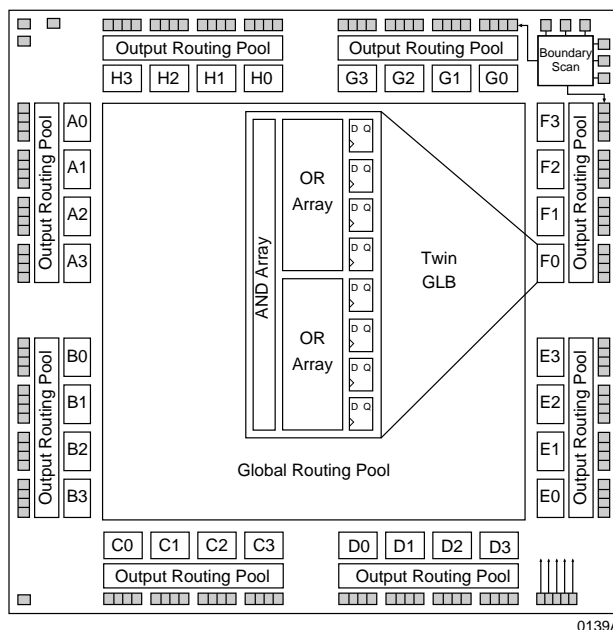


Features

- **HIGH-DENSITY PROGRAMMABLE LOGIC**
 - 128 I/O Pins
 - 11000 PLD Gates
 - 384 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 E²C²MOS[®] TECHNOLOGY**
 - $f_{max} = 90$ MHz Maximum Operating Frequency
 - $t_{pd} = 12$ 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 OFFERS THE FOLLOWING ADDED FEATURES**
 - 5V In-System ProgrammableTM (ISPTM) 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
- **ispLSI AND pLSI DEVELOPMENT TOOLS**
 - pDS[®] Software**
 - Easy to Use PC WindowsTM Interface
 - Boolean Logic Compiler
 - Manual Partitioning, Automatic Place and Route
 - pDS+TM Software**
 - Industry Standard, Third-Party Design Environments
 - Schematic Capture, State Machine, HDL
 - Automatic Partitioning and Place and Route
 - Comprehensive Logic and Timing Simulation
 - PC and Workstation Platforms

Functional Block Diagram



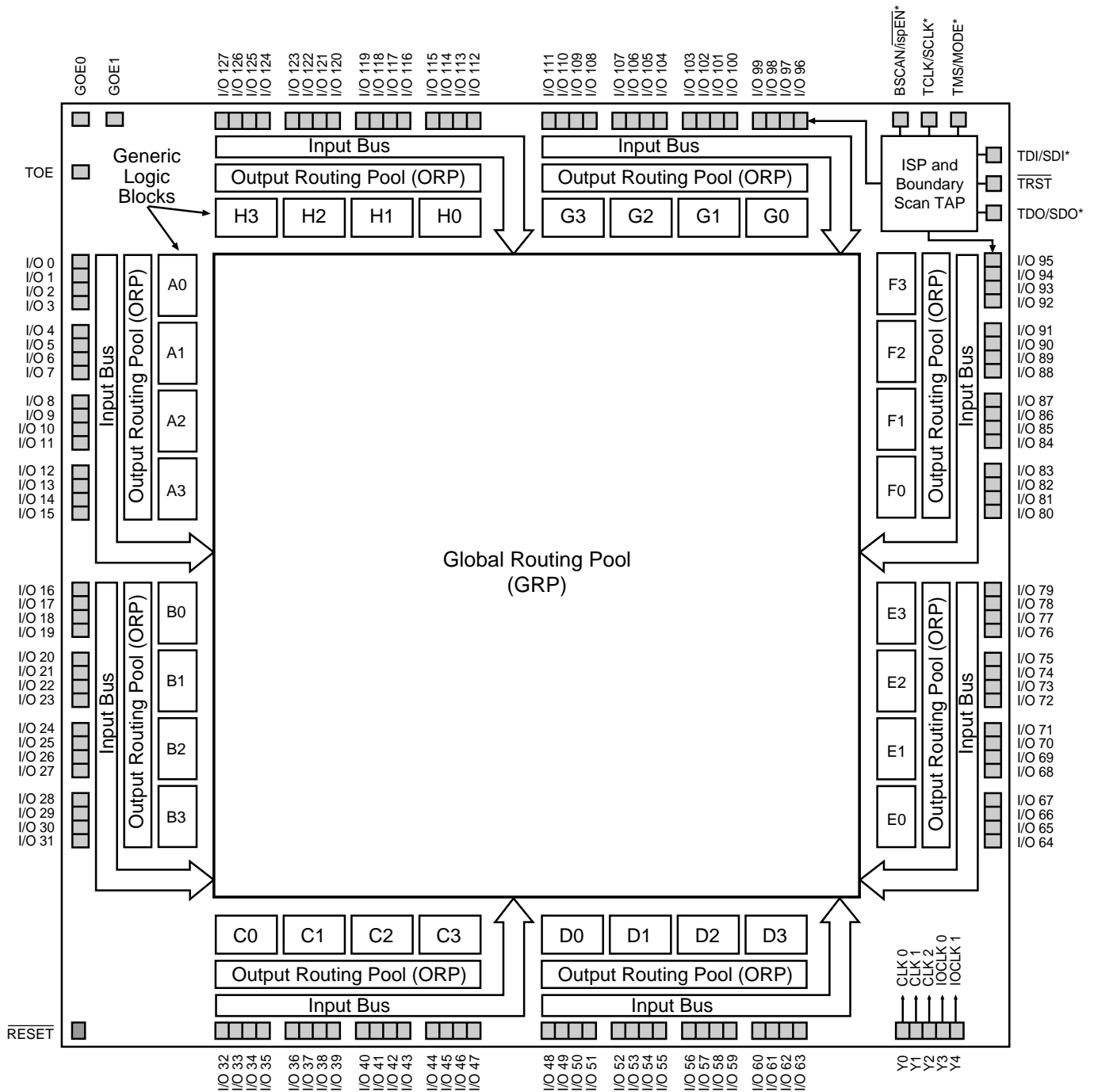
Description

The ispLSI and pLSI 3256A are High-Density Programmable Logic Devices which contain 384 Registers, 128 Universal I/O pins, five Dedicated Clock Input Pins, eight Output Routing Pools (ORP), and a Global Routing Pool (GRP) which allows complete inter-connectivity between all of these elements. The ispLSI 3256A features 5-Volt in-system programmability and in-system diagnostic capabilities. The ispLSI 3256A offers non-volatile "on-the-fly" reprogrammability of the logic, as well as the interconnect to provide truly reconfigurable systems. It is architecturally and parametrically compatible to the pLSI 3256A devices.

The basic unit of logic on the ispLSI and pLSI 3256A devices is the Twin Generic Logic Block (Twin GLB) labelled A0, A1...H3. There are a total of 32 of these Twin GLBs in the ispLSI and pLSI 3256A devices. 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 and pLSI 3256A Functional Block Diagram



* ispLSI 3256A Only

0139isp/3256A

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 128 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 128 I/O Cells are grouped into eight sets of 16 bits. Each of these I/O groups is associated with a logic Megablock through the use of the ORP. These groups of 16 I/O cells share one Product Term Output Enable which is associated with a specific pair of Megablocks and two Global Output Enables.

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 and pLSI 3256A Device contains eight 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 and pLSI 3256A devices 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 at right lists key attributes of the device along with the number of resources available.

An additional feature of the ispLSI and pLSI 3256A 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 3256A supports the full boundary scan IEEE 1149.1 specification for ISP programming and board-level tests via the TAP controller port. It is also fully backward compatible to the Lattice ISP interface. While fully JEDEC file and functionally compatible with the earlier ispLSI and pLSI 3256 devices, the 3256A requires a modified Boundary Scan Description Library (BSDL) model to support boundary scan test and programming. As a result, existing 3256 test programs that use the boundary scan test feature must be updated to use the 3256A. Please contact Lattice Applications for the new model.

The ispLSI and pLSI 3256A supports all IEEE 1149.1 mandatory instructions, which include BYPASS, EXTEST and SAMPLE.

Key Attributes of the ispLSI and pLSI 3256A

| Attribute | Quantity |
|---------------|----------|
| Twin GLBs | 32 |
| Registers | 384 |
| I/O Pins | 128 |
| Global Clocks | 5 |
| Global OE | 2 |
| Test OE | 1 |

Table 1-0003A/3256

Absolute Maximum Ratings ¹

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 ... 150°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 - 0005/3256

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

| SYMBOL | PARAMETER | TYPICAL | UNITS | TEST CONDITIONS |
|--------|-------------------|---------|-------|--------------------------------|
| C_1 | I/O Capacitance | 9 | pf | $V_{CC} = 5.0V, V_{IO} = 2.0V$ |
| C_2 | Clock Capacitance | 11 | pf | $V_{CC} = 5.0V, V_Y = 2.0V$ |

Table 2-0006/3256A

Data Retention Specifications

| PARAMETER | MINIMUM | MAXIMUM | UNITS |
|-------------------------------|---------|---------|--------|
| Data Retention | 20 | — | Years |
| ispLSI Erase/Reprogram Cycles | 10000 | — | Cycles |
| pLSI Erase/Reprogram Cycles | 100 | — | Cycles |

Table 2- 0008B

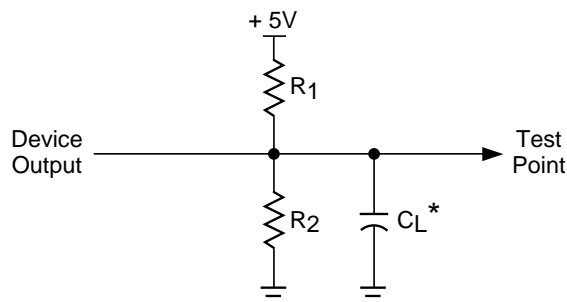
Switching Test Conditions

| | |
|--------------------------------|------------------|
| Input Pulse Levels | GND to 3.0V |
| Input Rise and Fall Time | ≤ 3ns 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

Figure 2. Test Load



*CL includes Test Fixture and Probe Capacitance.

0213A

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

Table 2-0007isp/3256A

- 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. Guaranteed but not 100% tested.
- Measured using sixteen 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 datasheet and Thermal Management section of the 1996 Lattice Semiconductor Data Book to estimate maximum I_{CC} .

External Switching Characteristics^{1, 2, 3}

Over Recommended Operating Conditions

| PARAMETER | TEST ⁵ COND. | # ² | DESCRIPTION ¹ | -90 | | -70 | | -50 | | UNITS |
|-------------------------------|----------------------------|----------------|---|------|------|------|------|------|------|-------|
| | | | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| t_{pd1} | A | 1 | Data Prop. Delay, 4PT Bypass, ORP Bypass | – | 12.0 | – | 15.0 | – | 20.0 | ns |
| t_{pd2} | A | 2 | Data Prop. Delay | – | 15.0 | – | 18.0 | – | 24.5 | ns |
| f_{max} | A | 3 | Clk Frequency with Internal Feedback ³ | 90 | – | 77 | – | 57 | – | MHz |
| f_{max} (Ext.) | – | 4 | Clk Frequency with Ext. Feedback $\left(\frac{1}{t_{su2} + t_{co1}}\right)$ | 61 | – | 50 | – | 37 | – | MHz |
| f_{max} (Tog.) | – | 5 | Clk Frequency, Max. Toggle ⁴ | 125 | – | 83 | – | 63 | – | MHz |
| t_{su1} | – | 6 | GLB Reg. Setup Time before Clk, 4 PT Bypass | 8.0 | – | 9.5 | – | 12.5 | – | ns |
| t_{co1} | A | 7 | GLB Reg. Clk to Output Delay, ORP Bypass | – | 7.5 | – | 9.0 | – | 12.0 | ns |
| t_{h1} | – | 8 | GLB Reg. Hold Time after Clk, 4 PT Bypass | 0.0 | – | 0.0 | – | 0.0 | – | ns |
| t_{su2} | – | 9 | GLB Reg. Setup Time before Clk | 9.0 | – | 11.0 | – | 15.0 | – | ns |
| t_{co2} | – | 10 | GLB Reg. Clk to Output Delay | – | 9.0 | – | 10.5 | – | 14.0 | ns |
| t_{h2} | – | 11 | GLB Reg. Hold Time after Clk | 0.0 | – | 0.0 | – | 0.0 | – | ns |
| t_{r1} | A | 12 | Ext. Reset Pin to Output Delay | – | 13.5 | – | 15.0 | – | 20.0 | ns |
| t_{rw1} | – | 13 | Ext. Reset Pulse Duration | 6.5 | – | 10.0 | – | 13.5 | – | ns |
| t_{ptoen} | B | 14 | Input to Output Enable | – | 16.0 | – | 18.0 | – | 24.5 | ns |
| t_{ptoedis} | C | 15 | Input to Output Disable | – | 16.0 | – | 18.0 | – | 24.5 | ns |
| t_{goeen} | B | 16 | Global OE Output Enable | – | 10.0 | – | 11.0 | – | 13.5 | ns |
| t_{goedis} | C | 17 | Global OE Output Disable | – | 10.0 | – | 11.0 | – | 13.5 | ns |
| t_{toeen} | B | 18 | Test OE Output Enable | – | 10.0 | – | 17.0 | – | 23.0 | ns |
| t_{toedis} | C | 19 | Test OE Output Disable | – | 10.0 | – | 17.0 | – | 23.0 | ns |
| t_{wh} | – | 20 | Ext. Synchronous Clk Pulse Duration, High | 4.0 | – | 6.0 | – | 8.0 | – | ns |
| t_{wl} | – | 21 | Ext. Synchronous Clk Pulse Duration, Low | 4.0 | – | 6.0 | – | 8.0 | – | ns |
| t_{su3} | – | 22 | I/O Reg Setup Time before Ext. Sync Clk (Y3, Y4) | 5.0 | – | 5.0 | – | 7.0 | – | ns |
| t_{h3} | – | 23 | I/O Reg Hold Time after Ext. Sync Clk (Y3, Y4) | 0.0 | – | 0.0 | – | 0.0 | – | ns |

Table 2 - 0030A/3256A

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_{max} (Toggle) may be less than 1/(t_{wh} + t_{wl}). This is to allow for a clock duty cycle of other than 50%.
5. Reference Switching Test Conditions section.

Internal Timing Parameters¹

Over Recommended Operating Conditions

| PARAMETER | # ² | DESCRIPTION | -90 | | -70 | | -50 | | UNITS |
|----------------------|----------------|--|------|------|------|------|------|------|-------|
| | | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| Inputs | | | | | | | | | |
| t _{iobp} | 24 | I/O Register Bypass | – | 1.9 | – | 2.4 | – | 3.3 | ns |
| t _{iolat} | 25 | I/O Latch Delay | – | 1.9 | – | 2.4 | – | 3.3 | ns |
| t _{iosu} | 26 | I/O Register Setup Time before Clock | 5.7 | – | 6.2 | – | 8.6 | – | ns |
| t _{ioh} | 27 | I/O Register Hold Time after Clock | 3.1 | – | 3.9 | – | 5.3 | – | ns |
| t _{ioco} | 28 | I/O Register Clock to Out Delay | – | 1.5 | – | 1.9 | – | 2.6 | ns |
| t _{ior} | 29 | I/O Register Reset to Out Delay | – | 2.8 | – | 3.6 | – | 4.9 | ns |
| GRP | | | | | | | | | |
| t _{grp} | 30 | GRP Delay | – | 2.4 | – | 3.0 | – | 4.1 | ns |
| GLB | | | | | | | | | |
| t _{4ptbp} | 31 | 4 Product Term Bypass Path Delay (Comb.) | – | 4.8 | – | 5.9 | – | 7.6 | ns |
| t _{4ptbp} | 32 | 4 Product Term Bypass Path Delay (Reg.) | – | 4.8 | – | 5.9 | – | 7.6 | ns |
| t _{1ptxor} | 33 | 1 Product Term/XOR Path Delay | – | 5.4 | – | 6.4 | – | 8.8 | ns |
| t _{20ptxor} | 34 | 20 Product Term/XOR Path Delay | – | 6.4 | – | 7.4 | – | 10.1 | ns |
| t _{xoradj} | 35 | XOR Adjacent Path Delay ³ | – | 6.9 | – | 8.1 | – | 11.1 | ns |
| t _{gbp} | 36 | GLB Register Bypass Delay | – | 0.1 | – | 0.1 | – | 0.1 | ns |
| t _{gsu} | 37 | GLB Register Setup Time before Clock | 1.0 | – | 1.8 | – | 2.4 | – | ns |
| t _{gh} | 38 | GLB Register Hold Time after Clock | 4.8 | – | 6.0 | – | 8.2 | – | ns |
| t _{gco} | 39 | GLB Register Clock to Output Delay | – | 1.6 | – | 1.8 | – | 2.2 | ns |
| t _{gro} | 40 | GLB Register Reset to Output Delay | – | 2.6 | – | 2.8 | – | 3.8 | ns |
| t _{ptre} | 41 | GLB Product Term Reset to Register Delay | – | 8.6 | – | 10.5 | – | 14.2 | ns |
| t _{ptoe} | 42 | GLB Product Term Output Enable to I/O Cell Delay | – | 4.9 | – | 5.4 | – | 7.3 | ns |
| t _{ptck} | 43 | GLB Product Term Clock Delay | 2.8 | 5.3 | 3.2 | 6.3 | 4.3 | 8.5 | ns |
| ORP | | | | | | | | | |
| t _{orp} | 44 | ORP Delay | – | 2.3 | – | 2.7 | – | 3.6 | ns |
| t _{orpbp} | 45 | ORP Bypass Delay | – | 0.9 | – | 1.2 | – | 1.6 | ns |

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.

Table 2 - 0036A/3256A

Internal Timing Parameters¹

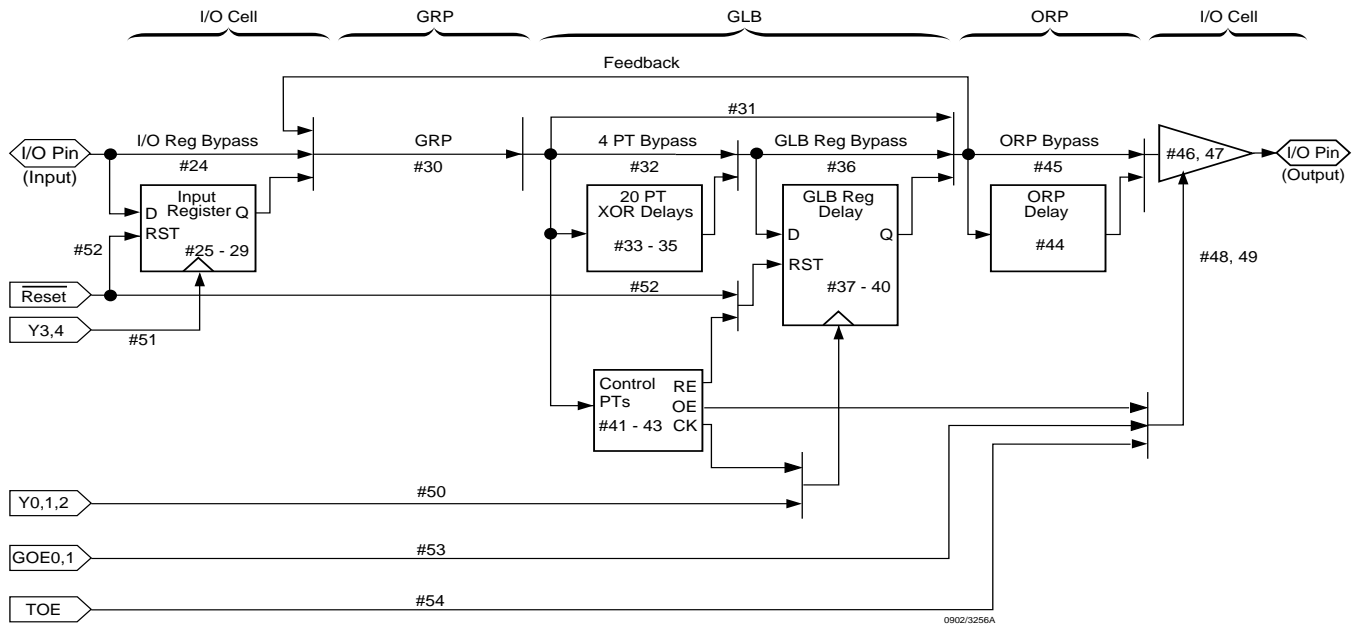
Over Recommended Operating Conditions

| PARAMETER | # ² | DESCRIPTION | -90 | | -70 | | -50 | | UNITS |
|--------------|----------------|--|------|------|------|------|------|------|-------|
| | | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | |
| Outputs | | | | | | | | | |
| tob | 46 | Output Buffer Delay | – | 1.9 | – | 2.4 | – | 3.3 | ns |
| tobs | 47 | Output Buffer Delay, Slow Slew | – | 11.9 | – | 12.4 | – | 13.3 | ns |
| toen | 48 | I/O Cell OE to Output Enabled | – | 6.8 | – | 7.2 | – | 9.8 | ns |
| todis | 49 | I/O Cell OE to Output Disabled | – | 6.8 | – | 7.2 | – | 9.8 | ns |
| Clocks | | | | | | | | | |
| tgy0/1/2 | 50 | Clock Delay, Y0 or Y1 or Y2 to Global GLB Clock Line | 2.7 | 2.7 | 3.6 | 3.6 | 4.9 | 4.9 | ns |
| tioy3/4 | 51 | Clock Delay, Y3 or Y4 to I/O Cell Global Clock Line | 0.7 | 3.7 | 1.2 | 5.2 | 1.6 | 7.0 | ns |
| Global Reset | | | | | | | | | |
| tgr | 52 | Global Reset to GLB and I/O Registers | – | 6.7 | – | 7.1 | – | 9.6 | ns |
| tgoe | 53 | Global OE Pad Buffer | – | 2.3 | – | 2.8 | – | 3.7 | ns |
| ttoe | 54 | Test OE Pad Buffer | – | 3.2 | – | 9.8 | – | 13.2 | ns |

Table 2-0037A/3256A

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 and pLSI 3256A Timing Model



Derivations of tsu, th and tco from the Product Term Clock¹

$$\begin{aligned}
 t_{su} &= \text{Logic} + \text{Reg su} - \text{Clock (min)} \\
 &= (t_{iobp} + t_{grp} + t_{20ptxor}) + (t_{gsu}) - (t_{iobp} + t_{grp} + t_{ptck(min)}) \\
 &= (\#24 + \#30 + \#34) + (\#37) - (\#24 + \#30 + \#43) \\
 4.6 \text{ ns} &= (1.9 + 2.4 + 6.4) + (1.0) - (1.9 + 2.4 + 2.8) \\
 \\
 t_h &= \text{Clock (max)} + \text{Reg h} - \text{Logic} \\
 &= (t_{iobp} + t_{grp} + t_{ptck(max)}) + (t_{gh}) - (t_{iobp} + t_{grp} + t_{20ptxor}) \\
 &= (\#24 + \#30 + \#43) + (\#38) - (\#24 + \#30 + \#34) \\
 3.7 \text{ ns} &= (1.9 + 2.4 + 5.3) + (4.8) - (1.9 + 2.4 + 6.4) \\
 \\
 t_{co} &= \text{Clock (max)} + \text{Reg co} + \text{Output} \\
 &= (t_{iobp} + t_{grp} + t_{ptck(max)}) + (t_{gco}) + (t_{orp} + t_{ob}) \\
 &= (\#24 + \#30 + \#43) + (\#39) + (\#44 + \#46) \\
 15.4 \text{ ns} &= (1.9 + 2.4 + 5.3) + (1.6) + (2.3 + 1.9)
 \end{aligned}$$

Table 2-0042-16/3256A

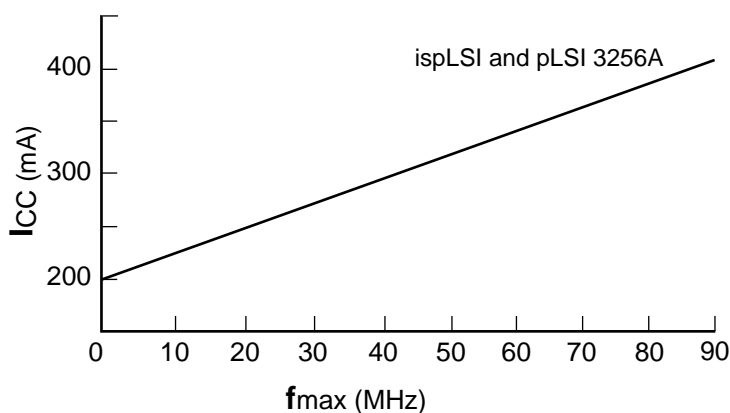
Note: Calculations are based on timing specs for the ispLSI 3256A-90L.

Power Consumption

Power Consumption in the ispLSI and pLSI 3256A 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 16 16-bit Counters
Typical Current at 5V, 25° C

ICC can be estimated for the ispLSI and pLSI 3256A using the following equation:

$$I_{CC} = 40 + (\# \text{ of PTs} * 0.31) + (\# \text{ of nets} * \text{Max. freq} * 0.0094) \text{ where:}$$

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 (VCC = 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.

0127A-16-80-isp/3256A

In-System Programmability

ispLSI devices are the in-system programmable versions of Lattice Semiconductor's high density programmable Large Scale Integration (pLSI) devices. By integrating all the high voltage programming circuitry on-chip, programming can be accomplished by simply shifting data into the device. Once the function is programmed, the non-volatile E²CMOS cells will not lose the pattern even when the power is turned off.

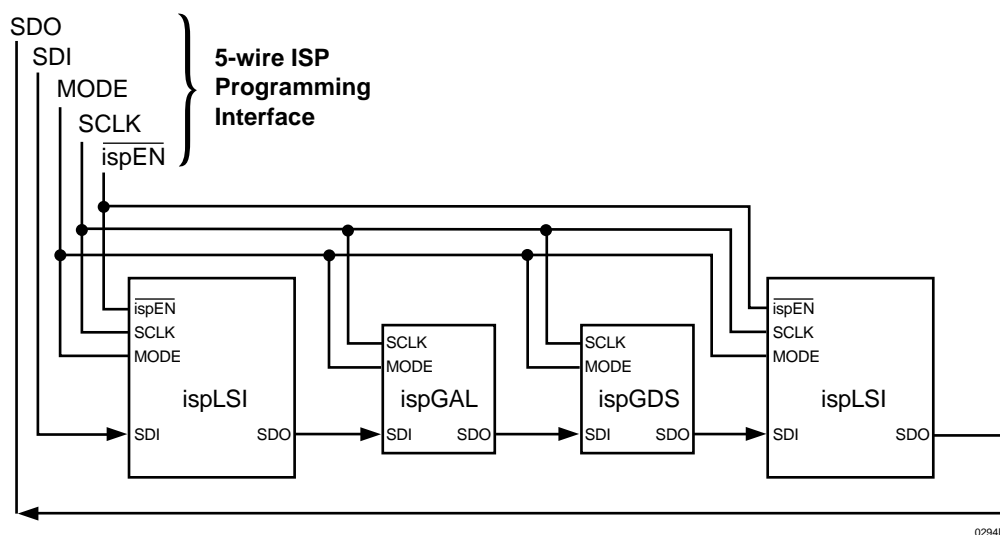
The ispLSI 3256A may be programmed using either the Lattice ISP or boundary scan (IEEE 1149.1-compatible) protocols. The programming protocol is determined by the state of the BSCAN/ispEN pin.

All necessary programming is done via five TTL level logic interface signals. These five signals are fed into the

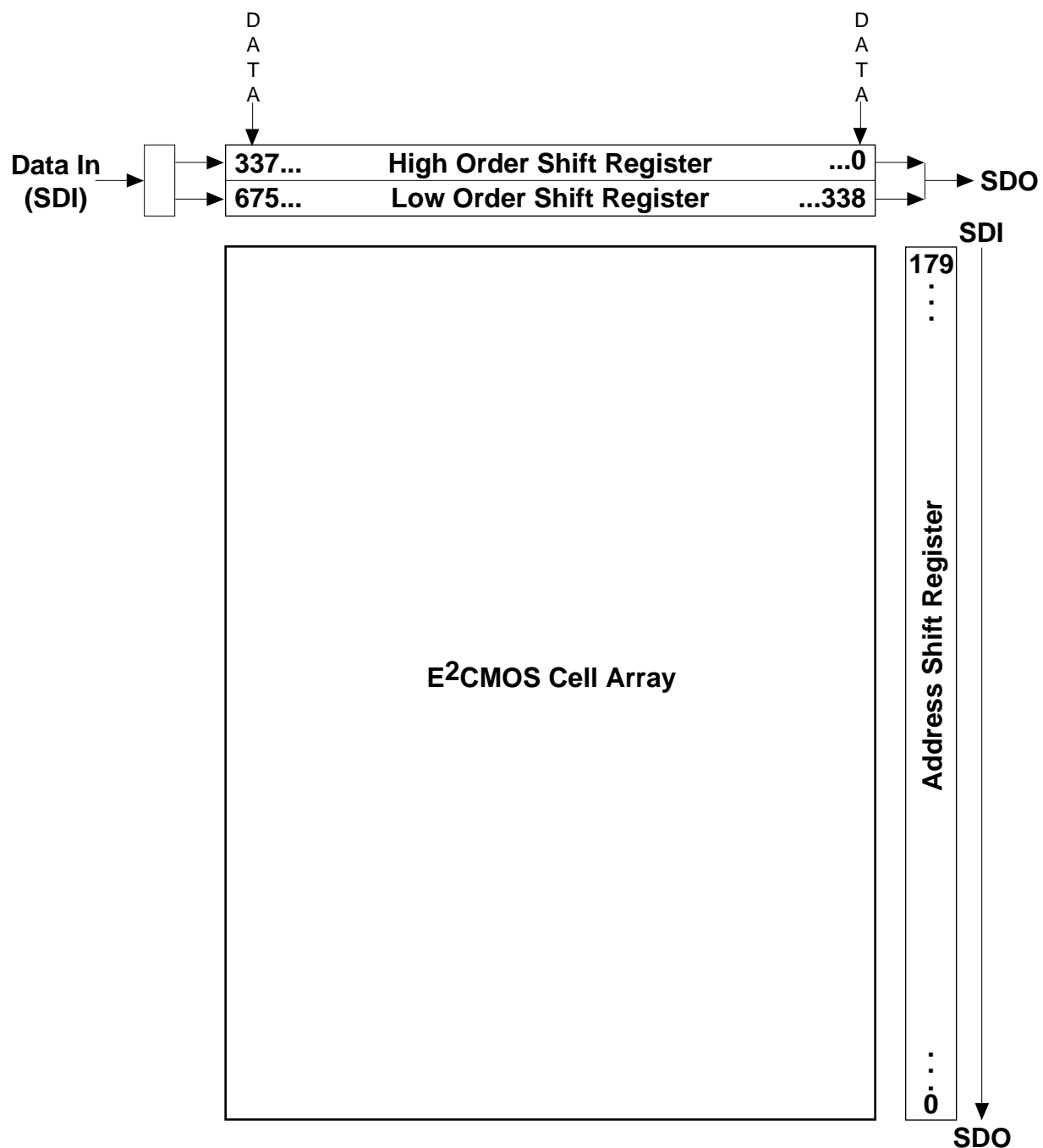
on-chip programming circuitry where a state machine controls the programming. The simple signals for interface include isp Enable ($\overline{\text{ispEN}}$), Serial Data In (SDI/TDI), Serial Data Out (SDO/TDO), Serial Clock (SCLK/TCK) and Mode (MODE) control. Figure 4 illustrates the block diagram of one possible scheme for the programming interface of the Lattice ISP devices. For details on the operation of the internal state machine and programming of the device please refer to the ISP Architecture and Programming section of the 1996 Lattice Semiconductor Data Book.

The device identifier for the ispLSI 3256A is 0010 0010 (22 hex). This code is the unique device identifier which is generated when a read ID command is performed.

Figure 4. ISP Programming Interface



ispLSI 3256A Shift Register Layout



0182A/3256

Note: A logic "1" in the address shift register enables the row for programming or verification. A logic "0" disables it.

Boundary Scan

Lattice Semiconductor offers support for the IEEE 1149.1 Boundary Scan specification on the 3000 Family of devices for both test and programming.

The user interfaces to the boundary scan circuitry through the Test Access Port (TAP). The TAP consists of a control state machine, instruction decoder and instruction register.

The TAP is controlled using the test control lines: Test Data IN (TDI), Test Data Out (TDO), Test Mode Select (TMS), Test Reset ($\overline{\text{TRST}}$) and Test Clock (TCK).

All of the input cells and I/O cells are serially connected together in a long chain. The scan out of one cell is connected to the scan in of the next cell. The cells are connected in the following order: TDI to IO63 thru IO32 to Y4, Y3, Y2, Y1, RESET, TOE, GOE1, GOE0, Y0, IO31 thru IO0 to IO64 thru IO127 to TDO.

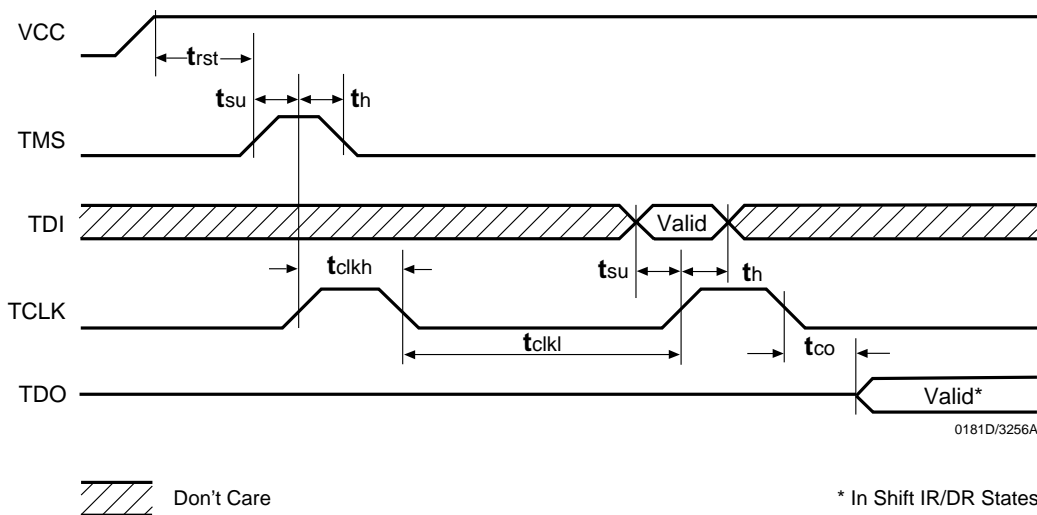
The timing specifications for Boundary Scan are listed below. The waveforms are shown in figure 5.

Boundary Scan Timing Specifications

| SYMBOL | PARAMETER | CONDITION | MIN. | TYP. | MAX. | UNITS |
|------------|--------------------------------|-----------|------|------|------|---------------|
| V_{CC} | Supply Voltage | | 4.75 | 5.0 | 5.25 | V |
| t_{rst} | Reset Time from Valid V_{CC} | | 100 | — | — | μs |
| t_{su} | Setup Time | | 60 | — | — | ns |
| t_h | Hold Time | | 60 | — | — | ns |
| t_{co} | Clock to Output | | — | — | 60 | ns |
| t_{clkh} | Clock Pulse Duration, High | | 60 | — | — | ns |
| t_{clkl} | Clock Pulse Duration, Low | | 60 | — | — | ns |

Table 2-0028A/3256A

Figure 5. Boundary Scan Waveforms



Pin Description

| NAME | MQFP PIN NUMBERS | | | | | DESCRIPTION |
|----------------------|------------------|-------------|-------------|------------|------|--|
| I/O 0 - I/O 4 | 25, | 26, | 28, | 29, | 30, | Input/Output Pins - These are the general purpose I/O pins used by the logic array. |
| I/O 5 - I/O 9 | 32, | 33, | 34, | 35, | 36, | |
| I/O 10 - I/O 14 | 37, | 38, | 39, | 40, | 41, | |
| I/O 15 - I/O 19 | 42, | 43, | 44, | 46, | 47, | |
| I/O 20 - I/O 24 | 48, | 49, | 50, | 52, | 53, | |
| I/O 25 - I/O 29 | 54, | 55, | 56, | 57, | 58, | |
| I/O 30 - I/O 34 | 59, | 60, | 61, | 62, | 64, | |
| I/O 35 - I/O 39 | 65, | 66, | 67, | 68, | 69, | |
| I/O 40 - I/O 44 | 70, | 72, | 73, | 74, | 75, | |
| I/O 45 - I/O 49 | 76, | 77, | 78, | 79, | 80, | |
| I/O 50 - I/O 54 | 82, | 83, | 84, | 85, | 86, | |
| I/O 55 - I/O 59 | 87, | 88, | 89, | 90, | 92, | |
| I/O 60 - I/O 64 | 93, | 94, | 95, | 96, | 105, | |
| I/O 65 - I/O 69 | 106, | 108, | 109, | 110, | 112, | |
| I/O 70 - I/O 74 | 113, | 114, | 115, | 116, | 117, | |
| I/O 75 - I/O 79 | 118, | 119, | 120, | 121, | 122, | |
| I/O 80 - I/O 84 | 123, | 124, | 126, | 127, | 128, | |
| I/O 85 - I/O 89 | 129, | 130, | 132, | 133, | 134, | |
| I/O 90 - I/O 94 | 135, | 136, | 137, | 138, | 139, | |
| I/O 95 - I/O 99 | 140, | 141, | 142, | 144, | 145, | |
| I/O 100 - I/O 104 | 146, | 147, | 148, | 149, | 150, | |
| I/O 105 - I/O 109 | 152, | 153, | 154, | 155, | 156, | |
| I/O 110 - I/O 114 | 157, | 158, | 159, | 160, | 2, | |
| I/O 115 - I/O 119 | 3, | 4, | 5, | 6, | 7, | |
| I/O 120 - I/O 124 | 8, | 9, | 11, | 13, | 14, | |
| I/O 125 - I/O 127 | 15, | 16, | 17 | | | |
| GOE0 and GOE1 TOE | 100 and 99 98 | | | | | Global Output Enable input pins. Test output enable pin. |
| RESET | 20 | | | | | Active Low (0) Reset pin which resets all of the GLB and I/O registers in the device. |
| Y0, Y1 and Y2 | 18, 19, 103 | | | | | Dedicated Clock inputs. These clock inputs are connected to one of the clock inputs of all the GLBs on the device. |
| Y3 and Y4 | 102, 101 | | | | | Dedicated Clock inputs. These clock inputs are connected to one of the clock inputs of all the I/O cells in the device. |
| BSCAN/ispEN** | 21 | | | | | 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 SLCK are enabled. Note: This pin does not enable the programming mode. |
| TDI/SDI* | 22 | | | | | Input – This pin performs two functions depending on the state of the BSCAN/ispEN pin. It is the Test Data input to the TAP Controller when the ispEN is logic high. TDI is used to load BSCAN test data or programming data. When ispEN is logic low, it functions as an input pin to load programming data into the ISP state machine. |
| TCK/SCLK* | 23 | | | | | Input – This pin performs two functions, depending on the state of the BSCAN/ispEN pin. It is the Test Clock input pin when BSCAN/ispEN is logic high. When BSCAN/ispEN is logic low, it functions as the clock for the ISP state machine. |
| TMS/MODE* | 24 | | | | | Input – This pin performs two functions, depending on the state of the BSCAN/ispEN pin. It is the Test Mode Select input pin when BSCAN/ispEN is logic high. When BSCAN/ispEN is logic low, it functions to control the operation of the ISP state machine. |
| TRST | 97 | | | | | Input – Test Reset, active low to reset the Boundary Scan state machine. |
| TDO/SDO* | 104 | | | | | Output – This pin performs two functions, depending on the state of the BSCAN/ispEN pin. It is the Test Data Output pin when BSCAN/ispEN is logic high, and either BSCAN test data or programming data is shifted out. When BSCAN/ispEN is logic low, it is the Serial Data Output of the ISP state machine. |
| GND | 1, 81, | 10, 107, | 27, 125, | 45, 143 | 63, | Ground (GND) |
| VCC | 12, 111, | 31, 131, | 51, 151 | 71, | 91, | V _{CC} |

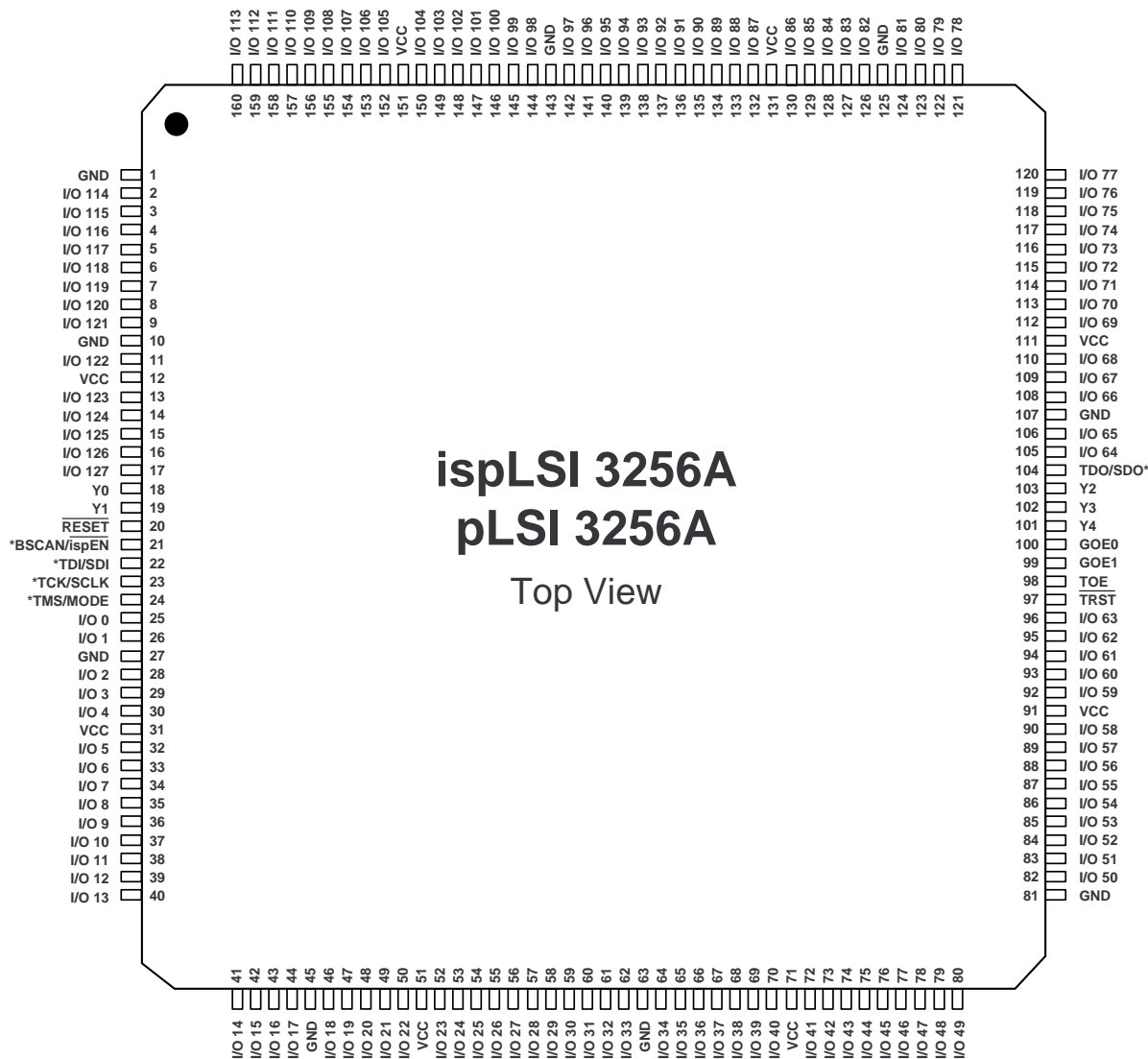
* ispLSI 3256A only

Table 2-0002Bisp/3256A

** ispEN for ispLSI 3256A only, NC for pLSI 3256A must be left floating or tied to V_{CC}, must not be grounded or tied to any other signal.

Pin Configuration

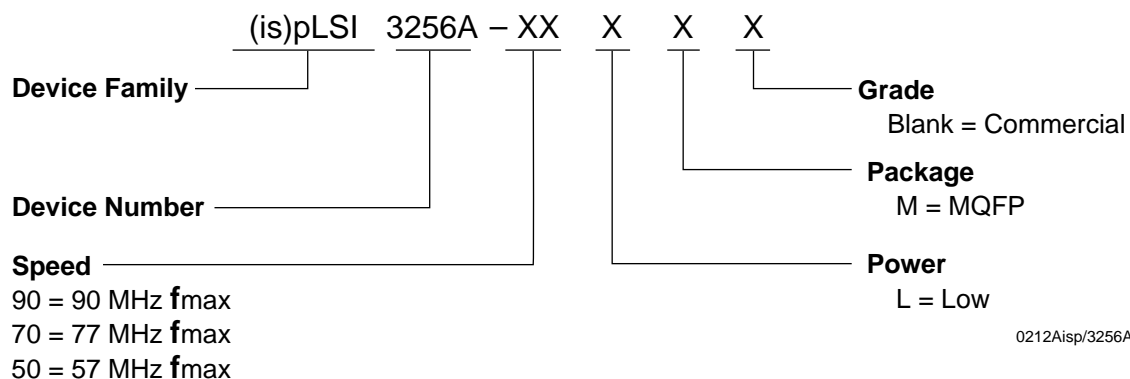
ispLSI and pLSI 3256A 160-pin MQFP



*Pins have dual function capability for ispLSI 3256A only.

160-MQFP/3256A

Part Number Description



Ordering Information

| FAMILY | f_{max} (MHz) | t_{pd} (ns) | ORDERING NUMBER | PACKAGE |
|--------|-----------------|---------------|-------------------|--------------|
| ispLSI | 90 | 12 | ispLSI 3256A-90LM | 160-Pin MQFP |
| | 77 | 15 | ispLSI 3256A-70LM | 160-Pin MQFP |
| | 57 | 20 | ispLSI 3256A-50LM | 160-Pin MQFP |
| pLSI | 90 | 12 | pLSI 3256A-90LM | 160-Pin MQFP |
| | 77 | 15 | pLSI 3256A-70LM | 160-Pin MQFP |
| | 57 | 20 | pLSI 3256A-50LM | 160-Pin MQFP |

Table 2 - 0041A-08isp/3256A



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