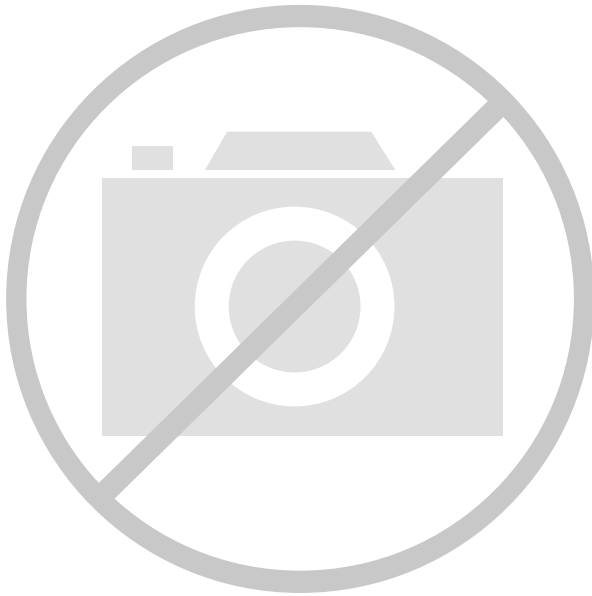




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## Understanding [Embedded - CPLDs \(Complex Programmable Logic Devices\)](#)

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       | 2.3V ~ 2.7V                                                                                                                                                             |
| Number of Logic Elements/Blocks | 16                                                                                                                                                                      |
| Number of Macrocells            | 256                                                                                                                                                                     |
| Number of Gates                 | -                                                                                                                                                                       |
| Number of I/O                   | 128                                                                                                                                                                     |
| Operating Temperature           | -40°C ~ 105°C (TJ)                                                                                                                                                      |
| Mounting Type                   | Surface Mount                                                                                                                                                           |
| Package / Case                  | 256-LBGA                                                                                                                                                                |
| Supplier Device Package         | 256-FTBGA (17x17)                                                                                                                                                       |
| Purchase URL                    | <a href="https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4256b-5ftn256ai">https://www.e-xfl.com/product-detail/lattice-semiconductor/lc4256b-5ftn256ai</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.

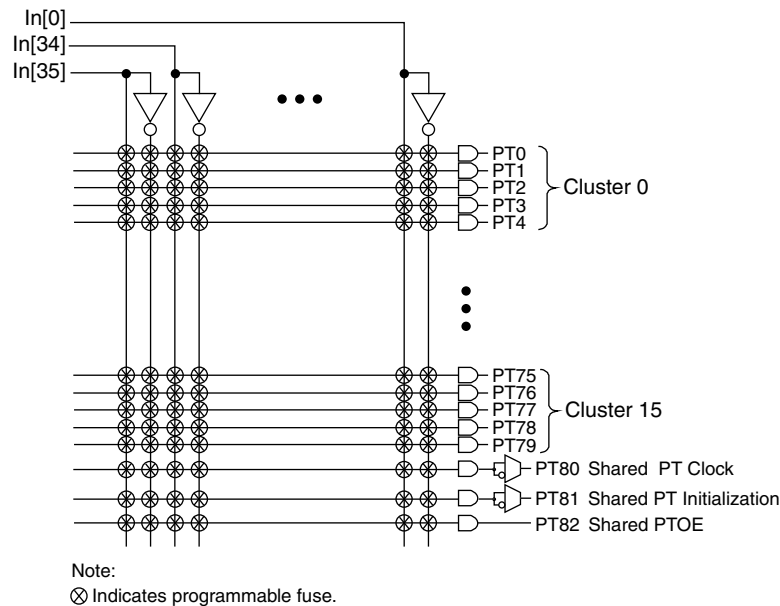
The ispMACH 4000 combines high speed and low power with the flexibility needed for ease of design. With its robust Global Routing Pool and Output Routing Pool, this family delivers excellent First-Time-Fit, timing predictability, routing, pin-out retention and density migration.

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.

**Figure 3. AND Array**

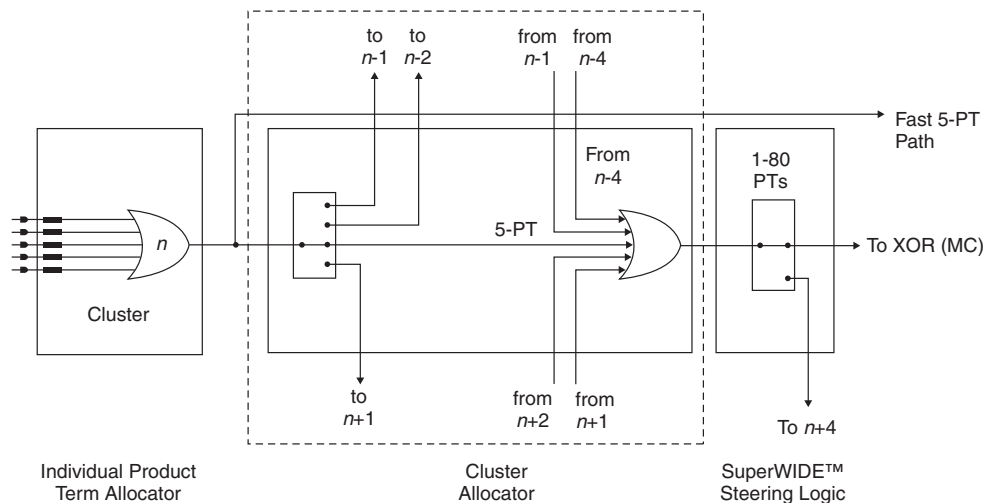
## Enhanced Logic Allocator

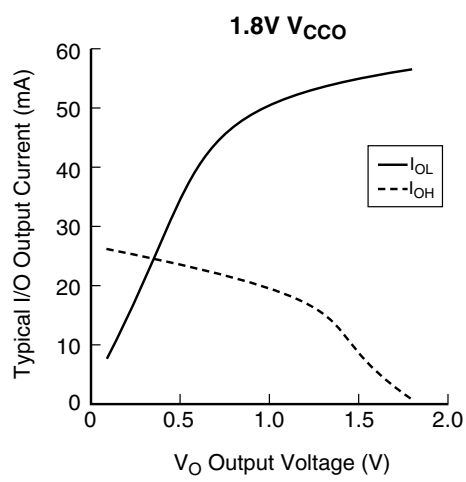
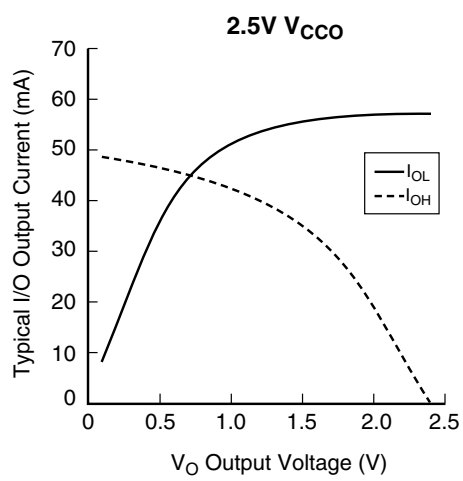
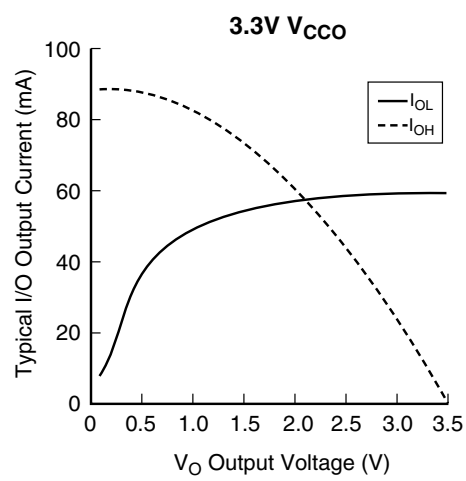
Within the logic allocator, product terms are allocated to macrocells in product term clusters. Each product term cluster is associated with a macrocell. The cluster size for the ispMACH 4000 family is 4+1 (total 5) product terms. The software automatically considers the availability and distribution of product term clusters as it fits the functions within a GLB. The logic allocator is designed to provide three speed paths: 5-PT fast bypass path, 20-PT Speed Locking path and an up to 80-PT path. The availability of these three paths lets designers trade timing variability for increased performance.

The enhanced Logic Allocator of the ispMACH 4000 family consists of the following blocks:

- Product Term Allocator
- Cluster Allocator
- Wide Steering Logic

Figure 4 shows a macrocell slice of the Logic Allocator. There are 16 such slices in the GLB.

**Figure 4. Macrocell Slice**



## ispMACH 4000Z External Switching Characteristics

Over Recommended Operating Conditions

| Parameter                     | Description <sup>1, 2, 3</sup>                                                    | -35  |      | -37  |      | -42  |      | Units |
|-------------------------------|-----------------------------------------------------------------------------------|------|------|------|------|------|------|-------|
|                               |                                                                                   | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>PD</sub>               | 5-PT bypass combinatorial propagation delay                                       | —    | 3.5  | —    | 3.7  | —    | 4.2  | ns    |
| t <sub>PD_MC</sub>            | 20-PT combinatorial propagation delay through macrocell                           | —    | 4.4  | —    | 4.7  | —    | 5.7  | ns    |
| t <sub>S</sub>                | GLB register setup time before clock                                              | 2.2  | —    | 2.5  | —    | 2.7  | —    | ns    |
| t <sub>ST</sub>               | GLB register setup time before clock with T-type register                         | 2.4  | —    | 2.7  | —    | 2.9  | —    | ns    |
| t <sub>SIR</sub>              | GLB register setup time before clock, input register path                         | 1.0  | —    | 1.1  | —    | 1.3  | —    | ns    |
| t <sub>SIRZ</sub>             | GLB register setup time before clock with zero hold                               | 2.0  | —    | 2.1  | —    | 2.6  | —    | 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                           | 1.0  | —    | 1.0  | —    | 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                                                | —    | 3.0  | —    | 3.2  | —    | 3.5  | ns    |
| t <sub>R</sub>                | External reset pin to output delay                                                | —    | 5.0  | —    | 6.0  | —    | 7.3  | ns    |
| t <sub>RW</sub>               | External reset pulse duration                                                     | 1.5  | —    | 1.7  | —    | 2.0  | —    | ns    |
| t <sub>PTOE/DIS</sub>         | Input to output local product term output enable/disable                          | —    | 7.0  | —    | 8.0  | —    | 8.0  | ns    |
| t <sub>GPTOE/DIS</sub>        | Input to output global product term output enable/disable                         | —    | 6.5  | —    | 7.0  | —    | 8.0  | ns    |
| t <sub>GOE/DIS</sub>          | Global OE input to output enable/disable                                          | —    | 4.5  | —    | 4.5  | —    | 4.8  | ns    |
| t <sub>CW</sub>               | Global clock width, high or low                                                   | 1.0  | —    | 1.5  | —    | 1.8  | —    | ns    |
| t <sub>GW</sub>               | Global gate width low (for low transparent) or high (for high transparent)        | 1.0  | —    | 1.5  | —    | 1.8  | —    | ns    |
| t <sub>WIR</sub>              | Input register clock width, high or low                                           | 1.0  | —    | 1.5  | —    | 1.8  | —    | ns    |
| f <sub>MAX</sub> <sup>4</sup> | Clock frequency with internal feedback                                            | —    | 267  | —    | 250  | —    | 220  | MHz   |
| f <sub>MAX</sub> (Ext.)       | clock frequency with external feedback, [1 / (t <sub>S</sub> + t <sub>CO</sub> )] | —    | 192  | —    | 175  | —    | 161  | 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 (Cont.)****Over Recommended Operating Conditions**

| Parameter          | Description           | -5   |      | -75  |      | -10  |      | Units |
|--------------------|-----------------------|------|------|------|------|------|------|-------|
|                    |                       | Min. | Max. | Min. | Max. | Min. | Max. |       |
| t <sub>GPTOE</sub> | Global PT OE Delay    | —    | 5.58 | —    | 5.58 | —    | 5.78 | ns    |
| t <sub>PTOE</sub>  | Macrocell PT OE Delay | —    | 3.58 | —    | 4.28 | —    | 4.28 | 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 4000Z Internal Timing Parameters

Over Recommended Operating Conditions

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

**ispMACH 4000Z Timing Adders <sup>1</sup>**

| Adder Type                        | Base Parameter                                            | Description                                | -35  |      | -37  |      | -42  |      | Units |
|-----------------------------------|-----------------------------------------------------------|--------------------------------------------|------|------|------|------|------|------|-------|
|                                   |                                                           |                                            | Min. | Max. | Min. | Max. | Min. | Max. |       |
| Optional Delay Adders             |                                                           |                                            |      |      |      |      |      |      |       |
| t <sub>INDIO</sub>                | t <sub>INREG</sub>                                        | Input register delay                       | —    | 1.00 | —    | 1.00 | —    | 1.30 | ns    |
| t <sub>EXP</sub>                  | t <sub>MCELL</sub>                                        | Product term expander delay                | —    | 0.40 | —    | 0.40 | —    | 0.45 | ns    |
| t <sub>ORP</sub>                  | —                                                         | Output routing pool delay                  | —    | 0.40 | —    | 0.40 | —    | 0.40 | ns    |
| t <sub>BLA</sub>                  | t <sub>ROUTE</sub>                                        | Additional block load-ing adder            | —    | 0.04 | —    | 0.05 | —    | 0.05 | ns    |
| t <sub>IOI</sub> Input Adjusters  |                                                           |                                            |      |      |      |      |      |      |       |
| LVTTTL_in                         | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVTTTL standard                      | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS33_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 3.3 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS25_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 2.5 standard                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| LVC MOS18_in                      | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using LVC MOS 1.8 standard                 | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_in                            | t <sub>IN</sub> , t <sub>GCLK_IN</sub> , t <sub>GOE</sub> | Using PCI compatible input                 | —    | 0.60 | —    | 0.60 | —    | 0.60 | ns    |
| t <sub>IOO</sub> Output Adjusters |                                                           |                                            |      |      |      |      |      |      |       |
| LVTTTL_out                        | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as TTL buffer            | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS33_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 3.3V buffer           | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| LVC MOS25_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 2.5V buffer           | —    | 0.10 | —    | 0.10 | —    | 0.10 | ns    |
| LVC MOS18_out                     | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as 1.8V buffer           | —    | 0.00 | —    | 0.00 | —    | 0.00 | ns    |
| PCI_out                           | t <sub>BUF</sub> , t <sub>EN</sub> , t <sub>DIS</sub>     | Output configured as PCI compatible buffer | —    | 0.20 | —    | 0.20 | —    | 0.20 | ns    |
| Slow Slew                         | t <sub>BUF</sub> , t <sub>EN</sub>                        | Output configured for slow slew rate       | —    | 1.00 | —    | 1.00 | —    | 1.00 | ns    |

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

Timing v.2.2

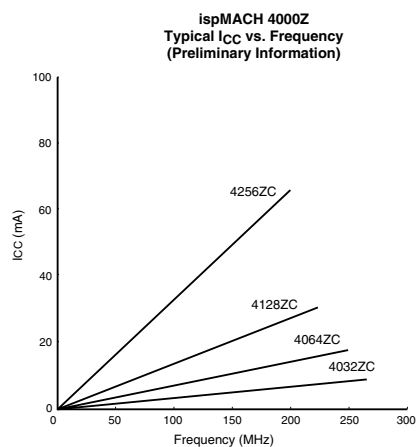
1. Refer to TN1004, [ispMACH 4000 Timing Model Design and Usage Guidelines](#) for information regarding the use of these adders.



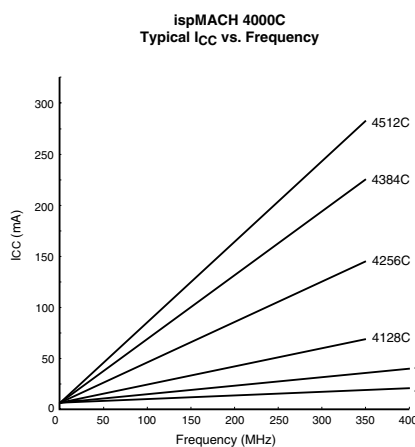
## Boundary Scan Waveforms and Timing Specifications

| Symbol       | Parameter                                                      | Min. | Max. | Units |
|--------------|----------------------------------------------------------------|------|------|-------|
| $t_{BTCP}$   | TCK [BSCAN test] clock cycle                                   | 40   | —    | ns    |
| $t_{BTCH}$   | TCK [BSCAN test] pulse width high                              | 20   | —    | ns    |
| $t_{BTCL}$   | TCK [BSCAN test] pulse width low                               | 20   | —    | ns    |
| $t_{BTSU}$   | TCK [BSCAN test] setup time                                    | 8    | —    | ns    |
| $t_{BTH}$    | TCK [BSCAN test] hold time                                     | 10   | —    | ns    |
| $t_{BRF}$    | TCK [BSCAN test] rise and fall time                            | 50   | —    | mV/ns |
| $t_{BTCO}$   | TAP controller falling edge of clock to valid output           | —    | 10   | ns    |
| $t_{BTOZ}$   | TAP controller falling edge of clock to data output disable    | —    | 10   | ns    |
| $t_{BTVO}$   | TAP controller falling edge of clock to data output enable     | —    | 10   | ns    |
| $t_{BTCPSU}$ | BSCAN test Capture register setup time                         | 8    | —    | ns    |
| $t_{BTCPH}$  | BSCAN test Capture register hold time                          | 10   | —    | ns    |
| $t_{BTUCO}$  | BSCAN test Update reg, falling edge of clock to valid output   | —    | 25   | ns    |
| $t_{BTUOZ}$  | BSCAN test Update reg, falling edge of clock to output disable | —    | 25   | ns    |
| $t_{BTUOV}$  | BSCAN test Update reg, falling edge of clock to output enable  | —    | 25   | ns    |

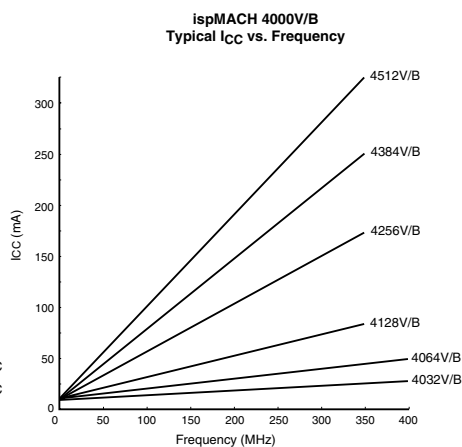
## Power Consumption



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>

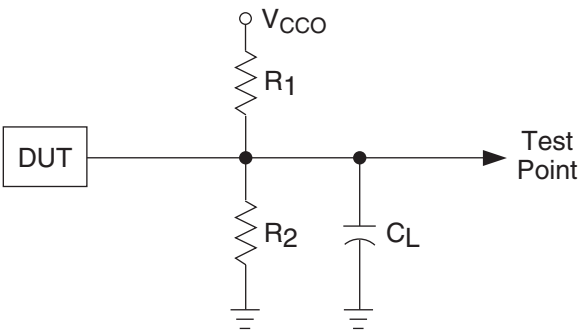
| Device          | A     | B     |
|-----------------|-------|-------|
| ispMACH 4032V/B | 11.3  | 0.010 |
| ispMACH 4032C   | 1.3   | 0.010 |
| ispMACH 4064V/B | 11.5  | 0.010 |
| ispMACH 4064C   | 1.5   | 0.010 |
| ispMACH 4128V/B | 11.5  | 0.011 |
| ispMACH 4128C   | 1.5   | 0.011 |
| ispMACH 4256V/B | 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](#).

Switching Test Conditions

Figure 12 shows the output test load that is used for AC testing. The specific values for resistance, capacitance, voltage, and other test conditions are shown in Table 11.

Figure 12. Output Test Load, LVTTTL and LVCMOS Standards



0213A/ispm4k

Table 11. Test Fixture Required Components

| Test Condition               | $R_1$        | $R_2$        | $C_L^1$ | Timing Ref.              | $V_{CCO}$          |
|------------------------------|--------------|--------------|---------|--------------------------|--------------------|
| LVCMOS I/O, (L -> H, H -> L) | 106 $\Omega$ | 106 $\Omega$ | 35pF    | LVCMOS 3.3 = 1.5V        | LVCMOS 3.3 = 3.0V  |
|                              |              |              |         | LVCMOS 2.5 = $V_{CCO}/2$ | LVCMOS 2.5 = 2.3V  |
|                              |              |              |         | LVCMOS 1.8 = $V_{CCO}/2$ | LVCMOS 1.8 = 1.65V |
| LVCMOS I/O (Z -> H)          | $\infty$     | 106 $\Omega$ | 35pF    | 1.5V                     | 3.0V               |
| LVCMOS I/O (Z -> L)          | 106 $\Omega$ | $\infty$     | 35pF    | 1.5V                     | 3.0V               |
| LVCMOS I/O (H -> Z)          | $\infty$     | 106 $\Omega$ | 5pF     | $V_{OH} - 0.3$           | 3.0V               |
| LVCMOS I/O (L -> Z)          | 106 $\Omega$ | $\infty$     | 5pF     | $V_{OL} + 0.3$           | 3.0V               |

1.  $C_L$  includes test fixtures and probe capacitance.

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

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

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

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

**ispMACH 4032Z and 4064Z Logic Signal Connections: 56-Ball csBGA (Cont.)**

| Ball Number | Bank Number | ispMACH 4032Z   |                 | ispMACH 4064Z  |                |
|-------------|-------------|-----------------|-----------------|----------------|----------------|
|             |             | GLB/MC/Pad      | ORP             | GLB/MC/Pad     | ORP            |
| K5          | 0           | A15             | A <sup>15</sup> | B0             | B <sup>0</sup> |
| H6          | 0           | CLK1/I          | -               | CLK1/I         | -              |
| K6          | 1           | CLK2/I          | -               | CLK2/I         | -              |
| H7          | 1           | B0              | B <sup>0</sup>  | C0             | C <sup>0</sup> |
| K7          | 1           | B1              | B <sup>1</sup>  | C1             | C <sup>1</sup> |
| K8          | 1           | B2              | B <sup>2</sup>  | C2             | C <sup>2</sup> |
| K9          | 1           | B3              | B <sup>3</sup>  | C4             | C <sup>3</sup> |
| K10         | 1           | B4              | B <sup>4</sup>  | C6             | C <sup>4</sup> |
| J10         | -           | TMS             | -               | TMS            | -              |
| H8          | 1           | B5              | B <sup>5</sup>  | C8             | C <sup>5</sup> |
| H10         | 1           | B6              | B <sup>6</sup>  | C10            | C <sup>6</sup> |
| G10         | 1           | B7              | B <sup>7</sup>  | C11            | C <sup>7</sup> |
| G8          | 1           | GND (Bank 1)    | -               | GND (Bank 1)   | -              |
| F8          | 1           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| F10         | 1           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| E8          | 1           | VCCO (Bank 1)   | -               | VCCO (Bank 1)  | -              |
| E10         | 1           | B8              | B <sup>8</sup>  | D15            | D <sup>7</sup> |
| D8          | 1           | B9              | B <sup>9</sup>  | D12            | D <sup>6</sup> |
| D10         | 1           | B10             | B <sup>10</sup> | D10            | D <sup>5</sup> |
| C10         | 1           | B11             | B <sup>11</sup> | D8             | D <sup>4</sup> |
| B10         | 1           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| A10         | -           | TDO             | -               | TDO            | -              |
| A9          | -           | VCC             | -               | VCC            | -              |
| C8          | -           | GND             | -               | GND            | -              |
| A8          | 1           | NC <sup>1</sup> | -               | I <sup>1</sup> | -              |
| A7          | 1           | B12             | B <sup>12</sup> | D6             | D <sup>3</sup> |
| C7          | 1           | B13             | B <sup>13</sup> | D4             | D <sup>2</sup> |
| C6          | 1           | B14             | B <sup>14</sup> | D2             | D <sup>1</sup> |
| A6          | 1           | B15/GOE1        | B <sup>15</sup> | D0/GOE1        | D <sup>0</sup> |
| C5          | 1           | CLK3/I          | -               | CLK3/I         | -              |
| A5          | 0           | CLK0/I          | -               | CLK0/I         | -              |
| C4          | 0           | A0/GOE0         | A <sup>0</sup>  | A0/GOE0        | A <sup>0</sup> |
| A4          | 0           | A1              | A <sup>1</sup>  | A1             | A <sup>1</sup> |
| A3          | 0           | A2              | A <sup>2</sup>  | A2             | A <sup>2</sup> |
| A2          | 0           | A3              | A <sup>3</sup>  | A4             | A <sup>3</sup> |
| A1          | 0           | A4              | A <sup>4</sup>  | A6             | A <sup>4</sup> |

1. For device migration considerations, these NC pins are input signal pins in ispMACH 4064Z devices.

**ispMACH 4064V/B/C/Z, 4128V/B/C/Z, 4256V/B/C/Z Logic Signal Connections:  
100-Pin TQFP**

| Pin Number | Bank Number | ispMACH 4064V/B/C/Z |      | ispMACH 4128V/B/C/Z |     | ispMACH 4256V/B/C/Z |     |
|------------|-------------|---------------------|------|---------------------|-----|---------------------|-----|
|            |             | GLB/MC/Pad          | ORP  | GLB/MC/Pad          | ORP | GLB/MC/Pad          | ORP |
| 1          | -           | GND                 | -    | GND                 | -   | GND                 | -   |
| 2          | -           | TDI                 | -    | TDI                 | -   | TDI                 | -   |
| 3          | 0           | A8                  | A^8  | B0                  | B^0 | C12                 | C^3 |
| 4          | 0           | A9                  | A^9  | B2                  | B^1 | C10                 | C^2 |
| 5          | 0           | A10                 | A^10 | B4                  | B^2 | C6                  | C^1 |
| 6          | 0           | A11                 | A^11 | B6                  | B^3 | C2                  | C^0 |
| 7          | 0           | GND (Bank 0)        | -    | GND (Bank 0)        | -   | GND (Bank 0)        | -   |
| 8          | 0           | A12                 | A^12 | B8                  | B^4 | D12                 | D^3 |
| 9          | 0           | A13                 | A^13 | B10                 | B^5 | D10                 | D^2 |
| 10         | 0           | A14                 | A^14 | B12                 | B^6 | D6                  | D^1 |
| 11         | 0           | A15                 | A^15 | B13                 | B^7 | D4                  | D^0 |
| 12*        | 0           | I                   | -    | I                   | -   | I                   | -   |
| 13         | 0           | VCCO (Bank 0)       | -    | VCCO (Bank 0)       | -   | VCCO (Bank 0)       | -   |
| 14         | 0           | B15                 | B^15 | C14                 | C^7 | E4                  | E^0 |
| 15         | 0           | B14                 | B^14 | C12                 | C^6 | E6                  | E^1 |
| 16         | 0           | B13                 | B^13 | C10                 | C^5 | E10                 | E^2 |
| 17         | 0           | B12                 | B^12 | C8                  | C^4 | E12                 | E^3 |
| 18         | 0           | GND (Bank 0)        | -    | GND (Bank 0)        | -   | GND (Bank 0)        | -   |
| 19         | 0           | B11                 | B^11 | C6                  | C^3 | F2                  | F^0 |
| 20         | 0           | B10                 | B^10 | C5                  | C^2 | F6                  | F^1 |
| 21         | 0           | B9                  | B^9  | C4                  | C^1 | F10                 | F^2 |
| 22         | 0           | B8                  | B^8  | C2                  | C^0 | F12                 | F^3 |
| 23*        | 0           | I                   | -    | I                   | -   | I                   | -   |
| 24         | -           | TCK                 | -    | TCK                 | -   | TCK                 | -   |
| 25         | -           | VCC                 | -    | VCC                 | -   | VCC                 | -   |
| 26         | -           | GND                 | -    | GND                 | -   | GND                 | -   |
| 27*        | 0           | I                   | -    | I                   | -   | I                   | -   |
| 28         | 0           | B7                  | B^7  | D13                 | D^7 | G12                 | G^3 |
| 29         | 0           | B6                  | B^6  | D12                 | D^6 | G10                 | G^2 |
| 30         | 0           | B5                  | B^5  | D10                 | D^5 | G6                  | G^1 |
| 31         | 0           | B4                  | B^4  | D8                  | D^4 | G2                  | G^0 |
| 32         | 0           | GND (Bank 0)        | -    | GND (Bank 0)        | -   | GND (Bank 0)        | -   |
| 33         | 0           | VCCO (Bank 0)       | -    | VCCO (Bank 0)       | -   | VCCO (Bank 0)       | -   |
| 34         | 0           | B3                  | B^3  | D6                  | D^3 | H12                 | H^3 |
| 35         | 0           | B2                  | B^2  | D4                  | D^2 | H10                 | H^2 |
| 36         | 0           | B1                  | B^1  | D2                  | D^1 | H6                  | H^1 |
| 37         | 0           | B0                  | B^0  | D0                  | D^0 | H2                  | H^0 |
| 38         | 0           | CLK1/I              | -    | CLK1/I              | -   | CLK1/I              | -   |
| 39         | 1           | CLK2/I              | -    | CLK2/I              | -   | CLK2/I              | -   |
| 40         | -           | VCC                 | -    | VCC                 | -   | VCC                 | -   |
| 41         | 1           | C0                  | C^0  | E0                  | E^0 | I2                  | I^0 |

**ispMACH 4064V/B/C/Z, 4128V/B/C/Z, 4256V/B/C/Z Logic Signal Connections:  
100-Pin TQFP (Cont.)**

| Pin Number | Bank Number | ispMACH 4064V/B/C/Z |                | ispMACH 4128V/B/C/Z |                | ispMACH 4256V/B/C/Z |                |
|------------|-------------|---------------------|----------------|---------------------|----------------|---------------------|----------------|
|            |             | GLB/MC/Pad          | ORP            | GLB/MC/Pad          | ORP            | GLB/MC/Pad          | ORP            |
| 83         | 1           | VCCO (Bank 1)       | -              | VCCO (Bank 1)       | -              | VCCO (Bank 1)       | -              |
| 84         | 1           | D3                  | D <sup>3</sup> | H6                  | H <sup>3</sup> | P12                 | P <sup>3</sup> |
| 85         | 1           | D2                  | D <sup>2</sup> | H4                  | H <sup>2</sup> | P10                 | P <sup>2</sup> |
| 86         | 1           | D1                  | D <sup>1</sup> | H2                  | H <sup>1</sup> | P6                  | P <sup>1</sup> |
| 87         | 1           | D0/GOE1             | D <sup>0</sup> | H0/GOE1             | H <sup>0</sup> | P2/OE1              | P <sup>0</sup> |
| 88         | 1           | CLK3/I              | -              | CLK3/I              | -              | CLK3/I              | -              |
| 89         | 0           | CLK0/I              | -              | CLK0/I              | -              | CLK0/I              | -              |
| 90         | -           | VCC                 | -              | VCC                 | -              | VCC                 | -              |
| 91         | 0           | A0/GOE0             | A <sup>0</sup> | A0/GOE0             | A <sup>0</sup> | A2/GOE0             | A <sup>0</sup> |
| 92         | 0           | A1                  | A <sup>1</sup> | A2                  | A <sup>1</sup> | A6                  | A <sup>1</sup> |
| 93         | 0           | A2                  | A <sup>2</sup> | A4                  | A <sup>2</sup> | A10                 | A <sup>2</sup> |
| 94         | 0           | A3                  | A <sup>3</sup> | A6                  | A <sup>3</sup> | A12                 | A <sup>3</sup> |
| 95         | 0           | VCCO (Bank 0)       | -              | VCCO (Bank 0)       | -              | VCCO (Bank 0)       | -              |
| 96         | 0           | GND (Bank 0)        | -              | GND (Bank 0)        | -              | GND (Bank 0)        | -              |
| 97         | 0           | A4                  | A <sup>4</sup> | A8                  | A <sup>4</sup> | B2                  | B <sup>0</sup> |
| 98         | 0           | A5                  | A <sup>5</sup> | A10                 | A <sup>5</sup> | B6                  | B <sup>1</sup> |
| 99         | 0           | A6                  | A <sup>6</sup> | A12                 | A <sup>6</sup> | B10                 | B <sup>2</sup> |
| 100        | 0           | A7                  | A <sup>7</sup> | A14                 | A <sup>7</sup> | B12                 | B <sup>3</sup> |

\*This pin is input only.

**ispMACH 4128V/B/C Logic Signal Connections: 128-Pin TQFP**

| Pin Number | Bank Number | ispMACH 4128V/B/C |                 |
|------------|-------------|-------------------|-----------------|
|            |             | GLB/MC/Pad        | ORP             |
| 1          | 0           | GND               | -               |
| 2          | 0           | TDI               | -               |
| 3          | 0           | VCCO (Bank 0)     | -               |
| 4          | 0           | B0                | B <sup>0</sup>  |
| 5          | 0           | B1                | B <sup>1</sup>  |
| 6          | 0           | B2                | B <sup>2</sup>  |
| 7          | 0           | B4                | B <sup>3</sup>  |
| 8          | 0           | B5                | B <sup>4</sup>  |
| 9          | 0           | B6                | B <sup>5</sup>  |
| 10         | 0           | GND (Bank 0)      | -               |
| 11         | 0           | B8                | B <sup>6</sup>  |
| 12         | 0           | B9                | B <sup>7</sup>  |
| 13         | 0           | B10               | B <sup>8</sup>  |
| 14         | 0           | B12               | B <sup>9</sup>  |
| 15         | 0           | B13               | B <sup>10</sup> |
| 16         | 0           | B14               | B <sup>11</sup> |
| 17         | 0           | VCCO (Bank 0)     | -               |
| 18         | 0           | C14               | C <sup>11</sup> |

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

| Pin Number | Bank Number | ispMACH 4128V/B/C |                 |
|------------|-------------|-------------------|-----------------|
|            |             | GLB/MC/Pad        | ORP             |
| 19         | 0           | C13               | C <sup>10</sup> |
| 20         | 0           | C12               | C <sup>9</sup>  |
| 21         | 0           | C10               | C <sup>8</sup>  |
| 22         | 0           | C9                | C <sup>7</sup>  |
| 23         | 0           | C8                | C <sup>6</sup>  |
| 24         | 0           | GND (Bank 0)      | -               |
| 25         | 0           | C6                | C <sup>5</sup>  |
| 26         | 0           | C5                | C <sup>4</sup>  |
| 27         | 0           | C4                | C <sup>3</sup>  |
| 28         | 0           | C2                | C <sup>2</sup>  |
| 29         | 0           | C0                | C <sup>0</sup>  |
| 30         | 0           | VCCO (Bank 0)     | -               |
| 31         | 0           | TCK               | -               |
| 32         | 0           | VCC               | -               |
| 33         | 0           | GND               | -               |
| 34         | 0           | D14               | D <sup>11</sup> |
| 35         | 0           | D13               | D <sup>10</sup> |
| 36         | 0           | D12               | D <sup>9</sup>  |
| 37         | 0           | D10               | D <sup>8</sup>  |
| 38         | 0           | D9                | D <sup>7</sup>  |
| 39         | 0           | D8                | D <sup>6</sup>  |
| 40         | 0           | GND (Bank 0)      | -               |
| 41         | 0           | VCCO (Bank 0)     | -               |
| 42         | 0           | D6                | D <sup>5</sup>  |
| 43         | 0           | D5                | D <sup>4</sup>  |
| 44         | 0           | D4                | D <sup>3</sup>  |
| 45         | 0           | D2                | D <sup>2</sup>  |
| 46         | 0           | D1                | D <sup>1</sup>  |
| 47         | 0           | D0                | D <sup>0</sup>  |
| 48         | 0           | CLK1/I            | -               |
| 49         | 1           | GND (Bank 1)      | -               |
| 50         | 1           | CLK2/I            | -               |
| 51         | 1           | VCC               | -               |
| 52         | 1           | E0                | E <sup>0</sup>  |
| 53         | 1           | E1                | E <sup>1</sup>  |
| 54         | 1           | E2                | E <sup>2</sup>  |
| 55         | 1           | E4                | E <sup>3</sup>  |
| 56         | 1           | E5                | E <sup>4</sup>  |
| 57         | 1           | E6                | E <sup>5</sup>  |
| 58         | 1           | VCCO (Bank 1)     | -               |
| 59         | 1           | GND (Bank 1)      | -               |
| 60         | 1           | E8                | E <sup>6</sup>  |
| 61         | 1           | E9                | E <sup>7</sup>  |



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

| Device  | Part Number                  | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|------------------------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4512V | LC4512V-35FT256C             | 512        | 3.3     | 3.5             | ftBGA   | 256            | 208 | C     |
|         | LC4512V-5FT256C              | 512        | 3.3     | 5               | ftBGA   | 256            | 208 | C     |
|         | LC4512V-75FT256C             | 512        | 3.3     | 7.5             | ftBGA   | 256            | 208 | C     |
|         | LC4512V-35F256C <sup>1</sup> | 512        | 3.3     | 3.5             | fpBGA   | 256            | 208 | C     |
|         | LC4512V-5F256C <sup>1</sup>  | 512        | 3.3     | 5               | fpBGA   | 256            | 208 | C     |
|         | LC4512V-75F256C <sup>1</sup> | 512        | 3.3     | 7.5             | fpBGA   | 256            | 208 | C     |
|         | LC4512V-35T176C              | 512        | 3.3     | 3.5             | TQFP    | 176            | 128 | C     |
|         | LC4512V-5T176C               | 512        | 3.3     | 5               | TQFP    | 176            | 128 | C     |
|         | LC4512V-75T176C              | 512        | 3.3     | 7.5             | TQFP    | 176            | 128 | C     |

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

## ispMACH 4000V (3.3V) Industrial Devices

| Family  | Part Number     | Macrocells | Voltage | t <sub>PD</sub> | Package | Pin/Ball Count | I/O | Grade |
|---------|-----------------|------------|---------|-----------------|---------|----------------|-----|-------|
| LC4032V | LC4032V-5T48I   | 32         | 3.3     | 5               | TQFP    | 48             | 32  | I     |
|         | LC4032V-75T48I  | 32         | 3.3     | 7.5             | TQFP    | 48             | 32  | I     |
|         | LC4032V-10T48I  | 32         | 3.3     | 10              | TQFP    | 48             | 32  | I     |
|         | LC4032V-5T44I   | 32         | 3.3     | 5               | TQFP    | 44             | 30  | I     |
|         | LC4032V-75T44I  | 32         | 3.3     | 7.5             | TQFP    | 44             | 30  | I     |
|         | LC4032V-10T44I  | 32         | 3.3     | 10              | TQFP    | 44             | 30  | I     |
| LC4064V | LC4064V-5T100I  | 64         | 3.3     | 5               | TQFP    | 100            | 64  | I     |
|         | LC4064V-75T100I | 64         | 3.3     | 7.5             | TQFP    | 100            | 64  | I     |
|         | LC4064V-10T100I | 64         | 3.3     | 10              | TQFP    | 100            | 64  | I     |
|         | LC4064V-5T48I   | 64         | 3.3     | 5               | TQFP    | 48             | 32  | I     |
|         | LC4064V-75T48I  | 64         | 3.3     | 7.5             | TQFP    | 48             | 32  | I     |
|         | LC4064V-10T48I  | 64         | 3.3     | 10              | TQFP    | 48             | 32  | I     |
|         | LC4064V-5T44I   | 64         | 3.3     | 5               | TQFP    | 44             | 30  | I     |
|         | LC4064V-75T44I  | 64         | 3.3     | 7.5             | TQFP    | 44             | 30  | I     |
|         | LC4064V-10T44I  | 64         | 3.3     | 10              | TQFP    | 44             | 30  | I     |
| LC4128V | LC4128V-5T144I  | 128        | 3.3     | 5               | TQFP    | 144            | 96  | I     |
|         | LC4128V-75T144I | 128        | 3.3     | 7.5             | TQFP    | 144            | 96  | I     |
|         | LC4128V-10T144I | 128        | 3.3     | 10              | TQFP    | 144            | 96  | I     |
|         | LC4128V-5T128I  | 128        | 3.3     | 5               | TQFP    | 128            | 92  | I     |
|         | LC4128V-75T128I | 128        | 3.3     | 7.5             | TQFP    | 128            | 92  | I     |
|         | LC4128V-10T128I | 128        | 3.3     | 10              | TQFP    | 128            | 92  | I     |
|         | LC4128V-5T100I  | 128        | 3.3     | 5               | TQFP    | 100            | 64  | I     |
|         | LC4128V-75T100I | 128        | 3.3     | 7.5             | TQFP    | 100            | 64  | I     |
|         | LC4128V-10T100I | 128        | 3.3     | 10              | TQFP    | 100            | 64  | I     |

## 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

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

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

| Device  | Part Number      | Macrocells | Voltage | t <sub>PD</sub> | Package        | Pin/Ball Count | I/O | Grade |
|---------|------------------|------------|---------|-----------------|----------------|----------------|-----|-------|
| LC4032V | LC4032V-5TN48I   | 32         | 3.3     | 5               | Lead-free TQFP | 48             | 32  | I     |
|         | LC4032V-75TN48I  | 32         | 3.3     | 7.5             | Lead-free TQFP | 48             | 32  | I     |
|         | LC4032V-10TN48I  | 32         | 3.3     | 10              | Lead-free TQFP | 48             | 32  | I     |
|         | LC4032V-5TN44I   | 32         | 3.3     | 5               | Lead-free TQFP | 44             | 30  | I     |
|         | LC4032V-75TN44I  | 32         | 3.3     | 7.5             | Lead-free TQFP | 44             | 30  | I     |
|         | LC4032V-10TN44I  | 32         | 3.3     | 10              | Lead-free TQFP | 44             | 30  | I     |
| LC4064V | LC4064V-5TN100I  | 64         | 3.3     | 5               | Lead-free TQFP | 100            | 64  | I     |
|         | LC4064V-75TN100I | 64         | 3.3     | 7.5             | Lead-free TQFP | 100            | 64  | I     |
|         | LC4064V-10TN100I | 64         | 3.3     | 10              | Lead-free TQFP | 100            | 64  | I     |
|         | LC4064V-5TN48I   | 64         | 3.3     | 5               | Lead-free TQFP | 48             | 32  | I     |
|         | LC4064V-75TN48I  | 64         | 3.3     | 7.5             | Lead-free TQFP | 48             | 32  | I     |
|         | LC4064V-10TN48I  | 64         | 3.3     | 10              | Lead-free TQFP | 48             | 32  | I     |
|         | LC4064V-5TN44I   | 64         | 3.3     | 5               | Lead-free TQFP | 44             | 30  | I     |
|         | LC4064V-75TN44I  | 64         | 3.3     | 7.5             | Lead-free TQFP | 44             | 30  | I     |
|         | LC4064V-10TN44I  | 64         | 3.3     | 10              | Lead-free TQFP | 44             | 30  | I     |
| LC4128V | LC4128V-5TN144I  | 128        | 3.3     | 5               | Lead-free TQFP | 144            | 96  | I     |
|         | LC4128V-75TN144I | 128        | 3.3     | 7.5             | Lead-free TQFP | 144            | 96  | I     |
|         | LC4128V-10TN144I | 128        | 3.3     | 10              | Lead-free TQFP | 144            | 96  | I     |
|         | LC4128V-5TN128I  | 128        | 3.3     | 5               | Lead-free TQFP | 128            | 92  | I     |
|         | LC4128V-75TN128I | 128        | 3.3     | 7.5             | Lead-free TQFP | 128            | 92  | I     |
|         | LC4128V-10TN128I | 128        | 3.3     | 10              | Lead-free TQFP | 128            | 92  | I     |
|         | LC4128V-5TN100I  | 128        | 3.3     | 5               | Lead-free TQFP | 100            | 64  | I     |
|         | LC4128V-75TN100I | 128        | 3.3     | 7.5             | Lead-free TQFP | 100            | 64  | I     |
|         | LC4128V-10TN100I | 128        | 3.3     | 10              | Lead-free TQFP | 100            | 64  | I     |