
# SiI3132
# PCI Express to Serial ATA Controller

# Data Sheet

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## Revision History

| Revision | Date | Comment |
|---|---|---|
| A | 4/8/05 | Derived from preliminary datasheet rev 0.3 |
| A1 | 8/15/05 | Updated register description for BAR0 Offset $50_H$ |
| A2 | 8/11/06 | Corrected inconsistent sentences (minor fixes including mistyping) |
| C | 2/2/07 | This document is no longer under NDA, removed confidential markings. Updated Marking Specification. |
| D | 2/23/07 | Changes to package drawing. New formatting applied. |

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# Overview

The Silicon Image SiI3132 is a two-port PCI Express to Serial ATA controller. The SiI3132 is designed to provide multiple-port serial ATA connectivity with minimal host overhead and host-to-device latency. The SiI3132 supports a 1-lane 2.5 Gbit/s PCI Express bus and the Serial ATA Generation 2 transfer rate of 3.0 Gbit/s (300 MByte/s).

# Features

## Overall Features

- Host Protocol:
    - Optimized for transaction oriented designs — minimal Host overhead
    - Supports two command issuance mechanisms:
        - Efficient in both embedded and PC implementations
        - Reduces dependency on bridge behavior
- Supports up to 4-Mbit external flash for BIOS expansion
- Supports a master/slave $I^2C$ interface
- Supports external flash or serial EEPROM for programmable subsystem vendor ID / subsystem product ID
- Fabricated in a 0.18µ CMOS process with a 1.8 volt core and 3.3 volt I/Os
- Available in an 88-pin QFN package (10x10 mm, 0.4 mm lead pitch). **An EPAD must be soldered to PCB GND**
- JTAG boundary scan

## PCI Express Features

- Supports 1-lane 2.5 Gbit/s PCI Express
- Internal application interface multiplexed to 2 ports
- All registers appear in unified memory space
- All registers accessible through I/O space
- Full-chip command completion status accessible with single PCI Express access

## Serial ATA Features

- Integrated Serial ATA Link and PHY logic
- Compliant with Serial ATA 1.0 specifications
- Supports Serial ATA Generation 2 transfer rate of 3.0 Gbit/s
- Plesiochronous, Single PLL architecture, 1 PLL for 2 ports
- Output Swing Control
- Supports two independent Serial ATA channels:
    - Independent Link, Transport, and data FIFO
    - Independent command fetch, scatter/gather, and command execution with hard-coded state machines — no code space or download
    - Supports Legacy Command Queuing (LCQ)
    - Supports Native Command Queuing (NCQ)
    - Supports Non-zero offsets NCQ
    - Supports Out of order data delivery NCQ
    - Supports FIS-based switching with Port Multipliers
- 31 Commands and Scatter/Gather Tables per port on-chip
- Protocol Override per Command
- Staggered Spin-up Control

# References

- Serial ATA / High Speed Serialized AT Attachment specification, Revision 1.0
- PCI Express Base Specification Revision 1.0a

# Electrical Characteristics

## Device Electrical Characteristics

Specifications are for commercial temperature range, 0°C to +70°C, unless otherwise specified.

**Table 1. Absolute Maximum Ratings**

| Symbol | Parameter | Ratings | Unit |
|---|---|---|---|
| VDDO | I/O Supply Voltage | 4.0 | V |
| VDDD | Core Supply Voltage | 2.15 | V |
| VDDSRX, VDDSTX VDDSPLL, VDDPRX VDDPTX, VDDPTXPLL VDDPRXPLL, VDDX | Supply Voltage for SATA and PCI Express Receivers, Transmitters, and PLLs, respectively | 2.15 | V |
| $V_{IN}$ | Input Voltage | -0.3 ~ VDD+0.3 | V |
| $I_{OUT}$ | DC Output Current | 16 | mA |
| $\theta_{JA}$ | Thermal Resistance, Junction to Ambient, Still Air | 22.2[1] | °C/W |
| $T_{STG}$ | Storage Temperature | -65 ~ 150 | °C |

Notes: [1] An EPAD must be soldered to PCB GND

**Table 2. DC Specifications**

| Symbol | Parameter | Condition | Type | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| VDDD | Core Supply Voltage | - | - | 1.71 | 1.8 | 1.89 | V |
| VDDSRX | SATA Receiver Supply Voltage | - | - | | | | |
| VDDSTX | SATA Transmitter Supply Voltage | - | - | | | | |
| VDDSPLL | SATA SerDes PLL Supply Voltage | - | - | | | | |
| VDDPRX | PCI Exp Receiver Supply Voltage | - | - | | | | |
| VDDPTX | PCI Exp Transmitter Supply Voltage | - | - | | | | |
| VDDPTXPLL | PCI Exp Transmitter PLL Supply Voltage | - | - | | | | |
| VDDPRXPLL | PCI Exp Receiver PLL Supply Voltage | - | - | | | | |
| VDDX | Oscillator Supply Voltage | - | - | | | | |
| VDDO | Supply Voltage(I/O) | - | - | 3.0 | 3.3 | 3.6 | V |
| $IDD_{1.8V-3G}$ | Supply Current (1.8V Supply) | 3-GHz Operating | - | - | 450 | 570 | mA |
| $IDD_{1.8V-1.5G}$ | Supply Current (1.8V Supply) | 1.5-GHz Operating | - | - | 380 | 500 | mA |
| $V_{IH}$ | Input High Voltage | 3.3V I/O | | 2.0 | - | - | V |
| $V_{IL}$ | Input Low Voltage | 3.3V I/O | | | | 0.8 | V |
| V+ | Input High Voltage | 3.3V I/O | Schmitt | - | 1.8 | 2.3 | V |
| V- | Input Low Voltage | 3.3V I/O | Schmitt | 0.5 | 0.9 | - | V |
| $V_H$ | Hysteresis Voltage | 3.3V I/O | Schmitt | 0.4 | - | - | V |
| $I_{IH}$ | Input High Current | $V_{IN}$ = VDD | - | -10 | - | 10 | µA |
| $I_{IL}$ | Input Low Current | $V_{IN}$ = VSS | - | -10 | - | 10 | µA |
| $V_{OH}$ | Output High Voltage | - | - | 2.4 | - | - | V |
| $V_{OL}$ | Output Low Voltage | - | - | - | - | 0.4 | V |
| $I_{OZ}$ | 3-State Leakage Current | - | - | -10 | - | 10 | µA |

Note: 3.3V power consumption depends on LED, JTAG, Enclosure management status. If all are disabled, 3.3V power consumption will be µA.

**Table 3. SATA Interface DC Specifications**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $V_{SATA\_DOUT}$ | TX+/TX- differential peak-to-peak voltage swing. | Terminated by 50 Ω. BAR1 1050h [4:0] = 0x0C[1] | 400 | 550 | 700 | mV |
| $V_{SATA\_DIN}$ | RX+/RX- differential peak-to-peak input sensitivity | - | 240 | - | - | mV |
| $V_{SATA\_SQ}$ | RX+/RX- OOB Signal Detection Threshold | - | 50 | 125 | 240 | mV |
| $V_{SATA\_ACCM}$ | Tx AC common-mode voltage | - | - | | 50 | mV |
| $Z_{SATA\_DIN}$ | Tx Pair Differential impedance | - | 85 | 100 | 115 | Ω |
| $Z_{SATA\_DOUT}$ | Rx Pair Differential impedance | - | 85 | 100 | 115 | Ω |
| $Z_{SATA\_SIN}$ | Tx Single-Ended impedance | - | 40 | - | - | Ω |
| $Z_{SATA\_SOUT}$ | Rx Single-Ended impedance | - | 40 | - | - | Ω |

Notes: [1] 0x0A is a reset value

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**Table 4. PCI Express Interface DC Specifications**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $V_{PCI\_DOUT}$ | TX+/TX- differential peak-to-peak voltage swing. | Terminated by 50 Ω. | 800 | 1000 | 1200 | mV |
| $V_{PCI\_DE-RATIO}$ | Tx De-Emphasized Differential Output Voltage | Ratio | - 3.0 | -3.5 | -4.0 | dB |
| $V_{PCI\_DIN}$ | RX+/RX- differential peak-to-peak input sensitivity | - | 175 | | 1200 | mV |
| $Z_{PCI\_DIN}$ | Tx Pair Differential impedance | DC impedance | 80 | 100 | 120 | Ω |
| $Z_{PCI\_DOUT}$ | Rx Pair Differential impedance | DC impedance | 80 | 100 | 120 | Ω |
| $Z_{PCI\_SIN}$ | Tx Single-Ended impedance | DC impedance | 40 | 50 | 60 | Ω |
| $Z_{PCI\_SOUT}$ | Rx Single-Ended impedance | DC impedance | 40 | 50 | 60 | Ω |
| $Z_{PCI\_RX-HIGH-IMP-DC}$ | Rx Powered Down Impedance | DC impedance | 200k | - | - | Ω |
| $Z_{PCI\_RX-IDLE-DET-DIFFp-p}$ | Electrical Idle Detect Threshold | Measured at the Rx pins | 65 | - | 175 | mV |

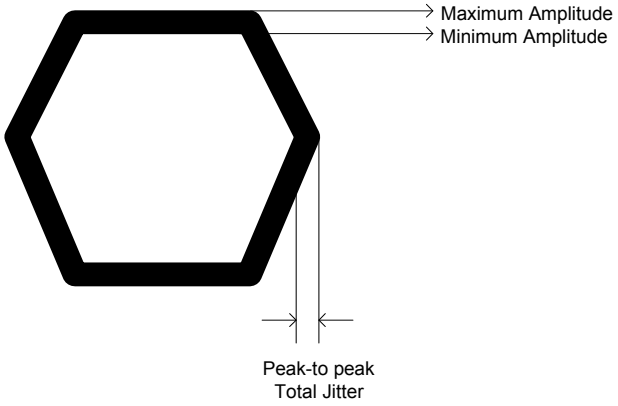



**Figure 1. Eye Diagram**

## SATA Interface Timing Specifications

**Table 5. SATA Interface Timing Specifications**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $T_{TX\_RISE\_FALL}$ | Rise and Fall time at transmitter | 20%-80% at Gen 1<br>20%-80% at Gen 2 | 100<br>67 | - | 273<br>136 | ps |
| $T_{TX\_TOL\_FREQ}$ | Tx Frequency Long Term Stability | - | -350 | - | +350 | ppm |
| $T_{TX\_AC\_FREQ}$ | Tx Spread-Spectrum Modulation Deviation | CLKI = SSC AC modulation, subject to the "Downspread SSC" triangular modulation (30-33 kHz) profile per 6.6.4.5 in SATA 1.0 specification | -5000 | - | +0 | ppm |
| $T_{TX\_SKEW}$ | Tx Differential Skew | - | - | - | 15 | ps |

## SATA Interface Transmitter Output Jitter Characteristics

**Table 6. SATA Interface Transmitter Output Jitter Characteristics, 1.5 Gbit/s**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $TJ_{5UI\_15G}$ | Total Jitter, Data-Data 5UI | Measured at Tx output pins peak to peak phase variation Random data pattern | - | 80 | - | ps |
| $DJ_{5UI\_15G}$ | Deterministic Jitter, Data-Data 5UI | Measured at Tx output pins peak to peak phase variation Random data pattern | - | 40 | - | ps |
| $TJ_{250UI\_15G}$ | Total Jitter, Data-Data 250UI | Measured at Tx output pins peak to peak phase variation Random data pattern | - | 100 | - | ps |
| $DJ_{250UI\_15G}$ | Deterministic Jitter, Data-Data 250UI | Measured at Tx output pins peak to peak phase variation Random data pattern | - | 60 | - | ps |

**Table 7. SATA Interface Transmitter Output Jitter Characteristics, 3 Gbit/s**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $TJ_{fBAND/10\_3G}$ | Total Jitter, $f_{C3dB}=f_{BAUD}/10$ | Measured at SATA Compliance Point<br>Random data pattern<br>Load = LL Laboratory Load | - | 60 | - | ps |
| $DJ_{fBAND/10\_3G}$ | Deterministic Jitter, $f_{C3dB}=f_{BAUD}/10$ | Measured at SATA Compliance Point<br>Random data pattern<br>Load = LL Laboratory Load | - | 15 | - | ps |
| $TJ_{fBAND/500\_3G}$ | Total Jitter, $f_{C3dB}=f_{BAUD}/500$ | Measured at SATA Compliance Point<br>Random data pattern<br>Load = LL Laboratory Load | - | 70 | - | ps |
| $DJ_{fBAND/500\_3G}$ | Deterministic Jitter, $f_{C3dB}=f_{BAUD}/500$ | Measured at SATA Compliance Point<br>Random data pattern<br>Load = LL Laboratory Load | - | 20 | - | ps |

## PCI Express Interface Timing Specifications

**Table 8. PCI Express Interface Timing Specifications**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $T_{PCI\_UI}$ | Tx / Rx Unit Interval | SSC disabled | 399.88 | 400 | 400.12 | ps |
| $T_{PCI\_TX\_RISE\_FALL}$ | Rise and Fall time at transmitter | 20%-80% | 0.125 | - | - | UI |
| $T_{PCI\_TX-IDLE-MIN}$ | Minimum time spent in Electrical Idle | - | 50 | - | - | UI |
| $T_{PCI\_TX-IDLE-SET-TO-IDLE}$ | Maximum time to transition to a valid Electrical Idle after sending an Electrical Idle ordered set | - | - | - | 20 | UI |
| $T_{PCI\_TX-IDLE-TO-TO-DIFF-DATA}$ | Maximum time to transition to valid TX specifications after leaving an Electrical Idle condition | - | - | - | 20 | UI |
| $T_{PVPERL}$ | Power stable to PERST# inactive | - | 100 | - | - | ms |
| $T_{PERST-CLK}$ | REFCLK stable before PERST# inactive | - | 100 | - | - | us |
| $T_{PERST}$ | PERST# active time | - | 100 | - | - | us |

## PCI Express Interface Transmitter Output Jitter Characteristics

**Table 9. PCI Express Interface Transmitter Output Jitter Characteristics**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $TJ_{PCIe}$ | Total Jitter | Defined by PCI Express Base Specification Rev 1.1 | - | 65 | - | ps |

## CLKI SATA Reference Clock Input Requirements

**Table 10. CLKI SerDes Reference Clock Input Requirement**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $T_{CLKI\_FREQ}$ | Nominal Frequency | - | - | 25 | - | MHz |
| $V_{CLKI\_IH}$ | Input High Voltage | - | 0.7xVDDX | - | - | V |
| $V_{CLKI\_IL}$ | Input Low Voltage | - | - | - | 0.3xVDDX | V |
| $T_{CLKI\_J}$ | CLKI frequency tolerance | - | -50 | - | +50 | ppm |
| $T_{CLKI\_RISE\_FALL}$ | Rise and Fall time at CLKI | 25-MHz reference | - | - | 4 | ns |
| $T_{CLKI\_RJ}$ | Random Jitter | Measured at CLKI pin<br>$10^{-12}$ Bit Error Ratio<br>1 sigma deviation | - | - | 50 | psrms |
| $T_{CLKI\_TJ}$ | Total Jitter | Measured at CLKI pin<br>$10^{-12}$ Bit Error Ratio<br>peak-to-peak phase noise | - | - | 1 | ns |
| $T_{CLKI\_RC\_DUTY}$ | CLKI duty cycle | 20%-80% | 40 | - | 60 | % |

## Power Supply Noise Requirements

**Table 11. Power Supply Noise Requirement**

| Symbol | Parameter | Condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $V_{NOISE\_VDDA}$ | 1.8V Analog Power Noise | peak-to-peak sinewave across 500-kHz to 3-GHz frequency range.<br>Measured with differential probe trigger by noise source | - | - | 50 | mV |
| $V_{NOISE\_VDDD}$ | 1.8V Digital Power Noise | | - | - | 100 | mV |
| $V_{NOISE\_VDDO}$ | 3.3V IO Power Noise | | - | - | 200 | mV |

# Pin Definitions

## SiI3132 Pin Listing

This section describes the pin-out of the SiI3132 PCI Express to Serial ATA host controller. Table 12 gives the pin numbers, pin names, pin types, drive types where applicable, internal resistors where applicable, and descriptions. Power pins (VDD and VSS) are excluded from this listing.

**Table 12. SiI3132 Pin Listing**

| Pin # | Pin Name | Type | Drive | Internal Resistor | Description |
|---|---|---|---|---|---|
| 4 | RX1+ | Diff In | - | - | Serial port 1 differential receiver + input |
| 5 | RX1- | Diff In | - | - | Serial port 1 differential receiver – input |
| 8 | TX1- | Diff Out | - | - | Serial port 1 differential transmitter – output |
| 9 | TX1+ | Diff Out | - | - | Serial port 1 differential transmitter + output |
| 13 | TX0+ | Diff Out | - | - | Serial port 0 differential transmitter + output |
| 14 | TX0- | Diff Out | - | - | Serial port 0 differential transmitter – output |
| 17 | RX0- | Diff In | - | - | Serial port 0 differential receiver – input |
| 18 | RX0+ | Diff In | - | - | Serial port 0 differential receiver + input |
| 20 | REFCLK+ | Diff In | - | - | PCI Express differential reference clock + input |
| 21 | REFCLK- | Diff In | - | - | PCI Express differential reference clock - input |
| 25 | PRX+ | Diff In | - | - | PCI Express differential receiver + input |
| 26 | PRX- | Diff In | - | - | PCI Express differential receiver – input |
| 29 | PTX- | Diff Out | - | - | PCI Express differential transmitter – output |
| 30 | PTX+ | Diff Out | - | - | PCI Express differential transmitter + output |
| 34 | PERST_N | I-Schmitt | - | - | PCI Express Reset |
| 36 | LED1 | OD | 12 mA | - | Channel 1 activity LED indicator |
| 37 | LED0 | OD | 12 mA | - | Channel 0 activity LED indicator |
| 39 | FL_DATA0 | I/O | 8 mA | PU-70k | Flash Memory Data 0 |
| 40 | FL_DATA1 | I/O | 8 mA | PU-70k | Flash Memory Data 1 |
| 41 | FL_DATA2 | I/O | 8 mA | PU-70k | Flash Memory Data 2 |
| 42 | FL_DATA3 | I/O | 8 mA | PU-70k | Flash Memory Data 3 |
| 43 | FL_DATA4 | I/O | 8 mA | PU-70k | Flash Memory Data 4 |
| 45 | FL_DATA5 | I/O | 8 mA | PU-70k | Flash Memory Data 5 |
| 46 | FL_DATA6 | I/O | 8 mA | PU-70k | Flash Memory Data 6 |
| 47 | FL_DATA7 | I/O | 8 mA | PU-70k | Flash Memory Data 7 |
| 49 | FL_ADDR00 | I/O | 8 mA | PU-70k | Flash Memory Address 0 |
| 50 | FL_ADDR01 | I/O | 8 mA | PU-70k | Flash Memory Address 1 |
| 51 | FL_ADDR02 | I/O | 8 mA | PU-70k | Flash Memory Address 2 |
| 52 | FL_ADDR03 | I/O | 8 mA | PU-70k | Flash Memory Address 3 |
| 53 | FL_ADDR04 | I/O | 8 mA | PU-70k | Flash Memory Address 4 |
| 55 | FL_ADDR05 | I/O | 8 mA | PU-70k | Flash Memory Address 5 |
| 56 | FL_ADDR06 | I/O | 8 mA | PU-70k | Flash Memory Address 6 |
| 57 | FL_ADDR07 | I/O | 8 mA | PU-70k | Flash Memory Address 7 |
| 58 | FL_ADDR08 | I/O | 8 mA | PU-70k | Flash Memory Address 8 |
| 59 | FL_ADDR09 | I/O | 8 mA | PU-70k | Flash Memory Address 9 |
| 61 | FL_ADDR10 | I/O | 8 mA | PU-70k | Flash Memory Address 10 |
| 62 | FL_ADDR11 | I/O | 8 mA | PU-70k | Flash Memory Address 11 |

**Table 12. SiI3132 Pin Listing (continued)**

| Pin # | Pin Name | Type | Drive | Internal Resistor | Description |
|---|---|---|---|---|---|
| 63 | FL_ADDR12 | I/O | 8 mA | PU-70k | Flash Memory Address 12 |
| 64 | FL_ADDR13 | I/O | 8 mA | PU-70k | Flash Memory Address 13 |
| 65 | FL_ADDR14 | I/O | 8 mA | PU-70k | Flash Memory Address 14 |
| 68 | FL_ADDR15 | I/O | 8 mA | PU-70k | Flash Memory Address 15 |
| 69 | FL_ADDR16 | I/O | 8 mA | PU-70k | Flash Memory Address 16 |
| 70 | FL_ADDR17 | I/O | 8 mA | PU-70k | Flash Memory Address 17 |
| 71 | FL_ADDR18 | I/O | 8 mA | PU-70k | Flash Memory Address 18 |
| 72 | FL_RD_N | I/O | 8 mA | PU-70k | Flash Memory Read Strobe |
| 73 | FL_WR_N | I/O | 8 mA | PU-70k | Flash Memory Write Strobe |
| 74 | FL_CS_N | I/O | 8 mA | PU-70k | Flash Memory Chip Select |
| 76 | TMS | I | - | PU-70k | JTAG Test Mode Select |
| 77 | TCK | I-Schmitt | - | - | JTAG Test Clock |
| 78 | TDI | I | - | PU-70k | JTAG Test Data In |
| 79 | TDO | O | 4 mA | - | JTAG Test Data Out |
| 80 | TRSTN | I | - | PU-70k | JTAG Test Reset |
| 81 | SCAN_MODE | I | -- | PD-60k | Internal Scan Mode Control |
| 82 | I2C_SDAT | I/O-Schmitt | 4 mA | PU-70k | $I^2C$ Serial Data |
| 83 | I2C_SCLK | I/O-Schmitt | 4 mA | PU-70k | $I^2C$ Serial Clock |
| 86 | XTALO | Analog | - | - | Crystal Output |
| 87 | XTALI/CLKI | Analog | - | - | Crystal or Clock Input |

**Table 13. Pin Types**

| Pin Type | Pin Description |
|---|---|
| I | Input Pin with LVTTL Thresholds |
| I-Schmitt | Input Pin with Schmitt Trigger |
| O | Output Pin |
| I/O | Bi-directional Pin |
| I/O-Schmitt | Bi-directional Pin with Schmitt Trigger |
| OD | Open Drain Output Pin |

## SiI3132 Pin Diagram

Figure 2 shows the pin layout for the SiI3132.

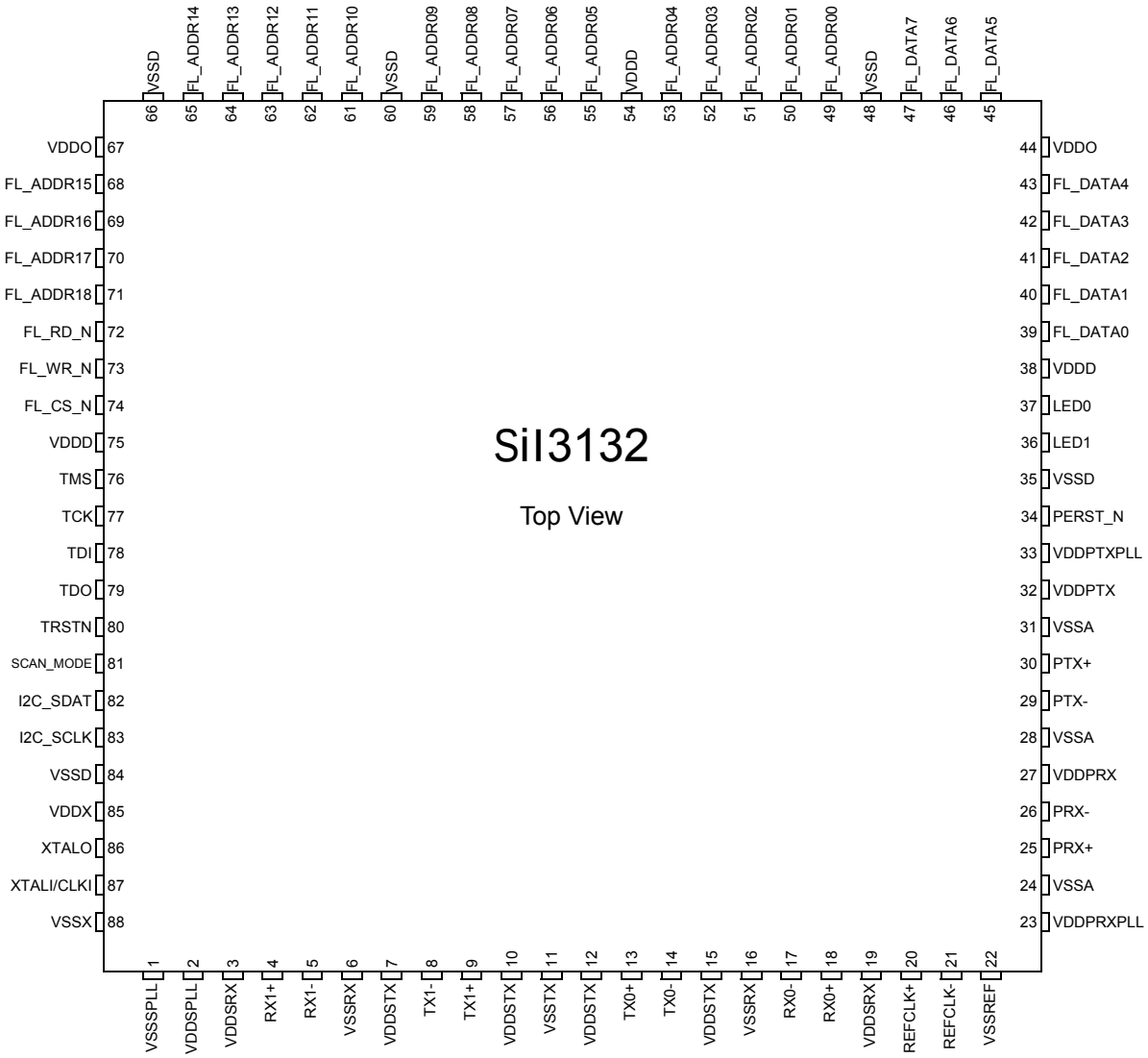



**Figure 2. Pin Diagram**

# SiI3132 Pin Descriptions

## PCI Express Pins

**Table 14. PCI Express Pin Descriptions**

| Signal Name | Pin Number(s) | Description |
|---|---|---|
| PRx+ | 25 | **Receive +**. Serial receiver differential signal, positive side. Must be AC coupled |
| PRx- | 26 | **Receive** -. Serial receiver differential signal, negative side. Must be AC coupled |
| PTx+ | 30 | **Transmit** +. Serial transmitter differential signal, positive side. Must be AC coupled with a 100nF capacitor |
| PTx- | 29 | **Transmit -**. Serial transmitter differential signal, negative side. Must be AC coupled with a 100nF capacitor |
| REFCLK+ | 20 | **Reference Clock +**. PCI Express system supplied differential reference clock, positive side. This input signal must be compliant with PCI Express Card Electromechanical Specification Revision 1.0a |
| REFCLK- | 21 | **Reference Clock -**. PCI Express system supplied differential reference clock, negative side. This input signal must be compliant with PCI Express Card Electromechanical Specification Revision 1.0a |
| PERST_N | 34 | **Reset**. PERST_N initializes the PCI Express interface and sets internal registers to their initial state. |

## Flash / $I^2C$ / LED Pins

**Table 15. Flash / $I^2C$ / LED Pin Descriptions**

| Signal Name | Pin Number(s) | Description |
|---|---|---|
| FL_ADDR[18:00] | 49-53, 55-59, 61-65, 68-71 | **Flash Address**. FL_ADDR[18:00] is the Flash Memory address for up to 512k of flash Memory. |
| FL_DATA[07:00] | 39-43, 45-47 | **Flash Data**. 8-bit flash memory data bus |
| FL_RD_N | 72 | **Flash Read Enable**. Active low |
| FL_WR_N | 73 | **Flash Write Enable**. Active low |
| FL_CS_N | 74 | **Flash Chip Select**. Active low |
| I2C_SDAT | 82 | **$I^2C$ Serial Data**. Serial Interface ($I^2C$) data line (internally connected to PHY $I^2C$ data line) |
| I2C_SCLK | 83 | **$I^2C$ Serial Clock**. Serial Interface ($I^2C$) clock (internally connected to PHY $I^2C$ clock) |
| LED[1:0] | 36, 37 | **Activity LED**. Activity LED drivers for channels 1 and 0. |

## Serial ATA Signals

**Table 16. Serial ATA Signal Pin Descriptions**

| Signal Name | Pin Number(s) | Description |
|---|---|---|
| Rx[1:0]+ | 4, 18 | **Receive +**. Serial receiver differential signal, positive side. Must be AC coupled |
| Rx[1:0]- | 5, 17 | **Receive -**. Serial receiver differential signal, negative side. Must be AC coupled |
| Tx[1:0]+ | 9, 13 | **Transmit +**. Serial transmitter differential signal, positive side. Must be AC coupled |
| Tx[1:0]- | 8, 14 | **Transmit -**. Serial transmitter differential signal, negative side. Must be AC coupled |
| XTALI/CLKI | 87 | **Crystal In**. Crystal oscillator pin for SerDes reference clock. When external clock source is selected, the 25-MHz external clock will come in through this pin. The clock must be 1.8V swing and the precision recommendation is ±50ppm. Please refer for the detail |
| XTALO | 86 | **Crystal Out**. Crystal oscillator pin for SerDes reference clock. A 25-MHz crystal must be used. |

## Test Pins

**Table 17. Test Pin Descriptions**

| Signal Name | Pin Number(s) | Description |
|---|---|---|
| TMS | 76 | **JTAG Test Mode Select** |
| TCK | 77 | **JTAG Test Clock** |
| TDI | 78 | **JTAG Test Data In** |
| TDO | 79 | **JTAG Test Data Out** |
| TRSTN | 80 | **JTAG Test Reset**. This pin must be tied to ground if JTAG function is not used. |
| SCAN_MODE | 81 | **Scan Mode**. Used for factory testing; do not connect. |

## Power/Ground Pins

All like-named power/ground pins, in Table 18 below, are connected together within the package.

**Table 18. Power/Ground Pin Descriptions**

| Pin Name | Pin Number(s) | Description |
|---|---|---|
| VDDSRX | 3, 19 | **Receiver Power**. These pins provide 1.8V for the Serial ATA receivers. |
| VSSRX | 6, 16 | **Receiver Ground**. These pins provide the Ground reference for the Serial ATA receivers. |
| VDDSTX | 7, 10, 12, 15 | **Transmitter Power**. These pins provide 1.8V for the Serial ATA transmitters. |
| VSSTX | 11 | **Transmitter Ground**. This pin provides the Ground reference for the Serial ATA transmitters. |
| VDDPRX | 27 | **Receiver Power**. This pin provides 1.8V for the PCI Express receivers. |
| VDDPTX | 32 | **Transmitter Power**. This pin provides 1.8V for the PCI Express transmitters. |
| VDDPTXPLL | 33 | **PLL Power**. This pin provides 1.8V for the PCI Express transmitter PLL. |
| VDDPRXPLL | 23 | **PLL Power**. This pin provides 1.8V for the PCI Express receiver PLL. |
| VSSA | 24, 28, 31 | **PCI-E Ground**. These pins provide the Ground reference for the PCI Express SerDes. |
| VDDSPLL | 2 | **PLL Power**. This pin provides 1.8V for the Serial ATA PLL and crystal oscillator. |
| VSSSPLL | 1 | **PLL Ground**. This pin provides the Ground reference for the Serial ATA PLL. |
| VSSREF | 22 | **Reference Clock Ground**. This pin provides the Ground reference for the PCI-Express reference clock receiver. |
| VDDX | 85 | **Oscillator Power**. This pin provides 1.8V for the crystal oscillator (associated with XTALI and XTALO pins). |
| VSSX | 88 | **Oscillator Ground**. This pin provides the Ground reference for the crystal oscillator (associated with XTALI and XTALO pins). |
| VDDO | 44, 67 | **I/O Power**. These pins provide 3.3V for the digital I/O. |
| VDDD | 38, 54, 75 | **Digital Power**. These pins provide 1.8V for the digital logic. |
| VSSD | 35, 48, 60, 66, 84 | **Digital Ground**. These pins provide the Ground reference for the digital portion of the chip. |

# Package Drawing

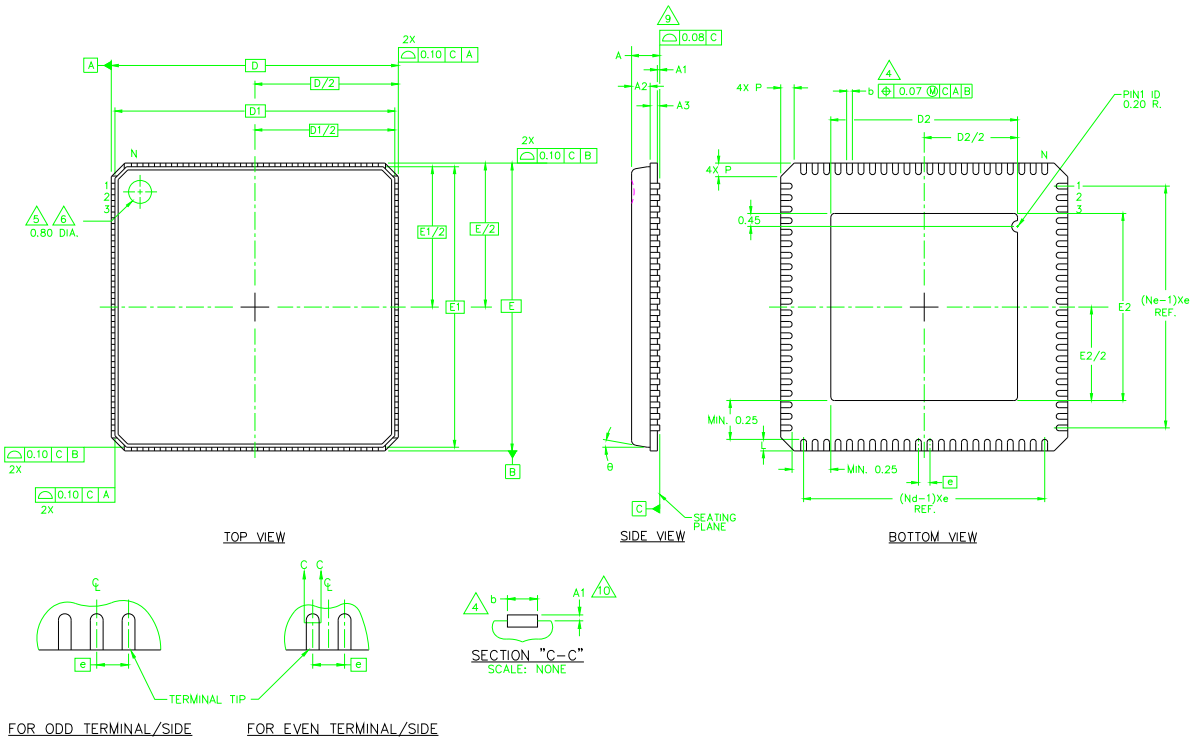



**Figure 3. Package Drawing 88 QFN**

**Table 19. Package Dimensions**

| Symbol | Dimensions (mm) | | |
|---|---|---|---|
| | Minimum | Nominal | Maximum |
| e | | 0.40 | |
| L | 0.30 | 0.40 | 0.50 |
| b | 0.15 | 0.20 | 0.25 |
| D2 | 5.85 | 6.00[1] | 6.65 |
| E2 | 5.85 | 6.00[1] | 6.65 |
| A | - | 0.85 | 0.90 |
| A1 | 0.00 | 0.02 | 0.05 |
| A2 | - | 0.65 | 0.70 |
| A3 | 0.20 REF | | |
| D | 10.00 BSC | | |
| D1 | 9.75 BSC | | |
| E | 10.00 BSC | | |
| E1 | 9.75 BSC | | |
| θ | | | 12° |
| P | 0.24 | 0.42 | 0.60 |

Note: [1] **It is required that an EPAD is soldered to PCB ground** and the landing area be incorporated on the PCB within the footprint of the package corresponding to the EPAD. The size of this landing area can be larger than the exposed pad on the package, **should be at least the same as the maximum size of exposed pad of the package (6.65 x 6.65mm). If the traces are within the maximum size of exposed pad, the trace may short to the exposed pad when the package has the exposed pad with the maximum dimension.**

## Part Ordering Number

SiI3132CNU (88-pin QFN lead free package with an exposed pad)

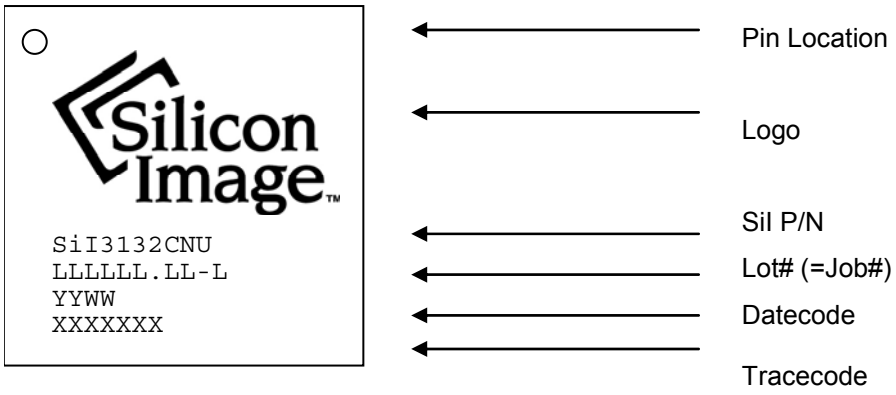



**Figure 4. Marking Specification**

# Programming Model

## SiI3132 Block Diagram

The SiI3132 programs the major logic modules are illustrated in Figure 5.

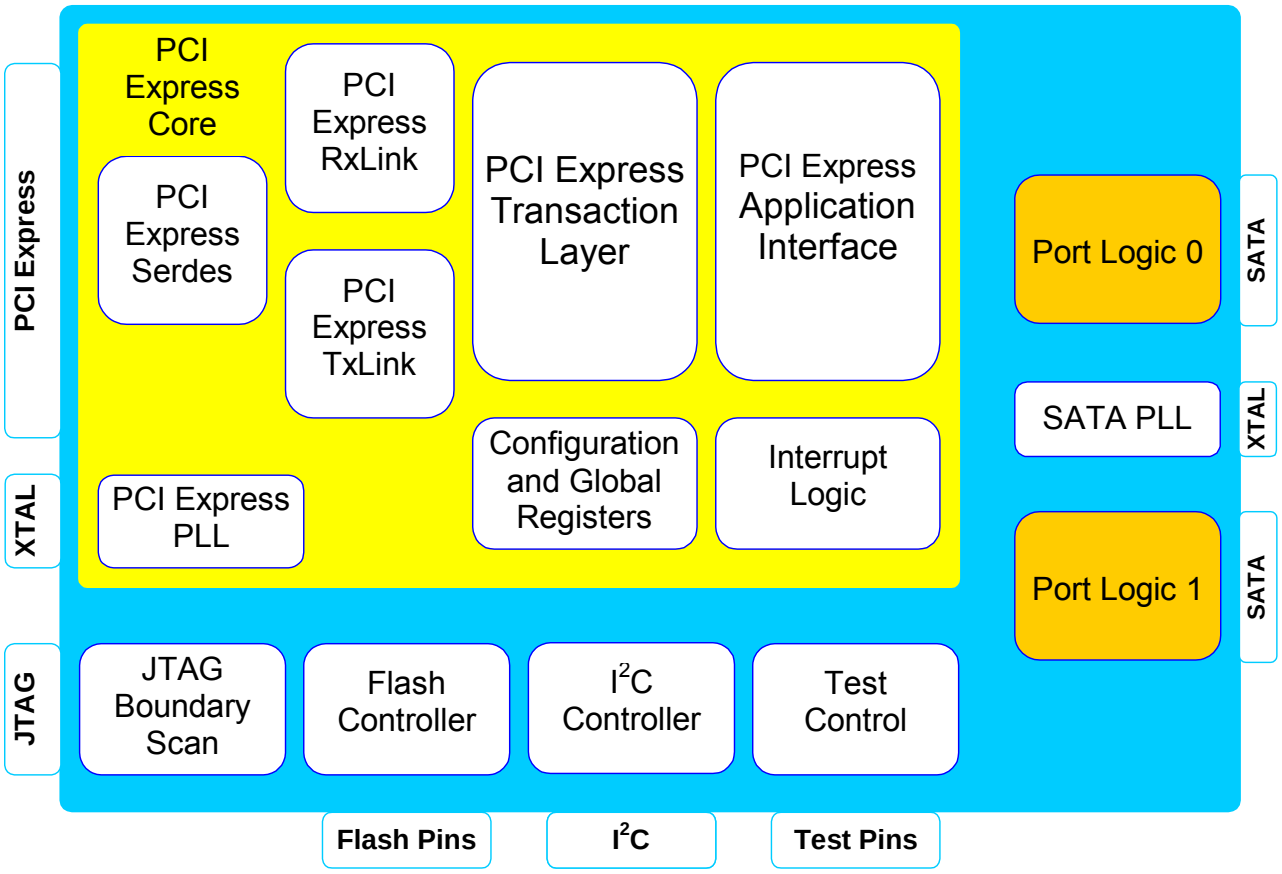



**Figure 5. SiI3132 Block Diagram**

The PCI Express Core logic block provides PCI Express 1.0a compatibility. The Global Register File block corresponds to the registers addressed by Base Address Register 0; refer to “PCI Express Capability” section on page 46 for more information.

The initialization function provided by the $I^2C$ Controller and Flash Controller is described in “” section on page 34 for more information.

## SiI3132 SATA Port Block Diagram

The block diagram illustrated in Figure 6 shows the logic structure of each of the SiI3132 SATA Ports.

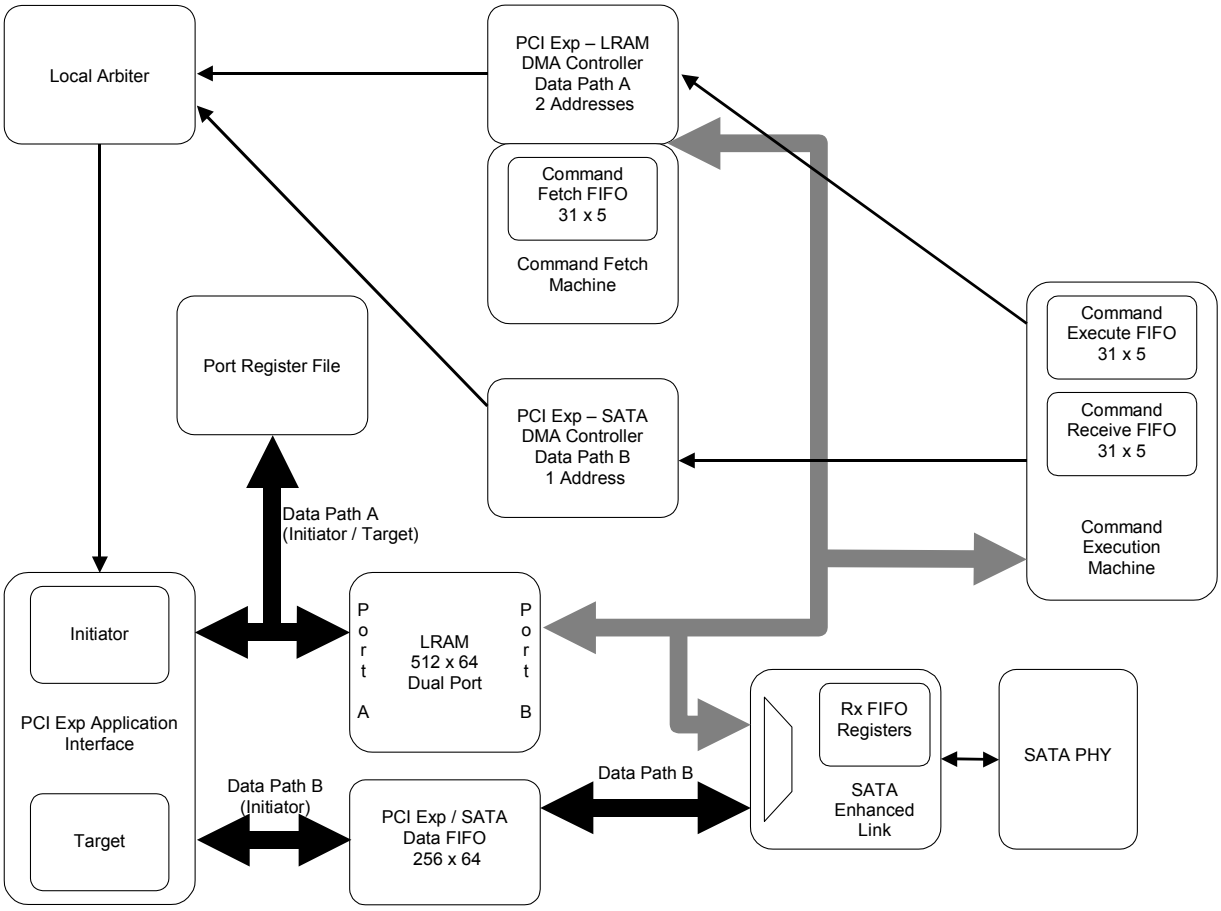



**Figure 6. Port Logic Block Diagram**

The Port Logic consists of:

- A Local Arbiter that arbitrates between the two DMA Controllers
- A DMA Controller for the PCI Express to LRAM Data Path
- A DMA Controller for the PCI Express to Serial-ATA Data Path
- A 512x64 Local RAM (LRAM) that contains: 31 LRAM Slots each of which is 128 bytes (16 Qwords) and 128 bytes used to support 16 Port Multiplier devices (1 Qword per device)
- A Data FIFO that contains 2048 bytes (256 Qwords)
- A State Machine for Command Fetch
- A State Machine for Command Execution
- A Serial-ATA Link
- A Serial-ATA PHY

Each of the two state machines has an associated FIFO which, when non-empty, indicates that processing is required. The FIFO is loaded with a 5-bit command “slot” number to activate a state machine. The slot number can range from 0 to 30, corresponding to the maximum number of active commands supported.

Command flow begins with a host driver building a command in a non-cached region of host memory. The data structure is referred to as a PRB (Port Request Block). The 64-byte PRB is transferred into an available command slot in the LRAM by one of two methods: the direct method or the indirect method. The host driver is responsible

for determining which slots are available. Either of the two command transfer methods may be used for each command transfer. The two methods are:

*Direct Command Transfer Method – Host controlled write to Slot*

In systems that have the capability to perform burst writes, this is the preferred method of command transfer. Embedded systems would most likely use this method. LRAM is directly mapped through use of Base Address Register 1, and appears as a block of memory to the host driver. The host driver writes the PRB contents into the appropriate slot in LRAM. Ideally, this operation is performed as a single PCI Express transaction. The 5-bit slot number (0-30) is written to the *Command Execution FIFO*. The Active bit associated with the selected slot becomes set in the Port Slot Status register. Note that the *Command Fetch FIFO* and *Command Fetch State Machine* are not used for the direct method of command transfer.

*Indirect Command Transfer Method – SiI3132 controlled command transfer*

The host driver builds a PRB in host memory, selects a free slot, and writes the physical address of the PRB into the Activation register corresponding to the selected slot. This causes the SiI3132 to push the 5-bit slot number (0-30) into the *Command Fetch FIFO.* The *Command Fetch State Machine,* while in an idle state, continuously interrogates the *Command Fetch FIFO* for a "non-empty" condition. Upon retrieval of a 5-bit slot number from the FIFO, the *Command Fetch State Machine* retrieves the physical address of the PRB from the corresponding activation register*,* sets the Active bit associated with the selected slot in the Port Slot Status register, and queues a PCI Express read of the PRB into the associated Slot in LRAM. The *Command Fetch State Machine* waits for completion of the transfer, pushes the 5-bit slot number into the *Command Execution FIFO,* and returns to the idle state, waiting for a non-empty condition in the *Command Fetch FIFO*.

The *Command Execution State Machine* is responsible for directing the flow of the command and response FISes between the command slot and the serial ATA link, directing the flow of data between PCI Express and the serial ATA link, and posting completion status to the host. It is also responsible for error handling when exceptions occur in the normal command flow. Command execution begins when the idle *Command Execution State Machine* recognizes that the serial ATA bus is in a non-busy state and the *Command Execution FIFO* is non-empty. The *Command Execution State Machine* retrieves the 5-bit slot number (0-30) from the *Command Execution FIFO* and uses it to index the command slot in LRAM. The command FIS is addressed and sent to the serial ATA link to be sent to the device. Control flags in the command slot determine the type of data transfer. The *Command Execution State Machine* waits for a response FIS from the device and directs its activities accordingly. If the received FIS is a data FIS, the DMA address and count are determined by examining the Scatter/Gather Entries in the PRB and, if necessary, "walking" a Scatter/Gather Table. The DMA address and count are loaded into the DMA controller and the controller is armed. A DMA activate FIS causes similar behavior, with data flowing from PCI Express to the Serial ATA link. When the command has completed, the Command Completion bit in the Port Interrupt Status register is set to reflect the successful completion of the command. If an error occurred, the Command Error bit is set in the Port Interrupt Status register.

The basic command flow proceeds as follows:

1. The host builds a 64-byte Port Request Block (PRB) that contains:
    - The Register- Host to Device FIS to send to the SATA device
    - Up to two scatter/gather entries to define regions of host memory to be accessed for associated read/write data. Additional scatter/gather entries may be associated with the command.
    - Various optional control flags to direct the SiI3132 to perform special processing, to control interrupt assertion, to vary the normal protocol flow, etc.
2. The host issues the command to the SiI3132.
3. The SiI3132 executes the command, performing all interaction with the SATA device and transferring data between host memory and the SATA device.
4. The SiI3132 asserts a PCI Express interrupt to indicate command completion.
5. The host reads the SiI3132 port slot status to determine which command(s) have completed.

# Data Structures

## The Command Slot

Each port within the SiI3132 contains 31 command slots. The slots are numbered 0 through 30. Each command issued by the host occupies a single command slot. The host decides which slot to use and issues a command to the selected slot. A command slot occupies 128 bytes within the SiI3132 RAM array and consists of a 64 byte PRB (Port Request Block) and a 64-byte scatter/gather table. The host builds the PRB. It contains the Register-Host To Device FIS to transmit to the attached SATA device and up to two scatter/gather entries that define host memory regions to be used for any read/write data associated with the command. If more scatter/gather entries are required to define additional host memory regions, the SiI3132 will fetch them from host memory as needed. The host may simply append the additional SGT entries to the PRB, or one of the scatter/gather entries in the PRB may be used to define an SGT (scatter/gather table) that resides in host memory.

The host may issue commands to any number of available command slots. The host may freely intermix non-queued, legacy queued, native queued, PIO, and DMA command types in any available slot. Commands will always be executed in the order that they were issued. The SiI3132 will enforce command type issuance to the SATA device and will not allow incompatible command types to be issued to a device. This relieves the host of the burden of making sure that incompatible command types are not intermixed in the device.

It is the host's responsibility to manage slot usage. The host must keep track of which slots have commands outstanding and which slots are available for new commands. Issuing a command to a slot that is currently in use will result in unpredictable behavior.

For queued commands, the slot number is used as the queue tag. It is the host's responsibility to ensure that the tag number in the Register-Host to Device FIS defined in the PRB matches the slot number to which the command is issued.

## The Scatter/Gather Entry (SGE)

A scatter/gather entry (SGE) defines a region of host memory to be used for data transfer associated with a command. Each scatter/gather entry defines a single contiguous physically addressed region.

**Table 20. Scatter/Gather Entry (SGE**

| 31 | | | | 0 | |
|---|---|---|---|---|---|
| Data Address Low | | | | | 0x00 |
| Data Address High | | | | | 0x04 |
| Data Count | | | | | 0x08 |
| TRM (31) | LNK (30) | DRD (29) | XCF (28) | Reserved[27:0] | 0x0C |

The first quadword, at offset 0, contains the physical address of the region in host memory. The entire 64-bit address must be defined. On 32-bit systems the upper 32 bits must be zero. The data address may point to a region to be used for data transfer, or it may point to a scatter/gather table (SGT), which is a collection of four SGEs. The LNK bit (bit 30 at offset 0x0c) defines the type of region. When LNK is zero, the region is a data region; when LNK is one, the region is a scatter/gather table that will be fetched by the SiI3132 to obtain a data region definition.

The Data Count field at offset 0x08 defines the length, in bytes, of the contiguous data region. When the LNK bit is set to one, indicating an SGT link, the SiI3132 ignores this field.

The TRM bit (bit 31 at offset 0x0c), when set to one, indicates that this is the final SGE associated with the command and no additional SGEs follow it.

The DRD bit (bit 29 at offset 0x0c), when set to one, directs the SiI3132 to discard the data read from the device for the length associated with the data count. When this bit is set to one, the SiI3132 ignores the data address.

The XCF bit (bit 28 at offset 0x0c) indicates whether the region defined by this SGE is to be used for data transfer (XCF set to zero) or an external command fetch (XCF set to one). See section 0 for additional information on external command processing.

## The Scatter/Gather Table (SGT)

The SGT is simply a contiguous collection of four SGEs. The PRB contains two SGEs. When more than two SGEs are required to fully define the entire data transfer of a command, the SiI3132 fetches additional SGEs in groups of four at a time, or one SGT. The SGT occupies the upper 64 bytes of a command slot in SiI3132 RAM. When needed, only one SGT resides in RAM at a time. The SiI3132 fetches each required SGT, overwriting the previous SGT in RAM. Because the first two SGEs reside in the PRB RAM area, they are always available in case the SiI3132 needs to rescan the scatter/gather list for out of order data delivery.

SGTs must reside on a quadword (64-bit) naturally aligned boundary in host memory. In other words, bits[2:0] of the physical address of the SGT in host memory must be zero.

**Table 21. Scatter/Gather Table (SGT**

| 31 | | | | 0 | |
|---|---|---|---|---|---|
| SGE0 Data Address Low | | | | | 0x00 |
| SGE0 Data Address High | | | | | 0x04 |
| SGE0 Data Count | | | | | 0x08 |
| SGE0 TRM | SGE0 LNK | SGE0 DRD | SGE0 XCF | Reserved[27:0] | 0x0C |
| SGE1 Data Address Low | | | | | 0x10 |
| SGE1 Data Address High | | | | | 0x14 |
| SGE1 Data Count | | | | | 0x18 |
| SGE1 TRM | SGE1 LNK | SGE1 DRD | SGE1 XCF | Reserved[27:0] | 0x1C |
| SGE2 Data Address Low | | | | | 0x20 |
| SGE2 Data Address High | | | | | 0x24 |
| SGE2 Data Count | | | | | 0x28 |
| SGE2 TRM | SGE2 LNK | SGE2 DRD | SGE2 XCF | Reserved[27:0] | 0x2C |
| SGE3 Data Address Low | | | | | 0x30 |
| SGE3 Data Address High | | | | | 0x34 |
| SGE3 Data Count | | | | | 0x38 |
| SGE3 TRM | SGE3 LNK | SGE3 DRD | SGE3 XCF | Reserved[27:0] | 0x3C |

## The Port Request Block (PRB)

The host builds a PRB to define a command to be executed by the SiI3132. The PRB occupies the first 64 bytes of a command slot in SiI3132 RAM. Once a command is issued, the PRB is overwritten in SiI3132 RAM as necessary to keep track of command context and execution status. The host should not depend on being able to read the contents of the PRB in slot RAM after command issuance. Upon command execution completion, the PRB area of the command slot may contain status information that can be read by the host, dependent upon the command type. The PRB structure can take several forms, dependent upon the command type that it defines.

The PRB contains the following major elements:

- A Control Field to indicate the type of PRB and any features to execute.
- A Protocol Override field used to optionally alter the normal SATA protocol flow.
- A FIS area that contains the initial FIS to be transmitted to the device upon PRB execution.
- Up to two Scatter/Gather entries (SGEs) to define areas of host memory that will be used for any data transfer associated with the PRB. For PACKET commands, the first SGE contains the 12 or 16-byte ATAPI command to be transmitted to the device.

Regardless of whether the command is to be issued with the direct or indirect method, the host driver should build the PRB as a structure in host memory. If the command is to be issued using the direct issuance method, the PRB can be copied from host RAM to the appropriate slot in SiI3132 RAM. If the command is to be issued using the indirect method, the host driver should write the physical address of the PRB to the command activation register associated with the desired command slot.

The PRB must reside on a quadword (64-bit) naturally aligned boundary in host memory. In other words, bits[2:0] of the physical address of the PRB in host memory must be zero.

The PRB can take various forms, depending on the type of command being issued. The command types are:

- Standard ATA Commands. This includes all the common ATA commands such as READ SECTORS, WRITE SECTORS, READ DMA, WRITE DMA, IDENTIFY DEVICE, SMART, etc. Also included are the queued commands in both legacy and SATA native queue modes. For these commands, the PRB contains the entire “Register – Host to Device” FIS containing the ATA command. By default, the SiI3132 decodes the ATA command type and executes the necessary SATA protocol automatically. The host driver may, optionally, execute any desired SATA protocol on a per-command basis.
- PACKET Commands. ATAPI PACKET commands operate in a similar fashion to the standard ATA commands. The “Register – Host to Device” FIS contains the ATA PACKET command. The 12 or 16-byte ATAPI command is placed in the area normally reserved for the first SGE. The SiI3132 does not decode the contents of the 12 or 16-byte ATAPI command, so the host driver indicates the direction of any data transfer associated with the command.
- Soft Reset. A special form of the PRB instructs the SiI3132 to transmit a soft reset sequence to a device. The SiI3132 creates the necessary “Register – Host to Device” FISes required for the sequence. No SGEs are required for this PRB type. Other than the control field, the only item that needs to be populated is the PMP field, to direct the soft reset sequence to the proper device in the event that a port multiplier is attached. Upon successful command completion, the “Register – Device to Host” FIS is available in the command slot, allowing the host driver to view the device signature.
- External Command. The external command feature allows the host driver to transmit any arbitrary FIS that will not fit in the FIS area of the PRB. This feature is useful in custom applications that have a need to send large FISes or Data FISes in a fashion that does not comply with the defined SATA protocol
- Interlocked FIS Reception. The interlocked FIS feature allows the host driver to receive any desired FIS type directly to a host memory buffer, bypassing all SATA protocol for that FIS type. To use this feature, the host first specifies the FIS type(s) to be interlocked. Then, any number of available command slots can be reserved for the reception of FISes matching the defined type(s).

## The PRB Control Field

The Control Field (offset 0x00, bits [15:0]) is used to indicate the type of PRB and features that are desired. For a standard ATA command, this field will normally contain a default value of 0x0000. Table 22 describes the bit functions for each bit in the Control Field.

**Table 22. Control Field Bit Definitions**

| Bit | Name | Description |
|---|---|---|
| 0 | control_protocol_override | The Protocol Override Field is to be used instead of the default protocol for this command. |
| 1 | control_retransmit | Allows retransmission if an error occurs during an external command transmission. |
| 2 | control_external_command | The command FIS shall be fetched from host memory. This feature is used to send arbitrary FISes that will not fit in the command FIS area of the PRB. |
| 3 | control_receive | Reserves a command slot to be used to receive an interlocked FIS as described by the port FIS_CONFIG register. |
| 4 | control_packet_read | Indicates that the packet command associated with this PRB will transfer data from the device to the host. This bit must be set for all packet commands that perform read data transfers. |
| 5 | control_packet_write | Indicates that the packet command associated with this PRB will transfer data from the host to the device. This bit must be set for all packet commands that perform write data transfers. |
| 6 | control_interrupt_mask | Setting this bit to one will prevent the SiI3132 from issuing a normal successful completion interrupt for this command. |
| 7 | control_soft_reset | Causes the SiI3132 to issue a soft reset FIS sequence to the device. |
| 15:8 | reserved | Must be zero |

## The PRB Protocol Override Field

The Protocol Override Field (offset 0x00, bits [31:16]) is used to specify a protocol behavior other than the default for this PRB. PRBs for which the default protocol is to be used should set this field to 0x0000. The SiI3132 will decode the 8-bit ATA command at PRB offset 0x0a and automatically execute the default protocol for the command. In certain cases it might be desirable to specify a non-default protocol to be used, such as with vendor specific device commands. To override the protocol, the host driver must set control_protocol_override (Control Field, bit 0) to one and place the desired protocol in this field. Table 23 describes the Protocol Override bit positions.

**Table 23. Protocol Override Bit Definitions**

| Bit | Name | Description |
|---|---|---|
| 16 | protocol_packet | This command is to be executed as an ATAPI packet command. |
| 17 | protocol_legacy_queue | This command is to be executed as an ATA legacy queued command. |
| 18 | protocol_native_queue | This command is to be executed as a SATA native queued command. |
| 19 | protocol_read | This command is expected to transfer data from device to host. |
| 20 | protocol_write | This command is expected to transfer data from host to device. |
| 21 | protocol_transparent | This command is to be executed with no protocol. After the initial command FIS is successfully sent to the device, completion status will be posted without waiting for additional device transmissions. |
| 31:22 | Reserved | Must be zero. |

Note that there is no distinction between DMA and PIO data transfers in the protocol. The SiI3132 is a native serial ATA device and relies on the SATA interface protocol to determine the data transfer type between the device and the SiI3132. From the host driver's perspective, all commands, whether PIO or DMA, transfer data through use of scatter/gather entries defined in the PRB and scatter/gather tables.

## Standard ATA Command PRB Structure

Table 24 shows the layout for standard ATA commands. The Control and protocol override fields must be populated as described above.

**Table 24. Port Request Block for Standard ATA Command**

| 31 | | | | | | | | 0 | |
|---|---|---|---|---|---|---|---|---|---|
| Protocol Override | | | | Control | | | | | 0x00 |
| Received Transfer Count | | | | | | | | | 0x04 |
| Features / Error | Command / Status | C | R | R | R | PMP | FIS Type | | 0x08 |
| Dev/Head | Cyl High | Cyl Low | | | | | Sector Number | | 0x0C |
| Features (Exp) | Cyl High (Exp) | Cyl Low (Exp) | | | | | Sector Num (Exp) | | 0x10 |
| Device Control | Reserved | Sector Count (Exp) | | | | | Sector Count | | 0x14 |
| Reserved | Reserved | Reserved | | | | | Reserved | | 0x18 |
| Reserved – Must Be Zero | | | | | | | | | 0x1C |
| SGE0 Data Address Low | | | | | | | | | 0x20 |
| SGE0 Data Address High | | | | | | | | | 0x24 |
| SGE0 Data Count | | | | | | | | | 0x28 |
| SGE0 TRM | SGE0 LNK | SGE0 DRD | SGE0 XCF | Reserved[27:0] | | | | | 0x2C |
| SGE1 Data Address Low | | | | | | | | | 0x30 |
| SGE1 Data Address High | | | | | | | | | 0x34 |
| SGE1 Data Count | | | | | | | | | 0x38 |
| SGE1 TRM | SGE1 LNK | SGE1 DRD | SGE1 XCF | Reserved[27:0] | | | | | 0x3C |

The Received Transfer Count field (offset 0x04) is reserved as an input to the SiI3132 and should be populated with a value of all zeroes. Upon successful command completion, this field will contain the total number of data bytes received during the command execution. The host driver may use this field to determine the transfer size for commands in which the total transfer size is unknown, such as ATAPI inquiries.

The FIS area (offset 0x08 through 0x1f) must be populated with the initial FIS to be sent to the device. This area contains the FIS header and all task file registers to describe the ATA command. Table 25 describes the FIS area fields.

**Table 25. PRB FIS Area Definition**

| Offset | Bit(s) | Name | Description |
|---|---|---|---|
| 0x08 | 7:0 | FIS Type | The FIS type field must be populated with a valid SATA FIS type. In all but special custom cases this value will be 0x27, which defines a “Register – Host to Device” FIS type. |
| | 11:8 | PMP | 4-bit Port Multiplier Port field that defines the port to which this command will be directed. If no port multiplier is attached, this field should be populated with all zeros |
| | 14:12 | Reserved | Must be zero. |
| | 15 | Command/Device Control | This bit must be set to one to indicate that this FIS contains a command. |
| | 23:16 | Task File Command | Populate with the desired ATA command type. |
| | 31:24 | Features | Populate with the desired features for this ATA command. |
| 0x0c | 7:0 | Sector Number (LBA[7:0]) | These fields should be populated with desired command-specific parameters. |
| | 15:8 | Cylinder Low (LBA[15:8]) | |
| | 23:16 | Cylinder High (LBA[23:16]) | |
| | 31:24 | Device/Head (LBA[27:24] for non-extended commands) | |
| 0x10 | 7:0 | Sector Number (Exp.) (LBA[31:24] for extended commands) | These fields should be populated with desired command-specific parameters. |
| | 15:8 | Cylinder Low (Exp.) (LBA[39:32] for extended commands) | |
| | 23:16 | Cylinder High (Exp.) (LBA[47:40] for extended commands) | |
| | 31:24 | Features (Exp.) | |
| 0x14 | 7:0 | Sector Count | These fields should be populated with desired command-specific parameters. The Reserved field must be zero for standard ATA commands that use the “Register –Host to Device” FIS to initiate a command. |
| | 15:8 | Sector Count (Exp.) | |
| | 23:16 | Reserved | |
| | 31:24 | Device Control | |
| 0x18 | 31:0 | Reserved | This field is reserved and must be zero for standard ATA commands that use the “Register – Host to Device” FIS to initiate a command. |

## PACKET Command PRB Structure

Table 26 shows the layout for PACKET commands. The Control and protocol override fields must be populated as described above. The PACKET PRB FIS area is structured the same as a standard ATA command. The FIS area contains the PACKET ATA command. After the initial PACKET command is transmitted, the device will respond with a “PIO Setup” FIS, requesting a 12 or 16-byte ATAPI command. The host driver must populate the area normally used for the first SGE with the desired ATAPI command. The length of the ATAPI command is determined by the value of the packet length bit (Port Control, bit 5). If packet length is 0, 12 bytes will be transmitted. If packet length is one, 16 bytes will be transmitted. The packet length field must be initialized with the packet length value returned by the device in the IDENTIFY PACKET command. Table 26 shows a representative 12-byte ATAPI command layout. The highlighted ATAPI packet is an example typical of some commands; other command packets will have different formats within the highlighted bytes.

**Table 26. Port Request Block for PACKET Command**

| 31 | | | | | | | 0 | |
|---|---|---|---|---|---|---|---|---|
| Protocol Override | | | | Control | | | | 0x00 |
| Received Transfer Count | | | | | | | | 0x04 |
| Features / Error | Command / Status | C | R | R | R | PMP | FIS Type | 0x08 |
| Dev/Head | Cyl High | Cyl Low | | | | | Sector Number | 0x0C |
| Features (Exp) | Cyl High (Exp) | Cyl Low (Exp) | | | | | Sector Num (Exp) | 0x10 |
| Device Control | Reserved | Sector Count (Exp) | | | | | Sector Count | 0x14 |
| Reserved | Reserved | Reserved | | | | | Reserved | 0x18 |
| Reserved – Must Be Zero | | | | | | | | 0x1C |
| LBA | LBA (MSB) | Reserved | | | | | ATAPI opcode | 0x20 |
| XFR Length (MSB) | Reserved | LBA (LSB) | | | | | LBA | 0x24 |
| Reserved | Reserved | Reserved | | | | | XFR Length (LSB) | 0x28 |
| Reserved | Reserved | Reserved | | | | | Reserved | 0x2C |
| SGE1 Data Address Low | | | | | | | | 0x30 |
| SGE1 Data Address High | | | | | | | | 0x34 |
| SGE1Data Count | | | | | | | | 0x38 |
| SGE1 TRM | SGE1 LNK | SGE1 DRD | SGE1 XCF | Reserved[27:0] | | | | 0x3C |

The SiI3132 does not decode the ATAPI command to determine the necessity or direction of any associated data transfer. The host driver must supply this information by setting control_packet_read (control field, bit4) or control_packet_write (control field, bit 5) for any PACKET command that requires data transfer. Failure to set one of these bits for an ATAPI command that requests data transfer will result in an Overrun or Underrun Command Error condition.

## Soft Reset PRB Structure

To send a soft reset sequence, the host driver need only fill in the PMP field (offset 0x8, bits[11:8]) and set control_soft_reset (control field, bit 7). The SiI3132 will send a soft reset sequence to the device and wait for a "Register – Device to Host" FIS to deliver the device signature and terminate the command. Upon successful command completion, the host may inspect the FIS area of the slot in SiI3132 RAM (offset 0x08 through 0x1f) to determine the returned device signature. Please note that a soft reset is executed in the same manner as other PRBs. It will be executed in the order in which it was issued. Port Ready (Port Status, bit 31) must be one in order to issue this command. The shaded areas of Table 27 depict valid fields in slot RAM following successful command completion. These fields do not need to be supplied as inputs and may be in any state upon command issuance.

**Table 27. Port Request Block for Soft Reset Command**

| 31 | | | | | | | 0 | |
|---|---|---|---|---|---|---|---|---|
| N/A | | | | | | | Control (0x0080) | 0x00 |
| N/A | | | | | | | | 0x04 |
| Features / Error | Command / Status | C | R | R | R | PMP | FIS Type | 0x08 |
| Dev/Head | Cyl High | Cyl Low | | | | | Sector Number | 0x0C |
| Features (Exp) | Cyl High (Exp) | Cyl Low (Exp) | | | | | Sector Num (Exp) | 0x10 |
| Device Control | Reserved | Sector Count (Exp) | | | | | Sector Count | 0x14 |
| N/A | | | | | | | | 0x18 |
| N/A | | | | | | | | 0x0C |
| N/A | | | | | | | | 0x10 |
| N/A | | | | | | | | 0x14 |
| N/A | | | | | | | | 0x18 |
| N/A | | | | | | | | 0x1C |
| N/A | | | | | | | | 0x20 |
| N/A | | | | | | | | 0x24 |
| N/A | | | | | | | | 0x28 |
| N/A | | | | | | | | 0x2C |
| N/A | | | | | | | | 0x30 |
| N/A | | | | | | | | 0x34 |
| N/A | | | | | | | | 0x38 |
| N/A | | | | | | | | 0x3C |

## External Command PRB Structure

An external command PRB is indicated by setting control_external_command (control field, bit 2). External commands execute in a manner similar to standard commands except that the initial command FIS is fetched from host memory instead of the PRB FIS area. By default, an external command uses the “transparent” protocol. That is, the command will be terminated immediately following the successful transmission of the external command FIS. If this is not the desired protocol, the host driver can set control_protocol_override (control field, bit 0) and place the desired protocol in the Protocol Override field (offset 0x00, bits [31:16]).

The external command FIS length may be any size (up to the 8k SATA limit) and will be automatically padded to a dword boundary. The SiI3132 will frame the FIS, adding SOF, EOF, and CRC. The host memory FIS image must contain the FIS header (FIS Type, PMP, etc.). The PRB PMP field (offset 0x08, bits [11:8]) must be populated to direct the FIS to the desired port multiplier port, or must be zero if no port multiplier is attached. For port multiplier applications, it is important that the PMP field in the host-resident FIS and the PRB match for proper operation.

The location of the external command FIS is defined in additional SGEs with the XCF bit (SGE offset 0x0c, bit 28) set to one. Any type of command may be sent using an external command, including commands that have associated data transfers. Data transfer host memory locations are defined in SGEs with the XCF bit (SGE offset 0x0c, bit 28) set to zero. SGEs used to define the external command FIS and SGEs used to define data transfer may be freely mixed in any order. The presence or absence of the XCF bit informs the SiI3132 whether an SGE should be used for the current transfer operation.

**Table 28. Port Request Block for External Commands**

| 31 | | | | | 0 | |
|---|---|---|---|---|---|---|
| Protocol Override | | | | Control | | 0x00 |
| Received Transfer Count | | | | | | 0x04 |
| Reserved | | | | PMP | Reserved | 0x08 |
| | | | | | | 0x0C |
| | | | | | | 0x10 |
| | | | | | | 0x14 |
| | | | | | | 0x18 |
| Reserved – Must Be Zero | | | | | | 0x1C |
| SGE0 Data Address Low | | | | | | 0x20 |
| SGE0 Data Address High | | | | | | 0x24 |
| SGE0 Data Count | | | | | | 0x28 |
| SGE0 TRM | SGE0 LNK | SGE0 DRD | SGE0 XCF | Reserved[27:0] | | 0x2C |
| SGE1 Data Address Low | | | | | | 0x30 |
| SGE1 Data Address High | | | | | | 0x34 |
| SGE1 Data Count | | | | | | 0x38 |
| SGE1 TRM | SGE1 LNK | SGE1 DRD | SGE1 XCF | Reserved[27:0] | | 0x3C |

## Interlocked Receive PRB Structure

Reserving a command slot to receive an interlocked FIS is indicated by setting control_receive (control field, bit 3). To receive an interlocked FIS into host memory, the host driver first specifies the FIS type(s) to be interlocked by writing the appropriate value to the FIS Configuration register (port registers, offset 0x1028). The PRB is populated with SGEs that define the host memory region(s) that will be used to receive the interlocked FIS. When a FIS of the defined type is received, it will be written to the defined host memory area and the command will be completed. If an error occurs during receipt of the FIS, or the SGEs define an area that is not large enough to contain the entire FIS, the FIS will be rejected with an R_ERR response and the command will not complete. When an interlocked FIS is received without error into a memory region that is large enough to contain it, the command will be successfully completed and the host driver may use the received FIS in any manner. The command slot is then free to be redefined as a receive slot or as any other command type.

After successfully receiving an interlocked FIS, the low-level link will be receiving WTRM primitives from the transmitting device, which is expecting a response. By default, the SiI3132 waits for the host driver to write a response bit to the port control register. If the host driver writes Interlock Accept (Port Control Set register, bit 12), an R_OK response will be transmitted. If the host driver writes Interlock Reject (Port Control Set register, bit 11), an R_ERR response will be transmitted. The host driver may also elect to set Auto Interlock Accept (Port Control Set register, bit 14) before performing interlocked operations. Setting this bit will cause an R_OK response to be sent for all subsequently received interlocked FISes, without additional intervention from the host driver. It should be noted that in this mode, it is possible to receive one or more additional interlocked FISes before the host driver has had a chance to reserve command slots to receive them. If this occurs, any interlocked FIS that arrives without a reserved slot available will be acknowledged and discarded.

**Table 29. Port Request Block For Receiving Interlocked FIS**

| 31 | | | | 0 | |
|---|---|---|---|---|---|
| Protocol Override | | | | Control | 0x00 |
| Received Transfer Count | | | | | 0x04 |
| | | | | | 0x08 |
| | | | | | 0x0C |
| | | | | | 0x10 |
| | | | | | 0x14 |
| | | | | | 0x18 |
| Reserved – Must Be Zero | | | | | 0x1C |
| SGE0 Data Address Low | | | | | 0x20 |
| SGE0 Data Address High | | | | | 0x24 |
| SGE0 Data Count | | | | | 0x28 |
| SGE0 TRM | SGE0 LNK | SGE0 DRD | SGE0 XCF | Reserved[27:0] | 0x2C |
| SGE1 Data Address Low | | | | | 0x30 |
| SGE1 Data Address High | | | | | 0x34 |
| SGE1 Data Count | | | | | 0x38 |
| SGE1 TRM | SGE1 LNK | SGE1 DRD | SGE1 XCF | Reserved[27:0] | 0x3C |

# Operation

## Command Issuance

Before a command can be executed, it must reside in a slot in SiI3132 RAM and the SiI3132 must be informed that the PRB is ready to be executed. To accomplish this, the host must issue the command in one of two ways:

1. Indirect Command Issuance. The indirect method is the most common and flexible method of issuing commands. With this method, the host builds the PRB in host memory and writes the physical address of the PRB into one of 31 command activation registers, each associated with a command slot. This causes the SiI3132 to fetch the PRB from host memory and deposit it in the selected slot of SiI3132 RAM. After the command is fetched, the SiI3132 automatically informs the execution unit that the command is ready for execution.

   The host may issue commands through additional command activation registers at any time without regard as to whether the previous PRB has been fetched. The SiI3132 will fetch the PRBs in the order requested when the necessary resources are available.

2. Direct Command Issuance. The host may write the 64-byte PRB directly into SiI3132 slot RAM. The RAM area is defined in the port register map and the host can easily calculate the slot offset to write the PRB. After the PRB is written to RAM, the host informs the execution unit that it is ready to process by writing the slot number into the command execution FIFO register.

   Please note that when the direct command issue method is used, it is not possible to append scatter/gather entries to the PRB without defining a LNK in one of the PRB resident scatter/gather entries.

## Reset and Initialization

The SiI3132 has a hierarchical reset structure that allows initialization of the entire chip, single port, an attached device, or the internal command queue. In general, asserting a reset at a high level will cause all underlying circuits to be reset. There are five levels of reset and initialization possible. The resets, listed from highest to lowest level, are described in the sections that follow.

### PERST# Reset

The PERST# reset pin, when asserted, holds the entire chip in a reset state. All configuration, global, and port registers are initialized to their default state. When deasserted, PCI Express configuration space is programmable, but the global and port register spaces and the port state machines/command queue remain in a reset state until the Global and Port Resets are deasserted through software control.

### Global Reset

The Global Reset (Global Control Register, bit 31), when asserted, initializes all global registers, except PHY Configuration, and all port registers to the default state. All Port Resets are set to one (asserted) while Global Reset is asserted. The Global Reset must be cleared to zero to allow access to the global register space or to release any Port Reset. Software may use the Global Reset to initialize all ports with a single operation.

### Port Reset

Each port contains a Port Reset (Port Control Set/Clear, bit 0) that remains set to one after the Global Reset is cleared to zero. While Port Reset is asserted, all port registers, except Port PHY Configuration and OOB Bypass (Port Control Set/Clear, bit 25), are initialized to their default state. The port state machines are reset and the command queue is cleared. The Port Reset must be cleared to zero by writing a one to bit zero of the Port Control Clear Register to release the Port Reset condition. Software may assert the port reset condition at any time by writing a one to bit zero of the Port Control Set Register.

### Device Reset

Each port contains a Device Reset (Port Control Set, bit 1) that may be used by software to reset an attached device without affecting the contents of the port registers. Writing a one to bit 1 of Port Control Set causes the execution state machines and pending command queue to be initialized. Then, a COMRESET is transmitted to the attached device. The effect of this sequence is to clear any outstanding commands and reset the attached device. The Device Reset bit is self-clearing. After the reset sequence has completed, the bit will be cleared to zero.

### Port Initialize

Each port contains a Port Initialize (Port Control Set, bit 2) that may be used by software to initialize the port data structures without affecting the contents of the port registers or resetting the device. Writing a one to bit 1 of Port Control Set causes the execution state machines and pending command queue to be initialized. The effect of this sequence is to clear any outstanding commands. The Port Initialize bit is self-clearing. After the initialization sequence has completed, the bit will be cleared to zero.

### Port Ready

Each port contains a Port Ready indicator (Port Status, bit 31) that is cleared to zero by any of the above reset conditions. The Port Ready signal, when one, indicates that the port is ready to execute commands. For all resets except Port Initialize, the Port Ready signal will not be asserted until a PHY ready condition is achieved. When Port Initialize is set, Port Ready will be cleared to zero then set to one after any currently active data transfers or FIS transmission/reception operations have completed and port initialization has completed.

## Port Reset Operation

Upon release of Port Reset, the low-level power management state machine is enabled and OOB signaling is initiated to the device. The SiI3132 starts OOB signaling by transmitting a COMRESET to the device. If the device responds with COMINIT and the OOB sequence is successful, a PHY ready condition will result, indicating that a link has been successfully established and the device may transmit an initial register FIS. At this time, the Port Ready signal will be asserted, indicating that the host driver may issue commands. If the device does not respond within the prescribed time allowed for OOB, the low-level power management machine will initiate another OOB sequence after a fixed delay. The period between OOB attempts is approximately 100 milliseconds.

Upon receipt of an initial “Register – Device to Host” FIS that clears the task file status BSY state, the port is allowed to transmit commands to the device.

## Initialization Sequence

The following is an example sequence of events that software might use to initialize the SiI3132 and enumerate an attached device or port multiplier. The sequence assumes that the system has powered up, the PERST# Reset has been deasserted, and the system has enumerated the PCI Express bus. Configuration space, including the Base Address Registers, has been initialized. It is now necessary to enable each port and determine the device type, if any, that is attached to each port.

1. Remove the Global Reset by writing 0x00000000 to the Global Control Register (Global offset 0x40).
2. For each Port to be initialized:
    a. Clear Port Reset by writing one to Port Reset of Port Control Clear Register (Port offset (port*0x2000)+0x1004, bit 0).
    b. If 32-bit platform and 32-bit activation is desired, write one to 32-bit Activation of Port Control Set Register (Port offset (port*0x2000)+0x1000, bit 10).
    c. To enable interrupts for command completion and command errors, write 0x00000003 to the Port Interrupt Enable Set Register (Port offset (port*0x2000)+0x1010).
    d. To determine if device is present, poll the SStatus Register (Port offset (port*0x2000)+0x1f04) for a PHYRDY condition indicated by the DET field (bits[3:0]) having a value of 0x3.

e. Wait until Port Ready in Port Status Register (Port offset (port*0x2000)+0x1000, bit 31) is one. If desired, an interrupt may be armed in the Port Interrupt Set Register (bit 2). Any change in Port Ready state will assert an interrupt.
f. If the software supports port multipliers, build a Soft Reset PRB in host memory. Set the PMP field to 0x0f to direct the command to the control port of a port multiplier. Issue the command to any available slot. If the software does not support port multipliers, skip this step, as sending this command will cause the port multiplier to disable legacy access to device 0.
g. Upon successful command completion of the soft reset command, read the device signature from the command slot (Port offset (port*0x2000)+(slot*0x80)+0x14(LSB), 0x0c, 0x0d, 0x0e(MSB)).
h. If the signature is 0x96690101, then the attached device is a Port Multiplier. Perform the Port Multiplier Enumeration procedure:
    i. Enable Port Multiplier context switching by writing a one to PM Enable in the Port Control Set Register (Port offset (port*0x2000)+0x1000, bit 13).
    ii. Read the Port Multiplier GSCR[2] register by issuing a Read Port Multiplier command to the control port. This register contains the number of device ports on the Port Multiplier.
    iii. For each Port Multiplier Device Port:
        1. Enable the PHY by writing a 1, then a 0 to the Scontrol Register (PSCR[2]) DET field. Issue a Port Multiplier Write command for each of these operations.
        2. Wait for a PHYRDY condition in the port by polling the SStatus Register (PSCR[0]) .
        3. Clear the X-bit and all other error bits in the Serror Register (PSCR[1]) by writing all ones to the register with a Write Port Multiplier command. The port is now ready for operation.
        4. Issue a Soft Reset command with the PMP field set to the appropriate port. This will return a device signature for the attached device.
        5. Issue the appropriate Identify Device or Identify Packet Device command and any associated Set Features, Set Write Multiple commands as may be necessary to initialize the device.
i. If the signature is 0xeb140101, then the attached device is an ATAPI PACKET device.
    i. Issue Identify Packet Device command to get device specific parameters
    ii. While drive is not ready and timeout has not expired:
        1. Issue Test unit ready PACKET command
        2. If the command completes successfully, drive is ready
        3. Else, if command error indicates Device error condition due to drive not ready, write Initialize Port to the Port Control Register (port*0x2000)+0x1000, bit 2)
        4. Wait until Port Ready in Port Status Register (Port offset (port*0x2000)+0x1000, bit 31) is one. If desired, an interrupt may be armed in the Port Interrupt Set Register (bit 2). Any change in Port Ready state will assert an interrupt.
    iii. Drive is ready for use. Issue appropriate Set Features, Set Read Multiple commands as needed.
j. If the signature is 0x00000101, then the attached device is a disk drive.
    i. Issue Identify Device command to get device specific parameters
    ii. Drive is ready for use. Issue appropriate Set Features, Set Read Multiple commands as needed.

## Interrupts and Command Completion

Each port of the SiI3132 produces a single interrupt, which is an accumulation of various possible interrupt events. In its default mode, the SiI3132 combines the interrupts from the ports into a single interrupt that may be used either for INTA emulation or for a Message Signaled Interrupt. In certain embedded environments, it might be desirable for each port to generate an independent interrupt. Software may configure each port to direct its interrupt to one of four emulated interrupts. The Interrupt Steering field in the Port Interrupt Enable Set/Clear register (Port offset 0x1010/1014, bit [31:30]) is used to direct the port interrupt. By default, this field is set to a value of zero, indicating that the interrupt is directed to INTA. The register may be set to one of four values, shown in Table 30.

**Table 30. Interrupt Steering**

| Interrupt Steering Value | Interrupt |
|---|---|
| 0 | INTA |
| 1 | INTB |
| 2 | INTC |
| 3 | INTD |

## Interrupt Sources

Figure 7 on page 30 depicts a logical representation of the interrupt routing for the SiI3132. For each port, the possible interrupt causes are:

- Command Completion. Indicates that one or more commands have successfully completed. This interrupt is cleared in one of two ways, dependent upon the state of Interrupt NCoR (Port Control Register, bit 3). Reading the port Slot Status Register will clear this interrupt condition if Interrupt NCoR is zero. Writing a one to bit 0 or 16 of the port Interrupt Status Register will clear this interrupt condition if Interrupt NCoR is one. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- Command Error. Indicates that a command did not complete successfully. The port Command Error register will contain an error code indicating the actual cause of failure. When this bit is set, Port Ready will be set to zero and no additional commands will be processed until the port is initialized by one of the reset methods and Port Ready is asserted. Writing a one to bit 1 or 17 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- Port Ready. Indicates that the Port Ready state has changed from zero to one. Writing a one to bit 2 or 18 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- Power Management Change. Indicates that the port power management state has been modified. The current power management state can be determined by reading the port SStatus Register. Writing a one to bit 3 or 19 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- PHY Ready Change. Indicates that the PHY state has changed from Not Ready to Ready or from Ready to Not Ready. The current PHY state can be determined by reading the port SStatus Register. Writing a one to bit 4 or 20 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- COMWAKE Received. Indicates that a COMWAKE OOB signal has been decoded on the receiver. Writing a one to bit 5 or 21 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- Unrecognized FIS. Indicates that the F-bit has been set in the Serror Diag field. Writing a one to bit 6 or 22 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- Device Exchanged. Indicates that the X-bit has been set in the Serror Diag field. The X-bit is set upon receipt of a COMINIT from the device. Writing a one to bit 7 or 23 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.
- 8b/10b Decode Error Threshold Exceeded. Indicates that the 8b/10b Decode Error counter has exceeded the programmed non-zero threshold value. Writing any value to the port 8b/10b Decode Error Counter Register or writing a one to bit 8 or 24 of the Interrupt Status Clear Register will clear this interrupt condition. This interrupt is enabled by writing a non-zero value to the threshold field (bit[31:16]) of the port 8b/10b Decode Error Counter Register. Writing a zero the threshold field will disable this interrupt.
- CRC Error Threshold Exceeded. Indicates that the CRC Error counter has exceeded the programmed non-zero threshold value. Writing any value to the port CRC Error Counter Register or writing a one to bit 9 or 25 of the Interrupt Status Clear Register will clear this interrupt condition. This interrupt is enabled by

writing a non-zero value to the threshold field (bit[31:16]) of the port CRC Error Counter Register. Writing a zero to the threshold field will disable this interrupt.

- Handshake Error Threshold Exceeded. Indicates that the Handshake Error counter has exceeded the programmed non-zero threshold value. A handshake error occurs when an R_ERR primitive is received. Writing any value to the port Handshake Error Counter Register or writing a one to bit 10 or 26 of the Interrupt Status Clear Register will clear this interrupt condition. This interrupt is enabled by writing a non-zero value to the threshold field (bit[31:16]) of the port Handshake Error Counter Register. Writing a zero to the threshold field will disable this interrupt.
- SDB Notify. Indicates that a “Set Device Bits” FIS has been received with the N-bit set in the control field. ATAPI and Port Multiplier devices optionally use this feature to signal the host that an event has occurred that requires further scrutiny. Writing a one to bit 11 or 27 of the port Interrupt Status Register clears this interrupt condition. This interrupt is enabled or disabled with the corresponding bit in the port Interrupt Enable Set/Clear Register.

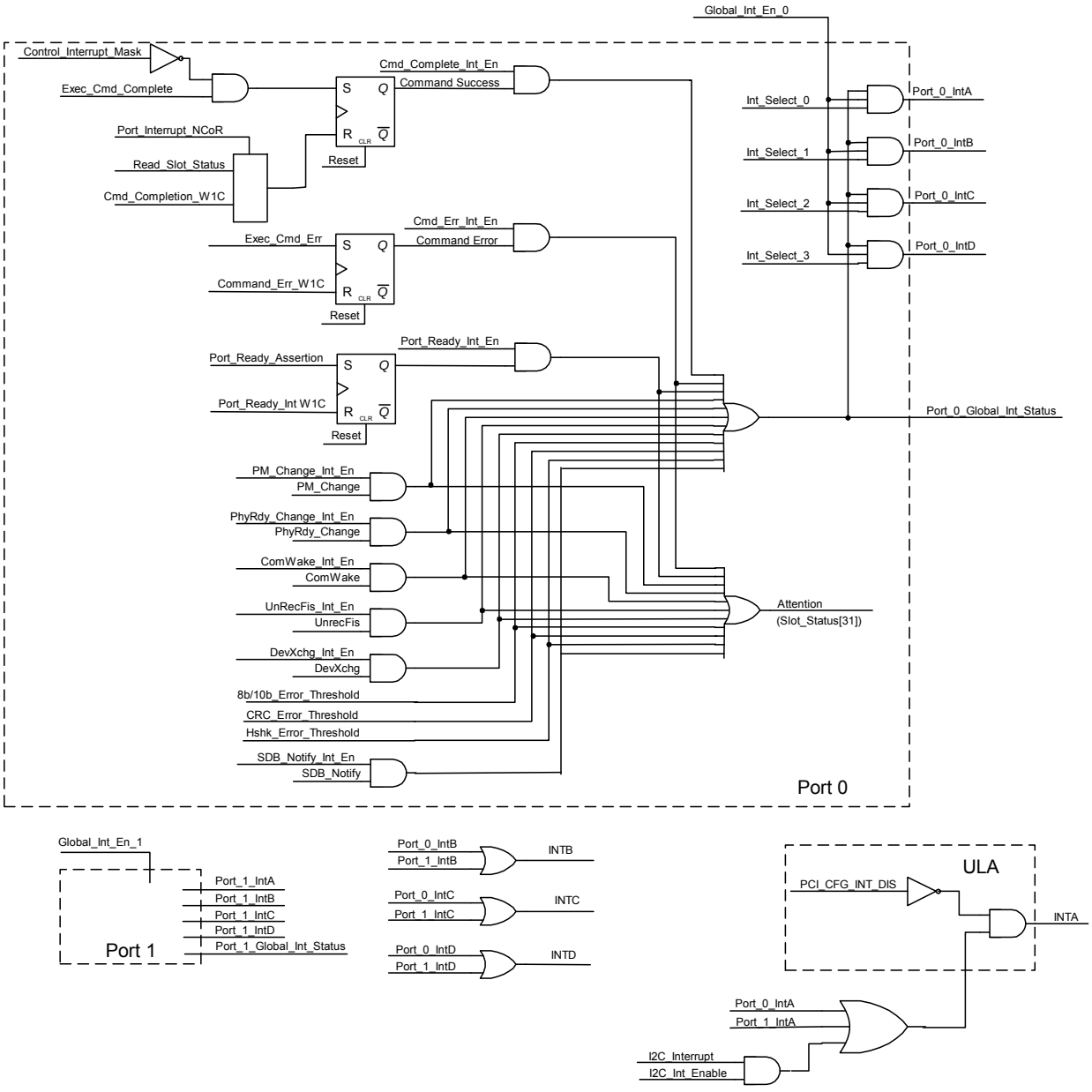



**Figure 7. SiI3132 Interrupt Map**

**Table 31. Port Interrupt Causes and Control**

| Interrupt Cause | Interrupt Status Bit | | To Clear: | To Enable: | To Disable: |
|---|---|---|---|---|---|
| | Masked | Raw | | | |
| Command Complete | 0 | 16 | If Interrupt W1C == 0<br>Read Slot Status<br><br>If Interrupt W1C == 1<br>Write 1 to Port Interrupt Status bit 0 or 16,<br>OR,<br>write one to desired port bit(s) in Global Interrupt Status. | Write 1 to Interrupt Enable Set bit 0 | Write 1 to Interrupt Enable Clear bit 0<br>OR<br>Write 1 to control_interrupt_mask in PRB Control field |
| Command Error | 1 | 17 | Write 1 to Interrupt Status bit 1 or 17 | Write 1 to Interrupt Enable Set bit 1 | Write 1 to Interrupt Enable Clear bit 1 |
| Port Ready | 2 | 18 | Write 1 to Interrupt Status bit 2 or 18 | Write 1 to Interrupt Enable Set bit 2 | Write 1 to Interrupt Enable Clear bit 2 |
| Power Management Change | 3 | 19 | Write 1 to Interrupt Status bit 3 or 19 | Write 1 to Interrupt Enable Set bit 3 | Write 1 to Interrupt Enable Clear bit 3 |
| PHY Ready Change | 4 | 20 | Write 1 to Interrupt Status bit 4 or 20 | Write 1 to Interrupt Enable Set bit 4 | Write 1 to Interrupt Enable Clear bit 4 |
| COMWAKE Received | 5 | 21 | Write 1 to Interrupt Status bit 5 or 21 | Write 1 to Interrupt Enable Set bit 5 | Write 1 to Interrupt Enable Clear bit 5 |
| Unrecognized FIS Received | 6 | 22 | Write 1 to Interrupt Status bit 6 or 22 | Write 1 to Interrupt Enable Set bit 6 | Write 1 to Interrupt Enable Clear bit 6 |
| Device Exchanged | 7 | 23 | Write 1 to Interrupt Status bit 7 or 23 | Write 1 to Interrupt Enable Set bit 7 | Write 1 to Interrupt Enable Clear bit 7 |
| 8b/10b Decode Error Threshold | 8 | 24 | Write 1 to Interrupt Status bit 8 or 24<br>OR<br>Write any value to 8b/10b Decode Error Counter bits[15:0] | Write non-zero value to 8b/10b Decode Error Counter bits[31:16] | Write zero to 8b/10b Decode Error Counter bits[31:16] |
| CRC Error Threshold | 9 | 25 | Write 1 to Interrupt Status bit 9 or 25<br>OR<br>Write any value to CRC Error Counter bits[15:0] | Write non-zero value to CRC Error Counter bits[31:16] | Write zero to CRC Error Counter bits[31:16] |
| Handshake Error Threshold | 10 | 26 | Write 1 to Interrupt Status bit 10 or 26<br>OR<br>Write any value to Handshake Error Counter bits[15:0] | Write non-zero value to Handshake Error Counter bits[31:16] | Write zero to Handshake Error Counter bits[31:16] |
| Set Device Bits Notification Received | 11 | 27 | Write 1 to Interrupt Status bit 11 or 27 | Write 1 to Interrupt Enable Set bit 11 | Write 1 to Interrupt Enable Clear bit 11 |

## Command Completion — The Slot Status Register

The Slot Status register is designed such that an interrupt service routine can determine the successful completion state of outstanding commands, dismiss the command completion interrupt, and determine if any other enabled interrupt events are pending in a port with a single read of the Slot Status register.

The Slot Status Register (Port offset 0x1800 or Global offset 0x00 + (port * 4)) bits 0 through 30 reflect the status of each of the 31 command slots in a port. When a PRB is issued to a command slot, the corresponding bit in the Slot Status register is set to one, indicating that the command is in progress. When a command is successfully completed, the corresponding command slot bit is cleared in the Slot Status register. The host driver may read the Slot Status register at any time to determine the activity state of any issued commands.

By default, a successfully completed command will set the command complete bit in the port Interrupt Status register. If the Command Complete interrupt is enabled, an interrupt will be asserted simultaneously. The host driver may optionally set control_interrupt_mask in the PRB Control field to prevent the command complete bit from being set on a per-command basis. This is useful when the host issues a series of commands and wants to be interrupted only after a selected command completes.

The command complete bit and associated interrupt will be cleared when the Slot Status register is read, unless the host driver has set Interrupt No Clear on Read (Port Control Set/Clear register, bit 3). If Interrupt No Clear on Read is set to one, the host driver must write a one to the Command Complete bit in the Interrupt Status Clear register in order to clear the command complete bit and associated interrupt.

## The Attention Bit

Bit 31 of the Slot Status register is the Attention bit. When set to one, it indicates that an enabled interrupt source, other than command completion, is asserted. It is possible that the Slot Status register can indicate an Attention condition while also showing that commands have successfully completed in bits 0 through 30. The interrupt service routine should always post-process any completed commands in addition to servicing a possible Attention condition. The Attention bit is set only for interrupt conditions that have been enabled as described in the *Interrupt Sources* section. The Attention bit will remain set to one in the Slot Status register until all enabled interrupt conditions have been cleared.

## Interrupt Service Procedure

The SiI3132 is designed to efficiently service interrupt events with minimal host overhead. There are a number of methods that the host may use to quickly determine the interrupt cause within any of the ports. The Global Interrupt Status Register (Global offset 0x44) may be read to determine which ports are interrupting. Then, the Slot Status Register for the interrupting ports may be read to determine the interrupt cause. Alternately, all port Slot Status Registers may be read in a single burst operation from the Global Register space starting at Global offset 0x00. If Interrupt No Clear on Read (port Control Register, Bit 3) is zero, any command complete interrupt will be cleared when the Slot Status registers are read. The host driver should then compare the outstanding command status in bits 0 through 30 to its internal copy of outstanding commands to determine which, if any, commands have successfully completed. Once the successful command completions have been noted, the host should check the Attention bit (bit 31) to determine if any other enabled interrupt events are pending on the port. If the Attention bit is one, the host should read the port Interrupt Status Register (Port offset (port*0x2000)+0x1008) to ascertain the cause for the Attention condition. Once the Attention condition has been resolved and cleared, normal processing may continue.

## Interrupt No Clear on Read

By default, the Command Completion interrupt condition is cleared when the port Slot Status Register is read. In some cases, such as debug environments, clearing of the Command Completion interrupt might not be the desired effect of reading the Slot Status Register. In these cases, the host driver should set the Interrupt No Clear on Read bit (bit 3) in the port Control Register. When this bit is set, the host must clear the Command Completion interrupt by one of the following methods:

1. Write a one to the corresponding port interrupt status bit(s) in the Global Interrupt Status Register (Global offset 0x44). Or,
2. Write a one to bit 0 or bit 16 of the port Interrupt Status Register (Port offset (port*0x2000)+ 0x1008).

Method 1 allows Command Complete interrupts for multiple ports to be cleared in a single write operation. Method 2 will clear Command Complete only for the corresponding port.

## Error Processing

When an error occurs during command processing, the SiI3132 records the error condition and halts execution until the host driver is able to restore normal operation. The SiI3132 does not attempt to automatically recover from error conditions. Rather, it provides the host with the necessary information to handle the error condition. Errors that occur during command execution cause the Command Error bit to be set to one in the port Interrupt Status Register (Port offset (port*0x2000)+ 0x1008) and an error code to be placed in the port Command Error Register (Port offset (port*0x2000)+ 0x1024). Please see section documenting the “Port Command Error” register on page 68 for a complete list of possible error codes. Execution is then halted. Port Ready (Port Status Register, bit 31) will be cleared to zero. Only the port with the error condition is halted. All other ports will continue to process normally. If the Command Error interrupt is enabled, an interrupt is asserted and the Attention bit is asserted in the port Slot Status Register. The corresponding Slot Status bit for the command in error will NOT be cleared to zero, because the command did not complete successfully. If only non-queued commands are outstanding, the slot number for the command in error is available in the Port Status Register, bits[20:16]. The host may use this information to ascertain which outstanding command caused the error condition.

To recover from a Command Error condition, it is necessary to initialize the port by one of the Port Reset methods described in section 0 (Reset and Initialization). It might not be necessary to reset the device in all error cases. In fact, to properly recover from native queued error conditions, it may be necessary to send additional commands to the device in error to obtain additional error information. At the minimum, it will be necessary to assert a Port Initialize and wait for Port Ready before additional commands may be issued.

Errors may be grouped into three categories to determine the proper recovery action:

- Recoverable errors. Error codes 1 and 2 are device specific errors. These errors occur when the device returns an error bit in the final register FIS or in a Set Device Bits FIS. Depending upon the severity of the error type reported by the device, it might not be necessary to reset the device. If the error code is 1, the register FIS received from the device is available in the command slot PRB. The host may determine the error reported by the device by examining the error register field of this structure. Please see section 0for more information regarding error recovery procedures.
- Locally detected data errors. Error code 3 is a unique error type. It indicates that the SiI3132 detected an error during command execution but the device failed to report the error upon command completion. For non-queued commands, this error type may be treated the same as a recoverable error. If queued commands are outstanding, the device must be reset because it is necessary to make sure that all queued commands are flushed from the device upon an error condition. Because the device did not report an error, it is unlikely that the queue has been flushed in the device.
- Fatal Errors. All other error codes indicate that an error condition has occurred that requires both the device and the internal operational state of the SiI3132 to be reset. The most common method to perform this function is to issue a Device Reset.

### Error Recovery Procedures

When a device returns error status for an outstanding command, the SiI3132 will halt command processing, post an error type of 1 or 2 in the Port Command Error register, set the command error bit in the interrupt status register and, if enabled, assert an interrupt to the host. The host driver may wish to attempt error recovery without resetting the device that issued the error. Note that error recovery procedures should only be attempted for error types 1 and 2. Error type 3 is also recoverable if no queued commands are outstanding. It is recommended that all other error types result in a reset of the affected device(s).

If the device in error is directly attached to the SiI3132 device port, the host may simply issue a Port Initialize by setting bit 2 in the Port Control Set register and waiting for a Port Ready condition. The host may then re-issue any commands that were outstanding when the error occurred. If native queued commands were outstanding, the host should issue a READ LOG EXTENDED for Log Page 10h to determine the details of the error condition. Refer to the Serial ATA II specification for further details on error handling with native queuing.

If the device in error is attached to a port multiplier, it is necessary for the host driver to wait until all outstanding commands to other devices attached to the port multiplier have completed before issuing the Port Initialize function. This is accomplished through a series of steps:

1. The host driver must note the PM port number for the device in error by extracting the PMP field (bit[8:5]) from the Port Context Register (port offset 0x1e04). The PMP field contains the PM port number for the device in error. It is then necessary to determine if any commands are outstanding for non-error devices. If there are no commands outstanding for non-error devices, the host driver may simply proceed to step 4 to issue a Port Initialize and wait for a Port Ready condition before reissuing commands.
2. If commands are outstanding to non-error devices, the host should set the Port Resume bit (bit 6) in the Port Control Set Register. Setting this bit will cause the following actions:
    a. Force a Device Busy condition for the currently selected PM port (the port to which the device in error is attached) so that no additional issued commands will be sent to the device in error.
    b. Continue processing of commands that have been issued.
3. The host driver must monitor command completion progress and determine when all commands for non-error devices have completed. Please note that the Port Slot Status register will still have a bit set for each outstanding command on the device in error. These bits will not be cleared and the host must ignore them while waiting for command completion on non-error devices. If another recoverable error occurs while waiting for commands to complete, the host driver must follow the same recovery steps for the new device in error, starting with step 1 above. It is possible to have multiple devices in an error recovery state concurrently. When the host driver has detected that all commands for non-error devices have completed, it must perform the following steps.
    a. Clear Port Resume (Port Control Clear Register, Bit 6).
    b. Clear bit[16:13] in the Port Device Status Register for the device(s) in error ((port*0x2000) + 0xf80 + (PM port of device in error * 8)). This action clears the device_busy, native_queue, legacy_queue, and service_pending bits to ready the device for further command processing.
    c. Write zeroes (0x00000000) to the Port Device QActive Register for the device(s) in error ((port*0x2000) + 0xf84 + (PM port of device in error * 8)). This action ensures that all queued command context is removed before re-issuing commands.
    d. Issue a Port Initialize and wait for Port Ready condition.
4. The host driver may now resume normal command processing. The host driver must determine which commands need to be re-issued to the device in error. Note that if native queued commands were outstanding to the device in error, the host must issue a READ LOG EXTENDED command to clear the pending error condition and determine the tag number (slot number) of the command in error before resuming command processing.

**Note:** It is a good idea to clear Port Resume (Port Control Clear Register, Bit 6) whenever a Port Initialize or Port Device Reset is issued. This ensures that the Port Resume bit is always cleared when starting normal processing in the event that an abnormal exit is taken from the error recovery procedure.

## Auto-Initialization

The SiI3132 supports an external flash and/or EEPROM device for BIOS extensions and user-defined PCI configuration header data.

## Auto-Initialization from Flash

The SiI3132 initiates the flash detection and configuration space loading sequence upon the release of PERST#. It begins by reading the highest two addresses ($7FFFF_H$ and $7FFFE_H$), checking for the correct data signature pattern – $AA_H$ and $55_H$, respectively. If the data signature pattern is correct, the SiI3132 continues to sequence the address downward, reading a total of twelve bytes. If the Data Signature is correct ($55_H$ at $7FFFC_H$), the last eight bytes are loaded into the PCI Configuration Space registers.

If both flash and EEPROM are installed, the PCI Configuration Space registers will be loaded with the EEPROM's data.

While the sequence is active, the SiI3132 responds to all PCI bus accesses with a Target Retry.

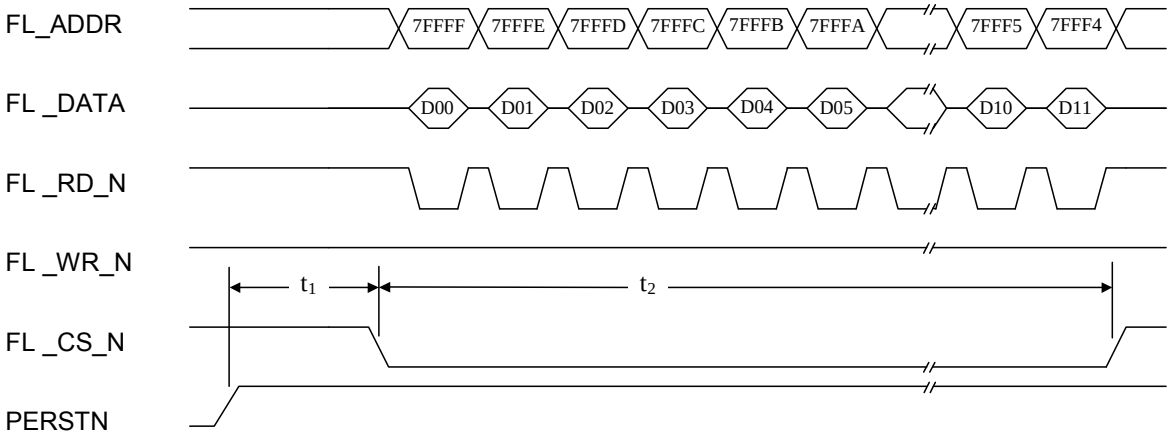



**Figure 8. Auto-Initialization from Flash Timing**

**Table 32. Auto-Initialization from Flash Timing**

| Parameter | Value | Description |
|---|---|---|
| $t_1$ | 660 ns | PCI reset to flash Auto-Initialization cycle begin |
| $t_2$ | 4200 ns | Flash Auto-Initialization cycle time |

**Table 33. Flash Data Description**

| Address | Data Byte | Description |
|---|---|---|
| $7FFFF_H$ | D00 | Data Signature = $AA_H$ |
| $7FFFE_H$ | D01 | Data Signature = $55_H$ |
| $7FFFD_H$ | D02 | AA = 120 ns flash device / Else, 240 ns flash device |
| $7FFFC_H$ | D03 | Data Signature = $55_H$ |
| $7FFFB_H$ | D04 | PCI Device ID [23:16] |
| $7FFFA_H$ | D05 | PCI Device ID [31:24] |
| $7FFF9_H$ | D06 | PCI Class Code [15:08] |
| $7FFF8_H$ | D07 | PCI Class Code [23:16] |
| $7FFF7_H$ | D08 | PCI Sub-System Vendor ID [07:00] |
| $7FFF6_H$ | D09 | PCI Sub-System Vendor ID [15:08] |
| $7FFF5_H$ | D10 | PCI Sub-System ID [23:16] |
| $7FFF4_H$ | D11 | PCI Sub-System ID [31:24] |

## Auto-Initialization from EEPROM

The SiI3132 initiates the EEPROM detection and configuration space loading sequence after the flash read sequence. The SiI3132 supports EEPROMs with an $I^2C$ serial interface. The sequence of operations consists of the following.

1. START condition defined as a high-to-low transition on I2C_SDAT while I2C_SCLK is high.
2. Control byte = 1010 (Control Code) + 000 (Chip Select) + 0 (Write Address)
3. Acknowledge
4. Starting address field = 00000000.
5. Acknowledge
6. Sequential data bytes separated by Acknowledges.
7. STOP condition.

While the sequence is active, the SiI3132 responds to all PCI bus accesses with a Target Retry.

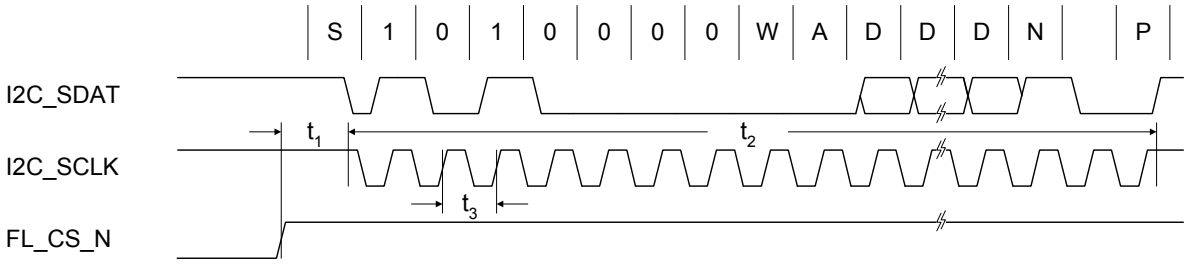



**Figure 9. Auto-Initialization from EEPROM Timing**

**Table 34. Auto-Initialization from EEPROM Timing**

| Parameter | Value | Description |
|---|---|---|
| $t_1$ | 26.00 µs | End of Auto-Initialization from flash to start of Auto-Initialization from EEPROM |
| $t_2$ | 1.4 ms | Auto-Initialization from EEPROM cycle time |
| $t_3$ | 10 µs | EEPROM serial clock period |

**Table 35. Auto-Initialization from EEPROM Timing Symbols**

| Parameter | Description |
|---|---|
| S | START condition |
| W | R/W 0 = Write Command, 1 = Read Command |
| A | Acknowledge |
| D | Serial data |
| N | No-Acknowledge |
| P | STOP condition |

**Table 36. EEPROM Data Description**

| Address | Data Byte | Description |
|---|---|---|
| $00_H$ | D00 | Memory Present Pattern = $AA_H$ |
| $01_H$ | D01 | Memory Present Pattern = $55_H$ |
| $02_H$ | D02 | Data Signature = $AA_H$ |
| $03_H$ | D03 | Data Signature = $55_H$ |
| $04_H$ | D04 | PCI Device ID [23:16] |
| $05_H$ | D05 | PCI Device ID [31:24] |
| $06_H$ | D06 | PCI Class Code [15:08] |
| $07_H$ | D07 | PCI Class Code [23:16] |
| $08_H$ | D08 | PCI Sub-System Vendor ID [07:00] |
| $09_H$ | D09 | PCI Sub-System Vendor ID [15:08] |
| $0A_H$ | D10 | PCI Sub-System ID [23:16] |
| $0B_H$ | D11 | PCI Sub-System ID [31:24] |

# Register Definitions

This section describes the registers within the SiI3132.

## PCI Configuration Space

As shown in Table 37, the PCI Configuration Space registers define the operation of the SiI3132 on the PCI Express bus.

**Table 37. SiI3132 PCI Configuration Space**

| Address Offset | Register Name | | | |
|---|---|---|---|---|
| $00_H$ | Device ID | | Vendor ID | |
| $04_H$ | PCI Status | | PCI Command | |
| $08_H$ | PCI Class Code | | | Revision ID |
| $0C_H$ | BIST | Header Type | Latency Timer | Cache Line Size |
| $10_H$ | Base Address Register 0 | | | |
| $14_H$ | | | | |
| $18_H$ | Base Address Register 1 | | | |
| $1C_H$ | | | | |
| $20_H$ | Base Address Register 2 | | | |
| $24_H$ | Reserved | | | |
| $28_H$ | Reserved | | | |
| $2C_H$ | Subsystem ID | | Subsystem Vendor ID | |
| $30_H$ | Expansion ROM Base Address | | | |
| $34_H$ | Reserved | | | Capabilities Ptr |
| $38_H$ | Reserved | | | |
| $3C_H$ | Max Latency | Min Grant | Interrupt Pin | Interrupt Line |
| $40_H$ | Reserved | | | |
| $44_H$ | Reserved | | | |
| $48_H$ | Reserved | | | Hdr Wr Ena |
| $4C_H$ | Reserved | | | |
| $50_H$ | Reserved | | | |
| $54_H$ | Power Management Capabilities | | Next Capability | Pwr Mgt Cap ID |
| $58_H$ | Data | Reserved | Control and Status | |
| $5C_H$ | Message Control | | Next Capability | MSI Cap ID |
| $60_H$ | Message Address | | | |
| $64_H$ | | | | |
| $68_H$ | Reserved | | Message Data | |
| $6C_H$ | Reserved | | | |
| $70_H$ | PCI Express Capabilities Register | | Next Capability | PCI Exp Cap ID |
| $74_H$ | Device Capabilities | | | |
| $78_H$ | Device Status | | Device Control | |
| $7C_H$ | Link Capabilities | | | |
| $80_H$ | Link Status | | Link Control | |
| $84_H$-$EF_H$ | Reserved | | | |
| $F0_H$-$FF_H$ | Indirect Access | | | |
| $100_H$ | Advanced Error Reporting Capability | | | |
| $104_H$ | Uncorrectable Error Status | | | |
| $108_H$ | Uncorrectable Error Mask | | | |
| $10C_H$ | Uncorrectable Error Severity | | | |

**Table 37. SiI3132 PCI Configuration Space (continued)**

| Address Offset | Register Name |
|---|---|
| $110_H$ | Correctable Error Status |
| $114_H$ | Correctable Error Mask |
| $118_H$ | Advanced Error Capabilities and Control |
| $11C_H$-$12B_H$ | Header Log |

## Device ID – Vendor ID

Address Offset: $00_H$
Access Type: Read /Write
Reset Value: 0x3132_1095

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Device ID | | | | | | | | | | | | | | | | Vendor ID | | | | | | | | | | | | | | | |

This register defines the Device ID and Vendor ID associated with the SiI3132. The register bits are defined below.

- **Bit [31:16]**: Device ID (R/W) – Device ID. The value in this bit field is one of the following:
  - The default value of 0x3132 to identify the device as a Silicon Image SiI3132 .
  - The value loaded from an external memory device; if an external memory device – flash or EEPROM – is present with the correct signature, the Device ID is loaded from that device after reset. See “Auto-Initialization from Flash” section on page 35 for more information.
  - System programmed value; if bit 0 of the Configuration register ($48_H$) is set, the Device ID is system programmable.
- **Bit [15:00]**: Vendor ID (R) – Vendor ID. This field defaults to 0x1095 to identify the vendor as Silicon Image.

## PCI Status – PCI Command

Address Offset: $04_H$
Access Type: Read/Write/Write-One-to-Clear
Reset Value: 0x0010_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Det Par Err | Sig Sys Err | Rcvd M Abort | Rcvd T Abort | Sig T Abort | Reserved | | Det M Par Err | Reserved | | | Capabilities List | Int Status | Reserved | | | | | | | | Int Disable | Reserved | SERR Enable | Reserved | Par Error Resp | Reserved | | | Bus Master | Memory Space | IO Space |

This register defines the various control functions associated with the PCI bus. The register bits are defined below.

- **Bit 31**: Det Par Err (R/W1C) – Detected Parity Error.
- **Bit 30**: Sig Sys Err (R/W1C) – Signaled System Error.
- **Bit 29**: Rcvd M Abort (R/W1C) – Received Master Abort.
- **Bit 28**: Rcvd T Abort (R/W1C) – Received Target Abort.
- **Bit 27**: Sig T Abort (R/W1C) – Signaled Target Abort.
- **Bit 24**: Det M Par Err (R/W1C) – Detected Master Data Parity Error.
- **Bit 20**: Capabilities List (R) – PCI Capabilities List. This bit is hardwired to 1 to indicate that the SiI3132 implements Capabilities registers for Power Management, PCI-X, and Message Signaled Interrupt.

- **Bit [19]**: Interrupt Status (R).
- **Bit [26:25,23:21,18:11,9,7,5:3]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [10]**: Interrupt Disable (R/W).
- **Bit 08**: SERR Enable (R/W) – SERR Enable.
- **Bit 06**: Par Error Resp (R/W) – Parity Error Response Enable.
- **Bit 02**: Bus Master (R/W) – Bus Master Enable. This bit set enables the SiI3132 to act as PCI bus master, i.e., issue Memory Requests.
- **Bit 01**: Memory Space (R/W) – Memory Space Enable. This bit set enables the SiI3132 to respond to memory space accesses.
- **Bit 00**: I/O Space (R/W) – I/O Space Enable. This bit is hardwired to 0; the SiI3132 does not respond to I/O space accesses.

## PCI Class Code – Revision ID

Address Offset: $08_H$
Access Type: Read/Write
Reset Value: 0x0180_0001

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PCI Class Code | | | | | | | | | | | | | | | | | | | | | | | | Revision ID | | | | | | | |

This register defines the various control functions associated with the PCI bus. The register bits are defined below.

- **Bit [31:08]**: PCI Class Code (R) – PCI Class Code. This value in this bit field is one of the following:
  - The default value of 018000h for Mass Storage Class.
  - The value loaded from an external memory device; if an external memory device – flash or EEPROM – is present with the correct signature, the PCI Class Code is loaded from that device after reset. See “Auto-Initialization from Flash” section on page 35 for more information.
  - System programmed value; if bit 0 of the Configuration register ($48_H$) is set the PCI Class Code is system programmable.
- **Bit [07:00]**: Revision ID (R) – Chip Revision ID. This bit field is hardwired to indicate the revision level of the chip design; revision $01_H$ is defined by this specification.

## BIST – Header Type – Latency Timer – Cache Line Size

Address Offset: $0C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BIST | | | | | | | | Header Type | | | | | | | | Latency Timer | | | | | | | | Cache Line Size | | | | | | | |

This register defines the various control functions associated with the PCI bus. The register bits are defined below.

- **Bit [31:24]**: BIST (R). This bit field is hardwired to $00_H$.
- **Bit [23:16]**: Header Type (R). This bit field is hardwired to $00_H$.
- **Bit [15:08]**: Latency Timer (R). This field is hardwired to $00_H$.
- **Bit [07:00]**: Cache Line Size (R/W). This bit field is Read/Write for legacy purposes. The field is not used by the SiI3132.

## Base Address Register 0

Address Offset: $10_H$
Access Type: Read/Write
Reset Value: 0x0000_0000_0000_0004

| 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base Address Register 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
| Base Address Register 0 | | | | | | | | | | | | | | | | | | | | | | | | | 0000100 | | | | | | |

This register defines the addressing of the Global Registers within the SiI3132. The register bits are defined below.

- **Bit [63:07]**: Base Address Register 0 (R/W). This register defines the base address for the 128-byte Memory Space containing the Global Registers.
- **Bit [06:00]**: (R). This bit field is hardwired to $0000100_B$ to indicate a 64-bit base address.

## Base Address Register 1

Address Offset: $18_H$
Access Type: Read/Write
Reset Value: 0x0000_0000_0000_0004

| 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base Address Register 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
| Base Address Register 1 | | | | | | | | | | | | | | | | | | 00 0000 0000 0100 | | | | | | | | | | | | | |

This register defines the addressing of the Port Registers and LRAM within the SiI3132. The register bits are defined below.

- **Bit [63:15]**: Base Address Register 1 (R/W). This register defines the base address for the 16kbyte Memory Space containing the Port Registers.
- **Bit [14:00]**: (R). This bit field is hardwired to $0004_H$ to indicate a 64-bit base address.

## Base Address Register 2

Address Offset: $20_H$
Access Type: Read/Write
Reset Value: 0x0000_0001

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Base Address Register 2 | | | | | | | | | | | | | | | | | | | | | | | | | 000 0001 | | | | | | |

This register defines the addressing of the Indirect I/O registers within the SiI3132. The register bits are defined below.

- **Bit [31:04]**: Base Address Register 2 (R/W). This register defines the base address for the 128-byte I/O Space.
- **Bit [03:00]**: (R). This bit field is hardwired to $000\_0001_B$.

## Subsystem ID — Subsystem Vendor ID

Address Offset: $2C_H$
Access Type: Read/Write
Reset Value: 0x3132_1095

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subsystem ID | | | | | | | | | | | | | | | | Subsystem Vendor ID | | | | | | | | | | | | | | | |

This register defines the Subsystem ID fields associated with the PCI bus. The register bits are defined below.

- **Bit [31:16]**: Subsystem ID (R/W) – Subsystem ID. The value in this bit field is one of the following:
  - The default value of 0x3132
  - The value loaded from an external memory device; if an external memory device – flash or EEPROM – is present with the correct signature, the Subsystem ID is loaded from that device after reset. See “Auto-Initialization from Flash” section on page 35 for more information.
  - System programmed value; if bit 0 of the Configuration register ($48_H$) is set the Subsystem ID is system programmable.
- **Bit [15:00]**: Subsystem Vendor ID (R/W) – Subsystem Vendor ID. The value in this bit field is one of the following:
  - The default value of 0x1095
  - The value loaded from an external memory device; if an external memory device – flash or EEPROM – is present with the correct signature, the Subsystem Vendor ID is loaded from that device after reset. See “Auto-Initialization from Flash” section on page 35 for more information.
  - System programmed value; if bit 0 of the Configuration register ($48_H$) is set the Subsystem Vendor ID is system programmable.

## Expansion ROM Base Address

Address Offset: $30_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Expansion ROM Base Address | | | | | | | | | | | | | 000_0000_0000_0000_000 | | | | | | | | | | | | | | | | | | Exp ROM Enable |

This register defines the Expansion ROM base address associated with the PCI bus. The register bits are defined below.

- **Bit [31:19]**: Expansion ROM Base Address (R/W) – Expansion ROM Base Address. This bit field defines the upper bits of the Expansion ROM base address.
- **Bit [18:01]**: (R). This bit field is hardwired to $00000_H$ to indicate that the Expansion ROM address range is 512k bytes.
- **Bit [00]**: Exp ROM Enable (R/W) – Expansion ROM Enable. This bit is set to enable Expansion ROM access.

## Capabilities Pointer

Address Offset: $34_H$
Access Type: Read
Reset Value: 0x0000_0054

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | Capabilities Pointer | | | | | | | |

This register defines the link to a list of new capabilities associated with the PCI bus. The register bits are defined below.

- **Bit [31:08]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [07:00]**: Capabilities Pointer (R) – Capabilities Pointer. This bit field contains $54_H$, the address for the 1st Capabilities register set, the PCI Power Management Capability.

## Max Latency – Min Grant – Interrupt Pin – Interrupt Line

Address Offset: $3C_H$
Access Type: Read/Write
Reset Value: 0x0000_0100

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max Latency | | | | | | | | Min Grant | | | | | | | | Interrupt Pin | | | | | | | | Interrupt Line | | | | | | | |

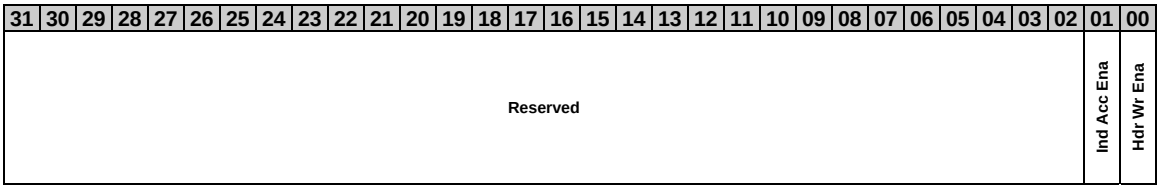
This register defines various control functions associated with the PCI bus. The register bits are defined below.

- **Bit [31:24]**: Max Latency (R) – Maximum Latency. This bit field is hardwired to $00_H$.
- **Bit [23:16]**: Min Grant (R) – Minimum Grant. This bit field is hardwired to $00_H$.
- **Bit [15:08]**: Interrupt Pin (R) – Interrupt Pin Used. This bit field is hardwired to $01_H$ to indicate that the SiI3132 uses the INTA interrupt. The INTB, INTC, and INTD interrupts may be used by enabling them in the Port Interrupt Enable registers; this use is outside the PCI specification.

- **Bit [07:00]**: Interrupt Line (R/W) – Interrupt Line. This bit field is used by the system to indicate interrupt line routing information. The SiI3132 does not use this information.

## Header Write Enable

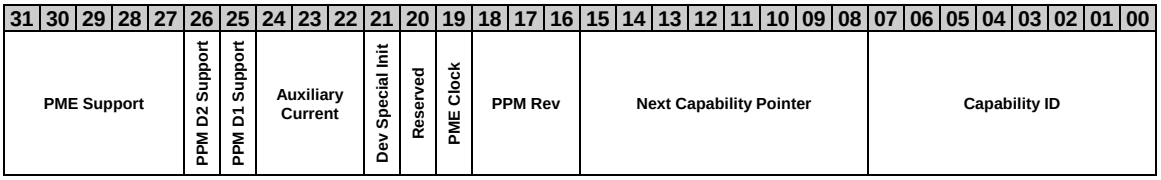
Address Offset: $48_H$
Access Type: Read/Write
Reset Value: 0x0000_0000




- **Bit [31:02]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [01]**: Ind Acc Ena (R) – Indirect Access Enable. This bit enables the Indirect Access registers at offset $F0_H$-$FF_H$.
- **Bit [00]**: Hdr Wr Ena (R) – Header Write Enable. This bit enables writing to registers defined as read-only by the PCI specification. This bit is required to meet PCI compliance testing that expects certain registers to be read-only. This bit is set to enable write access to the following registers in the PCI Configuration Header: Device ID ($03\text{-}02_H$), PCI Class Code ($09\text{-}0B_H$), Subsystem Vendor ID ($2D\text{-}2C_H$), and Subsystem ID ($2F\text{-}2E_H$).

## Power Management Capability

Address Offset: $54_H$
Access Type: Read Only
Reset Value: 0x0622_5C01




This register defines the power management capabilities associated with the PCI bus. The register bits are defined below.

- **Bit [31:27]**: PME Support (R) – Power Management Event Support. This bit field is hardwired to $00_H$; the SiI3132 does not support PME.
- **Bit [26]**: PPM D2 Support (R) – PCI Power Management D2 Support. This bit is hardwired to 1.
- **Bit [25]**: PPM D1 Support (R) – PCI Power Management D1 Support. This bit is hardwired to 1.
- **Bit [24:22]**: Auxiliary Current (R) – Auxiliary Current. This bit field is hardwired to $000_B$.
- **Bit [21]**: Dev Special Init (R) – Device Special Initialization. This bit is hardwired to 1 to indicate that the SiI3132 requires special initialization.
- **Bit [20]**: Reserved (R). This bit is reserved and returns zero on a read.
- **Bit [19]**: PME Clock (R) – Power Management Event Clock. This bit is hardwired to 0.
- **Bit [18:16]**: PPM Rev (R) – PCI Power Management Revision. This bit field is hardwired to $010_B$ to indicate compliance with the PCI Power Management Interface Specification revision 1.1.
- **Bit [15:08]**: Next Capability Pointer (R) – PCI Next Capability Pointer. This bit field is hardwired to $5C_H$ to point to the 2nd Capabilities register, the MSI Capability.
- **Bit [07:00]**: Capability ID (R) – PCI Capability ID. This bit field is hardwired to $01_H$ to indicate that this is a PCI Power Management Capability.

## Power Management Control + Status

Address Offset: $58_H$
Access Type: Read/Write
Reset Value: 0x0C00_2000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PPM Data | | | | | | | | Reserved | | | | | | | | PME Status | PPM Data Scale | | PPM Data Sel | | | | PME Ena | Reserved | | | | | | PPM Power State | |

This register defines the power management capabilities associated with the PCI bus. The register bits are defined below.

- **Bit [31:24]**: PPM Data (R) – PCI Power Management Data. This bit field is hardwired to 0x0C to indicate a power consumption of 1.2 Watt.
- **Bit [23:16]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [15]**: PME Status (R) – PME Status. This bit is hardwired to 0. The SiI3132 does not support PME.
- **Bit [14:13]**: PPM Data Scale (R) – PCI Power Management Data Scale. This bit field is hardwired to $01_B$ to indicate a scaling factor of 100 mW.
- **Bit [12:09]**: PPM Data Sel (R/W) – PCI Power Management Data Select. This bit field is set by the system to indicate which data field is to be reported through the PPM Data bits (although current implementation hardwires the PPM Data to indicate 1.2 Watt).
- **Bit [08]**: PME Ena (R) – PME Enable. This bit is hardwired to 0. The SiI3132 does not support PME.
- **Bit [07:02]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [01:00]**: PPM Power State (R/W) – PCI Power Management Power State. This bit field is set by the system to dictate the current Power State: 00 = D0 (Normal Operation), 01 = D1, 10 = D2, and 11 = D3 (Hot).

## MSI Capability

Address Offset: $5C_H$
Access Type: Read/Write
Reset Value: 0x0080_7005

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | 64-bit Addr | Multiple Message Enable | | | Multiple Message Capable | | | MSI Enable | Next Capability Pointer | | | | | | | | Capability ID | | | | | | | |

This register defines the MSI Capability Message Control. The register bits are defined below.

- **Bit [31:24]**: Reserved (R) – This bit field is reserved and returns zeros on a read.
- **Bit [23]**: 64-bit Addr (R) – 64-bit Address Capable. This bit is hardwired to 1.
- **Bit [22:20]**: Multiple Message Enable (R/W) – This bit field defaults to $000_B$.
- **Bit [19:17]**: Multiple Message Capable (R/W) – This bit field defaults to $000_B$.
- **Bit [16]**: MSI Enable (R/W) – This bit is set to enable Message Signaled Interrupts.
- **Bit [15:08]**: Next Capability Pointer (R) –Next Capability Pointer. This bit field is hardwired to $70_H$ to point to the 3rd Capabilities register, the PCI Express Capability.
- **Bit [07:00]**: Capability ID (R) – This bit field is hardwired to $05_H$ to indicate that this is a MSI Capability.

## Message Address

Address Offset: $60_H$-$67_H$
Access Type: Read/Write
Reset Value: 0x0000_0000_0000_0000

| 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Message Address Upper | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
| Message Address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 00 | |

This register specifies the memory address for an MSI memory write transaction. The memory address must be of a dword (bits 1:0 must be 0).

## MSI Message Data

Address Offset: $68_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | Message Data | | | | | | | | | | | | | | | |

This register specifies the MSI Message Data. The register bits are defined below.

- **Bit [31:16]**: Reserved (R) – This bit field is reserved and returns zeros on a read.
- **Bit [15:00]**: Message Data (R/W) – This bit field specifies the Message Data for an MSI memory write transaction.

## PCI Express Capability

Address Offset: $70_H$
Access Type: Read Only
Reset Value: 0x0011_0010

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | Interrupt Message Number | | | | | Reserved | Device Type | | | | Version | | | | Next Capability Pointer | | | | | | | | Capability ID | | | | | | | |

- **Bit [31:30,24]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [29:25]**: Interrupt Message Number (R) – This bit field is hardwired to 0.
- **Bit [23:20]**: Device Type (R) – This bit field is hardwired to $0001_B$ to indicate a PCI Express Legacy Endpoint device.
- **Bit [19:16]**: Version (R) – This bit field is hardwired to $01_H$ to indicate compliance with the PCI Express Specification revision 1.0a.
- **Bit [15:08]**: Next Capability Pointer (R) – PCI Next Capability Pointer. This bit field is hardwired to $00_H$ (this is the last capability).

- **Bit [07:00]**: Capability ID (R) – PCI Capability ID. This bit field is hardwired to $10_H$ to indicate that this is a PCI Express Capability.

## Device Capabilities

Address Offset: $74_H$
Access Type: Read Only
Reset Value: 0x0000_0003

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | Slot Power | | | | | | | | | | Reserved | | | Pwr Indicator | Atten Indicator | Atten Button | L1 Latency | | | L0s Latency | | | Ext Tag Sup | Phantom Functions | | Max Payload | | |

- **Bit [31:28,17:15]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [27:18]**: Slot Power (R) – Captured Slot Power Limit Value and Limit Scale. This bit field is hardwired to 0.
- **Bit [14]**: Pwr Indicator (R) – Power Indicator Present. This bit field is hardwired to 0.
- **Bit [13]**: Atten Indicator (R) – Attention Indicator Present. This bit field is hardwired to 0.
- **Bit [12]**: Atten Button (R) – Attention Button Present. This bit field is hardwired to 0.
- **Bit [11:09]**: L1 Latency (R) – This bit field is hardwired to $000_B$.
- **Bit [08:06]**: L0s Latency (R) – This bit field is hardwired to $000_B$.
- **Bit [05]**: Ext Tag Sup (R) – Extended Tag Field Supported. This bit is hardwired to 0.
- **Bit [04:03]**: Phantom Functions (R) – This bit field is hardwired to 0.
- **Bit [02:00]**: Max Payload (R) – Max_Payload_Size Supported. This bit field is hardwired to $011_B$ to indicate that a maximum 1024-byte payload is supported.

## Device Status and Control

Address Offset: $78_H$
Access Type: Read/Write/Write 1 to Clear
Reset Value: 0x0000_2000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | Trans Pending | AUX Power | Unsup Req Det | Fatal Error Det | Non-Fatal Error | Corr Error Det | Reserved | Max Read Request Size | | | EnSnp Not Req | Aux Pwr PM En | Phntm Fnc En | Ext Tag Fld En | Max Payload Size | | | En Rlxd Ord | UnsReq Rep En | Fatal Err Rep En | NonFtl Err Rep En | Corr Err Rep En |

- **Bit [31:22,15]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [21]**: Trans Pending (R) – Transactions Pending.
- **Bit [20]**: AUX Power (R) – AUX Power Detected. This bit is hardwired to 0.
- **Bit [19]**: Unsup Req Det (R/W1C) – Unsupported Request Detected.
- **Bit [18]**: Fatal Error Det (R/W1C) – Fatal Error Detected.
- **Bit [17]**: Non-Fatal Error (R/W1C) – Non-Fatal Error Detected.
- **Bit [16]**: Corr Error Det (R/W1C) – Correctable Error Detected.
- **Bit [14:12]**: Max Read Request Size (R/W) – Allowable values are $000_B$ to $011_B$ (128 to 1024 bytes). Default is $010_B$ (512 bytes).
- **Bit [11]**: EnSnp Not Req (R) – Enable No Snoop. This bit is hardwired to 0.
- **Bit [10]**: Aux Pwr PM En (R) – Auxiliary Power PM Enable. This bit is hardwired to 0.
- **Bit [09]**: Phntm Fnc En (R) – Phantom Functions Enable. This bit is hardwired to 0.
- **Bit [08]**: Ext Tag Fld En (R) – Extended Tag Field Enable. This bit is hardwired to 0.
- **Bit [07:05]**: Max Payload Size (R/W) – Allowable values are $000_B$ to $011_B$ (128 to 1024 bytes). Default is $000_B$ (128 bytes).

- **Bit [04]**: En Rlxd Ord (R) – Enable Relaxed Ordering. This bit field is hardwired to 0.
- **Bit [03]**: UnsReq Rep En (R/W) – Unsupported Request Reporting Enable.
- **Bit [02]**: Fatal Err Rep En (R/W) – Fatal Error Reporting Enable.
- **Bit [01]**: NonFtl Err Rep En (R/W) – Non-Fatal Error Reporting Enable.
- **Bit [00]**: Corr Err Rep En (R/W) – Correctable Error Reporting Enable.

## Link Capabilities

Address Offset: $7C_H$
Access Type: Read Only
Reset Value: 0x0000_7411

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Port Number | | | | | | | | Reserved | | | | | | L1 Exit Latency | | | L0s Exit Latency | | | ASPM Support | | Maximum Link Width | | | | | | Maximum Link Speed | | | |

- **Bit [31:24]**: Port Number (R) – This bit field is hardwired to $00_H$.
- **Bit [23:18]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [17:15]**: L1 Exit Latency (R) – This bit field is hardwired to $000_B$.
- **Bit [14:12]**: L0s Exit Latency (R) – This bit field is hardwired to $111_B$.
- **Bit [11:10]**: ASPM Support (R) – This bit field is hardwired to $01_B$.
- **Bit [09:04]**: Maximum Link Width (R) – This bit field is hardwired to $000001_B$.
- **Bit [03:00]**: Maximum Link Speed (R) – This bit field is hardwired to $0001_B$.

## Link Status and Control

Address Offset: $80_H$
Access Type: Read/Write
Reset Value: 0x0011_0000 or 0x1011_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | Slot Clk Config | Link Training | Link Train Err | Negotiated Link Width | | | | | | Link Speed | | | | Reserved | | | | | | | | Ext Synch | Comm Clk Cfg | Retrain Link | Link Disable | RCB | Reserved | ASPM Control | |

- **Bit [31:29,15:08,02]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [28]**: Slot Clk Config (R) – Slot Clock Configuration. This bit is 1 if the reference clock is detected.
- **Bit [27]**: Link Training (R) –This bit is hardwired to 0.
- **Bit [26]**: Link Train Err (R) – This bit is hardwired to 0.
- **Bit [25:20]**: Negotiated Link Width (R) – This bit field is hardwired to $000001_B$.
- **Bit [19:16]**: Link Speed (R) – This bit field is hardwired to $0001_B$.
- **Bit [07]**: Ext Synch (R/W) – Extended Synch.
- **Bit [06]**: Comm Clk Cfg (R/W) – Common Clock Configuration.
- **Bit [05]**: Retrain Link (R) – This bit is hardwired to 0.
- **Bit [04]**: Link Disable (R) – This bit is hardwired to 0.
- **Bit [03]**: RCB (R/W) – Read Completion Boundary.
- **Bit [01:00]**: ASPM Control (R/W)

## Global Register Offset

Address Offset: $F0_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | | Dword Offset | | | | | 00 | |

This register provides indirect addressing of a Global Register otherwise accessible directly via Base Address Register 0. The dword address offset for an indirect access is in bits 6 to 2; bits 31 to 7, 1, and 0 are reserved and should always be 0.

Note that this is physically the same register as that addressed by Base Address Register 2, Offset $00_H$.

## Global Register Data

Address Offset: $F4_H$
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As defined for indirectly accessed register | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides the indirect access addressed by the Global Register Offset register.

## Port Register Offset

Address Offset: $F8_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | Dword Offset | | | | | | | | | | | | 00 | |

This register provides indirect addressing of a Port Register otherwise accessible directly via Base Address Register 1. The dword address offset for an indirect access is in bits 13 to 2; bits 31 to 14, 1, and 0 are reserved and should always be 0.

Note that this is physically the same register as that addressed by Base Address Register 2, Offset $08_H$.

## Port Register Data

Address Offset: $FC_H$
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As defined for indirectly accessed register | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides the indirect access addressed by the Port Register Offset register.

## Advanced Error Reporting Capability

Address Offset: $100_H$
Access Type: Read Only
Reset Value: 0x0001_0001

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Next Capability Pointer | | | | | | | | | | | | Version | | | | Extended Capability ID | | | | | | | | | | | | | | | |

- **Bit [31:20]**: Next Capability Pointer (R) – PCI Next Capability Pointer. This bit field is hardwired to $000_H$ (this is the last capability).
- **Bit [19:16]**: Version (R) – This bit field is hardwired to $01_H$ to indicate compliance with the PCI Express Specification revision 1.0a.
- **Bit [15:00]**: Extended Capability ID (R) – PCI Capability ID. This bit field is hardwired to $0001_H$ to indicate that this is an Advanced Error Reporting Capability.

## Uncorrectable Error Status

Address Offset: $104_H$
Access Type: Read/Write 1 to Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | Unsup Req Err | ECRC Error | Malformed TLP | Rx Overflow (0) | Unexp Comp | Comp Abort | Comp Timeout | FC Protocol Err | Poisoned TLP | Reserved | | | | | | | DL Protocol Err | Reserved | | | Training Error |

- **Bit [31:21,11:05,03:01]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [20]**: Unsup Req Err (R/W1C) – Unsupported Request Error Status.
- **Bit [19]**: ECRC Error (R/W1C) – ECRC Error Status.
- **Bit [18]**: Malformed TLP (R/W1C) – Malformed TLP Status.
- **Bit [17]**: Rx Overflow (R) – Receiver Overflow Status; always 0.
- **Bit [16]**: Unexp Comp (R/W1C) – Unexpected Completion Status.
- **Bit [15]**: Comp Abort (R/W1C) – Completer Abort Status.
- **Bit [14]**: Comp Timeout (R/W1C) – Completion Timeout Status.
- **Bit [13]**: FC Protocol Err (R/W1C) – Flow Control Protocol Error Status. This bit is hardwired to 0 (as are its mask and error severity bits).
- **Bit [12]**: Poisoned TLP (R/W1C) – Poisoned TLP Status.
- **Bit [04]**: DL Protocol Err (R/W1C) – Data Link Protocol Error Status.
- **Bit [00]**: Training Error (R) – This bit is hardwired to 0 (as are its mask and error severity bits).

## Uncorrectable Error Mask

Address Offset: $108_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | Unsup Req Err | ECRC Error | Malformed TLP | Rx Overflow (0) | Unexp Comp | Comp Abort | Comp Timeout | FC Protocol Err | Poisoned TLP | Reserved | | | | | | | DL Protocol Err | Reserved | | | Training Error |

The bits of this register are the mask bits for corresponding bits of the Uncorrectable Error Status register.

## Uncorrectable Error Severity

Address Offset: $10C_H$
Access Type: Read/Write
Reset Value: 0x0004_0010

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | Unsup Req Err | ECRC Error | Malformed TLP | Rx Overflow (0) | Unexp Comp | Comp Abort | Comp Timeout | FC Protocol Err | Poisoned TLP | Reserved | | | | | | | DL Protocol Err | Reserved | | | Training Error |

The bits of this register are the error severity bits for corresponding bits of the Uncorrectable Error Status register.

## Correctable Error Status

Address Offset: $110_H$
Access Type: Read/Write 1 to Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | Replay Timeout | Reserved | | | REPLAY_NUM | Bad DLLP | Bad TLP | Reserved | | | | | | Rx Error |

- **Bit [31:13,11:09,05:01]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [12]**: Replay Timeout (R/W1C) – Replay Timer Timeout Status.
- **Bit [08]**: REPLAY_NUM (R/W1C) – REPLAY_NUM Rollover Status.
- **Bit [07]**: Bad DLLP (R/W1C) – Bad DLLP Status.
- **Bit [06]**: Bad TLP (R/W1C) – Bad TLP Status.
- **Bit [00]**: Rx Error (R/W1C) – Receiver Error Status. This bit is hardwired to 0 (as is the corresponding mask bit).

## Correctable Error Mask

Address Offset: $114_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | Replay Timeout | Reserved | | | REPLAY_NUM | Bad DLLP | Bad TLP | Reserved | | | | | | | Rx Error |

The bits of this register are the mask bits for corresponding bits of the Correctable Error Status register.

## Advanced Error Capabilities and Control

Address Offset: $118_H$
Access Type: Read/Write
Reset Value: 0x0000_00A0

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | ECRC Chk En | ECRC Chk Cap | ECRC Gen En | ECRC Gen Cap | First Error Pointer | | | | |

- **Bit [31: 09]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [08]**: ECRC Chk En (R/W) – ECRC Check Enable.
- **Bit [07]**: ECRC Chk Cap (R) – ECRC Check Capable. This bit is hardwired to 1.
- **Bit [06]**: ECRC Gen En (R/W) – ECRC Generation Enable.
- **Bit [05]**: ECRC Gen Cap (R) – ECRC Generation Capable. This bit is hardwired to 1.
- **Bit [04:00]**: First Error Pointer (R).

## Header Log

Address Offset: $11C_H$ / $120_H$ / $124_H$ / $128_H$
Access Type: Read Only
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Header Log (1st dword) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Header Byte 0 | | | | | | | | Header Byte 1 | | | | | | | | Header Byte 2 | | | | | | | | Header Byte 3 | | | | | | | |
| Header Log (2nd dword) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Header Byte 4 | | | | | | | | Header Byte 5 | | | | | | | | Header Byte 6 | | | | | | | | Header Byte 7 | | | | | | | |
| Header Log (3rd dword) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Header Byte 8 | | | | | | | | Header Byte 9 | | | | | | | | Header Byte 10 | | | | | | | | Header Byte 11 | | | | | | | |
| Header Log (4th dword) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Header Byte 12 | | | | | | | | Header Byte 13 | | | | | | | | Header Byte 14 | | | | | | | | Header Byte 15 | | | | | | | |

This 16-byte register contains the header of a TLP associated with an error.

## Internal Register Space – Base Address 0

These registers are 32 or 64 bits wide and are the Global Registers of the SiI3132. Access to this register space is through the PCI Memory space.

**Table 38. SiI3132 Internal Register Space – Base Address 0**

| Address Offset | Register Name | |
|---|---|---|
| $00_H$ | Port 0 Slot Status | |
| $04_H$ | Port 1 Slot Status | |
| $08_H$-$3F_H$ | Reserved | |
| $40_H$ | Global Control | |
| $44_H$ | Global Interrupt Status | |
| $48_H$ | PHY Configuration | |
| $4C_H$-$5F_H$ | Reserved | |
| $60_H$ | $I^2C$ Control | |
| $64_H$ | $I^2C$ Status | |
| $68_H$ | $I^2C$ Slave Address | |
| $6C_H$ | $I^2C$ Data Buffer | |
| $70_H$ | Flash Address | |
| $74_H$ | GPIO | Flash Data |
| $78_H$-$7F_H$ | Reserved | |

### Port Slot Status Registers

Address Offset: $00_H$-$07_H$
Access Type: Read
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Attention | Slot Status | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

These 2 registers provide the Status for the 31 Command Slots for each of the 2 ports. These registers also appear in Port register space. Reading this register will clear the Command Completion Status for the port if the Interrupt No Clear on Read bit (bit 3) of the Port Control register is 0. The register bits are defined below.

- **Bit [31]**: Attention (R) – This bit indicates that something occurred in the corresponding port that requires the attention of the host. Other port registers must be examined to determine the origin of the error. This bit is the logical OR of the masked interrupt conditions, except for Command Completion, reported in the Port Interrupt Status register.
- **Bit [30:0]**: Slot Status (R) – These bits are the Active status bits corresponding to Slot numbers 30 to 0. The Active status bit for a slot is set when the Slot number is written to the Command Execution FIFO (direct command transfer method) or when a Command Activation register is written (indirect command transfer method).

## Global Control

Address Offset: $40_H$
Access Type: Read/Write
Reset Value: 0x8100_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Global Reset | MSIACK | $I^2C$ Int Enable | Reserved | | | | 3Gb/s Capable | Reserved | | | | | | | | | | | | | | | | | | | | | | Port 1 Int Enable | Port 0 Int Enable |

This register controls various functions of the chip.

- **Bit [31]**: Global Reset (R/W). This bit, when set to one, asserts a port reset to all ports. This bit must be cleared to zero to allow normal operation. Once set by this bit, all port resets will remain set to one until explicitly cleared to zero through the individual port control clear registers. Refer to the port control set register description for more information.
- **Bit [30]**: MSI Acknowledge (W). Writing a one to this bit acknowledges a Message Signaled Interrupt and permits generation of another MSI. This bit is cleared immediately after the acknowledgement is recognized by the control logic, hence the bit will always be read as a zero. If all interrupt conditions are removed subsequent to an MSI, it is not necessary to assert this Acknowledge; another MSI will be generated when an interrupt condition occurs.
- **Bit [29]**: $I^2C$ Int Enable (R/W). This bit, when set to one, allows assertion of an interrupt when the $I^2C$ interrupt is asserted. When set to zero, the interrupt is masked.
- **Bit [28:25,23:2]**: Reserved (R). These bits are reserved and will return zeroes when read.
- **Bit [24]**: 3Gb/s Capable (R). This bit is hardwired to one.
- **Bit [1:0]**: Port Interrupt Enable (R/W). These bits, when set to one, allow assertion of an interrupt when the corresponding port asserts an interrupt. When set to zero, the corresponding port interrupts are masked.

## Global Interrupt Status

Address Offset: $44_H$
Access Type: Read/Write 1 Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | $I^2C$ Interrupt | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | Port 1 Interrupt | Port 0 Interrupt |

This register is used to determine the status of various chip functions.

- **Bit [31:30]**: Reserved (R). This bit field is reserved and returns zeroes when read.
- **Bit [29]**: $I^2C$ Interrupt (R). This bit indicates that the $I^2C$ Interrupt is pending. The interrupt source must be cleared (in the $I^2C$ Status register) for this bit to be zero. This bit will not report interrupt sources that are not enabled in the $I^2C$ Control register.
- **Bit [28:2]**: Reserved (R). This bit field is reserved and returns zeroes when read.
- **Bit [1:0]**: Port Interrupt Status (R/W1C). These bits, when set to one, indicate that the corresponding port has an interrupt condition pending. Writing a 1 to any of these bits clears the corresponding Command Completion Interrupt Status, but not other interrupt sources.

## PHY Configuration

Address Offset: $48_H$
Access Type: Read/Write
Reset Value: 0x0000_2C40

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | PHY Confgig | | | | | | | | | | | | | | | |

This register is reset to 0x00002C40.

- **Bit [31:16]**: Reserved (R/W) – This bit field is reserved and must be always zeros.
- **Bit [15:04]**: PHY Configuration (R/W) – These bits should not be changed from their defaults as erratic operation may result.
- **Bit [03:00]**: SATA SSC (R/W) – If this bit field set to 1111b, all channel Tx outputs Spread Spectrum Clocking.

## BIST Control Register

Address Offset: $50_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

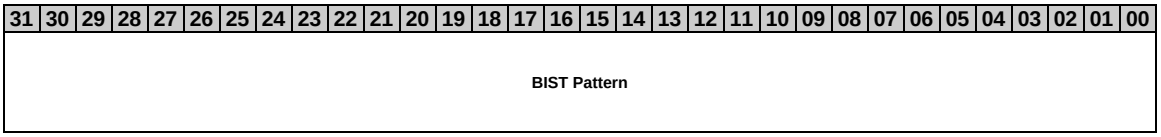
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BISTenable | BISTpatsel | Reserved | | | | | | | | | | | | BISTcompsel | | Reserved | | | | | | | | | | | | BISTrun | | | |

This register is used to control Data Loopback BIST.

- **Bit [31]**: BISTenable (R/W) – This bit enables the data paths for running data loopback BIST.
- **Bit [30]**: BISTpatsel (R/W) – This bit selects whether a repeating pattern (supplied from the BIST Pattern register) or a pseudorandom pattern is used for running data loopback BIST. Setting the bit to 1 selects the repeating pattern.
- **Bit [29:18]**: Reserved (R/W). These bits are reserved and must write zeros.
- **Bit [17:16]**: BISTcompsel (R/W). This bit field selects the port from which loopback data is selected for pattern comparison.
- **Bit [15:04]**: Reserved (R/W). These bits are reserved and must write zeros.
- **Bit [03:00]**: BISTrun (R/W). This bit field selects the port(s) that transmit loopback data.

## BIST Pattern Register

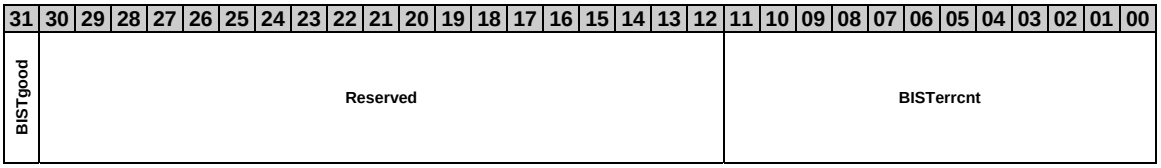
Address Offset: $54_H$
Access Type: Read/Write
Reset Value: 0x0000_0000




This register contains the 32-bit fixed pattern that is repeatedly transmitted in data loopback when the BISTpatsel bit (bit 30) of the BIST Control register is set to 1.

## BIST Status Register

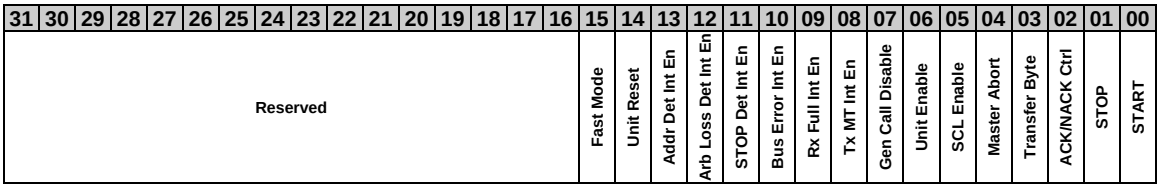
Address Offset: $58_H$
Access Type: Read
Reset Value: 0x8000_0000




- **Bit [31]**: BISTgood (R) – This bit indicates that all comparisons have been good since initiating data loopback BIST. This bit is initialized (to 1) when the BISTenable bit is zero in the BIST Control register.
- **Bit [30:12]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [11:00]**: BISTerrcnt (R). This bit field indicates the number of comparisons that have been in error since initiation of data loopback BIST. This counter is a saturating counter (it stops counting at $0FFF_H$). This counter is cleared when the BISTenable bit is zero in the BIST Control register.

## $I^2C$ Control

Address Offset: $60_H$
Access Type: Read/Write
Reset Value: 0x0000_0000




This register contains bits to control the operation of the $I^2C$ interface.

- **Bit [31:16]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [15]**: Fast Mode (R/W). This bit, when set, enables 400 kbit/s operation (instead of 100 kbit/s)
- **Bit [14]**: Unit Reset (R/W). This bit, when set, resets the $I^2C$ controller.
- **Bit [13]**: Addr Det Int En (R/W). Slave Address Detected Interrupt Enable – This bit enables interrupt generation upon the detection of the Slave Address or the General Call Address.
- **Bit [12]**: Arb Loss Det Int En (R/W). Arbitration Loss Detected Interrupt Enable – This bit enables interrupt generation upon losing arbitration in Master Mode. If this bit is not set, and arbitration is lost during transmission of the control byte, the arbitration and transmission will be automatically repeated.

- **Bit [11]**: STOP Det Int En (R/W). Slave STOP Detected Interrupt Enable – This bit enables interrupt generation upon detection of a STOP condition while in Slave Mode.
- **Bit [10]**: Bus Error Int En (R/W). Bus Error Interrupt Enable – This bit enables interrupt generation upon detection of an $I^2C$ error.
- **Bit [09]**: Rx Full Int En (R/W). Receive Buffer Full Interrupt Enable – This bit enables interrupt generation when a byte has been received and is in the $I^2C$ Data Buffer register.
- **Bit [08]**: Tx MT Int En (R/W). Transmit Buffer Empty Interrupt Enable – This bit enables interrupt generation after the data byte in the $I^2C$ Data Buffer register has been transmitted.
- **Bit [07]**: Gen Call Disable (R/W). General Call Disable – This bit disables detection of a General Call Address.
- **Bit [06]**: Unit Enable (R/W). This bit must be set to enable any $I^2C$ controller operations.
- **Bit [05]**: SCL Enable (R/W). This bit must be set to enable the $I^2C$ Clock output for Master Mode operations.
- **Bit [04]**: Master Abort (R/W). This bit may be set along with STOP to send a STOP without first transferring a byte.
- **Bit [03]**: Transfer Byte (R/W). Set to initiate the transfer to/from the Data Buffer.
- **Bit [02]**: ACK/NACK Ctrl (R/W). Set to send a NACK instead of an ACK after receiving a data byte. Note that an ACK will be sent in response to slave address detection regardless of this bit. Sending a NACK in Slave Mode will set the Bus Error status.
- **Bit [01]**: STOP (R/W). Set to send a STOP following transfer of a byte (using Transfer Byte) or immediately (using Master Abort).
- **Bit [00]**: START (R/W). Set to send a START prior to transfer of a byte (using Transfer Byte).

## $I^2C$ Status

Address Offset: $64_H$
Access Type: Read/Write 1 to Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | Bus Error Det | Slave Addr Det | Gen Call Det | Rx Full | Tx MT | Arb Loss Det | STOP Det | Bus Busy | Unit Busy | ACK/NACK Status | Read/Write |

This register contains bits to report the status of the $I^2C$ interface.

- **Bit [31:11]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [10]**: Bus Error Det (R/W1C). Bus Error Detected – This bit reports the detection of an illegal NACK either received in Master Mode or sent in Slave Mode. This bit is not set by the legal NACK at the end of a transfer that signals the end to the slave.
- **Bit [09]**: Slave Addr Det (R/W1C). Slave Address Detected – This bit reports the detection of the Slave Address or of the General Call Address (when enabled). The byte received containing the address is placed into the $I^2C$ Data Buffer register.
- **Bit [08]**: Gen Call Det (R/W1C). General Call Address Detected – This bit reports the detection of the General Call Address.
- **Bit [07]**: Rx Full (R/W1C). $I^2C$ Data Buffer Receive Full – A data byte has been received and an ACK or NACK has been sent. This bit is set on the rising edge of the $I^2C$ clock allowing for some minimal (one bit) time for an interrupt before insertion of wait states.
- **Bit [06]**: Tx MT (R). $I^2C$ Data Buffer Transmit Empty – A data byte has been transmitted and an ACK or NACK has been received. This bit is set on the rising edge of the $I^2C$ clock allowing for some minimal (one bit) time for an interrupt before insertion of wait states.
- **Bit [05]**: Arb Loss Det (R/W1C). Arbitration Loss Detected – This bit indicates that arbitration has been lost. If the corresponding interrupt is not enabled, and the arbitration loss is detected during selection, i.e., during the control byte transmission, the arbitration will be repeated automatically; if arbitration is lost later during data transmission, no repeat is possible and is not attempted.

- **Bit [04]**: STOP Det (R/W1C). Slave STOP Detected.
- **Bit [03]**: Bus Busy (R). Indicates that the $I^2C$ bus is busy because of activity other than that generated by the $I^2C$ controller.
- **Bit [02]**: Unit Busy (R). Indicates that the $I^2C$ controller is busy.
- **Bit [01]**: ACK/NACK Status (R). Indicates status of last ACK or NACK sent or received.
- **Bit [00]**: Read/Write (R). Indicates state of the R/W# bit of the $I^2C$ slave address (either the one sent in Master Mode or the one received in Slave Mode).

## $I^2C$ Slave Address

Address Offset: $68_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | | Slave Address | | | | | | |

This register contains the 7-bit Slave Address to which the $I^2C$ controller will respond.

## $I^2C$ Data Buffer

Address Offset: $6C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | | Data Buffer | | | | | | |

This register contains the buffer for $I^2C$ send/receive data.

## Flash Address

Address Offset: $70_H$
Access Type: Read/Write
Reset Value: 0xXXXX_XXXX

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GPIO Enable | Reserved '0001' | | | | Mem Present | Mem Access Start | Mem Access Type | Reserved | | | | | Memory Address | | | | | | | | | | | | | | | | | | | |

This register is the address and command/status register for the flash memory interface. The register bits are defined below.

- **Bit [31]**: GPIO Enable (R/W). This bit, when set to one, enables the use of the flash Data pins for General Purpose I/O.
- **Bit [30:27]**: Reserved (R). This bit field is reserved and returns '0001' on a read.
- **Bit [26]**: Mem Present (R) – Memory Present. This bit set indicates that the auto-initialization signature was read correctly from the flash Memory.

- **Bit [25]**: Mem Access Start (R/W) – Memory Access Start. This bit is set to initiate an operation to flash memory. This bit is self-clearing when the operation is complete.
- **Bit [24]**: Mem Access Type (R/W) – Memory Access Type. This bit is set to define a read operation from flash memory. This bit is cleared to define a write operation to flash memory.
- **Bit [23:19]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [18:00]**: Memory Address (R/W). This bit field is programmed with the address for a flash memory read or write access.

## Flash Memory Data / GPIO Control

Address Offset: $74_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | GPIO Control | | | | | | | | Transition Detect | | | | | | | | Memory Data | | | | | | | |

This register contains the GPIO data/control fields and the flash memory data register.

- **Bit [31:24]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [23:16]**: GPIO Control (R/W). The bits of this field are written to control the output type for corresponding flash data lines; if a bit is a 1 the corresponding output is an open drain output (only driven low); if a 0 the corresponding output is always driven. To use a GPIO pin as an input, the control bit must be set to 1 (open-drain output) and the data bit must be set to 1 (undriven).
- **Bit [15:08]**: Transition Detect (R/C). The bits of this field report signal transition detection on the corresponding Flash data input; reading the register resets the transition detect bits.
- **Bit [07:00]**: Memory Data (R/W) – Flash Memory Data. This bit field is used for flash write data on a write operation, and returns the flash read data on a read operation. For GPIO, this field is used to write the GPIO output register and to read the GPIO input signals.

## Internal Register Space – Base Address 1

These registers are 32 bits wide and are the Port Registers and LRAM of the SiI3132. Access to these registers is through the PCI Memory space. Register descriptions that follow specify the address offset for Port 0; Port 1 registers are at the Port 0 offset plus $2000_H$.

**Table 39. SiI3132 Internal Register Space – Base Address 1**

| Address Offset | Register Name |
|---|---|
| $000_H$-$F7F_H$ | Port 0 LRAM Slots |
| $F80_H$-$FFF_H$ | Port Multiplier Device Status/QActive Registers |
| $1000_H$ | Write: Port 0 Control Set / Read: Port 0 Status |
| $1004_H$ | Write: Port 0 Control Clear |
| $1008_H$ | Port 0 Interrupt Status |
| $100C_H$ | Reserved |
| $1010_H$ | Port 0 Interrupt Enable Set |
| $1014_H$ | Port 0 Interrupt Enable Clear |
| $1018_H$ | Reserved |
| $101C_H$ | 32-bit Activation Upper Address |
| $1020_H$ | Port 0 Command Execution FIFO |
| $1024_H$ | Port 0 Command Error |
| $1028_H$ | Port 0 FIS Configuration |
| $102C_H$ | Port 0 PCI Exp Request FIFO Threshold |
| $1030_H$-$103F_H$ | Reserved |
| $1040_H$ | Port 0 8B/10B Decode Error Counter |
| $1044_H$ | Port 0 CRC Error Counter |
| $1048_H$ | Port 0 Handshake Error Counter |
| $104C_H$ | Reserved |
| $1050_H$ | Port PHY Configuration |
| $1054_H$-$17FF_H$ | Reserved |
| $1800_H$ | Port 0 Slot Status |
| $1804_H$-$1BFF_H$ | Reserved |
| $1C00_H$-$1CF7_H$ | Command Activation Registers |
| $1CF8_H$-$1E03F_H$ | Reserved |
| $1E04_H$ | Port Context Register |
| $1E08_H$-$1EFF_H$ | Reserved |
| $1F00_H$ | Port 0 SControl |
| $1F04_H$ | Port 0 SStatus |
| $1F08_H$ | Port 0 SError |
| $1F0C_H$ | Port 0 SActive (indirect location) |
| $1F10_H$ | Port 0 SNotification |
| $1F14_H$-$1FFF_H$ | Reserved |
| $2000_H$-$3FFF_H$ | Port 1 Registers mapped as above |

## Port LRAM

Address Offset: $000_H$-$FFF_H$
Access Type: Read/Write
Reset Value: indeterminate

The Port LRAM consists of 31 Slots of 128 bytes each and a 32nd "Slot" used to hold 16 Port Multiplier Device Specific Registers.

**Table 40. Port LRAM layout**

| Address Offset | Description |
|---|---|
| $000_H$-$07F_H$ | Slot 0 |
| $080_H$-$0FF_H$ | Slot 1 |
| $100_H$-$17F_H$ | Slot 2 |
| $180_H$-$EFF_H$ | Slots 3-29 |
| $F00_H$-$F7F_H$ | Slot 30 |
| $F80_H$-$F83_H$ | Port Multiplier Device 0 Status Register |
| $F84_H$-$F87_H$ | Port Multiplier Device 0 QActive Register |
| $F88_H$-$F8B_H$ | Port Multiplier Device 1 Status Register |
| $F8C_H$-$F8F_H$ | Port Multiplier Device 1 QActive Register |
| $F90_H$-$FF7_H$ | Port Multiplier Device Registers for Devices 2-14 |
| $FF8_H$-$FFB_H$ | Port Multiplier Device 15 Status Register |
| $FFC_H$-$FFF_H$ | Port Multiplier Device 15 QActive Register |

**Table 41. Port LRAM Slot layout**

| Address Offset | Description | |
|---|---|---|
| $000_H$-$01F_H$ | Current FIS and Control | Port Request Block (PRB) |
| $020_H$-$02F_H$ | Scatter/Gather Entry 0 or ATAPI command packet | |
| $030_H$-$03F_H$ | Scatter/Gather Entry 1 | |
| $040_H$-$047_H$ | Command Activation Register (Actual) | |
| $040_H$-$07F_H$ | Scatter/Gather Table | |
| $1C00_H$-$1C07_H$ | Command Activation Register (Shadow) | |

A Port LRAM Slot is 128 bytes used to define Serial-ATA commands. The addresses shown above are for slot 0.

## Port Slot Status

Address Offset: $1800_H$
Access Type: Read
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Attention | Slot Status | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides the status for the 31 Command Slots for the Serial-ATA port. This register also appears along with the Port Status register of the other port in Global register space. Reading this register will clear the Command Completion Status for the port if the Interrupt No Clear on Read bit (bit 3) of the Port Control register is 0. The register bits are defined below.

- **Bit [31]**: Attention (R) – This bit indicates that something occurred in the port that requires the attention of the host. Other port registers must be examined to determine the origin of the error. This bit is the logical OR of the masked interrupt conditions reported in the Port Interrupt Status register.
- **Bit [30:0]**: Slot Status (R) – These bits are the Active status bits corresponding to Slot numbers 30 to 0. The Active status bit is set when a command is transferred to the Slot RAM.

## Port Control Set

Address Offset: Set: $1000_H$
Access Type: Write One To Set
Reset Value: N/A

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | OOB Bypass | Reserved | | | | | | | | | LED On | Auto Interlock Accept | PM Enable | Interlock Accept | Interlock Rejec t | 32-bit Activation | Scramble Disable | CONT Disable | Transmit BIST | Resume | Packet Length | LED Disable | Interrupt NCoR | Port Initialize | Device Reset | Port Reset |

This register is used to direct various port operations. A one written to a bit position sets that bit in the control register.

- **Bit [31:26,24:16]**: Reserved (R). These bits are reserved.
- **Bit [25]**: OOB Bypass (W1S). If this bit is set, the Link will bypass the OOB initialization sequence following a reset. This bit is reset by Global Reset, and not reset by Port Reset.
- **Bit [15]**: LED On (W1S). This bit turns on the LED Port Activity indicator regardless of the state of LED Disable (bit 4).
- **Bit [14]**: Auto Interlock Accept (W1S). When this bit is set the link will accept any interlocked FIS reception. The link will transmit R_OK in response to the received FIS.
- **Bit [13]**: PM Enable (W1S). This bit enables Port Multiplier support.
- **Bit [12]**: Interlock Accept (W1S). This bit is used to signal the link to accept an interlocked FIS reception. The link will transmit R_OK in response to the received FIS. This bit is self-clearing.
- **Bit [11]**: Interlock Reject (W1S). This bit is used to signal the link to reject an interlocked FIS reception. The link will transmit R_ERR in response to the received FIS. This bit is self-clearing.
- **Bit [10]**: 32-bit Activation (W1S). When this bit is set to one, a write to the low 32 bits of a Command Activation register will cause the 32-bit Activation Upper Address register contents to be written to the upper 32 bits of the Command Activation register and will trigger command execution. When this bit is zero, a write to the upper 32 bits or all 64 bits of a command activation register is required to trigger command execution. This bit is set for environments that do not address more than $2^{32}$ bytes of host memory.
- **Bit [9]**: Scrambler Disable (W1S). When this bit is set to one, the Link scrambler operation is disabled.

- **Bit [8]**: CONT Disable (W1S). When this bit is set to one, the Link will not generate a CONT following repeated primitives.
- **Bit [7]**: Transmit BIST (W1S). This bit causes transmission of a BIST FIS.
- **Bit [6]**: Resume (W1S). This bit is used to enable processing of outstanding commands to additional devices connected to a port multiplier after a command error has occurred. When this bit is set, the internal BUSY status will be set for the device corresponding to the value of the current Port Multiplier Port. This will prevent additional commands from being sent to the device in error until a Port Initialize operation is performed.
- **Bit [5]**: Packet Length (W1S). This bit directs the length of the packet command to be sent for commands with packet protocol. When this bit is zero, a 12-byte packet will be sent. When this bit is one, a 16-byte packet will be sent. This bit should be set to the same value as derived from word 0 of the identify packet command returned data.
- **Bit [4]**: LED Disable (R/W). This bit disables the operation of the LED Port Activity indicator.
- **Bit [3]**: Interrupt No Clear on Read (W1S). When this bit is set to one, a command completion interrupt may be cleared only by writing a one to the Command Completion bit in the Port Interrupt Status register. When this bit is zero, reading the Port Slot Status register may also be used to clear the Command Completion interrupt.
- **Bit [2]**: Port Initialize (W1S). Setting this bit to one causes all commands to be flushed from the port and all command execution parameters to be set to an initialized state. Setting this bit to one causes the port ready bit in the port status register to be cleared to zero. When the initialization procedure is complete, the port ready bit will be set to one. This bit is self-clearing and will be cleared upon execution by the port.
- **Bit [1]**: Device Reset (W1S). Setting this bit to one causes all commands to be flushed from the port and all command execution parameters to be set to an initialized state. Setting this bit to one causes the port ready bit in the port status register to be cleared to zero. The port will generate the COMRESET primitive on the serial ATA bus. When the out of band sequence and initialization procedure is complete, the port ready bit will be set to one. This bit is self-clearing and will be cleared upon execution by the port.
- **Bit [0]**: Port Reset (W1S). Setting this bit to one causes the port to be held in a reset state. No commands will be executed while in this state. All port registers and functions are reset to their initial state, except as noted below. All commands are flushed from the port and all command execution parameters are set to an initialized state. Setting this bit to one causes the port ready bit in the port status register to be cleared to zero. Upon setting this bit to zero from an asserted state, the port will generate the COMRESET primitive on the serial ATA bus. When the out of band sequence and initialization procedure is complete, the port ready bit will be set to one. This bit is set to one by the Global reset, which is set by a PCI reset, and remains set until cleared by the host (by writing a one to bit 0 of the Port Control Clear register).
  The register bits that are not initialized by the Port Reset are:
  - OOB Bypass (bit 25) in Port Control (this register)
  - Port PHY Configuration register (all bits)

## Port Status

Address Offset: $1000_H$
Access Type: Read
Reset Value: 0x001F_0001

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Port Ready | Reserved | | | | | OOB Bypass | Reserved | | | | Active Slot | | | | | LED On | Auto Interlock Accept | PM Enable | Interlock Accept | Interlock Reject | 32-bit Activation | Scramble Disable | CONT Disable | Transmit BIST | Resume | Packet Length | LED Disable | Interrupt NCoR | Port Initialize | Device Reset | Port Reset |

This register is used to determine the status of various port functions.

- **Bit [31]**: Port Ready (R). This bit reports the Port Ready status. The transition from 0 to 1 of this bit generates the Port Ready Interrupt Status (bit 18/2 of the Port Interrupt Status register).
- **Bit [30:26,24:21]**: Reserved (R). These bits are reserved.
- **Bit [20:16]**: Active Slot (R). This bit field contains the slot number of the command currently being executed. When a command error occurs, this bit field indicates the slot containing the command in error.
- **Bit [25,15:0]**: These bits reflect the current state of the corresponding bits in the Port Control register. Refer to the Port Control Set register for a complete description.

## Port Control Clear

Address Offset: $1004_H$
Access Type: Write One To Clear
Reset Value: N/A

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | OOB Bypass | Reserved | | | | | | | | | LED On | Auto Interlock Accept | PM Enable | Reserved | | 32-bit Activation | Scramble Disable | CONT Disable | Transmit BIST | Resume | Packet Length | LED Disable | Interrupt NCoR | Reserved | | Port Reset |

This register is used to direct various port operations. A one written to a bit position clears that bit in the control register.

- **Bit [31:26,24:16,12:11,2:1]**: Reserved (R). These bits are reserved.
- **Bit [25, 15:13,10:3,0]**: (W1C) Writing a one to these bits clears the associated bit position of the Port Control register. Refer to the Port Control Set register for bit descriptions.

## Port Interrupt Status

Address Offset: $1008_H$
Access Type: Read/Write 1 Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | SDB Notify | Hshk Error Thresh | CRC Error Thresh | 8b/10 Error Thresh | DevExchg | UnrecFIS | Comwake | PhyRdyChg | PM Change | Port Ready | Command Error | Cmd Completion | Reserved | | | | SDB Notify | Hshk Error Thresh | CRC Error Thresh | 8b/10 Error Thresh | DevExchg | UnrecFIS | Comwake | PhyRdyChg | PM Change | Port Ready | Command Error | Cmd Completion | | |

This register is used to report the interrupt status. The status bits in the upper half of the register report the described condition. The status bits in the lower half of the register are masked by the corresponding interrupt enable bits or by the setting in the corresponding threshold registers. Writing a 1 to either interrupt status bit clears it.

- **Bit [31:28,15:12]**: Reserved (R). These bits are reserved.
- **Bit [27/11]**: SDB Notify (W1C). This bit indicates that a Set Device Bits FIS was received with the N-bit (bit 15 of first dword) set to one.
- **Bit [26/10]**: Handshake Error Threshold (W1C). This bit indicates that the Handshake error count is equal to or greater than the Handshake error threshold. Bit 10 is masked if the Handshake Error Threshold register contains a zero threshold setting. When a 1 is written to this bit, both the status bit and the Handshake Error Counter are cleared.
- **Bit [25/9]**: CRC Error Threshold (W1C). This bit indicates that the CRC error count is equal to or greater than the CRC error threshold. Bit 9 is masked if the CRC Error Threshold register contains a zero threshold setting. When a 1 is written to this bit, both the status bit and the CRC Error Counter are cleared.
- **Bit [24/8]**: 8b/10b Decode Error Threshold (W1C). This bit indicates that the 8b/10b Decode error count is equal to or greater than the 8b/10b Decode error threshold. Bit 8 is masked if the 8b/10b Decode Error Threshold register contains a zero threshold setting. When a 1 is written to this bit, both the status bit and the 8b/10b Decode Error Counter are cleared.
- **Bit [23/7]**: DevExchg (Device Exchanged) (W1C) – This bit is the X bit in the DIAG field of the SError register. It may be cleared by writing a corresponding one bit to either register.
- **Bit [22/6]**: UnrecFIS (Unrecognized FIS Type) (W1C) – This bit is the F bit in the DIAG field of the SError register. It may be cleared by writing a corresponding one bit to either register.
- **Bit [21/5]**: ComWake (W1C) – This bit is the W bit in the DIAG field of the SError register. It may be cleared by writing a corresponding one bit to either register.
- **Bit [20/4]**: PhyRdyChg (W1C) – This bit is the N bit in the DIAG field of the SError register. It may be cleared by writing a corresponding one bit to either register.
- **Bit [19/3]**: PM Change (W1C). This bit indicates that a change has occurred in the power management state.
- **Bit [18/2]**: Port Ready (W1C). This bit indicates that the port has become ready to accept and execute commands. This status indicates that Port Ready (bit 31 in the Port Status register) has made a 0 to 1 transition. Clearing this status does not change the Port Ready bit in the Port Status register and this status is not set subsequently until the Port Ready bit changes state.
- **Bit [17/1]**: Command Error (W1C). This bit indicates that an error occurred during command execution. The error type can be determined via the port error register.
- **Bit [16/0]**: Command Completion (W1C). This bit indicates that one or more commands have completed execution.

## Port Interrupt Enable Set / Port Interrupt Enable Clear

Address Offset: $1010_H$ / $1014_H$
Access Type: Read/Write 1 Set/Write 1 Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interrupt Steering | | | | | | | | | | | | | | | | | | | | SDB Notify | Reserved | | | DevExchg | UnrecFIS | Comwake | PhyRdyChg | PM Change | Port Ready | Command Error | Cmd Completion |

The Interrupt Enable register is controlled by these registers. Writing to the Interrupt Enable Set register sets the Interrupt Enable bits; the enable bit is set for each corresponding bit to which a 1 is written. Writing to the Interrupt Enable Clear register clears the Interrupt Enable bits; the enable bit is cleared for each corresponding bit to which a 1 is written. The Interrupt Enable register may be read at either address offset.

Note that bits 8, 9, and 10 do not have an enable bit; the corresponding interrupts are enabled by corresponding threshold registers.

- **Bit [31:30]**: Interrupt Steering (R/W). This bit field specifies which one of the four interrupts is to be used for interrupts from this port. INTA is selected by $00_B$; INTB by $01_B$; INTC by $10_B$; and INTD by $11_B$.
- **Bit [29:12,10:8]**: Reserved (R). These bits are reserved and return zeros on a read.
- **Bit [11,7:0]**: Interrupt Enables (R/W1S/W1C). These bits are the interrupt enables for the corresponding bits of the Interrupt Status register.

## 32-bit Activation Upper Address

Address Offset: $101C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upper Address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register contains the 32-bit value written to the upper half of the Command Activation register when the lower half of that register is written and the 32-bit Activation control bit (bit 10) is set in the Port Control register.

## Port Command Execution FIFO

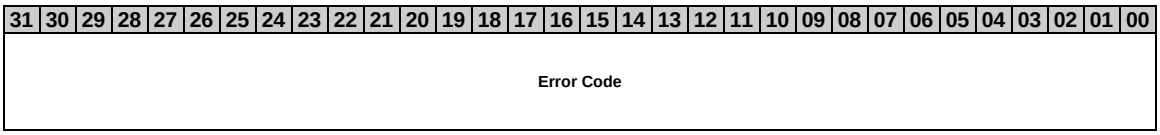
Address Offset: $1020_H$
Access Type: Read/Write
Reset Value: 0x0000_00XX

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | Execution Slot Number | | | | |

When written, this register causes the supplied slot number to be pushed into the tail of the command execution FIFO. A valid PRB must be populated in the associated slot in port LRAM. When read, this register supplies the entry at the head of the command execution FIFO. The FIFO is not popped as a result of a read operation.

## Port Command Error

Address Offset: $1024_H$
Access Type: Read
Reset Value: 0x0000_0000




This register contains the error type resulting from a command error. Table 42 lists the error codes, error names, and error descriptions.

**Table 42. Command Error Codes**

| Error Name | Code | Description |
|---|---|---|
| DEVICEERROR | 1 | The ERR bit was set in a "register - device to host" FIS received from the device. The task file registers are written back to PRB slot for host scrutiny. |
| SDBERROR | 2 | The ERR bit was set in a "set device bits" FIS received from the device. |
| DATAFISERROR | 3 | The SiI3132 detected an error during command execution that was not reported by the device upon command completion. |
| SENDFISERROR | 4 | The SiI3132 was unable to send the Initial command FIS for a command. This can occur if a low-level link error occurs during command transmission. |
| INCONSISTENTSTATE | 5 | The SiI3132 detected an inconsistency in protocol. Any departure from standard Serial ATA protocol that causes indecision in the internal sequencers will cause this error. |
| DIRECTIONERROR | 6 | A Data FIS was received when a write data protocol was specified or a DMA Activate FIS was received when a read data protocol was specified. |
| UNDERRUNERROR | 7 | While transferring data from the SiI3132 to a device, the end of the Scatter Gather list was encountered before the entire transfer was completed. The device is requesting additional data but there is no Scatter Gather Entry to define the source of data. |
| OVERRUNERROR | 8 | While transferring data from a device to the SiI3132, the end of the Scatter Gather list was encountered before the entire transfer was completed. Data was received from the device but there is no Scatter Gather Entry to define where the data should be deposited. |
| LLOVERRUNERROR | 9 | Low level overrun error. While transferring data from a device to the SiI3132, the transfer count received in a PIO Setup or DMA Setup FIS has been satisfied and there is additional data being received from the device. |
| PACKETPROTOCOLERROR | 11 | During the first PIO setup of Packet command, the data direction bit was invalid, indicating a transfer from device to host. |
| PLDSGTERRORBOUNDARY | 16 | A requested Scatter Gather Table not aligned on a quadword boundary. All addresses defining Scatter Gather Tables must be quadword aligned. Bits[2:0] must be zeroes. |
| PLDSGTERRORTARGETABORT | 17 | A PCI Target Abort occurred while the SiI3132 was fetching a Scatter Gather Table from host memory. |
| PLDSGTERRORMASTERABORT | 18 | A PCI Master Abort occurred while the SiI3132 was fetching a Scatter Gather Table from host memory. |
| PLDSGTERRORPCIPERR | 19 | A PCI Parity Error occurred while the SiI3132 was fetching a Scatter Gather Table from host memory. |
| PLDCMDERRORBOUNDARY | 24 | The address of a PRB written to a command activation register was not aligned on a quadword boundary. All PRB addresses must be quadword aligned. Bits[2:0] must be zeroes. |
| PLDCMDERRORTARGETABORT | 25 | A PCI Target Abort occurred while the SiI3132 was fetching a Port Request Block (PRB) from host memory. |

**Table 42. Command Error Codes (continued)**

| Error Name | Code | Description |
|---|---|---|
| PLDCMDERRORMASTERABORT | 26 | A PCI Master Abort occurred while the SiI3132 was fetching a Port Request Block (PRB) from host memory. |
| PLDCMDERRORPCIPERR | 27 | A PCI Parity Error occurred while the SiI3132 was fetching a Port Request Block (PRB) from host memory. |
| PSDERRORTARGETABORT | 33 | A PCI Target Abort occurred while data transfer was underway between the SiI3132 and host memory. |
| PSDERRORMASTERABORT | 34 | A PCI Master Abort occurred while data transfer was underway between the SiI3132 and host memory. |
| PSDERRORPCIPERR | 35 | A PCI Parity Error occurred while data transfer was underway between the SiI3132 and host memory. |
| SENDSERVICEERROR | 36 | A FIS was received while attempting to transmit a Service FIS. Following the receipt of a Set Device Bits FIS containing a service request, the device sent another FIS before allowing the host to send a Service FIS. |

## Port FIS Configuration

Address Offset: $1028_H$
Access Type: Read/Write
Reset Value: 0x1000_1555

| 31 30 | 29 28 | 27 26 | 25 24 | 23 22 | 21 20 | 19 18 | 17 16 | 15 14 | 13 12 | 11 10 | 09 08 | 07 06 | 05 04 | 03 02 | 01 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | FIS27cfg | FIS34cfg | FIS39cfg | FIS41cfg | FIS46cfg | FIS58cfg | FIS5Fcfg | FISA1cfg | FISA6cfg | FISB8cfg | FISBFcfg | FISC7cfg | FISD4cfg | FISD9cfg | FISOcfg |

This register contains bits for controlling Serial ATA FIS reception. For each possible FIS type, a 2-bit code defines the desired reception behavior as follows:

- 00 – Accept FIS without interlock.
- 01 – Reject FIS without interlock
- 10 – Interlock FIS. Receive FIS into slot reserved for interlocked FIS reception. If no slot has been reserved, reject the FIS.
- 11 – Reserved.

Bit[1:0] (FISOcfg) defines the 2-bit code for all other FIS types not defined by bits [29:2].

The following table defines the default behavior of FIS configuration.

**Table 43. Default FIS Configurations**

| FIS Code | FIS Name | Configuration Bits | | Default Action |
|---|---|---|---|---|
| | | Signals | Default Value | |
| 27h | Register (Host to Device) | fis27cfg[1:0] | 01b | reject FIS without interlock |
| 34h | Register (Device to Host) | fis34cfg[1:0] | 00b | accept FIS without interlock |
| 39h | DMA Activate | fis39cfg[1:0] | 00b | accept FIS without interlock |
| 41h | DMA Setup | fis41cfg[1:0] | 00b | accept FIS without interlock |
| 46h | Data | fis46cfg[1:0] | 00b | accept FIS without interlock |
| 58h | BIST Activate | fis58cfg[1:0] | 00b | accept far-end retimed loopback, reject any other |
| 5Fh | PIO Setup | fis5Fcfg[1:0] | 00b | accept FIS without interlock |
| A1h | Set Device Bits | fisa1cfg[1:0] | 00b | accept FIS without interlock |
| A6h | reserved | fisa6cfg[1:0] | 01b | reject FIS without interlock |
| B8h | reserved | fisb8cfg[1:0] | 01b | reject FIS without interlock |
| BFh | reserved | fisbFcfg[1:0] | 01b | reject FIS without interlock |
| C7h | reserved | fisc7cfg[1:0] | 01b | reject FIS without interlock |
| D4h | reserved | fisd4cfg[1:0] | 01b | reject FIS without interlock |
| D9h | reserved | fisd9cfg[1:0] | 01b | reject FIS without interlock |
| Others | reserved | fisocfg[1:0] | 01b | reject FIS without interlock |

## Port PCI Express Request FIFO Threshold

Address Offset: $102C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | PCI Exp Write Request Threshold | | | | | | | | Reserved | | | Reserved | | | | | PCI Exp Read Request Threshold | | | | | | | | Reserved | | |

This register contains threshold levels at which the PCI Express master state machine will request the PCI Express bus relative to the amount of data or free space in the data FIFO. The data FIFO capacity is 2kbyte (256 Qwords). When writing to host memory (reading data from a device), the PCI Express Write Request Threshold is compared to the amount of data in the data FIFO. When the FIFO contents exceed the threshold value, a request is issued to write the data to host memory, emptying the contents of the data FIFO. When reading host memory (writing data to a device) the PCI Express Read Request Threshold is compared to the amount of free space in the data FIFO. When the free space exceeds the threshold value, a request is issued to read data from host memory to fill the FIFO.

- **Bit [31:27]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [26:19]:** PCI Exp Write Request Threshold (R/W). This field defines the number of Qwords that must be in the data FIFO before issuing a PCI Express request. A value of zero will cause a request if the FIFO contains any amount of data.
- **Bit [18:16]**: Reserved (R). This bit field is reserved and returns zeros on a read. This field is defined so that the host may write a byte count value into the threshold register.
- **Bit [15:11]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [10:3]:** PCI Exp Read Request Threshold (R/W). This field defines the number of Qwords that must be available in the data FIFO before issuing a PCI Express request. A value of zero will cause a request if the FIFO contains any free space and the DMA is active.
- **Bit [2:0]**: Reserved (R). This bit field is reserved and returns zeros on a read. This field is defined so that the host may write a byte count value into the threshold register.

## Port 8B/10B Decode Error Counter

Address Offset: $1040_H$
Access Type: Read/Write/Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8B/10B Decode Error Threshold | | | | | | | | | | | | | | | | 8B/10B Decode Error Counter | | | | | | | | | | | | | | | |

This register counts the number of 8B/10B Decode Errors that have occurred since last cleared.

- **Bit [31:16]**: 8B/10B Decode Error Threshold (R/W). This bit field defines the count at which an interrupt will be asserted. When the count in bits 15:0 is equal to this value, an 8B/10B interrupt will be latched. A threshold value of zero disables interrupt assertion and masks the corresponding interrupt status bit in the Port Interrupt Status register.
- **Bit [15:0]**: 8B/10B Decode Error Count (R/WC). This bit field represents the count of 8B/10B errors that have occurred since this register was last written. Any write to this register field will clear both the counter and the interrupt condition. Clearing the interrupt status bit will also clear the counter. The count will not overflow. Once this register reaches its maximum count, it will retain that count until cleared to zero by a write operation.

## Port CRC Error Counter

Address Offset: $1044_H$
Access Type: Read/Write/Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRC Error Counter Threshold | | | | | | | | | | | | | | | | CRC Error Counter | | | | | | | | | | | | | | | |

This register counts the number of Serial ATA CRC Errors that have occurred since last cleared.

- **Bit [31:16]**: Serial ATA CRC Error Threshold (R/W). This bit field defines the count at which an interrupt will be asserted. When the count in bits 15:0 is equal to this value, a serial ATA CRC interrupt will be latched. A threshold value of zero disables interrupt assertion and masks the corresponding interrupt status bit in the Port Interrupt Status register.
- **Bit [15:0]**: Serial ATA CRC Error Count (R/WC). This bit field represents the count of Serial ATA CRC errors that have occurred since this register was last written. Any write to this register will clear both the counter and the interrupt condition. Clearing the interrupt status bit will also clear the counter. The count will not overflow. Once this register reaches its maximum count, it will retain that count until cleared to zero by a write operation.

## Port Handshake Error Counter

Address Offset: $1048_H$
Access Type: Read/Write/Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Serial ATA Handshake Error Counter Threshold | | | | | | | | | | | | | | | | Serial ATA Handshake Error Counter | | | | | | | | | | | | | | | |

This register counts the number of Serial ATA Handshake Errors that have occurred since last cleared.

- **Bit [31:16]**: Serial ATA Handshake Error Threshold (R/W). This bit field defines the count at which an interrupt will be asserted. When the count in bits 15:0 is equal to this value, a serial ATA Handshake interrupt will be latched. A threshold value of zero disables interrupt assertion and masks the corresponding interrupt status bit in the Port Interrupt Status register.
- **Bit [15:0]**: Serial ATA Handshake Error Count (R/WC). This bit field represents the count of Serial ATA Handshake errors that have occurred since this register was last written. Any write to this register will clear both the counter and the interrupt condition. Clearing the interrupt status bit will also clear the counter. The count will not overflow. Once this register reaches its maximum count, it will retain that count until cleared to zero by a write operation.

## Port PHY Configuration

Address Offset: $1050_H$
Access Type: Read/Write
Reset Value: 0x0000_020C

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHY Status | | | | | | | | | | | | | | | | PHY Config | | | | | | | | | | | | | | | |

The Port PHY Configuration register is reset by the Global Reset, not by the Port Reset. The reset value is 0x0000020C.

- **Bit[31:16]**: PHY Status (R). These bits report status of the PHY (currently always 0).
- **Bit[15:5]**: PHY Config (R/W). These bits configure the PHY. The value should not be changed as erratic operation may result.
- **Bit[4:0]**: Tx Amplitude (R/W) These bits set the nominal output swing for the Transmitter. The amplitude will be increased by 50mV by an increment of the value.

## Port Device Status Register

Address Offset: $F80_H$ (PM Port 0)/ $F88_H$ (PM Port 1) / $F90_H$ (PM Port 2) / $F98_H$ (PM Port 3) / $FA0_H$ (PM Port 4) / $FA8_H$ (PM Port 5) / $FB0_H$ (PM Port 6) / $FB8_H$ (PM Port 7) / $FC0_H$ (PM Port 8) / $FC8_H$ (PM Port 9) / $FD0_H$ (PM Port 10) / $FD8_H$ (PM Port 11) / $FE0_H$ (PM Port 12) / $FE8_H$ (PM Port 13) / $FF0_H$ (PM Port 14) / $FF8_H$ (PM Port 15)
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reserved | | | | | | | | | | | | | | | service_pending | legacy_queue | native_queue | device_busy | exec_active_slot | | | | | pio_end_status | | | | | | | |

These 16 registers contain information useful for diagnosing behavior of the execution unit. These 16 registers contain Port Multiplier device specific information. Address Offset bits 6 to 3 are the Port Multiplier Port number for the device to which the status bits apply. There is one register for each of 16 possible port multiplier ports. These registers are part of the LRAM.

- **Bit [31:17]**: Reserved
- **Bit [16]**: service_pending (R/W). Indicates that a service request has been received from this device and a SERVICE command has not yet been acknowledged.
- **Bit [15]**: legacy_queue (R/W). Indicates that one or more legacy queued commands are outstanding to this device.
- **Bit [14]**: native_queue (R/W). Indicates that one or more native queued commands are outstanding to this device.
- **Bit [13]**: device_busy (R/W). Virtual BSY bit indicating that a command has been issued to the device without receipt of a final register FIS or that a data transfer is in progress.
- **Bit [12:08]**: exec_active_slot (R/W). Contains the slot number of the last command active on this device.
- **Bit [07:00]**: pio_end_status (R/W). Contains the PIO ending status of the last PIO setup command received from this device.

## Port Device QActive Register

Address Offset: $F84_H$ (PM Port 0)/ $F8C_H$ (PM Port 1) / $F94_H$ (PM Port 2) / $F9C_H$ (PM Port 3) / $FA4_H$ (PM Port 4) / $FAC_H$ (PM Port 5) / $FB4_H$ (PM Port 6) / $FBC_H$ (PM Port 7) / $FC4_H$ (PM Port 8) / $FCC_H$ (PM Port 9) / $FD4_H$ (PM Port 10) / $FDC_H$ (PM Port 11) / $FE4_H$ (PM Port 12) / $FEC_H$ (PM Port 13) / $FF4_H$ (PM Port 14) / $FFC_H$ (PM Port 15)
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| QActive[31:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

These 16 registers contain Port Multiplier device specific status indicating outstanding queued commands in the device. For each bit set to one, a queued command, legacy or native, is outstanding associated with the slot number corresponding to the bit position. There is one register for each of 16 possible port multiplier ports. Address Offset bits 6 to 3 are the Port Multiplier Port number for the device to which the status bits apply.

- **Bit [31:00]**: Each bit corresponds to a slot number that contains an active outstanding legacy or native queued command.

## Port Context Register

Address Offset: $1E04_H$
Access Type: Read

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | PM Port | | | | Slot | | | | |

- **Bit [31:09]**: Reserved
- **Bit [08:05]**: PM Port (R). This field contains the Port Multiplier port number corresponding to the last FIS transferred (transmit or receive). Upon a processing halt due to a device specific error, this field contains the PM port corresponding to the device that returned error status.
- **Bit [04:00]**: Slot (R). This field contains the slot number of the last command processed by the execution unit. Note that this slot number does not necessarily correspond to the command in error during error halt conditions. For native queue error recovery, the command slot in error must be determined by issuing a READ LOG EXTENDED to the device to determine the tag number of the command in error.

## SControl

Address Offset: $1F00_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | PMP | | | | SPM | | | | IPM | | | | SPD | | | | DET | | | |

This register is the SControl register as defined by the Serial ATA specification.

- **Bit [31:16]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [19:16]**: PMP (R/W). This field identifies the currently selected Port Multiplier port for accessing the SActive register and some bit fields of the Diagnostic registers.
- **Bit [15:12]**: SPM (R/W). This field selects a power management state. A non-zero value written to this field causes initiation of the select power management state. This field self-resets to 0 as soon as action begins to initiate the power management state transition.

| Value | Definition |
|---|---|
| 0000 | No power management state transition requested |
| 0001 | Transition to the Partial power management state initiated |
| 0010 | Transition to the Slumber power management state initiated |
| 0100 | Transition from a power management state initiated (ComWake asserted) |
| others | Reserved |

- **Bit [11:08]**: IPM (R/W) – This field identifies the interface power management states that may be invoked via the Serial ATA interface power management capabilities.

| Value | Definition |
|---|---|
| 0000 | No interface power management restrictions (Partial and Slumber modes enabled) |
| 0001 | Transitions to the Partial power management state are disabled |
| 0010 | Transitions to the Slumber power management state are disabled |
| 0011 | Transitions to both the Partial and Slumber power management states are disabled |
| others | Reserved |

- **Bit [07:04]**: SPD (R/W) – This field identifies the highest allowed communication speed the interface is allowed to negotiate.

| Value | Definition |
|---|---|
| 0000 | No restrictions (default value) |
| 0001 | Limit to Generation 1 (1.5 Gbit/s) |
| 0010 | Limit to Generation 2 (3.0 Gbit/s) |
| others | Reserved |

- **Bit [03:00]**: DET (R/W) – This field controls host adapter device detection and interface initialization.

| Value | Action |
|---|---|
| 0000 | No action |
| 0001 | COMRESET is periodically generated until another value is written to the field |
| 0100 | No action |
| Others | Reserved, no action |

## SStatus

Address Offset: $1F04_H$
Access Type: Read
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | IPM | | | | SPD | | | | DET | | | |

This register is the SStatus register as defined by the Serial ATA specification.

- **Bit [31:12]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [11:08]**: IPM (R) – This field identifies the current interface power management state.

| Value | Definition |
|---|---|
| 0000 | Device not present or communication not established |
| 0001 | Interface in active state |
| 0010 | Interface in Partial power management state |
| 0110 | Interface in Slumber power management state |
| Others | Reserved |

- **Bit [07:04]**: SPD (R) – This field identifies the negotiated interface communication speed.

| Value | Definition |
|---|---|
| 0000 | No negotiated speed |
| 0001 | Generation 1 communication rate (1.5 Gbit/s) |
| 0010 | Generation 2 communication rate (3.0 Gbit/s) |
| Others | Reserved |

- **Bit [03:00]**: DET (R) – This field indicates the interface device detection and PHY state.

| Value | Action |
|---|---|
| 0000 | No device detected and PHY communication not established |
| 0001 | Device presence detected but PHY communication not established |
| 0011 | Device presence detected and PHY communication established |
| 0100 | PHY in offline mode as a result of the interface being disabled or running in a BIST loopback mode |
| Others | Reserved, no action |

## SError

Address Offset: $1F08_H$
Access Type: Read/Write 1 Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | R | R | R | R | X | F | T | S | H | C | D | B | W | I | N | R | R | R | R | E | P | C | T | R | R | R | R | R | R | M | I |
| DIAG | | | | | | | | | | | | | | | | ERR | | | | | | | | | | | | | | | |

This register is the SError register as defined by the Serial ATA specification.

- **Bit [31:16]**: DIAG (R/W1C) – This field contains bits defined as shown in the following table. Writing a 1 to the register bit clears the B, C, F, N, H, W, and X bits. Writing a 1 to the corresponding bits in the Port Interrupt Status register also clears the F, N, W, and X bits. The B, C, and H bits operate independently of the corresponding error counter registers; if the error counters are used, these bits should be ignored.

**Table 44. SError Register Bits (DIAG Field)**

| Bit | Definition | Description |
|---|---|---|
| B | 10b to 8b decode error | Latched decode error or disparity error from the Serial ATA PHY |
| C | CRC error | Latched CRC error from the Serial ATA PHY |
| D | Disparity error | N/A, always 0; this error condition is combined with the decode error and reported as B error |
| F | Unrecognized FIS type | Latched Unrecognized FIS error from the Serial ATA Link |
| I | PHY Internal error | N/A, always 0 |
| N | PHYRDY change | Indicates a change in the status of the Serial ATA PHY |
| H | Handshake error | Latched Handshake error from the Serial ATA PHY |
| R | Reserved | Always 0 |
| S | Link Sequence error | N/A, always 0 |
| T | Transport state transition error | N/A, always 0 |
| W | ComWake | Latched ComWake status from the Serial ATA PHY |
| X | Device Exchanged | Latched ComInit status from the Serial ATA PHY |

- **Bit [15:00]**: ERR – This field is not implemented; all bits are always 0.

## SActive

Address Offset: $1F0C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Active bits | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides indirect access of the Port Device QActive registers (see section 0 for description). It contains the Active bits used to determine the activity of native queued commands for the selected Port Multiplier port (selection in SControl). A one in any bit position indicates that the corresponding command is still active in the device.

### SNotification

Address Offset: $1F10_H$
Access Type: Read/Write 1 to Clear
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | Notify bits | | | | | | | | | | | | | | | |

This register reports the devices that have sent a Set Device Bits FIS with the Notification bit set.

- **Bit [31:16]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [15:00]**: Notify bits (R/W1C) – These 16 bits correspond to the 16 possible devices connected to a Port Multiplier on this port.

## Internal Register Space – Base Address 2

These registers are 32-bits wide and provide Indirect Register Access to the registers of the SiI3132. Access to this register space is through the PCI I/O space.

**Table 45. SiI3132 Internal Register Space – Base Address 2**

| Address Offset | Register Name |
|---|---|
| $00_H$ | Global Register Offset |
| $04_H$ | Global Register Data |
| $08_H$ | Port Register Offset |
| $0C_H$ | Port Register Data |

### Global Register Offset

Address Offset: $00_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | | | | | | | | Dword Offset | | | | | 00 | |

This register provides indirect addressing of a Global Register otherwise accessible directly via Base Address Register 0. The dword address offset for an indirect access is in bits 6 to 2; bits 31 to 7, 1, and 0 are reserved and should always be 0.

### Global Register Data

Address Offset: $04_H$
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As defined for indirectly accessed register | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides the indirect access addressed by the Global Register Offset register.

## Port Register Offset

Address Offset: $08_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reserved | | | | | | | | | | | | | | | | | | Dword Offset | | | | | | | | | | | | 00 | |

This register provides indirect addressing of a Port Register otherwise accessible directly via Base Address Register 1. The dword address offset for an indirect access is in bits 13 to 2; bits 31 to 14, 1, and 0 are reserved and should always be 0.

## Port Register Data

Address Offset: $0C_H$
Access Type: Read/Write

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As defined for indirectly accessed register | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

This register provides the indirect access addressed by the Port Register Offset register.

## Power Management

The register bits described in Table 46 control Power Management in a SiI3132 port.

**Table 46. Power Management Register Bits**

| Register | Bits | Description |
|---|---|---|
| Interrupt Status | PM Change<br>Bit 3 | This bit reports a change in the Power Management mode. It corresponds to the interrupt enabled by bit 3 of the Port Interrupt Enable register. |
| SError | W<br>Bit 18 | This bit reports a ComWake received from the Serial ATA bus. It corresponds to the interrupt enabled by bit 5 of the Port Interrupt Enable register. |
| Interrupt Status | ComWake<br>Bit 5 | |
| SControl | SPM<br>Bits 15-12 | This bit field initiates transitions to/from Partial or Slumber power management states; bit 14 corresponds to ComWake (exit power management); bit 13 corresponds to Slumber mode; bit 12 corresponds to Partial mode. |
| SControl | IPM<br>Bits 11-8 | This bit field disables transitions to Partial or Slumber power management states; bit 9 corresponds to Slumber mode; bit 8 corresponds to Partial mode. |
| SStatus | IPM<br>Bits 11-8 | This bit field reports the power management state; ‘0110’ corresponds to Slumber mode; ‘0010’ corresponds to Partial mode. |

There are two power management modes: Partial and Slumber. These power management modes may be software initiated through the SControl register or device initiated from the Serial ATA device.

Transitions to and from either power management mode generate an interrupt, the Power Management Mode Change Interrupt, which may be masked in the Port Interrupt Enable register (bit 3).

Partial/Slumber mode may be initiated by software through the SControl register. By setting the SPM field to either ‘0001’ (Partial) or ’0010’ (Slumber), software causes a PMREQ to the Serial ATA device, which will respond with either a PMACK or PMNAK. If a PMACK is received the Partial/Slumber mode is entered. A PMNAK is ignored; the request remains asserted.

The Serial ATA device may initiate Partial/Slumber mode. Software enables the acknowledgement of this request by setting the IPM field in the SControl register to ‘0001’ (Partial), ‘0010’ (Slumber), or ‘0011’ (Partial or Slumber). If enabled, a PMACK will be sent to the device; if not enabled, a PMNAK will be sent. When the request is received and its acknowledgement is enabled, Partial/Slumber mode is entered.

Partial/Slumber mode status is reported in the SStatus register (‘0010’/’0110’ in the IPM field).

Partial/Slumber mode is cleared by ComWake (asserted when the SPM field is set to ‘0100’).

# Flash, GPIO, EEPROM, and I²C Programming

## Flash Memory Access

The SiI3132 supports an external flash memory device of up to 4 Mbits (512 kbytes) in capacity. Access to the flash memory is available using either PCI Direct Access or Register Access.

### PCI Direct Access

Access to the Expansion ROM is enabled by setting bit 0 in the Expansion Rom Base Address register at Offset 30h of the PCI Configuration Space. When this bit is set, bits [31:19] of the same register are programmable by the system to set the base address for all flash memory accesses. Read and write operations with the flash memory are initiated by Memory Read and Memory Write commands on the PCI bus. Accesses may be as bytes, words, or dwords.

### Register Access

This type of flash memory access is carried out through a sequence of internal register read and write operations. The proper programming sequences are detailed below.

#### Flash Write Operation

Verify that Flash Address register bit 25 (Mem Access Start) is zero. The bit is one when a memory access is in progress. It is zero when the memory access is complete and ready for another operation.

Program the write address for the flash memory access. The address field is bits [18:0] in the Flash Address register.

Program the write data for the flash memory access. The data field is bits [7:0] in the Flash Memory Data register.

Program Flash Address register bit 24 (Mem Access Type) to zero for a memory write.

Initiate the flash memory access by setting bit 25 in the Flash Address register.

#### Flash Read Operation

Verify that Flash Address register bit 25 (Mem Access Start) is zero. The bit is one when a memory access is in progress. It is zero when the memory access is complete and ready for another operation.

Program the read address for the flash memory access. The address field is bits [18:0] in the Flash Address register.

Program Flash Address register bit 24 (Mem Access Type) to one for a memory read.

Initiate the flash memory access by setting bit 25 in the Flash Address register.

Verify that Flash Address register bit 25 (Mem Access Start) is clear. The bit is one when a memory access is in progress. It is zero when the memory access is complete.

Read the data from bits [7:0] in the Flash Memory Data register.

## I²C Operation

The SiI3132 provides a Multimaster I²C interface. For Auto-initialization of some PCI Configuration registers an external 256-byte EEPROM memory device may be connected to this I²C interface (see section 0). Two registers are provided for programmed read/write access to the I²C interface: the I²C Address register and the I²C Data/Control register.

### I²C Write Operation

Verify that I²C Data/Control register bit 31 (I²C Access Start) is zero. The bit is one when an access is in progress. It is zero when the access is complete and another operation may be started.

Write '1' to clear bit 28 in the I²C Data/Control register. This bit is set if an error occurred during a previous access.

Program the write address for the access in the I²C Address register.

Program the write data for the access in the I²C Data/Control register (bits 7:0).

Write zero to bit 24 (I²C Access Type) in the I²C Address register.

Initiate the I²C write by setting bit 31 (I²C Access Start) in the I²C Data/Control register.

Poll bit 31 in the I²C Data/Control register. The bit is one while an access is in progress. It becomes zero when the access completes. (Alternatively, the I²C Interrupt may be enabled. See the Global Control register and Global Interrupt Status register descriptions on page 55.)

Check bit 28 in the I²C Data/Control register. The bit is set if an error occurred during the access.

### I²C Read Operation

Verify that I²C Data/Control register bit 31 (I²C Access Start) is zero. The bit is one when an access is in progress. It is zero when the access is complete and another operation may be started.

Write '1' to clear bit 28 in the I²C Data/Control register. The bit is set if an error occurred during a previous access.

Program the read address for the access in the I²C Address register.

Write one to bit 24 (I²C Access Type) in the I²C Address register.

Initiate the I²C read by setting bit 31 (I²C Access Start) in the I²C Data/Control register.

Poll bit 31 in the I²C Data/Control register. The bit is one while an access is in progress. It becomes zero when the access completes. (Alternatively, the I²C Interrupt may be enabled. See the Global Control register and Global Interrupt Status register descriptions on page 55.)

Check bit 28 in the I²C Data/Control register. The bit is set if an error occurred during the access.

Read the data from bits 7:0 in the I²C Data/Control register.

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