August 2006

Revision History

Revision	Comment	Date
A	Derived from preliminary specification of SiI3531	10/12/06
C	This document is no longer under NDA. Removed confidential markings	02/02/07

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1 Overview

The Silicon Image SiI3531A is a PCI Express to single port Serial ATA controller. The SiI3531A is designed to provide serial ATA connectivity with minimal host overhead and host to device latency. The SiI3531A supports a 1-lane 2.5 Gb/s PCI Express bus and the Serial ATA Generation 2 transfer rate of 3.0 Gb/s (300 MB/s).

1.1 Features

1.1.1 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
- Fabricated in a 0.18µ CMOS process with a 1.8 volt core and 3.3 volt I/Os
- Available in a 48-pin QFN package (7x7 mm, 0.4 mm lead pitch). **EPAD must be soldered to PCB GND.**

1.1.2 PCI Express Features

- Supports 1-lane 2.5 Gb/s PCI Express
- 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

1.1.3 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 Gb/s
  - Output Swing Control
- Supports Native Queuing
- Supports First Party DMA
- Supports Port Multipliers
- 31 Commands and Scatter/Gather Tables on-chip
- Protocol Override per Command

1.2 References

- Serial ATA / High Speed AT Attachment specification, Revision 1.0a
- Serial ATA II: Extensions to Serial ATA 1.0a, Revision 1.2
- Serial ATA II: Port Multiplier, Revision 1.1 and Revision 1.2
- Serial ATA II: Electrical Specification, Revision 1.0
- Serial ATA II: Cables and Connectors, Volumes 1 and 2
- PCI Express Base Specification Revision 1.0a
- PCI Express Card Electromechanical Specification Revision 1.1

2 Electrical Characteristics

2.1 Device Electrical Characteristics

Specifications are for Commercial Temperature range, 0°C to +70°C, unless otherwise specified.

Symbol	Parameter	Ratings	Unit
VDDO	I/O Supply Voltage	4.0	V
VDDD	Core Supply Voltage	2.15	V
VDDSRX VDDSTX VDDSPLL VDDPRX VDDPTX VDDPPLL VDDX	Supply Voltage for S-ATA Receivers, Transmitters, PLLs Oscillator, respectively	2.15	V
V_{IN}	Input Voltage	-0.3 ~ VDD+0.3	V
I_{OUT}	DC Output Current	16	mA
θ_{JA}	Thermal Resistance, Junction to Ambient, Still Air	29.9[1]	°C/W
T_{STG}	Storage Temperature	-65 ~ 150	°C

Note1: **EPAD must be soldered to PCB GND**

Table 2-1 Absolute Maximum Ratings

Symbol	Parameter	Condition	Type	Limits			Unit
				Min	Typ	Max	
VDDD	Core Supply Voltage	-	-	1.71	1.8	1.89	V
VDDSRX	S-ATA Receiver Supply Voltage	-	-				
VDDSTX	S-ATA Transmitter Supply Voltage	-	-				
VDDSPLL	S-ATA SerDes PLL Supply Voltage	-	-				
VDDPRX	PCI Exp Receiver Supply Voltage	-	-				
VDDPTX	PCI Exp Transmitter Supply Voltage	-	-				
VDDPPLL	PCI Exp SerDes PLL Supply Voltage	-	-				
VDDX	Oscillator Power	-	-				
VDDO	Supply Voltage(I/O)	-	-	3.0	3.3	3.6	V
$IDD_{1.8V}$	Supply Current (1.8V Supply)	3GHz Operating	-	-	290*	330*	mA
V_{IH}	Input High Voltage	-	-	2.0	-	-	V
V_{IL}	Input Low Voltage	-	-	-	-	0.8	V
V+	Input High Voltage	-	Schmitt	2.0	-	-	V
V-	Input Low Voltage	-	Schmitt	-	-	0.8	V
V_H	Hysteresis Voltage	-	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

*3.3V power consumption depends on LED status. If all LEDs are disabled, 3.3V power consumption will be uA.

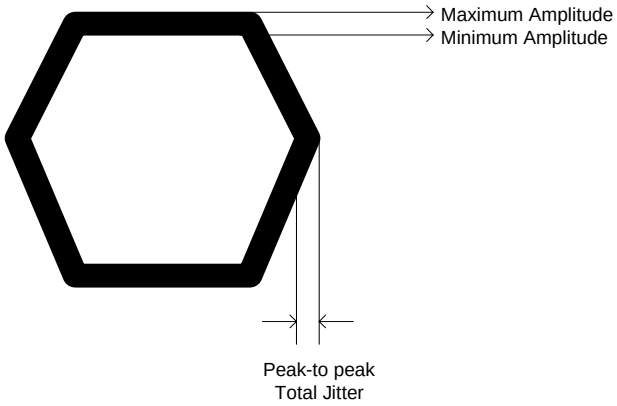
Table 2-2 DC Specifications

Symbol	Parameter	Condition	Limits			Unit
			Min	Typ	Max	
V_{DOUT}	TX+/TX- differential peak-to-peak voltage swing.	Terminated by 50 Ohms. Tx Swing Value = 1100	400	500	700	mV
V_{DIN}	RX+/RX- differential peak-to-peak input sensitivity		200			mV
V_{SATA_SQ}	RX+/RX- OOB Signal Detection Threshold		50	125	200	mV
V_{SATA_ACCM}	Tx AC common-mode voltage				50	mV
Z_{SATA_DIN}	Tx Pair Differential impedance		85	100	115	ohms
Z_{SATA_DOUT}	Rx Pair Differential impedance		85	100	115	ohms
Z_{SATA_SIN}	Tx Single-Ended impedance		40			ohms
Z_{SATA_SOUT}	Rx Single-Ended impedance		40			ohms

Table 2-3 SATA 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 Ohms.	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	ohms
Z_{PCI_DOUT}	Rx Pair Differential impedance	DC impedance	80	100	120	ohms
Z_{PCI_SIN}	Tx Single-Ended impedance	DC impedance	40	50	60	ohms
Z_{PCI_SOUT}	Rx Single-Ended impedance	DC impedance	40	50	60	ohms
$Z_{PCI\_RX-HIGH-IMP-DC}$	Rx Powered Down Impedance	DC impedance	200k			ohms
$Z_{PCI\_RX-IDLE-DET-DIFFp-p}$	Electrical Idle Detect Threshold	Measured at the Rx pins	65		175	mV

Table 2-4 PCI Express Interface DC Specifications



Eye Diagram

2.2 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 20%-80% at Gen 2	100 67		273 136	ps
$T_{TX\_TOL\_FREQ}$	Tx Frequency Long Term Stability		-350		+350	ppm

Table 2-5 SATA Interface Timing Specifications

2.3 SATA Interface Transmitter Output Jitter Characteristics

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		50		ps
TJ_{250UI_15G}	Total Jitter, Data-Data 250UI	Measured at Tx output pins peak to peak phase variation Random data pattern		85		ps
DJ_{250UI_15G}	Deterministic Jitter, Data-Data 250UI	Measured at Tx output pins peak to peak phase variation Random data pattern		55		ps

Table 2-6 SATA Interface Transmitter Output Jitter Characteristics, 1.5 Gb/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 clock pattern Load = LL Laboratory Load		70*		ps
$DJ_{fBAND/10\_3G}$	Deterministic Jitter, $f_{C3dB}=f_{BAUD}/10$	Measured at SATA Compliance Point clock pattern Load = LL Laboratory Load		45*		ps
$TJ_{fBAND/500\_3G}$	Total Jitter, $f_{C3dB}=f_{BAUD}/500$	Measured at SATA Compliance Point Random data pattern Load = LL Laboratory Load		80		ps
$DJ_{fBAND/500\_3G}$	Deterministic Jitter, $f_{C3dB}=f_{BAUD}/500$	Measured at SATA Compliance Point Random data pattern Load = LL Laboratory Load		55		ps

Table 2-7 SATA Interface Transmitter Output Jitter Characteristics, 3 Gb/s

* With $f_{C3dB}=f_{BAUD}/10$ bandwidth, jitter analysis algorithm provided by oscilloscope manufacture requires full transition density which is clock pattern. A series resistor of 75ohms should be populated close to the VDDX pin

2.4 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

Table 2-8 PCI Express Interface Timing Specifications

2.5 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		80		ps

Table 2-9 PCI Express Interface Transmitter Output Jitter Characteristics

2.6 XTALI Requirements

Symbol	Parameter	Condition	Limits			Unit
			Min	Typ	Max	
T_{XTAL_FREQ}	Nominal Frequency			25		MHz
T_{XTALI_J}	XTALI frequency tolerance	-	-50		+50	ppm

Table 2-10 XTALI Requirements

2.7 Power Supply Noise Requirements

Symbol	Parameter	Condition	Limits			Unit
			Min	Typ	Max	
V_{NOISE_VDDA}	1.8V Analog Power Noise	peak-to-peak sinewave across 50KHz to 50MHz frequency range. 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

Table 2-11 Power Supply Noise Requirements

3 Pin Definition

3.1 SiI3531A Pin Listing

This section describes the pin-out of the SiI3531A PCI Express to Serial ATA host controller. The table below 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 3-1 SiI3531A Pin Listing

Pin #	Pin Name	Type	Drive	Internal Resistor	Description
2	XTALO	Analog			Crystal Output
3	XTALI	Analog			Crystal Input
7	SRx+	Diff In			Serial ATA differential receiver + input
8	SRx-	Diff In			Serial ATA differential receiver – input
10	STx-	Diff Out			Serial ATA differential transmitter – output
11	STx+	Diff Out			Serial ATA differential transmitter + output
15	PRx+	Diff In			PCI Express differential receiver + input
16	PRx-	Diff In			PCI Express differential receiver – input
19	PTx-	Diff Out			PCI Express differential transmitter – output
20	PTx+	Diff Out			PCI Express differential transmitter + output
23	REFCLK+	Diff In			PCI Express differential reference clock + input
24	REFCLK-	Diff In			PCI Express differential reference clock - input
25	PERST_N	I-Schmitt			PCI Express Reset
27	LED0	OD	12 mA		Activity LED indicator
30	LED1	OD	12 mA		Connect LED indicator
31	HPL_N	I-Schmitt		70K Pull Up	Hot Plug Switch input
32	LED2	OD	12 mA		Hot Plug Attention LED indicator
33	LED3	OD	12 mA		Hot Plug Power LED indicator
34	NC	-		58K Pull Down	Do Not Connect to any circuitry
35	NC	-		58K Pull Down	Do Not Connect to any circuitry
36	HPLE_N	I		70K Pull Up	Hot Plug Enable
38	NC	-		70K Pull Up	Do Not Connect to any circuitry
39	NC	-		70K Pull Up	Do Not Connect to any circuitry
40	NC	-		70K Pull Up	Do Not Connect to any circuitry
41	NC	-		70K Pull Up	Do Not Connect to any circuitry
43	NC	-		70K Pull Up	Do Not Connect to any circuitry
44	NC	-		70K Pull Up	Do Not Connect to any circuitry
45	NC	-		70K Pull Up	Do Not Connect to any circuitry
47	NC	-		58K Pull Down	Do Not Connect to any circuitry

Table 3-2 Pin Types	
Pin Type	**Pin Description**
I	Input Pin with LVTTL Thresholds
I-Schmitt	Input Pin with Schmitt Trigger
Analog	Analog Input Pin
I/O-Schmitt	Bi-directional Pin with Schmitt Trigger
OD	Open Drain Output Pin

3.2 SiI3531A Pin Diagrams

The diagram below shows the pin layout for the SiI3531A in a 48 QFN package.

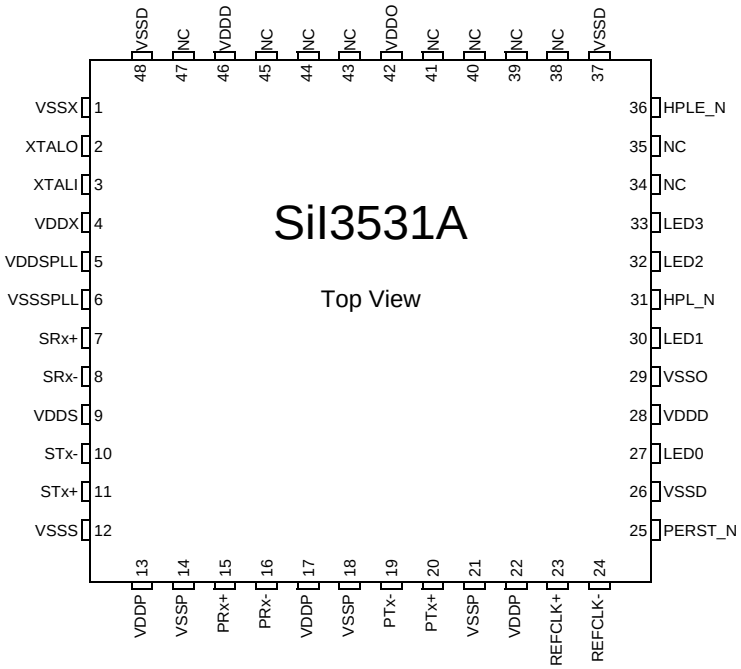


Figure 3-1 Pin Diagram for 48 QFN

3.3 SiI3531A Pin Descriptions

3.3.1 PCI Express Pins

Signal Name	Pin Number(s)	Description
PRx+	15	**Receive +.** Serial receiver differential signal, positive side.
PRx-	16	**Receive -.** Serial receiver differential signal, negative side.
PTx+	20	**Transmit +.** Serial transmitter differential signal, positive side.
PTx-	19	**Transmit -.** Serial transmitter differential signal, negative side.
REFCLK+	23	**Reference Clock +.** PCI Express system supplied differential reference clock, positive side.
REFCLK-	24	**Reference Clock -.** PCI Express system supplied differential reference clock, negative side.
PERST_N	25	**Reset.** PERST_N initializes the PCI Express interface and sets internal registers to their initial state.

3.3.2 LED / Hot Plug pins

Signal Name	Pin Number(s)	Description
LED0	27	**Activity LED.** Activity LED driver for the Serial ATA channel. This is an active low output (LED lit when pin is at 0V).
LED1	30	**Connect LED.** Connect LED driver for the Serial ATA channel. This is an active low output (LED lit when pin is at 0V).
LED2	32	**Hot Plug LED.** ATTENTION LED driver for Hot Plug. This is an active low output (LED lit when pin is at 0V).
LED3	33	**Hot Plug LED.** POWER LED driver for Hot Plug. This is an active low output (LED lit when pin is at 0V).
HPL_N	31	**Hot Plug Switch input.** Input for the Hot Plug Attention switch. This is an active low input (closed switch connects input to 0V).
HPLE_N	36	**Hot Plug enable.** Active low enable for the Hot Plug I/Os.

3.3.3 Serial ATA Signals

Signal Name	Pin Number(s)	Description
SRx+	7	**Receive +.** Serial receiver differential signal, positive side.
SRx-	8	**Receive -.** Serial receiver differential signal, negative side.
STx+	11	**Transmit +.** Serial transmitter differential signal, positive side.
STx-	10	**Transmit -.** Serial transmitter differential signal, negative side.
XTALI	3	**Crystal In.** Crystal oscillator pin for SerDes reference clock. The clock precision recommendation is ±50ppm.
XTALO	2	**Crystal Out.** Crystal oscillator pin for SerDes reference clock. A 25MHz crystal must be used.

3.3.4 NC Pins

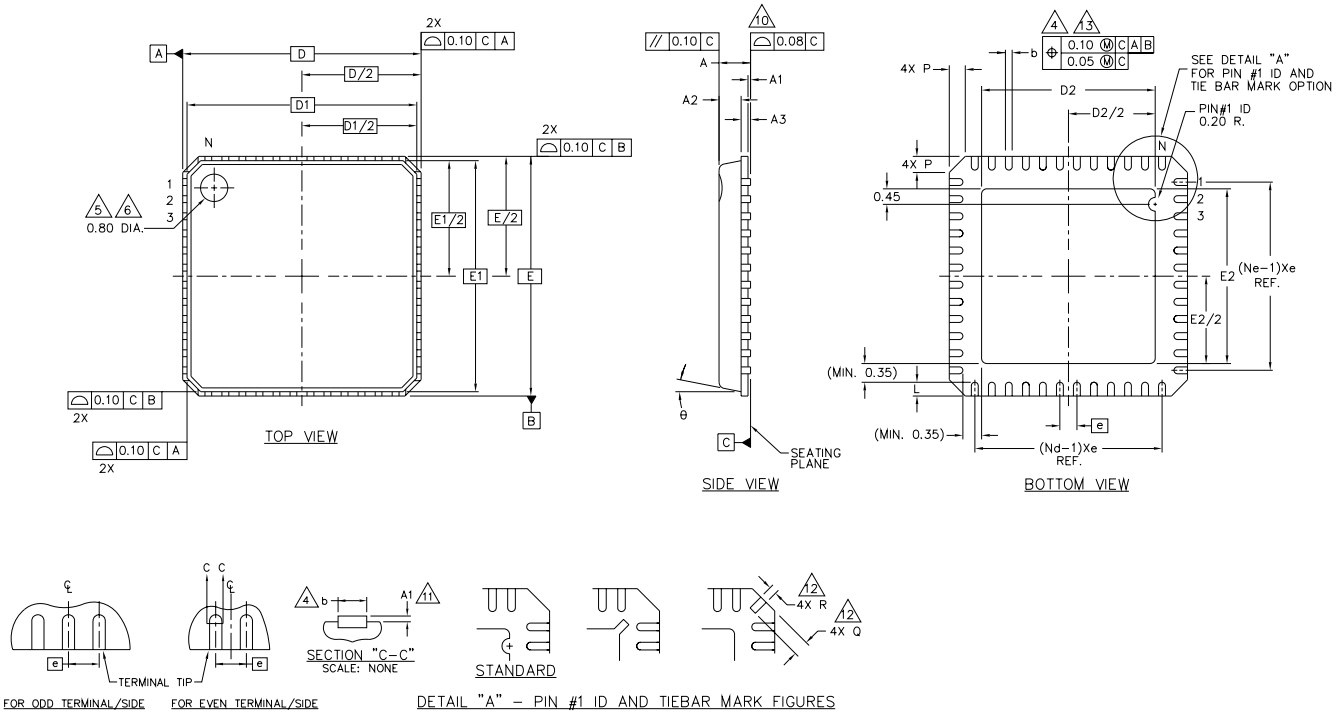
Signal Name	Pin Number(s)	Description
NC	34,35,38,39,40,41 43,44,45,47	**Do not connect.** Must leave open for normal operation

3.3.5 Power/Ground Pins

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

Pin Name	Pin Number(s)	Description
VDDS	9	**SATA Power.** This pin provides 1.8V for the Serial ATA receivers and transmitters.
VSSS	12	**SATA Ground.** This pin provides the Ground reference for the Serial ATA receivers and transmitters.
VDDSPLL	5	**SATA PLL Power.** This pin provides 1.8V for the PLL of the Serial ATA PHY.
VSSSPLL	6	**SATA PLL Ground.** This pin provides the Ground reference for the PLL of the Serial ATA PHY.
VDDP	13, 17, 22	**PCI-E Power.** These pins provide 1.8V for the PCI Express receivers and transmitters.
VSSP	14, 18, 21	**PCI-E Ground.** These pins provide the Ground reference for the PCI Express SerDes.
VDDX	4	**Oscillator Power.** This pin provides 1.8V for the crystal oscillator (associated with XTALI and XTALO pins). To minimize this noise coupling to an integrated PLL, a series resistor of 75ohms should be populated close to the VDDX pin
VSSX	1	**Oscillator Ground.** This pin provides the Ground reference for the crystal oscillator (associated with XTALI and XTALO pins).
VDDO	42	**I/O Power.** This pin provides 3.3V for the digital I/O.
VSSO	29	**I/O Ground.** This pin provides the Ground reference for the digital I/O.
VDDD	28, 46	**Digital Power.** These pins provide 1.8V for the digital logic.
VSSD	26, 37, 48	**Digital Ground.** These pins provide the Ground reference for the digital portion of the chip.

4 Package Drawing



***EPAD must be soldered to PCB GND.**

Figure 4-1 Package Drawing 48 QFN

Symbol	Dimensions (mm)		
	Minimum	Nominal	Maximum
e		0.50	
L	0.30	0.40	0.50
b	0.18	0.25	0.30
D2	5.31	5.46	5.61
E2	5.31	5.46	5.61
A	-	0.85	1.00
A1	0.00	0.02	0.05
A2	-	0.65	0.80
A3	0.20 REF		
D	7.00 BSC		
D1	6.75 BSC		
E	7.00 BSC		
E1	6.75 BSC		
θ			14°
P	0.24	0.42	0.60

Table 4-1 Package Dimensions

Part Ordering Number:
SiI3531ACNU (48 pin QFN lead free package)

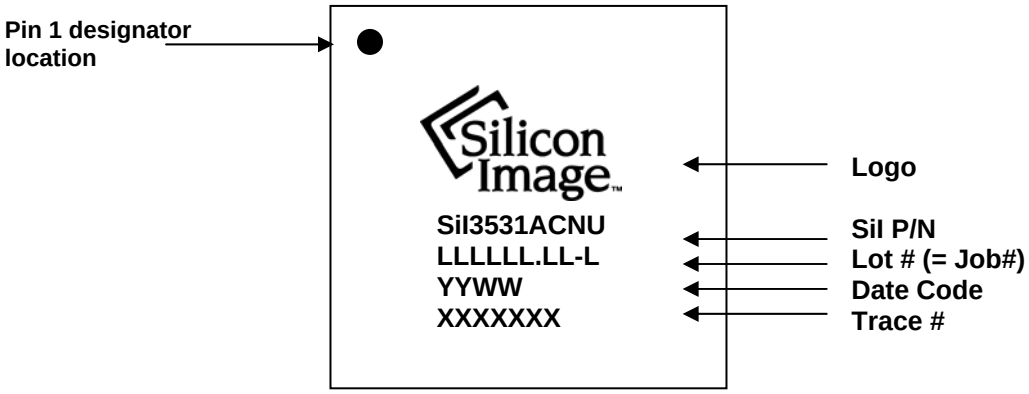


Figure 4-2 Marking Specification – Sil3531ACNU

5 Programming Model

5.1 SiI3531A Block Diagram

The SiI3531A contains the major logic modules shown below.

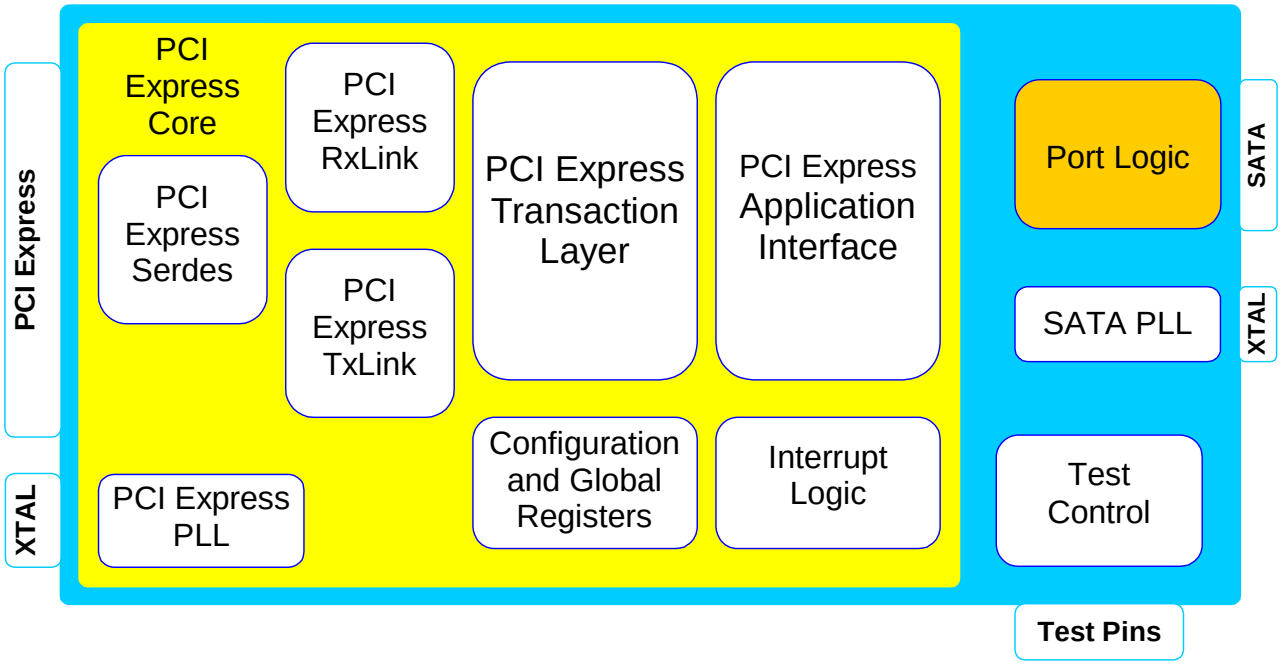


Figure 5-1 SiI3531A Block Diagram

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 Section 6.1.17 on page 50.

5.2 SiI3531A S-ATA Port Block Diagram

The block diagram below shows the logic structure of the SiI3531A Serial-ATA Port.

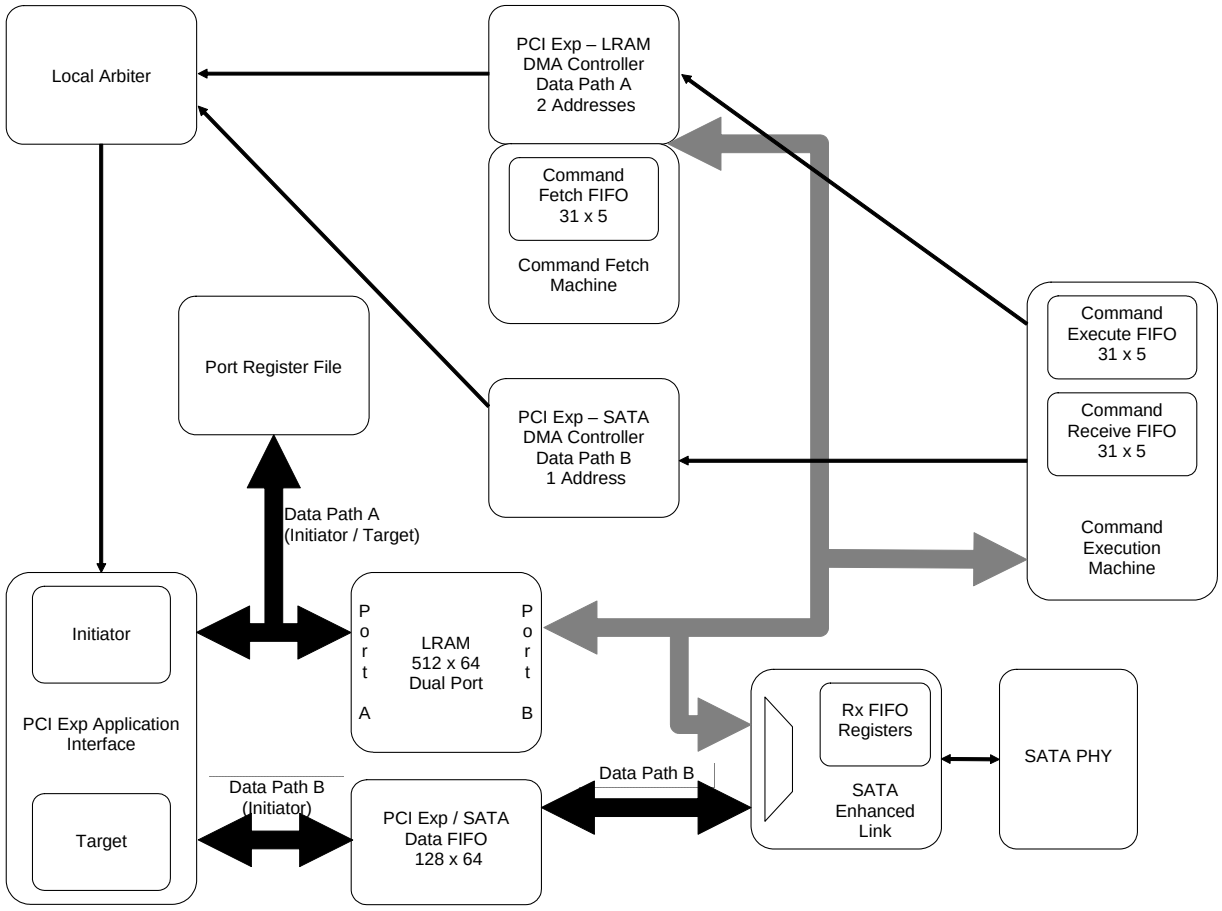


Figure 5-2 Port Logic Block Diagram

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 1024 bytes (128 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 – SiI3531A 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 SiI3531A 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 SiI3531A to perform special processing, to control interrupt assertion, to vary the normal protocol flow, etc.
2. The host issues the command to the SiI3531A.
3. The SiI3531A executes the command, performing all interaction with the SATA device and transferring data between host memory and the SATA device.
4. The SiI3531A asserts a PCI Express interrupt to indicate command completion.
5. The host reads the SiI3531A port slot status to determine which command(s) have completed.

5.3 Data Structures

5.3.1 The Command Slot

Each port within the SiI3531A 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 SiI3531A 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 SiI3531A 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 SiI3531A 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.

5.3.2 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.

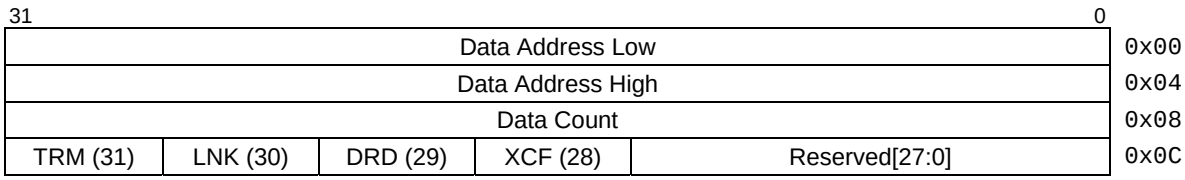


Table 5-1 Scatter/Gather Entry (SGE)

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 SiI3531A 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 SiI3531A 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 SiI3531A to discard the data read from the device for the length associated with the data count. When this bit is set to one, the SiI3531A 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 5.3.10 for additional information on external command processing.

5.3.3 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 SiI3531A 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 SiI3531A RAM. When needed, only one SGT resides in RAM at a time. The SiI3531A fetches each required SGT, overwriting the previous SGT in RAM. Since the first two SGEs reside in the PRB RAM area, they are always available in case the SiI3531A 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.

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

Table 5-2 Scatter/Gather Table (SGT)

5.3.4 The Port Request Block (PRB)

The host builds a PRB to define a command to be executed by the SiI3531A. The PRB occupies the first 64 bytes of a command slot in SiI3531A RAM. Once a command is issued, the PRB is overwritten in SiI3531A 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 SiI3531A 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 SiI3531A 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 SiI3531A 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 SiI3531A to transmit a soft reset sequence to a device. The SiI3531A 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).

5.3.5 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 5-3 describes the bit functions for each bit in the Control Field.

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 SiI3531A from issuing a normal successful completion interrupt for this command.
7	control_soft_reset	Causes the SiI3531A to issue a soft reset FIS sequence to the device.
15:8	reserved	Must be zero

Table 5-3 Control Field Bit Definitions

5.3.6 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 SiI3531A 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 5-4 describes the Protocol Override bit positions.

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.

Table 5-4 Protocol Override Bit Definitions

Note that there is no distinction between DMA and PIO data transfers in the protocol. The SiI3531A is a native serial ATA device and relies on the SATA interface protocol to determine the data transfer type between the device and the SiI3531A. 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.

5.3.7 Standard ATA Command PRB Structure

Table 5-5 shows the layout for standard ATA commands. The Control and protocol override fields must be populated as described above.

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

Table 5-5 Port Request Block For Standard ATA Commands

The Received Transfer Count field (offset 0x04) is reserved as an input to the SiI3531A 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 5-6 describes the FIS area fields.

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.

Table 5-6 PRB FIS Area Definition

5.3.8 PACKET Command PRB Structure

Table 5-7 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 5-7 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.

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

Table 5-7 Port Request Block For PACKET Command

The SiI3531A 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.

5.3.9 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 SiI3531A 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 SiI3531A 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. In Table 5-8, shaded areas 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.

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

Table 5-8 Port Request Block For Soft Reset Command

5.3.10 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 SiI3531A 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 SiI3531A whether an SGE should be used for the current transfer operation.

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

Table 5-9 Port Request Block For External Commands

5.3.11 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 SiI3531A 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.

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

Table 5-10 Port Request Block For Receiving Interlocked FIS

5.4 Operation

5.4.1 Command Issuance

Before a command can be executed, it must reside in a slot in SiI3531A RAM and the SiI3531A 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 SiI3531A to fetch the PRB from host memory and deposit it in the selected slot of SiI3531A RAM. After the command is fetched, the SiI3531A 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 SiI3531A will fetch the PRB's in the order requested when the necessary resources are available.

2. Direct Command Issuance
   The host may write the 64-byte PRB directly into SiI3531A 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.

5.4.2 Reset and Initialization

The SiI3531A 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:

5.4.2.1 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 de-asserted, 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 de-asserted through software control.

5.4.2.2 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.

5.4.2.3 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.

5.4.2.4 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.

5.4.2.5 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.

5.4.3 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.

5.4.4 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 SiI3531A 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.

5.4.5 Initialization Sequence

The following is an example sequence of events that software might use to initialize the SiI3531A and enumerate an attached device or port multiplier. The sequence assumes that the system has powered up, the PERST# Reset has been de-asserted, 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.

5.4.6 Interrupts and Command Completion

Each port of the SiI3531A produces a single interrupt, which is an accumulation of various possible interrupt events. In its default mode, the SiI3531A 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:

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

Table 5-11 Interrupt Steering

5.4.7 Interrupt Sources

Figure 5-3 on page 38 depicts a logical representation of the interrupt routing for the SiI3531A. 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.

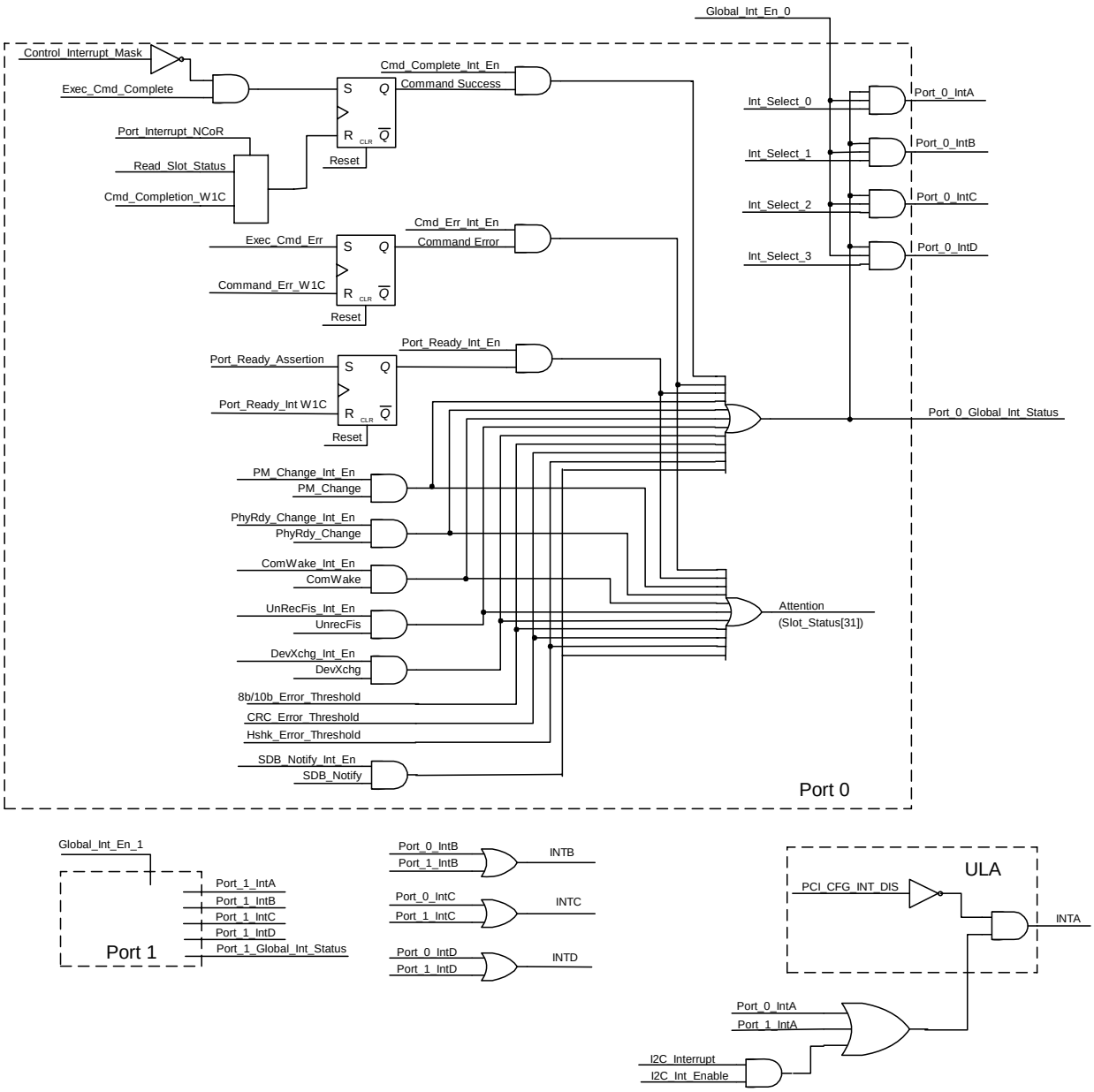


Figure 5-3 SiI3531A Interrupt Map

Interrupt Cause	Interrupt Status Bit		To Clear:	To Enable:	To Disable:
	Masked	Raw			
Command Complete	0	16	If Interrupt W1C == 0 Read Slot Status If Interrupt W1C == 1 Write 1 to Port Interrupt Status bit 0 or 16, OR, 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 OR 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 OR 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 OR 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 OR 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

Table 5-12 Port Interrupt Causes And Control

5.4.8 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.

5.4.9 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.

5.4.10 Interrupt Service Procedure

The SiI3531A 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.

5.4.11 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.

5.4.12 Error Processing

When an error occurs during command processing, the SiI3531A records the error condition and halts execution until the host driver is able to restore normal operation. The SiI3531A 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 (xxx- Port Command Error register) 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, since 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 5.4.2 (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 5.4.13for more information regarding error recovery procedures.
- Locally detected data errors. Error code 3 is a unique error type. It indicates that the SiI3531A 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 since it is necessary to make sure that all queued commands are flushed from the device upon an error condition. Since 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 SiI3531A to be reset. The most common method to perform this function is to issue a

5.4.13 Error recovery procedures

When a device returns error status for an outstanding command, the SiI3531A 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 SiI3531A 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.

6 Register Definitions

This section describes the registers within the SiI3531A.

6.1 PCI Configuration Space

The PCI Configuration Space registers define the operation of the SiI3531A on the PCI Express bus.

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	Reserved			
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			
110_H	Correctable Error Status			
114_H	Correctable Error Mask			
118_H	Advanced Error Capabilities and Control			
$11C_H$-$12B_H$	Header Log			

Table 6-1 SiI3531A PCI Configuration Space

6.1.1 Device ID – Vendor ID

Address Offset: 00_H
Access Type: Read /Write
Reset Value: 0x3531_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 SiI3531A. 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 0x3531 to identify the device as a Silicon Image SiI3531A.
  - 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.

6.1.2 PCI Status – PCI Command

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

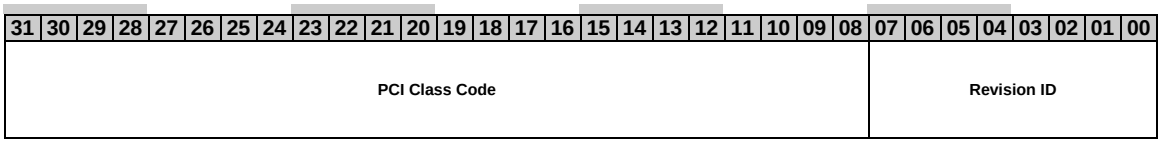
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Det Par Err	Sig Sys Err	Rcvd M Abort	Rcvd T Abort	Sig T Abort	Reserved		Det M Par Err	Reserved			Capabilities List	Int Status	Reserved								Int Disable	Reserved	SERR Enable	Reserved	Par Error Resp	Reserved			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 SiI3531A 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 SiI3531A 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 SiI3531A to respond to memory space accesses.
- **Bit 00**: I/O Space (R/W) – I/O Space Enable. This bit set enables the SiI3531A to respond to I/O space accesses.

6.1.3 PCI Class Code – Revision ID

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

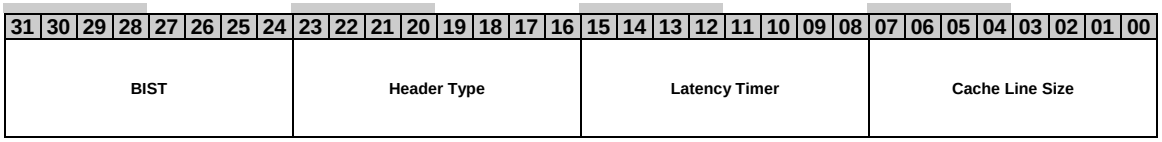


This register defines the various control functions associated with the PCI bus. The register bits are defined below.

- **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.
  - 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.

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

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

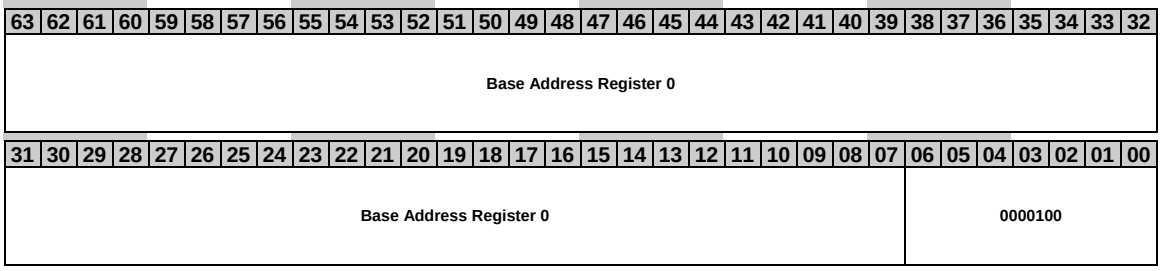


This register defines the various control functions associated with the PCI bus. The register bits are defined below.

- **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 SiI3531A.

6.1.5 Base Address Register 0

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

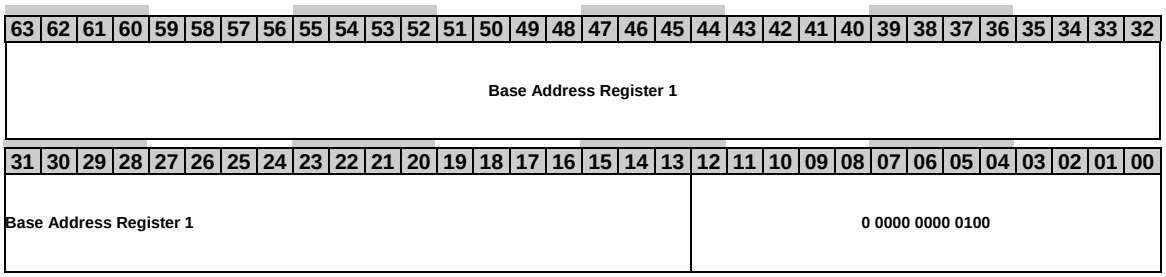


This register defines the addressing of the Global Registers within the SiI3531A. The register bits are defined below.

- **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.

6.1.6 Base Address Register 1

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

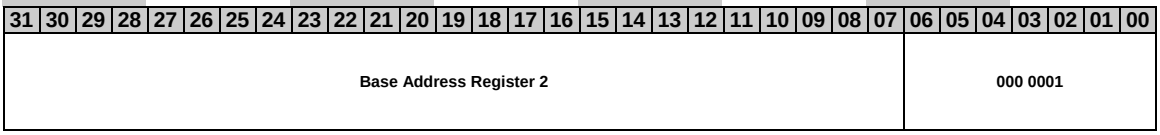


This register defines the addressing of the Port Registers and LRAM within the SiI3531A. The register bits are defined below.

- **Bit [63:13]**: Base Address Register 1 (R/W). This register defines the base address for the 16Kbyte Memory Space containing the Port Registers.
- **Bit [12:00]**: (R). This bit field is hardwired to 0004_H to indicate a 64-bit base address.

6.1.7 Base Address Register 2

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

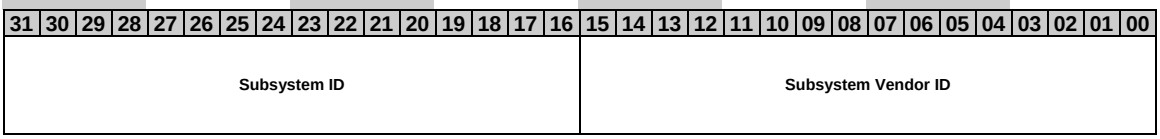


This register defines the addressing of the Indirect I/O registers within the SiI3531A. The register bits are defined below.

- **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.

6.1.8 Subsystem ID – Subsystem Vendor ID

Address Offset: $2C_H$
Access Type: Read/Write
Reset Value: 0x3531_1095



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 0x3531
- 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
- system programmed value; if bit 0 of the Configuration register (48_H) is set the Subsystem Vendor ID is system programmable.

6.1.9 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.

6.1.10 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 SiI3531A 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 SiI3531A does not use this information.

6.1.11 Header Write Enable

Address Offset: 48_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																														Ind Acc Ena	Hdr Wr Ena

- **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 (03-02_H), PCI Class Code (09-$0B_H$), Subsystem Vendor ID ($2D$-$2C_H$), and Subsystem ID ($2F$-$2E_H$).

6.1.12 Power Management Capability

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

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
PME Support					PPM D2 Support	PPM D1 Support	Auxiliary Current			Dev Special Init	Reserved	PME Clock	PPM Rev			Next Capability Pointer								Capability ID							

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 SiI3531A 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 SiI3531A 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.

6.1.13 Power Management Control + Status

Address Offset: 58_H
Access Type: Read/Write
Reset Value: 0x0800_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 0x08 to indicate a power consumption of 800 milliwatts.
- **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 SiI3531A 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 milliwatts.
- **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 SiI3531A 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).

6.1.14 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) – This bit field is hardwired 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.

6.1.15 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).

6.1.16 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.

6.1.17 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.

6.1.18 Device Capabilities

Address Offset: 74_H
Access Type: Read Only
Reset Value: 0x0000_8003

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		Role-based Err Rep	Pwr Indicator	Atten Indicator	Atten Button	L1 Latency				L0s Latency				Ext Tag Sup	Phantom Functions		Max Payload		

- **Bit [31:28,17:16]**: 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 [15]**: Role-based Err Rep (R) – Role-based Error Reporting. This bit is hardwired to 1.
- **Bit [14]**: Pwr Indicator (R) – Power Indicator Present. This bit is set if Hot Plug is enabled (HPLE_N pin connected to 0) to indicate the presence of the Hot Plug Power Indicator.
- **Bit [13]**: Atten Indicator (R) – Attention Indicator Present. This bit is set if Hot Plug is enabled (HPLE_N pin connected to 0) to indicate the presence of the Hot Plug Attention Indicator.
- **Bit [12]**: Atten Button (R) – Attention Button Present. This bit is set if Hot Plug is enabled (HPLE_N pin connected to 0) to indicate the presence of the Hot Plug Attention switch (connected to the HPL_N pin).
- **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.

6.1.19 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.

6.1.20 Link Capabilities

Address Offset: $7C_H$
Access Type: Read Only
Reset Value: 0x0003_F411

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 111_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.

6.1.21 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)

6.1.22 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.

6.1.23 Global Register Data

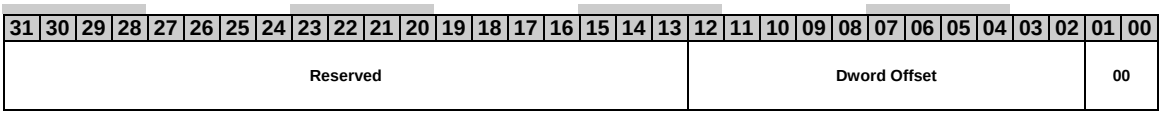
Address Offset: $F4_H$
Access Type: Read/Write

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.

6.1.24 Port Register Offset

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

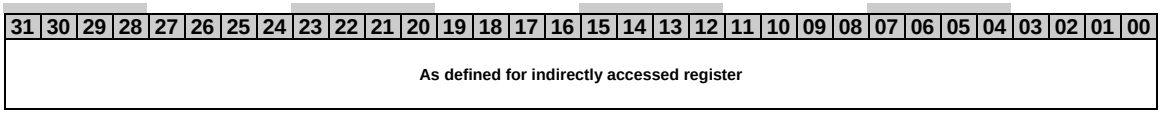


This register provides indirect addressing of a Port Register otherwise accessible directly via Base Address Register 1. The Dword address offset for an indirect access is in bits 12 to 2; bits 31 to 13, 1, and 0 are reserved and should always be 0.

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

6.1.25 Port Register Data

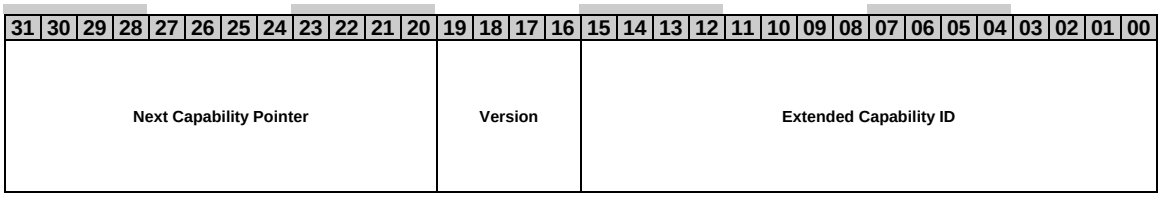
Address Offset: FC_H
Access Type: Read/Write



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

6.1.26 Advanced Error Reporting Capability

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



- **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.

6.1.27 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							Surprise Down	DL Protocol Err	Reserved			Undefined

- **Bit [31:21,11:06,03:01]**: 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 [05]**: Surprise Down (R/W1C) – Surprise Down Error Status.
- **Bit [04]**: DL Protocol Err (R/W1C) – Data Link Protocol Error Status.
- **Bit [00]**: Undefined (R/W) – This bit is reset to 0, but may be written. The definition of this bit was changed in revision 1.1 of the PCI-Express specification.

6.1.28 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							Surprise Down	DL Protocol Err	Reserved			Undefined

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

6.1.29 Uncorrectable Error Severity

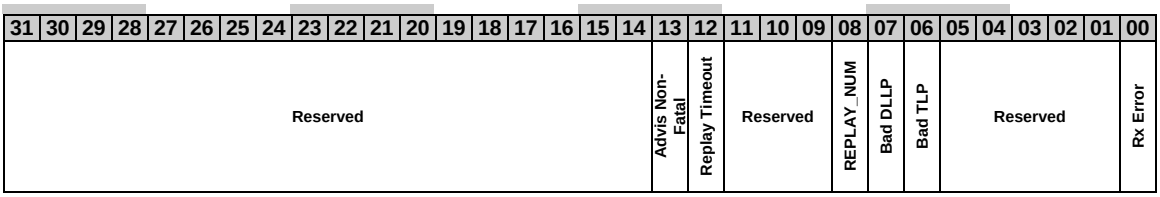
Address Offset: $10C_H$
Access Type: Read/Write
Reset Value: 0x0006_2031

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							Surprise Down	DL Protocol Err	Reserved			Undefined

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

6.1.30 Correctable Error Status

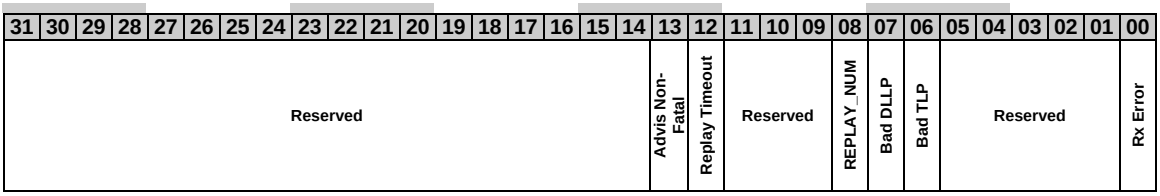
Address Offset: 110_H
Access Type: Read/Write 1 to Clear
Reset Value: 0x0000_0000



- **Bit [31:14,11:09,05:01]**: Reserved (R) – These bits are reserved and return zero on a read.
- **Bit [13]**: Advis Non-Fatal (R/W1C) – Advisory Non-Fatal Error Status.
- **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).

6.1.31 Correctable Error Mask

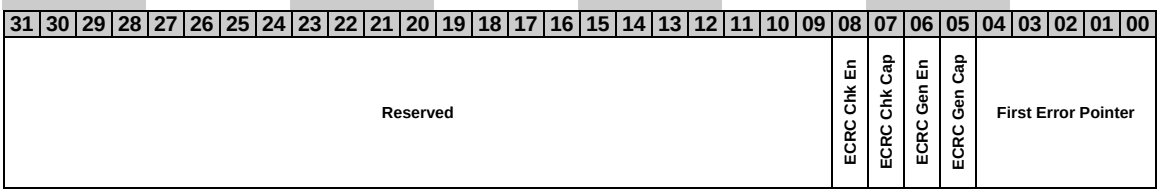
Address Offset: 114_H
Access Type: Read/Write
Reset Value: 0x0000_2000



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

6.1.32 Advanced Error Capabilities and Control

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



- **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).

6.1.33 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.

6.2 Internal Register Space – Base Address 0

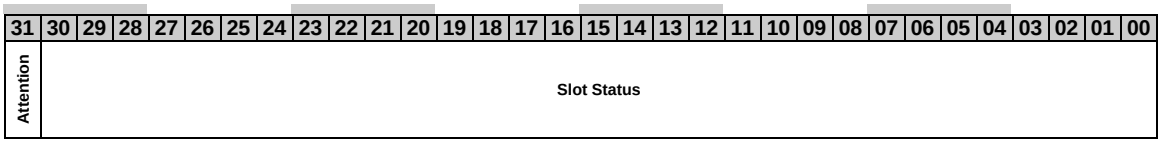
These registers are 32 or 64 bits wide and are the Global Registers of the SiI3531A. Access to this register space is through the PCI Memory space.

Address Offset	Register Name
00_H	Port Slot Status
04_H-$3F_H$	Reserved
40_H	Global Control
44_H	Global Interrupt Status
48_H	PHY Configuration
$4C_H$-77_H	Reserved
78_H	Configuration Register Offset
$7C_H$	Configuration Register Data

Table 6-2 SiI3531A Internal Register Space – Base Address 0

6.2.1 Port Slot Status Register

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

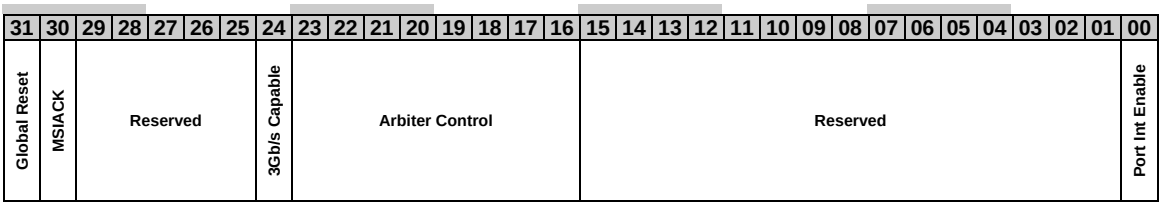


This register provides the Status for the 31 Command Slots for the port. This register also appears in Port register space. Reading this register will clear the Command Completion Status for the port if the Interrupt No Clear on Read bit (bit 3) of the Port Control register is 0. The register bits are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

- **Bit [31]**: Attention (R) – This bit indicates that something occurred 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).

6.2.2 Global Control

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

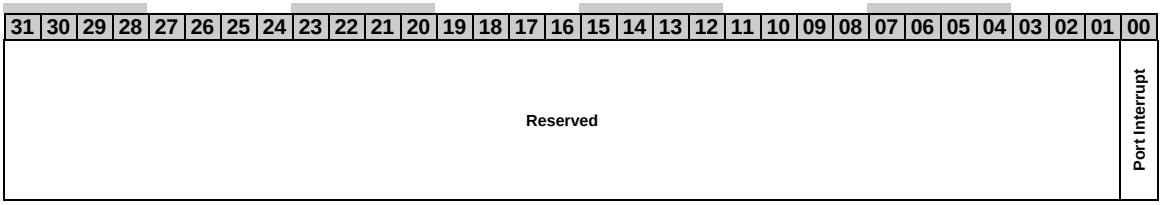


This register controls various functions of the chip.

- **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 [29:25,15:1]**: Reserved (R). These bits are reserved and will return zeroes when read.
- **Bit [23:16]**: Arbiter Control (R/W). This bit field, when set to 42_H, selects an alternate arbitration algorithm.
- **Bit [24]**: 3Gb/s Capable (R). This bit is always one to indicate that the device is configured and tested for 3Gb/s (S-ATA generation 2) operation.
- **Bit [0]**: Port Interrupt Enable (R/W). This bit, when set to one, allows assertion of an interrupt when the port asserts an interrupt. When set to zero, the port interrupts are masked.

6.2.3 Global Interrupt Status

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

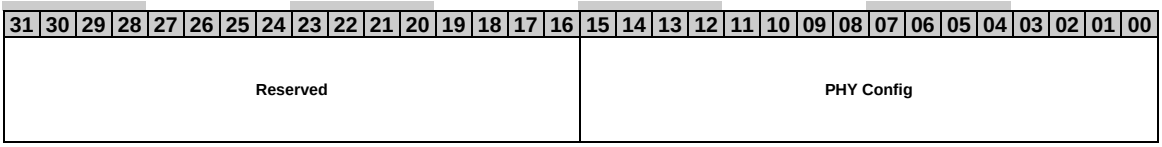


This register is used to determine the status of various chip functions.

- **Bit [31:1]**: Reserved (R). This bit field is reserved and returns zeroes when read.
- **Bit [0]**: Port Interrupt Status (R/W1C). This bit, when set to one, indicates that the port has an interrupt condition pending. Writing a 1 to this bit clears the Command Completion Interrupt Status, but not other interrupt sources.

6.2.4 PHY Configuration

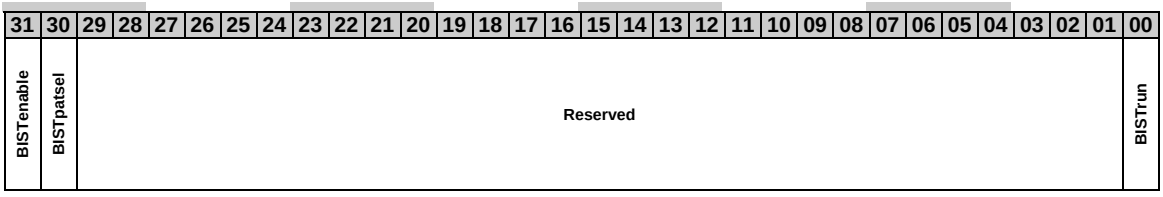
Address Offset: 48_H
Access Type: Read/Write
Reset Value: 0x0000_2C40



The PHY Configuration register is reset to 0x00002C40. These bits should not be changed from their defaults as erratic operation may result (including bits identified as Reserved).

6.2.5 BIST Control Register

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

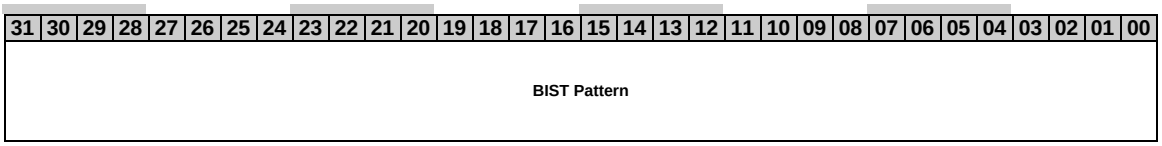


This register is used to control Data Loopback BIST.

- **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 [29:01]**: Reserved (R). These bits are reserved and return zeros on a read.
- **Bit [00]**: BISTrun (R/W). This bit enables the transmission of loopback data.

6.2.6 BIST Pattern Register

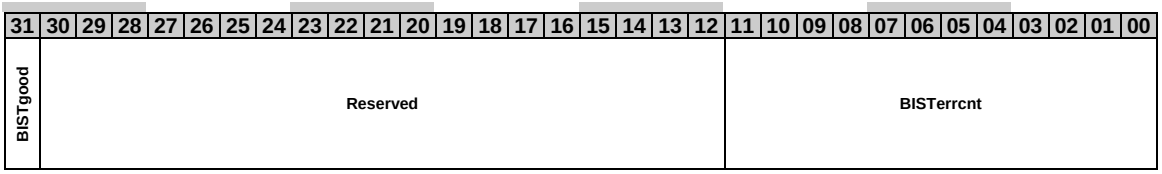
Address Offset: 54_H
Access Type: Read/Write
Reset Value: 0x0000_0000



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.

6.2.7 BIST Status Register

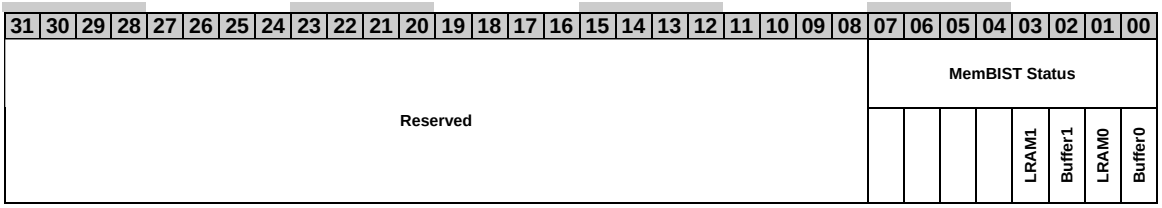
Address Offset: 58_H
Access Type: Read
Reset Value: 0x8000_0000



- **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.

6.2.8 MemBIST Status Register

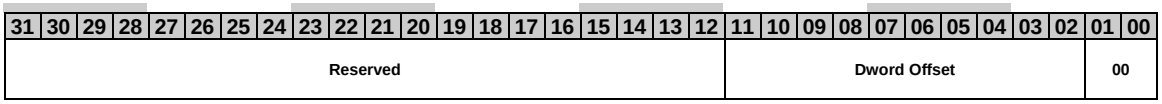
Address Offset: $5C_H$
Access Type: Read
Reset Value: 0x0000_0000



- **Bit [31:08]**: Reserved (R). This bit field is reserved and returns zeros on a read.
- **Bit [07:00]**: MemBIST Status (R). This bit field indicates the status of MemBIST for each RAM. Each status bit is set to 1 for a successful test.

6.2.9 Configuration Register Offset

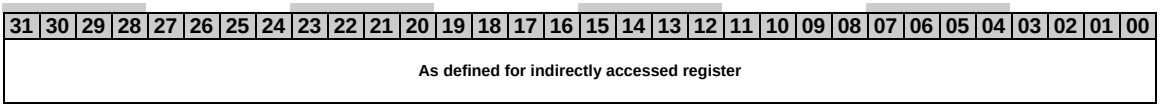
Address Offset: 78_H
Access Type: Read/Write
Reset Value: 0x0000_0000



This register provides indirect addressing of a Configuration Register. The Dword address offset for an indirect access is in bits 11 to 2; bits 31 to 12, 1, and 0 are reserved and should always be 0.

6.2.10 Configuration Register Data

Address Offset: $7C_H$
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 Configuration Register Offset register. All accesses must be 32-bit (Dword) accesses.

6.3 Internal Register Space – Base Address 1

These registers are 32 bits wide and are the Port Registers and LRAM of the SiI3531A. Access to these registers is through the PCI Memory space.

Address Offset	Register Name
000_H-$F7F_H$	Port LRAM Slots
$F80_H$-FFF_H	Port Multiplier Device Status/QActive Registers
1000_H	Write: Port Control Set / Read: Port Status
1004_H	Write: Port Control Clear
1008_H	Port Interrupt Status
$100C_H$	Reserved
1010_H	Port Interrupt Enable Set
1014_H	Port Interrupt Enable Clear
1018_H	Reserved
$101C_H$	32-bit Activation Upper Address
1020_H	Port Command Execution FIFO
1024_H	Port Command Error
1028_H	Port FIS Configuration
$102C_H$	Port PCI Exp Request FIFO Threshold
1030_H-$103F_H$	Reserved
1040_H	Port 8B/10B Decode Error Counter
1044_H	Port CRC Error Counter
1048_H	Port Handshake Error Counter
$104C_H$	Reserved
1050_H	Port PHY Configuration
1054_H-$17FF_H$	Reserved
1800_H	Port Slot Status
1804_H-$1BFF_H$	Reserved
$1C00_H$-$1CF7_H$	Command Activation Registers
$1CF8_H$-$1DFF_H$	Reserved
$1E00_H$-$1E2B_H$	Port EXEC Diagnostic Registers 0-10
$1E04_H$	Port Context Register
$1E2C_H$-$1E3F_H$	Reserved
$1E40_H$-$1E63_H$	Port PSD Diagnostic Registers 0-8
$1E64_H$-$1EFF_H$	Reserved
$1F00_H$	Port SControl
$1F04_H$	Port SStatus
$1F08_H$	Port SError
$1F0C_H$	Port SActive (indirect location)
$1F10_H$	Port SNotification
$1F14_H$-$1FFF_H$	Reserved

Table 6-3 SiI3531A Internal Register Space – Base Address 1

6.3.1 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.

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 6-4 Port LRAM 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)	

Table 6-5 Port LRAM Slot layout

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

6.3.1.1 Command Activation Register

The Command Activation Register is written using a shadow address. The Command Execution State Machine overwrites it when the Scatter/Gather Table is fetched. The translation of the shadow address to the actual LRAM address is shown here:

Address bit	12	11	10	9	8	7	6	5	4	3	210
Shadow Activation Register Address	1	1	1	0	0	Slot Number					000
Actual Activation Register LRAM Address	0	Slot Number					1	0	0	0	000

Table 6-6 Command Activation Register Address Translation

6.3.1.2 Port Multiplier Device Specific Registers

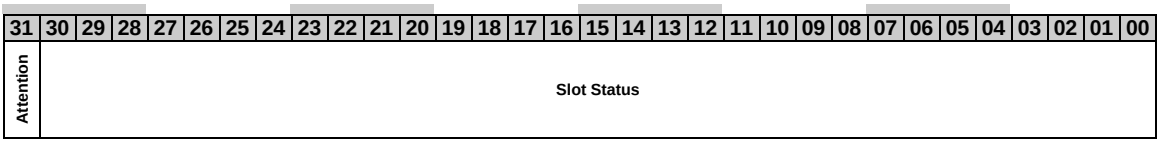
The Port Multiplier Device Specific Registers are 16 registers that contain the SActive register and the Diagnostic register for each of the 16 devices that may be connected to a Port Multiplier. Besides being directly addressable in the LRAM address space, the currently selected Port Multiplier Port SActive register may be indirectly addressed at offset $1F0C_H$. The LRAM address for this indirect (read-only) access is derived as shown here:

Address bit	12	11	10	9	8	7	6	5	4	3	210
SActive Indirect Register Address	1	1	1	1	1	0	0	0	0	1	100
Actual LRAM Address	0	1	1	1	1	1	PMP (in SControl)				000

Table 6-7 SActive Indirect Address Translation

6.3.2 Port Slot Status

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

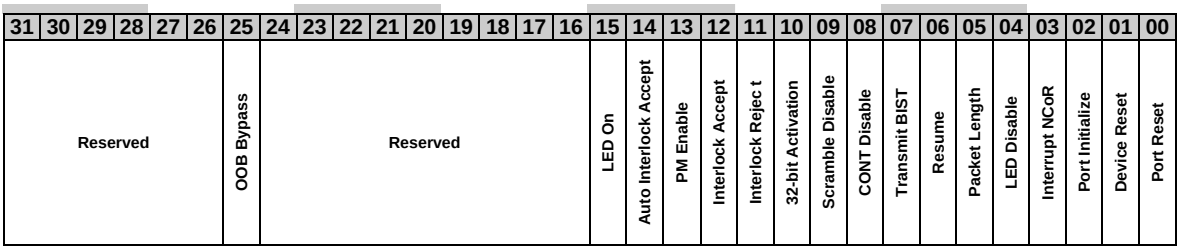


This register provides the status for the 31 Command Slots for the Serial-ATA port. This register also appears along with the Port Status register of the other port in Global register space. Reading this register will clear the Command Completion Status for the port if the Interrupt No Clear on Read 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.

6.3.3 Port Control Set

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



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).
- **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)

6.3.4 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.

6.3.5 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.

6.3.6 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.

6.3.7 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								Reserved												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.

6.3.8 32-bit Activation Upper Address

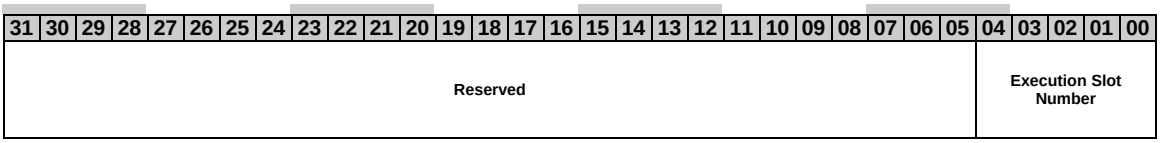
Address Offset: $101C_H$
Access Type: Read/Write
Reset Value: 0x0000_0000

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.

6.3.9 Port Command Execution FIFO

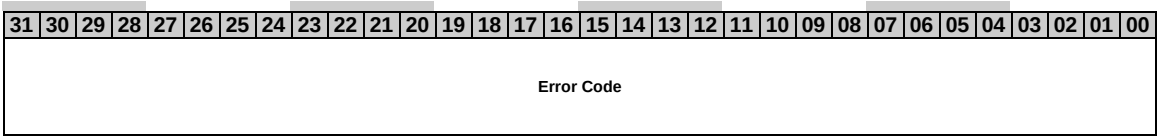
Address Offset: 1020_H
Access Type: Read/Write
Reset Value: 0x0000_00XX



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.

6.3.10 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. The following table lists the error codes, error names, and error descriptions.

Table 6-8 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 SiI3531A detected an error during command execution that was not reported by the device upon command completion.
SENDFISERROR	4	The SiI3531A 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 SiI3531A 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 SiI3531A 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 SiI3531A, 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.
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 SiI3531A was fetching a Scatter Gather Table from host memory.
PLDSGTERRORMASTERABORT	18	A PCI Master Abort occurred while the SiI3531A was fetching a Scatter Gather Table from host memory.
PLDSGTERRORPCIPERR	19	A PCI Parity Error occurred while the SiI3531A 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 SiI3531A was fetching a Port Request Block (PRB) from host memory.
PLDCMDERRORMASTERABORT	26	A PCI Master Abort occurred while the SiI3531A was fetching a Port Request Block (PRB) from host memory.
PLDCMDERRORPCIPERR	27	A PCI Parity Error occurred while the SiI3531A was fetching a Port Request Block (PRB) from host memory.
PSDERRORTARGETABORT	33	A PCI Target Abort occurred while data transfer was underway between the SiI3531A and host memory.
PSDERRORMASTERABORT	34	A PCI Master Abort occurred while data transfer was underway between the SiI3531A and host memory.
PSDERRORPCIPERR	35	A PCI Parity Error occurred while data transfer was underway between the SiI3531A 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.

6.3.11 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 6-9 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

6.3.12 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.

6.3.13 Port 8B/10B Decode Error Counter

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

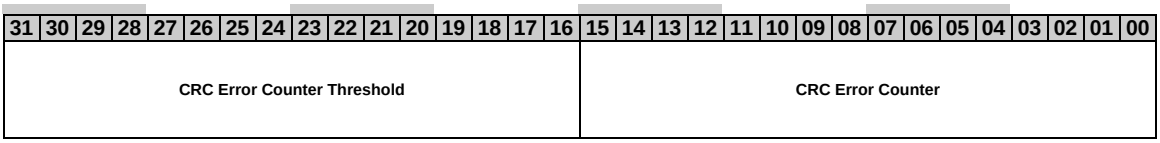
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
8B/10B Decode Error Threshold																8B/10B Decode Error Counter															

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.

6.3.14 Port CRC Error Counter

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

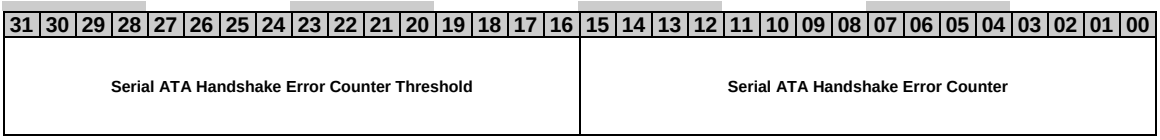


This register counts the number of Serial ATA CRC Errors that have occurred since last cleared.

- **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.

6.3.15 Port Handshake Error Counter

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



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.

6.3.16 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. They should not be changed from their defaults 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.

6.3.17 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.

6.3.18 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.

6.3.19 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.

6.3.20 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 (section 10.1.3).

- **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 Gb/s)

0010	Limit to Generation 2 (3.0 Gb/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

6.3.21 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 (section 10.1.1).

- **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 (reported if phygood false)
0001	Generation 1 communication rate (1.5 Gb/s)
0010	Generation 2 communication rate (3.0 Gb/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 (phygood false)
0001	Device presence detected but PHY communication not established
0011	Device presence detected and PHY communication established (phygood true)
0100	PHY in offline mode as a result of the interface being disabled or running in a BIST loopback mode
Others	Reserved, no action

6.3.22 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 (section 10.1.2).

- **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.

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

Table 6-10 SError Register Bits (DIAG Field)

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

6.3.23 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 6.3.18 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.

6.3.24 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.

6.4 Internal Register Space – Base Address 2

These registers are 32-bits wide and provide Indirect Register Access to the registers of the SiI3531A. Access to this register space is through the PCI I/O space.

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

Table 6-11 SiI3531A Internal Register Space – Base Address 2

6.4.1 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. Indirect access is not allowed to the Global registers at offsets 0x78 through 0x7F (Configuration register indirect access).

6.4.2 Global Register Data

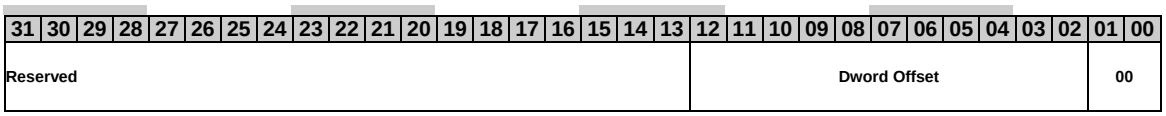
Address Offset: 04_H
Access Type: Read/Write

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.

6.4.3 Port Register Offset

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

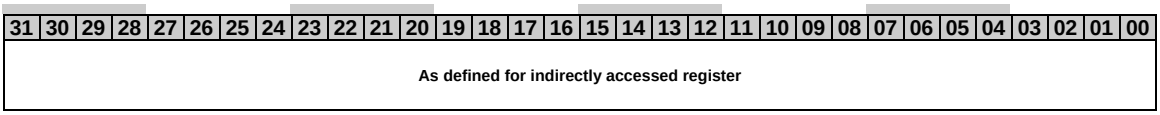


31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Reserved																			Dword Offset											00	

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 12 to 2; bits 31 to 13, 1, and 0 are reserved and should always be 0.

6.4.4 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.

7 Power Management

The following register bits control Power Management in the SiI3531A Port.

Register	Bits	Description
Interrupt Status	PM Change 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 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 Bit 5	
SControl	SPM 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 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 Bits 11-8	This bit field reports the power management state; '0110' corresponds to Slumber mode; '0010' corresponds to Partial mode.

Table 7-1 Power Management Register Bits

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').

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