



## Features

### ■ High Performance

- $f_{MAX}$  = 400MHz maximum operating frequency
- $t_{PD}$  = 2.5ns propagation delay
- Up to four global clock pins with programmable clock polarity control
- Up to 80 PTs per output

### ■ Ease of Design

- Enhanced macrocells with individual clock, reset, preset and clock enable controls
- Up to four global OE controls
- Individual local OE control per I/O pin
- Excellent First-Time-Fit<sup>™</sup> and refit
- Fast path, SpeedLocking<sup>™</sup> Path, and wide-PT path
- Wide input gating (36 input logic blocks) for fast counters, state machines and address decoders

### ■ Zero Power (ispMACH 4000Z) and Low Power (ispMACH 4000V/B/C)

- Typical static current 10 $\mu$ A (4032Z)
- Typical static current 1.3mA (4000C)
- 1.8V core low dynamic power
- ispMACH 4000Z operational down to 1.6V  $V_{CC}$

### ■ Broad Device Offering

- Multiple temperature range support
  - Commercial: 0 to 90°C junction ( $T_j$ )
  - Industrial: -40 to 105°C junction ( $T_j$ )
  - Extended: -40 to 130°C junction ( $T_j$ )
- For AEC-Q100 compliant devices, refer to LA-ispMACH 4000V/Z Automotive Data Sheet

### ■ Easy System Integration

- Superior solution for power sensitive consumer applications
- Operation with 3.3V, 2.5V or 1.8V LVCMOS I/O
- Operation with 3.3V (4000V), 2.5V (4000B) or 1.8V (4000C/Z) supplies
- 5V tolerant I/O for LVCMOS 3.3, LVTTTL, and PCI interfaces
- Hot-socketing
- Open-drain capability
- Input pull-up, pull-down or bus-keeper
- Programmable output slew rate
- 3.3V PCI compatible
- IEEE 1149.1 boundary scan testable
- 3.3V/2.5V/1.8V In-System Programmable (ISP<sup>™</sup>) using IEEE 1532 compliant interface
- I/O pins with fast setup path
- Lead-free package options

Table 1. ispMACH 4000V/B/C Family Selection Guide

	ispMACH 4032V/B/C	ispMACH 4064V/B/C	ispMACH 4128V/B/C	ispMACH 4256V/B/C	ispMACH 4384V/B/C	ispMACH 4512V/B/C
Macrocells	32	64	128	256	384	512
I/O + Dedicated Inputs	30+2/32+4	30+2/32+4/ 64+10	64+10/92+4/ 96+4	64+10/96+14/ 128+4/160+4	128+4/192+4	128+4/208+4
$t_{PD}$ (ns)	2.5	2.5	2.7	3.0	3.5	3.5
$t_S$ (ns)	1.8	1.8	1.8	2.0	2.0	2.0
$t_{CO}$ (ns)	2.2	2.2	2.7	2.7	2.7	2.7
$f_{MAX}$ (MHz)	400	400	333	322	322	322
Supply Voltages (V)	3.3/2.5/1.8V	3.3/2.5/1.8V	3.3/2.5/1.8V	3.3/2.5/1.8V	3.3/2.5/1.8V	3.3/2.5/1.8V
Pins/Package	44 TQFP 48 TQFP	44 TQFP 48 TQFP 100 TQFP	100 TQFP 128 TQFP 144 TQFP <sup>1</sup>	100 TQFP  144 TQFP <sup>1</sup> 176 TQFP 256 ftBGA <sup>2</sup> / fpBGA <sup>2,3</sup>	176 TQFP 256 ftBGA/ fpBGA <sup>3</sup>	176 TQFP 256 ftBGA/ fpBGA <sup>3</sup>

1. 3.3V (4000V) only.

2. 128-I/O and 160-I/O configurations.

3. Use 256 ftBGA package for all new designs. Refer to PCN#14A-07 for 256 fpBGA package discontinuance.

**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/ 64+10/64+10	64+10/96+4	64+10/96+6/ 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 56 csBGA	48 TQFP 56 csBGA 100 TQFP 132 csBGA	100 TQFP 132csBGA	100 TQFP 132 csBGA 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.

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

	ispMACH 4000C/Z (1.8V)	ispMACH 4000B (2.5V)	ispMACH 4000V (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	
$V_{CC}$	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	
$T_j$	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	$0 \leq V_{IN} \leq 3.0V, T_j = 105^\circ C$	—	±30	±150	µA
		$0 \leq V_{IN} \leq 3.0V, T_j = 130^\circ C$	—	±30	±200	µA

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.

## I/O Recommended Operating Conditions

Standard	$V_{CCO}$ (V) <sup>1</sup>	
	Min.	Max.
LVTTTL	3.0	3.6
LVC MOS 3.3	3.0	3.6
Extended LVC MOS 3.3 <sup>2</sup>	2.7	3.6
LVC MOS 2.5	2.3	2.7
LVC MOS 1.8	1.65	1.95
PCI 3.3	3.0	3.6

1. Typical values for  $V_{CCO}$  are the average of the min. and max. values.
2. ispMACH 4000Z only.

## DC Electrical Characteristics

### Over Recommended Operating Conditions

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$I_{IL}, I_{IH}^{1,4}$	Input Leakage Current (ispMACH 4000Z)	$0 \leq V_{IN} < V_{CCO}$	—	0.5	1	$\mu A$
$I_{IH}^1$	Input High Leakage Current (ispMACH 4000Z)	$V_{CCO} < V_{IN} \leq 5.5V$	—	—	10	$\mu A$
$I_{IL}, I_{IH}^1$	Input Leakage Current (ispMACH 4000V/B/C)	$0 \leq V_{IN} \leq 3.6V, T_j = 105^\circ C$	—	—	10	$\mu A$
		$0 \leq V_{IN} \leq 3.6V, T_j = 130^\circ C$	—	—	15	$\mu A$
$I_{IH}^{1,2}$	Input High Leakage Current (ispMACH 4000V/B/C)	$3.6V < V_{IN} \leq 5.5V, T_j = 105^\circ C$ $3.0V \leq V_{CCO} \leq 3.6V$	—	—	20	$\mu A$
		$3.6V < V_{IN} \leq 5.5V, T_j = 130^\circ C$ $3.0V \leq V_{CCO} \leq 3.6V$	—	—	50	$\mu A$
$I_{PU}$	I/O Weak Pull-up Resistor Current (ispMACH 4000Z)	$0 \leq V_{IN} \leq 0.7V_{CCO}$	-30	—	-150	$\mu A$
	I/O Weak Pull-up Resistor Current (ispMACH 4000V/B/C)	$0 \leq V_{IN} \leq 0.7V_{CCO}$	-30	—	-200	$\mu A$
$I_{PD}$	I/O Weak Pull-down Resistor Current	$V_{IL} (MAX) \leq V_{IN} \leq V_{IH} (MIN)$	30	—	150	$\mu A$
$I_{BHLS}$	Bus Hold Low Sustaining Current	$V_{IN} = V_{IL} (MAX)$	30	—	—	$\mu A$
$I_{BHHS}$	Bus Hold High Sustaining Current	$V_{IN} = 0.7 V_{CCO}$	-30	—	—	$\mu A$
$I_{BHLO}$	Bus Hold Low Overdrive Current	$0V \leq V_{IN} \leq V_{BHT}$	—	—	150	$\mu A$
$I_{BHHO}$	Bus Hold High Overdrive Current	$V_{BHT} \leq V_{IN} \leq V_{CCO}$	—	—	-150	$\mu A$
$V_{BHT}$	Bus Hold Trip Points	—	$V_{CCO} * 0.35$	—	$V_{CCO} * 0.65$	V
$C_1$	I/O Capacitance <sup>3</sup>	$V_{CCO} = 3.3V, 2.5V, 1.8V$	—	8	—	pf
		$V_{CC} = 1.8V, V_{IO} = 0$ to $V_{IH} (MAX)$	—		—	
$C_2$	Clock Capacitance <sup>3</sup>	$V_{CCO} = 3.3V, 2.5V, 1.8V$	—	6	—	pf
		$V_{CC} = 1.8V, V_{IO} = 0$ to $V_{IH} (MAX)$	—		—	
$C_3$	Global Input Capacitance <sup>3</sup>	$V_{CCO} = 3.3V, 2.5V, 1.8V$	—	6	—	pf
		$V_{CC} = 1.8V, V_{IO} = 0$ to $V_{IH} (MAX)$	—		—	

1. Input or I/O leakage current is measured with the pin configured as an input or as an I/O with the output driver tristated. It is not measured with the output driver active. Bus maintenance circuits are disabled.
2. 5V tolerant inputs and I/O should only be placed in banks where  $3.0V \leq V_{CCO} \leq 3.6V$ .
3.  $T_A = 25^\circ C, f = 1.0MHz$
4.  $I_{IH}$  excursions of up to 1.5 $\mu A$  maximum per pin above the spec limit may be observed for certain voltage conditions on no more than 10% of the device's I/O pins.

## Supply Current, ispMACH 4000V/B/C

## Over Recommended Operating Conditions

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
<b>ispMACH 4032V/B/C</b>						
ICC <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	11.8	—	mA
		V <sub>CC</sub> = 2.5V	—	11.8	—	mA
		V <sub>CC</sub> = 1.8V	—	1.8	—	mA
ICC <sup>4</sup>	Standby Power Supply Current	V <sub>CC</sub> = 3.3V	—	11.3	—	mA
		V <sub>CC</sub> = 2.5V	—	11.3	—	mA
		V <sub>CC</sub> = 1.8V	—	1.3	—	mA
<b>ispMACH 4064V/B/C</b>						
ICC <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	12	—	mA
		V <sub>CC</sub> = 2.5V	—	12	—	mA
		V <sub>CC</sub> = 1.8V	—	2	—	mA
ICC <sup>5</sup>	Standby Power Supply Current	V <sub>CC</sub> = 3.3V	—	11.5	—	mA
		V <sub>CC</sub> = 2.5V	—	11.5	—	mA
		V <sub>CC</sub> = 1.8V	—	1.5	—	mA
<b>ispMACH 4128V/B/C</b>						
ICC <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	12	—	mA
		V <sub>CC</sub> = 2.5V	—	12	—	mA
		V <sub>CC</sub> = 1.8V	—	2	—	mA
ICC <sup>4</sup>	Standby Power Supply Current	V <sub>CC</sub> = 3.3V	—	11.5	—	mA
		V <sub>CC</sub> = 2.5V	—	11.5	—	mA
		V <sub>CC</sub> = 1.8V	—	1.5	—	mA
<b>ispMACH 4256V/B/C</b>						
I <sub>CC</sub> <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	12.5	—	mA
		V <sub>CC</sub> = 2.5V	—	12.5	—	mA
		V <sub>CC</sub> = 1.8V	—	2.5	—	mA
I <sub>CC</sub> <sup>4</sup>	Standby Power Supply Current	V <sub>CC</sub> = 3.3V	—	12	—	mA
		V <sub>CC</sub> = 2.5V	—	12	—	mA
		V <sub>CC</sub> = 1.8V	—	2	—	mA
<b>ispMACH 4384V/B/C</b>						
I <sub>CC</sub> <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	13.5	—	mA
		V <sub>CC</sub> = 2.5V	—	13.5	—	mA
		V <sub>CC</sub> = 1.8V	—	3.5	—	mA
I <sub>CC</sub> <sup>4</sup>	Standby Power Supply Current	V <sub>CC</sub> = 3.3V	—	12.5	—	mA
		V <sub>CC</sub> = 2.5V	—	12.5	—	mA
		V <sub>CC</sub> = 1.8V	—	2.5	—	mA
<b>ispMACH 4512V/B/C</b>						
I <sub>CC</sub> <sup>1,2,3</sup>	Operating Power Supply Current	V <sub>CC</sub> = 3.3V	—	14	—	mA
		V <sub>CC</sub> = 2.5V	—	14	—	mA
		V <sub>CC</sub> = 1.8V	—	4	—	mA

## 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
<b>ispMACH 4032ZC</b>						
$ICC^{1,2,3,5}$	Operating Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	50	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	58	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	60	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	70	—	$\mu A$
$ICC^{4,5}$	Standby Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	10	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	13	20	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	15	25	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	22	—	$\mu A$
<b>ispMACH 4064ZC</b>						
$ICC^{1,2,3,5}$	Operating Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	80	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	89	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	92	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	109	—	$\mu A$
$ICC^{4,5}$	Standby Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	11	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	15	25	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	18	35	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	37	—	$\mu A$
<b>ispMACH 4128ZC</b>						
$ICC^{1,2,3,5}$	Operating Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	168	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	190	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	195	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	212	—	$\mu A$
$ICC^{4,5}$	Standby Power Supply Current	$V_{CC} = 1.8V, T_A = 25^\circ C$	—	12	—	$\mu A$
		$V_{CC} = 1.9V, T_A = 70^\circ C$	—	16	35	$\mu A$
		$V_{CC} = 1.9V, T_A = 85^\circ C$	—	19	50	$\mu A$
		$V_{CC} = 1.9V, T_A = 125^\circ C$	—	42	—	$\mu A$

## I/O DC Electrical Characteristics

### Over Recommended Operating Conditions

Standard	$V_{IL}$		$V_{IH}$		$V_{OL}$ Max (V)	$V_{OH}$ Min (V)	$I_{OL}^1$ (mA)	$I_{OH}^1$ (mA)
	Min (V)	Max (V)	Min (V)	Max (V)				
LVTTTL	-0.3	0.80	2.0	5.5	0.40	$V_{CCO} - 0.40$	8.0	-4.0
					0.20	$V_{CCO} - 0.20$	0.1	-0.1
LVCMOS 3.3	-0.3	0.80	2.0	5.5	0.40	$V_{CCO} - 0.40$	8.0	-4.0
					0.20	$V_{CCO} - 0.20$	0.1	-0.1
LVCMOS 2.5	-0.3	0.70	1.70	3.6	0.40	$V_{CCO} - 0.40$	8.0	-4.0
					0.20	$V_{CCO} - 0.20$	0.1	-0.1
LVCMOS 1.8 (4000V/B)	-0.3	0.63	1.17	3.6	0.40	$V_{CCO} - 0.45$	2.0	-2.0
					0.20	$V_{CCO} - 0.20$	0.1	-0.1
LVCMOS 1.8 (4000C/Z)	-0.3	$0.35 * V_{CC}$	$0.65 * V_{CC}$	3.6	0.40	$V_{CCO} - 0.45$	2.0	-2.0
					0.20	$V_{CCO} - 0.20$	0.1	-0.1
PCI 3.3 (4000V/B)	-0.3	1.08	1.5	5.5	$0.1 V_{CCO}$	$0.9 V_{CCO}$	1.5	-0.5
PCI 3.3 (4000C/Z)	-0.3	$0.3 * 3.3 * (V_{CC} / 1.8)$	$0.5 * 3.3 * (V_{CC} / 1.8)$	5.5	$0.1 V_{CCO}$	$0.9 V_{CCO}$	1.5	-0.5

1. The average DC current drawn by I/Os between adjacent bank GND connections, or between the last GND in an I/O bank and the end of the I/O bank, as shown in the logic signals connection table, shall not exceed  $n * 8mA$ . Where  $n$  is the number of I/Os between bank GND connections or between the last GND in a bank and the end of a bank.

## ispMACH 4000V/B/C External Switching Characteristics (Cont.)

Over Recommended Operating Conditions

Parameter	Description <sup>1, 2, 3</sup>	-5		-75		-10		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>PD</sub>	5-PT bypass combinatorial propagation delay	—	5.0	—	7.5	—	10.0	ns
t <sub>PD_MC</sub>	20-PT combinatorial propagation delay through macrocell	—	5.5	—	8.0	—	10.5	ns
t <sub>S</sub>	GLB register setup time before clock	3.0	—	4.5	—	5.5	—	ns
t <sub>ST</sub>	GLB register setup time before clock with T-type register	3.2	—	4.7	—	5.5	—	ns
t <sub>SIR</sub>	GLB register setup time before clock, input register path	1.2	—	1.7	—	1.7	—	ns
t <sub>SIRZ</sub>	GLB register setup time before clock with zero hold	2.2	—	2.7	—	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	1.0	—	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	—	ns
t <sub>CO</sub>	GLB register clock-to-output delay	—	3.4	—	4.5	—	6.0	ns
t <sub>R</sub>	External reset pin to output delay	—	6.3	—	9.0	—	10.5	ns
t <sub>RW</sub>	External reset pulse duration	2.0	—	4.0	—	4.0	—	ns
t <sub>P<sub>TOE/DIS</sub></sub>	Input to output local product term output enable/disable	—	7.0	—	9.0	—	10.5	ns
t <sub>G<sub>P<sub>TOE/DIS</sub></sub></sub>	Input to output global product term output enable/disable	—	9.0	—	10.3	—	12.0	ns
t <sub>G<sub>OE/DIS</sub></sub>	Global OE input to output enable/disable	—	5.0	—	7.0	—	8.0	ns
t <sub>CW</sub>	Global clock width, high or low	2.2	—	3.3	—	4.0	—	ns
t <sub>GW</sub>	Global gate width low (for low transparent) or high (for high transparent)	2.2	—	3.3	—	4.0	—	ns
t <sub>WIR</sub>	Input register clock width, high or low	2.2	—	3.3	—	4.0	—	ns
f <sub>MAX</sub> <sup>4</sup>	Clock frequency with internal feedback	227	—	168	—	125	—	MHz
f <sub>MAX</sub> (Ext.)	Clock frequency with external feedback, [1/ (t <sub>S</sub> + t <sub>CO</sub> )]	156	—	111	—	86	—	MHz

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

Timing v.3.2

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

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

4. Standard 16-bit counter using GRP feedback.



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

Over Recommended Operating Conditions

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

## ispMACH 4000V/B/C Internal Timing Parameters (Cont.)

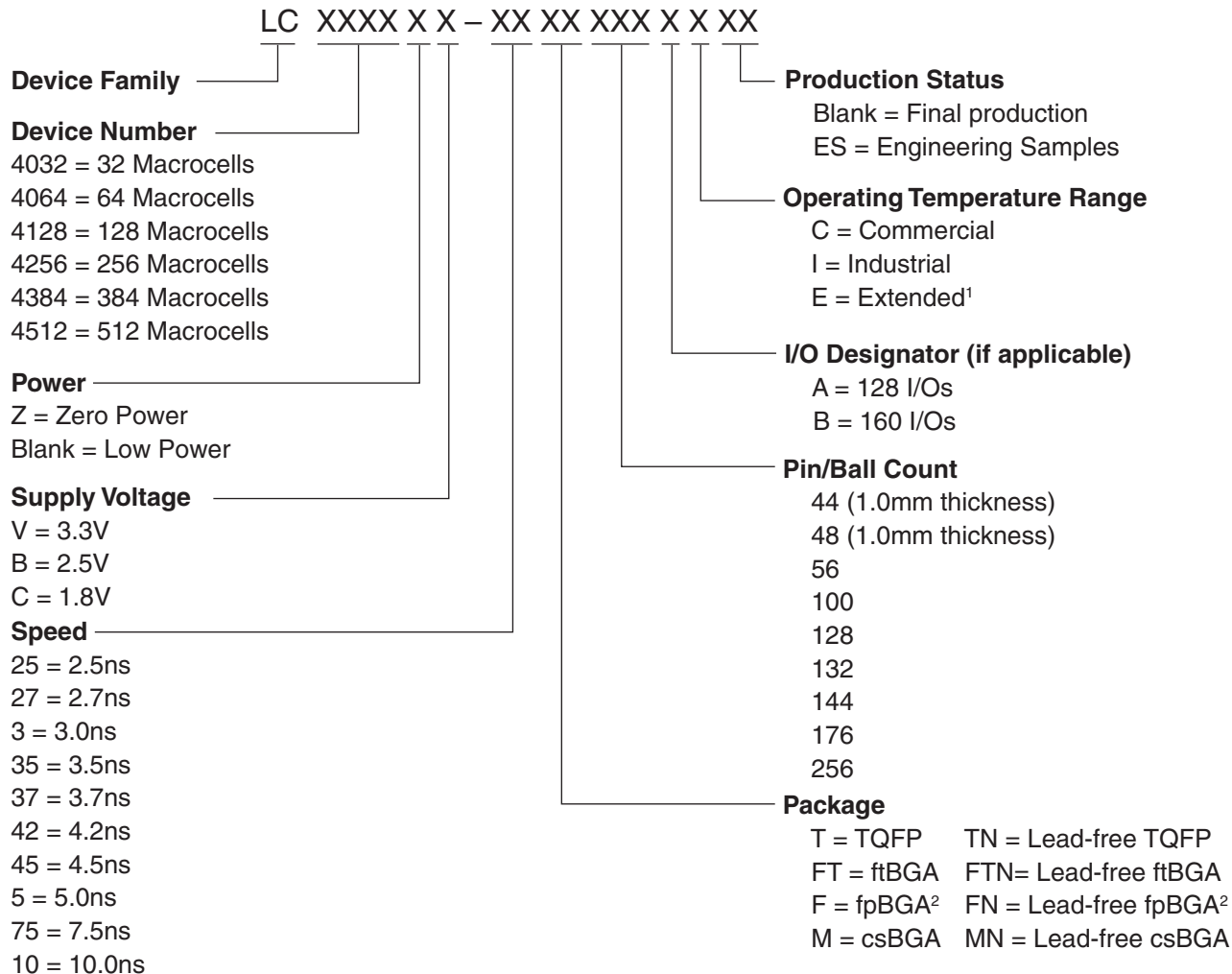
Over Recommended Operating Conditions

Parameter	Description	-5		-75		-10		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>GP</sub> TOE	Global PT OE Delay	—	5.58	—	5.58	—	5.78	ns
t <sub>P</sub> TOE	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 Timing Model in this data sheet for further details.

**Part Number Description**



1. For automotive AEC-Q100 compliant devices, refer to the LA-ispMACH 4000V/Z Automotive Family Data Sheet (DS1017).  
 2. Use ftBGA package. fpBGA package devices have been discontinued via PCN#14A-07.

**ispMACH 4000 Family Speed Grade Offering**

	-25	-27	-3	-35	-37	-42	-45	-5		-75			-10
	Com	Com	Com	Com	Com	Com	Com	Com	Ind	Com	Ind	Ext	Ind
ispMACH 4032V/B/C	✓							✓	✓	✓	✓	✓ <sup>1</sup>	✓
ispMACH 4064V/B/C	✓							✓	✓	✓	✓	✓ <sup>1</sup>	✓
ispMACH 4128V/B/C		✓						✓	✓	✓	✓	✓ <sup>1</sup>	✓
ispMACH 4256V/B/C			✓					✓	✓	✓	✓	✓	✓
ispMACH 4384V/B/C				✓				✓	✓	✓	✓		✓
ispMACH 4512V/B/C				✓				✓	✓	✓	✓		✓
ispMACH 4032ZC				✓				✓	✓	✓	✓	✓ <sup>1</sup>	
ispMACH 4064ZC					✓			✓	✓	✓	✓	✓ <sup>1</sup>	
ispMACH 4128ZC						✓				✓	✓	✓ <sup>1</sup>	
ispMACH 4256ZC							✓			✓	✓	✓	

1. 3.3V only.

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

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

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

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

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

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

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

Device	Part Number	Macrocells	Voltage	t <sub>PD</sub>	Package	Pin/Ball Count	I/O	Grade
LC4064C	LC4064C-25TN100C	64	1.8	2.5	Lead-free TQFP	100	64	C
	LC4064C-5TN100C	64	1.8	5	Lead-free TQFP	100	64	C
	LC4064C-75TN100C	64	1.8	7.5	Lead-free TQFP	100	64	C
	LC4064C-25TN48C	64	1.8	2.5	Lead-free TQFP	48	32	C
	LC4064C-5TN48C	64	1.8	5	Lead-free TQFP	48	32	C
	LC4064C-75TN48C	64	1.8	7.5	Lead-free TQFP	48	32	C
	LC4064C-25TN44C	64	1.8	2.5	Lead-free TQFP	44	30	C
	LC4064C-5TN44C	64	1.8	5	Lead-free TQFP	44	30	C
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	