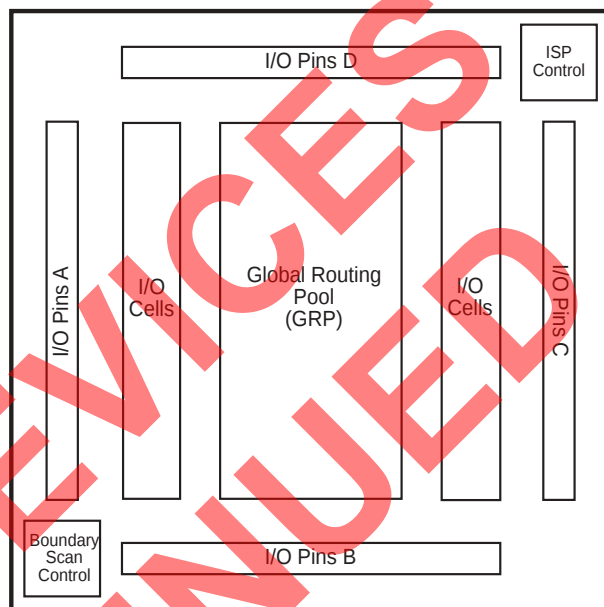


## Features

- **IN-SYSTEM PROGRAMMABLE GENERIC DIGITAL CROSSPOINT FAMILY**
  - Advanced Architecture Addresses Programmable PCB Interconnect, Bus Interface Integration and Jumper/Switch Replacement
  - “Any Input to Any Output” Routing
  - Fixed HIGH or LOW Output Option for Jumper/DIP Switch Emulation
  - Space-Saving PQFP and BGA Packaging
  - Dedicated IEEE 1149.1-Compliant Boundary Scan Test
- **HIGH PERFORMANCE E<sup>2</sup>CMOS<sup>®</sup> TECHNOLOGY**
  - 3.3V Core Power Supply
  - 3.5ns Input-to-Output/3.5ns Clock-to-Output Delay\*
  - 250MHz Maximum Clock Frequency\*
  - TTL/3.3V/2.5V Compatible Input Thresholds and Output Levels (Individually Programmable)\*
  - Low-Power: 16.5mA Quiescent I<sub>cc</sub>\*
  - 24mA I<sub>OL</sub> Drive with Programmable Slew Rate Control Option
  - PCI Compatible Drive Capability\*
  - Schmitt Trigger Inputs for Noise Immunity
  - Electrically Erasable and Reprogrammable
  - Non-Volatile E<sup>2</sup>CMOS Technology
- **ispGDXV OFFERS THE FOLLOWING ADVANTAGES**
  - 3.3V In-System Programmable Using Boundary Scan Test Access Port (TAP)
  - Change Interconnects in Seconds
- **FLEXIBLE ARCHITECTURE**
  - Combinatorial/Latched/Registered Inputs or Outputs
  - Individual I/O Tri-state Control with Polarity Control
  - Dedicated Clock/Clock Enable Input Pins (four) or Programmable Clocks/Clock Enables from I/O Pins (40)
  - Single Level 4:1 Dynamic Path Selection (T<sub>pd</sub> = 3.5ns)
  - Programmable Wide-MUX Cascade Feature Supports up to 16:1 MUX
  - Programmable Pull-ups, Bus Hold Latch and Open Drain on I/O Pins
  - Outputs Tri-state During Power-up (“Live Insertion” Friendly)
- **LEAD-FREE PACKAGE OPTIONS**

\* “VA” Version Only

## Functional Block Diagram



## Description

The ispGDXV/VA architecture provides a family of fast, flexible programmable devices to address a variety of system-level digital signal routing and interface requirements including:

- Multi-Port Multiprocessor Interfaces
- Wide Data and Address Bus Multiplexing (e.g. 16:1 High-Speed Bus MUX)
- Programmable Control Signal Routing (e.g. Interrupts, DMAREQs, etc.)
- Board-Level PCB Signal Routing for Prototyping or Programmable Bus Interfaces

The devices feature fast operation, with input-to-output signal delays (T<sub>pd</sub>) of 3.5ns and clock-to-output delays of 3.5ns.

The architecture of the devices consists of a series of programmable I/O cells interconnected by a Global Routing Pool (GRP). All I/O pin inputs enter the GRP directly or are registered or latched so they can be routed to the required I/O outputs. I/O pin inputs are defined as four sets (A,B,C,D) which have access to the four MUX inputs

## Description (Continued)

found in each I/O cell. Each output has individual, programmable I/O tri-state control (OE), output latch clock (CLK), clock enable (CLKEN), and two multiplexer control (MUX0 and MUX1) inputs. Polarity for these signals is programmable for each I/O cell. The MUX0 and MUX1 inputs control a fast 4:1 MUX, allowing dynamic selection of up to four signal sources for a given output. A wider 16:1 MUX can be implemented with the MUX expander feature of each I/O and a propagation delay increase of 2.0ns. OE, CLK, CLKEN, and MUX0 and MUX1 inputs can be driven directly from selected sets of I/O pins. Optional dedicated clock input pins give minimum clock-to-output delays. CLK and CLKEN share the same set of I/O pins. CLKEN disables the register clock when CLKEN = 0.

Through in-system programming, connections between I/O pins and architectural features (latched or registered inputs or outputs, output enable control, etc.) can be defined. In keeping with its data path application focus, the ispGDXV devices contain no programmable logic arrays. All input pins include Schmitt trigger buffers for noise immunity. These connections are programmed into the device using non-volatile E<sup>2</sup>CMOS technology. Non-volatile technology means the device configuration is saved even when the power is removed from the device.

In addition, there are no pin-to-pin routing constraints for 1:1 or 1:n signal routing. That is, any I/O pin configured as an input can drive one or more I/O pins configured as outputs.

The device pins also have the ability to set outputs to fixed HIGH or LOW logic levels (Jumper or DIP Switch mode). Device outputs are specified for 24mA sink and 12mA source current (at JEDEC LVTTTL levels) and can be tied together in parallel for greater drive. On the ispGDXVA, each I/O pin is individually programmable for 3.3V or 2.5V output levels as described later. Programmable output slew rate control can be defined independently for each I/O pin to reduce overall ground bounce and switching noise.

All I/O pins are equipped with IEEE1149.1-compliant Boundary Scan Test circuitry for enhanced testability. In addition, in-system programming is supported through the Test Access Port via a special set of private commands.

The ispGDXV I/Os are designed to withstand “live insertion” system environments. The I/O buffers are disabled during power-up and power-down cycles. When designing for “live insertion,” absolute maximum rating conditions for the V<sub>CC</sub> and I/O pins must still be met.

**Table 1. ispGDXV Family Members**

|                         | ispGDXVA Device |                                                |                |
|-------------------------|-----------------|------------------------------------------------|----------------|
|                         | ispGDX80VA      | ispGDX160VA                                    | ispGDX240VA    |
| I/O Pins                | 80              | 160                                            | 240            |
| I/O-OE Inputs*          | 20              | 40                                             | 60             |
| I/O-CLK / CLKEN Inputs* | 20              | 40                                             | 60             |
| I/O-MUXsel1 Inputs*     | 20              | 40                                             | 60             |
| I/O-MUXsel2 Inputs*     | 20              | 40                                             | 60             |
| Dedicated Clock Pins**  | 2               | 4                                              | 4              |
| EPEN                    | 1               | 1                                              | 1              |
| TOE                     | 1               | 1                                              | 1              |
| BSCAN Interface         | 4               | 4                                              | 4              |
| RESET                   | 1               | 1                                              | 1              |
| Pin Count/Package       | 100-Pin TQFP    | 208-Pin PQFP<br>208-Ball fpBGA<br>272-Ball BGA | 388-Ball fpBGA |

\* The CLK/CLK\_EN, OE, MUX0 and MUX1 terminals on each I/O cell can each be assigned to 25% of the I/Os.

\*\* Global clock pins Y0, Y1, Y2 and Y3 are multiplexed with CLKEN0, CLKEN1, CLKEN2 and CLKEN3 respectively in all devices.

## Architecture

The ispGDXV/VA architecture is different from traditional PLD architectures, in keeping with its unique application focus. The block diagram is shown below. The programmable interconnect consists of a single Global Routing Pool (GRP). Unlike ispLSI® devices, there are no programmable logic arrays on the device. Control signals for OEs, Clocks/Clock Enables and MUX Controls must come from designated sets of I/O pins. The polarity of these signals can be independently programmed in each I/O cell.

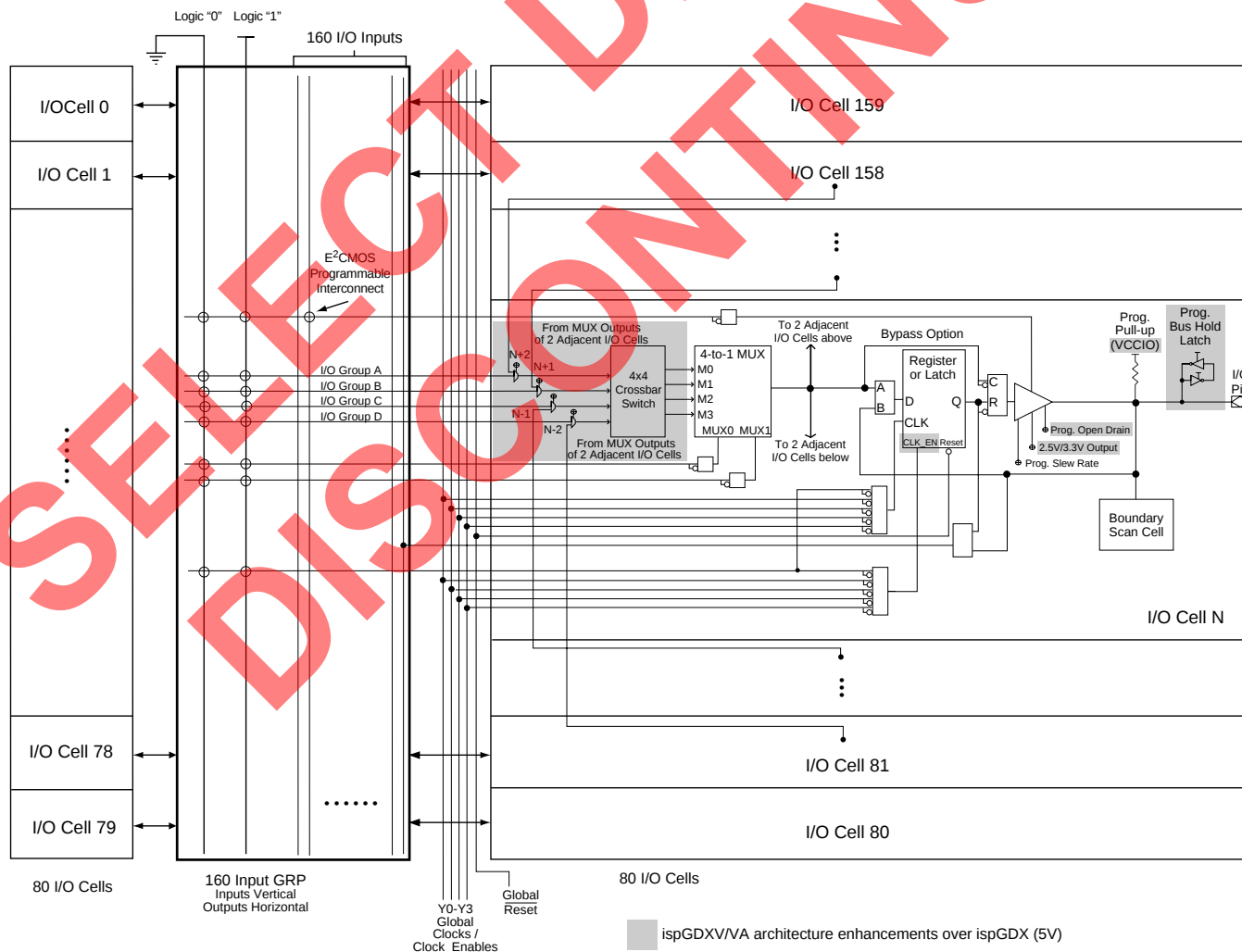
Each I/O cell drives a unique pin. The OE control for each I/O pin is independent and may be driven via the GRP by one of the designated I/O pins (I/O-OE set). The I/O-OE set consists of 25% of the total I/O pins. Boundary Scan test is supported by dedicated registers at each I/O pin. In-system programming is accomplished through the standard Boundary Scan protocol.

The various I/O pin sets are also shown in the block diagram below. The A, B, C, and D I/O pins are grouped together with one group per side.

## I/O Architecture

Each I/O cell contains a 4:1 dynamic MUX controlled by two select lines as well as a 4x4 crossbar switch controlled by software for increased routing flexibility (Figure 1). The four data inputs to the MUX (called M0, M1, M2, and M3) come from I/O signals in the GRP and/or adjacent I/O cells. Each MUX data input can access one quarter of the total I/Os. For example, in a 160 I/O ispGDXV, each data input can connect to one of 40 I/O pins. MUX0 and MUX1 can be driven by designated I/O pins called MUXsel1 and MUXsel2. Each MUXsel input covers 25% of the total I/O pins (e.g. 40 out of 160). MUX0 and MUX1 can be driven from either MUXsel1 or MUXsel2.

**Figure 1. ispGDXV/VA I/O Cell and GRP Detail (160 I/O Device)**



## I/O MUX Operation

| MUX1 | MUX0 | Data Input Selected |
|------|------|---------------------|
| 0    | 0    | M0                  |
| 0    | 1    | M1                  |
| 1    | 1    | M2                  |
| 1    | 0    | M3                  |

Flexible mapping of MUXsel<sub>x</sub> to MUX<sub>x</sub> allows the user to change the MUX select assignment after the ispGDXV/VA device has been soldered to the board. Figure 1 shows that the I/O cell can accept (by programming the appropriate fuses) inputs from the MUX outputs of four adjacent I/O cells, two above and two below. This enables cascading of the MUXes to enable wider (up to 16:1) MUX implementations.

The I/O cell also includes a programmable flow-through latch or register that can be placed in the input or output path and bypassed for combinatorial outputs. As shown in Figure 1, when the input control MUX of the register/latch selects the “A” path, the register/latch gets its inputs from the 4:1 MUX and drives the I/O output. When selecting the “B” path, the register/latch is directly driven by the I/O input while its output feeds the GRP. The programmable polarity Clock to the latch or register can be connected to any I/O in the I/O-CLK/CLKEN set (one-quarter of total I/Os) or to one of the dedicated clock input pins (Y<sub>x</sub>). The programmable polarity Clock Enable input to the register can be programmed to connect to any of the I/O-CLK/CLKEN input pin set or to the global clock enable inputs (CLKEN<sub>x</sub>). Use of the dedicated clock inputs gives minimum clock-to-output delays and minimizes delay variation with fanout. Combinatorial output mode may be implemented by a dedicated architecture bit and bypass MUX. I/O cell output polarity can be programmed as active high or active low.

## MUX Expander Using Adjacent I/O Cells

The ispGDXV/VA allows adjacent I/O cell MUXes to be cascaded to form wider input MUXes (up to 16 x 1) without incurring an additional full Tpd penalty. However, there are certain dependencies on the locality of the adjacent MUXes when used along with direct MUX inputs.

## Adjacent I/O Cells

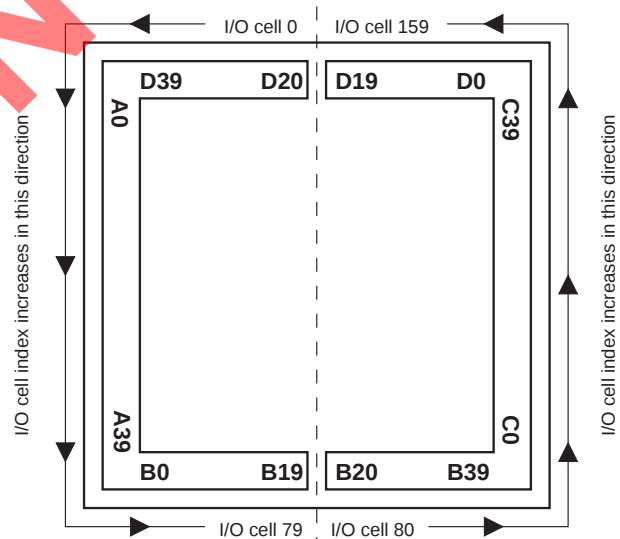
Expansion inputs MUXOUT[n-2], MUXOUT[n-1], MUXOUT[n+1], and MUXOUT[n+2] are fuse-selectable for each I/O cell MUX. These expansion inputs share the same path as the standard A, B, C and D MUX inputs, and

allow adjacent I/O cell outputs to be directly connected without passing through the global routing pool. The relationship between the [N+i] adjacent cells and A, B, C and D inputs will vary depending on where the I/O cell is located on the physical die. The I/O cells can be grouped into “normal” and “reflected” I/O cells or I/O “hemispheres.” These are defined as:

| Device        | Normal I/O Cells                 | Reflected I/O Cells              |
|---------------|----------------------------------|----------------------------------|
| ispGDX80VA    | TBA                              | TBA                              |
| ispGDX160V/VA | B19-B0, A39-A20, A19-A0, D39-D20 | B20-B39, C0-C19, C20-C39, D0-D19 |
| ispGDX240VA   | TBA                              | TBA                              |

Table 2 shows the relationship between adjacent I/O cells as well as their relationship to direct MUX inputs. Note that the MUX expansion is circular and that I/O cell B20, for example, draws on I/Os B19 and B18, as well as B21 and B22, even though they are in different hemispheres of the physical die. Table 2 shows some typical cases and all boundary cases. All other cells can be extrapolated from the pattern shown in the table.

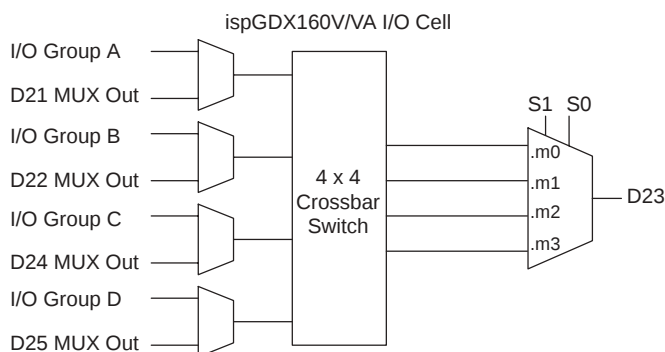
**Figure 2. I/O Hemisphere Configuration of ispGDX160V/VA**



## Direct and Expander Input Routing

Table 2 also illustrates the routing of MUX direct inputs that are accessible when using adjacent I/O cells as inputs. Take I/O cell D23 as an example, which is also shown in Figure 3.

**Figure 3. Adjacent I/O Cells vs. Direct Input Path for ispGDX160V/VA, I/O D23**



It can be seen from Figure 3 that if the D21 adjacent I/O cell is used, the I/O group “A” input is no longer available as a direct MUX input.

The ispGDXV/VA can implement MUXes up to 16 bits wide in a single level of logic, but care must be taken when combining adjacent I/O cell outputs with direct MUX inputs. Any particular combination of adjacent I/O cells as MUX inputs will dictate what I/O groups (A, B, C or D) can be routed to the remaining inputs. By properly choosing the adjacent I/O cells, all of the MUX inputs can be utilized.

**Table 2. Adjacent I/O Cells (Mapping of ispGDX160V/VA)**

|                        |     | Data A/<br>MUXOUT | Data B/<br>MUXOUT | Data C/<br>MUXOUT | Data D/<br>MUXOUT |
|------------------------|-----|-------------------|-------------------|-------------------|-------------------|
| Reflected<br>I/O Cells | B20 | B22               | B21               | B19               | B18               |
|                        | B21 | B23               | B22               | B20               | B19               |
|                        | B22 | B24               | B23               | B21               | B20               |
|                        | B23 | B25               | B24               | B22               | B21               |
|                        | D16 | D18               | D17               | D15               | D14               |
|                        | D17 | D19               | D18               | D16               | D15               |
|                        | D18 | D20               | D19               | D17               | D16               |
|                        | D19 | D21               | D20               | D18               | D17               |
| Normal<br>I/O Cells    | D20 | D18               | D19               | D21               | D22               |
|                        | D21 | D19               | D20               | D22               | D23               |
|                        | D22 | D20               | D21               | D23               | D24               |
|                        | D23 | D21               | D22               | D24               | D25               |
|                        | B16 | B14               | B15               | B17               | B18               |
|                        | B17 | B15               | B16               | B18               | B19               |
|                        | B18 | B16               | B17               | B19               | B20               |
|                        | B19 | B17               | B18               | B20               | B21               |

## Special Features

### Slew Rate Control

All output buffers contain a programmable slew rate control that provides software-selectable slew rate options.

### Open Drain Control

All output buffers provide a programmable Open-Drain option which allows the user to drive system level reset, interrupt and enable/disable lines directly without the need for an off-chip Open-Drain or Open-Collector buffer. Wire-OR logic functions can be performed at the printed circuit board level.

### Pull-up Resistor

All pins have a programmable active pull-up. A typical resistor value for the pull-up ranges from 50kΩ to 80kΩ.

### Output Latch (Bus Hold)

All pins have a programmable circuit that weakly holds the previously driven state when all drivers connected to the pin (including the pin's output driver as well as any other devices connected to the pin by external bus) are tristated.

## ispGDX160VA New Features

Unique to the ispGDX160VA are user-programmable I/Os supporting either 3.3V or 2.5V output voltage level options. The ispGDX160VA uses a VCCIO pin to provide the 2.5V reference voltage when used. The ispGDX160VA VCCIO pin occupies the same location as VCC on the ispGDX160V, allowing drop-in replacement. The ispGDX160VA offers improved performance by reducing fanout delays and has PCI compatible drive capability.

Only the ispGDX160VA is available in the fastest (3.5ns) Commercial speed grade and in -5, -7, and -9ns Industrial grades in all packages.

The ispGDX160VA has a device ID different from the ispGDX160V requiring that the latest Lattice download software be used for programming and verification. Although the ispGDX160VA and ispGDX160V are functionally equivalent, they are not 100% JEDEC compatible. All design files must be recompiled targeting the ispGDX160VA.

## Applications

The ispGDXV/VA Family architecture has been developed to deliver an in-system programmable signal routing solution with high speed and high flexibility. The devices are targeted for three similar but distinct classes of end-system applications:

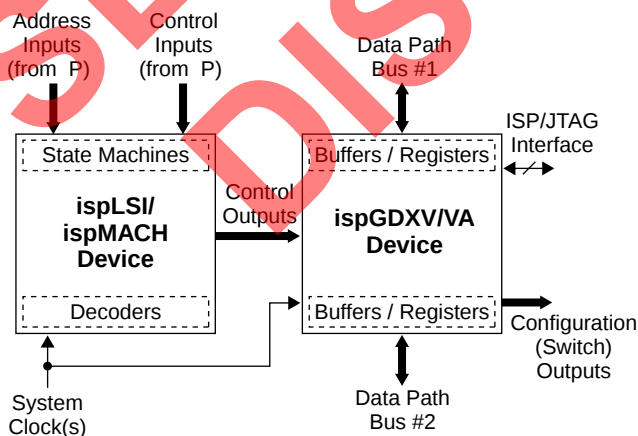
### Programmable, Random Signal Interconnect (PRSI)

This class includes PCB-level programmable signal routing and may be used to provide arbitrary signal swapping between chips. It opens up the possibilities of programmable system hardware. It is characterized by the need to provide a large number of 1:1 pin connections which are statically configured, i.e., the pin-to-pin paths do not need to change dynamically in response to control inputs.

### Programmable Data Path (PDP)

This application area includes system data path transceiver, MUX and latch functions. With today's 32- and 64-bit microprocessor buses, but standard data path glue components still relegated primarily to eight bits, PCBs are frequently crammed with a dozen or more data path glue chips that use valuable real estate. Many of these applications consist of "on-board" bus and memory interfaces that do not require the very high drive of standard glue functions but can benefit from higher integration. Therefore, there is a need for a flexible means to integrate these on-board data path functions in an analogous way to programmable logic's solution to control logic integration. Lattice's CPLDs make an ideal control logic complement to the ispGDXV/VA in-system programmable data path devices as shown below.

**Figure 4. ispGDXV/VA Complements Lattice CPLDs**



### Programmable Switch Replacement (PSR)

Includes solid-state replacement and integration of mechanical DIP Switch and jumper functions. Through in-system programming, pins of the ispGDXV/VA devices can be driven to HIGH or LOW logic levels to emulate the traditional device outputs. PSR functions do not require any input pin connections.

These applications actually require somewhat different silicon features. PRSI functions require that the device support arbitrary signal routing on-chip between any two pins with no routing restrictions. The routing connections are static (determined at programming time) and each input-to-output path operates independently. As a result, there is little need for dynamic signal controls (OE, clocks, etc.). Because the ispGDXV/VA device will interface with control logic outputs from other components (such as ispLSI or ispMACH™) on the board (which frequently change late in the design process as control logic is finalized), there must be no restrictions on pin-to-pin signal routing for this type of application.

PDP functions, on the other hand, require the ability to dynamically switch signal routing (MUXing) as well as latch and tri-state output signals. As a result, the programmable interconnect is used to define possible signal routes that are then selected dynamically by control signals from an external MPU or control logic. These functions are usually formulated early in the conceptual design of a product. The data path requirements are driven by the microprocessor, bus and memory architecture defined for the system. This part of the design is the earliest portion of the system design frozen, and will not usually change late in the design because the result would be total system and PCB redesign. As a result, the ability to accommodate arbitrary any pin-to-any pin re-routing is not a strong requirement as long as the designer has the ability to define his functions with a reasonable degree of freedom initially.

As a result, the ispGDXV/VA architecture has been defined to support PSR and PRSI applications (including bidirectional paths) with no restrictions, while PDP applications (using dynamic MUXing) are supported with a minimal number of restrictions as described below. In this way, speed and cost can be optimized and the devices can still support the system designer's needs.

The following diagrams illustrate several ispGDXV/VA applications.

## Applications (Continued)

Figure 5. Address Demultiplex/Data Buffering

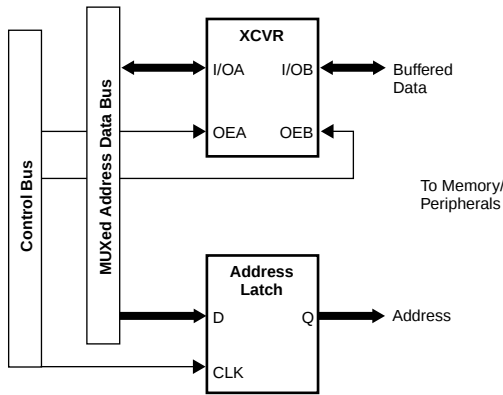


Figure 6. Data Bus Byte Swapper

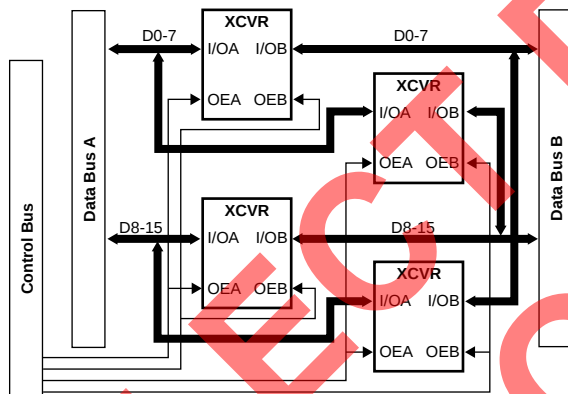
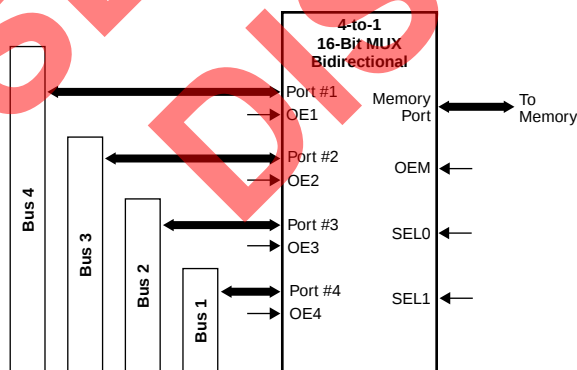


Figure 7. Four-Port Memory Interface



Note: All OE and SEL lines driven by external arbiter logic (not shown).

## Designing with the ispGDXV/VA

As mentioned earlier, this architecture satisfies the PRSI class of applications without restrictions: any I/O pin as a single input or bidirectional can drive any other I/O pin as output.

For the case of PDP applications, the designer does have to take into consideration the limitations on pins that can be used as control (MUX0, MUX1, OE, CLK) or data (MUXA-D) inputs. The restrictions on control inputs are not likely to cause any major design issues because the input possibilities span 25% of the total pins.

The MUXA-D input partitioning requires that designers consciously assign pinouts so that MUX inputs are in the appropriate, disjoint groups. For example, since the MUXA group includes I/O0-39 (160 I/O device), it is not possible to use I/O0 and I/O9 in the same MUX function. As previously discussed, data path functions will be assigned early in the design process and these restrictions are reasonable in order to optimize speed and cost.

## User Electronic Signature

The ispGDXV/VA Family includes dedicated User Electronic Signature (UES) E<sup>2</sup>CMOS storage to allow users to code design-specific information into the devices to identify particular manufacturing dates, code revisions, or the like. The UES information is accessible through the boundary scan programming port via a specific command. This information can be read even when the security cell is programmed.

## Security

The ispGDXV/VA Family includes a security feature that prevents reading the device program once set. Even when set, it does not inhibit reading the UES or device ID code. It can be erased only via a device bulk erase.

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

Supply Voltage  $V_{CC}$  ..... -0.5 to +5.4V  
 Input Voltage Applied ..... -0.5 to +5.6V  
 Off-State Output Voltage Applied ..... -0.5 to +5.6V  
 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).
2. Compliance with the Thermal Management section of the Lattice Semiconductor Data Book or CD-ROM is a requirement.

## DC Recommended Operating Conditions

| SYMBOL     | PARAMETER             |                                                             | MIN. | MAX. | UNITS |
|------------|-----------------------|-------------------------------------------------------------|------|------|-------|
| $V_{CC}$   | Supply Voltage        | Commercial $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$   | 3.00 | 3.60 | V     |
|            |                       | Industrial $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ | 3.00 | 3.60 | V     |
| $V_{CCIO}$ | I/O Reference Voltage |                                                             | 2.3  | 3.60 | V     |

Table 2-0005/gdx160va

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

| SYMBOL | PARAMETER                   | PACKAGE TYPE | TYPICAL | UNITS | TEST CONDITIONS                                  |
|--------|-----------------------------|--------------|---------|-------|--------------------------------------------------|
| $C_1$  | I/O Capacitance             | PQFP         | 7       | pf    | $V_{CC} = 3.3\text{V}$ , $V_{I/O} = 2.0\text{V}$ |
|        |                             | BGA, fpBGA   | 10      | pf    |                                                  |
| $C_2$  | Dedicated Clock Capacitance | PQFP         | 8       | pf    | $V_{CC} = 3.3\text{V}$ , $V_Y = 2.0\text{V}$     |
|        |                             | BGA, fpBGA   | 10      | pf    |                                                  |

Table 2-0006/gdx160va

## Erase/Reprogram Specifications

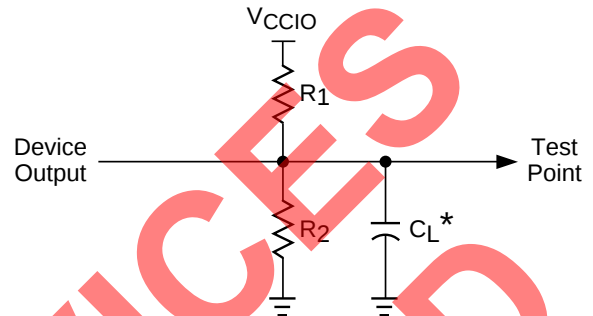
| PARAMETER              | MINIMUM | MAXIMUM | UNITS  |
|------------------------|---------|---------|--------|
| Erase/Reprogram Cycles | 10,000  | —       | Cycles |

## Switching Test Conditions

|                                |                                |
|--------------------------------|--------------------------------|
| Input Pulse Levels             | GND to VCCIO(MIN)              |
| Input Rise and Fall Time       | $\leq 1.5\text{ns}$ 10% to 90% |
| Input Timing Reference Levels  | VCCIO(MIN)/2                   |
| Output Timing Reference Levels | VCCIO(MIN)/2                   |
| Output Load                    | See Figure 8                   |

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

Figure 8. Test Load



\*CL includes Test Fixture and Probe Capacitance.

0213D

## Output Load Conditions (See Figure 8)

|                |                                           | 3.3V |      | 2.5V |      |      |
|----------------|-------------------------------------------|------|------|------|------|------|
| TEST CONDITION |                                           | R1   | R2   | R1   | R2   | CL   |
| A              |                                           | 153Ω | 134Ω | 156Ω | 144Ω | 35pF |
| B              | Active High                               | ∞    | 134Ω | ∞    | 144Ω | 35pF |
|                | Active Low                                | 153Ω | ∞    | 156Ω | ∞    | 35pF |
| C              | Active High to Z at V <sub>OH</sub> -0.5V | ∞    | 134Ω | ∞    | 144Ω | 5pF  |
|                | Active Low to Z at V <sub>OL</sub> +0.5V  | 153Ω | ∞    | 156Ω | ∞    | 5pF  |
| D              | Slow Slew                                 | ∞    | ∞    | ∞    | ∞    | 35pF |

Table 2-0004A/gdx160va

## DC Electrical Characteristics for 3.3V Range<sup>1</sup>

### Over Recommended Operating Conditions

| SYMBOL            | PARAMETER             | CONDITION                                                                      |                          | MIN. | TYP. | MAX. | UNITS |
|-------------------|-----------------------|--------------------------------------------------------------------------------|--------------------------|------|------|------|-------|
| V <sub>CCIO</sub> | I/O Reference Voltage | —                                                                              |                          | 3.0  | —    | 3.6  | V     |
| V <sub>IL</sub>   | Input Low Voltage     | V <sub>OH</sub> ≤ V <sub>OUT</sub> or V <sub>OUT</sub> ≤ V <sub>OL</sub> (MAX) |                          | -0.3 | —    | 0.8  | V     |
| V <sub>IH</sub>   | Input High Voltage    | V <sub>OH</sub> ≤ V <sub>OUT</sub> or V <sub>OUT</sub> ≤ V <sub>OL</sub> (MAX) |                          | 2.0  | —    | 5.25 | V     |
| V <sub>OL</sub>   | Output Low Voltage    | V <sub>CC</sub> = V <sub>CC</sub> (MIN)                                        | I <sub>OL</sub> = +100μA | —    | —    | 0.2  | V     |
|                   |                       |                                                                                | I <sub>OL</sub> = +24mA  | —    | —    | 0.55 | V     |
| V <sub>OH</sub>   | Output High Voltage   | V <sub>CC</sub> = V <sub>CC</sub> (MIN)                                        | I <sub>OH</sub> = -100μA | 2.8  | —    | —    | V     |
|                   |                       |                                                                                | I <sub>OH</sub> = -12mA  | 2.4  | —    | —    | V     |

1. I/O voltage configuration must be set to VCC.

Table 2-0007/gdx160va

## DC Electrical Characteristics for 2.5V Range<sup>1</sup>

### Over Recommended Operating Conditions

| SYMBOL            | PARAMETER             | CONDITION                                                                          | MIN. | TYP. | MAX. | UNITS |
|-------------------|-----------------------|------------------------------------------------------------------------------------|------|------|------|-------|
| V <sub>CCIO</sub> | I/O Reference Voltage | —                                                                                  | 2.3  | —    | 2.7  | V     |
| V <sub>IL</sub>   | Input Low Voltage     | V <sub>OH(MIN)</sub> ≤ V <sub>OUT</sub> or V <sub>OUT</sub> ≤ V <sub>OL(MAX)</sub> | -0.3 | —    | 0.7  | V     |
| V <sub>IH</sub>   | Input High Voltage    | V <sub>OH(MIN)</sub> ≤ V <sub>OUT</sub> or V <sub>OUT</sub> ≤ V <sub>OL(MAX)</sub> | 1.7  | —    | 5.25 | V     |
| V <sub>OL</sub>   | Output Low Voltage    | V <sub>CCIO</sub> =MIN, I <sub>OL</sub> = 100μA                                    | —    | —    | 0.2  | V     |
|                   |                       | V <sub>CCIO</sub> =MIN, I <sub>OL</sub> = 8mA                                      | —    | —    | 0.6  | V     |
| V <sub>OH</sub>   | Output High Voltage   | V <sub>CCIO</sub> =MIN, I <sub>OH</sub> = -100μA                                   | 2.1  | —    | —    | V     |
|                   |                       | V <sub>CCIO</sub> =MIN, I <sub>OH</sub> = -8mA                                     | 1.8  | —    | —    | V     |

1. I/O voltage configuration must be set to V<sub>CCIO</sub>.

2.5V/gdx160va

## DC Electrical Characteristics

### Over Recommended Operating Conditions

| SYMBOL                         | PARAMETER                                                   | CONDITION                                                              | MIN.            | TYP. <sup>2</sup> | MAX.            | UNITS  |
|--------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------|-----------------|-------------------|-----------------|--------|
| I <sub>IL</sub>                | Input or I/O Low Leakage Current                            | 0V ≤ V <sub>IN</sub> ≤ V <sub>IL</sub> (MAX)                           | —               | —                 | -10             | μA     |
| I <sub>IH</sub>                | Input or I/O High Leakage Current                           | (V <sub>CCIO</sub> -0.2) ≤ V <sub>IN</sub> ≤ V <sub>CCIO</sub>         | —               | —                 | 10              | μA     |
|                                |                                                             | V <sub>CCIO</sub> ≤ V <sub>IN</sub> ≤ 5.25V                            | —               | —                 | 50              | μA     |
| I <sub>PU</sub>                | I/O Active Pullup Current                                   | 0V ≤ V <sub>IN</sub> ≤ V <sub>IL</sub> (MAX)                           | —               | —                 | -200            | μA     |
| I <sub>BHLS</sub>              | Bus Hold Low Sustaining Current                             | V <sub>IN</sub> = V <sub>IL</sub> (MAX)                                | 40              | —                 | —               | μA     |
| I <sub>BHHS</sub>              | Bus Hold High Sustaining Current                            | V <sub>IN</sub> = V <sub>IH</sub> (MIN)                                | -40             | —                 | —               | μA     |
| I <sub>BHLO</sub>              | Bus Hold Low Overdrive Current                              | 0V ≤ V <sub>IN</sub> ≤ V <sub>CCIO</sub>                               | —               | —                 | 550             | μA     |
| I <sub>BHHO</sub>              | Bus Hold High Overdrive Current                             | 0V ≤ V <sub>IN</sub> ≤ V <sub>CCIO</sub>                               | —               | —                 | -550            | μA     |
| I <sub>BHT</sub>               | Bus Hold Trip Points                                        |                                                                        | V <sub>IL</sub> | —                 | V <sub>IH</sub> | V      |
| I <sub>OS</sub> <sup>1</sup>   | Output Short Circuit Current                                | V <sub>CC</sub> = 3.3V, V <sub>OUT</sub> = 0.5V, T <sub>A</sub> = 25°C | —               | —                 | -250            | mA     |
| I <sub>CCQ</sub> <sup>4</sup>  | Quiescent Power Supply Current                              | V <sub>IL</sub> = 0.5V, V <sub>IH</sub> = V <sub>CC</sub>              | —               | 16.5              | —               | mA     |
| I <sub>CC</sub>                | Dynamic Power Supply Current per Input Switching            | One input toggling at 50% duty cycle, outputs open.                    | —               | See Note 3        | —               | mA/MHz |
| I <sub>CONT</sub> <sup>5</sup> | Maximum Continuous I/O Pin Sink Current Through Any GND Pin | —                                                                      | —               | —                 | 160             | mA     |

1. One output at a time for a maximum of one second. V<sub>OUT</sub> = 0.5V was selected to avoid test problems by tester ground degradation. Characterized, but not 100% tested.

2. Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = 25°C.

3. I<sub>CC</sub> / MHz = (0.003 × I/O cell fanout) + 0.029.

e.g. An input driving four I/O cells at 40MHz results in a dynamic I<sub>CC</sub> of approximately ((0.003 × 4) + 0.029) × 40 = 1.64mA.

4. For a typical application with 50% of I/O pins used as inputs, 50% used as outputs or bi-directionals.

5. This parameter limits the total current sinking of I/O pins surrounding the nearest GND pin.

DC Char\_gdx160va

**External Timing Parameters**

Over Recommended Operating Conditions

| PARAMETER                        | TEST <sup>1</sup><br>COND. | #  | DESCRIPTION                                                             | -3    |      | -5   |      | UNITS |
|----------------------------------|----------------------------|----|-------------------------------------------------------------------------|-------|------|------|------|-------|
|                                  |                            |    |                                                                         | MIN.  | MAX. | MIN. | MAX. |       |
| t <sub>pd</sub> <sup>2</sup>     | A                          | 1  | Data Prop. Delay from Any I/O pin to Any I/O Pin (4:1 MUX)              | –     | 3.5  | –    | 5.0  | ns    |
| t <sub>sel</sub> <sup>2</sup>    | A                          | 2  | Data Prop. Delay from MUXsel Inputs to Any Output (4:1 MUX)             | –     | 3.5  | –    | 5.0  | ns    |
| f <sub>max</sub> (Tog.)          | –                          | 3  | Clock Frequency, Max. Toggle                                            | 250   | –    | 143  | –    | MHz   |
| f <sub>max</sub> (Ext.)          | –                          | 4  | Clock Frequency with External Feedback ( $\frac{1}{t_{su3}+t_{gco1}}$ ) | 166.7 | –    | 111  | –    | MHz   |
| t <sub>su1</sub>                 | –                          | 5  | Input Latch or Register Setup Time Before Y <sub>x</sub>                | 3.0   | –    | 4.0  | –    | ns    |
| t <sub>su2</sub>                 | –                          | 6  | Input Latch or Register Setup Time Before I/O Clock                     | 2.5   | –    | 3.0  | –    | ns    |
| t <sub>su3</sub>                 | –                          | 7  | Output Latch or Register Setup Time Before Y <sub>x</sub>               | 2.5   | –    | 4.0  | –    | ns    |
| t <sub>su4</sub>                 | –                          | 8  | Output Latch or Register Setup Time Before I/O Clock                    | 2.0   | –    | 3.0  | –    | ns    |
| t <sub>suce1</sub>               | –                          | 9  | Global Clock Enable Setup Time Before Y <sub>x</sub>                    | 2.5   | –    | 2.5  | –    | ns    |
| t <sub>suce2</sub>               | –                          | 10 | Global Clock Enable Setup Time Before I/O Clock                         | 1.5   | –    | 1.5  | –    | ns    |
| t <sub>suce3</sub>               | –                          | 11 | I/O Clock Enable Setup Time Before Y <sub>x</sub>                       | 3.0   | –    | 4.5  | –    | ns    |
| t <sub>h1</sub>                  | –                          | 12 | Input Latch or Reg. Hold Time (Y <sub>x</sub> )                         | 0.0   | –    | 0.0  | –    | ns    |
| t <sub>h2</sub>                  | –                          | 13 | Input Latch or Reg. Hold Time (I/O Clock)                               | 0.5   | –    | 1.5  | –    | ns    |
| t <sub>h3</sub>                  | –                          | 14 | Output Latch or Reg. Hold Time (Y <sub>x</sub> )                        | 0.0   | –    | 0.0  | –    | ns    |
| t <sub>h4</sub>                  | –                          | 15 | Output Latch or Reg. Hold Time (I/O Clock)                              | 1.0   | –    | 1.5  | –    | ns    |
| t <sub>hce1</sub>                | –                          | 16 | Global Clock Enable Hold Time (Y <sub>x</sub> )                         | 0.0   | –    | 0.0  | –    | ns    |
| t <sub>hce2</sub>                | –                          | 17 | Global Clock Enable Hold Time (I/O Clock)                               | 1.0   | –    | 1.5  | –    | ns    |
| t <sub>hce3</sub>                | –                          | 18 | I/O Clock Enable Hold Time (Y <sub>x</sub> )                            | 0.0   | –    | 0.0  | –    | ns    |
| t <sub>gco1</sub> <sup>2</sup>   | A                          | 19 | Output Latch or Reg. Clock (from Y <sub>x</sub> ) to Output Delay       | –     | 3.5  | –    | 5.0  | ns    |
| t <sub>gco2</sub> <sup>2</sup>   | A                          | 20 | Input Latch or Register Clock (from Y <sub>x</sub> ) to Output Delay    | –     | 6.0  | –    | 8.5  | ns    |
| t <sub>co1</sub> <sup>2</sup>    | A                          | 21 | Output Latch or Register Clock (from I/O pin) to Output Delay           | –     | 4.0  | –    | 6.0  | ns    |
| t <sub>co2</sub> <sup>2</sup>    | A                          | 22 | Input Latch or Register Clock (from I/O pin) to Output Delay            | –     | 7.0  | –    | 9.5  | ns    |
| t <sub>en</sub> <sup>2</sup>     | B                          | 23 | Input to Output Enable                                                  | –     | 5.0  | –    | 6.0  | ns    |
| t <sub>dis</sub> <sup>2</sup>    | C                          | 24 | Input to Output Disable                                                 | –     | 5.0  | –    | 6.0  | ns    |
| t <sub>toen</sub> <sup>2</sup>   | B                          | 25 | Test OE Output Enable                                                   | –     | 6.0  | –    | 6.0  | ns    |
| t <sub>toedis</sub> <sup>2</sup> | C                          | 26 | Test OE Output Disable                                                  | –     | 6.0  | –    | 6.0  | ns    |
| t <sub>wh</sub>                  | –                          | 27 | Clock Pulse Duration, High                                              | 2.0   | –    | 3.5  | –    | ns    |
| t <sub>wl</sub>                  | –                          | 28 | Clock Pulse Duration, Low                                               | 2.0   | –    | 3.5  | –    | ns    |
| t <sub>rst</sub>                 | –                          | 29 | Register Reset Delay from RESET Low                                     | –     | 8.0  | –    | 14.0 | ns    |
| t <sub>rw</sub>                  | –                          | 30 | Reset Pulse Width                                                       | 5.0   | –    | 10.0 | –    | ns    |
| t <sub>sl</sub>                  | D                          | 31 | Output Delay Adder for Output Timings Using Slow Slew Rate              | –     | 3.5  | –    | 5.0  | ns    |
| t <sub>sk</sub>                  | A                          | 32 | Output Skew (t <sub>gco1</sub> Across Chip)                             | –     | 0.5  | –    | 0.5  | ns    |

1. All timings measured with one output switching, fast output slew rate setting, except t<sub>sl</sub>.

2. The delay parameters are measured with V<sub>cc</sub> as I/O voltage reference. An additional 0.5ns delay is incurred when V<sub>ccio</sub> is used as I/O voltage reference.

**External Timing Parameters**

**Over Recommended Operating Conditions**

| PARAMETER                        | TEST <sup>1</sup><br>COND. | #  | DESCRIPTION                                                             | -7   |      | -9   |      | UNITS |
|----------------------------------|----------------------------|----|-------------------------------------------------------------------------|------|------|------|------|-------|
|                                  |                            |    |                                                                         | MIN. | MAX. | MIN. | MAX. |       |
| t <sub>pd</sub> <sup>2</sup>     | A                          | 1  | Data Prop. Delay from Any I/O pin to Any I/O Pin (4:1 MUX)              | –    | 7.0  | –    | 9.0  | ns    |
| t <sub>sel</sub> <sup>2</sup>    | A                          | 2  | Data Prop. Delay from MUXsel Inputs to Any Output (4:1 MUX)             | –    | 7.0  | –    | 9.0  | ns    |
| f <sub>max</sub> (Tog.)          | –                          | 3  | Clock Frequency, Max. Toggle                                            | 100  | –    | 83   | –    | MHz   |
| f <sub>max</sub> (Ext.)          | –                          | 4  | Clock Frequency with External Feedback ( $\frac{1}{t_{su3}+t_{gco1}}$ ) | 80   | –    | 62.5 | –    | MHz   |
| t <sub>su1</sub>                 | –                          | 5  | Input Latch or Register Setup Time Before Y <sub>x</sub>                | 5.5  | –    | 7.0  | –    | ns    |
| t <sub>su2</sub>                 | –                          | 6  | Input Latch or Register Setup Time Before I/O Clock                     | 4.5  | –    | 6.0  | –    | ns    |
| t <sub>su3</sub>                 | –                          | 7  | Output Latch or Register Setup Time Before Y <sub>x</sub>               | 5.5  | –    | 7.0  | –    | ns    |
| t <sub>su4</sub>                 | –                          | 8  | Output Latch or Register Setup Time Before I/O Clock                    | 4.5  | –    | 6.0  | –    | ns    |
| t <sub>suce1</sub>               | –                          | 9  | Global Clock Enable Setup Time Before Y <sub>x</sub>                    | 3.5  | –    | 4.0  | –    | ns    |
| t <sub>suce2</sub>               | –                          | 10 | Global Clock Enable Setup Time Before I/O Clock                         | 2.5  | –    | 3.0  | –    | ns    |
| t <sub>suce3</sub>               | –                          | 11 | I/O Clock Enable Setup Time Before Y <sub>x</sub>                       | 6.5  | –    | 8.5  | –    | ns    |
| t <sub>h1</sub>                  | –                          | 12 | Input Latch or Reg. Hold Time (Y <sub>x</sub> )                         | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>h2</sub>                  | –                          | 13 | Input Latch or Reg. Hold Time (I/O Clock)                               | 2.5  | –    | 3.0  | –    | ns    |
| t <sub>h3</sub>                  | –                          | 14 | Output Latch or Reg. Hold Time (Y <sub>x</sub> )                        | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>h4</sub>                  | –                          | 15 | Output Latch or Reg. Hold Time (I/O Clock)                              | 2.5  | –    | 3.0  | –    | ns    |
| t <sub>hce1</sub>                | –                          | 16 | Global Clock Enable Hold Time (Y <sub>x</sub> )                         | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>hce2</sub>                | –                          | 17 | Global Clock Enable Hold Time (I/O Clock)                               | 2.5  | –    | 3.0  | –    | ns    |
| t <sub>hce3</sub>                | –                          | 18 | I/O Clock Enable Hold Time (Y <sub>x</sub> )                            | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>gco1</sub> <sup>2</sup>   | A                          | 19 | Output Latch or Reg. Clock (from Y <sub>x</sub> ) to Output Delay       | –    | 7.0  | –    | 9.0  | ns    |
| t <sub>gco2</sub> <sup>2</sup>   | A                          | 20 | Input Latch or Register Clock (from Y <sub>x</sub> ) to Output Delay    | –    | 11.0 | –    | 13.5 | ns    |
| t <sub>co1</sub> <sup>2</sup>    | A                          | 21 | Output Latch or Register Clock (from I/O pin) to Output Delay           | –    | 9.0  | –    | 11.5 | ns    |
| t <sub>co2</sub> <sup>2</sup>    | A                          | 22 | Input Latch or Register Clock (from I/O pin) to Output Delay            | –    | 13.0 | –    | 15.7 | ns    |
| t <sub>en</sub> <sup>2</sup>     | B                          | 23 | Input to Output Enable                                                  | –    | 8.5  | –    | 10.5 | ns    |
| t <sub>dis</sub> <sup>2</sup>    | C                          | 24 | Input to Output Disable                                                 | –    | 8.5  | –    | 10.5 | ns    |
| t <sub>toen</sub> <sup>2</sup>   | B                          | 25 | Test OE Output Enable                                                   | –    | 8.5  | –    | 10.5 | ns    |
| t <sub>toedis</sub> <sup>2</sup> | C                          | 26 | Test OE Output Disable                                                  | –    | 8.5  | –    | 10.5 | ns    |
| t <sub>wh</sub>                  | –                          | 27 | Clock Pulse Duration, High                                              | 5.0  | –    | 6.0  | –    | ns    |
| t <sub>wl</sub>                  | –                          | 28 | Clock Pulse Duration, Low                                               | 5.0  | –    | 6.0  | –    | ns    |
| t <sub>rst</sub>                 | –                          | 29 | Register Reset Delay from RESET Low                                     | –    | 18.0 | –    | 22.0 | ns    |
| t <sub>rw</sub>                  | –                          | 30 | Reset Pulse Width                                                       | 14.0 | –    | 18.0 | –    | ns    |
| t <sub>sl</sub>                  | D                          | 31 | Output Delay Adder for Output Timings Using Slow Slew Rate              | –    | 7.0  | –    | 9.0  | ns    |
| t <sub>sk</sub>                  | A                          | 32 | Output Skew (tgco1 Across Chip)                                         | –    | 0.5  | –    | 1.0  | ns    |

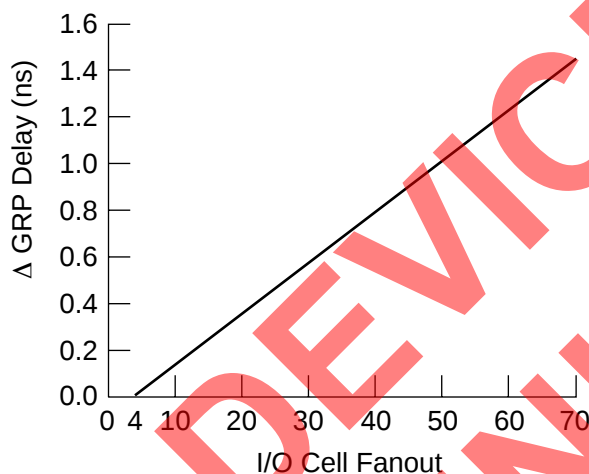
1. All timings measured with one output switching, fast output slew rate setting, except t<sub>sl</sub>.

2. The delay parameters are measured with V<sub>cc</sub> as I/O voltage reference. An additional 0.5ns delay is incurred when V<sub>ccio</sub> is used as I/O voltage reference.

### External Timing Parameters (Continued)

ispGDX160VA timings are specified with a GRP load (fanout) of four I/O cells. The figure below shows the  $\Delta$  GRP Delay with increased GRP loads. These deltas apply to any signal path traversing the GRP (MUXA-D, OE, CLK/CLKEN, MUXsel0-1). Global Clock signals which do not use the GRP have no fanout delay adder.

ispGDX160VA Maximum  $\Delta$  GRP Delay vs. I/O Cell Fanout



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

Over Recommended Operating Conditions

| PARAMETER              | #  | DESCRIPTION <sup>1</sup>                              | -3   |      | -5   |      | UNITS |
|------------------------|----|-------------------------------------------------------|------|------|------|------|-------|
|                        |    |                                                       | MIN. | MAX. | MIN. | MAX. |       |
| Inputs                 |    |                                                       |      |      |      |      |       |
| t <sub>io</sub>        | 32 | Input Buffer Delay                                    | —    | 0.4  | —    | 0.9  | ns    |
| GRP                    |    |                                                       |      |      |      |      |       |
| t <sub>grp</sub>       | 33 | GRP Delay                                             | —    | 1.1  | —    | 1.1  | ns    |
| MUX                    |    |                                                       |      |      |      |      |       |
| t <sub>muxd</sub>      | 34 | I/O Cell MUX A/B/C/D Data Delay                       | —    | 1.0  | —    | 1.5  | ns    |
| t <sub>muxexp</sub>    | 35 | I/O Cell MUX A/B/C/D Expander Delay                   | —    | 1.5  | —    | 2.0  | ns    |
| t <sub>muxs</sub>      | 36 | I/O Cell Data Select                                  | —    | 1.0  | —    | 1.5  | ns    |
| t <sub>muxsio</sub>    | 37 | I/O Cell Data Select (I/O Clock)                      | —    | 1.5  | —    | 3.0  | ns    |
| t <sub>muxsg</sub>     | 38 | I/O Cell Data Select (Yx Clock)                       | —    | 1.5  | —    | 2.0  | ns    |
| t <sub>muxselexp</sub> | 39 | I/O Cell MUX Data Select Expander Delay               | —    | 1.5  | —    | 2.0  | ns    |
| Register               |    |                                                       |      |      |      |      |       |
| t <sub>iolat</sub>     | 40 | I/O Latch Delay                                       | —    | 1.0  | —    | 1.0  | ns    |
| t <sub>iosu</sub>      | 41 | I/O Register Setup Time Before Clock                  | —    | 0.8  | —    | 2.0  | ns    |
| t <sub>ioh</sub>       | 42 | I/O Register Hold Time After Clock                    | —    | 1.7  | —    | 1.5  | ns    |
| t <sub>ioco</sub>      | 43 | I/O Register Clock to Output Delay                    | —    | 1.2  | —    | 0.5  | ns    |
| t <sub>ior</sub>       | 44 | I/O Reset to Output Delay                             | —    | 1.0  | —    | 1.5  | ns    |
| t <sub>cesu</sub>      | 45 | I/O Clock Enable Setup Time Before Clock              | —    | 2.3  | —    | 2.0  | ns    |
| t <sub>ceh</sub>       | 46 | I/O Clock Enable Hold Time After Clock                | —    | 0.2  | —    | 0.5  | ns    |
| Data Path              |    |                                                       |      |      |      |      |       |
| t <sub>fdbk</sub>      | 47 | I/O Register Feedback Delay                           | —    | 0.6  | —    | 0.9  | ns    |
| t <sub>iobp</sub>      | 48 | I/O Register Bypass Delay                             | —    | 0.0  | —    | 0.0  | ns    |
| t <sub>iob</sub>       | 49 | I/O Register Output Buffer Delay                      | —    | 0.0  | —    | 0.0  | ns    |
| t <sub>muxcg</sub>     | 50 | I/O Register A/B/C/D Data Input MUX Delay (Yx Clock)  | —    | 1.5  | —    | 2.0  | ns    |
| t <sub>muxcio</sub>    | 51 | I/O Register A/B/C/D Data Input MUX Delay (I/O Clock) | —    | 1.5  | —    | 3.0  | ns    |
| t <sub>iodg</sub>      | 52 | I/O Register I/O MUX Delay (Yx Clock)                 | —    | 3.5  | —    | 4.0  | ns    |
| t <sub>iodio</sub>     | 53 | I/O Register I/O MUX Delay (I/O Clock)                | —    | 3.5  | —    | 5.0  | ns    |
| Outputs                |    |                                                       |      |      |      |      |       |
| t <sub>ob</sub>        | 54 | Output Buffer Delay                                   | —    | 1.0  | —    | 1.5  | ns    |
| t <sub>obs</sub>       | 55 | Output Buffer Delay (Slow Slew Option)                | —    | 4.5  | —    | 6.5  | ns    |
| t <sub>oee</sub>       | 56 | I/O Cell OE to Output Enable                          | —    | 3.5  | —    | 4.0  | ns    |
| t <sub>oedis</sub>     | 57 | I/O Cell OE to Output Disable                         | —    | 3.5  | —    | 4.0  | ns    |
| t <sub>goe</sub>       | 58 | GRP Output Enable and Disable Delay                   | —    | 0.0  | —    | 0.0  | ns    |
| t <sub>toe</sub>       | 59 | Test OE Enable and Disable Delay                      | —    | 2.5  | —    | 2.0  | ns    |
| Clocks                 |    |                                                       |      |      |      |      |       |
| t <sub>ioclk</sub>     | 60 | I/O Clock Delay                                       | —    | 0.3  | —    | 2.0  | ns    |
| t <sub>gclk</sub>      | 61 | Global Clock Delay                                    | —    | 1.3  | —    | 2.0  | ns    |
| t <sub>gclkeng</sub>   | 62 | Global Clock Enable (Yx Clock)                        | —    | 1.5  | —    | 2.5  | ns    |
| t <sub>gclkenio</sub>  | 63 | Global Clock Enable (I/O Clock)                       | —    | 1.0  | —    | 3.5  | ns    |
| t <sub>ioclkeng</sub>  | 64 | I/O Clock Enable (Yx Clock)                           | —    | 0.5  | —    | 2.5  | ns    |
| Global Reset           |    |                                                       |      |      |      |      |       |
| t <sub>gr</sub>        | 65 | Global Reset to I/O Register Latch                    | —    | 6.0  | —    | 11.0 | ns    |

1. Internal Timing Parameters are not tested and are for reference only.

2. Refer to the Timing Model in this data sheet for further details.

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

Over Recommended Operating Conditions

| PARAMETER              | #  | DESCRIPTION <sup>1</sup>                              | -7   |      | -9   |      | UNITS |
|------------------------|----|-------------------------------------------------------|------|------|------|------|-------|
|                        |    |                                                       | MIN. | MAX. | MIN. | MAX. |       |
| Inputs                 |    |                                                       |      |      |      |      |       |
| t <sub>io</sub>        | 32 | Input Buffer Delay                                    | —    | 1.4  | —    | 1.9  | ns    |
| GRP                    |    |                                                       |      |      |      |      |       |
| t <sub>grp</sub>       | 33 | GRP Delay                                             | —    | 1.1  | —    | 1.1  | ns    |
| MUX                    |    |                                                       |      |      |      |      |       |
| t <sub>muxd</sub>      | 34 | I/O Cell MUX A/B/C/D Data Delay                       | —    | 2.0  | —    | 2.5  | ns    |
| t <sub>muxexp</sub>    | 35 | I/O Cell MUX A/B/C/D Expander Delay                   | —    | 2.5  | —    | 3.0  | ns    |
| t <sub>muxs</sub>      | 36 | I/O Cell Data Select                                  | —    | 2.0  | —    | 2.5  | ns    |
| t <sub>muxsio</sub>    | 37 | I/O Cell Data Select (I/O Clock)                      | —    | 4.5  | —    | 6.0  | ns    |
| t <sub>muxsg</sub>     | 38 | I/O Cell Data Select (Yx Clock)                       | —    | 2.5  | —    | 3.0  | ns    |
| t <sub>muxselexp</sub> | 39 | I/O Cell MUX Data Select Expander Delay               | —    | 2.5  | —    | 3.0  | ns    |
| Register               |    |                                                       |      |      |      |      |       |
| t <sub>iolat</sub>     | 40 | I/O Latch Delay                                       | —    | 1.0  | —    | 1.0  | ns    |
| t <sub>iosu</sub>      | 41 | I/O Register Setup Time Before Clock                  | —    | 3.2  | —    | 4.4  | ns    |
| t <sub>ioh</sub>       | 42 | I/O Register Hold Time After Clock                    | —    | 2.3  | —    | 2.6  | ns    |
| t <sub>ioco</sub>      | 43 | I/O Register Clock to Output Delay                    | —    | 0.5  | —    | 0.5  | ns    |
| t <sub>ior</sub>       | 44 | I/O Reset to Output Delay                             | —    | 1.5  | —    | 1.5  | ns    |
| t <sub>cesu</sub>      | 45 | I/O Clock Enable Setup Time Before Clock              | —    | 2.5  | —    | 2.0  | ns    |
| t <sub>ceh</sub>       | 46 | I/O Clock Enable Hold Time After Clock                | —    | 1.0  | —    | 2.0  | ns    |
| Data Path              |    |                                                       |      |      |      |      |       |
| t <sub>fdbk</sub>      | 47 | I/O Register Feedback Delay                           | —    | 1.2  | —    | 1.3  | ns    |
| t <sub>iobp</sub>      | 48 | I/O Register Bypass Delay                             | —    | 0.3  | —    | 0.6  | ns    |
| t <sub>iob</sub>       | 49 | I/O Register Output Buffer Delay                      | —    | 0.6  | —    | 0.7  | ns    |
| t <sub>muxcg</sub>     | 50 | I/O Register A/B/C/D Data Input MUX Delay (Yx Clock)  | —    | 2.5  | —    | 3.0  | ns    |
| t <sub>muxcio</sub>    | 51 | I/O Register A/B/C/D Data Input MUX Delay (I/O Clock) | —    | 4.5  | —    | 6.0  | ns    |
| t <sub>iodg</sub>      | 52 | I/O Register I/O MUX Delay (Yx Clock)                 | —    | 5.0  | —    | 6.0  | ns    |
| t <sub>iodio</sub>     | 53 | I/O Register I/O MUX Delay (I/O Clock)                | —    | 7.0  | —    | 9.0  | ns    |
| Outputs                |    |                                                       |      |      |      |      |       |
| t <sub>ob</sub>        | 54 | Output Buffer Delay                                   | —    | 2.2  | —    | 2.9  | ns    |
| t <sub>obs</sub>       | 55 | Output Buffer Delay (Slow Slew Option)                | —    | 9.2  | —    | 11.9 | ns    |
| t <sub>oee</sub>       | 56 | I/O Cell OE to Output Enable                          | —    | 6.0  | —    | 7.5  | ns    |
| t <sub>oedis</sub>     | 57 | I/O Cell OE to Output Disable                         | —    | 6.0  | —    | 7.5  | ns    |
| t <sub>goe</sub>       | 58 | GRP Output Enable and Disable Delay                   | —    | 0.0  | —    | 0.0  | ns    |
| t <sub>toe</sub>       | 59 | Test OE Enable and Disable Delay                      | —    | 2.5  | —    | 3.0  | ns    |
| Clocks                 |    |                                                       |      |      |      |      |       |
| t <sub>ioclk</sub>     | 60 | I/O Clock Delay                                       | —    | 3.2  | —    | 4.4  | ns    |
| t <sub>gclk</sub>      | 61 | Global Clock Delay                                    | —    | 2.7  | —    | 3.4  | ns    |
| t <sub>gclkeng</sub>   | 62 | Global Clock Enable (Yx Clock)                        | —    | 3.7  | —    | 5.4  | ns    |
| t <sub>gclkenio</sub>  | 63 | Global Clock Enable (I/O Clock)                       | —    | 5.7  | —    | 8.4  | ns    |
| t <sub>ioclkeng</sub>  | 64 | I/O Clock Enable (Yx Clock)                           | —    | 4.2  | —    | 6.4  | ns    |
| Global Reset           |    |                                                       |      |      |      |      |       |
| t <sub>qr</sub>        | 65 | Global Reset to I/O Register Latch                    | —    | 13.7 | —    | 16.4 | ns    |

1. Internal Timing Parameters are not tested and are for reference only.

2. Refer to the Timing Model in this data sheet for further details.

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

Supply Voltage  $V_{CC}$  ..... -0.5 to +5.4V  
 Input Voltage Applied ..... -0.5 to +5.6V  
 Off-State Output Voltage Applied ..... -0.5 to +5.6V  
 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).
2. Compliance with the Thermal Management section of the Lattice Semiconductor Data Book or CD-ROM is a requirement.

## DC Recommended Operating Conditions

| SYMBOL                       | PARAMETER          |                                            | MIN. | MAX. | UNITS |
|------------------------------|--------------------|--------------------------------------------|------|------|-------|
| V <sub>CC</sub>              | Supply Voltage     | Commercial T <sub>A</sub> = 0°C to +70°C   | 3.0  | 3.6  | V     |
|                              |                    | Industrial T <sub>A</sub> = -40°C to +85°C | 3.0  | 3.6  | V     |
| V <sub>IL</sub> <sup>1</sup> | Input Low Voltage  |                                            | -0.3 | 0.8  | V     |
| V <sub>IH</sub> <sup>1</sup> | Input High Voltage |                                            | 2.0  | 5.25 | V     |

1. Typical 100mV of input hysteresis.

Table 2-0005/gdxv

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

| SYMBOL | PARAMETER                   | TYPICAL | UNITS | TEST CONDITIONS                                  |
|--------|-----------------------------|---------|-------|--------------------------------------------------|
| $C_1$  | I/O Capacitance             | 8       | pf    | $V_{CC} = 3.3\text{V}$ , $V_{I/O} = 2.0\text{V}$ |
| $C_2$  | Dedicated Clock Capacitance | 10      | pf    | $V_{CC} = 3.3\text{V}$ , $V_Y = 2.0\text{V}$     |

Table 2 - 0006

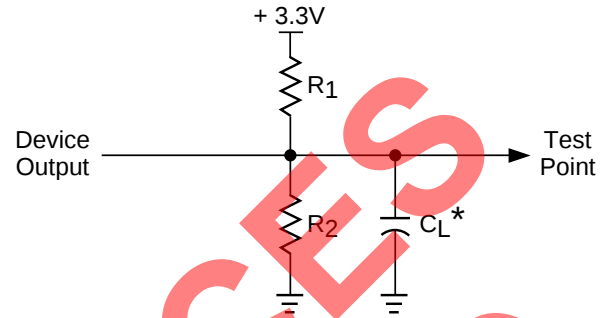
## Erase/Reprogram Specifications

| PARAMETER              | MINIMUM | MAXIMUM | UNITS  |
|------------------------|---------|---------|--------|
| Erase/Reprogram Cycles | 10,000  | —       | Cycles |

## Switching Test Conditions

|                                |                                |
|--------------------------------|--------------------------------|
| Input Pulse Levels             | GND to 3.0V                    |
| Input Rise and Fall Time       | $\leq 1.5\text{ns}$ 10% to 90% |
| Input Timing Reference Levels  | 1.5V                           |
| Output Timing Reference Levels | 1.5V                           |
| Output Load                    | See figure at right            |

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



\*CL includes Test Fixture and Probe Capacitance.

## Output Load Conditions

| TEST CONDITION |                                   | R1       | R2       | CL   |
|----------------|-----------------------------------|----------|----------|------|
| A              |                                   | 153Ω     | 134Ω     | 35pF |
| B              | Active High                       | $\infty$ | 134Ω     | 35pF |
|                | Active Low                        | 153Ω     | $\infty$ | 35pF |
| C              | Active High to Z at $V_{OH}-0.5V$ | $\infty$ | 134Ω     | 5pF  |
|                | Active Low to Z at $V_{OL}+0.5V$  | 153Ω     | $\infty$ | 5pF  |
| D              | Slow Slew                         | $\infty$ | $\infty$ | 35pF |

Table 2-0004A

## DC Electrical Characteristics

### Over Recommended Operating Conditions

| SYMBOL                   | PARAMETER                                                   | CONDITION                                          | MIN.     | TYP. <sup>2</sup> | MAX.     | UNITS  |
|--------------------------|-------------------------------------------------------------|----------------------------------------------------|----------|-------------------|----------|--------|
| <b>VOL</b>               | Output Low Voltage                                          | $I_{OL} = 24\text{ mA}$                            | —        | —                 | 0.55     | V      |
| <b>VOH</b>               | Output High Voltage                                         | $I_{OH} = -12\text{ mA}$                           | 2.4      | —                 | —        | V      |
| <b>IIL</b>               | Input or I/O Low Leakage Current                            | $0V \leq V_{IN} \leq V_{IL} (\text{Max.})$         | —        | —                 | -10      | μA     |
| <b>IIH</b>               | Input or I/O High Leakage Current                           | $V_{CC} \leq V_{IN} \leq 5.25V$                    | —        | —                 | 10       | μA     |
| <b>IIL-PU</b>            | I/O Active Pull-Up Current                                  | $0V \leq V_{IN} \leq V_{IL}$                       | —        | —                 | -150     | μA     |
| <b>IBHLS</b>             | Bus Hold Low Sustaining Current                             | $V_{IN} = V_{IL} (\text{Max.})$                    | 50       | —                 | —        | μA     |
| <b>IBHHS</b>             | Bus Hold High Sustaining Current                            | $V_{IN} = V_{IH} (\text{Min.})$                    | -50      | —                 | —        | μA     |
| <b>IBHLO</b>             | Bus Hold Low Overdrive Current                              | $0V \leq V_{IN} \leq V_{CC}$                       | —        | —                 | 550      | μA     |
| <b>IBHHO</b>             | Bus Hold High Overdrive Current                             | $0V \leq V_{IN} \leq V_{CC}$                       | —        | —                 | -550     | μA     |
| <b>IBHT</b>              | Bus Hold Trip Points                                        |                                                    | $V_{IL}$ | —                 | $V_{IH}$ | V      |
| <b>IOS<sup>1</sup></b>   | Output Short Circuit Current                                | $V_{CC} = 3.3V, V_{OUT} = 0.5V, T_A = 25^\circ C$  | —        | —                 | -250     | mA     |
| <b>ICCQ<sup>4</sup></b>  | Quiescent Power Supply Current                              | $V_{IL} = 0.5V, V_{IH} = V_{CC}$                   | —        | 70                | —        | mA     |
| <b>ICC</b>               | Dynamic Power Supply Current per Input Switching            | One input toggling @ 50% duty cycle, outputs open. | —        | See Note 3        | —        | mA/MHz |
| <b>ICONT<sup>5</sup></b> | Maximum Continuous I/O Pin Sink Current Through Any GND Pin |                                                    | —        | —                 | 96       | 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.
- Typical values are at  $V_{CC} = 3.3V$  and  $T_A = 25^\circ C$ .
- $I_{CC} / \text{MHz} = (0.01 \times \text{I/O cell fanout}) + 0.04$   
e.g. An input driving four I/O cells at 40 MHz results in a dynamic  $I_{CC}$  of approximately  $((0.01 \times 4) + 0.04) \times 40 = 3.2\text{ mA}$ .
- For a typical application with 50% of I/O pins used as inputs, 50% used as outputs or bidirectionals.
- This parameter limits the total current sinking of I/O pins surrounding the nearest GND pin.

**External Timing Parameters**

Over Recommended Operating Conditions

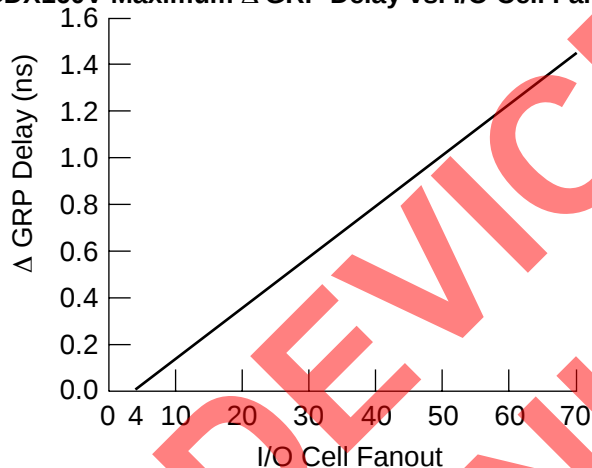
| PARAMETER               | TEST <sup>1</sup><br>COND. | #  | DESCRIPTION                                                           | -5   |      | -7   |      | UNITS |
|-------------------------|----------------------------|----|-----------------------------------------------------------------------|------|------|------|------|-------|
|                         |                            |    |                                                                       | MIN. | MAX. | MIN. | MAX. |       |
| t <sub>pd</sub>         | A                          | 1  | Data Prop. Delay from Any I/O pin to Any I/O pin (4:1 MUX)            | –    | 5.0  | –    | 7.0  | ns    |
| t <sub>sel</sub>        | A                          | 2  | Data Prop. Delay from MUXsel Inputs to Any Output (4:1 MUX)           | –    | 6.5  | –    | 9.0  | ns    |
| f <sub>max</sub> (Tog.) | –                          | 3  | Clock Frequency, Max. Toggle                                          | 143  | –    | 100  | –    | MHz   |
| f <sub>max</sub> (Ext.) | –                          | 4  | Clock Frequency with External Feedback ( $\frac{1}{tsu3+tgco1}$ )     | 110  | –    | 80.0 | –    | MHz   |
| t <sub>su1</sub>        | –                          | 5  | Input Latch or Register Setup Time Before Y <sub>x</sub>              | 4.0  | –    | 5.5  | –    | ns    |
| t <sub>su2</sub>        | –                          | 6  | Input Latch or Register Setup Time Before I/O Clock                   | 3.0  | –    | 4.5  | –    | ns    |
| t <sub>su3</sub>        | –                          | 7  | Output Latch or Register Setup Time Before Y <sub>x</sub>             | 4.0  | –    | 5.5  | –    | ns    |
| t <sub>su4</sub>        | –                          | 8  | Output Latch or Register Setup Time Before I/O Clock                  | 3.0  | –    | 4.5  | –    | ns    |
| t <sub>suce1</sub>      | –                          | 9  | Global Clock Enable Setup Time Before Y <sub>x</sub>                  | 2.5  | –    | 3.5  | –    | ns    |
| t <sub>suce2</sub>      | –                          | 10 | Global Clock Enable Setup Time Before I/O Clock                       | 1.5  | –    | 2.5  | –    | ns    |
| t <sub>suce3</sub>      | –                          | 11 | I/O Clock Enable Setup Time Before Y <sub>x</sub>                     | 4.5  | –    | 6.5  | –    | ns    |
| t <sub>h1</sub>         | –                          | 12 | Input Latch or Register Hold Time (Y <sub>x</sub> )                   | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>h2</sub>         | –                          | 13 | Input Latch or Register Hold Time (I/O Clock)                         | 1.5  | –    | 2.5  | –    | ns    |
| t <sub>h3</sub>         | –                          | 14 | Output Latch or Register Hold Time (Y <sub>x</sub> )                  | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>h4</sub>         | –                          | 15 | Output Latch or Register Hold Time (I/O Clock)                        | 1.5  | –    | 2.5  | –    | ns    |
| t <sub>hce1</sub>       | –                          | 16 | Global Clock Enable Hold Time (Y <sub>x</sub> )                       | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>hce2</sub>       | –                          | 17 | Global Clock Enable Hold Time (I/O Clock)                             | 1.5  | –    | 2.5  | –    | ns    |
| t <sub>hce3</sub>       | –                          | 18 | I/O Clock Enable Hold Time (Y <sub>x</sub> )                          | 0.0  | –    | 0.0  | –    | ns    |
| t <sub>gco1</sub>       | A                          | 19 | Output Latch or Register Clock (from Y <sub>x</sub> ) to Output Delay | –    | 5.0  | –    | 7.0  | ns    |
| t <sub>gco2</sub>       | A                          | 20 | Input Latch or Register Clock (from Y <sub>x</sub> ) to Output Delay  | –    | 8.5  | –    | 11.0 | ns    |
| t <sub>co1</sub>        | A                          | 21 | Output Latch or Register Clock (from I/O pin) to Output Delay         | –    | 6.0  | –    | 9.0  | ns    |
| t <sub>co2</sub>        | A                          | 22 | Input Latch or Register Clock (from I/O pin) to Output Delay          | –    | 9.5  | –    | 13.0 | ns    |
| t <sub>en</sub>         | B                          | 23 | Input to Output Enable                                                | –    | 6.0  | –    | 8.5  | ns    |
| t <sub>dis</sub>        | C                          | 24 | Input to Output Disable                                               | –    | 6.0  | –    | 8.5  | ns    |
| t <sub>toeen</sub>      | B                          | 25 | Test OE Output Enable                                                 | –    | 9.0  | –    | 12.0 | ns    |
| t <sub>toedis</sub>     | C                          | 26 | Test OE Output Disable                                                | –    | 9.0  | –    | 12.0 | ns    |
| t <sub>wh</sub>         | –                          | 27 | Clock Pulse Duration, High                                            | 3.5  | –    | 5.0  | –    | ns    |
| t <sub>wl</sub>         | –                          | 28 | Clock Pulse Duration, Low                                             | 3.5  | –    | 5.0  | –    | ns    |
| t <sub>rst</sub>        | –                          | 29 | Register Reset Delay from RESET Low                                   | –    | 14.0 | –    | 18.0 | ns    |
| t <sub>rw</sub>         | –                          | 30 | Reset Pulse Width                                                     | 10.0 | –    | 14.0 | –    | ns    |
| t <sub>sl</sub>         | D                          | 31 | Output Delay Adder for Output Timings Using Slow Slew Rate            | –    | 8.0  | –    | 12.0 | ns    |
| t <sub>sk</sub>         | A                          | 32 | Output Skew (tgco1 Across Chip)                                       | –    | 0.5  | –    | 0.5  | ns    |

1. All timings measured with one output switching, fast output slew rate setting, except t<sub>sl</sub>.

### External Timing Parameters (Continued)

ispGDX160V timings are specified with a GRP load (fanout) of four I/O cells. The figure below shows the  $\Delta$  GRP Delay with increased GRP loads. These deltas apply to any signal path traversing the GRP (MUXA-D, OE, CLK/CLKEN, MUXsel0-1). Global Clock signals which do not use the GRP have no fanout delay adder.

ispGDX160V Maximum  $\Delta$  GRP Delay vs. I/O Cell Fanout



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

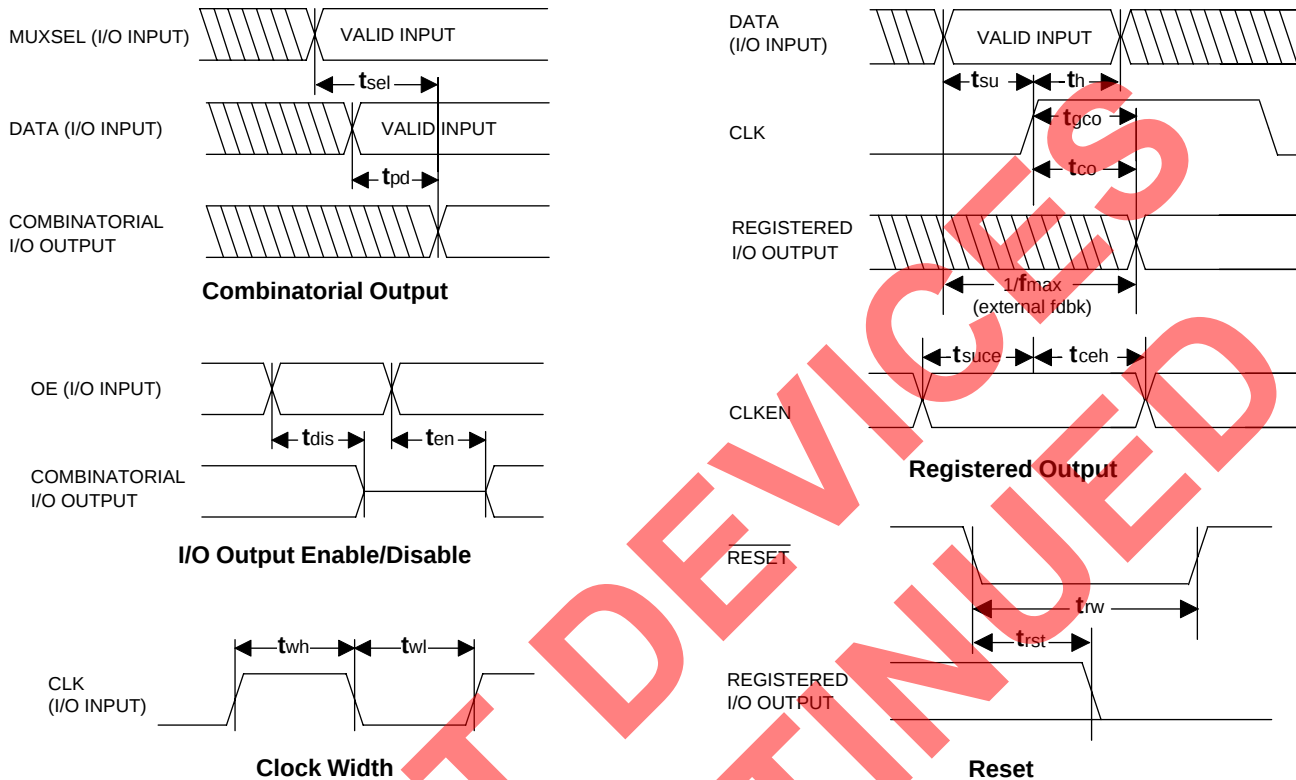
Over Recommended Operating Conditions

| PARAMETER              | #  | DESCRIPTION <sup>1</sup>                            | -5   |      | -7   |      | UNITS |
|------------------------|----|-----------------------------------------------------|------|------|------|------|-------|
|                        |    |                                                     | MIN. | MAX. | MIN. | MAX. |       |
| Inputs                 |    |                                                     |      |      |      |      |       |
| t <sub>io</sub>        | 32 | Input Buffer Delay                                  | —    | 0.9  | —    | 1.4  | ns    |
| GRP                    |    |                                                     |      |      |      |      |       |
| t <sub>grp</sub>       | 33 | GRP Delay                                           | —    | 1.1  | —    | 1.1  | ns    |
| MUX                    |    |                                                     |      |      |      |      |       |
| t <sub>muxd</sub>      | 34 | I/O Cell MUX A/B/C/D Data Delay                     | —    | 1.5  | —    | 2.0  | ns    |
| t <sub>muxexp</sub>    | 35 | I/O Cell MUX A/B/C/D Expander Delay                 | —    | 2.0  | —    | 2.5  | ns    |
| t <sub>muxs</sub>      | 36 | I/O Cell Data Select                                | —    | 3.0  | —    | 4.0  | ns    |
| t <sub>muxsio</sub>    | 37 | I/O Cell Data Select (I/O Clk)                      | —    | 4.5  | —    | 6.5  | ns    |
| t <sub>muxsg</sub>     | 38 | I/O Cell Data Select (Yx Clk)                       | —    | 3.5  | —    | 4.5  | ns    |
| t <sub>muxselexp</sub> | 39 | I/O Cell MUX Data Select Expander Delay             | —    | 3.5  | —    | 4.5  | ns    |
| Register               |    |                                                     |      |      |      |      |       |
| t <sub>iolat</sub>     | 40 | I/O Latch Delay                                     | —    | 1.0  | —    | 1.0  | ns    |
| t <sub>iosu</sub>      | 41 | I/O Register Setup Time Before Clock                | —    | 2.0  | —    | 3.2  | ns    |
| t <sub>ioh</sub>       | 42 | I/O Register Hold Time After Clock                  | —    | 1.5  | —    | 2.3  | ns    |
| t <sub>ioco</sub>      | 43 | I/O Register Clock to Output Delay                  | —    | 0.5  | —    | 0.5  | ns    |
| t <sub>ior</sub>       | 44 | I/O Reset to Output Delay                           | —    | 1.5  | —    | 1.5  | ns    |
| t <sub>cesu</sub>      | 45 | I/O Clock Enable Setup Time Before Clock            | —    | 2.0  | —    | 2.5  | ns    |
| t <sub>ceh</sub>       | 46 | I/O Clock Enable Hold Time After Clock              | —    | 0.5  | —    | 1.0  | ns    |
| Data Path              |    |                                                     |      |      |      |      |       |
| t <sub>fdbk</sub>      | 47 | I/O Register Feedback Delay                         | —    | 0.9  | —    | 1.2  | ns    |
| t <sub>iobp</sub>      | 48 | I/O Register Bypass Delay                           | —    | 0.0  | —    | 0.3  | ns    |
| t <sub>iobb</sub>      | 49 | I/O Register Output Buffer Delay                    | —    | 0.0  | —    | 0.6  | ns    |
| t <sub>muxcg</sub>     | 50 | I/O Register A/B/C/D Data Input MUX Delay (Yx Clk)  | —    | 2.0  | —    | 2.5  | ns    |
| t <sub>muxcio</sub>    | 51 | I/O Register A/B/C/D Data Input MUX Delay (I/O Clk) | —    | 3.0  | —    | 4.5  | ns    |
| t <sub>iodg</sub>      | 52 | I/O Register I/O MUX Delay (Yx Clk)                 | —    | 4.0  | —    | 5.0  | ns    |
| t <sub>iodio</sub>     | 53 | I/O Register I/O MUX Delay (I/O Clk)                | —    | 5.0  | —    | 7.0  | ns    |
| Outputs                |    |                                                     |      |      |      |      |       |
| t <sub>ob</sub>        | 54 | Output Buffer Delay                                 | —    | 1.5  | —    | 2.2  | ns    |
| t <sub>obs</sub>       | 55 | Output Buffer Delay (Slow Slew Option)              | —    | 9.5  | —    | 14.2 | ns    |
| t <sub>oee</sub>       | 56 | I/O Cell OE to Output Enable                        | —    | 4.0  | —    | 6.0  | ns    |
| t <sub>oedis</sub>     | 57 | I/O Cell OE to Output Disable                       | —    | 4.0  | —    | 6.0  | ns    |
| t <sub>goe</sub>       | 58 | GRP Output Enable and Disable Delay                 | —    | 0.0  | —    | 0.0  | ns    |
| t <sub>toe</sub>       | 59 | Test OE Enable and Disable Delay                    | —    | 5.0  | —    | 6.0  | ns    |
| Clocks                 |    |                                                     |      |      |      |      |       |
| t <sub>ioclk</sub>     | 60 | I/O Clock Delay                                     | —    | 2.0  | —    | 3.2  | ns    |
| t <sub>gclk</sub>      | 61 | Global Clock Delay                                  | —    | 2.0  | —    | 2.7  | ns    |
| t <sub>gclkeng</sub>   | 62 | Global Clock Enable (Yx Clk)                        | —    | 2.5  | —    | 3.7  | ns    |
| t <sub>gclkenio</sub>  | 63 | Global Clock Enable (I/O Clk)                       | —    | 3.5  | —    | 5.7  | ns    |
| t <sub>ioclkeng</sub>  | 64 | I/O Clock Enable (Yx Clk)                           | —    | 2.5  | —    | 4.2  | ns    |
| Global Reset           |    |                                                     |      |      |      |      |       |
| t <sub>gr</sub>        | 65 | Global Reset to I/O Register Latch                  | —    | 11.0 | —    | 13.7 | ns    |

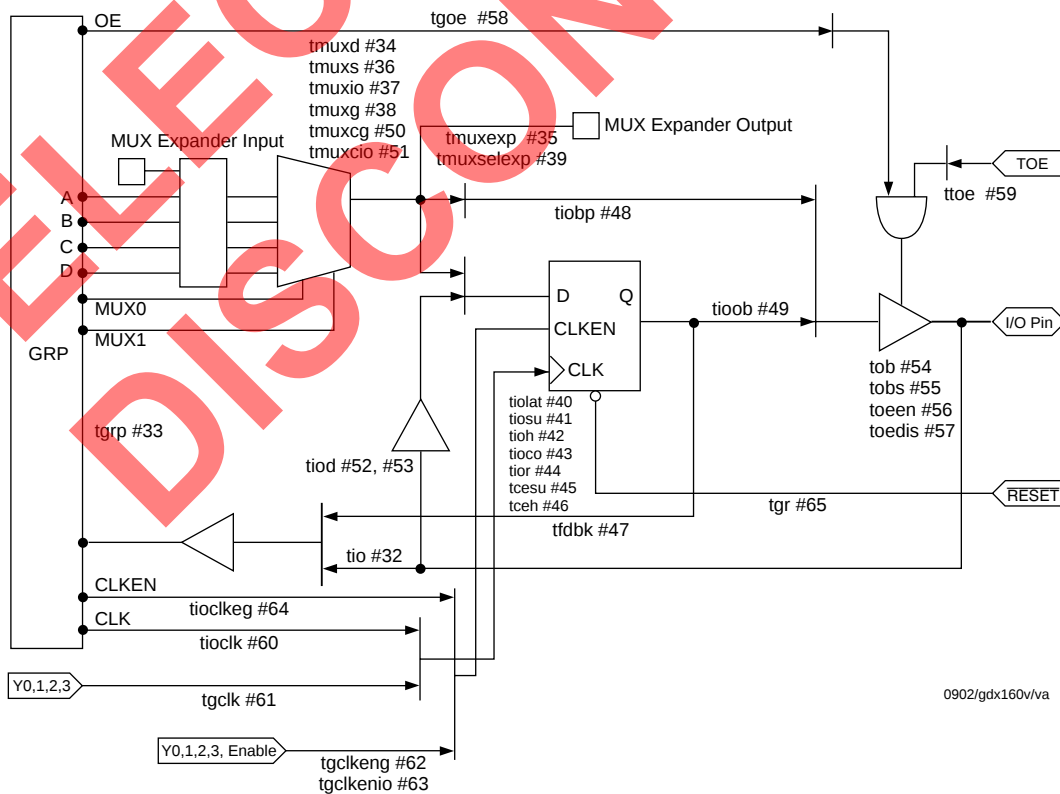
1. Internal Timing Parameters are not tested and are for reference only.

2. Refer to the Timing Model in this data sheet for further details.

## Switching Waveforms



## ispGDXV Timing Model



0902/gdx160v/va

## ispLEVER Development System

The ispLEVER Development System supports ispGDX design using a VHDL or Verilog language syntax. From creation to in-system programming, the ispLEVER system is an easy-to-use, self-contained design tool.

### Features

- VHDL and Verilog Synthesis Support Available
- ispGDX Design Compiler
  - Design Rule Checker
  - I/O Connectivity Checker
  - Automatic Compiler Function
- Industry Standard JEDEC File for Programming
- Min/Max Timing Report
- Interfaces To Popular Timing Simulators
- User Electronic Signature (UES) Support
- Detailed Log and Report Files For Easy Design Debug
- On-line Help
- Windows® XP, Windows 2000, Windows 98 and Windows NT® Compatible
- Solaris® and HP-UX Versions Available

## In-System Programmability

All necessary programming of the ispGDXV/VA is done via four TTL level logic interface signals. These four

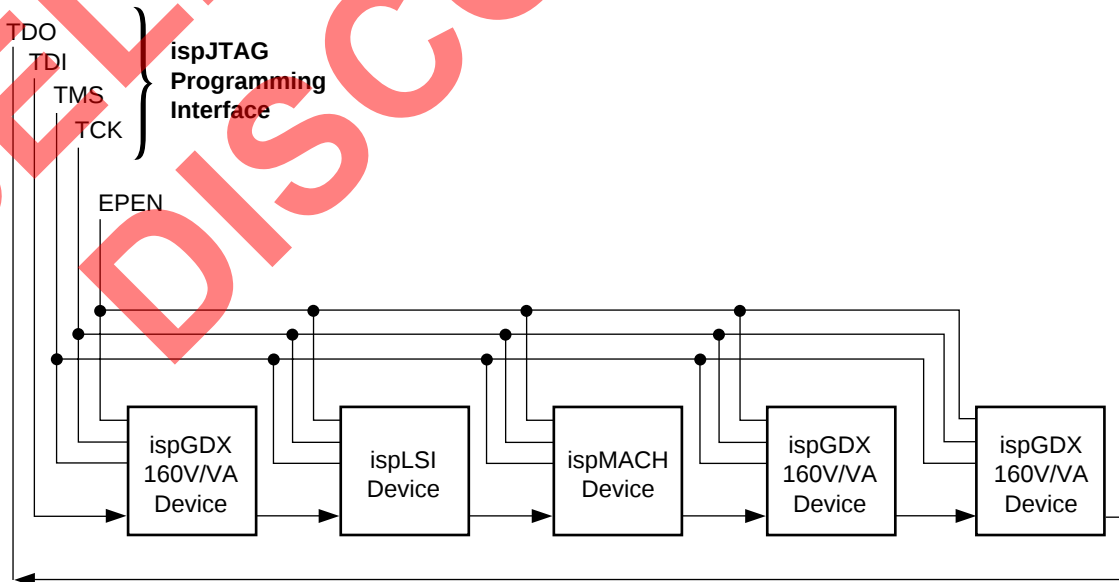
signals are fed into the on-chip programming circuitry where a state machine controls the programming.

On-chip programming can be accomplished using an IEEE 1149.1 boundary scan protocol. The IEEE 1149.1-compliant interface signals are Test Data In (TDI), Test Data Out (TDO), Test Clock (TCK) and Test Mode Select (TMS) control. The EPEN pin is also used to enable or disable the JTAG port.

The embedded controller port enable pin (EPEN) is used to enable the JTAG tap controller and in that regard has similar functionality to a TRST pin. When the pin is driven high, the JTAG TAP controller is enabled. This is also true when the pin is left unconnected, in which case the pin is pulled high by the permanent internal pullup. This allows ISP programming and BSCAN testing to take place as specified by the Instruction Table.

When the pin is driven low, the JTAG TAP controller is driven to a reset state asynchronously. It stays there while the pin is held low. After pulling the pin high the JTAG controller becomes active. The intent of this feature is to allow the JTAG interface to be directly controlled by the data bus of an embedded controller (hence the name Embedded Port Enable). The EPEN signal is used as a "device select" to prevent spurious programming and/or testing from occurring due to random bit patterns on the data bus. Figure 9 illustrates the block diagram for the ispJTAG™ interface.

Figure 9. ispJTAG Device Programming Interface



## Boundary Scan

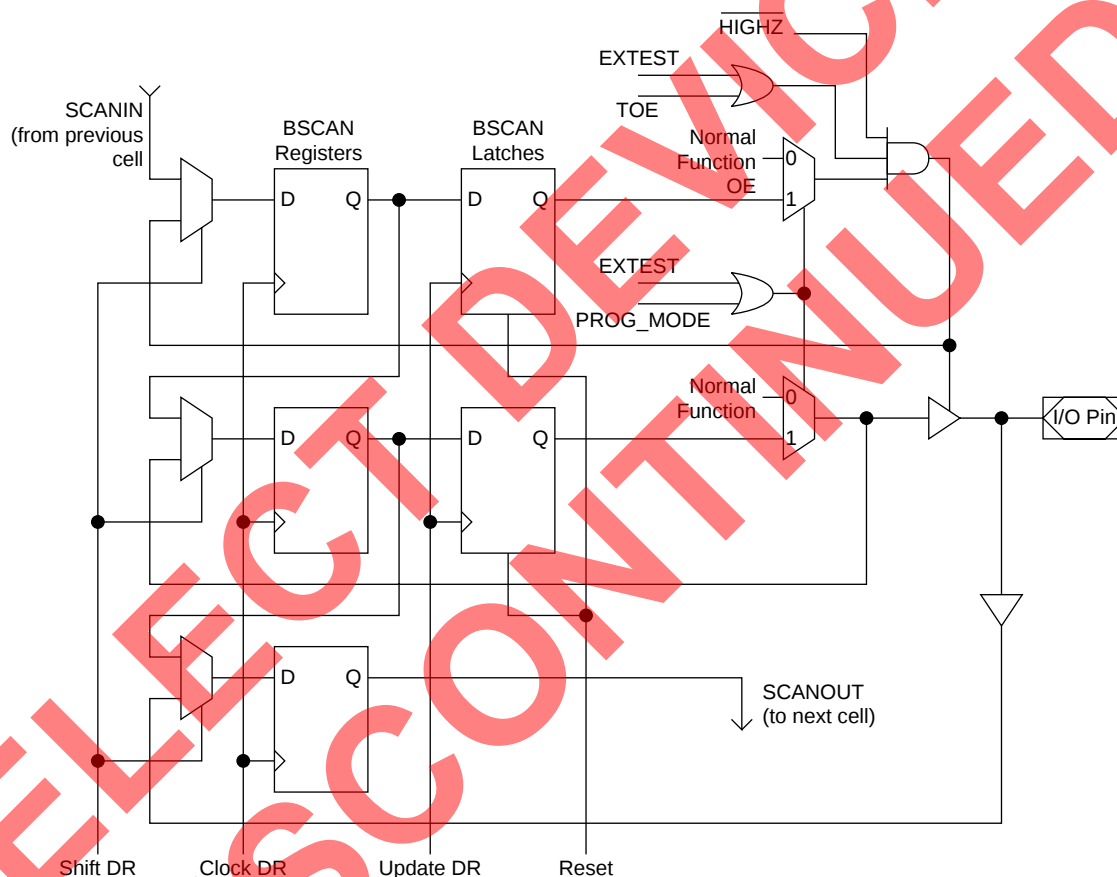
The ispGDXV/VA devices provide IEEE1149.1a test capability and ISP programming through a standard Boundary Scan Test Access Port (TAP) interface.

The boundary scan circuitry on the ispGDXV/VA Family operates independently of the programmed pattern. This

allows customers using boundary scan test to have full test capability with only a single BSDL file.

The ispGDXV/VA devices are identified by the 32-bit JTAG ICODE register. The device ID assignments are listed in Table 4.

**Figure 10. Boundary Scan Register Circuit for I/O Pins**



**Table 3. I/O Shift Register Order**

| DEVICE        | I/O SHIFT REGISTER ORDER                                                                                                        |
|---------------|---------------------------------------------------------------------------------------------------------------------------------|
| ispGDX160V/VA | TDI, TOE, Y2, Y3, RESET, Y1, Y0, I/O B20 .. B39, I/O C0 .. C39, I/O D0 .. D19, I/O B19 .. B0, I/O A39.. A0, I/O D39 .. D20, TDO |

I/O Shift Reg Order/ispGDXVA

**Table 4. ispGDX160V/VA Device ID Codes**

| DEVICE      | 32-BIT BOUNDARY SCAN ID CODE                   |
|-------------|------------------------------------------------|
| ispGDX160V  | 0000, 0000, 0011, 0101, 0011, 0000, 0100, 0011 |
| ispGDX160VA | 0001, 0000, 0011, 0101, 0011, 0000, 0100, 0011 |

ID Code/GDX160V/VA

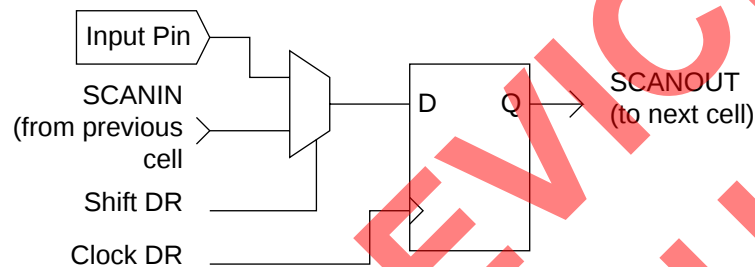
## Boundary Scan (Continued)

The ispJTAG programming is accomplished by executing Lattice private instructions under the Boundary Scan State Machine.

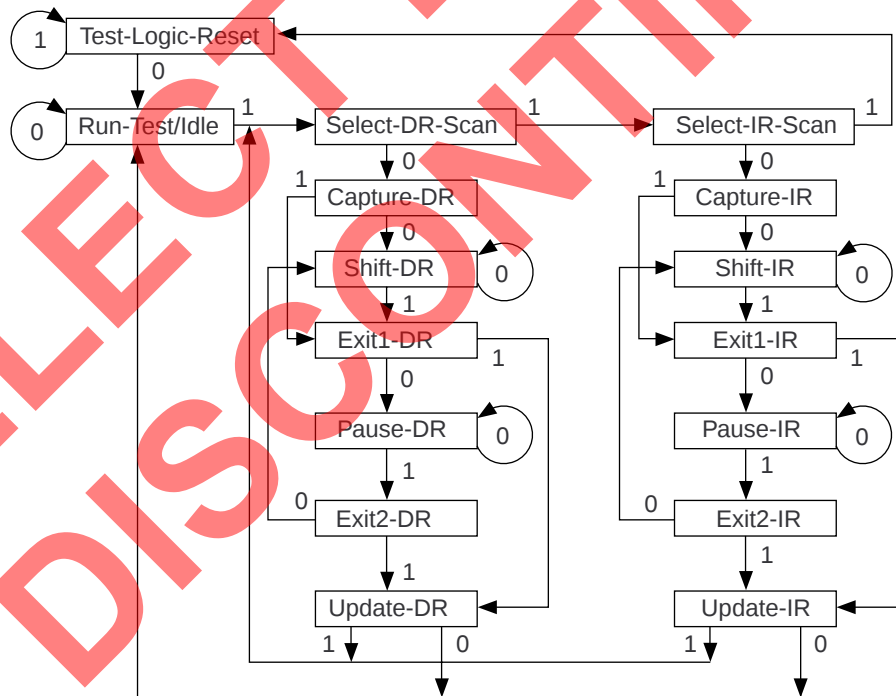
Download (ispDCD™), ispCODE 'C' routines or any third-party programmers. Contact Lattice Technical Support to obtain more detailed programming information.

Details of the programming sequence are transparent to the user and are handled by Lattice ISP Daisy Chain

**Figure 11. Boundary Scan Register Circuit for Input-Only Pins**

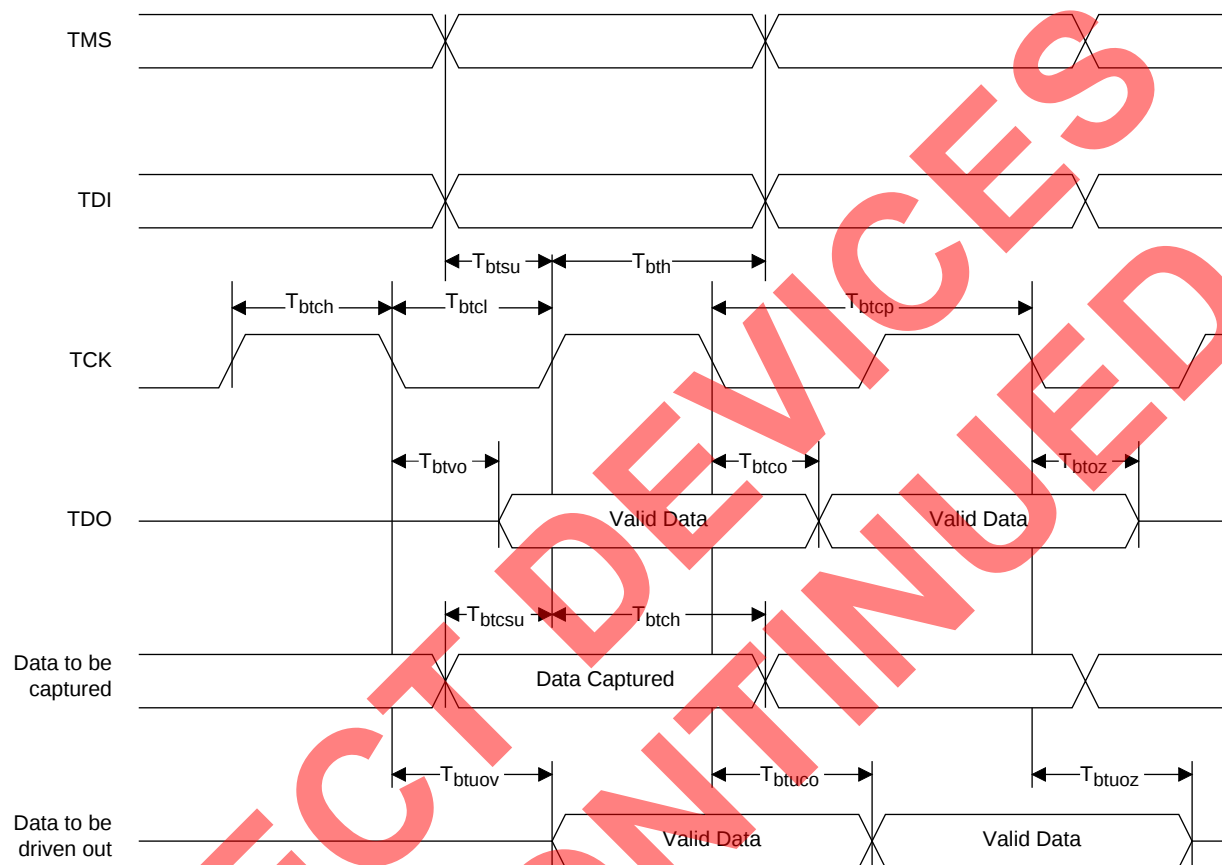


**Figure 12. Boundary Scan State Machine**



**Boundary Scan (Continued)**

**Figure 13. Boundary Scan Waveforms and Timing Specifications**



| Symbol      | Parameter                                                      | Min | Max | Units |
|-------------|----------------------------------------------------------------|-----|-----|-------|
| $t_{btcp}$  | TCK [BSCAN test] clock pulse width                             | 100 | –   | ns    |
| $t_{btch}$  | TCK [BSCAN test] pulse width high                              | 50  | –   | ns    |
| $t_{btcl}$  | TCK [BSCAN test] pulse width low                               | 50  | –   | ns    |
| $t_{btsu}$  | TCK [BSCAN test] setup time                                    | 20  | –   | ns    |
| $t_{bth}$   | TCK [BSCAN test] hold time                                     | 25  | –   | ns    |
| $t_{rf}$    | TCK [BSCAN test] rise and fall time                            | 50  | –   | mV/ns |
| $t_{btco}$  | TAP controller falling edge of clock to valid output           | –   | 25  | ns    |
| $t_{btoz}$  | TAP controller falling edge of clock to data output disable    | –   | 25  | ns    |
| $t_{btvo}$  | TAP controller falling edge of clock to data output enable     | –   | 25  | ns    |
| $t_{btcp}$  | BSCAN test Capture register setup time                         | 20  | –   | ns    |
| $t_{btch}$  | BSCAN test Capture register hold time                          | 25  | –   | ns    |
| $t_{btuco}$ | BSCAN test Update reg, falling edge of clock to valid output   | –   | 50  | ns    |
| $t_{btuo}$  | BSCAN test Update reg, falling edge of clock to output disable | –   | 50  | ns    |
| $t_{btuo}$  | BSCAN test Update reg, falling edge of clock to output enable  | –   | 50  | ns    |

## Signal Descriptions

| Signal Name        | Description                                                                                                                                                                                                                                                                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I/O                | Input/Output Pins – These are the general purpose bidirectional data pins. When used as outputs, each may be independently latched, registered or tristated. They can also each assume one other control function (OE, CLK/CLKEN, and MUXsel as described in the text).                                                                           |
| TOE                | Test Output Enable Pin – This pin tristates all I/P pins when a logic low is driven.                                                                                                                                                                                                                                                              |
| RESET              | Active LOW Input Pin – Resets all I/O register outputs when LOW.                                                                                                                                                                                                                                                                                  |
| Yx/CLKENx          | Input Pins –These can be either Global Clocks or Clock Enables.                                                                                                                                                                                                                                                                                   |
| EPEN               | Input Pin – JTAG TAP Controller Enable Pin. When high, JTAG operation is enabled. When low, JTAG TAP controller is driven to reset.                                                                                                                                                                                                               |
| TDI                | Input Pin – Serial data input during ISP programming or Boundary Scan mode.                                                                                                                                                                                                                                                                       |
| TCK                | Input Pin – Serial data clock during ISP programming or Boundary Scan mode.                                                                                                                                                                                                                                                                       |
| TMS                | Input Pin – Control input during ISP programming or Boundary Scan mode.                                                                                                                                                                                                                                                                           |
| TDO                | Output Pin – Serial data output during ISP programming or Boundary Scan mode.                                                                                                                                                                                                                                                                     |
| GND                | Ground (GND)                                                                                                                                                                                                                                                                                                                                      |
| VCC                | Vcc – Supply voltage (3.3V).                                                                                                                                                                                                                                                                                                                      |
| VCCIO <sup>2</sup> | Input – This pin is used if optional 2.5V output is to be used. Every I/O can independently select either 3.3V or the optional voltage as its output level. If the optional output voltage is not required, this pin must be connected to the VCC supply. Programmable pull-up resistors and bus-hold latches only draw current from this supply. |
| NC <sup>1</sup>    | No Connect.                                                                                                                                                                                                                                                                                                                                       |

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

2. "VA" version only.

## Signal Locations: ispGDX160V/VA

| Signal                    | 208-Pin PQFP                                                                             | 208-Ball fpBGA                                                                       | 272-Ball BGA                                                                                                                                                                                                                                                              |
|---------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TOE                       | 178                                                                                      | D9                                                                                   | A12                                                                                                                                                                                                                                                                       |
| $\overline{\text{RESET}}$ | 185                                                                                      | A8                                                                                   | D10                                                                                                                                                                                                                                                                       |
| Y0/CLKEN0                 | 75                                                                                       | N8                                                                                   | V10                                                                                                                                                                                                                                                                       |
| Y1/CLKEN1                 | 76                                                                                       | R8                                                                                   | Y10                                                                                                                                                                                                                                                                       |
| Y2/CLKEN2                 | 180                                                                                      | B9                                                                                   | C11                                                                                                                                                                                                                                                                       |
| Y3/CLKEN3                 | 181                                                                                      | C9                                                                                   | A11                                                                                                                                                                                                                                                                       |
| EPEN                      | 183                                                                                      | A9                                                                                   | B10                                                                                                                                                                                                                                                                       |
| TDI                       | 81                                                                                       | P9                                                                                   | Y12                                                                                                                                                                                                                                                                       |
| TCK                       | 80                                                                                       | T9                                                                                   | U11                                                                                                                                                                                                                                                                       |
| TMS                       | 79                                                                                       | T8                                                                                   | V11                                                                                                                                                                                                                                                                       |
| TDO                       | 78                                                                                       | P8                                                                                   | W11                                                                                                                                                                                                                                                                       |
| GND                       | 6, 15, 25, 35, 44, 54, 63, 77, 91, 100, 110, 119, 129, 139, 148, 159, 168, 182, 195, 204 | D4, D13, G7, G8, G9, G10, H7, H8, H9, H10, J7, J8, J9, J10, K7, K8, K9, K10, N4, N13 | A1, D4, D8, D13, D17, H4, H17, J9, J10, J11, J12, K9, K10, K11, K12, L9, L10, L11, L12, M9, M10, M11, M12, N4, N17, U4, U8, U13, U17                                                                                                                                      |
| VCC                       | 1, 17, 33, 49, 65, 89, 105, 121, 137, 153, 156 <sup>1</sup> , 170, 184, 193              | E13 <sup>1</sup> , F4, F13, L4, L13, M4, M13, N5, N11, N12, D5, D6, D12, E4          | C18 <sup>1</sup> , D6, D11, D15, F4, F17, K4, L17, R4, R17, U6, U10, U15                                                                                                                                                                                                  |
| VCCIO                     | 156 <sup>1</sup>                                                                         | E13 <sup>1</sup>                                                                     | C18 <sup>1</sup>                                                                                                                                                                                                                                                          |
| NC                        | 73, 74, 179                                                                              | A10, P7, T7                                                                          | A2, A6, A7, A10, A15, A19, A20, B1, B2, B4, B11, B14, B18, B19, B20, C2, C3, C10, D2, D3, D16, E2, E17, E19, H1, H3, H18, H20, K20, L1, N1, N3, N18, N20, T2, T4, T19, U5, U18, U19, V3, V14, V18, V19, W1, W2, W3, W7, W10, W14, W19, W20, Y1, Y2, Y6, Y9, Y11, Y18, Y20 |

1. VCC on ispGDX160V, VCCIO on ispGDX160VA.

## I/O Locations: ispGDX160V/VA (Ordered by I/O Signal Name and 208-Pin PQFP Location)

| I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal             | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA |
|------------|----------------|----------|-----------|---------|------------|----------------|----------|-----------|---------|------------------------|----------------|----------|-----------|---------|
| VCC        |                |          |           |         | I/O B13    | OE             | 66       | N6        | Y7      | GND                    |                |          |           |         |
| I/O A0     | CLK/CLKEN      | 2        | B2        | E4      | I/O B14    | MUXsel1        | 67       | T5        | V8      | I/O C28                | CLK/CLKEN      | 140      | G13       | G20     |
| I/O A1     | OE             | 3        | B1        | C1      | I/O B15    | MUXsel2        | 68       | R6        | W8      | I/O C29                | OE             | 141      | F16       | G19     |
| I/O A2     | MUXsel1        | 4        | C2        | D1      | I/O B16    | CLK/CLKEN      | 69       | P6        | Y8      | I/O C30                | MUXsel1        | 142      | F14       | F20     |
| I/O A3     | MUXsel2        | 5        | A1        | E3      | I/O B17    | OE             | 70       | T6        | U9      | I/O C31                | MUXsel2        | 143      | F15       | G18     |
| GND        |                |          |           |         | I/O B18    | MUXsel1        | 71       | N7        | V9      | I/O C32                | CLK/CLKEN      | 144      | E16       | F19     |
| I/O A4     | CLK/CLKEN      | 7        | C1        | E1      | I/O B19    | MUXsel2        | 72       | R7        | W9      | I/O C33                | OE             | 145      | E14       | E20     |
| I/O A5     | OE             | 8        | D3        | F3      | GND        |                |          |           |         | I/O C34                | MUXsel1        | 146      | E15       | G17     |
| I/O A6     | MUXsel1        | 9        | D2        | G4      | I/O B20    | CLK/CLKEN      | 82       | R9        | W12     | I/O C35                | MUXsel2        | 147      | D16       | F18     |
| I/O A7     | MUXsel2        | 10       | D1        | F2      | I/O B21    | OE             | 83       | N9        | V12     | GND                    |                |          |           |         |
| I/O A8     | CLK/CLKEN      | 11       | E3        | F1      | I/O B22    | MUXsel1        | 84       | T10       | U12     | I/O C36                | CLK/CLKEN      | 149      | C16       | D20     |
| I/O A9     | OE             | 12       | E2        | G3      | I/O B23    | MUXsel2        | 85       | P10       | Y13     | I/O C37                | OE             | 150      | D15       | E18     |
| I/O A10    | MUXsel1        | 13       | E1        | G2      | I/O B24    | CLK/CLKEN      | 86       | R10       | W13     | I/O C38                | MUXsel1        | 151      | D14       | D19     |
| I/O A11    | MUXsel2        | 14       | F3        | G1      | I/O B25    | OE             | 87       | N10       | V13     | I/O C39                | MUXsel2        | 152      | C15       | C20     |
| GND        |                |          |           |         | I/O B26    | MUXsel1        | 88       | T11       | Y14     | VCC                    |                |          |           |         |
| I/O A12    | CLK/CLKEN      | 16       | F2        | H2      | VCC        |                |          |           |         | I/O D0                 | CLK/CLKEN      | 154      | B16       | D18     |
| VCC        |                |          |           |         | I/O B27    | MUXsel2        | 90       | P11       | Y15     | I/O D1                 | OE             | 155      | A16       | C19     |
| I/O A13    | OE             | 18       | F1        | J4      | GND        |                |          |           |         | VCC/VCCIO <sup>1</sup> |                |          |           |         |
| I/O A14    | MUXsel1        | 19       | G4        | J3      | I/O B28    | CLK/CLKEN      | 92       | R11       | W15     | I/O D2                 | MUXsel1        | 157      | B15       | B17     |
| I/O A15    | MUXsel2        | 20       | G2        | J2      | I/O B29    | OE             | 93       | T12       | Y16     | I/O D3                 | MUXsel2        | 158      | A15       | C17     |
| I/O A16    | CLK/CLKEN      | 21       | G3        | J1      | I/O B30    | MUXsel1        | 94       | P12       | U14     | GND                    |                |          |           |         |
| I/O A17    | OE             | 22       | G1        | K2      | I/O B31    | MUXsel2        | 95       | R12       | V15     | I/O D4                 | CLK/CLKEN      | 160      | C14       | A18     |
| I/O A18    | MUXsel1        | 23       | H4        | K3      | I/O B32    | CLK/CLKEN      | 96       | T13       | W16     | I/O D5                 | OE             | 161      | B14       | A17     |
| I/O A19    | MUXsel2        | 24       | H2        | K1      | I/O B33    | OE             | 97       | R13       | Y17     | I/O D6                 | MUXsel1        | 162      | A14       | C16     |
| GND        |                |          |           |         | I/O B34    | MUXsel1        | 98       | T14       | Y16     | I/O D7                 | MUXsel2        | 163      | C13       | B16     |
| I/O A20    | CLK/CLKEN      | 26       | H3        | L2      | I/O B35    | MUXsel2        | 99       | P13       | W17     | I/O D8                 | CLK/CLKEN      | 164      | B13       | A16     |
| I/O A21    | OE             | 27       | H1        | L3      | GND        |                |          |           |         | I/O D9                 | OE             | 165      | A13       | C15     |
| I/O A22    | MUXsel1        | 28       | J1        | L4      | I/O B36    | CLK/CLKEN      | 101      | R14       | U16     | I/O D10                | MUXsel1        | 166      | C12       | D14     |
| I/O A23    | MUXsel2        | 29       | J3        | M1      | I/O B37    | OE             | 102      | T15       | V17     | I/O D11                | MUXsel2        | 167      | B12       | B15     |
| I/O A24    | CLK/CLKEN      | 30       | J2        | M2      | I/O B38    | MUXsel1        | 103      | T16       | W18     | GND                    |                |          |           |         |
| I/O A25    | OE             | 31       | J4        | M3      | I/O B39    | MUXsel2        | 104      | R15       | Y19     | I/O D12                | CLK/CLKEN      | 169      | D11       | C14     |
| I/O A26    | MUXsel1        | 32       | K1        | M4      | VCC        |                |          |           |         | VCC                    |                |          |           |         |
| VCC        |                |          |           |         | I/O C0     | CLK/CLKEN      | 106      | P14       | T17     | I/O D13                | OE             | 171      | A12       | A14     |
| I/O A27    | MUXsel2        | 34       | K3        | N2      | I/O C1     | OE             | 107      | P15       | V20     | I/O D14                | MUXsel1        | 172      | C11       | C13     |
| GND        |                |          |           |         | I/O C2     | MUXsel1        | 108      | R16       | U20     | I/O D15                | MUXsel2        | 173      | B11       | B13     |
| I/O A28    | CLK/CLKEN      | 36       | K2        | P1      | I/O C3     | MUXsel2        | 109      | N14       | T18     | I/O D16                | CLK/CLKEN      | 174      | D10       | A13     |
| I/O A29    | OE             | 37       | K4        | P2      | GND        |                |          |           |         | I/O D17                | OE             | 175      | A11       | D12     |
| I/O A30    | MUXsel1        | 38       | L1        | R1      | I/O C4     | CLK/CLKEN      | 111      | P16       | T20     | I/O D18                | MUXsel1        | 176      | B10       | C12     |
| I/O A31    | MUXsel2        | 39       | L2        | P3      | I/O C5     | OE             | 112      | N15       | R18     | I/O D19                | MUXsel2        | 177      | C10       | B12     |
| I/O A32    | CLK/CLKEN      | 40       | L3        | R2      | I/O C6     | MUXsel1        | 113      | N16       | P17     | GND                    |                |          |           |         |
| I/O A33    | OE             | 41       | M1        | T1      | I/O C7     | MUXsel2        | 114      | M14       | R19     | VCC                    |                |          |           |         |
| I/O A34    | MUXsel1        | 42       | M2        | P4      | I/O C8     | CLK/CLKEN      | 115      | M15       | R20     | I/O D20                | CLK/CLKEN      | 186      | C8        | A9      |
| I/O A35    | MUXsel2        | 43       | M3        | R3      | I/O C9     | OE             | 116      | M16       | P18     | I/O D21                | OE             | 187      | B8        | B9      |
| GND        |                |          |           |         | I/O C10    | MUXsel1        | 117      | L15       | P19     | I/O D22                | MUXsel1        | 188      | D8        | C9      |
| I/O A36    | CLK/CLKEN      | 45       | N1        | U1      | I/O C11    | MUXsel2        | 118      | L14       | P20     | I/O D23                | MUXsel2        | 189      | A7        | D9      |
| I/O A37    | OE             | 46       | N2        | T3      | GND        |                |          |           |         | I/O D24                | CLK/CLKEN      | 190      | C7        | A8      |
| I/O A38    | MUXsel1        | 47       | N3        | U2      | I/O C12    | CLK/CLKEN      | 120      | L16       | N19     | I/O D25                | OE             | 191      | B7        | B8      |
| I/O A39    | MUXsel2        | 48       | P1        | V1      | VCC        |                |          |           |         | I/O D26                | MUXsel1        | 192      | D7        | C8      |
| VCC        |                |          |           |         | I/O C13    | OE             | 122      | K13       | M17     | VCC                    |                |          |           |         |
| I/O B0     | CLK/CLKEN      | 50       | P2        | U3      | I/O C14    | MUXsel1        | 123      | K15       | M18     | I/O D27                | MUXsel2        | 194      | A6        | B7      |
| I/O B1     | OE             | 51       | R1        | V2      | I/O C15    | MUXsel2        | 124      | K14       | M19     | GND                    |                |          |           |         |
| I/O B2     | MUXsel1        | 52       | R2        | W4      | I/O C16    | CLK/CLKEN      | 125      | K16       | M20     | I/O D28                | CLK/CLKEN      | 196      | C6        | C7      |
| I/O B3     | MUXsel2        | 53       | T1        | V4      | I/O C17    | OE             | 126      | J13       | L19     | I/O D29                | OE             | 197      | B6        | B6      |
| GND        |                |          |           |         | I/O C18    | MUXsel1        | 127      | J15       | L18     | I/O D30                | MUXsel1        | 198      | A5        | A5      |
| I/O B4     | CLK/CLKEN      | 55       | P3        | Y3      | I/O C19    | MUXsel2        | 128      | J14       | L20     | I/O D31                | MUXsel2        | 199      | C5        | D7      |
| I/O B5     | OE             | 56       | T2        | Y4      | GND        |                |          |           |         | I/O D32                | CLK/CLKEN      | 200      | B5        | C6      |
| I/O B6     | MUXsel1        | 57       | R3        | V5      | I/O C20    | CLK/CLKEN      | 130      | J16       | K19     | I/O D33                | OE             | 201      | A4        | B5      |
| I/O B7     | MUXsel2        | 58       | P4        | W5      | I/O C21    | OE             | 131      | H14       | K18     | I/O D34                | MUXsel1        | 202      | B4        | A4      |
| I/O B8     | CLK/CLKEN      | 59       | T3        | Y5      | I/O C22    | MUXsel1        | 132      | H16       | K17     | I/O D35                | MUXsel2        | 203      | C4        | C5      |
| I/O B9     | OE             | 60       | R4        | V6      | I/O C23    | MUXsel2        | 133      | H15       | J20     | GND                    |                |          |           |         |
| I/O B10    | MUXsel1        | 61       | T4        | U7      | I/O C24    | CLK/CLKEN      | 134      | H13       | J19     | I/O D36                | CLK/CLKEN      | 205      | A3        | A3      |
| I/O B11    | MUXsel2        | 62       | P5        | W6      | I/O C25    | OE             | 135      | G16       | J18     | I/O D37                | OE             | 206      | C3        | D5      |
| GND        |                |          |           |         | I/O C26    | MUXsel1        | 136      | G14       | J17     | I/O D38                | MUXsel1        | 207      | B3        | C4      |
| I/O B12    | CLK/CLKEN      | 64       | R5        | V7      | VCC        |                |          |           |         | I/O D39                | MUXsel2        | 208      | A2        | B3      |
| VCC        |                |          |           |         | I/O C27    | MUXsel2        | 138      | G15       | H19     |                        |                |          |           |         |

NOTE: VCC and GND Pads Shown for Reference, <sup>1</sup>VCC in ispGDX160V

## I/O Locations: ispGDX160V/VA (Ordered by 208-Ball BGA Location)

| I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA |
|------------|----------------|----------|-----------|---------|------------|----------------|----------|-----------|---------|------------|----------------|----------|-----------|---------|
| I/O A3     | MUXsel2        | 5        | A1        | E3      | I/O A9     | OE             | 12       | E2        | G3      | I/O C8     | CLK            | 115      | M15       | R20     |
| I/O D39    | MUXsel2        | 208      | A2        | B3      | I/O A8     | CLK/CLK_EN     | 11       | E3        | F1      | I/O C9     | OE             | 116      | M16       | P18     |
| I/O D36    | CLK/CLKEN      | 205      | A3        | A3      | I/O C33    | OE             | 145      | E14       | E20     | I/O A36    | CLK/CLKEN      | 45       | N1        | U1      |
| I/O D33    | OE             | 201      | A4        | B5      | I/O C34    | MUXsel1        | 146      | E15       | G17     | I/O A37    | OE             | 46       | N2        | T3      |
| I/O D30    | MUXsel1        | 198      | A5        | A5      | I/O C32    | CLK/CLKEN      | 144      | E16       | F19     | I/O A38    | MUXsel1        | 47       | N3        | U2      |
| I/O D27    | MUXsel2        | 194      | A6        | B7      | I/O A13    | OE             | 18       | F1        | J4      | I/O B13    | OE             | 66       | N6        | Y7      |
| I/O D23    | MUXsel2        | 189      | A7        | D9      | I/O A12    | CLK/CLKEN      | 16       | F2        | H2      | I/O B18    | MUXsel1        | 71       | N7        | V9      |
| I/O D17    | OE             | 175      | A11       | D12     | I/O A11    | MUXsel2        | 14       | F3        | G1      | I/O B21    | OE             | 83       | N9        | V12     |
| I/O D13    | OE             | 171      | A12       | A14     | I/O C30    | MUXsel1        | 142      | F14       | F20     | I/O B25    | OE             | 87       | N10       | V13     |
| I/O D9     | OE             | 165      | A13       | C15     | I/O C31    | MUXsel2        | 143      | F15       | G18     | I/O C3     | MUXsel2        | 109      | N14       | T18     |
| I/O D6     | MUXsel1        | 162      | A14       | C16     | I/O C29    | OE             | 141      | F16       | G19     | I/O C5     | OE             | 112      | N15       | R18     |
| I/O D3     | MUXsel2        | 158      | A15       | C17     | I/O A17    | OE             | 22       | G1        | K2      | I/O C6     | MUXsel1        | 113      | N16       | P17     |
| I/O D1     | OE             | 155      | A16       | C19     | I/O A15    | MUXsel2        | 20       | G2        | J2      | I/O A39    | MUXsel2        | 48       | P1        | V1      |
| I/O A1     | OE             | 3        | B1        | C1      | I/O A16    | CLK/CLKEN      | 21       | G3        | J1      | I/O B0     | CLK/CLKEN      | 50       | P2        | U3      |
| I/O A0     | CLK/CLKEN      | 2        | B2        | E4      | I/O A14    | MUXsel1        | 19       | G4        | J3      | I/O B4     | CLK/CLKEN      | 55       | P3        | Y3      |
| I/O D38    | MUXsel1        | 207      | B3        | C4      | I/O C28    | CLK/CLKEN      | 140      | G13       | G20     | I/O B7     | MUXsel2        | 58       | P4        | W5      |
| I/O D34    | MUXsel1        | 202      | B4        | A4      | I/O C26    | MUXsel1        | 136      | G14       | J17     | I/O B11    | MUXsel2        | 62       | P5        | W6      |
| I/O D32    | CLK/CLKEN      | 200      | B5        | C6      | I/O C27    | MUXsel2        | 138      | G15       | H19     | I/O B16    | CLK/CLKEN      | 69       | P6        | Y8      |
| I/O D29    | OE             | 197      | B6        | B6      | I/O C25    | OE             | 135      | G16       | J18     | I/O B23    | MUXsel2        | 85       | P10       | Y13     |
| I/O D25    | OE             | 191      | B7        | B8      | I/O A21    | OE             | 27       | H1        | L3      | I/O B27    | MUXsel2        | 90       | P11       | Y15     |
| I/O D21    | OE             | 187      | B8        | B9      | I/O A19    | MUXsel2        | 24       | H2        | K1      | I/O B30    | MUXsel1        | 94       | P12       | U14     |
| I/O D18    | MUXsel1        | 176      | B10       | C12     | I/O A20    | CLK/CLKEN      | 26       | H3        | L2      | I/O B35    | MUXsel2        | 99       | P13       | W17     |
| I/O D15    | MUXsel2        | 173      | B11       | B13     | I/O A18    | MUXsel1        | 23       | H4        | K3      | I/O C0     | CLK/CLKEN      | 106      | P14       | T17     |
| I/O D11    | MUXsel2        | 167      | B12       | B15     | I/O C24    | CLK/CLKEN      | 134      | H13       | J19     | I/O C1     | OE             | 107      | P15       | V20     |
| I/O D8     | CLK/CLKEN      | 164      | B13       | A16     | I/O C21    | OE             | 131      | H14       | K18     | I/O C4     | CLK/CLKEN      | 111      | P16       | T20     |
| I/O D5     | OE             | 161      | B14       | A17     | I/O C23    | MUXsel2        | 133      | H15       | J20     | I/O B1     | OE             | 51       | R1        | V2      |
| I/O D2     | MUXsel1        | 157      | B15       | B17     | I/O C22    | MUXsel1        | 132      | H16       | K17     | I/O B2     | MUXsel1        | 52       | R2        | W4      |
| I/O D0     | CLK/CLKEN      | 154      | B16       | D18     | I/O A22    | MUXsel1        | 28       | J1        | L4      | I/O B6     | MUXsel1        | 57       | R3        | V5      |
| I/O A4     | CLK/CLKEN      | 7        | C1        | E1      | I/O A24    | CLK/CLKEN      | 30       | J2        | M2      | I/O B9     | OE             | 60       | R4        | V6      |
| I/O A2     | MUXsel1        | 4        | C2        | D1      | I/O A23    | MUXsel2        | 29       | J3        | M1      | I/O B12    | CLK/CLKEN      | 64       | R5        | V7      |
| I/O D37    | OE             | 206      | C3        | D5      | I/O A25    | OE             | 31       | J4        | M3      | I/O B15    | MUXsel2        | 68       | R6        | W8      |
| I/O D35    | MUXsel2        | 203      | C4        | C5      | I/O C17    | OE             | 126      | J13       | L19     | I/O B19    | MUXsel2        | 72       | R7        | W9      |
| I/O D31    | MUXsel2        | 199      | C5        | D7      | I/O C19    | MUXsel2        | 128      | J14       | L20     | I/O B20    | CLK/CLKEN      | 82       | R9        | W12     |
| I/O D28    | CLK/CLKEN      | 196      | C6        | C7      | I/O C18    | MUXsel1        | 127      | J15       | L18     | I/O B24    | CLK/CLKEN      | 86       | R10       | W13     |
| I/O D24    | CLK/CLKEN      | 190      | C7        | A8      | I/O C20    | CLK/CLKEN      | 130      | J16       | K19     | I/O B28    | CLK/CLKEN      | 92       | R11       | W15     |
| I/O D20    | CLK/CLKEN      | 186      | C8        | A9      | I/O A26    | MUXsel1        | 32       | K1        | M4      | I/O B31    | MUXsel2        | 95       | R12       | V15     |
| I/O D19    | MUXsel2        | 177      | C10       | B12     | I/O A28    | CLK/CLKEN      | 36       | K2        | P1      | I/O B33    | OE             | 97       | R13       | Y17     |
| I/O D14    | MUXsel1        | 172      | C11       | C13     | I/O A27    | MUXsel2        | 34       | K3        | N2      | I/O B36    | CLK/CLKEN      | 101      | R14       | U16     |
| I/O D10    | MUXsel1        | 166      | C12       | D14     | I/O A29    | OE             | 37       | K4        | P2      | I/O B39    | MUXsel2        | 104      | R15       | Y19     |
| I/O D7     | MUXsel2        | 163      | C13       | B16     | I/O C13    | OE             | 122      | K13       | M17     | I/O C2     | MUXsel1        | 108      | R16       | U20     |
| I/O D4     | CLK/CLKEN      | 160      | C14       | A18     | I/O C15    | MUXsel2        | 124      | K14       | M19     | I/O B3     | MUXsel2        | 53       | T1        | V4      |
| I/O C39    | MUXsel2        | 152      | C15       | C20     | I/O C14    | MUXsel1        | 123      | K15       | M18     | I/O B5     | OE             | 56       | T2        | Y4      |
| I/O C36    | CLK/CLKEN      | 149      | C16       | D20     | I/O C16    | CLK/CLKEN      | 125      | K16       | M20     | I/O B8     | CLK/CLKEN      | 59       | T3        | Y5      |
| I/O A7     | MUXsel2        | 10       | D1        | F2      | I/O A30    | MUXsel1        | 38       | L1        | R1      | I/O B10    | MUXsel1        | 61       | T4        | U7      |
| I/O A6     | MUXsel1        | 9        | D2        | G4      | I/O A31    | MUXsel2        | 39       | L2        | P3      | I/O B14    | MUXsel1        | 67       | T5        | V8      |
| I/O A5     | OE             | 8        | D3        | F3      | I/O A32    | CLK/CLKEN      | 40       | L3        | R2      | I/O B17    | OE             | 70       | T6        | U9      |
| I/O D26    | MUXsel1        | 192      | D7        | C8      | I/O C11    | MUXsel2        | 118      | L14       | P20     | I/O B22    | MUXsel1        | 84       | T10       | U12     |
| I/O D22    | MUXsel1        | 188      | D8        | C9      | I/O C10    | MUXsel1        | 117      | L15       | P19     | I/O B26    | MUXsel1        | 88       | T11       | Y14     |
| I/O D16    | CLK/CLKEN      | 174      | D10       | A13     | I/O C12    | CLK/CLKEN      | 120      | L16       | N19     | I/O B29    | OE             | 93       | T12       | Y16     |
| I/O D12    | CLK/CLKEN      | 169      | D11       | C14     | I/O A33    | OE             | 41       | M1        | T1      | I/O B32    | CLK/CLKEN      | 96       | T13       | W16     |
| I/O C38    | MUXsel1        | 151      | D14       | D19     | I/O A34    | MUXsel1        | 42       | M2        | P4      | I/O B34    | MUXsel1        | 98       | T14       | V16     |
| I/O C37    | OE             | 150      | D15       | E18     | I/O A35    | MUXsel2        | 43       | M3        | R3      | I/O B37    | OE             | 102      | T15       | V17     |
| I/O C35    | MUXsel2        | 147      | D16       | F18     | I/O C7     | MUXsel2        | 114      | M14       | R19     | I/O B38    | MUXsel1        | 103      | T16       | W18     |
| I/O A10    | MUXsel1        | 13       | E1        | G2      |            |                |          |           |         |            |                |          |           |         |

## I/O Locations: ispGDX160V/VA (Ordered by 272-Ball BGA Location)

| I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA | I/O Signal | Control Signal | 208 PQFP | 208 fpBGA | 272 BGA |
|------------|----------------|----------|-----------|---------|------------|----------------|----------|-----------|---------|------------|----------------|----------|-----------|---------|
| I/O D36    | CLK/CLKEN      | 205      | A3        | A3      | I/O C32    | CLK/CLKEN      | 144      | E16       | F19     | I/O C5     | OE             | 112      | N15       | R18     |
| I/O D34    | MUXsel1        | 202      | B4        | A4      | I/O C30    | MUXsel1        | 142      | F14       | F20     | I/O C7     | MUXsel2        | 114      | M14       | R19     |
| I/O D30    | MUXsel1        | 198      | A5        | A5      | I/O A11    | MUXsel2        | 14       | F3        | G1      | I/O C8     | CLK            | 115      | M15       | R20     |
| I/O D24    | CLK/CLKEN      | 190      | C7        | A8      | I/O A10    | MUXsel1        | 13       | E1        | G2      | I/O A33    | OE             | 41       | M1        | T1      |
| I/O D20    | CLK/CLKEN      | 186      | C8        | A9      | I/O A9     | OE             | 12       | E2        | G3      | I/O A37    | OE             | 46       | N2        | T3      |
| I/O D16    | CLK/CLKEN      | 174      | D10       | A13     | I/O A6     | MUXsel1        | 9        | D2        | G4      | I/O C0     | CLK/CLKEN      | 106      | P14       | T17     |
| I/O D13    | OE             | 171      | A12       | A14     | I/O C34    | MUXsel1        | 146      | E15       | G17     | I/O C3     | MUXsel2        | 109      | N14       | T18     |
| I/O D8     | CLK/CLKEN      | 164      | B13       | A16     | I/O C31    | MUXsel2        | 143      | F15       | G18     | I/O C4     | CLK/CLKEN      | 111      | P16       | T20     |
| I/O D5     | OE             | 161      | B14       | A17     | I/O C29    | OE             | 141      | F16       | G19     | I/O A36    | CLK/CLKEN      | 45       | N1        | U1      |
| I/O D4     | CLK/CLKEN      | 160      | C14       | A18     | I/O C28    | CLK/CLKEN      | 140      | G13       | G20     | I/O A38    | MUXsel1        | 47       | N3        | U2      |
| I/O D39    | MUXsel2        | 208      | A2        | B3      | I/O A12    | CLK/CLKEN      | 16       | F2        | H2      | I/O B0     | CLK/CLKEN      | 50       | P2        | U3      |
| I/O D33    | OE             | 201      | A4        | B5      | I/O C27    | MUXsel2        | 138      | G15       | H19     | I/O B10    | MUXsel1        | 61       | T4        | U7      |
| I/O D29    | OE             | 197      | B6        | B6      | I/O A16    | CLK/CLKEN      | 21       | G3        | J1      | I/O B17    | OE             | 70       | T6        | U9      |
| I/O D27    | MUXsel2        | 194      | A6        | B7      | I/O A15    | MUXsel2        | 20       | G2        | J2      | I/O B22    | MUXsel1        | 84       | T10       | U12     |
| I/O D25    | OE             | 191      | B7        | B8      | I/O A14    | MUXsel1        | 19       | G4        | J3      | I/O B30    | MUXsel1        | 94       | P12       | U14     |
| I/O D21    | OE             | 187      | B8        | B9      | I/O A13    | OE             | 18       | F1        | J4      | I/O B36    | CLK/CLKEN      | 101      | R14       | U16     |
| I/O D19    | MUXsel2        | 177      | C10       | B12     | I/O C26    | MUXsel1        | 136      | G14       | J17     | I/O C2     | MUXsel1        | 108      | R16       | U20     |
| I/O D15    | MUXsel2        | 173      | B11       | B13     | I/O C25    | OE             | 135      | G16       | J18     | I/O A39    | MUXsel2        | 48       | P1        | V1      |
| I/O D11    | MUXsel2        | 167      | B12       | B15     | I/O C24    | CLK/CLKEN      | 134      | H13       | J19     | I/O B1     | OE             | 51       | R1        | V2      |
| I/O D7     | MUXsel2        | 163      | C13       | B16     | I/O C23    | MUXsel2        | 133      | H15       | J20     | I/O B3     | MUXsel2        | 53       | T1        | V4      |
| I/O D2     | MUXsel1        | 157      | B15       | B17     | I/O A19    | MUXsel2        | 24       | H2        | K1      | I/O B6     | MUXsel1        | 57       | R3        | V5      |
| I/O A1     | OE             | 3        | B1        | C1      | I/O A17    | OE             | 22       | G1        | K2      | I/O B9     | OE             | 60       | R4        | V6      |
| I/O D38    | MUXsel1        | 207      | B3        | C4      | I/O A18    | MUXsel1        | 23       | H4        | K3      | I/O B12    | CLK/CLKEN      | 64       | R5        | V7      |
| I/O D35    | MUXsel2        | 203      | C4        | C5      | I/O C22    | MUXsel1        | 132      | H16       | K17     | I/O B14    | MUXsel1        | 67       | T5        | V8      |
| I/O D32    | CLK/CLKEN      | 200      | B5        | C6      | I/O C21    | OE             | 131      | H14       | K18     | I/O B18    | MUXsel1        | 71       | N7        | V9      |
| I/O D28    | CLK/CLKEN      | 196      | C6        | C7      | I/O C20    | CLK/CLKEN      | 130      | J16       | K19     | I/O B21    | OE             | 83       | N9        | V12     |
| I/O D26    | MUXsel1        | 192      | D7        | C8      | I/O A20    | CLK/CLKEN      | 26       | H3        | L2      | I/O B25    | OE             | 87       | N10       | V13     |
| I/O D22    | MUXsel1        | 188      | D8        | C9      | I/O A21    | OE             | 27       | H1        | L3      | I/O B31    | MUXsel2        | 95       | R12       | V15     |
| I/O D18    | MUXsel1        | 176      | B10       | C12     | I/O A22    | MUXsel1        | 28       | J1        | L4      | I/O B34    | MUXsel1        | 98       | T14       | V16     |
| I/O D14    | MUXsel1        | 172      | C11       | C13     | I/O C18    | MUXsel1        | 127      | J15       | L18     | I/O B37    | OE             | 102      | T15       | V17     |
| I/O D12    | CLK/CLKEN      | 169      | D11       | C14     | I/O C17    | OE             | 126      | J13       | L19     | I/O C1     | OE             | 107      | P15       | V20     |
| I/O D9     | OE             | 165      | A13       | C15     | I/O C19    | MUXsel2        | 128      | J14       | L20     | I/O B2     | MUXsel1        | 52       | R2        | W4      |
| I/O D6     | MUXsel1        | 162      | A14       | C16     | I/O A23    | MUXsel2        | 29       | J3        | M1      | I/O B7     | MUXsel2        | 58       | P4        | W5      |
| I/O D3     | MUXsel2        | 158      | A15       | C17     | I/O A24    | CLK/CLKEN      | 30       | J2        | M2      | I/O B11    | MUXsel2        | 62       | P5        | W6      |
| I/O D1     | OE             | 155      | A16       | C19     | I/O A25    | OE             | 31       | J4        | M3      | I/O B15    | MUXsel2        | 68       | R6        | W8      |
| I/O C39    | MUXsel2        | 152      | C15       | C20     | I/O A26    | MUXsel1        | 32       | K1        | M4      | I/O B19    | MUXsel2        | 72       | R7        | W9      |
| I/O A2     | MUXsel1        | 4        | C2        | D1      | I/O C13    | OE             | 122      | K13       | M17     | I/O B20    | CLK/CLKEN      | 82       | R9        | W12     |
| I/O D37    | OE             | 206      | C3        | D5      | I/O C14    | MUXsel1        | 123      | K15       | M18     | I/O B24    | CLK/CLKEN      | 86       | R10       | W13     |
| I/O D31    | MUXsel2        | 199      | C5        | D7      | I/O C15    | MUXsel2        | 124      | K14       | M19     | I/O B28    | CLK/CLKEN      | 92       | R11       | W15     |
| I/O D23    | MUXsel2        | 189      | A7        | D9      | I/O C16    | CLK/CLKEN      | 125      | K16       | M20     | I/O B32    | CLK/CLKEN      | 96       | T13       | W16     |
| I/O D17    | OE             | 175      | A11       | D12     | I/O A27    | MUXsel2        | 34       | K3        | N2      | I/O B35    | MUXsel2        | 99       | P13       | W17     |
| I/O D10    | MUXsel1        | 166      | C12       | D14     | I/O C12    | CLK/CLKEN      | 120      | L16       | N19     | I/O B38    | MUXsel1        | 103      | T16       | W18     |
| I/O D0     | CLK/CLKEN      | 154      | B16       | D18     | I/O A28    | CLK/CLKEN      | 36       | K2        | P1      | I/O B4     | CLK/CLKEN      | 55       | P3        | Y3      |
| I/O C38    | MUXsel1        | 151      | D14       | D19     | I/O A29    | OE             | 37       | K4        | P2      | I/O B5     | OE             | 56       | T2        | Y4      |
| I/O C36    | CLK/CLKEN      | 149      | C16       | D20     | I/O A31    | MUXsel2        | 39       | L2        | P3      | I/O B8     | CLK/CLKEN      | 59       | T3        | Y5      |
| I/O A4     | CLK/CLK_EN     | 7        | C1        | E1      | I/O A34    | MUXsel1        | 42       | M2        | P4      | I/O B13    | OE             | 66       | N6        | Y7      |
| I/O A3     | MUXsel2        | 5        | A1        | E3      | I/O C6     | MUXsel1        | 113      | N16       | P17     | I/O B16    | CLK/CLKEN      | 69       | P6        | Y8      |
| I/O A0     | CLK/CLKEN      | 2        | B2        | E4      | I/O C9     | OE             | 116      | M16       | P18     | I/O B23    | MUXsel2        | 85       | P10       | Y13     |
| I/O C37    | OE             | 150      | D15       | E18     | I/O C10    | MUXsel1        | 117      | L15       | P19     | I/O B26    | MUXsel1        | 88       | T11       | Y14     |
| I/O C33    | OE             | 145      | E14       | E20     | I/O C11    | MUXsel2        | 118      | L14       | P20     | I/O B27    | MUXsel2        | 90       | P11       | Y15     |
| I/O A8     | CLK/CLKEN      | 11       | E3        | F1      | I/O A30    | MUXsel1        | 38       | L1        | R1      | I/O B29    | OE             | 93       | T12       | Y16     |
| I/O A7     | MUXsel2        | 10       | D1        | F2      | I/O A32    | CLK/CLKEN      | 40       | L3        | R2      | I/O B33    | OE             | 97       | R13       | Y17     |
| I/O A5     | OE             | 8        | D3        | F3      | I/O A35    | MUXsel2        | 43       | M3        | R3      | I/O B39    | MUXsel2        | 104      | R15       | Y19     |
| I/O C35    | MUXsel2        | 147      | D16       | F18     |            |                |          |           |         |            |                |          |           |         |

**Signal Configuration: ispGDX160V/VA**

ispGDX160V/VA 272-Ball BGA Signal Diagram

|   | 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 D4                    | I/O D5          | I/O D8          | NC <sup>1</sup> | I/O D13         | I/O D16 | TOE     | Y3/<br>CLKEN3   | NC <sup>1</sup> | I/O D20         | I/O D24 | NC <sup>1</sup> | NC <sup>1</sup> | I/O D30         | I/O D34         | I/O D36         | NC <sup>1</sup> | GND             | A |
| B | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup>           | I/O D2          | I/O D7          | I/O D11         | NC <sup>1</sup> | I/O D15 | I/O D19 | NC <sup>1</sup> | EPEN            | I/O D21         | I/O D25 | I/O D27         | I/O D29         | I/O D33         | NC <sup>1</sup> | I/O D39         | NC <sup>1</sup> | NC <sup>1</sup> | B |
| C | I/O C39         | I/O D1          | VCCIO<br>VCC <sup>2</sup> | I/O D3          | I/O D6          | I/O D9          | I/O D12         | I/O D14 | I/O D18 | Y2/<br>CLKEN2   | NC <sup>1</sup> | I/O D22         | I/O D26 | I/O D28         | I/O D32         | I/O D35         | I/O D38         | NC <sup>1</sup> | NC <sup>1</sup> | I/O A1          | C |
| D | I/O C36         | I/O C38         | I/O D0                    | GND             | NC <sup>1</sup> | VCC             | I/O D10         | GND     | I/O D17 | VCC             | RESET           | I/O D23         | GND     | I/O D31         | VCC             | I/O D37         | GND             | NC <sup>1</sup> | NC <sup>1</sup> | I/O A2          | D |
| E | I/O C33         | NC <sup>1</sup> | I/O C37                   | NC <sup>1</sup> |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A0          | I/O A3          | NC <sup>1</sup> | I/O A4          | E |
| F | I/O C30         | I/O C32         | I/O C35                   | VCC             |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | VCC             | I/O A5          | I/O A7          | I/O A8          | F |
| G | I/O C28         | I/O C29         | I/O C31                   | I/O C34         |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A6          | I/O A9          | I/O A10         | I/O A11         | G |
| H | NC <sup>1</sup> | I/O C27         | NC <sup>1</sup>           | GND             |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | GND             | NC <sup>1</sup> | I/O A12         | NC <sup>1</sup> | H |
| J | I/O C23         | I/O C24         | I/O C25                   | I/O C26         |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A13         | I/O A14         | I/O A15         | I/O A16         | J |
| K | NC <sup>1</sup> | I/O C20         | I/O C21                   | I/O C22         |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | VCC             | I/O A18         | I/O A17         | I/O A19         | K |
| L | I/O C19         | I/O C17         | I/O C18                   | VCC             |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A22         | I/O A21         | I/O A20         | NC <sup>1</sup> | L |
| M | I/O C16         | I/O C15         | I/O C14                   | I/O C13         |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A26         | I/O A25         | I/O A24         | I/O A23         | M |
| N | NC <sup>1</sup> | I/O C12         | NC <sup>1</sup>           | GND             |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | GND             | NC <sup>1</sup> | I/O A27         | NC <sup>1</sup> | N |
| P | I/O C11         | I/O C10         | I/O C9                    | I/O C6          |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | I/O A34         | I/O A31         | I/O A29         | I/O A28         | P |
| R | I/O C8          | I/O C7          | I/O C5                    | VCC             |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | VCC             | I/O A35         | I/O A32         | I/O A30         | R |
| T | I/O C4          | NC <sup>1</sup> | I/O C3                    | I/O C0          |                 |                 |                 |         |         |                 |                 |                 |         |                 |                 |                 | NC <sup>1</sup> | I/O A37         | NC <sup>1</sup> | I/O A33         | T |
| U | I/O C2          | NC <sup>1</sup> | NC <sup>1</sup>           | GND             | I/O B36         | VCC             | I/O B30         | GND     | I/O B22 | TCK             | VCC             | I/O B17         | GND     | I/O B10         | VCC             | NC <sup>1</sup> | GND             | I/O B0          | I/O A38         | I/O A36         | U |
| V | I/O C1          | NC <sup>1</sup> | NC <sup>1</sup>           | I/O B37         | I/O B34         | I/O B31         | NC <sup>1</sup> | I/O B25 | I/O B21 | TMS             | Y0/<br>CLKEN0   | I/O B18         | I/O B14 | I/O B12         | I/O B9          | I/O B6          | I/O B3          | NC <sup>1</sup> | I/O B1          | I/O A39         | V |
| W | NC <sup>1</sup> | NC <sup>1</sup> | I/O B38                   | I/O B35         | I/O B32         | I/O B28         | NC <sup>1</sup> | I/O B24 | I/O B20 | TDO             | NC <sup>1</sup> | I/O B19         | I/O B15 | NC <sup>1</sup> | I/O B11         | I/O B7          | I/O B2          | NC <sup>1</sup> | NC <sup>1</sup> | NC <sup>1</sup> | W |
| Y | NC <sup>1</sup> | I/O B39         | NC <sup>1</sup>           | I/O B33         | I/O B29         | I/O B27         | I/O B26         | I/O B23 | TDI     | NC <sup>1</sup> | Y1/<br>CLKEN1   | NC <sup>1</sup> | I/O B16 | I/O B13         | NC <sup>1</sup> | I/O B8          | I/O B5          | I/O B4          | NC <sup>1</sup> | NC <sup>1</sup> | Y |
|   | 20              | 19              | 18                        | 17              | 16              | 15              | 14              | 13      | 12      | 11              | 10              | 9               | 8       | 7               | 6               | 5               | 4               | 3               | 2               | 1               |   |

**ispGDX160V/VA**  
Bottom View

|     |     |     |     |
|-----|-----|-----|-----|
| GND | GND | GND | GND |
| GND | GND | GND | GND |
| GND | GND | GND | GND |
| GND | GND | GND | GND |

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

2. VCCIO on ispGDX160VA. VCC on ispGDX160V.

**Signal Configuration: ispGDX160V/VA**

ispGDX160V/VA 208-Ball fpBGA Signal Diagram

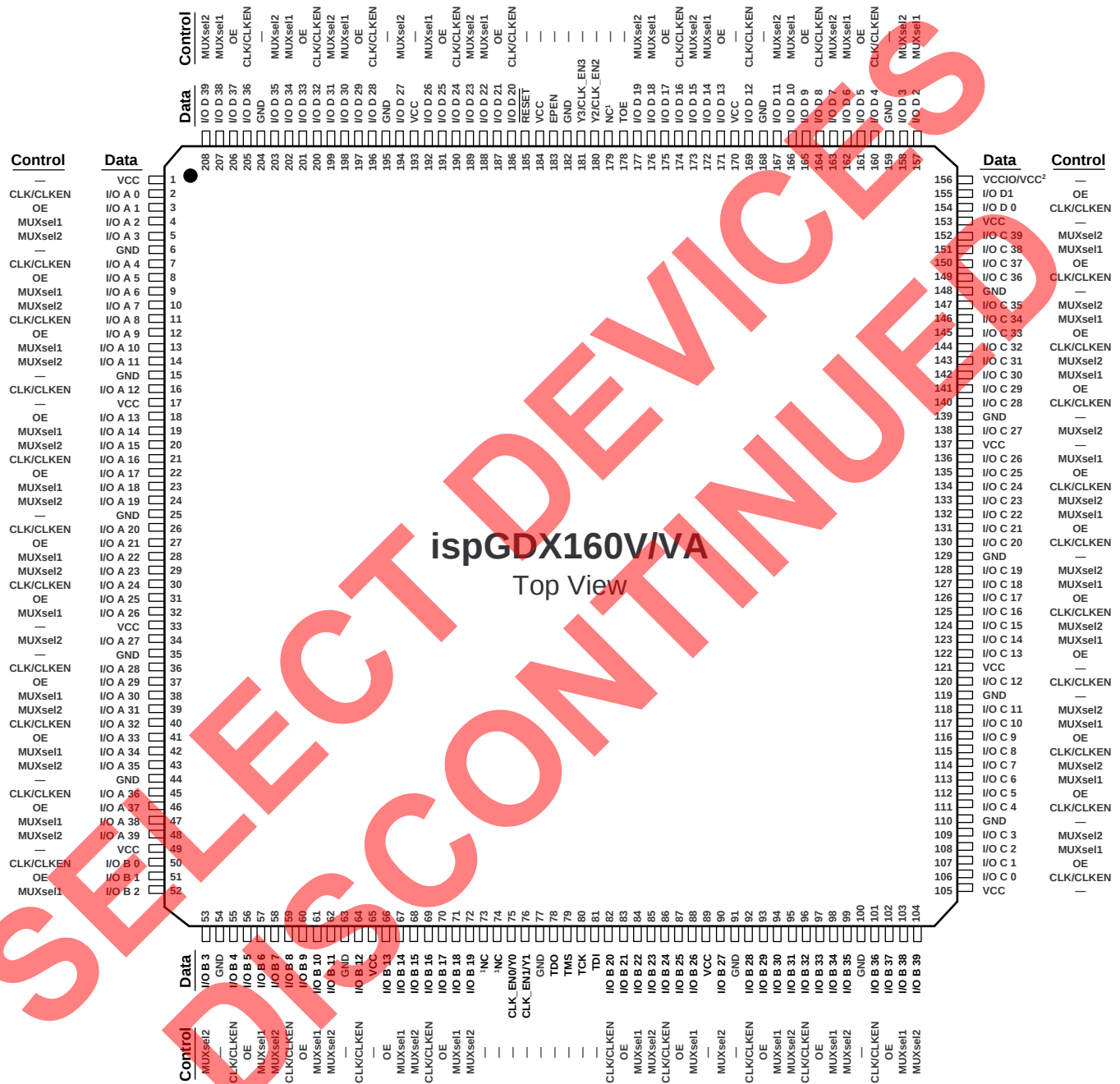
|     | 16      | 15      | 14      | 13                         | 12                                                                                                                                                                                                                                                                                                  | 11      | 10              | 9         | 8         | 7               | 6       | 5       | 4       | 3       | 2       | 1       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
|-----|---------|---------|---------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------|-----------|-----------------|---------|---------|---------|---------|---------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|--------|---------|---|
| A   | I/O D1  | I/O D3  | I/O D6  | I/O D9                     | I/O D13                                                                                                                                                                                                                                                                                             | I/O D17 | NC <sup>1</sup> | EPEN      | RESET     | I/O D23         | I/O D27 | I/O D30 | I/O D33 | I/O D36 | I/O D39 | I/O A3  | A   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| B   | I/O D0  | I/O D2  | I/O D5  | I/O D8                     | I/O D11                                                                                                                                                                                                                                                                                             | I/O D15 | I/O D18         | Y2/CLKEN2 | I/O D21   | I/O D25         | I/O D29 | I/O D32 | I/O D34 | I/O D38 | I/O A0  | I/O A1  | B   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| C   | I/O C36 | I/O C39 | I/O D4  | I/O D7                     | I/O D10                                                                                                                                                                                                                                                                                             | I/O D14 | I/O D19         | Y3/CLKEN3 | I/O D20   | I/O D24         | I/O D28 | I/O D31 | I/O D35 | I/O D37 | I/O A2  | I/O A4  | C   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| D   | I/O C35 | I/O C37 | I/O C38 | GND                        | VCC                                                                                                                                                                                                                                                                                                 | I/O D12 | I/O D16         | TOE       | I/O D22   | I/O D26         | VCC     | VCC     | GND     | I/O A5  | I/O A6  | I/O A7  | D   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| E   | I/O C32 | I/O C34 | I/O C33 | VCCIO/<br>VCC <sup>2</sup> | <div>ispGDX160V/VA</div> <div>Bottom View</div> <table><tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr><tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr><tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr><tr><td>GND</td><td>GND</td><td>GND</td><td>GND</td></tr></table> |         |                 |           |           |                 |         |         |         | GND     | GND     | GND     | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | VCC | I/O A8 | I/O A9 | I/O A10 | E |
| GND | GND     | GND     | GND     |                            |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         |         |         |         |         |         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| GND | GND     | GND     | GND     |                            |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         |         |         |         |         |         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| GND | GND     | GND     | GND     |                            |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         |         |         |         |         |         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| GND | GND     | GND     | GND     |                            |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         |         |         |         |         |         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| F   | I/O C29 | I/O C31 | I/O C30 | VCC                        | VCC                                                                                                                                                                                                                                                                                                 | I/O A11 | I/O A12         | I/O A13   | F         |                 |         |         |         |         |         |         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| G   | I/O C25 | I/O C27 | I/O C26 | I/O C28                    |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | I/O A14 | I/O A16 | I/O A15 | I/O A17 | G       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| H   | I/O C22 | I/O C23 | I/O C21 | I/O C24                    |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | I/O A18 | I/O A20 | I/O A19 | I/O A21 | H       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| J   | I/O C20 | I/O C18 | I/O C19 | I/O C17                    |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | I/O A25 | I/O A23 | I/O A24 | I/O A22 | J       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| K   | I/O C16 | I/O C14 | I/O C15 | I/O C13                    |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | I/O A29 | I/O A27 | I/O A28 | I/O A26 | K       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| L   | I/O C12 | I/O C10 | I/O C11 | VCC                        |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | VCC     | I/O A32 | I/O A31 | I/O A30 | L       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| M   | I/O C9  | I/O C8  | I/O C7  | VCC                        |                                                                                                                                                                                                                                                                                                     |         |                 |           |           |                 |         | VCC     | I/O A35 | I/O A34 | I/O A33 | M       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| N   | I/O C6  | I/O C5  | I/O C3  | GND                        | VCC                                                                                                                                                                                                                                                                                                 | VCC     | I/O B25         | I/O B21   | Y0/CLKEN0 | I/O B18         | I/O B13 | VCC     | GND     | I/O A38 | I/O A37 | I/O A36 | N   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| P   | I/O C4  | I/O C1  | I/O C0  | I/O B35                    | I/O B30                                                                                                                                                                                                                                                                                             | I/O B27 | I/O B23         | TDI       | TDO       | NC <sup>1</sup> | I/O B16 | I/O B11 | I/O B7  | I/O B4  | I/O B0  | I/O A39 | P   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| R   | I/O C2  | I/O B39 | I/O B36 | I/O B33                    | I/O B31                                                                                                                                                                                                                                                                                             | I/O B28 | I/O B24         | I/O B20   | Y1/CLKEN1 | I/O B19         | I/O B15 | I/O B12 | I/O B9  | I/O B6  | I/O B2  | I/O B1  | R   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
| T   | I/O B38 | I/O B37 | I/O B34 | I/O B32                    | I/O B29                                                                                                                                                                                                                                                                                             | I/O B26 | I/O B22         | TCK       | TMS       | NC <sup>1</sup> | I/O B17 | I/O B14 | I/O B10 | I/O B8  | I/O B5  | I/O B3  | T   |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |
|     | 16      | 15      | 14      | 13                         | 12                                                                                                                                                                                                                                                                                                  | 11      | 10              | 9         | 8         | 7               | 6       | 5       | 4       | 3       | 2       | 1       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |        |        |         |   |

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

2. VCCIO on ispGDX160VA. VCC on ispGDX160V.

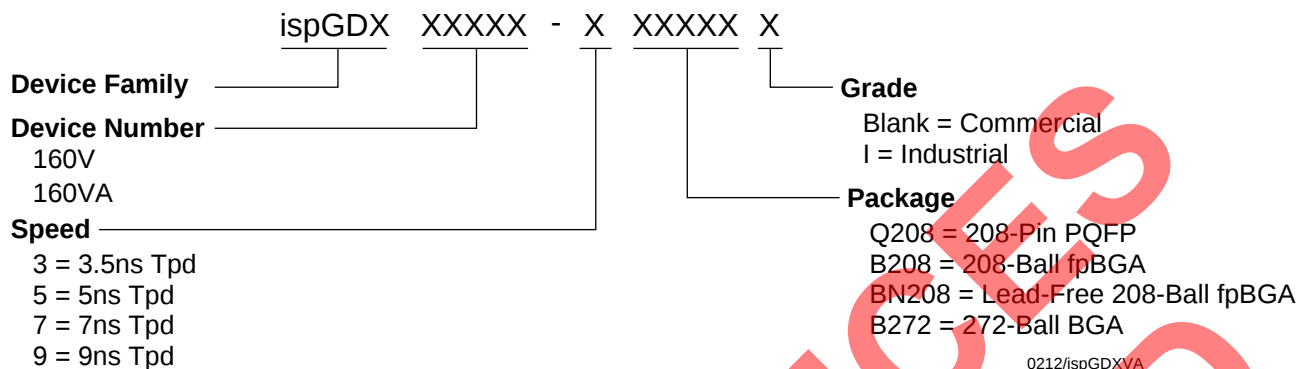
**Pin Configuration: ispGDX160V/VA**

**ispGDX160V/VA 208-Pin PQFP Pinout Diagram**



1. No Connect Pins (NC) are not to be connected to any active signal, Vcc or GND.
2. VCCIO on ispGDX160VA. VCC on ispGDX160V.

## Part Number Description



## Ordering Information

### Conventional Packaging

| COMMERCIAL |          |                   |                |
|------------|----------|-------------------|----------------|
| FAMILY     | tpd (ns) | ORDERING NUMBER   | PACKAGE        |
| ispGDXVA   | 3.5      | ispGDX160VA-3Q208 | 208-Pin PQFP   |
|            | 3.5      | ispGDX160VA-3B208 | 208-Ball fpBGA |
|            | 3.5      | ispGDX160VA-3B272 | 272-Ball BGA   |
|            | 5        | ispGDX160VA-5Q208 | 208-Pin PQFP   |
|            | 5        | ispGDX160VA-5B208 | 208-Ball fpBGA |
|            | 5        | ispGDX160VA-5B272 | 272-Ball BGA   |
|            | 7        | ispGDX160VA-7Q208 | 208-Pin PQFP   |
|            | 7        | ispGDX160VA-7B208 | 208-Ball fpBGA |
|            | 7        | ispGDX160VA-7B272 | 272-Ball BGA   |
| ispGDXV*   | 5        | ispGDX160V-5Q208  | 208-Pin PQFP   |
|            | 5        | ispGDX160V-5B208  | 208-Ball fpBGA |
|            | 5        | ispGDX160V-5B272  | 272-Ball BGA   |
|            | 7        | ispGDX160V-7Q208  | 208-Pin PQFP   |
|            | 7        | ispGDX160V-7B208  | 208-Ball fpBGA |
|            | 7        | ispGDX160V-7B272  | 272-Ball BGA   |

Table 2-0041A/ispGDXV/A

\*Use ispGDX160VA for new designs.

Note: The ispGDX160VA devices are dual-marked with both Commercial and Industrial grades. The Industrial speed grade is slower, e.g. ispGDX160VA-3B208-5I.

## Ordering Information (Cont.)

### Conventional Packaging (Cont.)

#### INDUSTRIAL

| FAMILY   | tpd (ns) | ORDERING NUMBER    | PACKAGE        |
|----------|----------|--------------------|----------------|
| ispGDXVA | 5        | ispGDX160VA-5Q208I | 208-Pin PQFP   |
|          | 5        | ispGDX160VA-5B208I | 208-Ball fpBGA |
|          | 5        | ispGDX160VA-5B272I | 272-Ball BGA   |
|          | 7        | ispGDX160VA-7Q208I | 208-Pin PQFP   |
|          | 7        | ispGDX160VA-7B208I | 208-Ball fpBGA |
|          | 7        | ispGDX160VA-7B272I | 272-Ball BGA   |
|          | 9        | ispGDX160VA-9Q208I | 208-Pin PQFP   |
|          | 9        | ispGDX160VA-9B208I | 208-Ball fpBGA |
|          | 9        | ispGDX160VA-9B272I | 272-Ball BGA   |
| ispGDXV* | 7        | ispGDX160V-7Q208I  | 208-Pin PQFP   |

\*Use ispGDX160VA for new designs.

Note: The ispGDX160VA devices are dual-marked with both Commercial and Industrial grades. The Industrial speed grade is slower, e.g. ispGDX160VA-3B208-5I.

Table 2-0041C/ispGDXV

### Lead-Free Packaging

#### COMMERCIAL

| FAMILY   | tpd (ns) | ORDERING NUMBER    | PACKAGE                  |
|----------|----------|--------------------|--------------------------|
| ispGDXVA | 3.5      | ispGDX160VA-3BN208 | Lead-Free 208-Ball fpBGA |
|          | 5        | ispGDX160VA-5BN208 | Lead-Free 208-Ball fpBGA |
|          | 7        | ispGDX160VA-7BN208 | Lead-Free 208-Ball fpBGA |

#### INDUSTRIAL

| FAMILY   | tpd (ns) | ORDERING NUMBER     | PACKAGE                  |
|----------|----------|---------------------|--------------------------|
| ispGDXVA | 5        | ispGDX160VA-5BN208I | Lead-Free 208-Ball fpBGA |
|          | 7        | ispGDX160VA-7BN208I | Lead-Free 208-Ball fpBGA |
|          | 9        | ispGDX160VA-9BN208I | Lead-Free 208-Ball fpBGA |

Note: The ispGDX160VA devices are dual-marked with both Commercial and Industrial grades. The Industrial speed grade is slower, e.g. ispGDX160VA-3B208-5I.