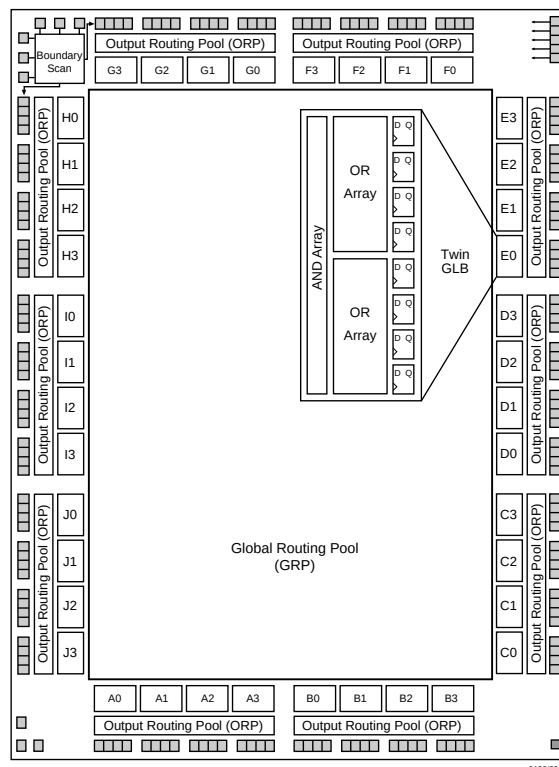


## Features

- **HIGH-DENSITY PROGRAMMABLE LOGIC**
  - 160 I/O Pins
  - 14000 PLD Gates
  - 480 Registers
  - High Speed Global Interconnect
  - Wide Input Gating for Fast Counters, State Machines, Address Decoders, etc.
  - Small Logic Block Size for Random Logic
- **HIGH-PERFORMANCE E<sup>2</sup>CMOS<sup>®</sup> TECHNOLOGY**
  - $f_{max} = 100$  MHz Maximum Operating Frequency
  - $t_{pd} = 10$  ns Propagation Delay
  - TTL Compatible Inputs and Outputs
  - Electrically Erasable and Reprogrammable
  - Non-Volatile
  - 100% Tested at Time of Manufacture
  - Unused Product Term Shutdown Saves Power
- **ispLSI FEATURES:**
  - 5V In-System Programmable (ISP<sup>™</sup>) Using Lattice ISP or Boundary Scan Test (IEEE 1149.1) Protocol
  - Increased Manufacturing Yields, Reduced Time-to-Market, and Improved Product Quality
  - Reprogram Soldered Devices for Faster Debugging
- **100% IEEE 1149.1 BOUNDARY SCAN COMPATIBLE**
- **OFFERS THE EASE OF USE AND FAST SYSTEM SPEED OF PLDs WITH THE DENSITY AND FLEXIBILITY OF FIELD PROGRAMMABLE GATE ARRAYS**
  - Complete Programmable Device Can Combine Glue Logic and Structured Designs
  - Enhanced Pin Locking Capability
  - Five Dedicated Clock Input Pins
  - Synchronous and Asynchronous Clocks
  - Programmable Output Slew Rate Control to Minimize Switching Noise
  - Flexible Pin Placement
  - Optimized Global Routing Pool Provides Global Interconnectivity
  - Pin Compatible with ispLSI 3160
- **ispDesignEXPERT<sup>™</sup> – LOGIC COMPILER AND COMPLETE ISP DEVICE DESIGN SYSTEMS FROM HDL SYNTHESIS THROUGH IN-SYSTEM PROGRAMMING**
  - Superior Quality of Results
  - Tightly Integrated with Leading CAE Vendor Tools
  - Productivity Enhancing Timing Analyzer, Explore Tools, Timing Simulator and ispANALYZER<sup>™</sup>
  - PC and UNIX Platforms

## Functional Block Diagram



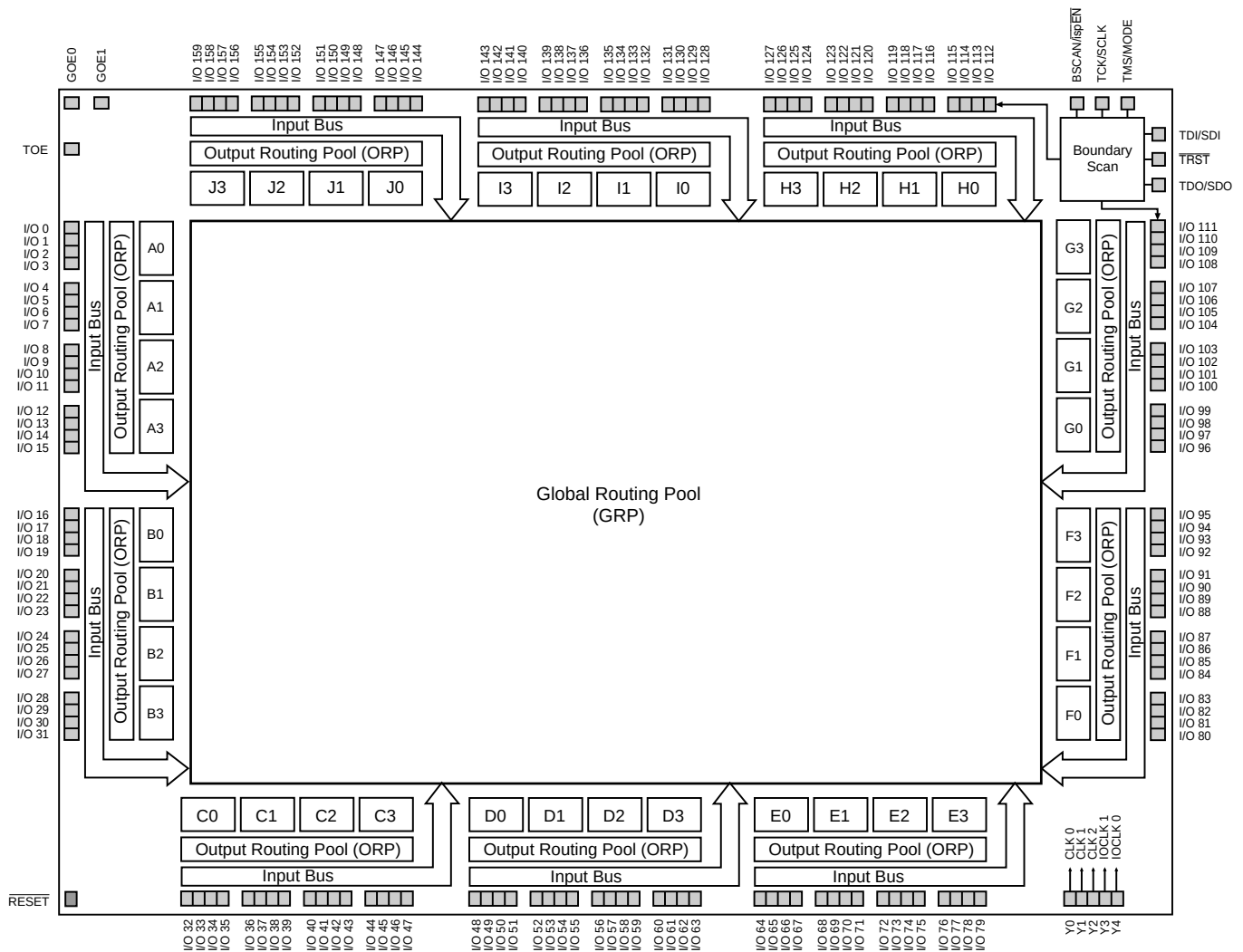
## Description

The ispLSI 3320 is a High-Density Programmable Logic Device containing 480 Registers, 160 Universal I/O pins, five Dedicated Clock Input Pins, ten Output Routing Pools (ORP) and a Global Routing Pool (GRP) which allows complete inter-connectivity between all of these elements. The ispLSI 3320 features 5V in-system programmability and in-system diagnostic capabilities. The ispLSI 3320 offers non-volatile reprogrammability of the logic, as well as the interconnect to provide truly reconfigurable systems.

The basic unit of logic on the ispLSI 3320 device is the Twin Generic Logic Block (Twin GLB) labelled A0, A1...J3. There are a total of 40 of these Twin GLBs in the ispLSI 3320 device. Each Twin GLB has 24 inputs, a programmable AND array and two OR/Exclusive-OR Arrays, and eight outputs which can be configured to be either combinatorial or registered. All Twin GLB inputs come from the GRP.

## Functional Block Diagram

Figure 1. ispLSI 3320 Functional Block Diagram



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## Description (continued)

All local logic block outputs are brought back into the GRP so they can be connected to the inputs of any other logic block on the device. The device also has 160 I/O cells, each of which is directly connected to an I/O pin. Each I/O cell can be individually programmed to be a combinatorial input, a registered input, a latched input, an output or a bidirectional I/O pin with 3-state control. The signal levels are TTL compatible voltages and the output drivers can source 4 mA or sink 8 mA. Each output can be programmed independently for fast or slow output slew rate to minimize overall output switching noise.

The 160 I/O cells are grouped into ten sets of 16 bits. Each of these I/O groups is associated with a logic Megablock through the use of the ORP. Each Megablock is able to provide one Product Term Output Enable (PTOE) signal which is globally distributed to all I/O cells. That PTOE signal can be generated within any GLB in the Megablock. Each I/O cell can select one of 12 available OEs (two Global OEs and ten PTOEs).

Four Twin GLBs, 16 I/O cells and one ORP are connected together to make a logic Megablock. The Megablock is defined by the resources that it shares. The outputs of the four Twin GLBs are connected to a set of 16 I/O cells by the ORP. The ispLSI 3320 Device contains ten of these Megablocks.

The GRP has as its inputs the outputs from all of the Twin GLBs and all of the inputs from the bidirectional I/O cells. All of these signals are made available to the inputs of the Twin GLBs. Delays through the GRP have been equalized to minimize timing skew and logic glitching.

Clocks in the ispLSI 3320 device are provided through five dedicated clock pins. The five pins provide three clocks to the Twin GLBs and two clocks to the I/O cells.

The table below lists key attributes of the device along with the number of resources available.

An additional feature of the ispLSI 3320 is the Boundary Scan capability, which is composed of cells connected between the on-chip system logic and the device's input and output pins. All I/O pins have associated boundary scan registers, with 3-state I/O using three boundary scan registers and inputs using one.

The ispLSI 3320 supports all IEEE 1149.1 mandatory instructions, which include BYPASS, EXTEST and SAMPLE.

## Key Attributes of the ispLSI 3320

| Attribute     | Quantity |
|---------------|----------|
| Twin GLBs     | 40       |
| Registers     | 480      |
| I/O Pins      | 160      |
| Global Clocks | 5        |
| Global OE     | 2        |
| Test OE       | 1        |

Table 1-0003/3320

## Absolute Maximum Ratings <sup>1</sup>

|                                                                               |                         |
|-------------------------------------------------------------------------------|-------------------------|
| Supply Voltage $V_{CC}$ .....                                                 | -0.5 to +7.0V           |
| Input Voltage Applied .....                                                   | -2.5 to $V_{CC} + 1.0V$ |
| Off-State Output Voltage Applied .....                                        | -2.5 to $V_{CC} + 1.0V$ |
| Storage Temperature .....                                                     | -65 to 150°C            |
| Case Temp. with Power Applied .....                                           | -55 to 125°C            |
| Max. Junction Temp. ( $T_J$ ) with Power Applied (208-Pin PQFP and MQFP) .... | 150°C                   |
| Max. Junction Temp. ( $T_J$ ) with Power Applied (320-Ball BGA) .....         | 140°C                   |

1. Stresses above those listed under the "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation of the device at these or at any other conditions above those indicated in the operational sections of this specification is not implied (while programming, follow the programming specifications).

## DC Recommended Operating Condition

| SYMBOL   | PARAMETER           | MIN. | MAX.         | UNITS |
|----------|---------------------|------|--------------|-------|
| $T_A$    | Ambient Temperature | 0    | 70           | °C    |
| $V_{CC}$ | Supply Voltage      | 4.75 | 5.25         | V     |
| $V_{IL}$ | Input Low Voltage   | 0    | 0.8          | V     |
| $V_{IH}$ | Input High Voltage  | 2.0  | $V_{CC} + 1$ | V     |

Table 2-0005/3320

## Capacitance ( $T_A=25^\circ\text{C}, f=1.0\text{ MHz}$ )

| SYMBOL | PARAMETER         | TYPICAL | UNITS | TEST CONDITIONS                |
|--------|-------------------|---------|-------|--------------------------------|
| $C_1$  | I/O Capacitance   | 10      | pf    | $V_{CC} = 5.0V, V_{IO} = 2.0V$ |
| $C_2$  | Clock Capacitance | 11      | pf    | $V_{CC} = 5.0V, V_Y = 2.0V$    |

Table 2-0006/3320

## Data Retention Specifications

| PARAMETER                     | MINIMUM | MAXIMUM | UNITS  |
|-------------------------------|---------|---------|--------|
| Data Retention                | 20      | —       | Years  |
| ispLSI Erase/Reprogram Cycles | 10000   | —       | Cycles |

Table 2-0008/3320

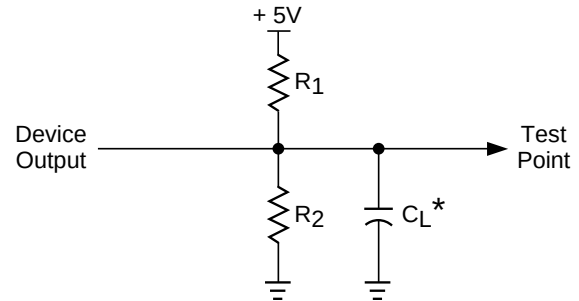
## Switching Test Conditions

|                                |                   |
|--------------------------------|-------------------|
| Input Pulse Levels             | GND to 3.0V       |
| Input Rise and Fall Time       | ≤ 3 ns 10% to 90% |
| Input Timing Reference Levels  | 1.5V              |
| Output Timing Reference Levels | 1.5V              |
| Output Load                    | See Figure 2      |

3-state levels are measured 0.5V from steady-state active level.

Table 2-0003/3320

Figure 2. Test Load



\* $C_L$  includes Test Fixture and Probe Capacitance.

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## Output Load conditions (See Figure 2)

| TEST CONDITION |                                   | R1   | R2   | CL   |
|----------------|-----------------------------------|------|------|------|
| A              |                                   | 470Ω | 390Ω | 35pF |
| B              | Active High                       | ∞    | 390Ω | 35pF |
|                | Active Low                        | 470Ω | 390Ω | 35pF |
| C              | Active High to Z at $V_{OH}-0.5V$ | ∞    | 390Ω | 5pF  |
|                | Active Low to Z at $V_{OL}+0.5V$  | 470Ω | 390Ω | 5pF  |

Table 2 - 0004A

## DC Electrical Characteristics

### Over Recommended Operating Conditions

| SYMBOL                               | PARAMETER                                           | CONDITION                                                 | MIN. | TYP. <sup>3</sup> | MAX. | UNITS |
|--------------------------------------|-----------------------------------------------------|-----------------------------------------------------------|------|-------------------|------|-------|
| <b>V<sub>OL</sub></b>                | Output Low Voltage                                  | $I_{OL} = 8 \text{ mA}$                                   | —    | —                 | 0.4  | V     |
| <b>V<sub>OH</sub></b>                | Output High Voltage                                 | $I_{OH} = -4 \text{ mA}$                                  | 2.4  | —                 | —    | V     |
| <b>I<sub>IL</sub></b>                | Input or I/O Low Leakage Current                    | $0V \leq V_{IN} \leq V_{IL} (\text{Max.})$                | —    | —                 | -10  | μA    |
| <b>I<sub>IH</sub></b>                | Input or I/O High Leakage Current                   | $3.5V \leq V_{IN} \leq V_{CC}$                            | —    | —                 | 10   | μA    |
| <b>I<sub>IL-isp</sub></b>            | $\overline{\text{ispEN}}$ Input Low Leakage Current | $0V \leq V_{IN} \leq V_{IL}$                              | —    | —                 | -150 | μA    |
| <b>I<sub>IL-PU</sub></b>             | I/O Active Pull-Up Current                          | $0V \leq V_{IN} \leq V_{IL}$                              | —    | —                 | -150 | μA    |
| <b>I<sub>OS</sub><sup>1</sup></b>    | Output Short Circuit Current                        | $V_{CC} = 5V, V_{OUT} = 0.5V$                             | —    | —                 | -200 | mA    |
| <b>I<sub>CC</sub><sup>2, 4</sup></b> | Operating Power Supply Current                      | $V_{IL} = 0.0V, V_{IH} = 3.0V, f_{CLOCK} = 1 \text{ MHz}$ | —    | 370               | —    | mA    |

- One output at a time for a maximum duration of one second.  $V_{OUT} = 0.5V$  was selected to avoid test problems by tester ground degradation. Characterized but not 100% tested. Table 2-0007/3320
- Measured using twenty 16-bit counters.
- Typical values are at  $V_{CC} = 5V$  and  $T_A = 25^\circ C$ .
- Maximum  $I_{CC}$  varies widely with specific device configuration and operating frequency. Refer to the Power Consumption section of this data sheet and Thermal Management section of the Lattice Semiconductor Data Book or CD-ROM to estimate maximum  $I_{CC}$ .

## External Switching Characteristics<sup>1, 2, 3</sup>

### Over Recommended Operating Conditions

| PARAMETER               | TEST <sup>5</sup><br>COND. | # <sup>2</sup> | DESCRIPTION <sup>1</sup>                                                 | -100 |      | -70  |      | UNITS |
|-------------------------|----------------------------|----------------|--------------------------------------------------------------------------|------|------|------|------|-------|
|                         |                            |                |                                                                          | MIN. | MAX. | MIN. | MAX. |       |
| t <sub>pd1</sub>        | A                          | 1              | Data Propagation Delay, 4PT Bypass, ORP Bypass                           | –    | 10.0 | –    | 15.0 | ns    |
| t <sub>pd2</sub>        | A                          | 2              | Data Propagation Delay                                                   | –    | 13.0 | –    | 18.0 | ns    |
| f <sub>max</sub>        | A                          | 3              | Clock Frequency with Internal Feedback <sup>3</sup>                      | 100  | –    | 70.0 | –    | MHz   |
| f <sub>max</sub> (Ext.) | –                          | 4              | Clock Frequency with External Feedback ( $\frac{1}{t_{su2} + t_{co1}}$ ) | 77.0 | –    | 50.0 | –    | MHz   |
| f <sub>max</sub> (Tog.) | –                          | 5              | Clock Frequency, Maximum Toggle <sup>4</sup>                             | 100  | –    | 83.0 | –    | MHz   |
| t <sub>su1</sub>        | –                          | 6              | GLB Reg. Setup Time before Clock, 4 PT Bypass                            | 6.0  | –    | 9.0  | –    | ns    |
| t <sub>co1</sub>        | A                          | 7              | GLB Reg. Clock to Output Delay, ORP Bypass                               | –    | 6.0  | –    | 9.0  | ns    |
| t <sub>h1</sub>         | –                          | 8              | GLB Reg. Hold Time after Clock, 4 PT Bypass                              | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>su2</sub>        | –                          | 9              | GLB Reg. Setup Time before Clock                                         | 7.0  | –    | 11.0 | –    | ns    |
| t <sub>co2</sub>        | –                          | 10             | GLB Reg. Clock to Output Delay                                           | –    | 7.0  | –    | 10.0 | ns    |
| t <sub>h2</sub>         | –                          | 11             | GLB Reg. Hold Time after Clock                                           | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>r1</sub>         | A                          | 12             | Ext. Reset Pin to Output Delay                                           | –    | 13.5 | –    | 15.0 | ns    |
| t <sub>rw1</sub>        | –                          | 13             | Ext. Reset Pulse Duration                                                | 6.5  | –    | 12.0 | –    | ns    |
| t <sub>ptoen</sub>      | B                          | 14             | Input to Output Enable                                                   | –    | 18.0 | –    | 21.0 | ns    |
| t <sub>ptodis</sub>     | C                          | 15             | Input to Output Disable                                                  | –    | 18.0 | –    | 21.0 | ns    |
| t <sub>goen</sub>       | B                          | 16             | Global OE Output Enable                                                  | –    | 9.0  | –    | 12.0 | ns    |
| t <sub>goedis</sub>     | C                          | 17             | Global OE Output Disable                                                 | –    | 9.0  | –    | 12.0 | ns    |
| t <sub>toen</sub>       | B                          | 18             | Test OE Output Enable                                                    | –    | 12.0 | –    | 15.0 | ns    |
| t <sub>toedis</sub>     | C                          | 19             | Test OE Output Disable                                                   | –    | 12.0 | –    | 15.0 | ns    |
| t <sub>wh</sub>         | –                          | 20             | Ext. Synchronous Clock Pulse Duration, High                              | 5.0  | –    | 6.0  | –    | ns    |
| t <sub>wl</sub>         | –                          | 21             | Ext. Synchronous Clock Pulse Duration, Low                               | 5.0  | –    | 6.0  | –    | ns    |
| t <sub>su3</sub>        | –                          | 22             | I/O Reg Setup Time before Ext. Synchronous Clock (Y3, Y4)                | 4.5  | –    | 5.0  | –    | ns    |
| t <sub>h3</sub>         | –                          | 23             | I/O Reg Hold Time after Ext. Sync Clock (Y3, Y4)                         | 0.0  | –    | 0.0  | –    | ns    |

Table 2-0030/3320

1. Unless noted otherwise, all parameters use 20 PTXOR path and ORP.
2. Refer to Timing Model in this data sheet for further details.
3. Standard 16-bit counter using GRP feedback.
4. f<sub>max</sub> (Toggle) may be less than 1/(t<sub>wh</sub> + t<sub>wl</sub>). This is to allow for a clock duty cycle of other than 50%.
5. Reference Switching Test Conditions section.

## Internal Timing Parameters<sup>1</sup>

Over Recommended Operating Conditions

| PARAMETER             | # <sup>2</sup> | DESCRIPTION                                      | -100 |      | -70  |      | UNITS |
|-----------------------|----------------|--------------------------------------------------|------|------|------|------|-------|
|                       |                |                                                  | MIN. | MAX. | MIN. | MAX. |       |
| Inputs                |                |                                                  |      |      |      |      |       |
| t <sub>iobp</sub>     | 24             | I/O Register Bypass                              | –    | 1.5  | –    | 3.2  | ns    |
| t <sub>iolat</sub>    | 25             | I/O Latch Delay                                  | –    | 13.0 | –    | 18.2 | ns    |
| t <sub>iosu</sub>     | 26             | I/O Register Setup Time before Clock             | 7.5  | –    | 9.0  | –    | ns    |
| t <sub>ioh</sub>      | 27             | I/O Register Hold Time after Clock               | -3.0 | –    | -4.0 | –    | ns    |
| t <sub>ioco</sub>     | 28             | I/O Register Clock to Out Delay                  | –    | 2.5  | –    | 4.2  | ns    |
| t <sub>ior</sub>      | 29             | I/O Register Reset to Out Delay                  | –    | 2.5  | –    | 4.2  | ns    |
| GRP                   |                |                                                  |      |      |      |      |       |
| t <sub>grp</sub>      | 30             | GRP Delay                                        | –    | 3.0  | –    | 3.5  | ns    |
| t <sub>feedback</sub> | 31             | Feedback Delay                                   | –    | 1.1  | –    | 1.6  | ns    |
| GLB                   |                |                                                  |      |      |      |      |       |
| t <sub>4ptbp</sub>    | 32             | 4 Product Term Bypass Path Delay (Comb.)         | –    | 3.5  | –    | 5.3  | ns    |
| t <sub>4ptbr</sub>    | 33             | 4 Product Term Bypass Path Delay (Reg.)          | –    | 3.5  | –    | 3.8  | ns    |
| t <sub>1ptxor</sub>   | 34             | 1 Product Term/XOR Path Delay                    | –    | 4.5  | –    | 5.8  | ns    |
| t <sub>20ptxor</sub>  | 35             | 20 Product Term/XOR Path Delay                   | –    | 4.5  | –    | 5.8  | ns    |
| t <sub>xoradj</sub>   | 36             | XOR Adjacent Path Delay <sup>3</sup>             | –    | 5.5  | –    | 7.3  | ns    |
| t <sub>gbp</sub>      | 37             | GLB Register Bypass Delay                        | –    | 0.5  | –    | 0.5  | ns    |
| t <sub>gsu</sub>      | 38             | GLB Register Setup Time before Clock             | 1.0  | –    | 2.5  | –    | ns    |
| t <sub>gh</sub>       | 39             | GLB Register Hold Time after Clock               | 4.9  | –    | 6.3  | –    | ns    |
| t <sub>gco</sub>      | 40             | GLB Register Clock to Output Delay               | –    | 0.5  | –    | 1.0  | ns    |
| t <sub>gro</sub>      | 41             | GLB Register Reset to Output Delay               | –    | 1.0  | –    | 1.0  | ns    |
| t <sub>ptre</sub>     | 42             | GLB Product Term Reset to Register Delay         | –    | 7.9  | –    | 11.5 | ns    |
| t <sub>ptoe</sub>     | 43             | GLB Product Term Output Enable to I/O Cell Delay | –    | 9.5  | –    | 9.3  | ns    |
| t <sub>ptck</sub>     | 44             | GLB Product Term Clock Delay                     | 3.2  | 3.2  | 4.5  | 4.5  | ns    |
| ORP                   |                |                                                  |      |      |      |      |       |
| t <sub>orp</sub>      | 45             | ORP Delay                                        | –    | 1.5  | –    | 2.0  | ns    |
| t <sub>orpbp</sub>    | 46             | ORP Bypass Delay                                 | –    | 0.0  | –    | 0.0  | ns    |

Table 2-0036/3320

1. Internal Timing Parameters are not tested and are for reference only.
2. Refer to Timing Model in this data sheet for further details.
3. The XOR adjacent path can only be used by hard macros.

## Internal Timing Parameters<sup>1</sup>

Over Recommended Operating Conditions

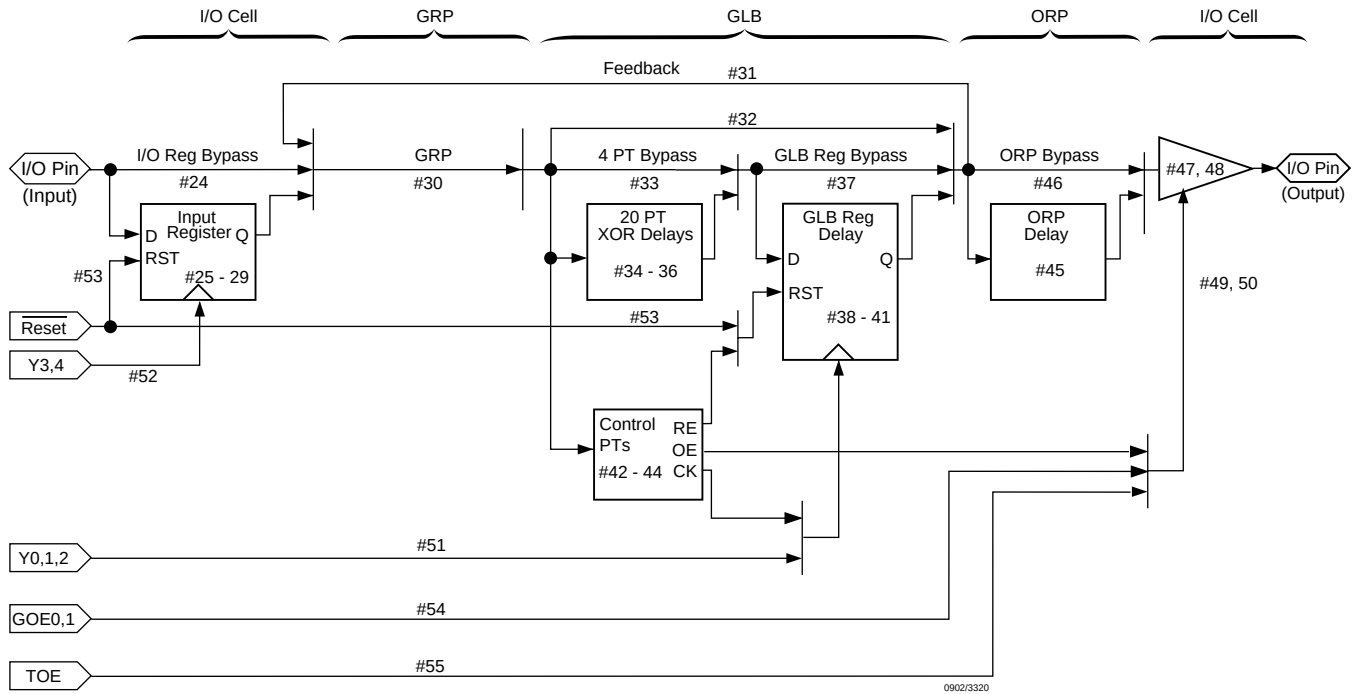
| PARAMETER    | # <sup>2</sup> | DESCRIPTION                                          | -100 |      | -70  |      | UNITS |
|--------------|----------------|------------------------------------------------------|------|------|------|------|-------|
|              |                |                                                      | MIN. | MAX. | MIN. | MAX. |       |
| Outputs      |                |                                                      |      |      |      |      |       |
| tob          | 47             | Output Buffer Delay                                  | –    | 2.0  | –    | 3.0  | ns    |
| tobs         | 48             | Output Buffer Delay, Slew Limited Adder              | –    | 12.0 | –    | 13.0 | ns    |
| toen         | 49             | I/O Cell OE to Output Enabled                        | –    | 4.0  | –    | 5.0  | ns    |
| todis        | 50             | I/O Cell OE to Output Disabled                       | –    | 4.0  | –    | 5.0  | ns    |
| Clocks       |                |                                                      |      |      |      |      |       |
| tgy0/1/2     | 51             | Clock Delay, Y0 or Y1 or Y2 to Global GLB Clock Line | 3.0  | 3.0  | 4.0  | 4.0  | ns    |
| tioy3/4      | 52             | Clock Delay, Y3 or Y4 to I/O Cell Global Clock Line  | 3.0  | 3.0  | 4.0  | 4.0  | ns    |
| Global Reset |                |                                                      |      |      |      |      |       |
| tgr          | 53             | Global Reset to GLB and I/O Registers                | –    | 9.0  | –    | 9.0  | ns    |
| tgoe         | 54             | Global OE Pad Buffer                                 | –    | 5.0  | –    | 7.0  | ns    |
| ttoe         | 55             | Test OE Pad Buffer                                   | –    | 8.0  | –    | 10.0 | ns    |

Table 2-0037/3320

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



**ispLSI 3320 Timing Model**



**Derivations of  $t_{su}$ ,  $t_h$  and  $t_{co}$  from the Product Term Clock<sup>1</sup>**

$$\begin{aligned}
 t_{su} &= \text{Logic} + \text{Reg su} - \text{Clock (min)} \\
 &= (t_{iobp} + t_{grp} + t_{20ptxor}) + (t_{gsu}) - (t_{iobp} + t_{grp} + t_{ptck(min)}) \\
 &= (\#24 + \#30 + \#35) + (\#38) - (\#24 + \#30 + \#44) \\
 2.3 \text{ ns} &= (1.5 + 3.0 + 4.5) + (1.0) - (1.5 + 3.0 + 3.2) \\
 t_h &= \text{Clock (max)} + \text{Reg h} - \text{Logic} \\
 &= (t_{iobp} + t_{grp} + t_{ptck(max)}) + (t_{gh}) - (t_{iobp} + t_{grp} + t_{20ptxor}) \\
 &= (\#24 + \#30 + \#44) + (\#39) - (\#24 + \#30 + \#35) \\
 3.6 \text{ ns} &= (1.5 + 3.0 + 3.2) + (4.9) - (1.5 + 3.0 + 4.5) \\
 t_{co} &= \text{Clock (max)} + \text{Reg co} + \text{Output} \\
 &= (t_{iobp} + t_{grp} + t_{ptck(max)}) + (t_{gco}) + (t_{orp} + t_{ob}) \\
 &= (\#24 + \#30 + \#44) + (\#40) + (\#45 + \#47) \\
 11.7 \text{ ns} &= (1.5 + 3.0 + 3.2) + (0.5) + (1.5 + 2.0)
 \end{aligned}$$

Table 2-0042/3320

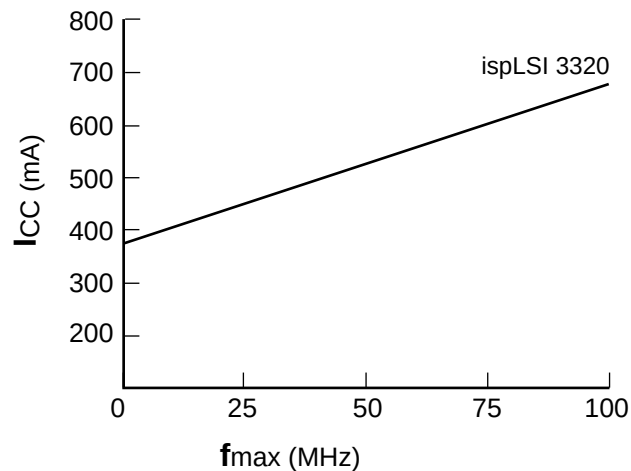
Note: Calculations are based on timing specs for the ispLSI 3320-100L.

## Power Consumption

Power consumption in the ispLSI 3320 device depends on two primary factors: the speed at which the device is operating and the number of product terms used.

Figure 3 shows the relationship between power and operating speed.

**Figure 3. Typical Device Power Consumption vs fmax**



Notes: Configuration of 20 16-bit Counters  
Typical Current at 5V, 25° C

ICC can be estimated for the ispLSI 3320 using the following equation:

$ICC = 60 + (\# \text{ of PTs} * 0.5) + (\# \text{ of nets} * \text{Max. freq} * 0.0095)$  where:

# of PTs = Number of Product Terms used in design

# of nets = Number of Signals used in device

Max. freq = Highest Clock Frequency to the device

The ICC estimate is based on typical conditions ( $V_{CC} = 5.0V$ , room temperature) and an assumption of 2 GLB loads on average exists. These values are for estimates only. Since the value of ICC is sensitive to operating conditions and the program in the device, the actual ICC should be verified.

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## Signal Descriptions

| Signal Name                      | Description                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GOE0, GOE1                       | Global Output Enable input pins.                                                                                                                                                                                                                                                                                                                                                 |
| I/O                              | Input/Output Pins – These are the general purpose I/O pins used by the logic array.                                                                                                                                                                                                                                                                                              |
| TOE                              | Test Output Enable pin – This pin tristates all I/O pins when a logic low is driven.                                                                                                                                                                                                                                                                                             |
| $\overline{\text{RESET}}$        | Active Low (0) Reset pin which resets all of the GLB and I/O registers in the device.                                                                                                                                                                                                                                                                                            |
| Y0, Y1, Y2                       | Dedicated Clock inputs. These clock inputs are connected to one of the clock inputs of all the GLBs on the device.                                                                                                                                                                                                                                                               |
| Y3, Y4                           | Dedicated Clock inputs. These clock inputs are connected to one of the clock inputs of all the I/O cells on the device.                                                                                                                                                                                                                                                          |
| BSCAN/ $\overline{\text{ispEN}}$ | Input – Dedicated in-system programming enable input pin. When this pin is high, the BSCAN TAP controller pins TMS, TDI, TDO and TCK are enabled. When this pin is brought low, the ISP State Machine control pins MODE, SDI, SDO and SCLK are enabled. High-to-low transition of this pin will put the device in the programming mode and put all I/O pins in the high-Z state. |
| TDI/SDI                          | Input – This pin performs two functions. It is the Test Data input pin when $\overline{\text{ispEN}}$ is logic high. When $\overline{\text{ispEN}}$ is logic low, it functions as an input pin to load programming data into the device. SDI is also used as one of the two control pins for the ISP State Machine.                                                              |
| TCK/SCLK                         | Input – This pin performs two functions. It is the Test Clock input pin when $\overline{\text{ispEN}}$ is logic high. When $\overline{\text{ispEN}}$ is logic low, it functions as a clock pin for the Serial Shift Register.                                                                                                                                                    |
| TMS/MODE                         | Input – This pin performs two functions. It is the Test Mode Select input pin when $\overline{\text{ispEN}}$ is logic high. When $\overline{\text{ispEN}}$ is logic low, it functions as a pin to control the operation of the ISP State Machine.                                                                                                                                |
| $\overline{\text{TRST}}$         | Input – Test Reset, active low to reset the Boundary Scan State Machine.                                                                                                                                                                                                                                                                                                         |
| TDO/SDO                          | Output – This pin performs two functions. When $\overline{\text{ispEN}}$ is logic low, it functions as the pin to read the ISP data. When $\overline{\text{ispEN}}$ is high, it functions as Test Data Out.                                                                                                                                                                      |
| GND                              | Ground (GND)                                                                                                                                                                                                                                                                                                                                                                     |
| VCC                              | Vcc                                                                                                                                                                                                                                                                                                                                                                              |
| NC <sup>1</sup>                  | No Connect.                                                                                                                                                                                                                                                                                                                                                                      |

1. NC pins are not to be connected to any active signals, VCC or GND.

## Signal Locations

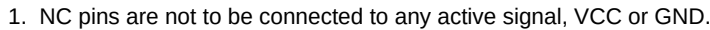
| Signal             | 208-Pin PQFP/MQFP                                                       | 320-Ball BGA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GOE0, GOE1         | 133, 134                                                                | AD12, AC11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TOE                | 30                                                                      | B14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| RESET              | 28                                                                      | D13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Y0, Y1, Y2, Y3, Y4 | 132, 130, 129, 128, 127                                                 | AA12, AC13, AB13, AA13, AD13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| BSCAN/ispEN        | 27                                                                      | B12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TDI/SDI            | 25                                                                      | C12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TCK/SCLK           | 24                                                                      | D12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TMS/MODE           | 23                                                                      | A12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TRST               | 29                                                                      | A13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TDO/SDO            | 185                                                                     | M4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| GND                | 11, 26, 42, 53, 65, 78, 92, 104, 115, 131, 146, 157, 169, 183, 196, 208 | A16, B13, C8, D6, D19, F4, F21, H22, J1, M2, N23, T24, U3, W4, W21, AA6, AA19, AB17, AC12, AD9                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| VCC                | 14, 39, 58, 80, 99, 118, 143, 162, 181, 203                             | B10, B18, C3, D4, D21, G2, K23, R2, V23, AA4, AA21, AC7, AC15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| NC <sup>1</sup>    | 76, 77, 79, 81, 180, 182, 184                                           | A1, A2, A3, A6, A9, A11, A14, A20, A23, A24, B1, B2, B5, B8, B9, B16, B17, B20, B23, B24, C5, C13, C17, C20, C24, D7, D11, D14, D17, D20, E1, E2, E3, E4, E22, E23, F24, G21, G23, H2, H3, H4, H23, J2, J23, J24, K3, L1, L4, L21, L24, M3, M21, M22, M23, N2, N3, N4, N21, N22, N24, P1, P4, P21, P24, R22, T1, T2, T23, U2, U21, U22, U23, V2, V4, W1, Y2, Y3, Y21, Y22, Y23, Y24, AA5, AA8, AA11, AA14, AA18, AB1, AB5, AB8, AB12, AB20, AC1, AC2, AC5, AC8, AC9, AC16, AC17, AC20, AC23, AC24, AD1, AD2, AD5, AD11, AD14, AD16, AD19, AD22, AD23, AD24 |

1. NC pins are not to be connected to any active signals, VCC or GND.

## I/O Locations

| Signal | PQFP/<br>MQFP | BGA | Signal | PQFP/<br>MQFP | BGA  | Signal  | PQFP/<br>MQFP | BGA  | Signal  | PQFP/<br>MQFP | BGA |
|--------|---------------|-----|--------|---------------|------|---------|---------------|------|---------|---------------|-----|
| I/O 0  | 31            | C14 | I/O 40 | 82            | P23  | I/O 80  | 135           | AB11 | I/O 120 | 186           | M1  |
| I/O 1  | 32            | A15 | I/O 41 | 83            | P22  | I/O 81  | 136           | AD10 | I/O 121 | 187           | L2  |
| I/O 2  | 33            | B15 | I/O 42 | 84            | R24  | I/O 82  | 137           | AC10 | I/O 122 | 188           | L3  |
| I/O 3  | 34            | C15 | I/O 43 | 85            | R23  | I/O 83  | 138           | AB10 | I/O 123 | 189           | K1  |
| I/O 4  | 35            | D15 | I/O 44 | 86            | R21  | I/O 84  | 139           | AA10 | I/O 124 | 190           | K2  |
| I/O 5  | 36            | A17 | I/O 45 | 87            | U24  | I/O 85  | 140           | AD8  | I/O 125 | 191           | K4  |
| I/O 6  | 37            | C16 | I/O 46 | 88            | T22  | I/O 86  | 141           | AB9  | I/O 126 | 192           | H1  |
| I/O 7  | 38            | D16 | I/O 47 | 89            | T21  | I/O 87  | 142           | AA9  | I/O 127 | 193           | J3  |
| I/O 8  | 40            | A18 | I/O 48 | 90            | V24  | I/O 88  | 144           | AD7  | I/O 128 | 194           | J4  |
| I/O 9  | 41            | A19 | I/O 49 | 91            | W24  | I/O 89  | 145           | AD6  | I/O 129 | 195           | G1  |
| I/O 10 | 43            | C18 | I/O 50 | 93            | V22  | I/O 90  | 147           | AB7  | I/O 130 | 197           | F1  |
| I/O 11 | 44            | B19 | I/O 51 | 94            | W23  | I/O 91  | 148           | AC6  | I/O 131 | 198           | G3  |
| I/O 12 | 45            | D18 | I/O 52 | 95            | V21  | I/O 92  | 149           | AA7  | I/O 132 | 199           | F2  |
| I/O 13 | 46            | C19 | I/O 53 | 96            | W22  | I/O 93  | 150           | AB6  | I/O 133 | 200           | G4  |
| I/O 14 | 47            | A21 | I/O 54 | 97            | AA24 | I/O 94  | 151           | AD4  | I/O 134 | 201           | F3  |
| I/O 15 | 48            | B21 | I/O 55 | 98            | AA23 | I/O 95  | 152           | AC4  | I/O 135 | 202           | D1  |
| I/O 16 | 49            | A22 | I/O 56 | 100           | AB24 | I/O 96  | 153           | AD3  | I/O 136 | 204           | D2  |
| I/O 17 | 50            | C21 | I/O 57 | 101           | AA22 | I/O 97  | 154           | AB4  | I/O 137 | 205           | C1  |
| I/O 18 | 51            | B22 | I/O 58 | 102           | AB23 | I/O 98  | 155           | AC3  | I/O 138 | 206           | D3  |
| I/O 19 | 52            | C22 | I/O 59 | 103           | AB22 | I/O 99  | 156           | AB3  | I/O 139 | 207           | C2  |
| I/O 20 | 54            | C23 | I/O 60 | 105           | AC22 | I/O 100 | 158           | AB2  | I/O 140 | 1             | B3  |
| I/O 21 | 55            | D22 | I/O 61 | 106           | AB21 | I/O 101 | 159           | AA3  | I/O 141 | 2             | C4  |
| I/O 22 | 56            | E21 | I/O 62 | 107           | AA20 | I/O 102 | 160           | Y4   | I/O 142 | 3             | D5  |
| I/O 23 | 57            | D23 | I/O 63 | 108           | AC21 | I/O 103 | 161           | AA2  | I/O 143 | 4             | B4  |
| I/O 24 | 59            | D24 | I/O 64 | 109           | AD21 | I/O 104 | 163           | AA1  | I/O 144 | 5             | A4  |
| I/O 25 | 60            | F22 | I/O 65 | 110           | AB19 | I/O 105 | 164           | W3   | I/O 145 | 6             | C6  |
| I/O 26 | 61            | E24 | I/O 66 | 111           | AD20 | I/O 106 | 165           | Y1   | I/O 146 | 7             | A5  |
| I/O 27 | 62            | F23 | I/O 67 | 112           | AC19 | I/O 107 | 166           | W2   | I/O 147 | 8             | B6  |
| I/O 28 | 63            | G22 | I/O 68 | 113           | AB18 | I/O 108 | 167           | V3   | I/O 148 | 9             | C7  |
| I/O 29 | 64            | H21 | I/O 69 | 114           | AA17 | I/O 109 | 168           | U4   | I/O 149 | 10            | D8  |
| I/O 30 | 66            | G24 | I/O 70 | 116           | AC18 | I/O 110 | 170           | V1   | I/O 150 | 12            | B7  |
| I/O 31 | 67            | J21 | I/O 71 | 117           | AD18 | I/O 111 | 171           | T4   | I/O 151 | 13            | A7  |
| I/O 32 | 68            | J22 | I/O 72 | 119           | AA16 | I/O 112 | 172           | T3   | I/O 152 | 15            | D9  |
| I/O 33 | 69            | H24 | I/O 73 | 120           | AB16 | I/O 113 | 173           | U1   | I/O 153 | 16            | C9  |
| I/O 34 | 70            | K21 | I/O 74 | 121           | AD17 | I/O 114 | 174           | R4   | I/O 154 | 17            | A8  |
| I/O 35 | 71            | K22 | I/O 75 | 122           | AA15 | I/O 115 | 175           | R3   | I/O 155 | 18            | D10 |
| I/O 36 | 72            | K24 | I/O 76 | 123           | AB15 | I/O 116 | 176           | R1   | I/O 156 | 19            | C10 |
| I/O 37 | 73            | L22 | I/O 77 | 124           | AD15 | I/O 117 | 177           | P3   | I/O 157 | 20            | A10 |
| I/O 38 | 74            | L23 | I/O 78 | 125           | AB14 | I/O 118 | 178           | P2   | I/O 158 | 21            | C11 |
| I/O 39 | 75            | M24 | I/O 79 | 126           | AC14 | I/O 119 | 179           | N1   | I/O 159 | 22            | B11 |

## ispLSI 3320 208-Pin PQFP (with Heat Spreader) and 208-Pin MQFP Pinout Diagram



14

**Signal Configuration**

**ispLSI 3320 320-Ball BGA Signal Diagram**

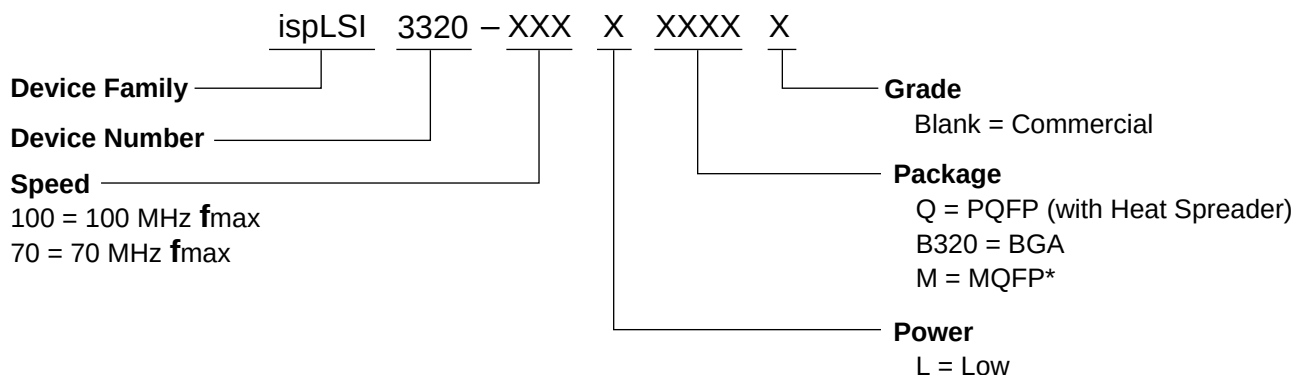
|    | 24              | 23              | 22              | 21              | 20              | 19              | 18              | 17              | 16              | 15     | 14              | 13              | 12              | 11              | 10      | 9               | 8               | 7               | 6               | 5               | 4               | 3               | 2               | 1               |    |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------|-----------------|-----------------|-----------------|-----------------|---------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| A  | NC <sup>1</sup> | NC <sup>1</sup> | I/O 16          | I/O 14          | NC <sup>1</sup> | I/O 9           | I/O 8           | I/O 5           | GND             | I/O 1  | NC <sup>1</sup> | TRST            | TMS/ MODE       | NC <sup>1</sup> | I/O 157 | NC <sup>1</sup> | I/O 154         | I/O 151         | NC <sup>1</sup> | I/O 146         | I/O 144         | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | A  |
| B  | NC <sup>1</sup> | NC <sup>1</sup> | I/O 18          | I/O 15          | NC <sup>1</sup> | I/O 11          | VCC             | NC <sup>1</sup> | NC <sup>1</sup> | I/O 2  | TOE             | GND             | ispEN/ BSCAN    | I/O 159         | VCC     | NC <sup>1</sup> | NC <sup>1</sup> | I/O 150         | I/O 147         | NC <sup>1</sup> | I/O 143         | I/O 140         | NC <sup>1</sup> | NC <sup>1</sup> | B  |
| C  | NC <sup>1</sup> | I/O 20          | I/O 19          | I/O 17          | NC <sup>1</sup> | I/O 13          | I/O 10          | NC <sup>1</sup> | I/O 6           | I/O 3  | I/O 0           | NC <sup>1</sup> | TDI/ SDI        | I/O 158         | I/O 156 | I/O 153         | GND             | I/O 148         | I/O 145         | NC <sup>1</sup> | I/O 141         | VCC             | I/O 139         | I/O 137         | C  |
| D  | I/O 24          | I/O 23          | I/O 21          | VCC             | NC <sup>1</sup> | GND             | I/O 12          | NC <sup>1</sup> | I/O 7           | I/O 4  | NC <sup>1</sup> | RESET           | TCK/ SCLK       | NC <sup>1</sup> | I/O 155 | I/O 152         | I/O 149         | NC <sup>1</sup> | GND             | I/O 142         | VCC             | I/O 138         | I/O 136         | I/O 135         | D  |
| E  | I/O 26          | NC <sup>1</sup> | NC <sup>1</sup> | I/O 22          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | E  |
| F  | NC <sup>1</sup> | I/O 27          | I/O 25          | GND             |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | GND             | I/O 134         | I/O 132         | I/O 130         | F  |
| G  | I/O 30          | NC <sup>1</sup> | I/O 28          | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 133         | I/O 131         | VCC             | I/O 129         | G  |
| H  | I/O 33          | NC <sup>1</sup> | GND             | I/O 29          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | I/O 126         | H  |
| J  | NC <sup>1</sup> | NC <sup>1</sup> | I/O 32          | I/O 31          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 128         | I/O 127         | NC <sup>1</sup> | GND             | J  |
| K  | I/O 36          | VCC             | I/O 35          | I/O 34          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 125         | NC <sup>1</sup> | I/O 124         | I/O 123         | K  |
| L  | NC <sup>1</sup> | I/O 38          | I/O 37          | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | I/O 122         | I/O 121         | NC <sup>1</sup> | L  |
| M  | I/O 39          | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | SDO/ TDO        | NC <sup>1</sup> | GND             | I/O 120         | M  |
| N  | NC <sup>1</sup> | GND             | NC <sup>1</sup> | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | I/O 119         | N  |
| P  | NC <sup>1</sup> | I/O 40          | I/O 41          | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | I/O 117         | I/O 118         | NC <sup>1</sup> | P  |
| R  | I/O 42          | I/O 43          | NC <sup>1</sup> | I/O 44          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 114         | I/O 115         | VCC             | I/O 116         | R  |
| T  | GND             | NC <sup>1</sup> | I/O 46          | I/O 47          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 111         | I/O 112         | NC <sup>1</sup> | NC <sup>1</sup> | T  |
| U  | I/O 45          | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 109         | GND             | NC <sup>1</sup> | I/O 113         | U  |
| V  | I/O 48          | VCC             | I/O 50          | I/O 52          |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | NC <sup>1</sup> | I/O 108         | NC <sup>1</sup> | I/O 110         | V  |
| W  | I/O 49          | I/O 51          | I/O 53          | GND             |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | GND             | I/O 105         | I/O 107         | NC <sup>1</sup> | W  |
| Y  | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> |                 |                 |                 |                 |                 |        |                 |                 |                 |                 |         |                 |                 |                 |                 |                 | I/O 102         | NC <sup>1</sup> | NC <sup>1</sup> | I/O 106         | Y  |
| AA | I/O 54          | I/O 55          | I/O 57          | VCC             | I/O 62          | GND             | NC <sup>1</sup> | I/O 69          | I/O 72          | I/O 75 | NC <sup>1</sup> | Y3              | Y0              | NC <sup>1</sup> | I/O 84  | I/O 87          | NC <sup>1</sup> | I/O 92          | GND             | NC <sup>1</sup> | VCC             | I/O 101         | I/O 103         | I/O 104         | AA |
| AB | I/O 56          | I/O 58          | I/O 59          | I/O 61          | NC <sup>1</sup> | I/O 65          | I/O 68          | GND             | I/O 73          | I/O 76 | I/O 78          | Y2              | NC <sup>1</sup> | I/O 80          | I/O 83  | I/O 86          | NC <sup>1</sup> | I/O 90          | I/O 93          | NC <sup>1</sup> | I/O 97          | I/O 99          | I/O 100         | NC <sup>1</sup> | AB |
| AC | NC <sup>1</sup> | NC <sup>1</sup> | I/O 60          | I/O 63          | NC <sup>1</sup> | I/O 67          | I/O 70          | NC <sup>1</sup> | NC <sup>1</sup> | VCC    | I/O 79          | Y1              | GND             | GOE 1           | I/O 82  | NC <sup>1</sup> | NC <sup>1</sup> | VCC             | I/O 91          | NC <sup>1</sup> | I/O 95          | I/O 98          | NC <sup>1</sup> | NC <sup>1</sup> | AC |
| AD | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | I/O 64          | I/O 66          | NC <sup>1</sup> | I/O 71          | I/O 74          | NC <sup>1</sup> | I/O 77 | NC <sup>1</sup> | Y4              | GOE 0           | NC <sup>1</sup> | I/O 81  | GND             | I/O 85          | I/O 88          | I/O 89          | NC <sup>1</sup> | I/O 94          | I/O 96          | NC <sup>1</sup> | NC <sup>1</sup> | AD |
|    | 24              | 23              | 22              | 21              | 20              | 19              | 18              | 17              | 16              | 15     | 14              | 13              | 12              | 11              | 10      | 9               | 8               | 7               | 6               | 5               | 4               | 3               | 2               | 1               |    |

320BGA/3320

1. NCs are not to be connected to any active signals, Vcc or GND.

Note: Ball A1 indicator dot on top side of package.

## Part Number Description



0212A/3320

## Ordering Information

### COMMERCIAL

| FAMILY | $f_{max}$ (MHz) | $t_{pd}$ (ns) | ORDERING NUMBER      | PACKAGE      |
|--------|-----------------|---------------|----------------------|--------------|
| ispLSI | 100             | 10            | ispLSI 3320-100LQ    | 208-Pin PQFP |
|        | 100             | 10            | ispLSI 3320-100LB320 | 320-Ball BGA |
|        | 100             | 10            | ispLSI 3320-100LM*   | 208-Pin MQFP |
|        | 70              | 15            | ispLSI 3320-70LQ     | 208-Pin PQFP |
|        | 70              | 15            | ispLSI 3320-70LB320  | 320-Ball BGA |
|        | 70              | 15            | ispLSI 3320-70LM*    | 208-Pin MQFP |

\*Use the 208-pin PQFP for new designs.

Table 2-0041A/3320