TECHNICAL
MANUAL

LSI53C1010R

PCI to Dual Channel Ultra160

SCSI Multifunction

Controller

Version 2.1

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LSI LOGIC ®

Preface

This book is the primary reference and technical manual for the LSI Logic LSI53C1010R PCI to Dual Channel Ultra160 SCSI Multifunction Controller. It contains a complete functional description for the product and includes complete physical and electrical specifications.

Audience

This document was prepared for system designers and programmers who are using this device to design an Ultra160 SCSI port for PCI-based personal computers, workstations, servers or embedded applications.

Organization

This document has the following chapters and appendixes:

- Chapter 1, **Introduction**, describes the general information about the LSI53C1010R.

- Chapter 2, **Functional Description**, describes the main functional areas of the chip in greater detail, including the interfaces to the SCSI bus and external memory.

- Chapter 3, **Signal Descriptions**, contains the pin diagram and signal descriptions.

- Chapter 4, **Registers**, describes each bit in the operating registers, and is organized by register address.

- Chapter 5, **SCSI SCRIPTS Instruction Set**, defines all of the SCSI SCRIPTS instructions that are supported by the LSI53C1010R.

- Chapter 6, **Specifications**, contains the electrical characteristics and AC timing diagrams.

- Appendix A, **Register Summary**, is a register summary.

- Appendix B, **External Memory Interface Diagram Examples**, contains several example interface drawings for connecting the LSI53C1010R to external ROMs.

Related Publications

For background please contact:

ANSI
11 West 42nd Street
New York, NY 10036
(212) 642-4900
Ask for document number X3.131-199X (SCSI-2)

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112
(800) 854-7179 or (303) 397-7956 (outside U.S.) FAX (303) 397-2740
Ask for document number X3.131-1994 (SCSI-2) or X3.253
(SCSI-3 Parallel Interface)

ENDL Publications
14426 Black Walnut Court
Saratoga, CA 95070
(408) 867-6642
Document names: *SCSI Bench Reference, SCSI Encyclopedia, SCSI Tutor*

Prentice Hall
113 Sylvan Avenue
Englewood Cliffs, NJ 07632
(800) 947-7700
Ask for document number ISBN 0-13-796855-8, *SCSI: Understanding the Small Computer System Interface*

SCSI Trade Association (STA)
www.scsita.org

LSI Logic World Wide Web Home Page
www.lsilogic.com

SCSI SCRIPTS™ Processors Programming Guide, Order Number
S14044.A

LSI Logic Internet Anonymous FTP Site
ftp.lsil.com (204.131.200.1)
Directory: /pub/symchips/scsi

PCI Special Interest Group
2575 N. E. Katherine
Hillsboro, OR 97214
(800) 433-5177; (503) 693-6232 (International); FAX (503) 693-8344

Conventions Used in This Manual

The word *assert* means to drive a signal true or active. The word
deassert means to drive a signal false or inactive.

Hexadecimal numbers are indicated by the prefix "0x"—for example,
0x32CF. Binary numbers are indicated by the prefix "0b"—for example,
0b0011.0010.1100.1111.

Revision Record

Revision	Date	Remarks
1.0	6/00	Preliminary version for engineering review.
2.0	11/00	Final version.
2.1	5/01	Changes to Chapter 3 and Chapter 6 pertaining to pinouts.

Contents

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Chapter 1
Introduction

This chapter provides a general overview of the LSI53C1010R PCI to Dual Channel Ultra160 SCSI Multifunction Controller. This chapter contains the following sections:

1.1 General Description

The LSI53C1010R PCI to Dual Channel Ultra160 SCSI Multifunction Controller brings Ultra160 SCSI performance to host adapter, workstation, and server designs, making it easy to add a high-performance SCSI bus to any PCI system. Features incorporated in this chip include Double Transition (DT) clocking, Cyclic Redundancy Check (CRC), and Domain Validation. These features comply with the Utra160 SCSI industry initiative.

DT clocking permits the LSI53C1010R to transfer data up to 160 megabytes per second (Mbytes/s) on each channel, for a total of 320 Mbytes/s. CRC improves the integrity of the SCSI data transmission through enhanced detection of communication errors. Asynchronous Information Protection (AIP) augments CRC to protect all nondata phases, providing complete end-to-end protection of the SCSI I/O. SUNElink™ Domain Validation detects the SCSI bus configuration and

automatically tests and adjusts the SCSI transfer rate to optimize interoperability. Three levels of Domain Validation are provided, assuring robust system operation.

The LSI53C1010R has a local memory bus. This allows local storage of the device's BIOS ROM in flash memory or standard EPROMs. The LSI53C1010R supports programming of local flash memory for BIOS updates. The chip is packaged in a 456 Ball Grid Array (BGA). Figure 1.1 shows a typical LSI53C1010R board application connected to external ROM or flash memory.

Figure 1.1   Typical LSI53C1010R Board Application
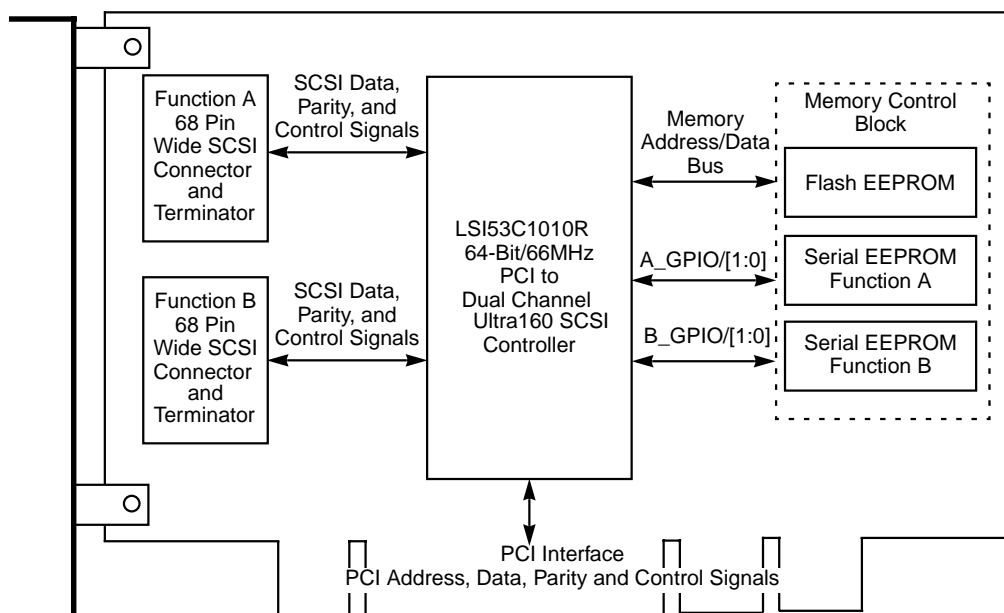
LVD LInk technology is the LSI Logic implementation of Low Voltage Differential (LVD). LVD Link transceivers allow the LSI53C1010R to perform either Single-Ended (SE) or LVD transfers. The LSI53C1010R integrates two high-performance SCSI cores, a 64-bit/66 MHz PCI bus master DMA core, and the LSI Logic SCSI SCRIPTS™ processor to meet the flexibility requirements of Ultra160 SCSI standards. It implements multithreaded I/O algorithms with minimum processor intervention, solving the protocol overhead problems of previous intelligent and nonintelligent adapter designs. Figure 1.2 illustrates a typical LSI53C1010R system application.

Figure 1.2   Typical LSI53C1010R System Application
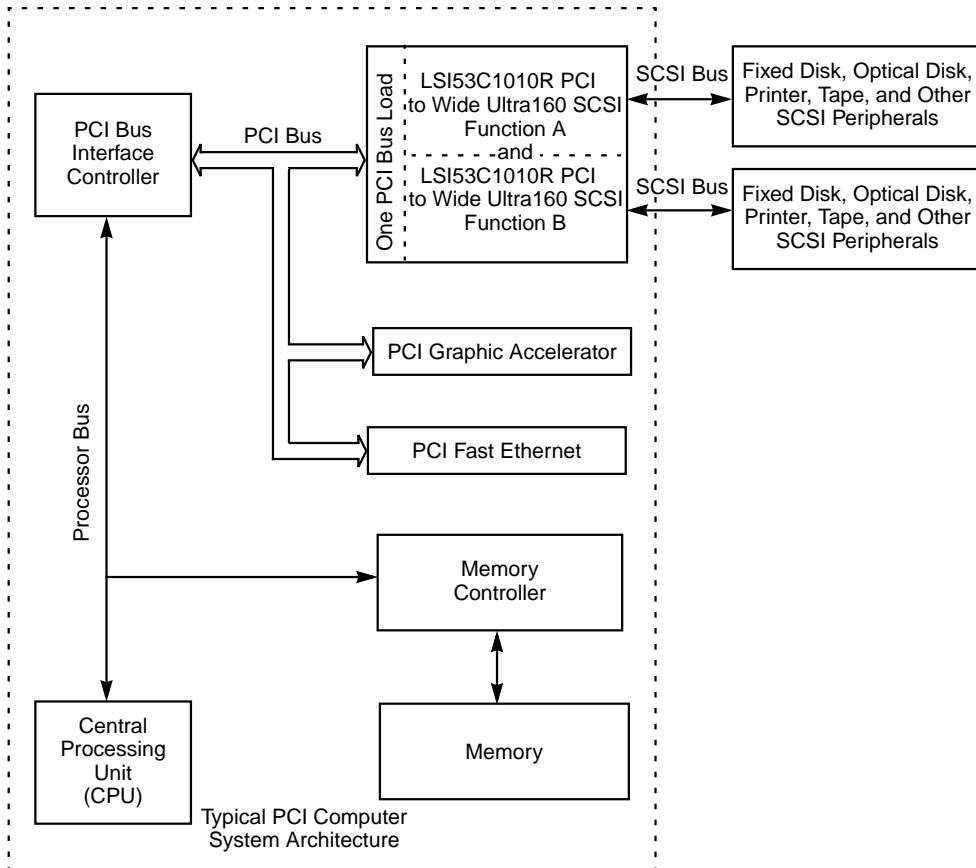
The LSI53C1010R is pin compatible with the LSI53C1030 PCI to Dual Channel Ultra320 SCSI Multifunction Controller. Proper board design, using LSI Logic *Design Considerations for the LSI53C1010R and LSI53C1030, SEN S11019*, allows seamless, low risk upgrade from the Ultra160 LSI53C1010R to the Ultra320 LSI53C1030.

1.2 Benefits of Ultra160 SCSI

Ultra160 SCSI delivers data up to two times faster than Ultra2 SCSI. Ultra160 SCSI is a subset of Ultra3 SCSI, which is an extension of the SPI-3 draft standard. When enabled, Ultra160 SCSI performs

80 megatransfers per second (megatransfers/s) resulting in approximately double the synchronous data transfer rates of Ultra2 SCSI. The LSI53C1010R performs 16-bit, Ultra160 SCSI synchronous data transfers as fast as 160 Mbytes/s on each channel providing a total bandwidth of 320 Mbytes/s. This advantage is most noticeable in heavily loaded systems, or large block size applications such as video on-demand and image processing.

The Ultra160 data transfer speed is accomplished using DT clocking. DT clocking refers to transferring data on both polarity edges of the request or acknowledge signals. Data is clocked on both rising and falling edges of the request and acknowledge signals. Double-edge clocking doubles data transfer speeds without increasing the clock rate.

Ultra160 SCSI also includes CRC, which offers higher levels of data reliability by ensuring complete integrity of transferred data. CRC is a 32-bit scheme, referred to as CRC-32. CRC is guaranteed to detect all single bit errors, any two bits in error, or any combination of errors within a single 32-bit range.

AIP is also supported by the LSI53C1010R, protecting all nondata phases, including command, status, and messages. CRC, along with AIP, provides end-to-end protection of the SCSI I/O.

SURElink Domain Validation provides 3 levels of integrity checking: Basic (level 1), Enhanced (level 2), and Margined (level 3). Further information on SURElink is available in Section 1.3, "Benefits of SURElink (Ultra160 SCSI Domain Validation)."

An advantage of Ultra160 SCSI is that it significantly improves SCSI bandwidth while preserving existing hardware and software investments. The primary software changes required are to enable the chip to perform synchronous negotiations for Ultra160 SCSI rates and to enable the clock quadrupler. Ultra160 SCSI uses the same connectors as Ultra SCSI and Ultra2 SCSI. Chapter 2 contains more information on migrating an Ultra SCSI or Ultra2 SCSI design to an Ultra160 SCSI design.

1.3 Benefits of SUBElink (Ultra160 SCSI Domain Validation)

SUBElink represents the very latest SCSI interconnect management solution. It ensures robust and low risk Ultra160 SCSI implementations by extending the Domain Validation guidelines documented in the ANSI T10 SPI-3 specifications. Domain Validation verifies that the system is capable of transferring data at Ultra160 speeds, allowing it to renegotiate to lower speed and bus width if necessary. SUBElink is the software control for the manageability enhancements in the LSI53C1010R. Fully integrated in the Storage Device Management System (SDMS™) software solution, SUBElink provides Domain Validation at boot time as well as throughout system operation. SUBElink extends to the DMI (Desktop Management Interface) based System Management components of SDMS, providing the network administrator remote management capability.

SUBElink Domain Validation provides 3 levels of integrity checking: Basic (level 1), Enhanced (level 2), and Margined (level 3). The basic check consists of an inquiry command to detect gross problems. The enhanced check sends a known data pattern using the Read and Write Buffer commands to detect additional problems. Margined check verifies that the physical parameters have some degree of margin. By varying LVD drive strength and REQ/ACK timing characteristics, level 3 verifies that no errors occur on the transfers. These altered signals are only used during the diagnostic check and not during normal system operation. If errors occur with any of these checks, the system can drop back to a lower transmission speed, on a per-target basis, to ensure robust system operation.

1.4 Benefits of LVD Link™

The LSI53C1010R supports LVD through LVD Link. This signaling technology increases the reliability of SCSI data transfers over longer distances than are supported by SE SCSI. The low current output of LVD allows the I/O transceivers to be integrated directly onto the chip. LVD provides the reliability of High Voltage Differential (HVD) SCSI without the added cost of external differential transceivers. Ultra160 SCSI with LVD allows a longer SCSI cable and more devices on the bus, with the same cables defined in the SCSI-3 Parallel Interface standard for

Ultra SCSI. LVD provides a long-term migration path to even faster SCSI transfer rates without compromising signal integrity, cable length, or connectivity.

For backward compatibility to existing SE devices, the LSI53C1010R features universal LVD Link transceivers that support LVD SCSI and SE SCSI. This allows use of the LSI53C1010R in both legacy and Ultra160 SCSI applications.

1.5 Benefits of TolerANT® Technology

The LSI53C1010R features TolerANT technology, which includes active negation on the SCSI drivers and input signal filtering on the SCSI receivers. Active negation causes the SCSI Request, Acknowledge, Data, and Parity signals to be actively driven HIGH rather than passively pulled up by terminators.

TolerANT receiver technology improves data integrity in unreliable cabling environments where other devices would be subject to data corruption. TolerANT receivers filter the SCSI bus signals to eliminate unwanted transitions, without the long signal delay associated with RC-type input filters. This improved driver and receiver technology helps eliminate double clocking of data which is the single biggest reliability issue with SCSI operations. TolerANT input signal filtering is a built-in feature of the LSI53C1010R and all LSI Logic Fast, Ultra, Ultra2, and Ultra160 SCSI devices.

The benefits of TolerANT technology include increased noise immunity when the signal transitions to HIGH, better performance due to balanced duty cycles, and improved fast SCSI transfer rates. In addition, TolerANT SCSI devices do not cause glitches on the SCSI bus at power-up or power-down. This protects other devices on the bus from data corruption. When used with the LVD LInk transceivers, TolerANT technology provides excellent signal quality and data reliability in real world cabling environments. TolerANT technology is compatible with both the Alternative One and Alternative Two termination schemes proposed by the American National Standards Institute.

1.6 Summary of LSI53C1010R Benefits

This section provides a summary of the LSI53C1010R features and benefits. It contains information on SCSI Performance, PCI Performance, Integration, Ease of Use, Flexibility, Reliability, and Testability.

1.6.1 SCSI Performance

The LSI53C1010R:

- Performs wide, Ultra160 SCSI synchronous data transfers as fast as 160 Mbytes/s on each SCSI channel for a total of 320 Mbytes/s using DT clocking.

- Supports CRC checking and generation in DT phases.

- Protects nondata phases with AIP.

- Supports Domain Validation:
    - Basic (level 1)
    - Enhanced (level 2)
    - Margined (level 3)

- Includes integrated LVD LInk universal transceivers:
    - Supports SE and LVD signals.
    - Allows greater device connectivity and longer cable length.
    - LVD LInk transceivers save the cost of external differential transceivers.
    - Supports a long-term performance migration path.

- Bursts of up to 512 bytes across the PCI bus with an independent 896–920 byte FIFO on each SCSI channel.

- Includes two separate SCSI channels on one chip.

- Handles phase mismatches in SCRIPTS without interrupting the system processor.

- Includes an on-chip SCSI clock quadrupler that allows the chip to achieve Ultra160 SCSI transfer rates with an input frequency of 40 MHz.

- Includes 8 Kbytes of internal RAM for SCRIPTS instruction storage for each SCSI channel.

- Supports 31 levels of SCSI synchronous offset in the Single Transition (ST) mode and 62 levels in the DT mode.

- Supports variable block size and scatter/gather data transfers.

- Performs sustained Memory-to-Memory DMA transfers to approximately 100 Mbytes/s.

- Minimizes the SCSI I/O start latency.

- Performs complex bus sequences without interrupts, including restoring data pointers.

- Reduces Interrupt Service Routine (ISR) overhead through a unique interrupt status reporting method.

- Includes SCSI Interrupt Steering Logic (SISL) for RAID Ready SCSI on mainboard applications with a separate interrupt for routing to a RAID adapter.

- Supports Load/Store SCRIPTS instructions to increase the performance of data transfers to and from the chip registers without using PCI cycles.

- Includes SCRIPTS support of 64-bit addressing.

- Supports target disconnect and later reconnect with no interrupt to the system processor.

- Supports multithreaded I/O algorithms in SCSI SCRIPTS with fast I/O context switching.

- Supports expanded Register Move instruction to support additional arithmetic capability.

1.6.2 PCI Performance

The LSI53C1010R:

- Complies with PCI 2.2 specification.

- Supports a 64-bit/66 MHz PCI interface for 528 Mbytes/s bandwidth that:
  - Can function in a 32-bit or 64-bit PCI slot
  - Operates at 33 or 66 MHz

- – Supports dual address cycle (DAC) generation for all SCRIPTS

- – Presents a single electrical load to the PCI Bus (True PCI Multifunction Device)

- Bursts 4/8, 8/16, 16/32, 32/64, or 64/128 Qword/Dword transfers across the PCI bus.

- Supports 32-bit or 64-bit word data bursts with variable burst lengths.

- Prefetches up to 8 Dwords of SCRIPTS instructions.

- Bursts SCRIPTS opcode fetches across the PCI bus.

- Performs zero wait-state bus master data bursts up to 528 Mbytes/s (@ 66 MHz).

- Supports PCI Cache Line Size (CLS) register.

- Supports PCI Write and Invalidate, Read Line, and Read Multiple commands.

- Complies with PCI Bus Power Management Specification Rev 1.1.

- Complies with PC99.

1.6.3 Integration

The following features ease integration of the LSI53C1010R into a system.

- Dual channel Ultra160 SCSI PCI multifunction controller.

- Integrated LVD transceivers.

- Full 32-bit or 64-bit PCI DMA bus master.

- Memory-to-Memory Move instructions allow use as a third-party PCI bus DMA controller.

- Integrated SCRIPTS processor.

1.6.4 Ease of Use

The following features of the LSI53C1010R make the device user friendly.

- The LSI53C1010R is pin compatible with the LSI53C1030 PCI to Dual Channel Ultra320 SCSI Multifunction Controller.

- Up to 1 Mbyte of add-in memory support for BIOS and SCRIPTS storage.

- Reduced SCSI development effort.

- Compiler-compatible with existing LSI Logic SCSI SCRIPTS processors.

- Direct connection to PCI and SCSI SE and LVD.

- Development tools and sample SCSI SCRIPTS available.

- Maskable and pollable interrupts.

- Wide SCSI, A or P cable, and up to 15 devices per SCSI channel are supported.

- Three programmable SCSI timers: Select/Reselect, Handshake-to-Handshake, and General Purpose.

- Software for PC-based operating system support.

- Support for relative jumps.

- SCSI Selected As ID bits for responding with multiple IDs.

1.6.5 Flexibility

The following features increase the flexibility of the LSI53C1010R:

- Universal LVD transceivers are backward compatible with SE devices.

- High level programming interface (SCSI SCRIPTS).

- Programs local and bus flash memory.

- Tailored SCSI sequences execute from main system RAM or internal SCRIPTS RAM.

- Flexible programming interface to tune I/O performance or to adapt to unique SCSI devices.

- Support for changes in the logical I/O interface definition.

- Low level access to all registers and all SCSI bus signals.

- Fetch, Master, and Memory Access control pins.

- Separate SCSI and system clocks.

- SCSI clock quadrupler bits enable Ultra160 SCSI transfer rates with a 40 MHz SCSI clock input.

- Selectable IRQ pin disable bit.
- Compatible with 3.3 V and 5 V PCI.

1.6.6 Reliability

The following features enhance the reliability of the LSI53C1010R:

- CRC and AIP provide end-to-end SCSI I/O protection.
- 2 kV ESD protection on SCSI signals.
- Protection against bus reflections due to impedance mismatches.
- Controlled bus assertion times (reduces RFI, improves reliability, and eases FCC certification).
- Latch-up protection greater than 150 mA.
- Voltage feed-through protection (minimum leakage current through SCSI pads).
- A high proportion of pins are power and ground.
- Power and ground isolation of I/O pads and internal chip logic.
- TolerANT technology provides:
  - Active negation of SCSI Data, Parity, Request, and Acknowledge signals for improved fast SCSI transfer rates.
  - Input signal filtering on SCSI receivers improves data integrity, even in noisy cabling environments.

1.6.7 Testability

The following features enhance the testability of the LSI53C1010R:

- All SCSI signals accessible through programmed I/O.
- SCSI bus signal continuity checking.
- Support for single-step mode operation.
- JTAG boundary scan.

Introduction

Chapter 2
Functional Description

This chapter provides a functional description of the LSI53C1010R. This chapter is divided into the following sections:

- Section 2.1, "PCI Functional Description"

- Section 2.2, "SCSI Functional Description"

- Section 2.3, "Parallel ROM Interface"

- Section 2.4, "Serial EEPROM Interface"

- Section 2.5, "Power Management"

The LSI53C1010R is composed of the following modules:

- 64-bit PCI Interface

- Two independent PCI to Wide Ultra160 SCSI Controllers

- ROM/Flash Memory Controller

- Serial EEPROM Controller

Figure 2.1 illustrates the relationship between these modules.

Figure 2.1   LSI53C1010R Block Diagram

PCI Bus

64-Bit PCI Interface, PCI Configuration Registers (2 sets)

Wide Ultra160 SCSI Channel

8 Kbyte SCRIPTS RAM	8 Dword SCRIPTS Prefetch Buffer

- 944 Byte DMA FIFO
- SCSI SCRIPTS Processor
- Operating Registers

ROM/Flash Memory Control

Serial EEPROM Controller and Autoconfiguration

SCSI FIFO and SCSI Control Block

Universal TolerANT Drivers and Receivers

Local Memory Bus

Wide Ultra160 SCSI Channel

8 Kbyte SCRIPTS RAM	8 Dword SCRIPTS Prefetch Buffer

- Operating Registers
- SCSI SCRIPTS Processor
- 944 Byte DMA FIFO

SCSI FIFO and SCSI Control Block

Universal TolerANT Drivers and Receivers

JTAG

JTAG Bus	SCSI Function A Wide Ultra160 SCSI Bus	ROM/Flash Memory Bus	2-Wire Serial EEPROM Bus (Function A)	2-Wire Serial EEPROM Bus (Function B)	SCSI Function B Wide Ultra160 SCSI Bus

The LSI53C1010R has two wide Ultra160 SCSI channels in a single package. Each SCSI channel (A and B) incorporates an independent DMA FIFO and a separate internal 8 Kbyte SCRIPTS RAM.

2.1 PCI Functional Description

The LSI53C1010R implements two PCI to Wide Ultra160 SCSI controllers in a single package. This configuration presents only one load to the PCI bus and uses only one REQ/ - GNT/ pair for PCI bus arbitration. Separate interrupt signals are generated for SCSI Function A and SCSI Function B.

2.1.1 PCI Addressing

There are three physical address spaces defined in the PCI specification:

- PCI Configuration space

- I/O space for operating registers

- Memory space for operating registers

2.1.1.1 Configuration Space

The host processor uses this configuration space to initialize the LSI53C1010R. Two independent sets of configuration space registers are defined, one set for each SCSI function. Each SCSI function contains the same register set with identical default values except for the Interrupt Pin. The configuration registers are initialized by the system BIOS using PCI configuration cycles. Each configuration space is a contiguous 256 x 8-bit set of addresses. Decoding C_BE[3:0]/ determines if a PCI cycle is intended to access the configuration register space. The IDSEL bus signal is a "chip select" that allows access to the configuration register space only. A configuration read/write cycle without IDSEL is ignored. The host processor uses the eight lower order address bits (AD[7:0]) to select a specific 8-bit register. Since the LSI53C1010R is a PCI Multifunction device, bits AD[10:8] decode either SCSI Function A Configuration register (AD[10:8] = 0b000) or SCSI Function B Configuration register (AD[10:8] = 0b001). Table 4.1 on page 4-2 is an illustration of the PCI Configuration Register Map.

At initialization time, each PCI device is assigned a base address for memory and I/O accesses. In the LSI53C1010R, the upper 24 bits of the address are selected. On every access, the LSI53C1010R compares its assigned base addresses with the value on the Address/Data bus during the PCI address phase. If the upper 24 bits match, the access is designated for the LSI53C1010R. The low order eight bits define the register to be accessed. A decode of C_BE[3:0]/ determines which register and what type of access is performed.

2.1.1.2 I/O Space

The PCI specification defines I/O space as a contiguous 32-bit I/O address that is shared by all system resources, including the LSI53C1010R. Base Address Register Zero (BAR0) (I/O) determines which 256-byte I/O area this device occupies.

2.1.1.3 Memory Space

The PCI specification defines memory space as a contiguous 64-bit memory address that is shared by all system resources. Base Address Register One (BAR1) (MEMORY) determines which 1 Kbyte memory area this device occupies. Each SCSI function uses an 8 Kbyte SCRIPTS RAM memory space. Base Address Register Two (BAR2) (MEMORY) determines the 8 Kbyte memory area the SCRIPTS RAM occupies.

2.1.2 PCI Bus Commands and Functions Supported

Bus commands indicate to the target the type of transaction the master is requesting. Bus commands are encoded on the C_BE[3:0]/ lines during the address phase. PCI bus commands and encoding types appear in Table 2.1.

Table 2.1   PCI Bus Commands and Encoding Types

C_BE[3:0]/	Command Type	Supported as Master	Supported as Slave
0000	Interrupt Acknowledge	No	No
0001	Special Cycle	No	No
0010	I/O Read	Yes	Yes
0011	I/O Write	Yes	Yes
0100	Reserved	N/A	N/A
0101	Reserved	N/A	N/A
0110	Memory Read	Yes	Yes
0111	Memory Write	Yes	Yes
1000	Reserved	N/A	N/A

Table 2.1   PCI Bus Commands and Encoding Types (Cont.)

C_BE[3:0]/	Command Type	Supported as Master	Supported as Slave
1001	Reserved	N/A	N/A
1010	Configuration Read	No	Yes
1011	Configuration Write	No	Yes
1100	Memory Read Multiple	Yes[1]	Yes (defaults to 0110)
1101	Dual Address Cycle (DAC)	Yes	Yes
1110	Memory Read Line	Yes[1]	Yes (defaults to 0110)
1111	Memory Write and Invalidate	Yes[2]	Yes (defaults to 0111)

1. See the DMA Mode (DMODE) register.
2. See the Chip Test Three (CTEST3) register.

2.1.2.1 Interrupt Acknowledge Command

The LSI53C1010R does not respond to this command as a slave and it never generates this command as a master.

2.1.2.2 Special Cycle Command

The LSI53C1010R does not respond to this command as a slave and it never generates this command as a master.

2.1.2.3 I/O Read Command

The LSI53C1010R uses the I/O Read command to read data from an agent mapped in the I/O address space. When decoding I/O cycles, the LSI53C1010R decodes the lower 32 address bits and ignores the upper 32 address bits.

2.1.2.4 I/O Write Command

The LSI53C1010R uses the I/O Write command to write data to an agent mapped in the I/O address space. When decoding I/O cycles, the LSI53C1010R decodes the lower 32 address bits and ignores the upper 32 address bits.

2.1.2.5 Reserved Command

The given bus encoding is reserved.

2.1.2.6 Memory Read Command

The LSI53C1010R uses the Memory Read command to read data from an agent mapped in the Memory Address Space. The target may perform an anticipatory read if such a read produces no side effects.

2.1.2.7 Memory Write Command

The LSI53C1010R uses the Memory Write command to write data to an agent mapped in the Memory Address Space. When the target returns "ready", it assumes responsibility for data coherency, which includes ordering.

2.1.2.8 Configuration Read Command

The Configuration Read command reads the configuration space of a device. The LSI53C1010R never generates this command as a master, but does respond to it as a slave. A device on the PCI bus selects the LSI53C1010R by asserting its IDSEL signal when AD[1:0] are 0b00. During the address phase of a configuration cycle, AD[7:2] address one of the 64 Dword registers in the configuration space of each device. C_BE[3:0]/ address the individual bytes within each Dword. AD[10:8] indicate which device on the LSI53C1010R is being addressed. The LSI53C1010R treats AD[63:11] as logical don't cares.

2.1.2.9 Configuration Write Command

The Configuration Write command writes the configuration space of a device. The LSI53C1010R never generates this command as a master, but does respond to it as a slave. A device on the PCI bus selects the LSI53C1010R by asserting its IDSEL signal when AD[1:0] are 0b00. During the address phase of a configuration cycle, AD[7:2] address one of the 64 Dword registers in the configuration space of each device. C_BE[3:0]/ address the individual bytes within each Dword. AD[10:8] indicate which device on the LSI53C1010R is being addressed. The LSI53C1010R treats AD[63:11] as logical don't cares.

2.1.2.10 Memory Read Multiple Command

This command is identical to the Memory Read command, except it additionally indicates that the master intends to fetch multiple cache lines before disconnecting. The LSI53C1010R supports PCI Memory Read Multiple functionality and issues Memory Read Multiple commands on the PCI bus when the Read Multiple mode is enabled. This mode is enabled by setting bit 2 (ERMP) of the DMA Mode (DMODE) register. If the cache mode is enabled, a Memory Read Multiple command is issued on all read cycles, except opcode fetches, when the following conditions are met:

- The CLSE bit (Cache Line Size Enable, bit 7, DMA Control (DCNTL) register) is set.

- The ERMP bit (Enable Read Multiple, bit 2, DMA Mode (DMODE) register) is set.

- The Cache Line Size (CLS) register for each function contains a legal burst size value (8, 16, 32, 64, or 128 Dwords) that is less than or equal to the DMODE burst size.

- The transfer crosses a cache line boundary.

When these conditions are met, the chip issues a Memory Read Multiple command instead of a Memory Read during all PCI read cycles.

Burst Size Selection – The Read Multiple command reads in multiple cache lines of data during a single bus ownership. Revision 2.2 of the PCI specification specifies the number of cache lines to read as a multiple of the cache line size. The logic selects the largest multiple of the cache line size based on the amount of data to transfer. The maximum allowable burst size is determined from the DMA Mode (DMODE) burst size bits and the Chip Test Five (CTEST5) register, bit 2.

2.1.2.11 Dual Address Cycles (DACs) Command

When 64-bit addressing is required, the LSI53C1010R performs DACs, per the PCI 2.2 specification. If any of the selector registers contain a nonzero value, a DAC is generated.

2.1.2.12 Memory Read Line Command

This command is identical to the Memory Read command, except it additionally indicates that the master intends to fetch a complete cache line. This command is intended for use with bulk sequential data transfers where the memory system and the requesting master might gain some performance advantage by reading to a cache line boundary rather than a single memory cycle. The Read Line function in the LSI53C1010R takes advantage of the PCI 2.2 specification regarding issuance of this command.

If the cache mode is disabled, no Read Line commands are issued.

If the cache mode is enabled, a Read Line command is issued on all read cycles, except nonprefetch opcode fetches, when the following conditions are met:

- The CLSE bit (Cache Line Size Enable, bit 7, of the DMA Control (DCNTL) register) is set.

- The ERL bit (Enable Read Line, bit 3, of the DMA Mode (DMODE) register) is set.

- The Cache Line Size (CLS) register for each function must contain a legal burst size value (8, 16, 32, 64, or 128 Dwords) that is less than or equal to the DMODE burst size.

- The transfer crosses a Dword boundary, but not a cache line boundary.

When these conditions are met, the chip issues a Read Line command instead of a Memory Read during all PCI read cycles. Otherwise, it issues a normal Memory Read command.

Read Multiple with Read Line Enabled – When both the Read Multiple and Read Line modes are enabled, the Read Line command is not issued if the above conditions are met. Instead, a Read Multiple command is issued.

If the Read Multiple mode is enabled, Read Multiple commands are issued if the Read Multiple conditions are met.

2.1.2.13 Memory Write and Invalidate Command

The Memory Write and Invalidate command is identical to the Memory Write command, except it additionally guarantees a minimum transfer of one complete cache line. That is, the master intends to write all bytes within the addressed cache line in a single PCI transaction unless interrupted by the target. This command requires implementation of the PCI Cache Line Size (CLS) register. The LSI53C1010R enables Memory Write and Invalidate cycles when bit 0 (WRIE), in the Chip Test Three (CTEST3) register, and bit 4 (WIE), in the PCI Command register, are set.

When the following conditions are met, Memory Write and Invalidate commands are issued:

- The following bits are set:
  - The CLSE bit (Cache Line Size Enable, bit 7, of the DMA Control (DCNTL) register),
  - The WRIE bit (Write and Invalidate Enable, bit 0, of the Chip Test Three (CTEST3) register),
  - Bit 4 of the PCI Configuration Command register.

- The Cache Line Size (CLS) register for each function contains a legal burst size value (8, 16, 32, 64, or 128 Dwords) that is less than or equal to the DMA Mode (DMODE) burst size.

- The chip has enough bytes in the DMA FIFO to complete at least one full cache line burst.

- The chip is aligned to a cache line boundary.

When these conditions are met, the LSI53C1010R issues a Write and Invalidate command instead of a Memory Write command during all PCI write cycles.

Multiple Cache Line Transfers – The Memory Write and Invalidate command can write multiple cache lines of data in a single bus ownership. The chip issues a burst transfer as soon as it reaches a cache line boundary. The transfer size is not automatically the cache line size, but rather a multiple of the cache line size specified in Revision 2.2 of the PCI specification. The logic selects the largest multiple of the cache line size based on the transfer size. The maximum allowable burst size is determined from the DMA Mode (DMODE) burst size bits, and

bit 2 of the Chip Test Five (CTEST5) register. If multiple cache line size transfers are not desired, set the DMODE burst size to exactly the cache line size and the chip will only issue single cache line transfers.

After each data transfer, the chip re-evaluates the burst size based on the amount of remaining data to transfer. It again selects the highest possible multiple of the cache line size, and no larger than the DMA Mode (DMODE) burst size. Usually, the chip selects the DMODE burst size after alignment and issues bursts of this size. The burst size is, in effect, throttled down toward the end of a long Memory Move or Block Move transfer until only the cache line size left is burst size. The chip finishes the transfer with this burst size.

Latency – In accordance with the PCI specification, the latency timer is ignored when issuing a Memory Write and Invalidate command. Therefore, when a latency time-out occurs, the LSI53C1010R continues to transfer up to a cache line boundary. At that point, the chip relinquishes the bus, and finishes the transfer at a later time using another bus ownership. If the chip is transferring multiple cache lines, it continues to transfer until the next cache boundary is reached.

PCI Target Retry – A retry is defined as a STOP with no TRDY/, indicating that no data was transferred. If the target issues a retry during a Memory Write and Invalidate transfer, the chip relinquishes the bus and immediately tries to finish the transfer on another bus ownership. The chip issues another Memory Write and Invalidate command on the next ownership, in accordance with the PCI specification.

PCI Target Disconnect – If the target device issues a disconnect during a Memory Write and Invalidate transfer, the LSI53C1010R relinquishes the bus and immediately tries to finish the transfer on another bus ownership. The chip does not issue another Memory Write and Invalidate command on the next ownership unless the address is aligned.

2.1.3 Internal Arbiter

The PCI to SCSI controller uses a single REQ/ - GNT/ signal pair to arbitrate for access to the PCI bus. An internal arbiter circuit allows the different bus mastering functions resident in the chip to arbitrate among themselves for the privilege of arbitrating for PCI bus access. There are two independent bus mastering functions inside the LSI53C1010R, one for each of the SCSI functions.

The internal arbiter uses a round robin arbitration scheme to decide which internal bus mastering function may arbitrate for access to the PCI bus. This ensures that no function is starved for access to the PCI bus.

2.1.4 PCI Cache Mode

The LSI53C1010R supports the PCI specification for an 8-bit Cache Line Size (CLS) register located in the PCI configuration space. The Cache Line Size (CLS) register provides the ability to sense and react to nonaligned addresses corresponding to cache line boundaries. In conjunction with the Cache Line Size (CLS) register, the PCI commands Memory Read Line (MRL), Memory Read Multiple (MRM), and Memory Write and Invalidate (MWI) are individually software enabled or disabled. Table 2.2 provides information on the PCI cache mode alignment.

Table 2.2   PCI Cache Mode Alignment

Host Memory			
	A		0x00
B			0x04
			0x08
	C		0x0C
	D		0x10
			0x14
			0x18
			0x1C
	E		0x20
			0x24
			0x28
			0x2C
		F	0x30
			0x34
			0x38

Table 2.2   PCI Cache Mode Alignment (Cont.)

			0x3C
G			0x40
			0x44
			0x48
			0x4C
	H		0x50
			0x54
			0x58
			0x5C
			0x60

2.1.4.1 Enabling Cache Mode

To enable the cache logic to issue PCI cache commands (Memory Read Line, Memory Read Multiple, and Memory Write and Invalidate) on any PCI master operation, the following conditions must be met:

- The Cache Line Size Enable bit in the DMA Control (DCNTL) register must be set.

- The PCI Cache Line Size (CLS) register must contain a valid binary cache size, i.e., 8, 16, 32, 64, or 128 Dwords. These values are the only valid cache sizes.

- The programmed burst size (in Dwords) must be equal to or greater than the cache line size register. The DMA Mode (DMODE) register, bits [7:6], and the Chip Test Five (CTEST5) register, bit 2, denote the burst length.

- The device must be performing a PCI Master transfer. The following PCI Master transactions do not utilize the PCI cache logic, so no PCI cache commands are issued during these types of cycles: a nonprefetch SCRIPTS fetch, a Load/Store data transfer, and a data flush operation. All other types of PCI Master transactions utilize the PCI cache logic.

Not only must the above four conditions be met in order for the cache logic to control the type of PCI cache command that is issued, proper alignment is also necessary during write operations. If these conditions are not met for any given PCI Master transaction, a Memory Read or Memory Write is issued and no cache write alignment is done.

2.1.4.2 Issuing Cache Commands

In order to issue each type of PCI cache command, the corresponding enable bit(s) must be set.

- To issue Memory Read Line commands, the Enable Read Line (ERL) bit in the DMA Mode (DMODE) register must be set.

- To issue Memory Read Multiples, the Enable Read Multiple (ERMP) bit in the DMA Mode (DMODE) register must be set.

- To issue Memory Write and Invalidates, both the Write and Invalidate Enable (WRIE) bit in the Chip Test Three (CTEST3) register and the Write and Invalidate Enable (WIE) bit in the PCI configuration Command register must be set.

If the corresponding cache command is not enabled, the cache logic falls back to the next command enabled. For example, if the Memory Read Multiple command is not enabled and the Memory Read Line command is, Memory Read Line command is issued in place of Memory Read Multiple command. If no cache commands are enabled, cache write alignment still occurs but no cache commands are issued; only Memory Reads and Memory Writes are issued.

2.1.4.3 Memory Read Caching

The type of Memory Read command issued depends on the starting location of the transfer and the number of bytes to be transferred. During reads, no cache alignment is done, as it is neither required nor optional according to PCI 2.2 specification. Reads are a programmed burst length in size, as set in the DMA Mode (DMODE) and Chip Test Five (CTEST5) registers. In the case of a transfer that is smaller than the burst length, all bytes for that transfer are read in one PCI burst transaction. If the transfer crosses a Dword boundary (A[1:0] = 0b00), a Memory Read Line command is issued. If the transfer crosses a cache boundary, as specified by the cache line size programmed into the PCI configuration

register, a Memory Read Multiple command is issued. If a transfer does not cross a Dword or cache boundary or if cache mode is not enabled a Memory Read command is issued.

2.1.4.4 Memory Write Caching

Memory Writes are aligned in a single burst transfer to reach a cache boundary. At that point, Memory Write and Invalidate commands are issued and continue at the burst length programmed into the DMA Mode (DMODE) register. Memory Write and Invalidate commands continue to be issued as long as the remaining byte count is greater than the Memory Write and Invalidate threshold. When the remaining byte count drops below this threshold, a single Memory Write burst is issued to complete the transfer.

In summary, the general pattern for PCI writes is:

- A single Memory Write to align to a cache boundary
- Multiple Memory Write and Invalidates
- A single data residual Memory Write to complete the transfer

2.1.4.5 Examples

The examples in this section employ the following abbreviations:
MR = Memory Read, MRL = Memory Read Line, MRM = Memory Read Multiple, MW = Memory Write, MWI = Memory Write and Invalidate.

Read Example 1 – Burst = 4 Dwords, Cache Line Size = 4 Dwords:

A to B:	MRL (6 bytes)
A to C:	MRL (13 bytes)
A to D:	MRM (16 bytes) MR (1 byte)
C to D:	MRM (5 bytes)
C to E:	MRM (16 bytes) MRM (5 bytes)
D to F:	MRM (16 bytes) MRM (16 bytes)

A to H:	MRM (16 bytes)
	MRM (16 bytes)
	MRM (16 bytes)
	MRM (16 bytes)
	MRM (16 bytes)
	MR (1 byte)

A to G:	MRM (16 bytes)
	MRM (16 bytes)
	MRM (16 bytes)
	MRM (16 bytes)
	MR (2 bytes)

Read Example 2 – Burst = 8 Dwords, Cache Line Size = 4 Dwords:

A to B:	MRL (6 bytes)
A to C:	MRL (13 bytes)
A to D:	MRM (17 bytes)
C to D:	MRM (5 bytes)
C to E:	MRM (21 bytes)
D to F:	MRM (32 bytes)

A to H:	MRM (32 bytes)
	MRM (32 bytes)
	MRM (17 bytes)

A to G:	MRM (32 bytes)
	MRM (32 bytes)
	MR (2 bytes)

Read Example 3 – Burst = 16 Dwords, Cache Line Size = 8 Dwords:

A to B:	MRL (6 bytes)
A to C:	MRL (13 bytes)
A to D:	MRL (17 bytes)
C to D:	MRL (5 bytes)
C to E:	MRM (21 bytes)
D to F:	MRM (32 bytes)

| **A to H:** | MRM (64 bytes) |
| | MRL (17 bytes) |

| **A to G:** | MRM (64 bytes) |
| | MR (2 bytes) |

Write Example 1 – Burst = 4 Dwords, Cache Line Size = 4 Dwords:

A to B: MW (6 bytes)

A to C: MW (13 bytes)

A to D: MW (17 bytes)

C to D: MW (5 bytes)

C to E: MW (3 bytes)
MWI (16 bytes)
MW (2 bytes)

D to F: MW (15 bytes)
MWI (16 bytes)
MW (1 byte)

A to H: MW (15 bytes)
MWI (16 bytes)
MWI (16 bytes)
MWI (16 bytes)
MWI (16 bytes)
MW (2 bytes)

A to G: MW (15 bytes)
MWI (16 bytes)
MWI (16 bytes)
MWI (16 bytes)
MW (3 bytes)

Write Example 2 – Burst = 8 Dwords, Cache Line Size = 4 Dwords:

A to B: MW (6 bytes)

A to C: MW (13 bytes)

A to D: MW (17 bytes)

C to D: MW (5 bytes)

C to E: MW (3 bytes)
MWI (16 bytes)
MW (2 bytes)

D to F: MW (15 bytes)
MWI (16 bytes)
MW (1 byte)

A to H:	MW (15 bytes)
	MWI (32 bytes)
	MWI (32 bytes)
	MW (2 bytes)
A to G:	MW (15 bytes)
	MWI (32 bytes)
	MWI (16 bytes)
	MW (3 bytes)

Write Example 3 – Burst = 16 Dwords, Cache Line Size = 8 Dwords:

A to B:	MW (6 bytes)
A to C:	MW (13 bytes)
A to D:	MW (17 bytes)
C to D:	MW (5 bytes)
C to E:	MW (21 bytes)
D to F:	MW (32 bytes)
A to H:	MW (31 bytes)
	MWI (32 bytes)
	MW (18 bytes)
A to G:	MW (31 bytes)
	MWI (32 bytes)
	MW (3 bytes)

2.1.4.6 Memory-to-Memory Moves

Memory-to-Memory Moves also support PCI cache commands, as described above, with one limitation: Memory Write and Invalidate on Memory-to-Memory Move writes are only supported if the source and destination address are quad word aligned. If the source and destination are not quad word aligned, i.e., Source Address[2:0] == Destination Address[2:0], write alignment is not performed and Memory Write and Invalidates are not issued.

The LSI53C1010R is little endian. This mode assigns the least significant byte to bits [7:0].

2.2 SCSI Functional Description

Both Ultra160 SCSI controllers on the LSI53C1010R support either an 8-bit or 16-bit SCSI bus. Each controller supports Wide Ultra160 SCSI synchronous transfer rates up to 160 Mbytes/s on an LVD SCSI bus. SCSI functions can be programmed with SCSI SCRIPTS, making it easy to "fine tune" the system for specific mass storage devices or Ultra160 SCSI requirements. Figure 2.1 on page 2-2 illustrates the relationship between the LSI53C1010R modules.

The LSI53C1010R offers low level register access or a high level control interface. Like first generation SCSI devices, the LSI53C1010R is accessed as a register-oriented device. The ability to sample and/or assert any signal on the SCSI bus is used in error recovery and diagnostic procedures.

The LSI53C1010R is controlled by the integrated SCRIPTS processor through a high level logical interface. Commands controlling the SCSI functions are fetched out of the main host memory or local memory. These commands instruct the SCSI functions to Select, Reselect, Disconnect, Wait for a Disconnect, Transfer Information, Change Bus Phases, and implement all other aspects of the SCSI protocol. The SCRIPTS processor is a special high speed processor optimized for SCSI protocol.

2.2.1 SCRIPTS Processor

The SCSI SCRIPTS processor allows fetches of both DMA and SCSI commands from host memory or internal SCRIPTS RAM. Algorithms written in SCSI SCRIPTS control the actions of the SCSI and DMA cores. The SCRIPTS processor, running off of the PCI clock, executes complex SCSI bus sequences independently of the host CPU.

Algorithms can be designed to tune SCSI bus performance to adjust to new bus device types, such as scanners, communication gateways, etc. They can also incorporate changes in the SCSI logical bus definitions without sacrificing I/O performance. SCSI SCRIPTS are hardware independent, so they can be used interchangeably on any host or CPU system bus. SCSI SCRIPTS handle conditions such as Phase Mismatch.

2.2.1.1 Phase Mismatch Handling in SCRIPTS

The LSI53C1010R can handle phase mismatches due to drive disconnects without needing to interrupt the processor. The primary goal of this logic is to completely eliminate the need for CPU intervention during an I/O disconnect/reselect sequence.

SCRIPTS control the storage of appropriate information needed to restart the I/O state, eliminating the need for processor intervention during an I/O disconnect/reselect sequence. Calculations are performed such that the appropriate information is available to SCRIPTS so that an I/O state can be properly stored for restart later.

The Phase Mismatch Jump logic is disabled at power-up. To enable the phase mismatch jump logic, set the Phase Mismatch Jump Enable bit (ENPMJ, bit 7 in the Chip Control Zero (CCNTL0) register). Utilizing the information supplied in the Phase Mismatch Jump Address registers allows all overhead involved in a disconnect/reselect sequence to be handled with a modest amount of SCRIPTS instructions. These registers are described in detail in Chapter 4, "Registers."

2.2.2 Internal SCRIPTS RAM

The LSI53C1010R has 8 Kbytes (2048 x 32 bits) of internal, general purpose RAM for each SCSI function. The RAM is designed for SCRIPTS program storage, but is not limited to this type of information. When the chip fetches SCRIPTS instructions or Table Indirect information from the internal RAM, these fetches remain internal to the chip and do not use the PCI bus. In addition, any SCRIPTS instruction that contains a source or destination address residing in SCRIPTS RAM memory space remains internal to the chip and does not generate PCI cycles. SCRIPTS instructions able to access SCRIPTS RAM memory space in this manner include Memory-to-Memory Moves, Load/Stores, and Block Moves. While an internal cycle is occurring, any external PCI slave cycle is retried on the PCI bus. Setting the DISRC (Disable Internal SCRIPTS RAM Cycles) bit in the Chip Control Zero (CCNTL0) register disables this feature.

SCRIPTS RAM should be initialized before it is read. Reading SCRIPTS RAM before initialization sets the SCRIPTS RAM parity bit, bit 7, in the Shadowed SCSI SGE Status 0 register.

PCI system BIOS can relocate the RAM anywhere in the 64-bit address space. Base Address Register Three (BAR3) (SCRIPTS RAM) and Base Address Register Four (BAR4) (SCRIPTS RAM), in the PCI configuration space, contain the base address of the internal RAM. To simplify SCRIPTS instruction loading, the base address of the RAM appears in the Scratch Register B (SCRATCHB) register when bit 3 of the Chip Test Two (CTEST2) register is set. The upper 32 bits of a 64-bit base address are in the SCRIPT Fetch Selector (SFS) register. The RAM is byte accessible from the PCI bus and is visible to any bus mastering device on the bus. External, CPU accesses to the RAM follow the same timing sequence as a standard slave register access, except that the required target wait states drop from 5 to 3. SCRIPTS RAM must first be written before being read in order to initialize SCRIPTS RAM parity. If a SCRIPTS RAM parity error is encountered a SCSI Gross Error interrupt will be signaled.

A complete set of development tools is available for writing custom drivers with SCSI SCRIPTS. For more information on the SCSI SCRIPTS instructions supported by the LSI53C1010R, see Chapter 5, "SCSI SCRIPTS Instruction Set."

2.2.3 64-Bit Addressing in SCRIPTS

The PCI interface for the LSI53C1010R provides 64-bit address and data capability in the initiator mode. The chip can also respond to 64-bit addressing in the target mode.

DACs can be generated for all SCRIPTS operations. There are six selector registers which hold the upper Dword of a 64-bit address. All but one of these is static and requires manual loading using a CPU access, a Load and Store instruction, or a memory move instruction. One of the selector registers is dynamic and is used during 64-bit direct block moves only. All selectors will default to zero, meaning the LSI53C1010R will power-up in a state where only Single Address Cycles (SACs) are generated. When any of the selector registers are written to a nonzero value, DACs are generated.

Direct, Table Indirect and Indirect Block Moves, Memory-to-Memory Moves, Load/Stores, and Jumps are all instructions with 64-bit address capability.

Note: Crossing the 4 Gbyte boundary on any one SCRIPTS operation is not permitted. Therefore, software must handle all such transactions.

2.2.4 Hardware Control of SCSI Activity LED

The LSI53C1010R controls an LED through the GPIO_0 pin to indicate that it is connected to the SCSI bus. This function was previously handled by a software driver.

Bit 3 (CON), in the Interrupt Status Zero (ISTAT0) register, is presented at the GPIO_0 pin when the following occurs:

- Bit 5 (LED_CNTL) in the General Purpose Pin Control (GPCNTL) register is set,

- Bit 6 (Fetch Enable) in the General Purpose Pin Control (GPCNTL) register is cleared,

- the LSI53C1010R is not performing an EEPROM autodownload.

The CON (Connected) bit in Interrupt Status Zero (ISTAT0) is set anytime the LSI53C1010R is connected to the SCSI bus either as an initiator or a target. This happens after the LSI53C1010R has successfully completed a selection or when it has successfully responded to a selection or reselection. The CON bit is also set when the LSI53C1010R wins arbitration in low level mode.

2.2.5 Designing an Ultra160 SCSI System

Software modifications are needed to take advantage of the Ultra160 speed in the LSI53C1010R. Since Ultra160 SCSI is based on existing SCSI standards, it can use existing drivers if they are able to negotiate for Ultra160 synchronous transfer rates. Also, the target device must be able to communicate at Ultra160 speed. The LSI53C1010R uses Domain Validation to determine whether or not the system is capable of Ultra160 SCSI before activating DT clocking. Refer to Section 2.2.5.1, "Ultra160 Features," for more information on DT clocking.

LVD SCSI fulfills the hardware requirements for Ultra160 SCSI transfer rates, increased cable lengths, and additional devices on the bus. All devices on the bus must have LVD SCSI capabilities to guarantee Ultra160 SCSI transfer rates. For additional information on Ultra160

SCSI, refer to the SCSI Parallel Interface-3 (SPI-3) working document that is available on the world wide web at the T10 Home Page, `http://www.t10.org`. Also, check the SCSI Trade Association web site at `http://www.scsita.org/`. Chapter 6, "Specifications," contains Ultra160 SCSI timing information. In addition to the guidelines in the draft standard, make the following software adjustments to accommodate Ultra160 SCSI transfers.

2.2.5.1 Ultra160 Features

Domain Validation – Domain Validation is a procedure in which a host queries a device to determine its ability to communicate at the negotiated Ultra160 data rate. In software, the following steps are performed to ensure the selected device can successfully transfer data at the negotiated speed.

Step 1.   Select a device.

Step 2.   Issue Inquiry command.

Step 3.   Issue Parallel Protocol Request (PPR) message.

Step 4.   Issue Write Buffer command.

Step 5.   Issue Read Buffer command.

Step 6.   Examine the data pattern to ensure validity.

If the commands complete successfully with no CRC errors, bus hangs, or data pattern errors, then the negotiated speed is valid.

CRC – CRC is the error detecting code used in Ultra160 SCSI. Four bytes are transferred with data to increase the reliability of data transfers. CRC is used in the DT Data-In and DT Data-Out phases only. Because CRC is implied with DT mode and only works with DT mode, the DT setting can be used for CRC.

DT Clocking – Ultra160 SCSI implements DT clocking to provide speeds up to 80 megatransfers/s. DT clocking means that the data is sampled on both the asserting and deasserting edge of REQ/ACK. DT clocking is only valid using a LVD SCSI bus.

In order to support DT clocking, there are two new phases for the SCSI bus. The old Data-In and Data-Out phases are now called single transition (ST) Data-In and ST Data-Out. The new phases are DT

Data-In and DT Data-Out. The use of DT and ST phases implies that the SCRIPTS engine may use a different jump point for DT or ST. Table 2.3 illustrates SCSI signal configuration for these phases.

Table 2.3   New Phases on SCSI Bus

Phase	MSG	C/D	I/O	Description
ST Data-Out	0	0	0	–
ST Data-In	0	0	1	–
DT Data-Out	1	0	0	Previously reserved
DT Data-In	1	0	1	Previously reserved

To indicate DT or ST mode, a bit is set in the current "selection" data reserved byte. BMOVE instructions identify the current BMOVE as either DT or ST through the phase bits.

2.2.5.2 Parallel Protocol Request

CRC, Sync/Wide, DT, Quick Arbitration and Selection (QAS), and "information units" are negotiated with a new SCSI extended message:

Byte 0	0x01	Extended message
Byte 1	0x06	Length
Byte 2	0x04	Parallel Protocol Request (PPR)
Byte 3	0xXX	Transfer Period Factor
Byte 4	0x00	Reserved
Byte 5	0xXX	Req/Ack Offset
Byte 6	0xXX	Transfer Width Exponent
Byte 7	0x0X	Protocol options

Transfer Period Factor (Byte 3) – Transfer Period Factor is the old Synchronous Period value. These are the same with one addition for the 80 megatransfers/s rate:

0x09	=	12.5 ns (Ultra160 SCSI) only valid when using DT
0x0A	=	25 ns (Ultra2 SCSI)
0x0B	=	30.3 ns
0x0C	=	50 ns (Ultra SCSI)
0x0D–0xFF	=	$value \times 4 = Period$ (in ns)

The transfer period depends on the data transfer speed, NOT the clock period. So, in DT mode, 0x09 means 12.5 ns between clock edges which really means a 25 ns clock period. In DT mode, 0x0A would mean a clock period of 50 ns but a data rate of 40 megatransfers/s (25 ns). In ST mode, 0x0A would mean a clock period of 25 ns and a data rate of 40 megatransfers/s.

Req/Ack Offset (Byte 5) – Req/Ack Offset is the maximum SCSI offset.

Transfer Width Exponent (Byte 6) – Transfer Width Exponent is the old width value. It is set to 0 (8-bit SCSI width) or 1 (16-bit SCSI width).

Note: For DT mode or when the Protocol Options field is nonzero, the Transfer Width Exponent must be one indicating a SCSI width of 16 bits.

Note: The Table Indirect data (used during selection/reselection) must be updated to enable certain control bits in the SCNTL4 register. Specific bits to look at include: bit 7, U3EN (Ultra160 Transfer Enable); bit 6, AIPEN (Asynchronous Information Protection Enable); and bits [3:0] (Extra Clock Setup/Hold).

Protocol Options (Byte 7) –

QAS_REQ	DT_REQ	IU_REQ	Description
0	0	0	Use ST Data-In and ST Data-Out phase to transfer data
0	1	0	Use DT Data-In and DT Data-Out phase to transfer data with CRC
0	1	1	Use DT Data-In and DT Data-Out phase to transfer data with information units
1	1	0	Use DT Data-In and DT Data-Out phase to transfer data with CRC and use the QAS method for arbitration
1	1	1	Use DT Data-In and DT Data-Out phase to transfer data with information units and use the QAS method for arbitration

A bus or device reset, power cycle, or change between LVD/SE modes invalidates these settings. A renegotiation resets the Protocol Options.

2.2.5.3 Asynchronous Information Protection (AIP)

The AIP feature provides error checking for asynchronous, nondata phases through BCH encoding. During the command, status, message in/out phases, the BCH code is transferred on the upper SCSI data bus. For details on the BCH code, see T10 119 document "Protection for the Asynchronous Phases".

The AIP error status and the live AIP code values are captured in the AIP Control Zero (AIPCNTL0) register for debug purposes. AIP checking is enabled by setting bit 6 in the SCSI Control Four (SCNTL4) register. AIP generation occurs by default and may be disabled by setting bit 3, Disable AIP Code Generation, in AIP Control One (AIPCNTL1).

The sequence ID is reset on any phase change, chip reset, bus free, or synchronous phase. It is also reset by writing the RAIPERR bit in the AIP Control One (AIPCNTL1) register.

All AIP errors are treated in the same fashion as parity errors. Bit 0 of the SCSI Interrupt Status Zero (SIST0) register indicates if SCSI parity, CRC, or AIP errors are present. The AIPERR bit in the AIP Control Zero (AIPCNTL0) register indicates if the error is an AIP error.

2.2.5.4 Register Considerations

The following is a summary of the registers and bits required to enable Ultra160 SCSI on the LSI53C1010R device.

- The PCI Device ID register value must be 0x21.

- The PCI Max_Lat (ML) register contains a value of 0x12, indicating it requires the bus every 4.5 µs.

- The SCSI Control Zero (SCNTL0) register:

  – Bit 3, EPC (Enable Parity/CRC/AIP Checking) is set to enable the CRC feature.

  – Bit 1, AAP (Assert SATN/ on Parity/CRC/AIP Error), is set in the initiator mode to automatically assert SATN/ on the detection of an error.

- The SCSI Control One (SCNTL1) register:

  – Bit 5, DHP (Disable Halt on Parity/CRC/AIP Error or ATN) (Target Only), is set in accordance with user requirements. When bit 5 is cleared, a SCSI transfer halts if an error occurs. When bit 5 is set, a SCSI transfer continues if an error occurs.

- The SCSI Control Three (SCNTL3) register:

  – Bit 7 is now reserved. It was previously the Ultra Enable bit.

  – Bits [6:4], SCF[2:0] (Synchronous Clock Conversion Factor), select the divisor of the SCLK frequency. The SCLK is divided before its presentation to the synchronous SCSI control logic.

  – Bit 3, EWS (Enable Wide SCSI), is set to enable wide SCSI. Ultra160 requires wide SCSI. Therefore, this bit must be set during these transfers.

  – Bits [2:0] are reserved.

- The SCSI Transfer (SXFER) register:

  – Bits [7:6] are reserved.

  – Bits [5:0], MO[5:0] (Max SCSI synchronous offset), are set for the maximum offset.

- The SCSI Status Two (SSTAT2) register:

  – Bit 2 is reserved. HVD SCSI is not supported.

- The SCSI Interrupt Enable Zero (SIEN0) register:
  - Bit 0, PAR (SCSI Parity/CRC/AIP Error), is set to detect a parity/CRC/AIP error while receiving or sending SCSI data. For more information, see SCSI Control One (SCNTL1), bit 5.

- The Chip Control Three (CCNTL3) register:
  - Bit 4, ENDSKEW (Enable REQ/ACK to Data skew control) is set to enable control of the relative skew between the SCSI REQ/ACK signal and the data signals.
  - Bits [3:2], DSKEW[1:0] (REQ/ACK - Data skew control), control the amount of skew between the SCSI REQ/ACK signal and the SCSI data signals. These bits are used for Ultra160 SCSI Domain Validation only and control the skew only if bit 4 is set.
  - Bits [1:0], LVDDL[1:0] (LVD Drive strength select), control the drive level of the LVD pad drivers. This feature is intended for use in Ultra160 SCSI Domain Validation testing environments only. Set these bits to 0b00 during normal operation.

- The SCSI Control Four (SCNTL4) register:
  - Bit 7, U3EN (Ultra160 Transfer Enable) is set to enable Ultra160 transfers.
  - Bit 6, AIPCKEN (AIP Checking Enable), is set to enable checking of the upper byte lane of protection information during Command, Status, and Message Phases.
  - Bits [5:4] are reserved.
  - Bit 3, XCLKH_DT (Extra Clock of Data Hold on DT Transfer Edge) is set to add a clock of data hold to synchronous DT SCSI transfers on the DT edge.
  - Bit 2, XCLKH_ST (Extra Clock of Data Hold on ST Transfer Edge) is set to add a clock of data hold to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts both ST and DT transfers as it affects data hold to the ST edge.
  - Bit 1, XCLKS_DT (Extra Clock of Data Setup on DT Transfer Edge) is set to add a clock of data setup to synchronous DT SCSI transfers on the DT edge. This bit only impacts DT transfers as it affects data setup to the DT edge.

– Bit 0, XCLKS_ST (Extra Clock of Data Setup on ST Transfer Edge) is set to add a clock of data setup to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts both ST and DT transfers as it affects data setup to the ST edge.

Note: The XCLKH_DT, XCLKH_ST, XCLKS_DT, and XCLKS_ST bits do not affect CRC timings.

- The AIP Control Zero (AIPCNTL0) register:

  – Bits [7:3] are reserved.

  – Bit 2, AIPERR_LIVE (AIP Error Status Live), represents the live error status for the AIP checking logic. This is not a latched value.

  – Bit 1, AIPERR (AIP Error Status), represents the error status for the AIP checking logic.

  – Bit 0, PARITYERR (Parity Error), represents the error status for the parity error.

- The AIP Control One (AIPCNTL1) register:

  – Bits [7:4] are reserved.

  – Bit 3, DISAIP (Disable AIP Code Generation), disables the AIP code generation on the SCSI bus.

  – Bit 2, RAIPERR (Reset AIP Error), allows an AIP error condition to be reset manually.

  – Bit 1, FBAIP (Force Bad AIP Value), causes bad AIP values to be sent over the SCSI bus.

  – Bit 0, RSQ (Reset AIP Sequence Value), causes the sequence value used in the calculation of the protection code to be reset.

- The CRC Pad Byte Value (CRCPAD) register:

  – Bits [15:0], the CRC Pad byte value, contain the value placed onto the bus for the CRC pad bytes.

- The CRC Control Zero (CRCCNTL0) register:

  – Bit 7, DCRCC (Disable CRC Checking), is set to cause the internal logic to not check or report CRC errors during Ultra160 transfers. The device continues to calculate and send CRCs as requested by the target per SPI-3 specification.

- Bit 6, DCRCPC (Disable CRC Protocol Checking) causes the LSI53C1010R to not check for a CRC request prior to a phase change on the SCSI bus. This condition creates a SCSI error condition and makes the device noncompliant with the SPI-3 specification. Do not set this bit under normal operating conditions.

- Bits [5:0] are reserved.

- The CRC Control One (CRCCNTL1) register:

  - Bit 7, CRCERR (CRC Error), indicates whether or not a CRC error has been detected during a DT Data In SCSI transfer. This bit is independent of the DCRCC bit setting. To clear this condition, either write this bit to a one or read the SIST0 and SIST1 registers. When CRC checking and the Parity/CRC/AIP Error interrupt are both enabled, CRCERR is mirrored in the SIST0 register, bit 0, as a Parity/CRC/AIP error.

  - Bit 6 is reserved.

  - Bit 5, ENAS (Enable CRC Auto Seed), is set to cause the CRC logic to automatically reseed itself after every CRC check performed during DT Data In SCSI transfers. When this bit is cleared, the SCSI control logic controls when the CRC logic is reseeded.

  - Bit 4, TSTSD (Test CRC Seed), is set to cause the CRC logic to immediately reseed itself. Do not set this bit during normal operation as it may cause corrupt CRCs to be generated.

  - Bit 3, TSTCHK (Test CRC Check), is set to cause the CRC logic to initiate a CRC check. Do not set this bit during normal operation as it creates spurious CRC errors.

  - Bit 2, TSTADD (Test CRC Accumulate), is set to cause the CRC block to include the value present in the input register in the current CRC calculation. A new output CRC value results. Do not set this bit during normal operation as corrupt CRC values result.

  - Bits [1:0], CRCDSEL[1:0] (CRC Data Register Selector), control the data visible in the CRC Data register.

- The CRC Data (CRCD) register:

  - Bits [31:0] CRCDATA (CRC Data). The value in this register is dependent upon the setting of the CRCDSEL bits.

2.2.5.5 Using the SCSI Clock Quadrupler

The LSI53C1010R can quadruple the frequency of a 40 MHz SCSI clock, allowing the system to perform Ultra160 SCSI transfers. This option is user-selectable with bit settings in the SCSI Test One (STEST1), SCSI Test Three (STEST3), and SCSI Control Three (SCNTL3) registers. At power-on or reset, the quadrupler is disabled and powered down. Follow these steps to use the clock quadrupler:

1. Set the SCLK Quadrupler Enable bit (SCSI Test One (STEST1) register, bit 3).

2. Do not poll bit 5 of the SCSI Test Four (STEST4) register. Bit 5 is reserved. Use a delay of 50 μs after the quadrupler enable bit is set in step 1.

3. Halt the SCSI clock by setting the Halt SCSI Clock bit (SCSI Test Three (STEST3) register, bit 5).

4. Set the clock conversion factor using the SCF (Synchronous clock Conversion Factor) field in the SCSI Control Three (SCNTL3) register.

5. Set the SCLK Quadrupler Select bit (SCSI Test One (STEST1), bit 2).

6. Clear the Halt SCSI Clock bit.

2.2.6 Prefetching SCRIPTS Instructions

The prefetch logic in the LSI53C1010R fetches 8 Dwords of instructions when enabled by setting the Prefetch Enable bit (bit 5) in the DMA Control (DCNTL) register. The maximum burst size that can be performed is automatically determined using the burst length values in the DMA Mode (DMODE) register. If the unit cannot perform bursts of at least 4 Dwords, it disables itself. While the chip is prefetching SCRIPTS instructions, it uses the PCI cache commands Memory Read Line and Memory Read Multiple, if PCI caching is enabled.

> Note: This feature is only useful when fetching SCRIPTS instructions from main memory. Due to the short access time of SCRIPTS RAM, prefetching is not necessary when fetching instructions from SCRIPTS RAM.

To ensure the LSI53C1010R always operates from the current version of the SCRIPTS instruction, the contents of the prefetch unit may be flushed under certain conditions. The contents of the prefetch unit are automatically flushed under the following conditions:

- On every Memory Move instruction

  The Memory Move instruction is used to place modified code into memory. To assure the device executes recent modifications, the prefetch unit flushes its contents and reloads the code each time an instruction is issued. To avoid inadvertently flushing the prefetch unit contents, use the No Flush option for all Memory Move operations that do not modify code within the next 8 Dwords. For more information refer to Chapter 5, "SCSI SCRIPTS Instruction Set."

- On every Store instruction

  The Store instruction may also be used to place modified code directly into memory. To avoid inadvertently flushing the prefetch unit contents, use the No Flush option for all Store operations that do not modify code within the next 8 Dwords.

- On every write to the DMA SCRIPTS Pointer (DSP) register.

- On all Transfer Control instructions, when the transfer conditions are met.

  This is necessary since the next instruction to be executed is not the sequential next instruction in the prefetch unit.

- When the Prefetch Flush bit (DMA Control (DCNTL) register, bit 6) is set.

  The unit flushes whenever this bit is set. This bit is self-clearing.

2.2.7 Opcode Fetch Burst Capability

Setting the Burst Opcode Fetch Enable bit (bit 1) in the DMA Mode (DMODE) register (0x38) causes the LSI53C1010R to burst in the first two Dwords of all instruction fetches. If the instruction is a Memory-to-Memory Move, the third Dword is accessed in a separate ownership. If the instruction is an indirect type, the additional Dword is accessed in a subsequent bus ownership. If the instruction is a Table Indirect Block Move, the device uses two accesses, each a two Dword burst, to obtain the four Dwords required.

This feature is only useful if Prefetching is disabled.

This feature is only useful if fetching SCRIPTS instructions from main memory. Due to the short access time of SCRIPTS RAM, burst opcode fetching is not necessary when fetching instructions from SCRIPTS RAM.

2.2.8 Load and Store Instructions

The LSI53C1010R supports the Load and Store instruction type, which simplifies data movement between memory and the internal registers. It also enables the chip to transfer bytes to addresses relative to the Data Structure Address (DSA) register. Load/Store data transfers to or from the SCRIPTS RAM remain internal to the chip and do not generate PCI bus cycles. While a Load/Store to or from SCRIPTS RAM is occurring, any external PCI slave cycles that occur are retried on the PCI bus. Setting the DISRC (Disable Internal SCRIPTS RAM Cycles) bit in the Chip Control Zero (CCNTL0) register disables this feature. For more information on the Load and Store instructions, refer to Chapter 5, "SCSI SCRIPTS Instruction Set."

2.2.9 JTAG Boundary Scan Testing

With one exception, the LSI53C1010R includes support for JTAG boundary scan testing in accordance with the IEEE 1149.1 specification. The exception concerns the TST_RSTN pin. This pin must not be toggled as it will reset the JTAG TAP controller. For more information, refer to the BSDL (Boundary Scan Descriptor Language) file.

This device accepts all required boundary scan instructions including the optional CLAMP, HIGH-Z, and IDCODE instructions. The optional JTAG pin TRST is not implemented. Reset of the JTAG logic through the TAP controller occurs when TMS is held HIGH for at least 5 TCK clock cycles.

The LSI53C1010R uses an 8-bit instruction register to support all boundary scan instructions. The data registers included in the device are the Boundary Data register, the IDCODE register, and the Bypass register. This device can handle a 20 MHz TCK frequency with all TAP pins having a 50% duty cycle.

2.2.10 Parity/CRC/AIP Options

The LSI53C1010R implements a flexible parity scheme that permits control of the parity sense, allows parity checking to be turned on or off, and can deliberately send a byte with bad parity over the SCSI bus. Table 2.4 defines the bits that are involved in parity control and observation. Table 2.5 describes the parity control function of the Enable Parity Checking and Assert SCSI Even Parity bits in the SCSI Control One (SCNTL1) register, bit 2, and the options available when a parity error occurs.

SCRIPTS RAM must first be written before being read in order to initialize SCRIPTS RAM parity. If a SCRIPTS RAM parity error is encountered, a SCSI Gross Error interrupt is signaled.

The LSI53C1010R supports CRC checking and generation in DT phases and CRC checking and generation during DT Data Transfers.

The new CRC registers are: CRC Pad Byte Value (CRCPAD); CRC Control Zero (CRCCNTL0); CRC Control One (CRCCNTL1); CRC Data (CRCD); SCSI Control Zero (SCNTL0), bit 3, EPC, and bit 1, AAP; Chip Control One (CCNTL1), bit 5, DHP; and SCSI Interrupt Enable Zero (SIEN0), bit 0, (SCSI Parity/CRC/AIP Error).

The new AIP registers are: SCSI Control Zero (SCNTL0), AIP Control Zero (AIPCNTL0), and AIP Control One (AIPCNTL1).

Table 2.4   Bits Used for Parity/CRC/AIP Control and Generation

Bit Name	Location	Description
AAP (Assert SATN/ on Parity/CRC/AIP Errors)	SCSI Control Zero (SCNTL0), Bit 1	When this bit is set, the LSI53C1010R SCSI function automatically asserts the SATN/ signal upon detection of a parity, CRC, or AIP error. SATN/ is only asserted in initiator mode.
EPC (Enable Parity/CRC/AIP Checking)	SCSI Control Zero (SCNTL0), Bit 3	When set, this bit enables parity checking on the LSI53C1010R. The LSI53C1010R checks for odd parity.
Assert Even SCSI Parity	SCSI Control One (SCNTL1), Bit 2	When set, this bit forces even SCSI parity on each byte sent to the SCSI bus from the LSI53C1010R.
Disable Halt on SATN/ or Parity/CRC/AIP Error (Target Mode Only)	SCSI Control One (SCNTL1), Bit 5	This bit determines if the LSI53C1010R halts operations when a parity error is detected in target mode.

Table 2.4   Bits Used for Parity/CRC/AIP Control and Generation (Cont.)

Bit Name	Location	Description
Enable Parity/CRC/AIP Error Interrupt	SCSI Interrupt Enable Zero (SIEN0), Bit 0	This bit determines whether the LSI53C1010R generates an interrupt when it detects a SCSI parity/CRC/AIP error.
Parity Error	SCSI Interrupt Status Zero (SIST0), Bit 0	This status bit is set whenever the LSI53C1010R detects a parity/CRC/AIP error on the SCSI bus.
Status of SCSI Parity Signal	SCSI Status Zero (SSTAT0), Bit 0	This status bit represents the active HIGH current state of the SCSI SDP0 parity signal.
SCSI SDP1 Signal	SCSI Status Two (SSTAT2), Bit 0	This bit represents the active HIGH current state of the SCSI SDP1 parity signal.
Latched SCSI Parity	SCSI Status Two (SSTAT2), Bit 3 SCSI Status One (SSTAT1), Bit 3	These bits reflect the SCSI odd parity signal corresponding to the data latched into the SCSI Input Data Latch (SIDL) register.
Master Parity Error Enable	Chip Test Four (CTEST4), Bit 3	This bit enables parity checking during PCI master data phases.
Master Data Parity Error	DMA Status (DSTAT), Bit 6	This bit is set when the LSI53C1010R, as a PCI master, detects a target device signaling a parity error during a data phase.
Master Data Parity Error Interrupt Enable	DMA Interrupt Enable (DIEN), Bit 6	By clearing this bit, a Master Data Parity Error does not cause assertion of INTA/ (or INTB/), but the status bit is set in the DMA Status (DSTAT) register.
AIP Checking Enable	SCSI Control Four (SCNTL4), Bit 6	Setting this bit enables the AIP checking of the upper byte lane of protection information during command, status, and message phases.
CRC Request OK	SCSI Control Zero (SCNTL0), Bit 2	This bit indicates that it is acceptable to force a CRC request. This bit is set only if a CRC request has been sent and no data has been transferred since that request. This bit can be used to determine if it is necessary to send a CRC request at the end of a data transfer prior to changing phases in target mode. Use this bit to prevent back to back CRC conditions.
Disable CRC Checking	CRC Control Zero (CRCCNTL0), Bit 7	This bit is set to cause internal logic not to check or report CRC errors during Ultra160 transfers.
Disable CRC Protocol Checking	CRC Control Zero (CRCCNTL0), Bit 6	This bit is set to cause the device not to check for a CRC request prior to a phase change on the SCSI bus. This condition normally causes a SCSI error condition. **Note**: Setting this bit makes the LSI53C1010R noncompliant to the SPI-3 specification. Do not set this bit under normal operating conditions.

Table 2.5   SCSI Parity Errors and Interrupts

DHP[1]	PAR[2]	Description
0	0	Halts when a parity error occurs in the target or initiator mode and does NOT generate an interrupt.
0	1	Halts when a parity error occurs in the target mode and generates an interrupt in the target or initiator mode.
1	0	Does not halt in target mode when a parity error occurs until the end of the transfer. An interrupt is not generated.
1	1	Does not halt in target mode when a parity error occurs until the end of the transfer. An interrupt is generated.

1. DHP = Disable Halt on SATN/ or Parity Error (bit 5 SCSI Control One (SCNTL1)).
2. PAR = Parity Error (bit 0 SCSI Interrupt Enable One (SIEN1)).

2.2.11 DMA FIFO

The DMA FIFO is 8 bytes wide by 112–115 transfers deep depending on the type and direction of data transfer. The DMA FIFO is illustrated in Figure 2.2. The small FIFO mode (112 bytes) is not supported by the LSI53C1010R.

Figure 2.2   DMA FIFO Sections
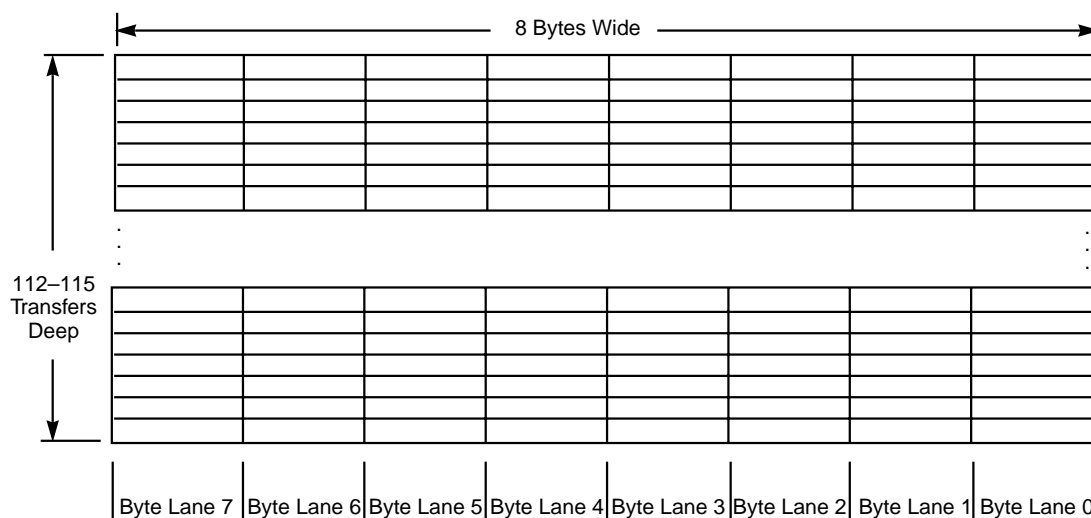
The LSI53C1010R supports 64-bit memory and automatically supports misaligned DMA transfers. The FIFO allows the LSI53C1010R to support 4, 8, 16, 32, 64, or 128 Dword bursts across the PCI bus interface.

2.2.12 SCSI Data Paths

The data path through the LSI53C1010R is dependent on whether data is moved into or out of the chip and whether the SCSI data transfer is asynchronous or synchronous. Figure 2.3 illustrates how data is moved to and from the SCSI bus in each of the different modes. The following sections determine if any bytes remain in the data path when the device halts an operation.

Figure 2.3   LSI53C1010R Host Interface SCSI Data Paths
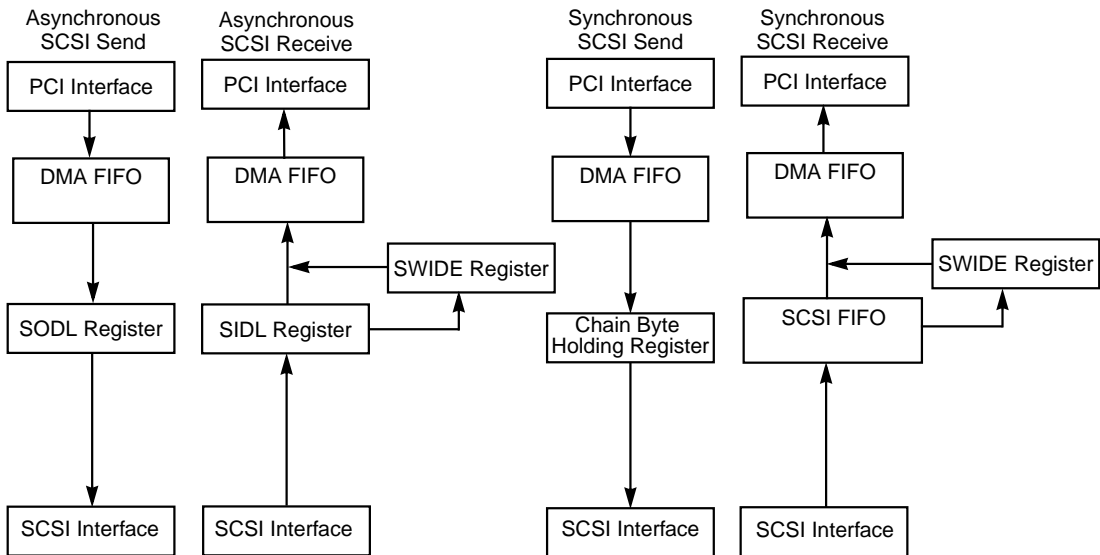
2.2.12.1 Asynchronous SCSI Send

To determine the number of bytes remaining in the DMA FIFO when a phase mismatch occurs, read the DMA FIFO Byte Count (DFBC) register. This 16-bit read only register contains the actual number of bytes remaining in the DMA FIFO. In addition, the SCSI Output Data Latch (SODL) register must be checked to determine if it contains any remaining bytes. If bit 5 (OLF) in the SCSI Status Zero (SSTAT0) register is set, then the least significant byte in the SODL register contains data.

If bit 5 (OLF1) in the SCSI Status Two (SSTAT2) register is set, then the most significant byte in the SODL register contains data. Checking these bits also reveals bytes left in the SODL register from a Chained Move operation with an odd byte count. To recover from all other error conditions, clear the DMA FIFO by setting bit 2 (CLF) in Chip Test Three (CTEST3) and retry the I/O.

If the Wide SCSI Send (WSS) bit in the SCSI Control Two (SCNTL2) register is set when a phase mismatch occurs, then adjustments must be made to the previous block move, not the current block move loaded into DCMD/DBC. To recover the byte of chain data in the SODL register, set the previous block move byte count to 1 and set the address to the last data address for that block move.

2.2.12.2 Synchronous SCSI Send

The DMA FIFO is the only location where data can reside when a phase mismatch occurs during a synchronous SCSI send transfer. To determine the number of bytes remaining in the DMA FIFO, read the DMA FIFO Byte Count (DFBC) register. This 16-bit, read only register contains the actual number of bytes remaining in the DMA FIFO. To recover from all other error conditions, clear the DMA FIFO by setting bit 2 (CLF) in Chip Test Three (CTEST3) and retry the I/O.

If the Wide SCSI Send (WSS) bit in the SCSI Control Two (SCNTL2) register is set when a phase mismatch occurs, then adjustments must be made to the previous block move, not the current block move loaded into DCMD/DBC. To recover the byte of chain data in the outbound chain byte holding register, set the previous block move byte count to one and set the address to the last data address for that block move.

2.2.12.3 Asynchronous SCSI Receive

When a phase mismatch occurs during an asynchronous SCSI receive, the only data that may remain in the device is a potential wide residue byte in the SCSI Wide Residue (SWIDE) register. If bit 0 (WSR) in SCSI Control Two (SCNTL2) is set, then the SWIDE register contains a residual byte. This byte can be flushed by executing a block move instruction with a byte count of one. To recover from all other error conditions, set the DMA FIFO by setting bit 2 (CLF) in Chip Test Three (CTEST3) and retry the I/O.

2.2.12.4 Synchronous SCSI Receive

When a phase mismatch occurs during a synchronous SCSI receive transfer, no data recovery operation is necessary. All data, including chain bytes from Chained Block Moves, are flushed from the device prior to the phase mismatch occurring. To recover from all other error conditions, clear the DMA FIFO by setting bit 2 (CLF) in Chip Test Three (CTEST3), clear the SCSI FIFO by setting bit 1 (CSF) in SCSI Test Three (STEST3), and retry the I/O.

2.2.13 SCSI Bus Interface

The LSI53C1010R performs SE and LVD transfers.

2.2.13.1 SCSI Bus Modes

To increase device connectivity and SCSI cable length, the LSI53C1010R features LVD Link™ technology, the LSI Logic implementation of LVD SCSI. LVD Link transceivers provide the inherent reliability of differential SCSI and a long-term migration path for faster SCSI transfer rates.

HVD is not supported by this device. Bit 2 (previously DIFF), of the SCSI Status Two (SSTAT2) register, and bit 5 (previously DIF), of the SCSI Test Two (STEST2) register, are reserved. The A_DIFFSENS or B_DIFFSENS signals still detect the different input voltages for HVD, LVD, and SE but the HVD feature is not present.

2.2.13.2 SCSI Termination

The terminator networks pull signals to an inactive voltage level and match the impedance seen at the end of the cable with the characteristic impedance of the cable. Terminators must be installed at the extreme ends of the SCSI chain, and only at the ends; no system should ever have more or less than two terminators. SCSI host adapters should provide a means of accommodating terminators. There should be a means of disabling the termination.

SE cables can use a 220 Ω pull-up resistor to the terminator power supply (Term Power) line and a 330 Ω pull-down resistor to ground. Because of the high-performance nature of the LSI53C1010R, regulated

(or active) termination is recommended. Figure 2.4 shows an active terminator. TolerANT technology active negation can be used with either termination network.

For information on terminators that support LVD, refer to the SPI-3 draft standard.

Note: If the LSI53C1010R is used in a design with an 8-bit SCSI bus, all 16 data lines must be terminated.

Figure 2.4   Regulated Termination for Ultra160 SCSI
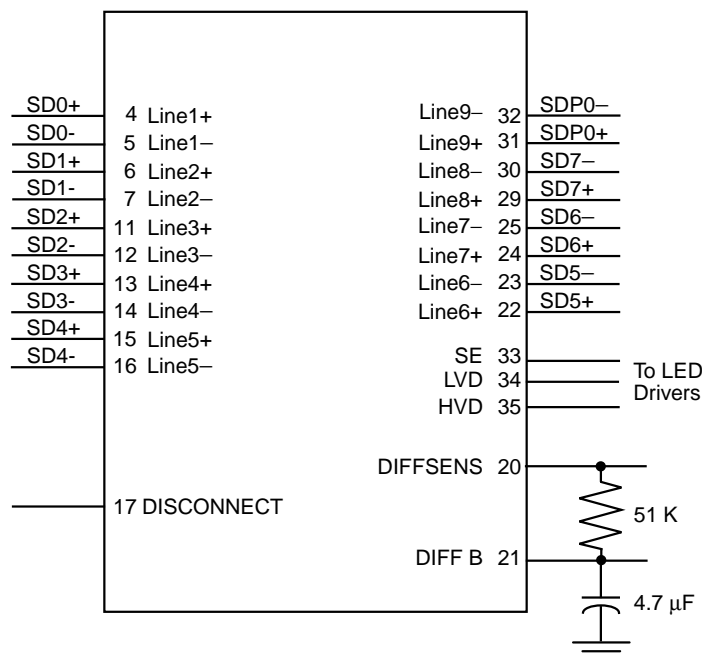
DIFFSENS connects to the SCSI bus DIFFSENS line to detect what type of devices (SE, LVD, or HVD) are connected to the SCSI bus.
DISCONNECT shuts down the terminator when it is not at the end of the bus. The disconnect pin low enables the terminator.

2.2.14 Select/Reselect During Selection/Reselection

In multithreaded SCSI I/O environments, it is not uncommon to be selected or reselected while trying to perform selection/reselection. This situation may occur when a SCSI controller (operating in the initiator mode) tries to select a target and is reselected by another. The Select

SCRIPTS instruction has an alternate address to which the SCRIPTS will jump when this situation occurs. The analogous situation for target devices is being selected while trying to perform a reselection.

Once a change in operating mode occurs, either the initiator SCRIPTS issues a Set Initiator instruction or the target SCRIPTS issues a Set Target instruction. The Selection and Reselection Enable bits (SCSI Chip ID (SCID) bits 5 and 6, respectively) should both be asserted, enabling the LSI53C1010R to respond as an initiator or as a target. If only selection is enabled, the LSI53C1010R cannot be reselected as an initiator. Status bits, in the SCSI Interrupt Status Zero (SIST0) register, and interrupt bits, in the SCSI Interrupt Enable Zero (SIEN0) register, indicate if the LSI53C1010R has been selected or reselected.

2.2.15 Synchronous Operation

The LSI53C1010R can transfer synchronous SCSI data in both the initiator and target modes. The LSI53C1010R SCLK input must be connected to a 40 MHz oscillator. The SCSI Transfer (SXFER) register controls the synchronous offset while the SCSI Control Three (SCNTL3) register controls the synchronous clock converters. These registers may be loaded by the CPU before SCRIPTS execution begins, from within SCRIPTS, with a Table Indirect I/O instruction, or with a Read-Modify-Write instruction.

The LSI53C1010R can receive data from the SCSI bus at a synchronous transfer period as short as 12.5 ns, regardless of the transfer period used to send data. The LSI53C1010R can receive data at one-fourth of the divided SCLK frequency. Depending on the SCLK frequency, the negotiated transfer period, and the synchronous clock divider, the LSI53C1010R can send synchronous data at intervals as short as 12.5 ns for Ultra160 SCSI, 25 ns for Ultra2 SCSI, 50 ns for Ultra SCSI, 100 ns for Fast SCSI, and 200 ns for SCSI-1.

Synchronous data transfer rates are controlled by bits in two different registers of the LSI53C1010R. Following is a brief description of these bits and the method used to determine the data transfer rate.

2.2.15.1 SCSI Control Three (SCNTL3) Register, Bits [6:4] (SCF[2:0]) Description

The SCF[2:0] bits select the factor by which the frequency of SCLK is divided before its presentation to the synchronous SCSI control logic.

The synchronous transfer speed is determined by the combination of the divided clock and the setting of the XCLKS_ST, XCLKS_DT, XCLKH_ST, and XCLKH_DT bits in the SCSI Control Four (SCNTL4) register. Table 2.6 provides the SCF clock dividers available. Refer to Table 4.4, "Double Transition Transfer Rates," and Table 4.5, "Single Transition Transfer Rates," located in the SCSI Control Four (SCNTL4) register description, for a full list of available synchronous transfer rates.

Table 2.6 lists the SCF divisor values.

Table 2.6   SCF Divisor Values

SCF2	SCF1	SCF0	SCLK Divisor
0	0	0	SCLK/3
0	0	1	SCLK/1
0	1	0	SCLK/1.5
0	1	1	SCLK/2
1	0	0	SCLK/3
1	0	1	SCLK/4
1	1	0	SCLK/6
1	1	1	SCLK/8

2.2.15.2 SCSI Control Four (SCNTL4) Register, Bits [3:0] Description

The following extra clock bits add an extra clock of setup or hold to a ST or DT transaction.

Bit 3, XCLKH_DT (Extra Clock of Data Hold on DT transfer edge), adds a clock of data hold to synchronous DT SCSI transfers on the DT edge. This bit only impacts DT transfers as it only affects data hold to the DT edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the rate at which the LSI53C1010R receives outbound REQs, ACKs, or data.

Bit 2, XCLKH_ST (Extra Clock of Data Hold on ST transfer edge), adds a clock of data hold to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts DT and ST transfers as it affects data hold to the ST edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the rate at which the LSI53C1010R receives outbound REQs, ACKs, or data.

Bit 1, XCLKS_DT (Extra Clock of Data Setup on DT transfer edge), adds a clock of data setup to synchronous DT SCSI transfers on the DT edge. This bit only impacts DT transfers as it only affects data hold to the DT edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the rate at which the LSI53C1010R receives outbound REQs, ACKs, or data.

Bit 0, XCLKS_ST (Extra Clock of Data Setup on ST transfer edge), adds a clock of data setup to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts DT and ST transfers as it affects data hold to the ST edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the rate at which the LSI53C1010R receives outbound REQs, ACKs, or data.

2.2.15.3 Determining the Data Transfer Rate

The synchronous receive rate can be calculated using the following formula:

$$\text{Receive Rate (DT)} = \frac{\text{Input Clock Rate}}{(\text{SCF Divisor} \times 2)} \quad \text{(Megatransfers/s)}$$

$$\text{Receive Rate (ST)} = \frac{\text{Input Clock Rate}}{(\text{SCF Divisor} \times 4)} \quad \text{(Megatransfers/s)}$$

Note: The receive rate is independent of the settings of the XCLKS_DT, XCLKS_ST, XCLKH_DT, XCLKH_ST bits.

The synchronous send rate, in units of megatransfers/s, can be calculated using the following formula:

$$\text{Send Rate (DT)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times \left(2 + \frac{\text{XCLKS\_DT} + \text{XCLKS\_ST} + \text{XCLKH\_DT} + \text{XCLKH\_ST}}{2}\right)}$$

$$\text{Send Rate (ST)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times (4 + \text{XCLKS\_ST} + \text{XCLKH\_ST})}$$

To configure the LSI53C1010R for Ultra160 DT transfers, perform the following steps:

Step 1.   Enable the SCSI Clock Quadrupler – The LSI53C1010R can quadruple the frequency of a 40 MHz SCSI clock, allowing the system to perform Ultra160 SCSI transfers. This option is user selectable through bit settings in the SCSI Test One (STEST1) register. At power-up or reset, the quadrupler is disabled and powered down. Follow the steps in the bit description to enable the clock quadrupler.

Step 2.   Program the Transfer Rate – Using SCNTL3 and SCNTL4, program the register to the 160 Mbytes/s transfer rate.

Step 3.   Program the Maximum SCSI Offset – Using SXFER, program the maximum SCSI DT Synchronous offset to 0x3E.

Step 4.   Enable TolerANT – Set the TolerANT Enable bit, SCSI Test Three (STEST3), bit 7. Active negation must be enabled for the LSI53C1010R to perform Ultra160 SCSI transfers.

Figure 2.5 illustrates the clock division factors used in each register as well as the role of the register bits in determining the transfer rate. An example of configuring the Ultra160 SCSI transfer speed is:

1.   Set SCNTL3 to 0x18.

2.   Set SXFER to 0x3E.

3.   Set SCNTL4 to 0x80.

These settings program the LSI53C1010R SCSI clocks to send and receive at 160 MHz with a synchronous SCSI offset of 0x3E.

Figure 2.5   Determining the Synchronous Transfer Rate
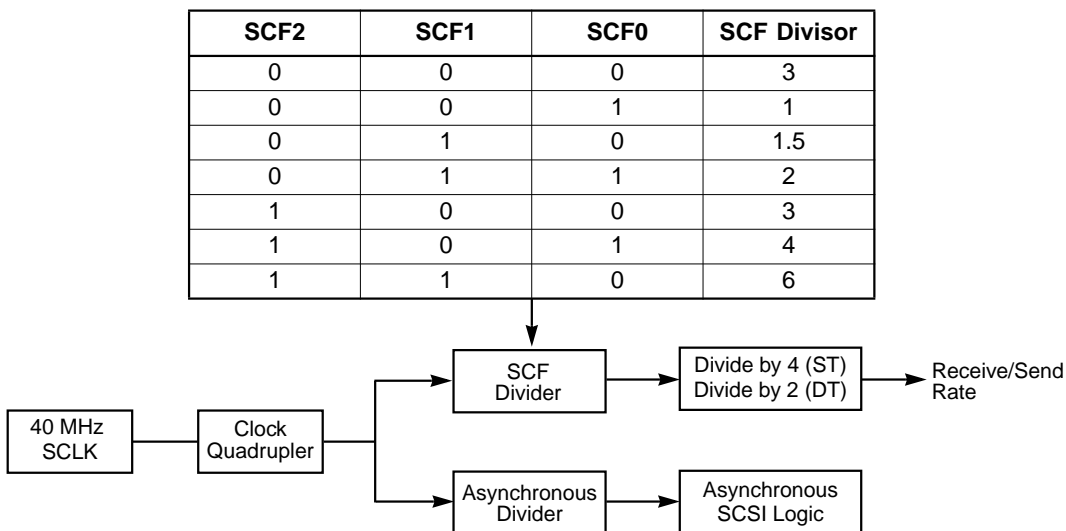
SCF2	SCF1	SCF0	SCF Divisor
0	0	0	3
0	0	1	1
0	1	0	1.5
0	1	1	2
1	0	0	3
1	0	1	4
1	1	0	6

$$\text{Receive Rate (DT)} = \frac{\text{Input Clock Rate}}{(\text{SCF Divisor} \times 2)} \quad \text{(Megatransfers/s)}$$

$$\text{Receive Rate (ST)} = \frac{\text{Input Clock Rate}}{(\text{SCF Divisor} \times 4)} \quad \text{(Megatransfers/s)}$$

$$\text{Send Rate (DT)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times \left(2 + \dfrac{\text{XCLKS\_DT} + \text{XCLKS\_ST} + \text{XCLKH\_DT} + \text{XCLKH\_ST}}{2}\right)}$$

$$\text{Send Rate (ST)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times (4 + \text{XCLKS\_ST} + \text{XCLKH\_ST})}$$

2.2.16 Interrupt Handling

The SCRIPTS processors in the LSI53C1010R perform most functions independently of the host microprocessor. However, certain interrupt situations must be handled by the external microprocessor. This section explains all aspects of interrupts as they apply to the LSI53C1010R.

2.2.16.1 Polling and Hardware Interrupts

The external microprocessor is informed of an interrupt condition by polling or hardware interrupts. Polling means that the microprocessor must continually loop and read a register until it detects a bit that is set

indicating an interrupt. This method is the fastest, but it diverts CPU time from other system tasks. The preferred method of detecting interrupts in most systems is hardware interrupts. In this case, the LSI53C1010R asserts the interrupt request (INTA/ or INTB/) line that interrupts the microprocessor, causing the microprocessor to execute an interrupt service routine. A hybrid approach uses hardware interrupts for long waits and polling for short waits.

SCSI Function A is routed to PCI Interrupt INTA/. SCSI Function B is normally routed to INTB/, but can be routed to INTA/ if a pull-up is connected to MAD[4]. See Section 3.9, "MAD Bus Programming," for additional information.

2.2.16.2 Registers

The registers in the LSI53C1010R used for detecting or defining interrupts are Interrupt Status Zero (ISTAT0), Interrupt Status One (ISTAT1), SCSI Interrupt Status Zero (SIST0), SCSI Interrupt Status One (SIST1), DMA Status (DSTAT), SCSI Interrupt Enable Zero (SIEN0), SCSI Interrupt Enable One (SIEN1), and DMA Interrupt Enable (DIEN). See the register descriptions in Chapter 4, "Registers," for additional information.

ISTAT – The ISTAT register includes the Interrupt Status Zero (ISTAT0) Interrupt Status One (ISTAT1), Mailbox Zero (MBOX0), and Mailbox One (MBOX1) registers. It is the only register that can be accessed as a slave during the SCRIPTS operation. Therefore, it is the register that is polled when polled interrupts are used. It is also the first register that should be read after the INTA/ (or INTB/) pin is asserted in association with a hardware interrupt.

The INTF (Interrupt-on-the-Fly) bit should be the first interrupt serviced. It must be written to one in order to clear it. This interrupt must be cleared before servicing any other interrupts indicated by SIP or DIP. Do not attempt to read the other chip status registers if the INTF bit is set, but SIP or DIP are not set.

If the SIP bit in the Interrupt Status Zero (ISTAT0) register is set, then a SCSI-type interrupt has occurred and the SCSI Interrupt Status Zero (SIST0) and SCSI Interrupt Status One (SIST1) registers should be read.

If the DIP bit in the Interrupt Status Zero (ISTAT0) register is set, then a DMA-type interrupt has occurred and the DMA Status (DSTAT) register should be read.

SCSI-type and DMA-type interrupts may occur simultaneously, so in some cases both SIP and DIP may be set. To avoid missing a SCSI interrupt, the SIST0 and SIST1 registers should be read before the DSTAT register is read.

When set, the SIRQD bit in ISTAT1 disables the INT/ pin for the corresponding SCSI function. The interrupt is not lost or ignored but is merely masked at the pin. If the INT/ pin is already asserted when SIRQD is set, the INT/ pin will remain asserted until the interrupt is serviced. Future interrupts will be masked at the pin until SIRQD is cleared.

Note that the host can read ISTAT as the SCRIPTS code is writing to ISTAT. In this case the data will be unstable, so the read should be retried.

SIST0 and SIST1 – The SCSI Interrupt Status Zero (SIST0) and SCSI Interrupt Status One (SIST1) registers contain the status of SCSI-type interrupts whether they are enabled in SIEN0 and SIEN1 or not. Reading these registers determines the conditions that caused the SCSI-type interrupt, clears any bits that are set in SIST0 and SIST1, and clears the SIP bit in ISTAT0. Since the LSI53C1010R SCSI functions stack interrupts, SIST0 and SIST1 are not necessarily cleared after a read; additional interrupts may still be pending.

If the LSI53C1010R is receiving data from the SCSI bus and a fatal interrupt condition occurs, the chip attempts to send the contents of the DMA FIFO to memory before generating the interrupt. Reading SCSI Interrupt Status Zero (SIST0) and SCSI Interrupt Status One (SIST1) will clear the CRC Error bit (bit 7) in the CRC Control One (CRCCNTL1) register.

If the LSI53C1010R is sending data to the SCSI bus and a fatal SCSI interrupt condition occurs, data could remain in the DMA FIFO. To determine if the DMA FIFO is empty, check the DMA FIFO Empty (DFE) bit in DMA Status (DSTAT) register. If this bit is cleared, set the CLF (Clear DMA FIFO) and CSF (Clear SCSI FIFO) bits before continuing.

The CLF bit is bit 2 in Chip Test Three (CTEST3) register. The CSF bit is bit 1 in SCSI Test Three (STEST3) register.

DSTAT – The DMA Status (DSTAT) register contains the status of DMA-type interrupts whether they are enabled in DIEN or not. Reading this register determines which condition(s) caused the DMA-type interrupt, clears any interrupt related bits in DSTAT, and clears the DIP bit in Interrupt Status Zero (ISTAT0) register. Since the LSI53C1010R SCSI functions stack interrupts, reading DSTAT does not necessarily clear the register as additional interrupts may be pending.

Bit 7 (DFE) in the DMA Status (DSTAT) register, is purely a status bit; it will not generate an interrupt and will not be cleared when read. DMA interrupts do not flush the DMA or SCSI FIFOs before generating the interrupt. Therefore, the DFE bit in the DSTAT register should be checked after any DMA interrupt. If the DFE bit is cleared, the FIFOs must either be cleared by setting the CLF (Clear DMA FIFO in CTEST3) and CSF (Clear SCSI FIFO in STEST3) bits, or flushed by setting the FLF (Flush DMA FIFO in CTEST3) bit.

SIEN0 and SIEN1 – The SCSI Interrupt Enable Zero (SIEN0) and SCSI Interrupt Enable One (SIEN1) registers are the interrupt enable registers for the SCSI interrupts in SCSI Interrupt Status Zero (SIST0) and SCSI Interrupt Status One (SIST1). Clearing the appropriate mask bit masks an interrupt.

DIEN – The DMA Interrupt Enable (DIEN) register is the interrupt enable register for DMA interrupts in DMA Status (DSTAT). Clearing the appropriate mask bit masks an interrupt.

2.2.16.3 Fatal vs. Nonfatal Interrupts

A fatal interrupt, as the name implies, always causes the SCRIPTS to stop running. All nonfatal interrupts become fatal when they are enabled by setting the appropriate interrupt enable bit. Interrupt masking is discussed in Section 2.2.16.4, "Masking." All DMA interrupts are fatal. The DMA interrupts are indicated by the DIP bit in Interrupt Status Zero (ISTAT0) and one or more bits in DMA Status (DSTAT).

Some SCSI interrupts are nonfatal. The SCSI interrupts are indicated by the SIP bit in the Interrupt Status Zero (ISTAT0) register and one or more bits in SCSI Interrupt Status Zero (SIST0) register or SCSI Interrupt Status One (SIST1) register.

When the LSI53C1010R is operating in the Initiator mode, Interrupt-on-the-Fly, Function Complete (CMP), Selected (SEL), Reselected (RSL), General Purpose Timer Expired (GEN), and Handshake-to-Handshake Timer Expired (HTH) interrupts are nonfatal.

When operating in the Target mode, Interrupt-on-the-Fly, SATN/ active (M/A), CMP, SEL, RSL, GEN, and HTH are nonfatal. Refer to the description for the Disable Halt on a Parity/CRC/AIP Error or SATN/ active (Target Mode Only) bit, DHP, in the SCSI Control One (SCNTL1) register to configure the chip's behavior when the SATN/ interrupt is enabled during Target mode operation.

The reason for nonfatal interrupts is to prevent the SCRIPTS from stopping when an interrupt occurs that does not require service from the CPU. This prevents an interrupt when arbitration is complete (CMP set), when the LSI53C1010R is selected or reselected (SEL or RSL set), when the initiator asserts ATN (target mode: SATN/ active), or when the General Purpose or handshake-to-handshake timers expire. These interrupts are not needed for events that occur during high level SCRIPTS operation.

2.2.16.4 Masking

Masking an interrupt means disabling or ignoring that interrupt. Clearing bits in the SCSI Interrupt Enable Zero (SIEN0) and SCSI Interrupt Enable One (SIEN1) registers will mask SCSI interrupts. Clearing bits in the DMA Interrupt Enable (DIEN) register will mask DMA interrupts. Masking an interrupt after INTA/ (or INTB/) is asserted does not cause INTA/ (or INTB/) to be negated. How the chip responds to masked interrupts depends on: whether polling or hardware interrupts are being used; whether the interrupt is fatal or nonfatal; and whether the chip is operating in the Initiator or Target mode.

If a nonfatal interrupt occurs while masked, SCRIPTS continues. The appropriate bit in the SCSI Interrupt Status Zero (SIST0) or SCSI Interrupt Status One (SIST1) is still set, the SIP bit in the Interrupt Status Zero (ISTAT0) is not set, and the INTA/ (or INTB/) pin is not asserted.

If a fatal interrupt occurs while masked, SCRIPTS halts. The appropriate bit in the DMA Status (DSTAT), SCSI Interrupt Status Zero (SIST0), or SCSI Interrupt Status One (SIST1) register is set, the SIP or DIP bit in the Interrupt Status Zero (ISTAT0) register is set, but the INTA/ (or INTB/) pin is not asserted.

Setting the SIRQD bit in the Interrupt Status One (ISTAT1) register disables the interrupt pin for the corresponding SCSI function. If an interrupt pin is already asserted and SIRQD is then set, the interrupt pin will remain asserted until serviced. Further interrupts will be blocked from the interrupt pin.

When the LSI53C1010R is initialized, enable all fatal interrupts if hardware interrupts are being used. If a fatal interrupt is disabled and that interrupt condition occurs, the SCRIPTS halts and the system never knows it unless it times out and checks the Interrupt Status Zero (ISTAT0), Interrupt Status One (ISTAT1), Mailbox Zero (MBOX0), and Mailbox One (MBOX1) registers after a certain period of inactivity.

If ISTAT is being polled instead of using hardware interrupts, then masking a fatal interrupt makes no difference since the SIP and DIP bits in the Interrupt Status Zero (ISTAT0) inform the system of interrupts, not the INTA/ (or INTB/) pin.

2.2.16.5 Stacked Interrupts

The LSI53C1010R stacks interrupts, if they occur, one after the other. If the SIP or DIP bits in the Interrupt Status Zero (ISTAT0) register are set (first level), then there is already at least one pending interrupt. Any future interrupts are stacked in extra registers behind the SCSI Interrupt Status Zero (SIST0), SCSI Interrupt Status One (SIST1), and DMA Status (DSTAT) registers (second level). When two interrupts have occurred and the two levels of the stack are full, any further interrupts set additional bits in the extra registers behind SIST0, SIST1, and DSTAT. When the first level of interrupts are cleared, all the later interrupts move into SIST0, SIST1, and DSTAT. After the first interrupt is cleared, the INTA/ (or INTB/) pin is deasserted for a minimum of three CLKs; the stacked interrupts move into SIST0, SIST1, or DSTAT; and the INTA/ (or INTB/) pin is asserted once again.

Since a masked nonfatal interrupt does not set the SIP or DIP bits, interrupt stacking does not occur. A masked, nonfatal interrupt still posts the interrupt in SCSI Interrupt Status Zero (SIST0), but does not assert the INTA/ (or INTB/) pin. Since no interrupt is generated, future interrupts move into SCSI Interrupt Status Zero (SIST0) or SCSI Interrupt Status One (SIST1) instead of stacking behind another interrupt. When another interrupt condition occurs, the bit corresponding to the earlier masked nonfatal interrupt is set.

A related situation to interrupt stacking is when two interrupts occur simultaneously. Since stacking does not occur until the SIP or DIP bits are set, there is a small timing window in which multiple interrupts can occur but are not stacked. These could be multiple SCSI interrupts (SIP set), multiple DMA interrupts (DIP set), or multiple SCSI and multiple DMA interrupts (both SIP and DIP set).

As previously mentioned, DMA interrupts do not attempt to flush the FIFOs before generating the interrupt. It is important to set either the Clear DMA FIFO (CLF) and Clear SCSI FIFO (CSF) bits if a DMA interrupt occurs and the DMA FIFO Empty (DFE) bit is not set. This is because any future SCSI interrupts are not posted until the DMA FIFO is cleared of data. These 'locked out' SCSI interrupts are posted as soon as the DMA FIFO is empty.

2.2.16.6 Halting in an Orderly Fashion

When an interrupt occurs, the LSI53C1010R attempts to halt in an orderly fashion.

- If the interrupt occurs in the middle of an instruction fetch, the fetch is completed, except in the case of a Bus Fault. Execution does not begin, but the DSP points to the next instruction since it is updated when the current instruction is fetched.

- If the DMA direction is a write to memory and a SCSI interrupt occurs, the LSI53C1010R attempts to flush the DMA FIFO to memory before halting. Under any other circumstances, only the current cycle is completed before halting, so the DFE bit in DMA Status (DSTAT) should be checked to determine if any data remains in the DMA FIFO.

- SCSI SREQ/SACK handshakes that are in progress are completed before halting.

- The LSI53C1010R attempts to clean up any outstanding synchronous offset before halting.

- In the case of Transfer Control Instructions, once instruction execution begins it continues to completion before halting.

- In the case of a JUMP/CALL WHEN/IF <phase> instruction, the DMA SCRIPTS Pointer (DSP) is updated to the transfer address before halting.

- All other instructions may halt before completion.

2.2.16.7 Sample Interrupt Service Routine

The following is a sample of an interrupt service routine for the LSI53C1010R. It can be repeated if polling is used, or should be called when the INTA/ (or INTB/) pin is asserted if hardware interrupts are used.

1. Read Interrupt Status Zero (ISTAT0).

2. If the INTF bit is set, write it to a one to clear this status.

3. If only the SIP bit is set, read SCSI Interrupt Status Zero (SIST0) and SCSI Interrupt Status One (SIST1) to clear the SCSI interrupt condition and get the SCSI interrupt status. The bits in the SIST0 and SIST1 tell which SCSI interrupts occurred and determine what action is required to service the interrupts.

4. If only the DIP bit is set, read DMA Status (DSTAT) to clear the interrupt condition and determine the DMA interrupt status. The bits in the DSTAT register indicate which DMA interrupts occurred and determine what action is required to service the interrupts.

5. If both the SIP and DIP bits are set, read SCSI Interrupt Status Zero (SIST0), SCSI Interrupt Status One (SIST1), and DMA Status (DSTAT) to clear the SCSI and DMA interrupt condition and determine the interrupt status. If using 8-bit reads of the SIST0, SIST1, and DSTAT registers to clear interrupts, insert a 12 clock delay between the consecutive reads to ensure that the interrupts clear properly. Both the SCSI and DMA interrupt conditions should be handled before leaving the Interrupt Service Routine (ISR). It is recommended that the DMA interrupt is serviced before the SCSI interrupt, because a serious DMA interrupt condition could influence how the SCSI interrupt is acted upon.

6. When using polled interrupts go back to step 1 before leaving the ISR in case any stacked interrupts moved in when the first interrupt was cleared. When using hardware interrupts, the INTA/ (or INTB/) pin is asserted again if there are any stacked interrupts. This should cause the system to re-enter the interrupt service routine.

2.2.17 Interrupt Routing

This section documents the recommended approach to RAID ready interrupt routing for the LSI53C1010R. In order to be compatible with RAID upgrade products and the LSI53C1010R, the following requirements must be met:

- When a RAID upgrade card is installed in the upgrade slot, interrupts from the mainboard SCSI controller(s) assigned to the RAID upgrade card must be routed to INTC/ and INTD/ of the upgrade slot and isolated from the mainboard interrupt controller. The system processor must not see interrupts from the SCSI controllers that are serviced by the RAID upgrade card. An upgrade slot is one that is connected to the interrupt routing logic for mainboard SCSI device(s). When a PCI RAID upgrade board is installed into the system, it will be plugged into this slot if it is to control mainboard SCSI device(s).

- The TDI pin of the upgrade slot must be connected to the INT_DIR/ pin of the LSI53C1010R.

- When a RAID upgrade card is not installed, interrupts from a SCSI core must not be presented to the system's interrupt controller using multiple interrupt inputs.

Figure 2.6 shows an example configuration. In this example the LSI53C1010R contains the interrupt routing logic.

The LSI53C1010R supports four different interrupt routing modes. Additional information for these modes may be found in the register description of SCSI Test One (STEST1) description in Chapter 4, "Registers." Each SCSI core within the chip may be configured independently by selecting the interrupt routing mode using bits [1:0] in the STEST1 register within each core. Mode 0 is the default mode and is compatible with RAID upgrade products.

If the implementation shown in Figure 2.6 is used, INTC/ and INTD/ of the PCI RAID upgrade slot cannot be used when a non-RAID upgrade card is installed in the slot. If this restriction is not acceptable, additional buffer logic must be implemented on the mainboard. As long as the interrupt routing requirements stated above are satisfied, a mainboard designer could implement this design with external logic.

Figure 2.6   Interrupt Routing Hardware Using the LSI53C1010R
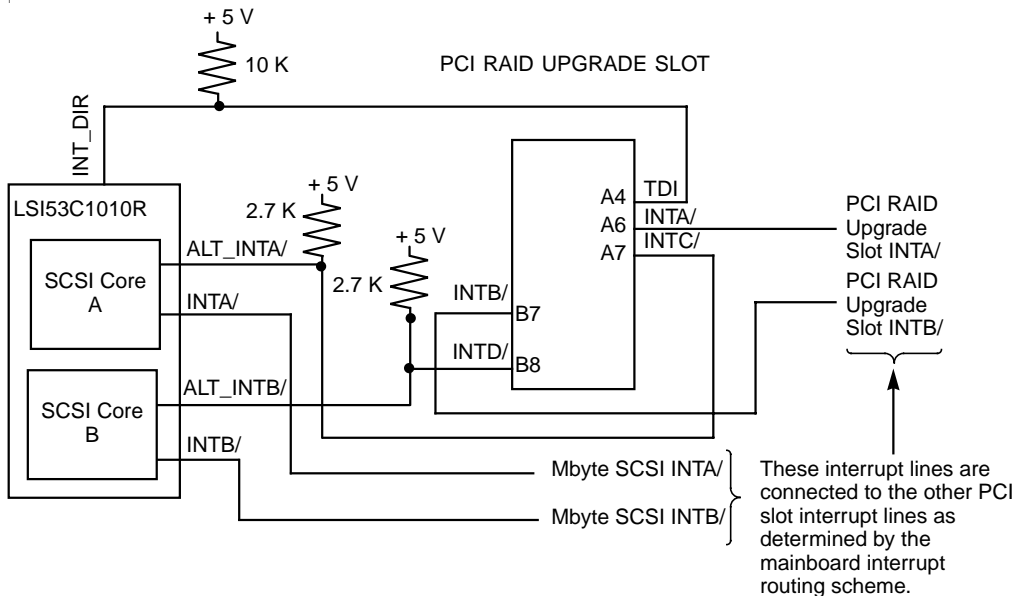
There can only be one entity controlling a mainboard SCSI core or conflicts will occur. Typically a SCSI core is controlled by the SCSI BIOS and an operating system driver. When a SCSI core is allocated to a RAID adapter, however, a mechanism must be implemented to prevent the SCSI BIOS and operating system driver from trying to access the SCSI core. The mainboard designer has several options to choose from for doing this.

• The **first option** is to have the SCSI core load its PCI Subsystem ID using a serial EPROM on power-up. If bit 15 in this ID is set, the LSI Logic BIOS and operating system drivers will ignore the chip. This makes it possible to control the assignment of the mainboard SCSI cores using a configuration utility.

- The **second option** is to provide mainboard and system BIOS support for Nonvolatile Storage (NVS). The SCSI core may then be enabled or disabled using the SCSI BIOS configuration utility. Not all versions of the LSI Logic drivers support this capability.

- The **third option** is to have the system BIOS not report the existence of the SCSI controller chips when the SCSI BIOS and operating systems make PCI BIOS calls. This approach requires modifications to the system BIOS and assumes the operating system uses PCI BIOS calls when searching for PCI devices.

2.2.18 Chained Block Moves

Since the LSI53C1010R has the capability to transfer 16-bit wide SCSI data, a unique situation occurs when dealing with odd bytes. The Chained Move (CHMOV) SCRIPTS instruction along with the Wide SCSI Send (WSS) and Wide SCSI Receive (WSR) bits in the SCSI Control Two (SCNTL2) register are used to facilitate these situations. The Chained Block Move instruction is illustrated in Figure 2.7.

Figure 2.7   Block Move and Chained Block Move Instructions
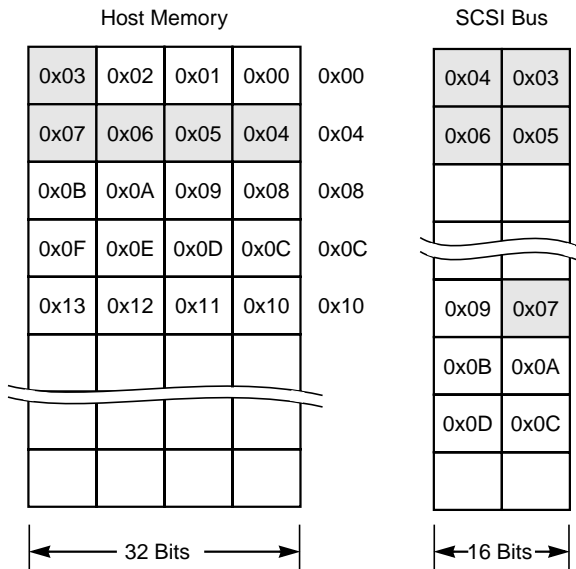
CHMOV 5, 3 when Data-Out

Moves five bytes from address 0x03 in the host memory to the SCSI bus. Bytes 0x03, 0x04, 0x05, and 0x06 are moved and byte 0x07 remains in the SCSI core (in the lower byte of the SODL register for asynchronous transfers, in the chain byte holding register for synchronous transfers). The stored byte is combined with the first byte of the following CHMOVE instruction.

CHMOVE 0x5, 0x9 when Data-In

Moves five bytes from address 0x09 in the host memory to the SCSI bus. The data in address 0x09 is married with the stored data (0x07) and transferred to the SCSI bus.

2.2.18.1 Wide SCSI Send Bit

The WSS bit is set following a wide SCSI send operation (Data-Out for initiator mode or Data-In for target mode) when the SCSI core is holding a byte of chain data. The SCSI core holds the byte when the controller detects a partial transfer at the end of a Chained Block Move SCRIPTS instruction. This flag is not set if a normal Block Move instruction is used. Under this condition, the SCSI controller does not send the low-order byte of the last partial memory transfer across the SCSI bus. Instead, the low-order byte is temporarily stored in the lower byte of the SCSI Output Data Latch (SODL) register for asynchronous transfers or in the chain byte holding register for synchronous transfers, and the WSS flag is set.

The hardware uses the WSS bit to determine what behavior must occur at the start of the next data send transfer. If the WSS bit is set at the start of the next transfer, the first byte (the high-order byte) of the next data send transfer is "married" with the byte of chain data. The two bytes are sent out across the bus regardless of the type of Block Move instruction (normal or chained). The WSS bit is automatically cleared when the "married" word is sent. Performing either a SCSI receive operation or any narrow transfer also clears the bit. In addition, SCRIPTS and the microprocessor can clear the WSS bit as well as use it for error detection and recovery purposes.

2.2.18.2 Wide SCSI Receive Bit

The WSR bit is set following a wide SCSI receive operation (Data-In for initiator mode or Data-Out for target mode) when the SCSI core is holding a byte of chain data. The SCSI core holds the byte when the

controller detects a partial transfer at the end of a Chained Block Move instruction. Under this condition the high-order byte is not transferred out the DMA channel to memory. Instead, it is stored in the SCSI Wide Residue (SWIDE) register and the WSR flag is set.

The hardware uses the WSR bit to determine what behavior must occur at the start of the next data receive transfer. If set the stored high-order byte may be residual data, valid data for a subsequent data transfer, or overrun data. The byte may be read as normal by starting a data receive transfer. The WSR bit is automatically cleared at the start of the next data receive transfer. Performing either a SCSI send operation or any narrow transfer also clears the bit. In addition, SCRIPTS and the microprocessor can clear the WSR bit as well as use it for error detection and recovery purposes.

2.2.18.3 SWIDE Register

For wide asynchronous receive data transfers, the SCSI Wide Residue (SWIDE) register holds the high-order byte of a partial SCSI transfer which has not yet been transferred to memory. This stored data may be a residue byte (and therefore ignored) or it may be valid data that is transferred to memory at the beginning of the next data receive Block Move instruction.

2.2.18.4 SODL Register

For wide asynchronous send data transfers, the low-order byte of the SCSI Output Data Latch (SODL) register holds the low-order byte of a partial memory transfer which has not yet been transferred across the SCSI bus. This stored data is usually "married" with the first byte of the next data send transfer, and both bytes are sent across the SCSI bus at the start of the next data send Block Move instruction.

2.2.18.5 Chained Block Move SCRIPTS Instruction

A Chained Block Move SCRIPTS instruction is primarily used to transfer consecutive data send or data receive blocks. Using the Chained Block Move instruction facilitates partial receive transfers and allows correct partial send behavior without additional opcode overhead. The behavior of the Chained Block Move instruction varies slightly for sending and receiving data.

For receive data (Data-In for the initiator or Data-Out for the target), a Chained Block Move instruction indicates that if a partial transfer occurred at the end of the instruction the WSR flag is set. The high order byte of the last SCSI transfer is stored in the SCSI Wide Residue (SWIDE) register rather than transferred to memory. The stored byte should be the first byte transferred to memory at the start of the Chained Block Move or regular Block Move data stream. Since the byte count always represents data transfers to/from memory (as opposed to/from the SCSI bus), the stored byte transferred out is one of the bytes in the count. If the WSR bit is cleared when a receive data Chained Block Move instruction is executed, the data transfer occurs similar to that of the regular Block Move instruction. It is recommended that all Block Move instructions be Chained Block Moves.

For send data (Data-Out for the initiator or Data-In for the target), a Chained Block Move instruction indicates that if a partial transfer terminates the Chained Block Move the WSS flag is set. The low-order byte should be stored in the lower byte of the SCSI Output Data Latch (SODL) register for asynchronous transfers or in the chain byte holding register for synchronous transfers and not sent across the SCSI bus. Without the Chained Block Move instruction, the last low-order byte would be sent across the SCSI bus. The starting byte count represents data bytes transferred from memory but not to the SCSI bus when a partial transfer exists. For example, if the instruction is an initiator Chained Block Move Data Out of five bytes (and WSS is not previously set), five bytes are transferred out of memory to the SCSI controller. Four bytes are transferred from the SCSI controller across the SCSI bus and one byte is temporarily stored as described above, waiting to be "married" with the first byte of the next Block Move instruction. If the WSS bit is set at the start of a data send command the first byte of the transfer is assumed to be the high-order byte and is "married" with the stored byte (which will be the low-order byte) before the two bytes are sent across the SCSI bus. It is recommended that all Block Move instructions be Chained Block Moves.

2.3 Parallel ROM Interface

The LSI53C1010R supports up to 1 Mbyte of external memory in binary increments from 16 Kbytes to allow the use of expansion ROM for add-in PCI cards. Both functions of the device share the ROM interface.

This interface is designed for low speed operations such as downloading instruction code from ROM; it is not intended for dynamic activities such as executing instructions.

System requirements include the LSI53C1010R, two or three external 8-bit address holding registers (HCT273 or HCT374), and the appropriate memory device. The 4.7 kΩ pull-up resistors on the MAD bus require HC or HCT external components to be used. Pull-up resistors on the 8-bit bidirectional memory bus at power-up determine the memory size and speed. The LSI53C1010R senses this bus shortly after the release of the Reset signal and configures the Expansion ROM Base Address register and the memory cycle state machines for the appropriate conditions.

The LSI53C1010R supports a variety of sizes and speeds of expansion ROM. An example set of interface drawings is in Appendix B, "External Memory Interface Diagram Examples." The encoding of pins MAD[3:1] allows the user to define how much external memory is available to the LSI53C1010R. Table 2.7 shows the memory space associated with the possible values of MAD[3:1]. The MAD[3:1] pins are fully described in Chapter 3, "Signal Descriptions."

Table 2.7   Parallel ROM Support

MAD[3:1]	Available Memory Space
000	16 Kbytes
001	32 Kbytes
010	64 Kbytes
011	128 Kbytes
100	256 Kbytes
101	512 Kbytes
110	1024 Kbytes
111	No external memory present, ROM interface disabled

To use one of the configurations mentioned above in a host adapter board design, put 4.7 kΩ pull-up resistors on the MAD pins corresponding to the available memory space. Each MAD pin has an

internal static pull-down; therefore, no external pull-down resistors are needed. For example, to connect to a 64 Kbytes external ROM use a pull-up on MAD[2]. If the external memory interface is not used, MAD[3:1] should be pulled HIGH.

The LSI53C1010R allows the system to determine the size of the available external memory using the Expansion ROM Base Address register in the PCI configuration space. For more information on how this works, refer to the PCI specification or the Expansion ROM Base Address register description in Chapter 4, "Registers."

MAD[0] is the slow ROM pin. When pulled up it enables two extra clock cycles of data access time to allow use of slower memory devices. The external memory interface also supports updates to flash memory.

2.4 Serial EEPROM Interface

For each SCSI function, the LSI53C1010R implements an interface permitting attachment of a serial EEPROM device to the GPIO[0] and GPIO[1] pins. There are two modes of operation relating to the serial EEPROM, the Subsystem ID register, and the Subsystem Vendor ID register for each SCSI function. These modes are programmable through the MAD[7] pin, which is sampled at power-up.

2.4.1 Default Download Mode

In this mode, MAD[7] is pulled down internally, GPIO[0] is the serial data signal (SDA) and GPIO[1] is the serial clock signal (SCL). Certain data in the serial EEPROM is automatically loaded into chip registers at power-up.

The format of the serial EEPROM data is defined in Table 2.8. If the download is enabled and an EEPROM is not present or the checksum fails, the Subsystem ID and Subsystem Vendor ID registers read back all zeros. At power-up five bytes are loaded into the chip from locations 0xFB through 0xFF.

The Subsystem ID and Subsystem Vendor ID registers are read only in accordance with the PCI specification, with a default value of all zeros if the download fails.

Table 2.8   Default Download Mode Serial EEPROM Data Format

Byte	Name	Description
0xFB	SVID(0)	Subsystem Vendor ID (SVID), LSB. This byte is loaded into the least significant byte of the Subsystem Vendor ID register in the appropriate PCI configuration space at chip power-up.
0xFC	SVID(1)	Subsystem Vendor ID (SVID), MSB. This byte is loaded into the most significant byte of the Subsystem Vendor ID register in the appropriate PCI configuration space at chip power-up.
0xFD	SID(0)	Subsystem ID (SID), LSB. This byte is loaded into the least significant byte of the Subsystem ID register in the appropriate PCI configuration space at chip power-up.
0xFE	SID(1)	Subsystem ID (SID), MSB. This byte is loaded into the most significant byte of the Subsystem ID register in the appropriate PCI configuration space at chip power-up.
0xFF	CKSUM	Checksum (CKSUM). This 8-bit checksum is formed by adding, bytewise, each byte contained in locations 0xFB–0xFE to the seed value (0x55) and then taking the 2's complement of the result.

2.4.2 No Download Mode

When MAD[7] is pulled up through an external resistor, the automatic download is disabled and data is not automatically loaded into chip registers at power-up. The Subsystem ID and Subsystem Vendor ID registers are read only, per the PCI specification, with a default value of 0x1000 and 0x1000 respectively.

2.5 Power Management

The LSI53C1010R complies with the PCI Bus Power Management Interface Specification, Revision 1.1, in which the D0, D1, D2, and D3 are defined.

D0 is the maximum powered state, and D3 is the minimum powered state. Power state D3 is further categorized as D3hot or D3cold. A function that is powered off is in the D3cold power state.

The LSI53C1010R power states are independently controlled through two power state bits that are located in the PCI Configuration Space Power Management Control/Status (PMCSR) register, 0x44–0x45. The power state bit settings are provided in Table 2.9.

Table 2.9   Power States

Configuration Register (0x44), Bits [1:0]	Power State	Function
00	D0	Maximum Power
01	D1	Disables SCSI clock
10	D2	Coma Mode
11	D3	Minimum Power

Although the PCI Bus Power Management Interface Specification does not allow power state transitions D2 to D1, D3 to D2, or D3 to D1, the LSI53C1010R hardware places no restriction on transitions between power states.

As the device transitions from one power level to a lower one, the attributes that occur from the higher power state level are carried over into the lower power state level. For example, D1 disables the SCSI CLK. Therefore, D2 includes this attribute as well as the attributes defined in the Power State D2 section. The PCI Function Power States - D0, D1, D2, and D3 are described below in conjunction with each SCSI function. Power state actions are separate for each function.

2.5.1 Power State D0

Power state D0 is the maximum power state and is the power-up default state for each function. The LSI53C1010R is fully functional in this state.

2.5.2 Power State D1

Power state D1 is a lower power state than D0. A function in this state places the LSI53C1010R core in the snooze mode and disables the SCSI CLK. In the snooze mode, a SCSI reset does not generate an IRQ/ signal.

2.5.3 Power State D2

Power state D2 is a lower power state than D1. A function in this state places the LSI53C1010R core in the coma mode. The following PCI Configuration Space Command register enable bits are suppressed:

- I/O Space Enable

- Memory Space Enable

- Bus Mastering Enable

- SERR/Enable

- Enable Parity Error Response

Thus, the function's memory and I/O spaces cannot be accessed, and the function cannot be a PCI bus master. Furthermore, SCSI and DMA interrupts are disabled when the function is in power state D2. If the function is changed from power state D2 to power state D1 or D0, the previous values of the PCI Command register are restored. Also, any pending interrupts before the function entered power state D2 are asserted.

2.5.4 Power State D3

Power state D3 is the minimum power state, which includes settings called D3hot and D3cold. D3hot allows the device to transition to D0 using software. The LSI53C1010R is considered to be in power state D3cold when power is removed from the device. D3cold can transition to D0 by applying V_{CC} and resetting the device.

Power state D3 is a lower power level than power state D2. A function in this state places the LSI53C1010R core in the coma mode. Furthermore, the function's soft reset is continually asserted while in power state D3, which clears all pending interrupts and 3-states the SCSI bus. In addition, the function's PCI Command register is cleared. If both of the LSI53C1010R functions are placed in power state D3, the Clock Quadrupler is disabled, which results in additional power savings.

Chapter 3
Signal Descriptions

This chapter describes the input and output signals of the LSI53C1010R. The chapter consists of the following sections:

3.1 Signal Organization

The LSI53C1010R has five major interfaces:

- PCI Interface
- SCSI Bus Interface
- GPIO
- Memory Interface
- Test Interface

Figure 3.1 illustrates the signals, their grouping, and their I/O direction. A slash (/) at the end of a signal name indicates that it is an active LOW signal. When the slash is absent, the signal is active at a HIGH voltage.

The PCI Interface contains many functional groups of signals. The SCSI Bus Interface contains two functional groups of signals.

There are five signal type definitions:

I   Input, a standard input-only signal.

O   Output, a standard output driver (typically a Totem Pole output).

I/O   Input and output (bidirectional).

T/S   3-state, a bidirectional, 3-state input/output signal.

S/T/S Sustained 3-state, an active LOW 3-state signal owned and driven by one and only one agent at a time.

Figure 3.1 illustrates the signal groupings. Pinout information and package drawings are available in Section 6.6, "Package Drawings."

Figure 3.1   LSI53C1010R Functional Signal Grouping
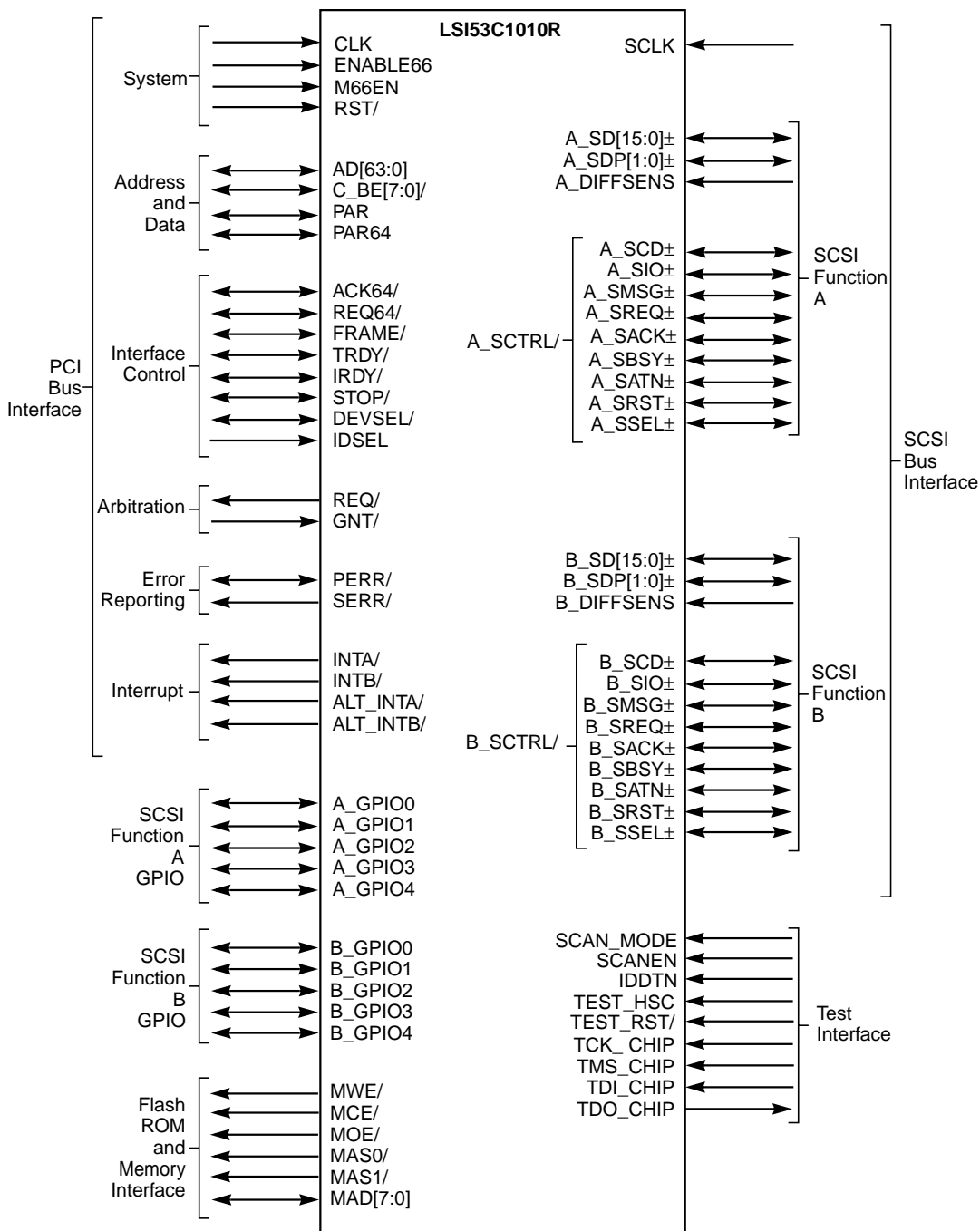
3.2 Internal Pull-ups and Pull-downs on LSI53C1010R Signals

Several LSI53C1010R signals use internal pull-ups and pull-downs.
Table 3.1 describes the conditions that enable these pull-ups and
pull-downs.

Table 3.1   LSI53C1010R Internal Pull-ups and Pull-downs

Pin Name	Pull Current	Conditions for Pull-up
INTA/, INTB/, ALT_INTA/, ALT_INTB/	25 µA	Pull-up enabled when the "AND-tree" mode is enabled by driving TEST_RST/ LOW or when the IRQ mode bit (bit 3 of DCNTL, 0X3B) is cleared.[1]
ENABLE66, M66EN, TCK_CHIP, TDI_CHIP, TEST_RST/, TMS_CHIP	25 µA	Pulled up internally.
AD[63:32], C_BE[7:4]/, PAR64	25 µA	Pulled down internally.
GPIO[4:0]	25 µA	Pulled up internally.
MAD[7:0]	25 µA	Pulled down internally.
SCAN_MODE, TEST_HSC	25 µA	Pulled down internally.
SCANEN, IDDTN	25 µA	Pulled down internally.

1. When bit 3 of the DMA Control (DCNTL) register is set, the pad becomes a totem pole output pad and drives both HIGH and LOW.

3.3 PCI Bus Interface Signals

The PCI Bus Interface Signals section contains tables describing the signals for the following signal groups: System Signals, Address and Data Signals, Interface Control Signals, Arbitration Signals, Error Reporting Signals, Interrupt Signals.

3.3.1 System Signals

Table 3.2 describes the System Signals group.

Table 3.2   System Signals

Name	Bump	Type	Strength	Description
CLK	AC9	I	N/A	**Clock** provides timing for all transactions on the PCI bus and is an input to every PCI device and all other PCI signals are sampled on the rising edge of CLK and other timing parameters are defined with respect to this edge.
ENABLE66	AC2	I	N/A	**Enable66** is used to enable the 66 MHz PCI operation. It sets the bit in the PCI Configuration Space indicating this device is 66 MHz capable. This pin has a static pull-up.
M66EN	AC5	I	N/A	**M66EN** is used to enable the 66 MHz PCI mode. This pin is connected to the M66EN PCI signal on the PCI bus. If this signal is pulled HIGH, the 66 Mhz PCI operation is enabled. This pin has a static pull-up. **Note**: Pulling this signal LOW will not affect the setting of the 66 MHz capable bit in the PCI Configuration Space.
RST/	AB10	I	N/A	**Reset** forces the PCI sequencer of each device to a known state. All T/S and S/T/S signals are forced to a HIGH impedance state and all internal logic is reset. The RST/ input is synchronized internally to the rising edge of CLK. To properly reset the device, the CLK input must be active while RST/ is active.

3.3.2 Address and Data Signals

Table 3.3 describes the Address and Data Signals group.

Table 3.3   Address and Data Signals

Name	Bump	Type	Strength	Description
AD[63:0]	W22, AB25, AC26, AA25, W23, Y25, Y26, V22, U22, V24, V23, U24, V25, W26, U23, U25, T22, T23, T25, R25, R22, P22, P23, R23, P24, P25, T26, R26, M26, L26, N25, N24, AE9, AF8, AE10, AB11, AC11, AE11, AE12, AB12, AC12, AD13, AE13, AF11, AF16, AE14, AC15, AC14, AD17, AE19, AC18, AB17, AB18, AF20, AE20, AC19, AF23, AE22, AB19, AD21, AF24, AC20, AE23, AC21	T/S	8 mA PCI	Physical longword **Address and Data** are multiplexed on the same PCI pins. A bus transaction consists of an address phase followed by one or more data phases. During the first clock of a transaction, AD[63:0] contain a 64-bit physical byte address. If the command is a DAC, implying a 64-bit address, AD[31:0] will contain the upper 32 bits of the address during the second clock of the transaction. During subsequent clocks, AD[63:0] contain data. PCI supports both read and write bursts. AD[7:0] define the least significant byte, and AD[63:56] define the most significant byte.
C_BE[7:0]/	AA23, AC25, Y23, AD26, AB13, AB14, AE18, AE21	T/S	8 mA PCI	Bus **Command and Byte Enables** are multiplexed on the same PCI pins. During the address phase of a transaction, C_BE[3:0]/ define the bus command. If the transaction is a DAC, C_BE[3:0]/ contain the DAC command and C_BE[7:4]/ define the bus command. C_BE[3:0]/ define the bus command during the second clock of the transaction. During the data phase, C_BE[7:0]/ are used as byte enables. The byte enables determine which byte lanes carry meaningful data: C_BE[0]/ applies to byte 0, and C_BE[7]/ to byte 7.
PAR	AF19	T/S	8 mA PCI	**Parity** is the even parity bit that protects the AD[31:0] and C_BE[3:0]/ lines. During the address phase, both the address and command bits are covered. During the data phase, both the data and byte enables are covered.

Table 3.3   Address and Data Signals (Cont.)

Name	Bump	Type	Strength	Description
PAR64	AA24	T/S	8 mA PCI	**Parity64** is the even parity bit that protects the AD[63:32] and C_BE[7:4]/ lines. During the address phase, the address and command bits are covered. During the data phase, both data and byte enables are covered.

3.3.3 Interface Control Signals

Table 3.4 describes the Interface Control Signals group.

Table 3.4   Interface Control Signals

Name	Bump	Type	Strength	Description
ACK64/	AB20	S/T/S	8 mA PCI	**Acknowledge 64-bit** transfer is driven by the current bus target to indicate its ability to transfer 64-bit data.
REQ64/	AD22	S/T/S	8 mA PCI	**Request 64-bit** transfer is driven by the current bus master to indicate a request to transfer 64-bit data.
FRAME/	AB15	S/T/S	8 mA PCI	**Cycle Frame** is driven by the current master to indicate the beginning and duration of an access. FRAME/ is asserted to indicate that a bus transaction is beginning. While FRAME/ is deasserted, either the transaction is in the final data phase or the bus is idle.
TRDY/	AE16	S/T/S	8 mA PCI	**Target Ready** indicates the target's ability to complete the current data phase of the transaction. TRDY/ is used with IRDY/. A data phase is completed on any clock when both TRDY/ and IRDY/ are sampled asserted. During a read, TRDY/ indicates that valid data is present on the AD bus. During a write, it indicates that the target is prepared to accept data.
IRDY/	AE15	S/T/S	8 mA PCI	**Initiator Ready** indicates the initiator's ability to complete the current data phase of the transaction. IRDY/ is used with TRDY/. A data phase is completed on any clock when both IRDY/ and TRDY/ are sampled asserted. During a write, IRDY/ indicates that valid data is present on the AD bus. During a read, it indicates that the master is prepared to accept data.

Table 3.4   Interface Control Signals (Cont.)

Name	Bump	Type	Strength	Description
STOP/	AB16	S/T/S	8 mA PCI	**Stop** indicates that the selected target is requesting the master to stop the current transaction.
DEVSEL/	AC16	S/T/S	8 mA PCI	**Device Select** indicates that the driving device has decoded its address as the target of the current access. As an input, it indicates to a master whether any device on the bus has been selected.
IDSEL	AC13	I	N/A	**Initialization Device Select** is used as a chip select, in place of the upper 24 address lines, during configuration read and write transactions.

3.3.4 Arbitration Signals

Table 3.5 describes the Arbitration Signals group.

Table 3.5   Arbitration Signals

Name	Bump	Type	Strength	Description
REQ/	AD10	O	8 mA PCI	**Request** indicates to the system arbiter that this agent requests use of the PCI bus. This is a point-to-point signal. Every master has its own REQ/ signal.
GNT/	AE8	I	N/A	**Grant** indicates to a specific agent that access to the PCI bus has been granted. This is a point-to-point signal. Every master has its own GNT/ signal.

3.3.5 Error Reporting Signals

Table 3.6 describes the Error Reporting Signals group.

Table 3.6   Error Reporting Signals

Name	Bump	Type	Strength	Description
PERR/	AE17	S/T/S	8 mA PCI	**Parity Error** may be pulsed active by an agent that detects a data parity error. PERR/ can be used by any agent to signal data corruption. On detection of a PERR/ pulse, a nonmaskable interrupt is generated to the host CPU, which often implies the system is unable to continue operation once error processing is complete.
SERR/	AC17	O	8 mA PCI	**System Error** is an open drain output used to report address parity errors as well as critical errors other than parity.

3.3.6 Interrupt Signals

Table 3.7 describes the Interrupt Signals group.

Table 3.7   Interrupt Signals

Name[1]	Bump	Type	Strength	Description
INTA/	AC8	O	8 mA PCI	**Interrupt Function A.** This signal, when asserted LOW, indicates that an interrupting condition in SCSI Function A requires service from the host CPU. The output drive of this pin is an open drain. See SCSI Test One (STEST1) for additional information about disabling this interrupt in a RAID environment. This interrupt pin is disabled if INT_DIR is driven LOW. If the SCSI Function B interrupt is rerouted at power-up using the INTA/ enable sense resistor (pull-up on MAD4), this signal indicates that an interrupting condition has occurred in either SCSI Function A or SCSI Function B.

Table 3.7   Interrupt Signals (Cont.)

Name[1]	Bump	Type	Strength	Description
INTB/	AE7	O	8 mA PCI	**Interrupt Function B.** This signal, when asserted LOW, indicates that an interrupt condition in SCSI Function B requires service from the host. The output drive of this pin is an open drain. See SCSI Test One (STEST1) for additional information about disabling this interrupt in a RAID environment. Disabled if INT_DIR is driven LOW. At power-up, this interrupt can be rerouted to INTA/ using the INTA/ enable sense resistor (pull-up on MAD4). This causes the LSI53C1010R to program the SCSI Function B PCI Interrupt Pin (IP) register to 0x01.
ALT_INTA/	AF7	O	8 mA PCI	**Alt Interrupt Function A.** This signal, when asserted LOW, indicates that an interrupting condition in SCSI Function A requires service. The output drive of this pin is an open drain. See SCSI Test One (STEST1) for additional information about disabling this interrupt in a RAID environment. If the SCSI Function B interrupt is rerouted at power-up, using the INTA/ enable sense resistor (pull-up on MAD4), this signal indicates that an interrupting condition has occurred in either SCSI Function A or SCSI Function B.
ALT_INTB/	AB9	O	8 mA PCI	**Alt Interrupt Function B.** This signal, when asserted LOW, indicates that an interrupting condition in SCSI Function B requires service. The output drive of this pin is an open drain. See SCSI Test One (STEST1) for additional information about disabling this interrupt in a RAID environment. At power-up, this interrupt can be rerouted to INTA/ using the INTA/ enable sense resistor (pull-up on MAD4). This causes the LSI53C1010R to program the SCSI Function B PCI Interrupt Pin (IP) register to 0x01.

1. See Register 0x4D, SCSI Test One (STEST1) in Chapter 4, "Registers," for additional information on these signals.

3.4 SCSI Bus Interface Signals

The SCSI Bus Interface Signals section contains tables describing the signals for the following signal groups: SCSI Bus Interface Signals, SCSI Function A Signals, and SCSI Function B Signals. SCSI Function A Signals and SCSI Function B Signals each have a subgroup: the SCSI Function A Control Signals and the SCSI Function B Control Signals. Table 3.8 contains signals that are common to both SCSI buses.

Table 3.8   SCSI Bus Interface Signal

Name	Bump	Type	Strength	Description
SCLK	F3	I	N/A	**SCSI Clock** is used to derive all SCSI-related timings. The speed of this clock must be 40 MHz. The clock frequency can be quadrupled to create the 160 MHz clock required internally by both SCSI functions.

3.4.1 SCSI Function A Signals

This section describes the signals for the SCSI Function A Signals group. Table 3.9 describes the SCSI Function A Signals and Table 3.10 describes the SCSI Function A Control Signals.

Table 3.9   SCSI Function A Signals

Name	Bump	Type	Strength	Description
A_SD[15:0]–	Y1, AA2, AB2, AD1, F2, G2, J4, H1, R4, T5, T2, U2, U5, V2, V4, W4	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function A Data**. LVD Mode: Negative half of the LVD Link pair for the SCSI data lines. A_SD[15:0]– form the 16-bit SCSI data bus. SE Mode: A_SD[15:0]– form the 16-bit SCSI data bus.
A_SD[15:0]+	W5, Y2, AA3, AC1, D1, G1, H4, H2, P3, R5, R2, T4, U4, U3, V5, V3	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function A Data**. LVD Mode: Positive half of the LVD Link pair for the SCSI data lines. A_SD[15:0]+ form the 16-bit data bus. SE Mode: A_SD[15:0]+ are at 0 V.

Table 3.9   SCSI Function A Signals (Cont.)

Name	Bump	Type	Strength	Description
A_SDP[1:0]–	W2, P4	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function A Parity.** LVD Mode: Negative half of the LVD Link pair for the SCSI parity lines. A_SDP[1:0]– are the SCSI data parity lines. SE Mode: A_SDP[1:0]– are the SCSI data parity lines.
A_SDP[1:0]+	W1, P5	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function A Parity.** LVD Mode: Positive half of the LVD Link pair for the SCSI parity lines. A_SDP[1:0]+ are the SCSI data parity lines. SE Mode: A_SDP[1:0]+ are at 0 V.
A_DIFFSENS	E2	I	N/A	**SCSI Function A Differential Sense** pin detects the present mode of the SCSI bus when connected to the DIFFSENS signal on the physical SCSI bus. LVD Mode: If a voltage between 0.7 V and 1.9 V is present, SCSI Function A operates in the LVD mode. SE Mode: When this pin is driven LOW (below 0.5 V), SE operation is indicated. SCSI Function A operates in the SE mode. HVD Mode: When this pin is detected HIGH (above 2.0 V), HVD operation is indicated. SCSI Function A is driven to the high impedance state. This pin is 5 V tolerant. The HVD Mode is not supported.

Table 3.10   SCSI Function A Control Signals

Name[1]	Bump	Type	Strength	Description
SCSI Function A Control includes the following signals:				
A_SCD– A_SCD+	K3 K4	I/O	SE: 48 mA SCSI	SCSI phase line, command/data.
A_SIO– A_SIO+	K5 J5		LVD: 12 mA	SCSI phase line, input/output.
A_SMSG– A_SMSG+	L2 L1		UniLVD	SCSI phase line, message.
A_SREQ– A_SREQ+	J2 J3			Data handshake line from target device.
A_SACK– A_SACK+	M5 L5			Data handshake signal from the initiator device.
A_SBSY– A_SBSY+	N3 N4			SCSI bus arbitration signal, busy.
A_SATN– A_SATN+	M4 N5			SCSI Attention, the initiator is requesting a message out phase.
A_SRST– A_SRST+	M1 M2			SCSI bus reset.
A_SSEL– A_SSEL+	L4 K2			SCSI bus arbitration signal, select device.

1. LVD Mode: The negative and positive halves of the LVD Link signal pairs are shown for SCSI Function A Control. SE Mode: The SCSI Function A Control signals are shown. All positive (+) signals are at 0 Volts.

3.4.2 SCSI Function B Signals

This section describes the SCSI Function B Signals group. Table 3.11 describes the SCSI Function B Signals and Table 3.12 describes the SCSI Function B Control Signals.

Table 3.11   SCSI Function B Signals

Name	Bump	Type	Strength	Description
B_SD[15:0]–	D8, E8, C6, A3, B21, D19, E18, A19, E13, A12, B11, B10, D10, C9, D9, B8	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function B Data**. LVD Mode: Negative half of the LVD Link pair for the SCSI data lines. B_SD[15:0]– form the 16-bit SCSI data bus. SE Mode: B_SD[15:0]– form the 16-bit SCSI data bus.
B_SD[15:0]+	B7, B6, B5, A4, A23, B20, A20, B19, E12, B12, D11, C10, E11, E10, B9, A8	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function B Data**. LVD Mode: Positive half of the LVD Link pair for the SCSI data lines. B_SD[15:0]+ form the 16-bit data bus. SE Mode: B_SD[15:0]+ are at 0 V.
B_SDP[1:0]–	A7, D12	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function B Parity**. LVD Mode: Negative half of the LVD Link pair for the SCSI parity lines. B_SDP[1:0]– are the SCSI data parity lines. SE Mode: B_SDP[1:0]– are the SCSI data parity lines.
B_SDP[1:0]+	E9, C13	I/O	SE: 48 mA SCSI LVD: 12 mA UniLVD	**SCSI Function B Parity**. LVD Mode: Positive half of the LVD Link pair for the SCSI parity lines. B_SDP[1:0]+ are the SCSI data parity lines. SE Mode: B_SDP[1:0]+ are at 0 V.

Table 3.11   SCSI Function B Signals (Cont.)

Name	Bump	Type	Strength	Description
B_DIFFSENS	B22	I	N/A	**SCSI Function B Differential Sense** pin detects the present mode of the SCSI bus when connected to the DIFFSENS signal on the physical SCSI bus. LVD Mode: If a voltage between 0.7 V and 1.9 V is present, SCSI Function B operates in the LVD mode. SE Mode: If a voltage below 0.5 V is present, SE operation is indicated. SCSI Function B operates in the SE mode. HVD Mode: When this pin is detected HIGH (above 2.0 V) HVD operation is indicated. SCSI Function B is driven to the high impedance state. This pin is 5 V tolerant. The HVD Mode is not supported.

Table 3.12   SCSI Function B Control Signals

Name[1]	Bump	Type	Strength	Description
SCSI Function B Control includes the following signals:				
B_SCD– B_SCD+	E16 D17	I/O	SE: 48 mA SCSI	SCSI phase line, command/data.
B_SIO– B_SIO+	E17 D18		LVD: 12 mA	SCSI phase line, input/output.
B_SMSG– B_SMSG+	B16 D16		UniLVD	SCSI phase line, message.
B_SREQ– B_SREQ+	B18 C18			Data handshake line from target device.
B_SACK– B_SACK+	D14 E14			Data handshake signal from the initiator device.
B_SBSY– B_SBSY+	A15 B15			SCSI bus arbitration signal, busy.
B_SATN– B_SATN+	B14 D13			SCSI Attention, the initiator is requesting a message out phase.
B_SRST– B_SRST+	E15 A16			SCSI bus reset.
B_SSEL– B_SSEL+	B17 C17			SCSI bus arbitration signal, select device.

1. LVD Mode: The negative and positive halves of the LVD Link signal pairs are shown for SCSI Function B Control. SE Mode: The SCSI Function B Control signals are shown. All positive (+) signals are at 0 Volts.

3.5 General Purpose I/O (GPIO) Signals

Table 3.13 and Table 3.14 describe the SCSI Function A and Function B GPIO Signals, respectively.

Table 3.13   SCSI Function A GPIO Signals

Name	Bump	Type	Strength	Description
A_GPIO0	H26	I/O	8 mA	**SCSI Function A General Purpose I/O pin 0.** This pin is programmable at power-up, through the MAD7 pin, to serve as the data signal for the serial EEPROM interface. When GPIO0 is not in the process of downloading EEPROM data it can be used to drive a SCSI Activity LED, if bit 5 in the General Purpose Pin Control (GPCNTL) register is set. Or, it can be used to indicate that the next bus request will be an opcode fetch if bit 6 in the GPCNTL register is set.
A_GPIO1	J25	I/O	8 mA	**SCSI Function A General Purpose I/O pin 1.** This pin is programmable at power-up, through the MAD7 pin, to serve as the clock signal for the serial EEPROM interface. If bit 7 of the General Purpose Pin Control (GPCNTL) register is set, this pin drives LOW when the LSI53C1010R is the bus master.
A_GPIO2	K24	I/O	8 mA	**SCSI Function A General Purpose I/O pin 2.** This pin powers up as an input.
A_GPIO3	H25	I/O	8 mA	**SCSI Function A General Purpose I/O pin 3.** This pin powers up as an input.
A_GPIO4	J23	I/O	8 mA	**SCSI Function A General Purpose I/O pin 4.** This pin powers up as an output. It can be used as the enable line for V_{PP} the 12 V power supply to the external flash memory interface.

Table 3.14 SCSI Function B GPIO Signals

Name	Bump	Type	Strength	Description
B_GPIO0	M25	I/O	8 mA	**SCSI Function B General Purpose I/O pin 0.** This pin is programmable at power-up through the MAD7 pin to serve as the data signal for the serial EEPROM interface. When GPIO0 is not in the process of downloading EEPROM data, it can be used to drive a SCSI Activity LED if bit 5 in the General Purpose Pin Control (GPCNTL) register is set. Or, it can be used to indicate that the next bus request will be an opcode fetch if bit 6 in the GPCNTL register is set.
B_GPIO1	L25	I/O	8 mA	**SCSI Function B General Purpose I/O pin 1.** This pin is programmable at power-up through the MAD7 pin to serve as the clock signal for the serial EEPROM interface. If bit 7 of the General Purpose Pin Control (GPCNTL) register is set, this pin is driven LOW when the LSI53C1010R is the bus master.
B_GPIO2	L23	I/O	8 mA	**SCSI Function B General Purpose I/O pin 2.** This pin powers up as an input.
B_GPIO3	K25	I/O	8 mA	**SCSI Function B General Purpose I/O pin 3.** This pin powers up as an input.
B_GPIO4	K23	I/O	8 mA	**SCSI Function B General Purpose I/O pin 4.** This pin powers up as an output. It can be used as the enable line for V_{PP} the 12 V power supply to the external flash memory interface.

3.6 Flash ROM and Memory Interface Signals

Table 3.15 describes the Flash ROM and Memory Interface Signals group.

Table 3.15   Flash ROM and Memory Interface Signals

Name	Bump	Type	Strength	Description
MWE/	H23	O	4 mA	**Memory Write Enable.** This pin is a write enable signal to an external flash memory.
MCE/	G25	O	4 mA	**Memory Chip Enable.** This pin is a chip enable signal to an external EEPROM or flash memory device.
MOE/	G26	O	4 mA	**Memory Output Enable.** This pin is an output enable signal to an external EEPROM or flash memory during read operations. It is also used to test the connectivity of the LSI53C1010R signals in the "AND-tree" test mode.
MAS0/	K22	O	4 mA	**Memory Address Strobe 0**. This pin latches in the least significant address byte (bits [7:0]) of an external EEPROM or flash memory. Since the LSI53C1010R moves addresses eight bits at a time, this pin connects to the clock of an external bank of flip-flops that assemble up to a 20-bit address for the external memory.
MAS1/	J24	O	4 mA	**Memory Address Strobe 1.** This pin latches in the most significant address byte (bits [15:8]) of an external EEPROM or flash memory. Since the LSI53C1010R moves addresses eight bits at a time, this pin connects to the clock of an external bank of flip-flops that assemble up to a 20-bit address for the external memory.
MAD[7:0]	D26, E25, H22, F24, G23, D25, F23, G22	I/O	4 mA	**Memory Address/Data Bus.** This bus, in conjunction with the memory address strobe pins and external address latches, assembles up to a 20-bit address for an external EEPROM or flash memory. This bus first issues the least significant byte and finishes with the most significant bits. It is also used to write data to a flash memory or read data into the chip from external EEPROM/flash memory. These pins have static pull-downs.

3.7 Test Interface Signals

Table 3.16 describes the Test Interface Signal group. Table 3.16 is divided into Internal Test Signals and JTAG Signals.

Table 3.16   Test Interface Signals

Name	Bump	Type	Strength	Description
Internal Test Signals:				
SCAN_MODE	E7	I	N/A	**Scan Mode**. For LSI Logic test purposes only. This pin has a static pull-down.
SCANEN	N22	I	N/A	**SCANEN.** For LSI Logic test purposes only. Pulled LOW internally.
IDDTN	Y4	I	N/A	**IDDTN.** For LSI Logic test purposes only. Pulled LOW internally.
TEST_HSC	D7	I	N/A	**Test Halt SCSI Clock.** For LSI Logic test purposes only. Pulled LOW internally. This signal can also cause a full chip reset.
TEST_RST/	AD5	I	N/A	**Test Reset.** For LSI Logic test purposes only. Pulled HIGH internally.
JTAG Signals:				
TCK_CHIP	AC6	I	N/A	**Test Clock.** This pin provides the clock for the JTAG test logic. This pin has a static pull-up.
TMS_CHIP	AE4	I	N/A	**Test Mode Select (TMS)**. The signal received at TMS is decoded by the Test Access Port (TAP) controller to control JTAG test operations. This pin has a static pull-up.
TDI_CHIP	AF3	I	N/A	**Test Data In.** This pin receives the serial test instructions for the JTAG test logic. This pin has a static pull-up.
TDO_CHIP	AD6	O	4 mA	**Test Data Out.** This pin is the serial output for test instructions and data from the JTAG test logic.

3.8 Power and Ground Signals

Table 3.17 describes the Power and Ground Signals group.

Table 3.17   Power and Ground Signals

Name[1]	Bump	Type	Strength	Description
VSS_IO	A5, A9, A13, A17, A21, A25, B1, B26, C4, C8, C12, C16, C20, D24, E1, F26, G3, H24, J1, K26, L3, L11, L12, L13, L14, L15, L16, M11, M12, M13, M14, M15, M16, M24, N1, N11, N12, N13, N14, N15, N16, P11, P12, P13, P14, P15, P16, P26, R3, R11, R12, R13, R14, R15, R16, T11, T12, T13, T14, T15, T16, T24, U1, V26, W3, Y24, AA1, AB26, AC3, AD7, AD11, AD15, AD19, AD23, AE1, AF2, AF6, AF10, AF14, AF18, AF22, AF26	G	N/A	Ground for PCI bus drivers/receivers, SCSI bus drivers/receivers, local memory interface drivers, and other I/O pins.
VDD_IO	A1, A2, A6, A10, A14, A18, A22, A26, C7, C11, C15, C19, C23, D3, E26, F1, G24, H3, J26, K1, L24, M3, N26, P1, R24, T3, U26, V1, W24, Y3, AA26, AB1, AC24, AD4, AD8, AD12, AD16, AD20, AE26, AF1, AF5, AF9, AF13, AF17, AF21, AF25	P	N/A	Power for the PCI bus drivers/receivers, SCSI bus drivers/receivers, local memory interface drivers/receivers, and other I/O pins.
VDDC	D6, E19, J22, M22, AD25, AE24, AC7, AE3, D2	P	N/A	Power for core logic.
VSSC	B4, C21, C26, F25, L22, AB24, AB23, AB8, AB7, G4	G	N/A	Ground for core logic.
VDDA	AE2, C1	P	N/A	Power for analog cells (clock quadrupler and DIFFSENS logic).

Table 3.17   Power and Ground Signals (Cont.)

Name[1]	Bump	Type	Strength	Description
VSSA	AB6, H5	G	N/A	Ground for analog cells (clock quadrupler and DIFFSENS logic).
A_VDDBIAS	T1	P	N/A	Power for the SCSI Function A RBIAS.
B_VDDBIAS	B13	P	N/A	Power for the SCSI Function B RBIAS.
B_RBIAS	A11	I	N/A	Used to connect an external resistor to generate the LVD Link pad bias current. The resistor value should be 10 kΩ. Connect the other end of the resistor to V_{DD}.
NC	A24, B2, B3, B23, B24, B25, C2, C3, C5, C14, C22, C24, C25, D4, D5, D15, D20, D21, D22, D23, E3, E4, E5, E6, E20, E21, E22, E23, E24, F4, F5, F22, G5, M23, N2, N23, P2, R1, W25, Y5, Y22, AA4, AA5, AA22, AB3, AB4, AB5, AB21, AB22, AC4, AC10, AC22, AC23, AD2, AD3, AD9, AD14, AD18, AD24, AE5, AE6, AE25, AF4, AF12, AF15	N/A	N/A	These pins are reserved or have no internal connection.

1. The I/O driver pad rows and digital core have isolated power supplies as indicated by the "I/O" and "CORE" extensions on their respective V_{SS} and V_{DD} names. Connect the power and ground pins directly to the primary power and ground planes of the circuit board. Apply bypass capacitors of 0.01 µF between adjacent V_{SS} and V_{DD} pairs wherever possible. Do not connect bypass capacitors between V_{SS} and V_{DD} pairs that cross power and ground bus boundaries.
2. To reduce signal noise that can affect Frequency Synthesizer (FSN) functionality, place a ferrite bead in series with the V_{DDA} and V_{SSA} pins. The recommended rating of the bead is 150 Ohms at 100 MHz.

3.9 MAD Bus Programming

The MAD[7:0] pins, in addition to serving as the address/data bus for the local memory interface, also are used to program power-up options for the chip. A particular option is programmed by allowing the internal

pull-down current sink to pull the pin LOW at reset or by connecting a 4.7 kΩ resistor between the appropriate MAD[x] pin and V$_{DD}$. The pull-down resistors require that HC or HCT external components are used for the memory interface. A description of the MAD bus pins follows:

- **MAD[7], Serial EEPROM programmable option** – When pulled LOW by the internal pull-down current sink, the automatic data download is enabled. When pulled HIGH by an external resistor, the automatic data download is disabled. See Section 2.4, "Serial EEPROM Interface," and the Subsystem ID (SID) and Subsystem Vendor ID (SVID) register descriptions.

- **MAD[6]** – Reserved.

- **MAD[5]** – Reserved.

- **MAD[4], INTA/ routing enable** – Placing a pull-up resistor on this pin causes SCSI Function B interrupt requests to appear on the INTA/ pin, along with SCSI Function A interrupt requests, instead of on INTB/. Placing a pull-up resistor on this pin also programs the SCSI Function B Interrupt Pin (IP) register in PCI configuration space to 0x01 instead of 0x02.

  Placing no resistor on this pin causes SCSI Function B interrupt requests to appear on the INTB/ pin and programs the SCSI Function B Interrupt Pin (IP) register in PCI configuration space to 0x02.

- **MAD[3:1]** – These pins set the size of the external expansion ROM device attached. Table 3.18 provides the encoding for these pins. A "0" indicates a pull-down resistor is attached while a "1" indicates a pull-up resistor attached.

Table 3.18   MAD[3:1] Pin Decoding

MAD[3:1]	Available Memory Space
000	16 Kbytes
001	32 Kbytes
010	64 Kbytes
011	128 Kbytes
100	256 Kbytes
101	512 Kbytes
110	1024 Kbytes
111	No external memory present

• **MAD[0], slow ROM** – When pulled up, this pin enables use of slower memory devices by including two extra data access cycles.

   Note: All MAD pins have internal pull-down resistors.

Chapter 4
Registers

This section contains descriptions of all LSI53C1010R registers. The term "set" refers to bits programmed to a binary one. Similarly, the term "cleared" refers to bits programmed to a binary zero. Do not access reserved bits. Reserved bit functions may change at any time. Unless otherwise indicated, all bits in the registers are active HIGH; the feature is enabled by setting the bit. The bottom row of every register diagram presents the default register values, which are enabled after the chip is powered on or reset.

This chapter contains the following sections:

- Section 4.1, "PCI Configuration Registers"
- Section 4.2, "SCSI Registers"
- Section 4.3, "SCSI Shadow Registers"

4.1 PCI Configuration Registers

To access the PCI Configuration registers, perform a configuration read or write to a device with its IDSEL pin asserted. The appropriate address value is in AD[10:8] during the address phase of the transaction. SCSI Function A is identified by a binary value of 0b000, and SCSI Function B by a value of 0b001. Each SCSI function contains the same register set with identical default values, except the Interrupt Pin (IP) register. Table 4.1 shows the PCI configuration registers implemented in the LSI53C1010R.

All PCI-compliant devices, such as the LSI53C1010R, support Vendor ID, Device ID, Command, and Status registers. Support of other PCI-compliant registers is optional. In the LSI53C1010R, registers that are not supported are not writable and return all zeros when read. Only

those registers and bits that are currently supported by the LSI53C1010R are described in this chapter. Do not access bits marked as Reserved.

Table 4.1   PCI Configuration Register Map

31 16	15 0	Address	Page
Device ID	Vendor ID	0x00	4-2
Status	Command	0x04	4-3
Class Code (CC)	Revision ID (RID)	0x08	4-6
Reserved Header Type (HT)	Latency Timer (LT) Cache Line Size (CLS)	0x0C	4-7
Base Address Register Zero (BAR0) (I/O)		0x10	4-9
Base Address Register One (BAR1) (MEMORY) bits [31:0]		0x14	4-9
Base Address Register Two (BAR2) (MEMORY) bits [31:0]		0x18	4-10
Base Address Register Three (BAR3) (SCRIPTS RAM) bits [31:0]		0x1C	4-10
Base Address Register Four (BAR4) (SCRIPTS RAM)) bits [31:0]		0x20	4-11
Reserved		0x24	4-11
Reserved		0x28	4-11
Subsystem ID (SID)	Subsystem Vendor ID (SVID)	0x2C	4-12
Expansion ROM Base Address (ERBA)		0x30	4-14
Reserved	Capabilities Pointer (CP)	0x34	4-15
Reserved		0x38	4-15
Max_Lat (ML) Min_Gnt (MG)	Interrupt Pin (IP) Interrupt Line (IL)	0x3C	4-16
Power Management Capabilities (PMC)	Next Item Pointer (NIP) Capability ID (CID)	0x40	4-18
Data Bridge Support Extensions (PMCSR_BSE)	Power Management Control/Status (PMCSR)	0x44	4-19

Registers: 0x00–0x01
Vendor ID
Read Only

15															0
							VID								
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

VID   **Vendor ID**   **[15:0]**
This 16-bit register identifies the manufacturer of the device. The Vendor ID is 0x1000.

Registers: 0x02–0x03
Device ID
Read Only

15															0
DID															
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1

DID　　　　　**Device ID**　　　　　　　　　　　　　**[15:0]**
This 16-bit register identifies the particular device. The
LSI53C1010R Device ID is 0x0021.

Registers: 0x04–0x05
Command
Read/Write

15							9	8	7	6	5	4	3	2	1	0
R								SE	R	EPER	R	WIE	R	EBM	EMS	EIS
0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0

The SCSI Command Register provides coarse control over a device's
ability to generate and respond to PCI cycles. When a zero is written to
this register, the LSI53C1010R is logically disconnected from the PCI
bus for all accesses except configuration accesses.

R　　　　　**Reserved**　　　　　　　　　　　　　**[15:9]**

SE　　　　　**SERR/Enable**　　　　　　　　　　　　　**8**
When this bit is set, the LSI53C1010R enables the
SERR/ driver. SERR/ is disabled when this bit is cleared.
The default value of this bit is zero. This bit and bit 6 must
be set to report address parity errors.

R　　　　　**Reserved**　　　　　　　　　　　　　**7**

EPER　　　　　**Enable Parity Error Response**　　　　　　**6**
When this bit is set, the LSI53C1010R detects parity
errors on the PCI bus and reports these errors to the
system. Only data parity checking is affected with this bit.
The LSI53C1010R always generates parity for the PCI
bus.

| **R** | **Reserved** | **5** |

WIE   **Write and Invalidate Enable**   **4**

When this bit is set, the LSI53C1010R can generate write and invalidate commands on the PCI bus. The WRIE bit in the Chip Test Three (CTEST3) register must also be set for the device to generate write and invalidate commands.

| **R** | **Reserved** | **3** |

EBM   **Enable Bus Mastering**   **2**

This bit controls the ability of the LSI53C1010R to act as a master on the PCI bus. A value of zero disables this device from generating PCI bus master accesses. A value of one allows the LSI53C1010R to behave as a bus master. The device must be a bus master to fetch SCRIPTS instructions and transfer data.

EMS   **Enable Memory Space**   **1**

This bit controls the ability of the LSI53C1010R to respond to Memory space accesses. A value of zero disables the device response. A value of one allows the LSI53C1010R to respond to Memory Space accesses at the address range specified by the Base Address Register One (BAR1) (MEMORY), Base Address Register Two (BAR2) (MEMORY), Base Address Register Three (BAR3) (SCRIPTS RAM), and the Base Address Register Four (BAR4) (SCRIPTS RAM) registers in the PCI configuration space.

EIS   **Enable I/O Space**   **0**

This bit controls the LSI53C1010R response to I/O space accesses. Clearing this bit disables the device response. Setting this bit allows the LSI53C1010R to respond to I/O Space accesses at the address range specified by the Base Address Register Zero (BAR0) (I/O) register in the PCI configuration space.

Registers: 0x06–0x07
Status
Read/Write

15	14	13	12	11	10	9	8	7	6	5	4	3			0
DPE	SSE	RMA	RTA	R	DT[1:0]		DPR	FBBC	R	66C	NC	R			
0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0

Reads to this register behave normally. Writes are slightly different in that bits can be cleared, but not set. A bit is cleared whenever the register is written, and the data in the corresponding bit location is a one. For example, to clear bit 15 and not affect any other bits, write the value 0x8000 to the register.

DPE   **Detected Parity Error (from Slave)**   **15**
This bit is set by the LSI53C1010R upon the detection of a data parity error, even if data parity error handling is disabled.

SSE   **Signaled System Error**   **14**
This bit is set whenever the device asserts the SERR/ signal.

RMA   **Received Master Abort (from Master)**   **13**
A master device should set this bit when its transaction (except for Special Cycle) is terminated with Master Abort.

RTA   **Received Target Abort (from Master)**   **12**
A master device should set this bit whenever its transaction is terminated by Target Abort.

R   **Reserved**   **11**

DT[1:0]   **DEVSEL/Timing**   **[10:9]**
These bits encode the timing of DEVSEL/. The timings are encoded as:

0b00	fast
0b01	medium
0b10	slow
0b11	reserved

These bits are read only and indicate the slowest time that a device asserts DEVSEL/ for any bus command except Configuration Read and Configuration Write. The LSI53C1010R only supports medium DEVSEL/ timing.

DPR   **Data Parity Error Reported**   **8**

This bit is set when the following conditions are met:

- The bus agent asserts PERR/ itself or observes PERR/ asserted and;

- The agent setting this bit acted as the bus master for the errant operation and;

- The Parity Error Response bit in the Command register is set.

FBBC   **Fast Back to Back Capable**   **7**

This bit is zero.

R   **Reserved**   **6**

66C   **66 MHz Capable**   **5**

When set, this bit indicates that the LSI53C1010R is capable of 66 MHz PCI operation. This bit is controlled by the ENABLE66 pin, which has a static pull-up.

NC   **New Capabilities**   **4**

This bit is set to indicate a list of extended capabilities such as PCI Power Management. This bit is read only.

R   **Reserved**   **[3:0]**

Register: 0x08
Revision ID (RID)
Read Only

7							0
			RID				
x	x	x	x	x	x	x	x

RID   **Revision ID**   **[7:0]**

This register indicates the current revision level of the device.

Registers: 0x09–0x0B
Class Code (CC)
Read Only

23																							0
												CC											
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CC　　　　　**Class Code**　　　　　　　　　　　　　　**[23:0]**

This 24-bit register identifies the generic function of the device. The upper byte of this register is a base class code, the middle byte is a subclass code, and the lower byte identifies a specific register-level programming interface. The value of this register is 0x010000, which identifies a SCSI controller.

Register: 0x0C
Cache Line Size (CLS)
Read/Write

7							0
			CLS				
0	0	0	0	0	0	0	0

CLS　　　　　**Cache Line Size**　　　　　　　　　　　**[7:0]**

This register specifies the system cache line size in units of 32-bit words. The value in this register is used by the device to determine whether to use Write and Invalidate or Write commands for performing write cycles, and whether to use Read, Read Line, or Read Multiple commands for performing read cycles as a bus master. Devices participating in the caching protocol use this field to determine when to retry burst accesses at cache line boundaries. These devices can ignore the PCI cache support lines (SDONE and SB0/) if this register is set to 0. If this register is programmed to a number which is not a power of 2, the device does not use PCI performance commands to execute data transfers.

Register: 0x0D
Latency Timer (LT)
Read/Write

7							0
LT							
0	0	0	0	0	0	0	0

LT   **Latency Timer**   **[7:0]**

The Latency Timer register specifies, in units of PCI bus clocks, the value of the Latency Timer for this PCI bus master. The SCSI functions of the LSI53C1010R support this timer. All eight bits are writable, allowing latency values of 0–255 PCI clocks. Use the following equation to calculate an optimum latency value for the SCSI functions of the LSI53C1010R.

Latency = 2 + (Burst Size * (typical wait states + 1))

Values greater than optimum are also acceptable.

Register: 0x0E
Header Type (HT)
Read Only

7							0
HT							
1	0	0	0	0	0	0	0

HT   **Header Type**   **[7:0]**

This 8-bit register identifies the layout of bytes 0x10 through 0x3F in configuration space and also whether or not the device contains multiple functions. Since the LSI53C1010R is a multifunction controller the value of this register is 0x80.

Register: 0x0F
Reserved

7							0
R							
0	0	0	0	0	0	0	0

This register is reserved.

Registers: 0x10–0x13
Base Address Register Zero (BAR0) (I/O)
Read/Write

31																															0
BAR0																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

BAR0   **Base Address Register Zero - I/O**   **[31:0]**
This base address register is used to map the operating register set into I/O space. The LSI53C1010R requires 256 bytes of I/O space for this base address register. Bit 0 is hardwired to one. Bit 1 is reserved and returns a zero on all reads. All other bits are used to map the device into I/O space. For detailed information on the operation of this register, refer to the PCI 2.2 specification.

Registers: 0x14–0x17
Base Address Register One (BAR1) (MEMORY)
Read/Write

31																															0
BAR1																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

BAR1   **Base Address Register One**   **[31:0]**
This base address register, in conjunction with Base Address Register Two (BAR2) (MEMORY), maps SCSI operating registers into memory space and represents the lower 32 bits of the memory address. Bits [9:0] are hardwired to 0b0000000100. The default value of this register is 0x00000004. The LSI53C1010R requires 1024 bytes of memory space. For detailed information on

the operation of this register, refer to the PCI 2.2 specification.

Registers: 0x18–0x1B
Base Address Register Two (BAR2) (MEMORY)
Read/Write

31																															0
															BAR2																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BAR2 **Base Address Register Two** **[31:0]**
This base address register, in conjunction with Base Address Register One (BAR1) (MEMORY), maps SCSI operating registers into memory space and represents the upper 32 bits of the memory address. The default value of this register is 0x00000000. The LSI53C1010R requires 1024 bytes of memory space. For detailed information on the operation of this register, refer to the PCI 2.2 specification.

Registers: 0x1C–0x1F
Base Address Register Three (BAR3) (SCRIPTS RAM)
Read/Write

31																															0
															BAR3																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

BAR3 **Base Address Register Three** **[31:0]**
This base address register, in conjunction with Base Address Register Four (BAR4) (SCRIPTS RAM), is used to map the SCRIPTS RAM into memory space and represents the lower 32 bits of the memory address. Bits [12:0] are hardwired to 0b0000000000100. The default value of this register is 0x00000004. The LSI53C1010R requires 8192 bytes of memory space for SCRIPTS RAM. For detailed information on the operation of this register, refer to the PCI 2.2 specification.

Registers: 0x20–0x23
Base Address Register Four (BAR4) (SCRIPTS RAM)
Read/Write

31   0

BAR4
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

BAR4   **Base Address Register Four**   **[31:0]**
This base address register, in conjunction with Base
Address Register Three (BAR3) (SCRIPTS RAM), is
used to map the SCRIPTS RAM into memory space and
represents the upper 32 bits of the memory address. The
default value of this register is 0x00000000. The
LSI53C1010R requires 8192 bytes of memory space for
SCRIPTS RAM. For detailed information on the operation
of this register, refer to the PCI 2.2 specification.

Registers: 0x24–0x27
Reserved

31   0

R
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

This register is reserved.

Registers: 0x28–0x2B
Reserved

31   0

R
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

This register is reserved.

Registers: 0x2C–0x2D
Subsystem Vendor ID (SVID)
Read Only

15															0
SVID															
If MAD7 is HIGH															
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
If MAD7 is LOW															
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

SVID **Subsystem Vendor ID** **[15:0]**

This 16-bit register is used to uniquely identify the vendor manufacturing the add-in board or subsystem where this PCI device resides. It provides a mechanism for an add-in card vendor to distinguish its cards from another vendor's cards, even if the cards have the same PCI controller installed on them (and therefore the same Vendor ID and Device ID).

If the external serial EEPROM interface is enabled (MAD[7] LOW), this register is automatically loaded at power-up from the external serial EEPROM and contains the value downloaded from the serial EEPROM or, if the download fails, a value of 0x0000.

If the external serial EEPROM interface is disabled (MAD[7] HIGH), this register returns a value of 0x1000. The 16-bit value that should be stored in the external serial EEPROM for this register is the vendor's PCI Vendor ID. This value must be obtained from the PCI Special Interest Group (SIG). Please see Section 2.4, "Serial EEPROM Interface," for more information on downloading a value for this register.

Registers: 0x2E–0x2F
Subsystem ID (SID)
Read Only

15															0
SID															
If MAD[7] is HIGH															
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
If MAD[7] is LOW															
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

SID   **Subsystem ID**   **[15:0]**

This 16-bit register is used to uniquely identify the add-in board or subsystem where this PCI device resides. It provides a mechanism for an add-in card vendor to distinguish its cards from one another even if the cards have the same PCI controller installed on them (and therefore the same Vendor ID and Device ID).

If the external serial EEPROM interface is enabled (MAD[7] is LOW), this register is automatically loaded at power-up from the external serial EEPROM and contains the value downloaded from the serial EEPROM or, if the download fails, a value of 0x0000.

If the external serial EEPROM is disabled (MAD[7] pulled HIGH), the register returns a value of 0x1000. The 16-bit value stored in the external serial EEPROM is vendor-specific. Please see Section 2.4, "Serial EEPROM Interface," for additional information on downloading a value for this register.

Registers: 0x30–0x33
Expansion ROM Base Address (ERBA)
Read/Write

31																				11	10									1	0
ERBA																					R										EREN
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This four-byte register handles the base address and size information for the expansion ROM.

ERBA   **Expansion ROM Base Address**   **[31:11]**
Bits [31:11] correspond to the upper 21 bits of the expansion ROM base address. The host system detects the size of the external memory by first writing the Expansion ROM Base Address (ERBA) register with all ones and then reading back the register. The SCSI functions of the LSI53C1010R respond with zeros in all don't care locations. The least significant one (1) that remains represents the binary version of the external memory size. For example, to indicate an external memory size of 32 Kbytes, this register, when written with ones and read back, returns ones in the upper 17 bits.

The size of the external memory is set through MAD[3:1]. Please see Section 3.9, "MAD Bus Programming," for the possible size encodings available.

R   **Reserved**   **[10:1]**

EREN   **Expansion ROM Enable**   **0**
The expansion ROM Enable bit, bit 0, is used to control whether or not the device accepts accesses to its expansion ROM. When the bit is set, address decoding is enabled, and a device is used with or without an expansion ROM depending on the system configuration.

Note: To access the external memory interface, also set the Memory Space bit in the Command register.

Register: 0x34
Capabilities Pointer (CP)
Read Only

7							0
CP							
0	1	0	0	0	0	0	0

CP   **Capabilities Pointer**   **[7:0]**
This register indicates that the first extended capability register is located at offset 0x40 in PCI Configuration Space.

Registers: 0x35–0x37
Reserved

23																							0
R																							
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This register is reserved.

Registers: 0x38–0x3B
Reserved

31																															0
R																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This register is reserved.

Register: 0x3C
Interrupt Line (IL)
Read/Write

7							0
IL							
0	0	0	0	0	0	0	0

IL   **Interrupt Line**   **[7:0]**
This register is used to communicate interrupt line routing information. POST software writes the routing information into this register as it configures the system. The value in this register tells which input of the system interrupt controller(s) the device's interrupt pin is connected to. Values in this register are specified by system architecture.

Register: 0x3D
Interrupt Pin (IP)
Read Only

7							0
IP							
SCSI Function A							
0	0	0	0	0	0	0	1
SCSI Function B if MAD[4] pulled LOW							
0	0	0	0	0	0	1	0
SCSI Function B if MAD[4] pulled HIGH							
0	0	0	0	0	0	0	1

IP   **Interrupt Pin**   **[7:0]**
This register is unique to each SCSI function. It tells which interrupt pin the device uses. Its value is set to 0x01 for the Function A (INTA/) signal, and 0x02 for the Function B (INTB/) signal at power-up if MAD[4] is pulled LOW. The Function B value is set to 0x01 (INTA/) if MAD[4] is pulled HIGH.

Note: Please see Section 3.9, "MAD Bus Programming," for additional information.

Register: 0x3E
Min_Gnt (MG)
Read Only

7							0
MG							
0	0	0	1	0	0	0	1

MG   **Min_Gnt**   **[7:0]**
This register is used to specify the desired settings for latency timer values. Min_Gnt is used to specify how long a burst period the device needs. The value specified in these registers is in units of 0.25 μs. The LSI53C1010R sets this register to 0x11.

Register: 0x3F
Max_Lat (ML)
Read Only

7							0
ML							
0	0	0	1	0	0	1	0

ML   **Max_Lat**   **[7:0]**
This register is used to specify the desired settings for latency timer values. Max_Lat is used to specify how often the device needs to gain access to the PCI bus. The value specified in this register is in units of 0.25 μs. The LSI53C1010R SCSI function sets this register to 0x12 indicating it needs the bus every 4.5 μs to maintain a data stream of 160 Mbytes/s.

Register: 0x40
Capability ID (CID)
Read Only

7							0
CID							
0	0	0	0	0	0	0	1

CID   **Capability ID**   **[7:0]**
This register indicates the type of data structure currently being used. It is set to 0x01, indicating the Power Management Data Structure.

Register: 0x41
Next Item Pointer (NIP)
Read Only

7							0
NIP							
0	0	0	0	0	0	0	0

NIP   **Next Item Pointer**   **[7:0]**
Bits [7:0] contain the offset location of the next item in the function's capabilities list. The LSI53C1010R has these bits set to zero indicating no further extended capabilities registers exist.

Registers: 0x42–0x43
Power Management Capabilities (PMC)
Read Only

15				11	10	9	8		6	5	4	3	2		0
PMES					D2S	D1S	AUX_C			DSI	R	PMEC	VER[2:0]		
0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0

PMES   **PME_Support**   **[15:11]**
Bits [15:11] define the power management states in which the LSI53C1010R will assert the PME pin. These bits are all set to zero because the LSI53C1010R does not provide a PME signal.

D2S   **D2_Support**   **10**
The LSI53C1010R sets this bit to indicate support for
power management state D2. Bits 9 and 10 are set to
indicate support for the D1 and D2 power states.

D1S   **D1_Support**   **9**
The LSI53C1010R sets this bit to indicate support for
power management state D1. Bits 9 and 10 are set to
indicate support for the D1 and D2 power states.

AUX_C   **Aux_Current**   **[8:6]**
The LSI53C1010R always returns zeros. This feature is
not supported.

DSI   **Device Specific Initialization**   **5**
This bit is cleared to indicate that the LSI53C1010R
requires no special initialization before the generic class
device driver is able to use it.

R   **Reserved**   **4**

PMEC   **PME Clock**   **3**
Bit 3 is cleared because the LSI53C1010R does not
provide a PME pin.

VER[2:0]   **Version**   **[2:0]**
These three bits are set to 0b010 to indicate that the
LSI53C1010R complies with Revision 1.1 of the PCI
Power Management Interface Specification.

Registers: 0x44–0x45
Power Management Control/Status (PMCSR)
Read/Write

15	14	13	12			9	8	7					2	1	0
PST	DSCL		DSLT				PEN	R						PWS[1:0]	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PST   **PME_Status**   **15**
The LSI53C1010R always returns a zero for this bit,
indicating that PME signal generation is not supported
from D3cold.

DSCL   **Data_Scale**   **[14:13]**

The LSI53C1010R does not support the Data register. Therefore, these two bits are always cleared.

DSLT   **Data_Select**   **[12:9]**

The LSI53C1010R does not support the Data register. Therefore, these four bits are always cleared.

PEN   **PME_Enable**   **8**

The LSI53C1010R always returns zero for this bit to indicate that PME assertion is disabled.

R   **Reserved**   **[7:2]**

PWS[1:0]   **Power State**   **[1:0]**

Bits [1:0] are used to determine the current power state of the LSI53C1010R. They are used to place the LSI53C1010R in a new power state. Power states are defined as:

0b00 D0

0b01 D1

0b10 D2

0b11 D3 hot

See Section 2.5, "Power Management," for descriptions of the Power Management States.

Register: 0x46
Bridge Support Extensions (PMCSR_BSE)
Read Only

7							0
BSE							
0	0	0	0	0	0	0	0

BSE   **Bridge Support Extensions**   **[7:0]**

This register indicates PCI Bridge specific functionality. The LSI53C1010R always returns 0x00.

Register: 0x47
Data
Read Only

7							0
DATA							
0	0	0	0	0	0	0	0

DATA **Data** **[7:0]**

This register provides an optional mechanism for the function to report state-dependent operating data. The LSI53C1010R always returns 0x00.

4.2 SCSI Registers

The control registers for the SCSI core are directly accessible from the PCI bus using Memory or I/O mapping. SCSI Function A and SCSI Function B contain the same register set with identical default values, except the Interrupt Pin registers. The address map of the SCSI registers is shown in Table 4.2.

The eight 32-bit, phase mismatch registers contain the byte count and addressing information required to update the Direct, Indirect, or Table Indirect BMOV instructions with new byte counts and addresses. The phase mismatch registers are the Phase Mismatch Jump Address One (PMJAD1), Phase Mismatch Jump Address Two (PMJAD2), Remaining Byte Count (RBC), Updated Address (UA), Entry Storage Address (ESA), Instruction Address (IA), SCSI Byte Count (SBC), and the Cumulative SCSI Byte Count (CSBC) registers. All of the phase mismatch registers can be read or written using the Load and Store SCRIPTS instructions, Memory-to-Memory Moves, Read/Write SCRIPTS instructions, or the CPU with SCRIPTS not running.

> Note: The only registers that the host CPU can access while the LSI53C1010R is executing SCRIPTS are the Interrupt Status Zero (ISTAT0), Interrupt Status One (ISTAT1), Mailbox Zero (MBOX0), and Mailbox One (MBOX1) registers; attempts to access other registers interfere with the operation of the chip. However, all operating registers are accessible with SCRIPTS. All read data is synchronized and stable when presented to the PCI bus.

> Note: Do not access reserved bits or registers.

Table 4.2   SCSI Register Map

31	16	15	0	Address	Page
SCNTL3	SCNTL2	SCNTL1	SCNTL0	0x00	4-24
GPREG	SDID	SXFER	SCID	0x04	4-33
SBCL	SSID	SOCL	SFBR	0x08	4-37
SSTAT2	SSTAT1	SSTAT0	DSTAT	0x0C	4-40
DSA				0x10	4-46
MBOX1	MBOX0	ISTAT1	ISTAT0	0x14	4-47
CTEST3	CTEST2	CTEST1	CTEST0	0x18	4-52
TEMP				0x1C	4-55
CTEST6	CTEST5	CTEST4	Reserved	0x20	4-56
DCMD	DBC			0x24	4-59
DNAD				0x28	4-60
DSP				0x2C	4-61
DSPS				0x30	4-61
SCRATCH A				0x34	4-62
DCNTL	SBR	DIEN	DMODE	0x38	4-62
ADDER				0x3C	4-69
SIST1	SIST0	SIEN1	SIEN0	0x40	4-69
GPCNTL	Reserved	SWIDE	Reserved	0x44	4-77
RESPID1	RESPID0	STIME1	STIME0	0x48	4-79
STEST3	STEST2	STEST1	STEST0	0x4C	4-83
CSO	STEST4	SIDL		0x50	4-88
CCNTL1	CCNTL0	SODL		0x54	4-90
CCNTL3	CCNTL2	SBDL		0x58	4-94
SCRATCH B				0x5C	4-96
SCRATCH C–SCRATCH R				0x60–0x9F	4-97
MMRS				0xA0	4-97
MMWS				0xA4	4-98
SFS				0xA8	4-98
DRS				0xAC	4-99
SBMS				0xB0	4-99
DBMS				0xB4	4-100
DNAD64				0xB8	4-100
AIPCNTL1	AIPCNTL0	Reserved	SCNTL4	0xBC	4-101
PMJAD1				0xC0	4-113
PMJAD2				0xC4	4-113
RBC				0xC8	4-114
UA				0xCC	4-115
ESA				0xD0	4-116
IA				0xD4	4-116
Reserved	SBC			0xD8	4-117
CSBC				0xDC	4-118
CRCCNTL1	CRCCNTL0	CRCPAD		0xE0	4-118
CRCD				0xE4	4-120
Reserved				0xE8–0xEF	4-121
Reserved		DFBC		0xF0	4-122
Reserved				0xF4-0xFF	4-122

Register: 0x00
SCSI Control Zero (SCNTL0)
Read/Write

7	6	5	4	3	2	1	0
ARB[1:0]		START	WATN	EPC	CRCOK	AAP	TRG
1	1	0	0	0	x	0	0

ARB[1:0]   **Arbitration Mode Bits 1 and 0**   **[7:6]**

A combination of the ARB bits selects either Simple or Full arbitration.

ARB1	ARB0	Arbitration Mode
0	0	Simple arbitration
0	1	Reserved
1	0	Reserved
1	1	Full arbitration, selection/reselection

Simple Arbitration

1. The LSI53C1010R SCSI function waits for a bus free condition to occur.

2. It asserts SBSY/ and its SCSI ID, contained in the SCSI Chip ID (SCID) register, onto the SCSI bus. If the SSEL/ signal is asserted by another SCSI device, the LSI53C1010R SCSI function deasserts SBSY/, deasserts its ID, and sets the Lost Arbitration bit (bit 3) in the SCSI Status Zero (SSTAT0) register.

3. After an arbitration delay, the CPU should read the SCSI Bus Control Lines (SBCL) register to check if a higher priority SCSI ID is present. If no higher priority ID bit is set, and the Lost Arbitration bit is not set, the LSI53C1010R SCSI function wins arbitration.

4. Once the LSI53C1010R SCSI function wins arbitration, SSEL/ must be asserted using the SCSI Output Control Latch (SOCL) for a bus clear and a bus settle delay (1.2 µs). Then, a low level selection is performed.

Full Arbitration, Selection/Reselection

1. The LSI53C1010R SCSI function waits for a bus free condition.

2. It asserts SBSY/ and its SCSI ID onto the SCSI bus. The SCSI ID asserted is the highest priority ID stored in the SCSI Chip ID (SCID) register.

3. If the SSEL/ signal is asserted by another SCSI device or if the LSI53C1010R SCSI function detects a higher priority ID, the LSI53C1010R SCSI function deasserts SBSY/, deasserts its ID, sets the Lost Arbitration bit, bit 3 in the SCSI Status Zero (SSTAT0) register, and waits until the next bus free state to try arbitration again.

4. The LSI53C1010R SCSI function repeats arbitration until it wins control of the SCSI bus. When it wins, the Won Arbitration bit is set in the SCSI Status Zero (SSTAT0) register, bit 2.

5. The LSI53C1010R SCSI function performs selection by asserting SSEL/, the target's ID (stored in the SCSI Destination ID (SDID) register), and the LSI53C1010R's ID (stored in the SCSI Chip ID (SCID) register) onto the SCSI bus.

6. After a selection is complete, the Function Complete bit is set in the SCSI Interrupt Status Zero (SIST0) register, bit 6.

7. If a selection time-out occurs, the Selection Time-out bit is set in the SCSI Interrupt Status One (SIST1) register, bit 2.

START **Start Sequence** **5**

When this bit is set, the LSI53C1010R starts the arbitration sequence indicated by the Arbitration Mode bits. The Start Sequence bit is accessed directly in low level mode; during SCSI SCRIPTS operations, this bit is controlled by the SCRIPTS processor. Do not start an arbitration sequence if the connected (CON) bit in the SCSI Control One (SCNTL1) register, bit 4, is set. This bit indicates that the LSI53C1010R is already connected to the SCSI bus. This bit is automatically cleared when

the arbitration sequence is complete. If a sequence is aborted, check bit 4 in the SCNTL1 register to verify that the LSI53C1010R is not connected to the SCSI bus.

WATN   **Select with SATN/ on a Start Sequence**   **4**

When this bit is set and the SCSI function is in the initiator mode, the SATN/ signal is asserted during selection of a SCSI target device. This is to inform the target that the LSI53C1010R SCSI function has a message to send. If a selection time-out occurs while attempting to select a target device, SATN/ is deasserted at the same time SSEL/ is deasserted. When this bit is cleared, the SATN/ signal is not asserted during selection. When executing SCSI SCRIPTS, this bit is controlled by the SCRIPTS processor, but manual setting is possible in the low level mode.

EPC   **Enable Parity/CRC/AIP Checking**   **3**

When this bit is set and the SCSI transfers are asynchronous or ST synchronous, the SCSI data bus is checked for odd parity when data is received from the SCSI bus in either the initiator or the target mode. If a parity error is detected, bit 0 of the SCSI Interrupt Status Zero (SIST0) register is set and an interrupt may be generated.

When SCSI transfers are DT synchronous, the CRC is checked when the target requests a CRC transfer using the DP0 signal on the SCSI bus. If a CRC error is detected, bit 0 of the SCSI Interrupt Status Zero (SIST0) register is set and an interrupt may be generated.

If the LSI53C1010R SCSI function is operating in the initiator mode and a parity error or CRC error is detected, SATN/ can optionally be asserted, but the transfer continues until the target changes phase or the block move in which the parity error was detected completes.

When this bit is clear, parity errors are not reported. CRC errors are reported in bit 0 of the SCSI Interrupt Status Zero (SIST0). To disable CRC checking and reporting, set bit 7, Disable CRC Checking, of CRC Control Zero (CRCCNTL0).

CRCOK   **CRC Request OK**   **2**
                 This bit indicates it is acceptable to force a CRC request.
                 This bit is set only if a CRC request has been sent and
                 no data has been transferred since the request. This bit
                 can be used to determine if it is necessary to send a CRC
                 request at the end of a data transfer, prior to changing
                 phases in target mode. This bit may be used to prevent
                 back to back CRC conditions.

AAP   **Assert SATN/ on Parity/CRC/AIP Error**   **1**
                 When this bit is set, the LSI53C1010R SCSI function
                 automatically asserts the SATN/ signal upon detection of
                 a parity error or CRC error. SATN/ is only asserted in the
                 initiator mode. The SATN/ signal is asserted before
                 deasserting SACK/ during the byte transfer with the parity
                 error. Also set the Enable Parity/CRC/AIP Checking bit
                 for the LSI53C1010R SCSI function to assert SATN/ in
                 this manner. A parity error or CRC error is detected on
                 data received from the SCSI bus.

                 If the Assert SATN/ on Parity/CRC/AIP Error bit is cleared
                 or the Enable Parity/CRC/AIP Checking bit is cleared,
                 SATN/ is not automatically asserted on the SCSI bus
                 when a Parity/CRC/AIP error is received.

TRG   **Target Mode**   **0**
                 This bit determines the default operating mode of the
                 LSI53C1010R SCSI function. The user must manually set
                 the target or initiator mode. This is done using the
                 SCRIPTS language (SET TARGET or CLEAR TARGET).
                 When this bit is set, the chip is a target device. When this
                 bit is cleared, the LSI53C1010R SCSI function is an
                 initiator device.

  Caution: Writing this bit while not connected may cause the loss of
                 a selection or reselection due to the changing of target or
                 initiator modes.

Register: 0x01
SCSI Control One (SCNTL1)
Read/Write

7	6	5	4	3	2	1	0
R	ADB	DHP	CON	RST	AESP	IARB	R
0	0	0	0	0	0	0	0

R   **Reserved**   **7**

ADB   **Assert SCSI Data Bus**   **6**
When this bit is set, the LSI53C1010R SCSI function
drives the contents of the SCSI Output Data Latch
(SODL) register onto the SCSI data bus. When the
LSI53C1010R SCSI function is an initiator, the SCSI I/O
signal must be inactive to assert the SODL contents onto
the SCSI bus. When the LSI53C1010R SCSI function is
a target, the SCSI I/O signal must be active to assert the
SODL contents onto the SCSI bus. The contents of the
SODL register can be asserted at any time, even before
the LSI53C1010R SCSI function is connected to the
SCSI bus. Clear this bit when executing SCSI SCRIPTS.
It is normally used only for diagnostics testing or
operation in low level mode.

DHP   **Disable Halt on Parity/CRC/AIP Error or ATN**
                 (Target Only)   **5**
The DHP bit is only defined for the target mode. When
this bit is cleared, the LSI53C1010R SCSI function halts
the SCSI data transfer when a Parity/CRC/AIP error is
detected or when the SATN/ signal is asserted. If SATN/
or a Parity/CRC/AIP error is received in the middle of a
data transfer, the LSI53C1010R SCSI function may
transfer up to three additional bytes before halting to
synchronize between internal core cells. During
synchronous operation, the LSI53C1010R SCSI function
transfers data until there are no outstanding synchronous
offsets. If the LSI53C1010R SCSI function is receiving
data, any data residing in the DMA FIFO is sent to
memory before halting.

When this bit is set, the LSI53C1010R SCSI function
does not halt the SCSI transfer when SATN/ or a
Parity/CRC/AIP error is received.

CON   **Connected**   **4**
This bit is automatically set any time the LSI53C1010R SCSI function is connected to the SCSI bus as an initiator or as a target. It is set after the LSI53C1010R SCSI function successfully completes arbitration or when it has responded to a bus initiated selection or reselection. This bit is also set after the chip wins simple arbitration when operating in low level mode. When this bit is cleared, the LSI53C1010R SCSI function is not connected to the SCSI bus.

The CPU can force a connected or disconnected condition by setting or clearing this bit.

RST   **Assert SCSI RST/ Signal**   **3**
Setting this bit asserts the SRST/ signal. The SRST/ output remains asserted until this bit is cleared. The 25 µs minimum assertion time defined in the SCSI specification must be timed out by the controlling microprocessor or a SCRIPTS loop.

AESP   **Assert Even SCSI Parity (force bad parity)**   **2**
When this bit is set, the LSI53C1010R SCSI function asserts even parity. It forces a SCSI parity error on each byte sent to the SCSI bus from the chip. If parity checking is enabled, then the LSI53C1010R SCSI function checks data received for odd parity. This bit is used for diagnostic testing and is cleared for normal operation.

IARB   **Immediate Arbitration**   **1**
Setting this bit causes the SCSI core to immediately begin arbitration once a Bus Free phase is detected following an expected SCSI disconnect. This bit is useful for multithreaded applications. The ARB[1:0] bits in SCSI Control Zero (SCNTL0) are set for full arbitration and selection before setting this bit.

Arbitration is retried until won. At that point, the LSI53C1010R SCSI function holds SBSY and SSEL asserted, and waits for a select or reselect sequence. The Immediate Arbitration bit is cleared automatically when the selection or reselection sequence is completed or times out.

An unexpected disconnect condition clears IARB with it attempting arbitration. See the SCSI Disconnect Unexpected bit (SCSI Control Two (SCNTL2), bit 7) for more information on expected versus unexpected disconnects.

It is possible to abort an immediate arbitration sequence. First, set the Abort bit in the Interrupt Status Zero (ISTAT0) register. Then one of two things eventually happens:

• The Won Arbitration bit (SCSI Status Zero (SSTAT0), bit 2) will be set. In this case, the Immediate Arbitration bit needs to be cleared. This completes the abort sequence and disconnects the chip from the SCSI bus. If it is not acceptable to go to the Bus Free phase immediately following the arbitration phase, it is possible to perform a low level selection instead.

• The abort completes because the LSI53C1010R SCSI function loses arbitration. This is detected by the clearing of the Immediate Arbitration bit. Do not use the Lost Arbitration bit (SCSI Status Zero (SSTAT0), bit 3) to detect this condition. In this case take no further action.

R   **Reserved**   **0**

Register: 0x02
SCSI Control Two (SCNTL2)
Read/Write

7	6	5	4	3	2	1	0
SDU	CHM	R		WSS	VUE0	VUE1	WSR
0	0	0	0	0	0	0	0

SDU   **SCSI Disconnect Unexpected**   **7**
This bit is valid in the initiator mode only. When this bit is set, the SCSI core is not expecting the SCSI bus to enter the Bus Free phase. If it does, an unexpected disconnect error is generated (see the Unexpected Disconnect bit in the SCSI Interrupt Status Zero (SIST0) register, bit 2). During normal SCRIPTS mode operation, this bit is set automatically whenever the SCSI core is reselected, or successfully selects another SCSI device. The SDU bit

should be cleared with a register write (Move 0x00 To SCSI Control Two (SCNTL2)) before the SCSI core expects a disconnect to occur, normally prior to sending an Abort, Abort Tag, Bus Device Reset, Clear Queue or Release Recovery message, or before deasserting SACK/ after receiving a Disconnect command or Command Complete message.

CHM   **Chained Mode**   **6**

This bit determines whether or not the SCSI core is programmed for chained SCSI mode. This bit is automatically set by the Chained Block Move (CHMOV) SCRIPTS instruction and is automatically cleared by the Block Move SCRIPTS instruction (MOVE). For more information, refer to Section 2.2.18, "Chained Block Moves."

R   **Reserved**   **[5:4]**

WSS   **Wide SCSI Send**   **3**

When read, this bit returns the value of the Wide SCSI Send (WSS) flag. Asserting this bit clears the WSS flag. This clearing function is self-clearing. For more information refer to Section 2.2.18, "Chained Block Moves."

VUE0   **Vendor Unique Enhancements, Bit 0**   **2**

This bit is a read only value indicating whether the group code field in the SCSI instruction is standard or vendor unique. If cleared, the bit indicates standard group codes; if set, the bit indicates vendor unique group codes. The value in this bit is reloaded at the beginning of all asynchronous target receives.

VUE1   **Vendor Unique Enhancement, Bit 1**   **1**

This bit is used to disable the automatic byte count reload during Block Move instructions in the Command phase. If this bit is cleared, the device reloads the Block Move byte count if the first byte received is one of the standard group codes. If this bit is set, the device does not reload the Block Move byte count, regardless of the group code.

WSR   **Wide SCSI Receive**   **0**

When read, this bit returns the value of the Wide SCSI Receive (WSR) flag. Setting this bit clears the WSR flag. This bit is self-clearing.

For more information refer to Section 2.2.18, "Chained Block Moves."

Register: 0x03
SCSI Control Three (SCNTL3)
Read/Write

7	6		4	3	2		0
R	SCF[2:0]			EWS	R		
0	0	0	0	0	0	0	0

This register is automatically loaded when a Table Indirect Select or Reselect SCRIPTS instruction is executed.

R   **Reserved**   **7**

SCF[2:0]   **Synchronous Clock Conversion Factor**   **[6:4]**

These bits select a factor by which the frequency of SCLK is divided before being presented to the synchronous SCSI control logic. The synchronous transfer speed is determined by the combination of the divided clock and the setting of the XCLKS and XCLKH bits in the SCSI Control Four (SCNTL4) register. The table below shows the clock dividers that are available. See the table in the SCSI Control Four (SCNTL4) register description for a full list of available transfer rates.

SCF2	SCF1	SCF0	Factor Frequency
0	0	0	SCLK/3
0	0	1	SCLK/1
0	1	0	SCLK/1.5
0	1	1	SCLK/2
1	0	0	SCLK/3

SCF2	SCF1	SCF0	Factor Frequency
1	0	1	SCLK/4
1	1	0	SCLK/6
1	1	1	SCLK/8

EWS **Enable Wide SCSI** **3**

When this bit is cleared, all information transfer phases are assumed to be eight bits, transmitted on SD[7:0]/ and SDP0/. When this bit is asserted, data transfers are performed 16 bits at a time; the least significant byte is on SD[7:0]/ and SDP0/, and the most significant byte is on SD[15:8]/ and SDP1/. Command, Status, and Message phases are not affected by this bit. Because Ultra160 DT SCSI transfers are always wide this bit must be set. If it is not set, a SGE interrupt will occur.

R **Reserved** **[2:0]**

Register: 0x04
SCSI Chip ID (SCID)
Read/Write

7	6	5	4	3			0
R	RRE	SRE	R	ENC[3:0]			
x	0	0	x	0	0	0	0

R **Reserved** **7**

RRE **Enable Response to Reselection** **6**

When this bit is set, the LSI53C1010R SCSI function is enabled to respond to bus-initiated reselection at the chip ID in the Response ID Zero (RESPID0) and Response ID One (RESPID1) registers. Note that the chip does not automatically reconfigure itself to the initiator mode as a result of being reselected.

SRE **Enable Response to Selection** **5**

When this bit is set, the LSI53C1010R SCSI function is able to respond to bus-initiated selection at the chip ID in the Response ID Zero (RESPID0) and Response ID One

(RESPID1) registers. Note that the chip does not automatically reconfigure itself to target mode as a result of being selected.

R   **Reserved**   **4**

ENC[3:0]   **Encoded Chip SCSI ID**   **[3:0]**
These bits are used to store the LSI53C1010R SCSI function encoded SCSI ID. This is the ID which the chip asserts when arbitrating for the SCSI bus. The IDs that the LSI53C1010R SCSI function responds to when selected or reselected are configured in the Response ID Zero (RESPID0) and Response ID One (RESPID1) registers. The priority of the 16 possible IDs, in descending order is:

Highest								**Lowest**							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8

Register: 0x05
SCSI Transfer (SXFER)
Read/Write

7	6	5					0
R		MO[5:0]					
0	0	0	0	0	0	0	0

This register is automatically loaded when a Table Indirect Select or Reselect SCRIPTS instruction is executed.

R   **Reserved**   **[7:6]**

MO[5:0]   **Max SCSI Synchronous Offset**   **[5:0]**
These bits describe the maximum SCSI synchronous offset used by the LSI53C1010R SCSI function when transferring synchronous SCSI data in either the initiator or target mode. Table 4.3 describes the possible combinations and their relationship to the synchronous data offset used by the LSI53C1010R SCSI function. These bits determine the LSI53C1010R SCSI function's method of transfer for ST/DT Data-In and ST/DT Data-Out phases only; all other information transfers occur asynchronously. Please note that the SCSI offset

for Ultra160 transfers is counted as the maximum number of data transfers allowed to be outstanding, not the maximum REQ pulses allowed to be outstanding.

During ST Data-In or ST Data-Out transfers the maximum supported offset is 31 (MO[5:0] = 0x1F).

During DT Data-In or DT Data-Out transfers the maximum supported offset is 62 (MO[5:0] = 0x3E).

Setting offset values outside the allowable range will result in data corruption.

A value of 0 in these bits program the device to perform asynchronous transfers. A value of 1 during DT transfers is illegal and will result in data corruption.

Table 4.3   Maximum Synchronous Offset

MO5	MO4	MO3	MO2	MO1	MO0	Synchronous Offset
0	0	0	0	0	0	0-Asynchronous
0	0	0	0	0	1	Reserved
0	0	0	0	1	0	2
0	0	0	0	1	1	3
...	...	...	...	...	...	...
...	...	...	...	...	...	...
...	...	...	...	...	...	...
1	1	1	0	0	1	57
1	1	1	0	1	0	58
1	1	1	0	1	1	59
1	1	1	1	0	0	60
1	1	1	1	0	1	61
1	1	1	1	1	0	62
1	1	1	1	1	1	Reserved

Register: 0x06
SCSI Destination ID (SDID)
Read/Write

7			4	3			0
R				ENC			
x	x	x	x	0	0	0	0

R   **Reserved**   **[7:4]**

ENC   **Encoded Destination SCSI ID**   **[3:0]**
Writing these bits sets the SCSI ID of the intended initiator or target during SCSI reselection or selection phases, respectively. When executing SCRIPTS, the SCRIPTS processor writes the destination SCSI ID to this register. The SCSI ID is defined by the user in a SCRIPTS Select or Reselect instruction. The value written is the binary-encoded ID. The priority of the 16 possible IDs, in descending order, is:

**Highest**								**Lowest**							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8

Register: 0x07
General Purpose (GPREG)
Read/Write

7		5	4				0
R			GPIO				
x	x	x	0	x	x	x	x

A write to this register will cause the data written to be output to the appropriate GPIO pin if it is set to output mode in that function's General Purpose Pin Control (GPCNTL) register.

R   **Reserved**   **[7:5]**

GPIO   **General Purpose I/O**   **[4:0]**
These bits are programmed through the General Purpose Pin Control (GPCNTL) register as inputs, outputs, or to perform special functions. As an output, these pins can be used to enable or disable external terminators. It is

also possible to program these signals as live inputs and sense them through a SCRIPTS register to register Move Instruction. GPIO[3:0] default as inputs and GPIO4 defaults as an output pin. When configured as inputs, an internal pull-up is enabled.

LSI Logic software uses the GPIO[1:0] signals to access serial EEPROM. GPIO1 is used as a clock, with the GPIO0 pin serving as data.

LSI Logic software also reserves the use of GPIO[4:2]. If there is a need to use GPIO[4:2], please check with LSI Logic for additional information.

Register: 0x08
SCSI First Byte Received (SFBR)
Read/Write

7							0
SFBR							
0	0	0	0	0	0	0	0

SFBR   **SCSI First Byte Received**   **[7:0]**

This register contains the first byte received in any asynchronous information transfer phase. For example, when a LSI53C1010R SCSI function is operating in the initiator mode, this register contains the first byte received in the Message-In, Status, and Data-In phases.

When a Block Move instruction is executed for a particular phase, the first byte received is stored in this register, even if the present phase is the same as the last phase. The first byte received value for a particular input phase is not valid until after a MOVE instruction is executed.

This register is also the accumulator for register read-modify-writes with the SCSI First Byte Received (SFBR) register as the destination. This allows bit testing after an operation.

The SCSI First Byte Received (SFBR) register is not writable using the CPU, and therefore not by a Memory Move. However, it can be loaded using SCRIPTS Read/Write operations. To load the SFBR with a byte

stored in system memory, the byte must first be moved to an intermediate LSI53C1010R SCSI function register (such as the SCRATCH register), and then to the SFBR.

This register also contains the state of the lower eight bits of the SCSI data bus during the Selection phase if the COM bit in the DMA Control (DCNTL) register is clear.

If the COM bit is cleared, do not access this register using SCRIPTS operations, as indeterminate operations may occur. (This includes SCRIPTS Read/Write operations and conditional transfer control instructions that initialize the SCSI First Byte Received (SFBR) register.)

Register: 0x09
SCSI Output Control Latch (SOCL)
Read/Write

7	6	5	4	3	2	1	0
REQ	ACK	BSY	SEL	ATN	MSG	C_D	I_O
0	0	0	0	0	0	0	0

This register is used primarily for diagnostic testing or programmed I/O operation. It is controlled by the SCRIPTS processor when executing SCSI SCRIPTS. SCSI Output Control Latch (SOCL) is used only when transferring data using programmed I/O. Some bits are set or cleared when executing SCSI SCRIPTS. Do not write to the register once the LSI53C1010R SCSI function starts executing normal SCSI SCRIPTS.

REQ	**Assert SCSI REQ/ Signal**	**7**
ACK	**Assert SCSI ACK/ Signal**	**6**
BSY	**Assert SCSI BSY/ Signal**	**5**
SEL	**Assert SCSI SEL/ Signal**	**4**
ATN	**Assert SCSI ATN/ Signal**	**3**
MSG	**Assert SCSI MSG/ Signal**	**2**
C_D	**Assert SCSI C_D/ Signal**	**1**
I_O	**Assert SCSI I_O/ Signal**	**0**

Register: 0x0A
SCSI Selector ID (SSID)
Read Only

7	6		4	3			0
VAL	R			ENID			
0	x	x	x	0	0	0	0

VAL   **SCSI Valid**   **7**
If VAL is asserted, then the two SCSI IDs are detected
on the bus during a bus-initiated selection or reselection,
and the encoded destination SCSI ID bits below are valid.
If VAL is deasserted, only one ID is present and the
contents of the encoded destination ID are meaningless.

R   **Reserved**   **[6:4]**

ENID   **Encoded Destination SCSI ID**   **[3:0]**
Reading the SSID register immediately after the
LSI53C1010R SCSI function is selected or reselected
returns the binary-encoded SCSI ID of the device that
performed the operation. These bits are invalid for targets
that are selected under the single initiator option of the
SCSI-1 specification. This condition is detected by
examining the VAL bit above.

Register: 0x0B
SCSI Bus Control Lines (SBCL)
Read Only

7	6	5	4	3	2	1	0
REQ	ACK	BSY	SEL	ATN	MSG	C_D	I_O
x	x	x	x	x	x	x	x

This register returns the SCSI control line status. A bit is set when the
corresponding SCSI control line is asserted. These bits are not latched;
they are a true representation of what is on the SCSI bus at the time the
register is read. The resulting read data is synchronized before being
presented to the PCI bus to prevent parity errors from being passed to
the system. This register is only used for diagnostics testing or operation
in the low level mode.

REQ	**Assert SCSI REQ/ Signal**	**7**
ACK	**Assert SCSI ACK/ Signal**	**6**
BSY	**Assert SCSI BSY/ Signal**	**5**
SEL	**Assert SCSI SEL/ Signal**	**4**
ATN	**Assert SCSI ATN/ Signal**	**3**
MSG	**Assert SCSI MSG/ Signal**	**2**
C_D	**Assert SCSI C_D/ Signal**	**1**
I_O	**Assert SCSI I_O/ Signal**	**0**

Register: 0x0C
DMA Status (DSTAT)
Read Only

7	6	5	4	3	2	1	0
DFE	MDPE	BF	ABRT	SSI	SIR	R	IID
1	0	0	0	0	0	x	0

Reading this register clears any bits that are set at the time the register is read, but does not necessarily clear the register in case additional interrupts are pending (the LSI53C1010R SCSI functions stack interrupts). The DIP bit in the Interrupt Status Zero (ISTAT0) register is also cleared. It is possible to mask DMA interrupt conditions individually through the DMA Interrupt Enable (DIEN) register.

When performing consecutive 8-bit reads of the DMA Status (DSTAT), SCSI Interrupt Status Zero (SIST0), and SCSI Interrupt Status One (SIST1) registers (in any order), insert a delay equivalent to 12 CLK periods between the reads to ensure that the interrupts clear properly. See Chapter 2, "Functional Description," for more information on interrupts.

DFE   **DMA FIFO Empty**   **7**
This status bit is set when the DMA FIFO is empty. It is possible to use it to determine if any data resides in the FIFO when an error occurs and an interrupt is generated. This bit is a pure status bit and does not cause an interrupt.

MDPE **Master Data Parity Error** **6**

This bit is set when the LSI53C1010R SCSI function, acting as a PCI master, detects a data parity error, or, when acting as a target device, signals a parity error during a data phase. This bit is completely disabled by the Master Parity Error Enable bit (bit 3 of Chip Test Four (CTEST4)).

BF **Bus Fault** **5**

This bit is set when a PCI bus fault condition is detected. A PCI bus fault can only occur when the LSI53C1010R SCSI function is bus master, and is defined as a cycle that ends with a Bad Address or Target Abort Condition.

ABRT **Aborted** **4**

This bit is set when an abort condition occurs. An abort condition occurs when a software abort command is issued by setting bit 7 of the Interrupt Status Zero (ISTAT0) register.

SSI **Single Step Interrupt** **3**

If the Single-Step Mode bit in the DMA Control (DCNTL) register is set, this bit is set and an interrupt generated after successful execution of each SCRIPTS instruction.

SIR **SCRIPTS Interrupt Instruction Received** **2**

This status bit is set whenever an interrupt instruction is evaluated as true.

R **Reserved** **1**

IID **Illegal Instruction Detected** **0**

This status bit is set any time an illegal or reserved instruction opcode is detected, whether the LSI53C1010R SCSI function is operating in single-step mode or automatically executing SCSI SCRIPTS.

Any of the following conditions during instruction execution also sets this bit:

- The LSI53C1010R SCSI function is executing a Wait Disconnect instruction and the SCSI REQ line is asserted without a disconnect occurring.

- A Block Move instruction is executed as an initiator with 0x000000 loaded into the DMA Byte Counter (DBC) register, indicating there are zero bytes to move.

- During a Transfer Control instruction, the Compare Data (bit 18) and Compare Phase (bit 17) bits are set in the DMA Byte Counter (DBC) register while the LSI53C1010R SCSI function is in target mode.

- During a Transfer Control instruction, the Carry Test bit (bit 21) is set and either the Compare Data (bit 18) or Compare Phase (bit 17) bit is set.

- A Transfer Control instruction is executed with the Wait for Valid phase bit (bit 16) set while the chip is in the target mode.

- A Load and Store instruction is issued with the memory address mapped to the operating registers of the chip, not including ROM or RAM.

- A Load and Store instruction is issued when the register address is not aligned with the memory address.

- A Load and Store instruction is issued with bit 5 in the DMA Command (DCMD) register cleared or bits 3 or 2 set.

- A Load and Store instruction is issued when the count value in the DMA Byte Counter (DBC) register is not set at 1, 2, 3, or 4.

- A Load and Store instruction attempts to cross a Dword boundary.

- A Memory Move instruction is executed with one of the reserved bits in the DMA Command (DCMD) register set.

- A Memory Move instruction is executed with the source and destination addresses not aligned.

- A 64-bit Table Indirect Block Move instruction is executed with a selector index value greater than 0x16.

- If the Select with ATN/ bit, bit 24, is set for any I/O instruction other than a Select instruction.

Register: 0x0D
SCSI Status Zero (SSTAT0)
Read Only

7	6	5	4	3	2	1	0
ILF	R	OLF	ARBIP	LOA	WOA	RST	SDP0
0	0	0	0	0	0	0	0

ILF **SIDL Least Significant Byte Full** **7**
This bit is set when the least significant byte in the SCSI Input Data Latch (SIDL) contains data. Data is transferred from the SCSI bus to the SCSI Input Data Latch register before being sent to the DMA FIFO and then to the host bus. The SCSI Input Data Latch (SIDL) register contains SCSI data received asynchronously. Synchronous data received does not flow through this register.

R **Reserved** **6**

OLF **SODL Least Significant Byte Full** **5**
This bit is set when the least significant byte in the SCSI Output Data Latch (SODL) contains data. The SODL register is the interface between the DMA logic and the SCSI bus for asynchronous send operations. In the asynchronous mode, data is transferred from the host bus to the SODL register, and then to the SCSI bus. It is possible to use this bit to determine how many bytes reside in the device when an error occurs.

ARBIP **Arbitration in Progress** **4**
Arbitration in Progress (ARBIP = 1) indicates that the LSI53C1010R SCSI function has detected a Bus Free condition, asserted SBSY, and asserted its SCSI ID onto the SCSI bus.

LOA **Lost Arbitration** **3**
When set, LOA indicates that the LSI53C1010R SCSI function has detected a bus free condition, arbitrated for the SCSI bus, and lost arbitration due to another SCSI device asserting the SSEL/ signal.

WOA **Won Arbitration** **2**
When set, WOA indicates that the LSI53C1010R SCSI function has detected a Bus Free condition, arbitrated for

the SCSI bus and won arbitration. The arbitration mode selected in the SCSI Control Zero (SCNTL0) register must be full arbitration and selection to set this bit.

RST   **SCSI RST/ Signal**   **1**

This bit reports the current status of the SCSI RST/ signal, and the RST signal (bit 3) in the SCSI Control One (SCNTL1) register. This bit is not latched and may change as it is read.

SDP0   **SCSI SDP0 Parity Signal**   **0**

This bit represents the present state of the SCSI SDP0/ parity signal. This signal is not latched and may change as it is read.

Register: 0x0E
SCSI Status One (SSTAT1)
Read Only

7			4	3	2	1	0
R				SDP0L	MSG	C_D	I_O
0	0	0	0	x	x	x	x

R   **Reserved**   **[7:4]**

SDP0L   **Latched SCSI Parity**   **3**

This bit reflects the SCSI parity signal (SDP0/) corresponding to the data latched in the SCSI Input Data Latch (SIDL). It changes when a new byte is latched into the least significant byte of the SIDL register. This bit is active HIGH, in other words, it is set when the parity signal is active.

MSG   **SCSI MSG/ Signal**   **2**

This SCSI phase status bit is latched on the asserting edge of SREQ/ when operating in either the initiator or target mode. This bit is set when the corresponding signal is active. This bit is useful when operating in the low level mode.

C_D   **SCSI C_D/ Signal**   **1**

This SCSI phase status bit is latched on the asserting edge of SREQ/ when operating in either the initiator or target mode. This bit is set when the corresponding signal is active. This bit is useful when operating in the low level mode.

I_O   **SCSI I_O/ Signal**   **0**

This SCSI phase status bit is latched on the asserting edge of SREQ/ when operating in either the initiator or target mode. This bit is set when the corresponding signal is active. This bit is useful when operating in the low level mode.

Register: 0x0F
SCSI Status Two (SSTAT2)
Read Only

7	6	5	4	3	2	1	0
ILF1	R	OLF1	R	SPL1	R	LDSC	SDP1
0	0	0	0	x	0	1	x

ILF1   **SIDL Most Significant Byte Full**   **7**

This bit is set when the most significant byte in the SCSI Input Data Latch (SIDL) contains data. Data is transferred from the SCSI bus to the SCSI Input Data Latch register before being sent to the DMA FIFO. The data is then sent to the host bus. The SIDL register contains SCSI data received asynchronously. Synchronous data received does not flow through this register.

R   **Reserved**   **6**

OLF1   **SODL Most Significant Byte Full**   **5**

This bit is set when the most significant byte in the SCSI Output Data Latch (SODL) contains data. The SODL register is the interface between the DMA logic and the SCSI bus for asynchronous send operations. In the asynchronous mode, data is transferred from the host bus to the SCSI Output Data Latch (SODL) register, and then to the SCSI bus. This bit can be used to determine how many bytes reside in the device when an error occurs.

R	**Reserved**	**4**

SPL1   **Latched SCSI Parity for SD[15:8]**   **3**

This active HIGH bit reflects the SCSI odd parity signal corresponding to the data latched into the most significant byte in the SCSI Input Data Latch (SIDL) register.

R	**Reserved**	**2**

LDSC   **Last Disconnect**   **1**

This bit is used in conjunction with the Connected (CON) bit in SCSI Control One (SCNTL1). It allows the user to detect the case in which a target device disconnects, and then a SCSI device selects or reselects the LSI53C1010R SCSI function. If the Connected bit and the LDSC bit are asserted, a disconnect is indicated. This bit is set when the Connected bit in SCNTL1 is off. This bit is cleared when a Block Move instruction is executed while the Connected bit in SCNTL1 is set.

SDP1   **SCSI SDP1 Parity Signal**   **0**

This bit represents the present state of the SCSI SDP1/ parity signal. It is not latched and may change as it is read.

Registers: 0x10–0x13
Data Structure Address (DSA)
Read/Write

31																															0
														DSA																	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
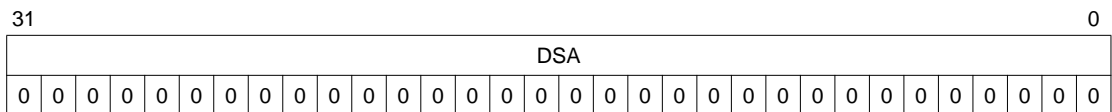
DSA   **Data Structure Address**   **[31:0]**

This 32-bit register contains the base address used for all Table Indirect calculations. The DSA register is usually loaded prior to starting an I/O, but it is possible for a SCRIPTS Memory Move to load the DSA during the I/O.

During any Memory-to-Memory Moves operation, the contents of this register are preserved. The power-up value of this register is indeterminate.

Register: 0x14
Interrupt Status Zero (ISTAT0)
Read/Write

7	6	5	4	3	2	1	0
ABRT	SRST	SIGP	SEM	CON	INTF	SIP	DIP
0	0	0	0	0	0	0	0

This is the only register that is accessible by the host CPU while a LSI53C1010R SCSI function is executing SCRIPTS (without interfering in the operation of the function). It is used to poll for interrupts if hardware interrupts are disabled. Read this register after servicing an interrupt to check for stacked interrupts.

ABRT   **Abort Operation**   **7**
Setting this bit aborts the current operation under execution by the LSI53C1010R SCSI function. If this bit is set and an interrupt is received, clear this bit before reading the DMA Status (DSTAT) register to prevent further aborted interrupts from being generated. The sequence to abort any operation is:

1. Set this bit.

2. Wait for an interrupt.

3. Read the Interrupt Status Zero (ISTAT0) register.

4. If the SCSI Interrupt Pending bit is set, read the SCSI Interrupt Status Zero (SIST0) or SCSI Interrupt Status One (SIST1) register to determine the cause of the SCSI Interrupt and return to Step 2.

5. If the SCSI Interrupt Pending bit is cleared and the DMA Interrupt Pending bit is set, write 0x00 to this register.

6. Read the DMA Status (DSTAT) register to verify the aborted interrupt and to determine if any other interrupting conditions have occurred.

SRST   **Software Reset**   **6**
Setting this bit resets the LSI53C1010R SCSI function. All operating registers are cleared to their respective default values and all SCSI signals are deasserted. Setting this bit does not assert the SCSI RST/ signal.

This reset does not clear the ID Mode bit or any of the
PCI configuration registers. This bit is not self-clearing; it
must be cleared to clear the reset condition. A hardware
reset also clears this bit.

Note: If SCRIPTS are running, then the ABRT bit (bit 7) must be
set prior to setting the SRST bit.

SIGP   **Signal Process**   **5**
SIGP is a R/W bit that is writable at any time. It is polled
and reset using Chip Test Two (CTEST2). The SIGP bit
is used in various ways to pass a flag to or from a running
SCRIPTS instruction.

The only SCRIPTS instruction directly affected by the
SIGP bit is Wait For Selection/Reselection. Setting the
SIGP bit causes this instruction to jump to the alternate
address immediately. The instructions at the alternate
jump address should check the status of SIGP to
determine the cause of the jump. The SIGP bit is usable
at any time and is not restricted to the wait for
selection/reselection condition.

SEM   **Semaphore**   **4**
The SCRIPTS processor may set this bit using a
SCRIPTS register write instruction. An external processor
may also set it while the LSI53C1010R SCSI function is
executing a SCRIPTS operation. This bit enables the
SCSI function to notify an external processor of a
predefined condition while SCRIPTS are running. The
external processor may also notify the LSI53C1010R
SCSI function of a predefined condition and the
SCRIPTS processor may take action while SCRIPTS are
executing.

CON   **Connected**   **3**
This bit is automatically set any time the LSI53C1010R
SCSI function is connected to the SCSI bus as an initiator
or as a target. It is set after successfully completing
selection or when the LSI53C1010R SCSI function
responds to a bus-initiated selection or reselection. It is
also set after the SCSI function wins arbitration when
operating in the low level mode. When this bit is cleared,
the LSI53C1010R SCSI function is not connected to the
SCSI bus.

INTF   **Interrupt-on-the-Fly**   **2**
This bit is asserted by an INTFLY instruction during
SCRIPTS execution. SCRIPTS programs do not halt
when the interrupt occurs. This bit can be used to notify
a service routine, running on the main processor while
the SCRIPTS processor is still executing a SCRIPTS
program. If this bit is set, when the Interrupt Status Zero
(ISTAT0) register is read it is not automatically cleared. To
clear this bit, write a one to it. The reset operation is
self-clearing.

Note: If the INTF bit is set but SIP or DIP is not set, do not
attempt to read the other chip status registers. An
interrupt-on-the-fly must be cleared before servicing any
other interrupts indicated by SIP or DIP.

After it has been set, this bit must be written to one to clear it.

SIP   **SCSI Interrupt Pending**   **1**
This status bit is set when an interrupt condition is
detected in the SCSI portion of the LSI53C1010R SCSI
function. The following conditions cause a SCSI interrupt
to occur:

- A phase mismatch (initiator mode) or SATN/ becomes
  active (target mode)

- An arbitration sequence completes

- A selection or reselection time-out occurs

- The LSI53C1010R SCSI function is selected

- The LSI53C1010R SCSI function is reselected

- A SCSI gross error occurs

- An unexpected disconnect occurs

- A SCSI reset occurs

- A parity error is detected

- The handshake-to-handshake timer expires

- The general purpose timer expires

To determine which condition(s) caused the
interrupt, read the SCSI Interrupt Status Zero (SIST0)
and SCSI Interrupt Status One (SIST1) registers.

DIP   **DMA Interrupt Pending**   **0**
This status bit is set when an interrupt condition is
detected in the DMA portion of the LSI53C1010R SCSI
function. The following conditions cause a DMA interrupt
to occur:

- A PCI parity error is detected

- A bus fault is detected

- An abort condition is detected

- A SCRIPTS instruction is executed in the single-step
  mode

- A SCRIPTS interrupt instruction is executed

- An illegal instruction is detected

To determine exactly which condition(s) caused the
interrupt, read the DMA Status (DSTAT) register.

Register: 0x15
Interrupt Status One (ISTAT1)
Read/Write

7				3	2	1	0
R					FLSH	SRUN	SI
0	0	0	0	0	0	0	0

R   **Reserved**   **[7:3]**

FLSH   **Flushing**   **2**
If this bit is set, the chip is flushing data from the DMA
FIFO. If cleared, no flushing is occurring. This bit is read
only. Writes do not affect the value of this bit.

SRUN   **SCRIPTS Running**   **1**
If this bit is set, the SCRIPTS engine is currently fetching
and executing SCRIPTS instructions. If it is cleared, the
SCRIPTS engine is not active. This bit is read only.
Writes do not affect the value of this bit.

SI   **SYNC_IRQD**   **0**
Setting this bit disables the INTA/ pin for Function A and
the INTB/ pin for Function B, except for the SCSI gross
error, bus fault, residual data in SCSI FIFO, and data
underflow interrupts. Clearing this bit enables normal

operation of the INTA/ (or INTB/) pin. If the INTA/ (or INTB/) is already asserted and this bit is set, INT remains asserted until the interrupt is serviced. At this point the interrupt line is blocked for future interrupts until this bit is cleared. In addition, this bit may be read and written while SCRIPTS are executing.

Register: 0x16
Mailbox Zero (MBOX0)
Read/Write

7							0
MBOX0							
0	0	0	0	0	0	0	0

MBOX0   **Mailbox Zero**   **[7:0]**
These are general purpose bits that may be read or written while SCRIPTS are running. They also may be read or written by the SCRIPTS processor.

Note: The host and the SCRIPTS processor code could access the same mailbox byte at the same time. Using one mailbox register as read only and the other as write only prevents this conflict.

Register: 0x17
Mailbox One (MBOX1)
Read/Write

7							0
MBOX1							
0	0	0	0	0	0	0	0

MBOX1   **Mailbox One**   **[7:0]**
These are general purpose bits that may be read or written while SCRIPTS are running. They also may be read or written by the SCRIPTS processor.

Note: The host and the SCRIPTS processor code could access the same mailbox byte at the same time. Using one mailbox register as read only and the other as write only prevents this conflict.

Register: 0x18
Chip Test Zero (CTEST0)
Read/Write

7							0
FMT							
1	1	1	1	1	1	1	1

FMT **Byte Empty in DMA FIFO** **[7:0]**
These bits identify the lower bytes in the DMA FIFO that are empty. Each bit corresponds to a byte lane in the DMA FIFO. For example, if byte lane three is empty, then FMT bit 3 is set. The FMT flags indicate the status of bytes at the bottom of the FIFO. Therefore, if all FMT bits are set, the DMA FIFO is empty.

Register: 0x19
Chip Test One (CTEST1)
Read Only

7							0
FFL							
0	0	0	0	0	0	0	0

FFL **Byte Full in DMA FIFO** **[7:0]**
These status bits identify the upper bytes in the DMA FIFO that are full. Each bit corresponds to a byte lane in the DMA FIFO. For example, if byte lane three is full then FFL bit 3 is set. The FFL flags indicate the status of bytes at the top of the FIFO. Therefore, if all FFL bits are set, the DMA FIFO is full.

Register: 0x1A
Chip Test Two (CTEST2)
Read Only (bit 3 write)

7	6	5	4	3	2		0
R	SIGP	CIO	CM	PCICIE	R		
x	0	x	x	0	x	x	x

R　　　　　　　**Reserved**　　　　　　　　　　　　　　　　　　**7**

SIGP　　　　　**Signal Process**　　　　　　　　　　　　　　　　**6**
This bit is a copy of the SIGP bit in the Interrupt Status Zero (ISTAT0) register (bit 5). The SIGP bit is used to signal a running SCRIPTS instruction. When this register is read, the SIGP bit in the ISTAT0 register is cleared.

CIO　　　　　　**Configured as I/O**　　　　　　　　　　　　　　**5**
This bit is defined as the Configuration I/O Enable Status bit. This read only bit indicates if the chip is currently enabled as I/O space.

CM　　　　　　 **Configured as Memory**　　　　　　　　　　　 **4**
This bit is defined as the configuration memory enable status bit. This read only bit indicates if the chip is currently enabled as memory space.

　Note:　Bits 4 and 5 may be set if the chip is mapped in both I/O and memory space. Also, bits 4 and 5 may be set if the chip is dual-mapped.

PCICIE　　　　**PCI Configuration Info Enable**　　　　　　　　**3**
This bit controls the shadowing of the PCI Base Address Register One (BAR1) (MEMORY), PCI Base Address Register Two (BAR2) (MEMORY), PCI Base Address Register Three (BAR3) (SCRIPTS RAM), PCI Base Address Register Four (BAR4) (SCRIPTS RAM), PCI Device ID, and PCI Revision ID (RID) into the Scratch Register A (SCRATCHA), Memory Move Read Selector (MMRS), Scratch Register B (SCRATCHB), Memory Move Write Selector (MMWS), and SCRIPT Fetch Selector (SFS) registers.

When it is set, MMWS contains bits [63:32] and SCRATCH B contains bits [31:0] of the RAM Base Address value from the PCI Configuration Base Address

Register Three (BAR3) (SCRIPTS RAM) and Base
Address Register Four (BAR4) (SCRIPTS RAM). This is
the base address for the 8 Kbytes of internal RAM.

Memory Move Read Selector (MMRS) contains bits
[63:32] and Scratch Register A (SCRATCHA) contains
bits [31:0] of the memory mapped operating register base
address. Bits [23:16] of SCRIPT Fetch Selector (SFS)
contain the PCI Revision ID (RID) register value and
bits [15:0] contain the PCI Device ID register value. When
this bit is set, only reads to the registers are affected,
writes occur normally.

When this bit is cleared, the SCRATCH A, MMRS,
SCRATCH B, MMWS, and SFS registers return to normal
operation.

Note: Bit 3 is the only writable bit in this register. All other bits are
read only. When modifying this register, all other bits must
be written to zero. Do not execute a Read-Modify-Write to
this register.

R   **Reserved**   **[2:0]**

Register: 0x1B
Chip Test Three (CTEST3)
Read/Write

7			4	3	2	1	0
		R		FLF	CLF	R	WRIE
0	0	0	0	0	0	0	0

R   **Reserved**   **[7:4]**

FLF   **Flush DMA FIFO**   **3**
When this bit is set, data residing in the DMA FIFO is
transferred to memory, starting at the address in the DMA
Next Address (DNAD) register. This bit is not
self-clearing; clear it once the data is successfully
transferred by the LSI53C1010R SCSI function.

Note: Polling of FIFO flags is allowed during flush operations.

| **CLF** | **Clear DMA FIFO** | **2** |

When this bit is set, all data pointers for the DMA FIFO are cleared. Any data in the FIFO is lost. After the LSI53C1010R SCSI function successfully clears the appropriate FIFO pointers and registers, this bit automatically clears.

Note: This bit does not clear the data visible at the bottom of the FIFO.

| **R** | **Reserved** | **1** |

| **WRIE** | **Write and Invalidate Enable** | **0** |

This bit, when set, causes the issuing of Write and Invalidate commands on the PCI bus whenever legal. The Write and Invalidate Enable bit in the PCI Configuration Command register must also be set for the chip to generate Write and Invalidate commands.

Registers: 0x1C–0x1F
Temporary (TEMP)
Read/Write

31																															0
															TEMP																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

| **TEMP** | **Temporary** | **[31:0]** |

This 32-bit register stores the Return instruction address pointer from the Call instruction. The address pointer stored in this register is loaded into the DMA SCRIPTS Pointer (DSP) register when a Return instruction is executed. This address points to the next instruction to execute. Do not write to this register while the LSI53C1010R SCSI function is executing SCRIPTS.

During any Memory-to-Memory Moves operation, the contents of this register are preserved. The power-up value of this register is indeterminate.

Register: 0x20
Reserved

7							0
R							
x	x	x	x	x	x	x	x

This register is reserved.

Register: 0x21
Chip Test Four (CTEST4)
Read/Write

7	6	5	4	3	2		0
R	FBL3	R		MPEE	FBL[2:0]		
0	0	0	0	0	0	0	0

R　　　　　　　**Reserved**　　　　　　　　　　　　　　　**7**

FBL3　　　　　**FIFO Byte Control 3**　　　　　　　　　**6**
This bit is used with FBL[2:0]. See Bits [2:0] description in this register.

R　　　　　　　**Reserved**　　　　　　　　　　　　　　**[5:4]**

MPEE　　　　　**Master Parity Error Enable**　　　　　**3**
Setting this bit enables parity checking during master data phases. A parity error during a bus master read is detected by the LSI53C1010R SCSI function. A parity error during a bus master write is detected by the target, and the LSI53C1010R SCSI function is informed of the error by the PERR/ pin being asserted by the target. When this bit is cleared, the LSI53C1010R SCSI function does not interrupt if a master parity error occurs. This bit is cleared at power-up.

FBL[2:0]　　　**FIFO Byte Control**　　　　　　　　　**[2:0]**

FBL3	FBL2	FBL1	FBL0	DMA FIFO Byte Lane	Pins
0	x	x	x	Disabled	N/A
1	0	0	0	0	D[7:0]
1	0	0	1	1	D[15:8]

FBL3	FBL2	FBL1	FBL0	DMA FIFO Byte Lane	Pins
1	0	1	0	2	D[23:16]
1	0	1	1	3	D[31:24]
1	1	0	0	4	D[39:32]
1	1	0	1	5	D[47:40]
1	1	1	0	6	D[53:48]
1	1	1	1	7	D[63:54]

These bits steer the contents of the Chip Test Six (CTEST6) register to the appropriate byte lane of the 64-bit DMA FIFO. If the FBL3 bit is set, then FBL2 through FBL0 determine which of eight byte lanes can be read or written. When cleared, the byte lane read or written is determined by the current contents of the DMA Next Address (DNAD) and DMA Byte Counter (DBC) registers. Each of the eight bytes that make up the 64-bit DMA FIFO is accessed by writing these bits to the proper value. For normal operation, FBL3 must equal zero.

Register: 0x22
Chip Test Five (CTEST5)
Read/Write

7	6	5		3	2	1	0
ADCK	BBCK	R			BL2	R	
0	0	0	0	0	0	0	0

ADCK   **Clock Address Incrementor**   **7**
Setting this bit increments the address pointer contained in the DMA Next Address (DNAD) register. The DNAD register is incremented based on the DNAD contents and the current DMA Byte Counter (DBC) value. This bit automatically clears itself after incrementing the DNAD register.

BBCK   **Clock Byte Counter**   **6**

Setting this bit decrements the byte count contained in the 24-bit DMA Byte Counter (DBC) register. It is decremented based on the DBC contents and the current DMA Next Address (DNAD) value. This bit automatically clears itself after decrementing the DBC register.

R   **Reserved**   **[5:3]**

BL2   **Burst Length Bit 2**   **2**

This bit works with bits 6 and 7 (BL[1:0]) in the DMA Mode (DMODE) register to determine the burst length. For complete definitions of this field, refer to the descriptions of DMODE bits 6 and 7.

R   **Reserved**   **[1:0]**

Register: 0x23
Chip Test Six (CTEST6)
Read/Write

7							0
DF							
0	0	0	0	0	0	0	0

DF   **DMA FIFO**   **[7:0]**

Writing to this register writes data to the appropriate byte lane of the DMA FIFO, as determined by the FBL bits in the Chip Test Four (CTEST4) register. Reading this register unloads data from the appropriate byte lane of the DMA FIFO, as determined by the FBL bits in the CTEST4 register. Data written to the FIFO is loaded into the top of the FIFO. Data read out of the FIFO is taken from the bottom. To prevent DMA data from being corrupted, this register should not be accessed before starting or restarting SCRIPTS operations. This register should be the last register read when performing register dumps because of its effects on other registers. Write to this register only when testing the DMA FIFO using the CTEST4 register. Writing to this register while the test mode is not enabled produces unexpected results.

Registers: 0x24–0x26
DMA Byte Counter (DBC)
Read/Write

23																							0
										DBC													
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DBC　　　　　**DMA Byte Counter**　　　　　　　　　　**[23:0]**

This 24-bit register determines the number of bytes transferred in a Block Move instruction. While sending data to the SCSI bus, the counter is decremented as data is moved into the DMA FIFO from memory. While receiving data from the SCSI bus, the counter is decremented as data is written to memory from the LSI53C1010R SCSI function. The DBC counter is decremented each time data is transferred on the PCI bus. It is decremented by an amount equal to the number of bytes transferred.

The maximum number of bytes transferred in any one Block Move command is 16,777,215 bytes. The maximum value that can be loaded into the DMA Byte Counter (DBC) register is 0xFFFFFF. If the instruction is a Block Move and a value of 0x000000 is loaded into the DBC register, an illegal instruction interrupt occurs if the LSI53C1010R SCSI function is not in the target mode, Command phase.

The DMA Byte Counter (DBC) register is also used to hold the least significant 24-bits of the first Dword of a SCRIPTS fetch, and to hold the offset value during Table Indirect I/O SCRIPTS. For a complete description see Chapter 5, "SCSI SCRIPTS Instruction Set." The power-up value of this register is indeterminate.

Register: 0x27
DMA Command (DCMD)
Read/Write

7							0
DCMD							
0	0	0	0	0	0	0	0

DCMD   **DMA Command**   **[7:0]**
This 8-bit register determines the instruction for the
LSI53C1010R SCSI function to execute. This register has
a different format for each instruction. For a complete
description see Chapter 5, "SCSI SCRIPTS Instruction
Set."

Registers: 0x28–0x2B
DMA Next Address (DNAD)
Read/Write

31																															0
DNAD																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DNAD   **DMA Next Address**   **[31:0]**
This 32-bit register contains the general purpose address
pointer. At the start of some SCRIPTS operations, its
value is copied from the DMA SCRIPTS Pointer Save
(DSPS) register. Its value may not be valid except in
certain abort conditions. The default value of this register
is zero.

Registers: 0x2C–0x2F
DMA SCRIPTS Pointer (DSP)
Read/Write

31   0

DSP
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
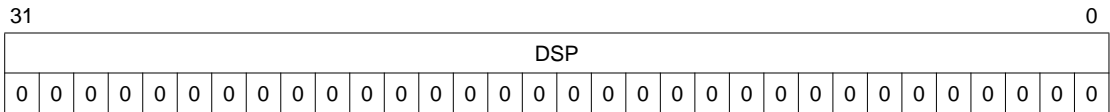
DSP **DMA SCRIPTS Pointer** **[31:0]**

To execute SCSI SCRIPTS, the address of the first SCRIPTS instruction must be written to this register. In normal SCRIPTS operation, once the starting address of the SCRIPT is written to this register, SCRIPTS are automatically fetched and executed until an interrupt condition occurs.

In the single-step mode, there is a single step interrupt after each instruction is executed. The DMA SCRIPTS Pointer (DSP) register does not need to be written with the next address. However, to fetch and execute the next SCRIPTS command, the Start DMA bit (bit 2, DMA Control (DCNTL) register) must be set each time the step interrupt occurs. When writing this register eight bits at a time, writing the upper eight bits begins execution of SCSI SCRIPTS. The default value of this register is zero.

Registers: 0x30–0x33
DMA SCRIPTS Pointer Save (DSPS)
Read/Write

31   0

DSPS
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
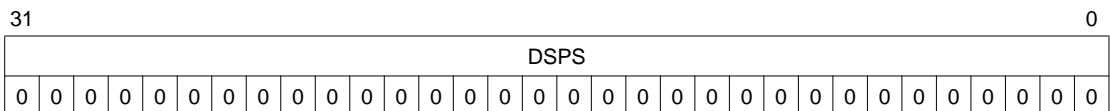
DSPS **DMA SCRIPTS Pointer Save** **[31:0]**

This register contains the second Dword of a SCRIPTS instruction. It is overwritten each time a SCRIPTS instruction is fetched. When a SCRIPTS interrupt instruction is executed, this register holds the interrupt vector. The power-up value of this register is indeterminate.

Registers: 0x34–0x37
Scratch Register A (SCRATCHA)
Read/Write

31																															0
															SCRATCHA																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SCRATCHA **Scratch Register A** **[31:0]**

This is a general purpose, user-definable scratch pad register. Apart from CPU access, only register read/write and Memory Moves into the SCRATCH register alter its contents. The power-up value of this register is indeterminate.

A special mode of this register is enabled by setting the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register. If this bit is set, Scratch Register A (SCRATCHA) returns bits [31:10] of the PCI Base Address Register One (BAR1) (MEMORY) in bits [31:10]. Bits [9:0] of SCRATCH A will always return zero in this mode. Writes to the SCRATCHA register have no effect. Clearing the PCI Configuration Info Enable bit causes the SCRATCH A register to return to normal operation.

Register: 0x38
DMA Mode (DMODE)
Read/Write

7	6	5	4	3	2	1	0
BL[1:0]		SIOM	DIOM	ERL	ERMP	BOF	MAN
0	0	0	0	0	0	0	0

BL[1:0] **Burst Length** **[7:6]**

These bits control the maximum number of Dwords transferred per bus ownership, regardless of whether the transfers are back-to-back, burst, or a combination of both. This value is also independent of the width (64-bit or 32-bit) of the data transfer on the PCI bus. The LSI53C1010R SCSI function asserts the Bus Request (PCIREQ/) output when the DMA FIFO can accommodate a transfer of at least one burst threshold of data. Bus Request (PCIREQ/) is also asserted during

start-of-transfer and end-of-transfer cleanup and alignment, even if less than a full burst of transfers is performed. The LSI53C1010R SCSI function inserts a "fairness delay" of four CLKs between burst transfers (set in BL[2:0]) during normal operation. The fairness delay is not inserted during PCI retry cycles. This gives the CPU and other bus master devices the opportunity to access the PCI bus between bursts.

BL2 (CTEST5 Bit 2)	BL1	BL0	Number of 64-Bit Transfers	Number of 32-Bit Transfers
0	0	0	4	8
0	0	1	4	8
0	1	0	8	16
0	1	1	16	32
1	0	0	32	64
1	0	1	64	128
1	1	0	64	128
1	1	1	Reserved	Reserved

SIOM   **Source I/O-Memory Enable**   **5**

This bit is defined as an I/O Memory Enable bit for the source address of a Memory Move or Block Move Command. If this bit is set, then the source address is in I/O space; if cleared, the source address is in memory space.

This function is useful for register-to-memory operations using the Memory Move instruction when a LSI53C1010R SCSI function is I/O mapped. Bits 4 and 5 of the Chip Test Two (CTEST2) register are used to determine the configuration status of the LSI53C1010R SCSI function.

DIOM   **Destination I/O-Memory Enable**   **4**

This bit is defined as an I/O Memory Enable bit for the destination address of a Memory Move or Block Move Command. If this bit is set, then the destination address is in I/O space; if cleared, the destination address is in memory space.

This function is useful for memory-to-register operations using the Memory Move instruction when a LSI53C1010R SCSI function is I/O mapped. Bits 4 and 5 of the Chip Test Two (CTEST2) register are used to determine the configuration status of the LSI53C1010R SCSI function.

ERL   **Enable Read Line**   **3**
This bit enables a PCI Read Line command. If this bit is set and the chip is about to execute a read cycle (other than an opcode fetch), the command is 0b1110.

ERMP   **Enable Read Multiple**   **2**
If this bit is set and cache mode is enabled, a Read Multiple command is used on all read cycles when it is legal.

BOF   **Burst Opcode Fetch Enable**   **1**
Setting this bit causes the LSI53C1010R SCSI function to fetch instructions in burst mode. Specifically, the chip bursts in the first two Dwords of all instructions using a single bus ownership. If the instruction is a Memory-to-Memory Moves type, the third Dword is accessed in a subsequent bus ownership. If the instruction is an indirect type, the additional Dword is accessed in a subsequent bus ownership. If the instruction is a table indirect block move type, the chip accesses the remaining two Dwords in a subsequent bus ownership, thereby fetching the four Dwords required in two bursts of two Dwords each. If prefetch is enabled, this bit has no affect. This bit also has no affect on fetches out of SCRIPTS RAM.

MAN   **Manual Start Mode**   **0**
Setting this bit prevents the LSI53C1010R SCSI function from automatically fetching and executing SCSI SCRIPTS when the DMA SCRIPTS Pointer (DSP) register is written. When this bit is set, the Start DMA bit in the DMA Control (DCNTL) register must be set to begin SCRIPTS execution. Clearing this bit causes the LSI53C1010R SCSI function to automatically begin fetching and executing SCSI SCRIPTS when the DMA SCRIPTS Pointer (DSP) register is written. This bit normally is not used for SCSI SCRIPTS operations.

Register: 0x39
DMA Interrupt Enable (DIEN)
Read/Write

7	6	5	4	3	2	1	0
R	MDPE	BF	ABRT	SSI	SIR	R	IID
x	0	0	0	0	0	x	0

This register contains the interrupt mask bits corresponding to the interrupting conditions described in the DMA Status (DSTAT) register. An interrupt is masked by clearing the appropriate mask bit. Masking an interrupt prevents INTA/ (for Function A) or INTB/ (for Function B) from being asserted for the corresponding interrupt, but the status bit is still set in the DMA Status (DSTAT) register. Masking an interrupt does not prevent setting the Interrupt Status Zero (ISTAT0) DIP. All DMA interrupts are considered fatal. Therefore, SCRIPTS halts when this condition occurs, whether or not the interrupt is masked. Setting a mask bit enables the assertion of INTA/, or INTB/, for the corresponding interrupt. A masked nonfatal interrupt does not prevent unmasked or fatal interrupts from getting through; interrupt stacking begins when either the Interrupt Status Zero (ISTAT0) SIP or DIP bit is set.

The INTA/ and INTB/ outputs are latched. Once asserted, they remain asserted until the interrupt is cleared by reading the appropriate status register. Masking an interrupt after the INTA/, or INTB/, output is asserted does not cause deassertion of INTA/ or INTB/. For more information on interrupts, see Chapter 2, "Functional Description."

R	**Reserved**	**7**
MDPE	**Master Data Parity Error**	**6**
BF	**Bus Fault**	**5**
ABRT	**Aborted**	**4**
SSI	**Single Step Interrupt**	**3**
SIR	**SCRIPTS Interrupt Instruction Received**	**2**
R	**Reserved**	**1**
IID	**Illegal Instruction Detected**	**0**

Register: 0x3A
Scratch Byte Register (SBR)
Read/Write

7							0
SBR							
0	0	0	0	0	0	0	0

SBR   **Scratch Byte Register**   **[7:0]**
This is a general purpose register. Apart from CPU access, only register Read/Write and Memory Moves into this register alter its contents. The default value of this register is zero. This register is called the DMA Watchdog Timer on previous LSI53C8XX family products.

Register: 0x3B
DMA Control (DCNTL)
Read/Write

7	6	5	4	3	2	1	0
CLSE	PFF	PFEN	SSM	IRQM	STD	R	COM
0	0	0	0	0	0	0	0

CLSE   **Cache Line Size Enable**   **7**
Setting this bit enables the LSI53C1010R SCSI function to sense and react to cache line boundaries set up by the DMA Mode (DMODE) or PCI Cache Line Size (CLS) register, whichever contains the smaller value. Clearing this bit disables the cache line size logic.

PFF   **Prefetch Flush**   **6**
Setting this bit causes the prefetch unit to flush its contents. This bit clears after the flush is complete.

PFEN   **Prefetch Enable**   **5**
Setting this bit enables an 8-Dword SCRIPTS instruction prefetch unit. The prefetch unit, when enabled, fetches 8 Dwords of instructions and instruction operands in bursts of 4 or 8 Dwords. Prefetching instructions allows the LSI53C1010R SCSI function to make more efficient use of the system PCI bus, thus improving overall system performance. A flush occurs whenever the PFF bit is set,

on all transfer control instructions (when the transfer conditions are met), on writes to the DMA SCRIPTS Pointer (DSP), on regular MMOV instructions, and when an interrupt is generated. Based on the burst length as determined by the values in the DMA Mode (DMODE) register, the unit automatically determines the maximum burst size that it is capable of performing. If the burst threshold is set to 8 Dwords, the prefetch unit fetches instructions in two bursts of 4 Dwords. If the burst threshold is set to 16 Dwords or greater, the prefetch unit fetches instructions in one burst of 8 Dwords. Burst thresholds of less than 8 Dwords cause the prefetch unit to be disabled. PCI Cache commands (Read Line and Read Multiple) are issued if PCI caching is enabled. Prefetching from SCRIPTS RAM is not supported and is unnecessary due to the speed of the fetches. When fetching from SCRIPTS RAM, the setting of this bit has no effect on the fetch mechanism from SCRIPTS RAM. The prefetch unit does not support 64-bit data instruction fetches across the PCI bus. Prefetches of SCRIPTS instructions are 32-bits in width.

SSM   **Single-Step Mode**   **4**

Setting this bit causes the LSI53C1010R SCSI function to stop after executing each SCRIPTS instruction and to generate a single step interrupt. When this bit is cleared the LSI53C1010R SCSI function does not stop after each instruction. It continues fetching and executing instructions until an interrupt condition occurs. For normal SCSI SCRIPTS operation, keep this bit cleared. To restart the LSI53C1010R SCSI function after it generates a SCRIPTS Step interrupt, read the Interrupt Status Zero (ISTAT0) and DMA Status (DSTAT) registers to recognize and clear the interrupt. Then set the START DMA bit in this register.

IRQM   **IRQ Mode**   **3**

When set, this bit enables a totem pole driver for the INTA/, or INTB/ pin. When cleared, this bit enables an open drain driver for the INTA/, or INTB/, pin with an internal weak pull-up. The bit should remain cleared to retain full PCI compliance.

STD **Start DMA Operation** **2**

The LSI53C1010R SCSI function fetches a SCSI SCRIPTS instruction from the address contained in the DMA SCRIPTS Pointer (DSP) register when this bit is set. This bit is required if the LSI53C1010R SCSI function is in one of the following modes:

- Manual start mode – Bit 0 in the DMA Mode (DMODE) register is set

- Single-step mode – Bit 4 in the DMA Control (DCNTL) register is set

When the LSI53C1010R SCSI function is executing SCRIPTS in manual start mode, the Start DMA bit must be set to start instruction fetches, but need not be set again until an interrupt occurs. When the LSI53C1010R SCSI function is in the single-step mode, set the Start DMA bit to restart execution of SCRIPTS after a single-step interrupt.

R **Reserved** **1**

COM **LSI53C700 Family Compatibility** **0**

When the COM bit is cleared, the LSI53C1010R SCSI function behaves in a manner compatible with the LSI53C700 family; selection/reselection IDs are stored in both the SCSI Selector ID (SSID) and SCSI First Byte Received (SFBR) registers. This bit is not affected by a software reset.

If the COM bit is cleared, do not access this register using SCRIPTS operation as indeterminate operations may occur. This includes SCRIPTS Read/Write operations and conditional transfer control instructions that initialize the SCSI First Byte Received (SFBR) register.

When the COM bit is set, the ID is stored only in the SCSI Selector ID (SSID) register, protecting the SCSI First Byte Received (SFBR) from being overwritten if a selection /reselection occurs during a DMA register-to-register operation.

Registers: 0x3C–0x3F
Adder Sum Output (ADDER)
Read Only

31																															0
															ADDER																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ADDER **Adder Sum Output** **[31:0]**
This register contains the output of the internal adder, and is used primarily for test purposes. The power-up value for this register is indeterminate.

Register: 0x40
SCSI Interrupt Enable Zero (SIEN0)
Read/Write

7	6	5	4	3	2	1	0
M/A	CMP	SEL	RSL	SGE	UDC	RST	PAR
0	0	0	0	0	0	0	0

This register contains the interrupt mask bits corresponding to the interrupting conditions described in the SCSI Interrupt Status Zero (SIST0) register. An interrupt is masked by clearing the appropriate mask bit. For more information on interrupts see Chapter 2, "Functional Description."

M/A **SCSI Phase Mismatch - Initiator Mode;**
SCSI ATN Condition - Target Mode **7**
In the initiator mode, this bit is set when the SCSI phase asserted by the target and sampled during SREQ/ does not match the expected phase in the SCSI Output Control Latch (SOCL) register. This expected phase is automatically written by SCSI SCRIPTS. In the target mode, this bit is set when the initiator asserts SATN/. See the Disable Halt on Parity Error or SATN/ Condition bit in the SCSI Control One (SCNTL1) register for more information on when this status is actually raised.

CMP **Function Complete** **6**
When set, this bit indicates the full arbitration and selection sequence is completed.

SEL   **Selected**   **5**

When set, this bit indicates the LSI53C1010R SCSI function is selected by a SCSI initiator device. For this to occur, set the Enable Response to Selection bit in the SCSI Chip ID (SCID) register.

RSL   **Reselected**   **4**

When set, this bit indicates the LSI53C1010R SCSI function is reselected by a SCSI target device. For this to occur, set the Enable Response to Reselection bit in the SCSI Chip ID (SCID) register.

SGE   **SCSI Gross Error**   **3**

The following conditions are considered SCSI Gross Errors:

- Offset Underflow occurs in target mode when a SACK/ signal is received before the corresponding SREQ/ signal has been sent.

- Offset Overflow occurs in initiator mode when an SREQ/ signal is received and causes the maximum offset, as defined by the MO[5:0] bits in the SXFER register, to be exceeded.

- In initiator mode, a phase change occurs with an outstanding SREQ/SACK offset.

- Residual Data in SCSI FIFO occurs when a transfer other than Synchronous Data Received is started with data left in the SCSI Synchronous Receive FIFO.

- Multiple CRC Requests occur when, during a synchronous DT transfer, multiple CRC requests are received within the same offset.

- A request for a Pad CRC word is received without the subsequent CRC word requests.

- A phase change occurs without a CRC Request.

Note: Checking for this condition can be disabled by setting the DISCRC bit in the CRCCNTL0 register.

- An illegal Force CRC Request Block Move is executed.

- A SCRIPTS RAM parity error occurs.

Note: The Shadowed SCSI SGE Status 0 register indicates which condition caused an SGE SCSI interrupt. This register is shadowed behind the SCSI Interrupt Status Zero (SIST0) register. It can be accessed by setting bit 7, the Enable Shadowed SGE Register (ShSGE) bit, in the Chip Control Two (CCNTL2) register.

UDC   **Unexpected Disconnect**   **2**
This condition only occurs in the initiator mode. It happens when the target, which the LSI53C1010R SCSI function is connected to, unexpectedly disconnects from the SCSI bus. See the SCSI Disconnect Unexpected bit in the SCSI Control Two (SCNTL2) register for more information on expected versus unexpected disconnects. Any disconnect in the low level mode causes this condition.

RST   **SCSI Reset Condition**   **1**
Indicates assertion of the SRST/ signal by the LSI53C1010R SCSI function or any other SCSI device. This condition is edge-triggered, so multiple interrupts cannot occur because of a single SRST/ pulse.

PAR   **SCSI Parity/CRC/AIP Error**   **0**
This bit indicates the LSI53C1010R SCSI function detected a Parity/CRC/AIP error while receiving or sending SCSI data. See the Disable Halt on Parity/CRC/AIP error or SATN/ Condition bits in the SCNTL1 register for more information about when this condition is raised.

Register: 0x41
SCSI Interrupt Enable One (SIEN1)
Read/Write

7		5	4	3	2	1	0
R			SBMC	R	STO	GEN	HTH
x	x	x	0	x	0	0	0

This register contains the interrupt mask bits corresponding to the interrupting conditions described in the SCSI Interrupt Status One (SIST1) register. An interrupt is masked by clearing the appropriate mask bit. For more information on interrupts refer to Chapter 2, "Functional Description."

R	**Reserved**	**[7:5]**

SBMC   **SCSI Bus Mode Change**   **4**

Setting this bit allows the LSI53C1010R to generate an interrupt when the DIFFSENS pin detects a change in voltage level that indicates the SCSI bus has changed between SE, LVD, or HVD modes. For example, when this bit is cleared and the SCSI bus changes modes, IRQ/ does not assert and the SIP bit in the Interrupt Status Zero (ISTAT0) register is not set. However, bit 4 in the SCSI Interrupt Status One (SIST1) register is set. Setting this bit allows the interrupt to occur.

R   **Reserved**   **3**

STO   **Selection or Reselection Time-out**   **2**

This bit is set when the SCSI device which the LSI53C1010R SCSI function is attempting to select or reselect does not respond within the programmed time-out period. See the description of the SCSI Timer Zero (STIME0) register, bits [3:0], for more information on the time-out timer.

GEN   **General Purpose Timer Expired**   **1**

This bit is set when the general purpose timer expires. The time measured is the time between enabling and disabling of the timer. See the description of the SCSI Timer One (STIME1) register, bits [3:0], for more information on the general purpose timer.

HTH   **Handshake-to-Handshake Timer Expired**   **0**

This bit is set when the handshake-to-handshake timer expires. The time measured is the SCSI Request-to-Request (target) or Acknowledge-to-Acknowledge (initiator) period. See the description of the SCSI Timer Zero (STIME0) register, bits [7:4], for more information on the handshake-to-handshake timer.

Register: 0x42
SCSI Interrupt Status Zero (SIST0)
Read Only

7	6	5	4	3	2	1	0
M/A	CMP	SEL	RSL	SGE	UDC	RST	PAR
0	0	0	0	0	0	0	0

Reading the SCSI Interrupt Status Zero (SIST0) register returns the status of the various interrupt conditions, whether they are enabled in the SCSI Interrupt Enable Zero (SIEN0) register or not. Each bit set indicates occurrence of the corresponding condition. Reading the SIST0 clears the interrupt status.

Reading this register clears any bits that are set at the time the register is read, but does not necessarily clear the register because additional interrupts may be pending; the LSI53C1010R SCSI functions stack interrupts. SCSI interrupt conditions are individually masked through the SCSI Interrupt Enable Zero (SIEN0) register.

When performing consecutive 8-bit reads of the DMA Status (DSTAT), SCSI Interrupt Status Zero (SIST0), and SCSI Interrupt Status One (SIST1) registers (in any order), insert a delay equivalent to 12 clock periods between the reads to ensure the interrupts clear properly. Also, if reading the registers when both the Interrupt Status Zero (ISTAT0) SIP and DIP bits may not be set, read the SIST0 and SIST1 registers before the DSTAT register to avoid missing a SCSI interrupt. For more information on interrupts refer to Chapter 2, "Functional Description."

M/A **Initiator Mode: Phase Mismatch; Target Mode: SATN/ Active** **7**
In the initiator mode, this bit is set if the SCSI phase asserted by the target does not match the instruction. The phase is sampled when SREQ/ is asserted by the target. In the target mode, this bit is set when the SATN/ signal is asserted by the initiator.

CMP **Function Complete** **6**
This bit is set when an arbitration only or full arbitration sequence is completed.

SEL   **Selected**   **5**

This bit is set when the LSI53C1010R SCSI function is selected by another SCSI device. For the LSI53C1010R SCSI function to respond to selection attempts, the Enable Response to Selection bit must be set in the SCSI Chip ID (SCID) register. The Response ID Zero (RESPID0) and Response ID One (RESPID1) registers must hold the chip's ID.

RSL   **Reselected**   **4**

This bit is set when the LSI53C1010R SCSI function is reselected by another SCSI device. The Enable Response to Reselection bit must be set in the SCSI Chip ID (SCID) register (and the Response ID Zero (RESPID0) and Response ID One (RESPID1) registers must hold the chip's ID) for the LSI53C1010R SCSI function to respond to reselection attempts.

SGE   **SCSI Gross Error**   **3**

This bit is set when the LSI53C1010R SCSI function encounters a SCSI Gross Error condition. The following conditions can result in a SCSI Gross Error:

- Offset Underflow occurs in target mode when a SACK/ signal is received before the corresponding SREQ/ signal has been sent.

- Offset Overflow occurs in initiator mode when an SREQ/ signal is received and causes the maximum offset, as defined by the MO[5:0] bits in the SXFER register, to be exceeded.

- In initiator mode, a phase change occurs with an outstanding SREQ/SACK offset.

- Residual Data in SCSI FIFO occurs when a transfer other than Synchronous Data Received is started with data left in the SCSI Synchronous Receive FIFO.

- Multiple CRC Requests occur when, during a synchronous DT transfer, multiple CRC requests are received within the same offset.

- A request for a Pad CRC word is received without the subsequent CRC word requests.

- A phase change occurs without a CRC Request.

Note: Checking for this condition can be disabled by setting the DCRC bit in the CRCCNTL0 register.

- An illegal Force CRC Request Block Move is executed.
- A SCRIPTS RAM parity error occurs.

Note: The Shadowed SCSI SGE Status 0 register indicates which condition caused an SGE SCSI interrupt. This register is shadowed behind the SCSI Interrupt Status Zero (SIST0) register. It can be accessed by setting bit 7, the Enable Shadowed SGE Register (ShSGE) bit, in the Chip Control Two (CCNTL2) register.

UDC   **Unexpected Disconnect**   **2**

This bit is set when the LSI53C1010R SCSI function is operating in the initiator mode and the target device unexpectedly disconnects from the SCSI bus. This bit is only valid when the LSI53C1010R SCSI function operates in the initiator mode. When the SCSI function operates in the low level mode, any disconnect causes an interrupt, even a valid SCSI disconnect. This bit is also set if a selection time-out occurs. Since a selection time-out is not considered an expected disconnect, an unexpected disconnect may occur before, at the same time, or stacked after the STO interrupt.

RST   **SCSI RST/ Received**   **1**

This bit is set when the LSI53C1010R SCSI function detects an active SRST/ signal, whether the reset is generated external to the chip or caused by the Assert SRST/ bit in the SCSI Control One (SCNTL1) register. This SCSI reset detection logic is edge-sensitive, so that multiple interrupts are not generated for a single assertion of the SRST/ signal.

PAR   **Parity/CRC/AIP Error**   **0**

This bit indicates the LSI53C1010R SCSI function detected a Parity/CRC/AIP error while receiving or sending SCSI data. See the Disable Halt on Parity/CRC/AIP Error or SATN/ condition bit in the SCSI Control One (SCNTL1) register for more information about when this condition is actually raised.

Register: 0x43
SCSI Interrupt Status One (SIST1)
Read Only

7		5	4	3	2	1	0
R			SBMC	R	STO	GEN	HTH
0	0	0	0	0	0	0	0

Reading the SIST1 register returns the status of the various interrupt conditions, whether they are enabled in the SCSI Interrupt Enable One (SIEN1) register or not. Each bit set indicates an occurrence of the corresponding condition. Reading the SIST1 clears the interrupt condition.

R   **Reserved**   **[7:5]**

SBMC   **SCSI Bus Mode Change**   **4**
            This bit is set when the DIFFSENS pin detects a change in voltage level indicating the SCSI bus has switched between SE, LVD, or HVD modes.

R   **Reserved**   **3**

STO   **Selection or Reselection Time-Out**   **2**
            This bit is set when the SCSI device which the LSI53C1010R SCSI function is attempting to select or reselect does not respond within the programmed time-out period. See the description of the SCSI Timer Zero (STIME0) register, bits [3:0], for more information on the time-out timer.

GEN   **General Purpose Timer Expired**   **1**
            This bit is set when the general purpose timer expires. The time measured is the time between enabling and disabling of the timer. See the description of the SCSI Timer One (STIME1) register, bits [3:0], for more information on the general purpose timer.

HTH   **Handshake-to-Handshake Timer Expired**   **0**
            This bit is set when the handshake-to-handshake timer expires. The time measured is the SCSI Request-to-Request (target) or Acknowledge-to-Acknowledge

(initiator) period. See the description of the SCSI Timer Zero (STIME0) register, bits [7:4], for more information on the handshake-to-handshake timer.

Register: 0x44
Reserved

7							0
R							
x	x	x	x	x	x	x	x

This register is reserved.

Register: 0x45
SCSI Wide Residue (SWIDE)
Read/Write

7							0
SWIDE							
0	0	0	0	0	0	0	0

SWIDE   **SCSI Wide Residue**   **[7:0]**
After a wide SCSI data receive operation, this register contains a residual data byte if the last byte received was never sent across the DMA bus. It represents either the first data byte of a subsequent data transfer, a residue byte which should be cleared when an Ignore Wide Residue message is received, or an overrun data byte. The power-up value of this register is indeterminate.

Register: 0x46
Reserved

7							0
R							
x	x	x	x	x	x	x	x

This register is reserved.

Register: 0x47
General Purpose Pin Control (GPCNTL)
Read/Write

7	6	5	4			1	0
ME	FE	LEDC	GPIO[4:2]			GPIO[1:0]	
0	0	x	0	1	1	1	1

This register is used to determine if the pins controlled by the General Purpose (GPREG) register are inputs or outputs. Bits [4:0] in GPCNTL correspond to bits [4:0] in the GPREG register. When the bits are enabled as inputs, an internal pull-up is also enabled.

ME   **Master Enable**   **7**

When the ME bit is set, the bus master state of the device is presented on GPIO1. GPIO1 goes low when the part is a bus master. When set, the ME bit is independent of the setting of bit 1 (GPIO1). If the GPIO1 is configured as an input while the ME bit is set, the Master bit will still toggle the GPIO1 pin.

FE   **Fetch Enable**   **6**

If the FE bit is set, GPIO0 reflects when an internal opcode fetch is being performed. GPIO0 goes low when an opcode fetch is performed. When set, the FE bit is independent of the setting of bit 0 (GPIO0). If GPIO0 is configured as an input, the Fetch bit still toggles GPIO0.

LEDC   **LED_CNTL**   **5**

If the LED_CNTL bit is set GPIO0 reflects the state of the SCSI bus, connected (GPIO0 is low) or not connected (GPIO0 is high). This occurs if bit 6 (FE) is not set and the chip is not currently performing an EEPROM autodownload. This bit provides a hardware solution for driving an external SCSI activity LED.

GPIO[4:2]   **GPIO Enable**   **[4:2]**

The general purpose control corresponds to bits [4:2] in the General Purpose (GPREG) register and to the GPIO4–GPIO2 pins. GPIO4 powers-up as a general purpose output. GPIO[3:2] power-up as general purpose inputs.

GPIO[1:0]　　　**GPIO Enable**　　　　　　　　　　　　**[1:0]**

These bits are set at power-up causing the GPIO1 and GPIO0 pins to become inputs. Clearing these bits cause GPIO[1:0] to become outputs.

Register: 0x48
SCSI Timer Zero (STIME0)
Read/Write

7			4	3			0
	HTH[3:0]				SEL[3:0]		
0	0	0	0	0	0	0	0

HTH[3:0]　　　**Handshake-to-Handshake Timer Period**　　　**[7:4]**

These bits select the handshake-to-handshake time-out period, which is the maximum time between SCSI handshakes (SREQ/ to SREQ/ in target mode; or, SACK/ to SACK/ in the initiator mode). When this timing is exceeded, an interrupt is generated and the HTH bit in the SCSI Interrupt Status One (SIST1) register is set. The following table contains time-out periods for the Handshake-to-Handshake Timer, the Selection/Reselection Timer (bits [3:0]), and the General Purpose Timer (SCSI Timer One (STIME1) bits [3:0]). For a more detailed explanation of interrupts, refer to Chapter 2, "Functional Description."

HTH [3:0], SEL [3:0]	Minimum Time-Out
0000	Disabled
0001	125 µs
0010	250 µs
0011	500 µs
0100	1 ms
0101	2 ms
0110	4 ms
0111	8 ms
1000	16 ms
1001	32 ms
1010	64 ms

HTH [3:0], SEL [3:0]	Minimum Time-Out
1011	128 ms
1100	256 ms
1101	512 ms
1110	1.024 s
1111	2.048 s

SEL[3:0]   **Selection Time-Out**   **[3:0]**
These bits select the SCSI selection/reselection time-out period. When this timing (plus the 200 μs selection abort time) is exceeded, the STO bit in the SCSI Interrupt Status One (SIST1) register is set. For a more detailed explanation of interrupts, refer to Chapter 2, "Functional Description."

Register: 0x49
SCSI Timer One (STIME1)
Read/Write

7	6	5	4	3			0
R	HTHBA	GENSF	HTHSF	GEN[3:0]			
x	0	0	0	0	0	0	0

R   **Reserved**   **7**

HTHBA   **Handshake-to-Handshake Timer Bus Activity**
Enable   **6**
Setting this bit causes this timer to begin testing for SCSI REQ/ and ACK/ activity as soon as SBSY/ is asserted, regardless of the agents participating in the transfer.

GENSF   **General Purpose Timer Scale Factor**   **5**
Setting this bit causes this timer to shift by a factor of 16. Refer to the SCSI Timer Zero (STIME0) register description for details.

HTH [3:0], SEL [3:0], GEN [3:0]	Minimum Time-Out	
	HTHSF = 0, GENSF = 0	HTHSF = 1, GENSF = 1
0000	Disabled	Disabled
0001	125 μs	2 ms
0010	250 μs	4 ms
0011	500 μs	8 ms
0100	1 μs	16 ms
0101	2 ms	32 ms
0110	4 ms	64 ms
0111	8 ms	128 ms
1000	16 ms	256 ms
1001	32 ms	512 ms
1010	64 ms	1 s
1011	128 ms	2 s
1100	256 ms	4.1 s
1101	512 ms	8.2 s
1110	1.024 s	16.4 s
1111	2.048 s	32.8 s

HTHSF   **Handshake-to-Handshake Timer Scale Factor**   **4**
Setting this bit causes this timer to shift by a factor of 16. Refer to the SCSI Timer Zero (STIME0) register description for details.

GEN[3:0]   **General Purpose Timer Period**   **[3:0]**
These bits select the period of the general purpose timer. The time measured is the time between enabling and disabling of the timer. When this timing is exceeded, the GEN bit in the SCSI Interrupt Status One (SIST1) register is set. Refer to the table under SCSI Timer Zero (STIME0), bits [3:0], for the available time-out periods.

Note: To reset a timer before it expires and obtain repeatable delays, the time value must be written to zero first, and then written back to the desired value. This is also required when changing from one time value to another.

Register: 0x4A
Response ID Zero (RESPID0)
Read/Write

7							0
RESPID0							
x	x	x	x	x	x	x	x

RESPID0   **Response ID Zero**   **[7:0]**

Response ID Zero (RESPID0) and Response ID One
(RESPID1) contain the selection or reselection IDs.
These two 8-bit registers contain the SCSI ID that the
chip responds to on the SCSI bus. Each bit represents
one possible ID; the most significant bit of Response ID
One (RESPID1) represents ID 15, and the least
significant bit of RESPID0 represents ID 0. The SCSI
Chip ID (SCID) register still contains the chip ID used
during arbitration. The chip can respond to more than
one ID because more than one bit can be set in the
RESPID1 and RESPID0 registers. However, the chip can
arbitrate with only one ID value in the SCSI Chip ID
(SCID) register.

Register: 0x4B
Response ID One (RESPID1)
Read/Write

7							0
RESPID1							
x	x	x	x	x	x	x	x

RESPID1   **Response ID One**   **[7:0]**

Response ID Zero (RESPID0) and Response ID One
(RESPID1) contain the selection or reselection IDs.
These two 8-bit registers contain the SCSI ID that the
chip responds to on the SCSI bus. Each bit represents
one possible ID; the most significant bit of RESPID1
represents ID 15, and the least significant bit of RESPID0
represents ID 0. The SCSI Chip ID (SCID) register still
contains the chip ID used during arbitration. The chip can
respond to more than one ID because more than one bit

can be set in the RESPID1 and RESPID0 registers. However, the chip can arbitrate with only one ID value in the SCSI Chip ID (SCID) register.

Register: 0x4C
SCSI Test Zero (STEST0)
Read Only

7			4	3	2	1	0
SSAID[3:0]				SLT	ART	SOZ	SOM
0	0	0	0	0	x	1	1

SSAID[3:0]   **SCSI Selected As ID**   **[7:4]**

These bits contain the encoded value of the SCSI ID that the LSI53C1010R SCSI function is selected or reselected as during a SCSI Selection or Reselection phase. These bits are read only and contain the encoded value of 16 possible IDs that could be used to select the LSI53C1010R SCSI function. During a SCSI Selection or Reselection phase when a valid ID is put on the bus, and the LSI53C1010R SCSI function responds to that ID, the "selected as" ID is written into these bits. These bits are used with Response ID Zero (RESPID0) and Response ID One (RESPID1) registers to allow response to multiple IDs on the bus.

SLT   **Selection Response Logic Test**   **3**

This bit is set when the LSI53C1010R SCSI function is ready to be selected or reselected. This does not take into account the bus settle delay of 400 ns. This bit is used for functional test and fault purposes.

ART   **Arbitration Priority Encoder Test**   **2**

This bit is always set when the LSI53C1010R SCSI function exhibits the highest priority ID asserted on the SCSI bus during arbitration. It is primarily used for chip level testing. It may be used during low level mode operation to determine if the LSI53C1010R SCSI function won arbitration.

SOZ   **SCSI Synchronous Offset Zero**   **1**

This bit indicates that the current synchronous SREQ/, SACK/ offset is zero. This bit is not latched and may change at any time. It is used in low level synchronous

SCSI operations. When this bit is set and if the LSI53C1010R is functioning as an initiator, the device is waiting for the target to request data transfers. When this bit is set and if the LSI53C1010R is functioning as a target, then the initiator has sent the offset number of acknowledges.

SOM **SCSI Synchronous Offset Maximum** **0**
This bit indicates that the current synchronous SREQ/, SACK/ offset is the maximum specified by bits [5:0] in the SCSI Transfer (SXFER) register. This bit is not latched and may change at any time. It is used in low level synchronous SCSI operations. If this bit is set and if the LSI53C1010R is functioning as a target, it is waiting for the initiator to acknowledge the data transfers. If the LSI53C1010R SCSI is functioning as an initiator, the target has sent the offset number of requests.

Register: 0x4D
SCSI Test One (STEST1)
Read/Write

7	6	5	4	3	2	1	0
R		DOSGE	DISGE	QEN	QSEL	IRM[1:0]	
0	0	0	0	0	0	0	0

R **Reserved** **[7:6]**

DOSGE **Disable Outbound SCSI Gross Errors** **5**
When set, this bit disables all SCSI gross errors related to outbound data transfers.

DISGE **Disable Inbound SCSI Gross Errors** **4**
When set, this bit disables all SCSI gross errors related to inbound data transfers.

QEN **SCLK Quadrupler Enable** **3**
This bit, when set, powers up the internal clock quadrupler circuit, which quadruples the SCLK 40 MHz clock to the internal 160 MHz SCSI clock required for Ultra2 and Ultra160 SCSI operation. When cleared, this bit powers down the internal quadrupler circuit. Refer to Chapter 2, "Functional Description," for information concerning the operation of the quadrupler.

QSEL   **SCLK Quadrupler Select**   **2**

This bit, when set, selects the output of the internal clock quadrupler as the internal SCSI clock. When cleared, this bit selects the clock presented on SCLK as the internal SCSI clock. Refer to Chapter 2, "Functional Description," for information concerning the operation of the quadrupler.

IRM[1:0]   **Interrupt Routing Mode**   **[1:0]**

The LSI53C1010R supports four different interrupt routing modes. These modes are described in the following table. Each SCSI core within the chip can be configured independently. Mode 0, the default mode, is compatible with RAID upgrade products.

Mode	Bits [1:0]	Operation
0	00	If the INT_DIR/ input pin is low, interrupts are signaled on ALT_INTx/. Otherwise, interrupts are signaled on both INTx/ and ALT_INTx/.
1	01	Interrupts are only signaled on INTx/, not ALT_INTx/. The INT_DIR/ input pin is ignored.
2	10	Interrupts are only signaled on ALT_INTx/. The INT_DIR/ input pin is ignored.
3	11	Interrupts are signaled on both INTx/ and ALT_INTx/. The INT_DIR input pin is ignored.

Register: 0x4E
SCSI Test Two (STEST2)
Read/Write

7	6	5	4	3	2	1	0
SCE	ROF	R		SZM	R		LOW
0	0	0	0	0	0	0	0

SCE   **SCSI Control Enable**   **7**

Setting this bit allows assertion of all SCSI control and data lines through the SCSI Output Control Latch (SOCL) and SCSI Output Data Latch (SODL) registers regardless of whether the LSI53C1010R SCSI function is configured as a target or initiator.

Note: Do not set this bit during normal operation, since it could cause contention on the SCSI bus. It is included for diagnostic purposes only.

ROF   **Reset SCSI Offset**   **6**

Setting this bit clears any outstanding synchronous SREQ/SACK offset. If a SCSI gross error occurs, set this bit. This bit automatically clears itself after resetting the synchronous offset.

R   **Reserved**   **[5:4]**

SZM   **SCSI High Impedance Mode**   **3**

Setting this bit places all the open-drain 48 mA SCSI drivers into a high impedance state.

R   **Reserved**   **[2:1]**

LOW   **SCSI Low Level Mode**   **0**

Setting this bit places the LSI53C1010R SCSI function in the low level mode. In this mode, no DMA operations occur and no SCRIPTS execute. Arbitration and selection may be performed by setting the start sequence bit as described in the SCSI Control Zero (SCNTL0) register. SCSI bus transfers are performed by manually asserting and polling SCSI signals. Clearing this bit allows instructions to be executed in the SCSI SCRIPTS mode.

Note: It is not necessary to set this bit for access to the SCSI bit-level registers (SCSI Output Data Latch (SODL), SCSI Bus Control Lines (SBCL), and input registers).

Register: 0x4F
SCSI Test Three (STEST3)
Read/Write

7	6	5	4	3	2	1	0
TE	R	HSC	DSI	R	TTM	CSF	R
0	0	0	0	0	0	0	0

TE   **TolerANT Enable**   **7**

Setting this bit enables the active negation portion of LSI Logic TolerANT technology. Active negation causes the SCSI Request, Acknowledge, Data, and Parity signals to be actively deasserted, instead of relying on external pull-ups, when the LSI53C1010R SCSI function is driving these signals. Active deassertion of these signals occurs only when the LSI53C1010R SCSI function is in an information transfer phase. When performing synchronous transfers, TolerANT should be enabled to improve setup and deassertion times. Active negation is disabled after reset or when this bit is cleared. For more information on LSI Logic TolerANT technology, see Chapter 1, "Introduction."

R   **Reserved**   **6**

HSC   **Halt SCSI Clock**   **5**

Setting this bit causes the internal divided SCSI clock to come to a stop in a glitchless manner. This bit is used for test purposes or to lower I_{DD} during a power-down mode. Refer to Chapter 2, "Functional Description," for operation of the SCSI clock quadrupler.

DSI   **Disable Single Initiator Response**   **4**

If this bit is set, the LSI53C1010R SCSI function ignores all bus-initiated selection attempts that employ the single-initiator option from SCSI-1. In order to select the LSI53C1010R SCSI function while this bit is set, the LSI53C1010R SCSI function's SCSI ID and the initiator's SCSI ID must both be asserted. Assert this bit in SCSI-2 systems so that a single bit error on the SCSI bus is not interpreted as a single initiator response.

| R | Reserved | 3 |

TTM   **Timer Test Mode**   **2**

Setting this bit facilitates testing of the selection time-out, general purpose, and handshake-to-handshake timers by greatly reducing all three time-out periods. Setting this bit starts all three timers. If the respective bits in the SCSI Interrupt Enable One (SIEN1) register are asserted, the LSI53C1010R SCSI function generates interrupts at time-out. This bit is intended for internal manufacturing diagnosis and should not be used in normal operation.

CSF   **Clear SCSI FIFO**   **1**

Setting this bit causes the "full flags" for the SCSI FIFO to be cleared. This empties the FIFO. This bit is self-clearing. In addition to the SCSI FIFO pointers, the SIDL, SODL, and SODR full bits in the SCSI Status Zero (SSTAT0) and SCSI Status Two (SSTAT2) are cleared.

| R | Reserved | 0 |

Registers: 0x50–0x51
SCSI Input Data Latch (SIDL)
Read Only

15															0
							SIDL								
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

SIDL   **SCSI Input Data Latch**   **[15:0]**

This register is used primarily for diagnostic testing, programmed I/O operation, or error recovery. Asynchronous Data received from the SCSI bus can be read from this register. When receiving asynchronous SCSI data, the data flows into this register and out to the host FIFO. This register differs from the SCSI Bus Data Lines (SBDL) register; the SCSI Input Data Latch (SIDL) contains latched data and the SCSI Bus Data Lines (SBDL) always contains exactly what is currently on the SCSI data bus. Reading this register causes the SCSI parity bit to be checked, and causes a parity error interrupt if the data is invalid. The power-up values are indeterminate.

Register: 0x52
SCSI Test Four (STEST4)
Read Only

7	6	5					0
SMODE[1:0]		R					
x	x	0	0	0	0	0	0

SMODE[1:0]   **SCSI Mode**   **[7:6]**

These bits contain the encoded value of the SCSI operating mode that is indicated by the voltage level sensed at the DIFFSENS pin. The incoming SCSI signal goes to a pair of analog comparators that determine the voltage window of the DIFFSENS signal. These voltage windows indicate LVD, SE, or HVD operation. The bit values are defined in the following table. When the HVD mode is detected, all of the LSI53C1010R 3-state outputs go to the high impedance state.

SMODE [1:0]	Operating Mode
00	Reserved
01	High Impedance State
10	SE SCSI
11	LVD SCSI

R   **Reserved**   **[5:0]**

Register: 0x53
Current Inbound SCSI Offset (CSO)
Read Only

7	6	5					0
R		CSO[5:0]					
0	0	0	0	0	0	0	0

R   **Reserved**   **[7:6]**

CSO[5:0]   **Current SCSI Offset**   **[5:0]**

These bits indicate the SCSI offset for synchronous inbound transfers. This also represents the number of data bytes in the SCSI FIFO in narrow transfer modes

and half the number of bytes in wide transfer mode. This does not include any CRC or PAD bytes that may be in the FIFO.

Registers: 0x54–0x55
SCSI Output Data Latch (SODL)
Read/Write

15															0
SODL															
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

SODL   **SCSI Output Data Latch**   **[15:0]**

This register is used primarily for diagnostics testing and programmed I/O operations. Data written to this register is asserted on the SCSI data bus by setting the Assert Data Bus bit in the SCSI Control One (SCNTL1) register. This register is used to send data using programmed I/O. Data flows through this register when sending data in asynchronous mode. It is also used to write to the synchronous data FIFO when testing the chip. The power-up value of this register is indeterminate.

Register: 0x56
Chip Control Zero (CCNTL0)
Read/Write

7	6	5	4	3	2	1	0
ENPMJ	PMJCTL	ENNDJ	DISFC	R		DISRC	DPR
0	0	0	0	x	x	0	0

ENPMJ   **Enable Phase Mismatch Jump**   **7**

Upon setting this bit, any phase mismatches do not interrupt but force a jump to an alternate location to handle the phase mismatch. Prior to actually taking the jump, the appropriate remaining byte counts and addresses are calculated to facilitate storage.

In the case of a SCSI send, any data in the part will be automatically cleared after being accounted for. In the case of a SCSI receive, all data will be flushed out of the part and accounted for prior to taking the jump. This

feature does not cover, however, the byte that may appear in SCSI Wide Residue (SWIDE). This byte must be flushed manually.

This bit also enables the flushing mechanism to flush data during a Data-In phase mismatch in a more efficient manner.

PMJCTL　　**Jump Control**　　　　　　　　　　　　　**6**
This bit controls which decision mechanism is used when jumping on phase mismatch. When this bit is cleared the LSI53C1010R will use Phase Mismatch Jump Address One (PMJAD1) when the WSR bit is cleared and Phase Mismatch Jump Address Two (PMJAD2) when the WSR bit is set. When this bit is set, the LSI53C1010R will use Phase Mismatch Jump Address Two (PMJAD2) on Data-Out (Data-Out, Command, Message-Out) transfers and Phase Mismatch Jump Address Two (PMJAD2) on Data-In (Data-In, Status, Message-In) transfers. The phase referred to here is the phase encoded in the block move SCRIPTS instruction, not the phase on the SCSI bus that caused the phase mismatch.

ENNDJ　　**Enable Jump On Nondata Phase Mismatches**　　**5**
This bit controls whether or not a jump is taken during a nondata phase mismatch (Message-In, Message-Out, Status, or Command). When this bit is cleared, jumps will only be taken on Data-In or Data-Out phases, and a phase mismatch interrupt will be generated for all other phases. When this bit is set, jumps will be taken regardless of the phase in the block move. Note that the phase referred to here is the phase encoded in the block move SCRIPTS instruction, not the phase on the SCSI bus that caused the phase mismatch.

DISFC　　**Disable Auto FIFO Clear**　　　　　　　　　**4**
This bit controls whether or not the FIFO is automatically cleared during a Data-Out phase mismatch. When set, data in the DMA FIFO and data in the SCSI Output Data Latch (SODL) and SODR (a hidden buffer register which is not accessible) registers are not cleared after calculations on them are complete. When cleared, the DMA FIFO, SODL, and SODR are automatically cleared. This bit also disables the enhanced flushing mechanism.

R	Reserved	[3:2]

DISRC   **Disable Internal SCRIPTS RAM Cycles**   **1**
This bit controls whether or not data transfers, for which the source/destination is located in SCRIPTS RAM, generate external PCI cycles.

If cleared, data transfers of this type do NOT generate PCI cycles and stay internal to the chip. If set, data transfers of this type generate PCI cycles. This does not affect SCRIPTS Fetch operations from SCRIPTS RAM, including Table Indirect and Indirect opcode fetches.

DPR   **Disable Pipe Req**   **0**
This bit controls whether or not overlapped arbitration on the PCI bus occurs. Overlapped arbitration is performed by asserting PCI REQ/ for one SCSI function while the other SCSI function is executing a PCI cycle. If set, overlapped arbitration is disabled.

Register: 0x57
Chip Control One (CCNTL1)
Read/Write

7	6	5	4	3	2	1	0
PULLDIS	PULLEN	DIS64MAS	DIS64SLV	DDAC	64TIMOD	EN64TIBMV	EN64DBMV
0	0	0	0	x	x	0	0

PULLDIS   **Pull Disable**   **7**
Setting this bit causes all internal pulls to be disabled on all pins. This bit is intended for manufacturing test only and should NOT be set for normal operation. PULLDIS has precedence over PULLEN if both bits are set.

PULLEN   **Pull Enable**   **6**
Setting this bit causes all internal pulls to be enabled on all pins. This bit is intended for manufacturing test only and should NOT be set for normal operation.

DIS64MAS   **Disable 64-bit Master Operation**   **5**
Setting this bit causes the LSI53C1010R to no longer request 64-bit master data transfers. If this bit is set by either SCSI channel, 64-bit data transfers will be disabled for all master transactions.

DIS64SLV   **Disable 64-bit Slave Cycles**   **4**

Setting this bit disables 64-bit slave data transfers to the SCRIPT RAM. This causes only 32-bit data transfers to occur.

DDAC   **Disable Dual Address Cycle**   **3**

When this bit is set, all 64-bit addressing as a master is disabled. No dual address cycles will be generated by the LSI53C1010R.

When this bit is cleared, the LSI53C1010R generates dual address cycles based on the master operation performed and the value of its associated selector register.

64TIMOD   **64-Bit Table Indirect Indexing Mode**   **2**

When this bit is cleared, bits [28:24] of the first table entry Dword will select one of 22 possible selectors to be used in a BMOV operation. When this bit is set, bits [31:24] of the first table entry Dword will be copied directly into DMA Next Address 64 (DNAD64) to provide 40-bit addressing capability. This bit will only function if the EN64TIBMV bit is set.

Index Mode 0 (64TIMOD clear) table entry format:

[31:29]	[28:24]	[23:0]
Reserved	Sel Index	Byte Count
Source/Destination Address [31:0]		

Index Mode 1 (64TIMOD set) table entry format:

[31:24]	[23:0]
Src/Dest Addr [39:32]	Byte Count
Source/Destination Address [31:0]	

EN64TIBMV   **Enable 64-bit Table Indirect BMOV**   **1**

Setting this bit enables 64-bit addressing for Table Indirect BMOVs using the upper byte (bits [31:24]) of the first Dword of the table entry. When this bit is cleared, Table Indirect BMOVs use the Static Block Move Selector (SBMS) register to obtain the upper 32 bits of the data address.

EN64DBMV   **Enable 64-bit Direct BMOV**   **0**

Setting this bit enables the 64-bit version of a direct
BMOV. When this bit is cleared, direct BMOVs use the
Static Block Move Selector (SBMS) register to obtain the
upper 32 bits of the data address.

Registers: 0x58–0x59
SCSI Bus Data Lines (SBDL)
Read Only

15															0
SBDL															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SBDL   **SCSI Bus Data Lines**   **[15:0]**

This register contains the SCSI data bus status. Even
though the SCSI data bus is active low, these bits are
active high. The signal status is not latched and is a true
representation of exactly what is on the data bus at the
time the register is read. This register is used when
receiving data using programmed I/O. This register can
also be used for diagnostics testing or in the low level
mode. The power-up value of this register is
indeterminate.

If the chip is in wide mode (SCSI Control Three
(SCNTL3), bit 3 is set) and SCSI Bus Data Lines (SBDL)
is read, both byte lanes are checked for parity regardless
of phase. When in a nondata phase, this will cause a
parity error interrupt to be generated because the upper
byte lane parity in invalid.

Register: 0x5A
Chip Control Two (CCNTL2)
Read/Write

7	6						0
ShSGE	R						
0	x	x	x	x	x	x	x

ShSGE   **Enable Shadowed SGE Register**   **7**
Setting this bit allows access to the SGE Status registers shadowed behind SIST0 and SIST1.

R   **Reserved**   **[6:0]**

Register: 0x5B
Chip Control Three (CCNTL3)
Read/Write

7		5	4	3	2	1	0
R			ENDSKEW	DSKEW[1:0]		LVDDL[1:0]	
0	0	0	0	0	0	0	0

R   **Reserved**   **[7:5]**

ENDSKEW   **Enable REQ/ACK to Data Skew Control**   **4**
Setting this bit enables the control of the relative skew between the SCSI REQ/ACK signals and the data signals. The actual amount of skew time is controlled by DSKEW[1:0] in this register.

DSKEW[1:0]   **Setup Data Skew Control**   **[3:2]**
These bits control the amount of skew between the SCSI REQ/ACK signal and the SCSI data signals during setup. The skew is affected only if the ENDSKEW bit is set.

  Note: These bits are used for Ultra160 SCSI Domain Validation only and should not be set during normal data transfer operations.

LVDDL[1:0]   **LVD Drive Strength Select**   **[1:0]**
These bits control the drive level of the LVD pad drivers.

Note: This feature is for Ultra160 SCSI Domain Validation testing environments only and should not be set during normal data transfer operations.

The table below shows the relative strength increase or decrease based on the LVDDL values.

LVDDL	Drive Level
00	Nominal
01	−20% Nominal
10	+20% Nominal
11	Reserved

Note: If one of the LVDDL [1:0] bits are set on either channel, both channels are affected.

Registers: 0x5C–0x5F
Scratch Register B (SCRATCHB)
Read/Write

31																															0
														SCRATCHB																	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SCRATCHB **Scratch Register B** **[31:0]**
This is a general purpose user definable scratch pad register. Apart from CPU access, only register Read/Write and Memory Moves directed at the SCRATCH register will alter its contents. The power-up values are indeterminate. A special mode of this register can be enabled by setting the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register. If this bit is set, bits [31:13] of the Scratch Register B (SCRATCHB) register return bits [31:13] of the PCI Base Address Register Three (BAR3) (SCRIPTS RAM). In this mode, bits [12:0] of SCRATCH B will always return zeros. Writes to the SCRATCH B register have no effect. Resetting the PCI Configuration Info Enable bit causes the SCRATCH B register to return to normal operation.

Registers: 0x60–0x9F
Scratch Registers C–R (SCRATCHC–SCRATCHR)
Read/Write

These are general purpose user definable scratch pad registers. Apart from CPU access, only register Read/Write, Memory Moves, and Load/Stores directed at a SCRATCH register alter its contents. The power-up values are indeterminate.

Registers: 0xA0–0xA3
Memory Move Read Selector (MMRS)
Read/Write

31																															0
MMRS																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
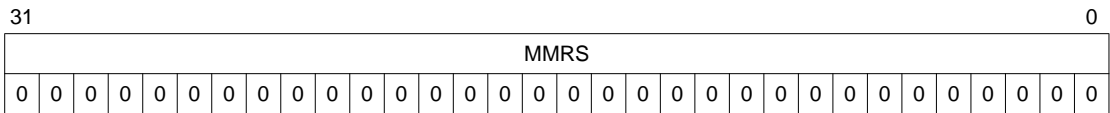
MMRS	**Memory Move Read Selector**	**[31:0]**

This register supplies AD[63:32] for data read operations during Memory-to-Memory Move and absolute address LOAD operations.

A special mode of this register can be enabled by setting the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register. If this bit is set, the Memory Move Read Selector (MMRS) register returns bits [31:0] of the memory mapped operating register, PCI Base Address Register Two (BAR2) (MEMORY), when read. In this mode, writes to the MMRS register have no effect. Clearing the PCI Configuration Info Enable bit causes the MMRS register to return to normal operation.

Registers: 0xA4–0xA7
Memory Move Write Selector (MMWS)
Read/Write

31   0

MMWS																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MMWS   **Memory Move Write Selector**   **[31:0]**

This register supplies AD[63:32] for data write operations during Memory-to-Memory Moves and absolute address STORE operations.

A special mode of this register can be enabled by setting the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register. If this bit is set, the MMWS register returns bits [31:0] of the SCRIPT RAM PCI Base Address Register Four (BAR4) (SCRIPTS RAM) in bits [31:0] of the MMWS register when read. In this mode, writes to the MMWS register have no effect. Clearing the PCI Configuration Info Enable bit causes the MMWS register to return to normal operation.

Registers: 0xA8–0xAB
SCRIPT Fetch Selector (SFS)
Read/Write

31   0

SFS																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SFS   **SCRIPT Fetch Selector**   **[31:0]**

This register supplies AD[63:32] during SCRIPT Fetches and Indirect Fetches (excluding Table Indirect Fetches). This register can be loaded automatically using a 64-bit jump instruction.

A special mode of this register can be enabled by setting the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register. If this bit is set, bits [23:16] of this register return the PCI Revision ID (RID) register value and bits [15:0] return the PCI Device ID register value when read. Writes to the SCRIPT Fetch Selector (SFS)

register have no effect. Clearing the PCI Configuration Info Enable bit causes the SFS register to return to normal operation.

Registers: 0xAC–0xAF
DSA Relative Selector (DRS)
Read/Write

```
31                                                                      0
┌──────────────────────────────────────────────────────────────────────┐
│                                DRS                                     │
├─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┤
│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│
└─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
```

DRS   **DSA Relative Selector**   **[31:0]**
This register supplies AD[63:32] during Table Indirect Fetches and Load/Store Data Structure Address (DSA) relative operations.

Registers: 0xB0–0xB3
Static Block Move Selector (SBMS)
Read/Write

```
31                                                                      0
┌──────────────────────────────────────────────────────────────────────┐
│                               SBMS                                     │
├─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┤
│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│0│
└─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
```

SBMS   **Static Block Move Selector**   **[31:0]**
This register supplies AD[63:32] during block move operations, reads, or writes. This register is static and is not changed when a 64-bit direct BMOV is used.

Registers: 0xB4–0xB7
Dynamic Block Move Selector (DBMS)
Read/Write

31   0

DBMS

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DBMS   **Dynamic Block Move Selector**   **[31:0]**
This register supplies AD[63:32] during block move operations, reads, or writes. This register is used only during 64-bit direct BMOV instructions. It is reloaded with the upper 32-bit data address upon execution of 64-bit direct BMOVs.

Registers: 0xB8–0xBB
DMA Next Address 64 (DNAD64)
Read/Write

31   0

DNAD64

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DNAD64   **DMA Next Address 64**   **[31:0]**
This register holds the current selector being used in a host transaction. The appropriate selector is copied to this register prior to beginning the host transaction.

Note: The crossing of selector boundaries in one memory operation is not supported.

Register: 0xBC
SCSI Control Four (SCNTL4)
Read/Write

7	6	5	4	3	2	1	0
U3EN	AIPCKEN	R		XCLKH_DT	XCLKH_ST	XCLKS_DT	XCLKS_ST
0	0	0	0	0	0	0	0

This register is automatically loaded when a Table Indirect Select or Reselect SCRIPTS instruction is executed.

U3EN   Ultra160 Transfer Enable   7
Setting this bit enables Ultra160 transfers. This bit will force all SCSI Block Move SCRIPTS instructions for ST Data-In or ST Data-Out phases to become DT Data-In or DT Data-Out phases.

AIPCKEN   AIP Checking Enable   6
Setting this bit enables the AIP checking of the upper byte lane of protection information during Command, Status, and Message phases. By default, AIP codes are generated on the SCSI bus during all asynchronous transfers. To disable this feature set bit 3, the Disable AIP Code Generation bit, in AIP Control One (AIPCNTL1).

R   Reserved   [5:4]

XCLKH_DT   Extra Clock of Data Hold on DT Transfer Edge   3
Setting this bit adds a clock of data hold to synchronous DT SCSI transfers on the DT edge. This bit only impacts DT transfers as it affects data hold to the DT edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the transfer rate at which the LSI53C1010R can receive inbound REQs, ACKs or data. Refer to Table 4.4 and Table 4.5 for a summary of available transfer rates and to Figure 4.1 through Figure 4.3 for examples of how the XCLKH bits function.

Note: This bit does not affect CRC timings.

XCLKH_ST   Extra Clock of Data Hold on ST Transfer Edge   2
Setting this bit adds a clock of data hold to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts both ST and DT transfers as it affects data hold to the ST

edge. Setting this bit reduces the synchronous send transfer rate but does not reduce the transfer rate at which the LSI53C1010R can receive inbound REQs, ACKs or data. Refer to Table 4.4 and Table 4.5 for a summary of available transfer rates and to Figure 4.1 through Figure 4.3 for examples of how the XCLKH bits function.

Note: This bit does not affect CRC timings.

XCLKS_DT   Extra Clock of Data Setup on DT Transfer Edge   1
Setting this bit adds a clock of data setup to synchronous DT SCSI transfers on the DT edge. This bit only impacts DT transfers as it only affects data setup to the DT edge. Setting this bit reduces the synchronous transfer send rate but does not reduce the transfer rate at which the LSI53C1010R can receive inbound REQs, ACKs or data. Refer to Table 4.4 and Table 4.5 for a summary of available transfer rates and to Figure 4.1 through Figure 4.3 for examples of how the XCLKS bits function.

Note: This bit does not affect CRC timings.

XCLKS_ST   Extra Clock of Data Setup on ST Transfer Edge   0
Setting this bit adds a clock of data setup to synchronous DT or ST SCSI transfers on the ST edge. This bit impacts both ST and DT transfers as it affects data setup to the ST edge. Setting this bit reduces the synchronous send transfer rate but does not reduce the transfer rate at which the LSI53C1010R can receive inbound REQs, ACKs or data. Refer to Table 4.4 and Table 4.5 for a summary of available transfer rates and to Figure 4.1 through Figure 4.3 for examples of how the XCLKS bits function.

Note: This bit does not affect CRC timings.

Synchronous Receive Rate Calculation

The synchronous receive rate, in megatransfers/s, can be calculated using the following formula:

$$\text{Receive Rate (DT)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times 2}$$

$$\text{Receive Rate (ST)} = \frac{\text{Input Clock Rate}}{\text{SCF Divisor} \times 4}$$

Note: The receive rate is independent of the settings of the XCLKS_DT, XCLKS_ST, XCLKH_DT, and XCLKH_ST bits.

Synchronous Send Rate Calculation

The synchronous send rate, in megatransfers/s, can be calculated using the following formula:

$$\text{Send Rate (DT)} = \frac{\text{Input Clock Rate}}{\left(\text{SCFDivisor} \times \left(2 + \frac{\text{XCLKS\_DT} + \text{XCLKS\_ST} + \text{XCLKH\_DT} + \text{XCLKH\_ST}}{2}\right)\right)}$$

$$\text{Send Rate (ST)} = \frac{\text{Input Clock Rate}}{\text{SCFDivisor} \times (4 + \text{XCLKS\_ST} + \text{XCLKH\_ST})}$$

Figure 4.1   Single Transition Transfer Waveforms

XCLKS_ST = 0
XCLKH_ST = 0

XCLKS_ST = 1
XCLKH_ST = 0

XCLKS_ST = 0
XCLKH_ST = 1

XCLKS_ST = 1
XCLKH_ST = 1
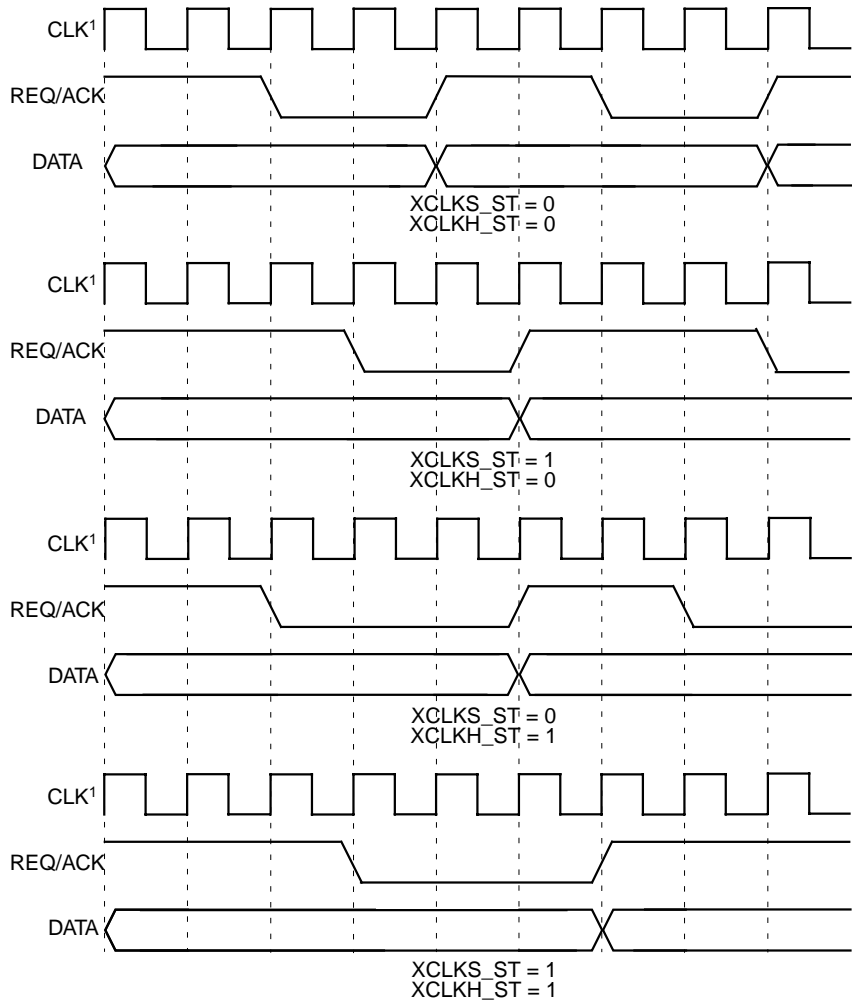
1. CLK = SCLK/SCF Divisor

Figure 4.2   Double Transition Transfer Waveforms (XCLKS Examples)

CLK[1]

REQ/ACK

DATA

XCLKS_DT = 0/XCLKS_ST = 0
XCLKH_DT = 0/XCLKH_ST = 0

CLK[1]

REQ/ACK

DATA

XCLKS_DT = 0/XCLKS_ST = 1
XCLKH_DT = 0/XCLKH_ST = 0

CLK[1]

REQ/ACK

DATA

XCLKS_DT = 1/XCLKS_ST = 0
XCLKH_DT = 0/XCLKH_ST = 0

CLK[1]

REQ/ACK

DATA

XCLKS_DT = 1/XCLKS_ST = 1
XCLKH_DT = 0/XCLKH_ST = 0
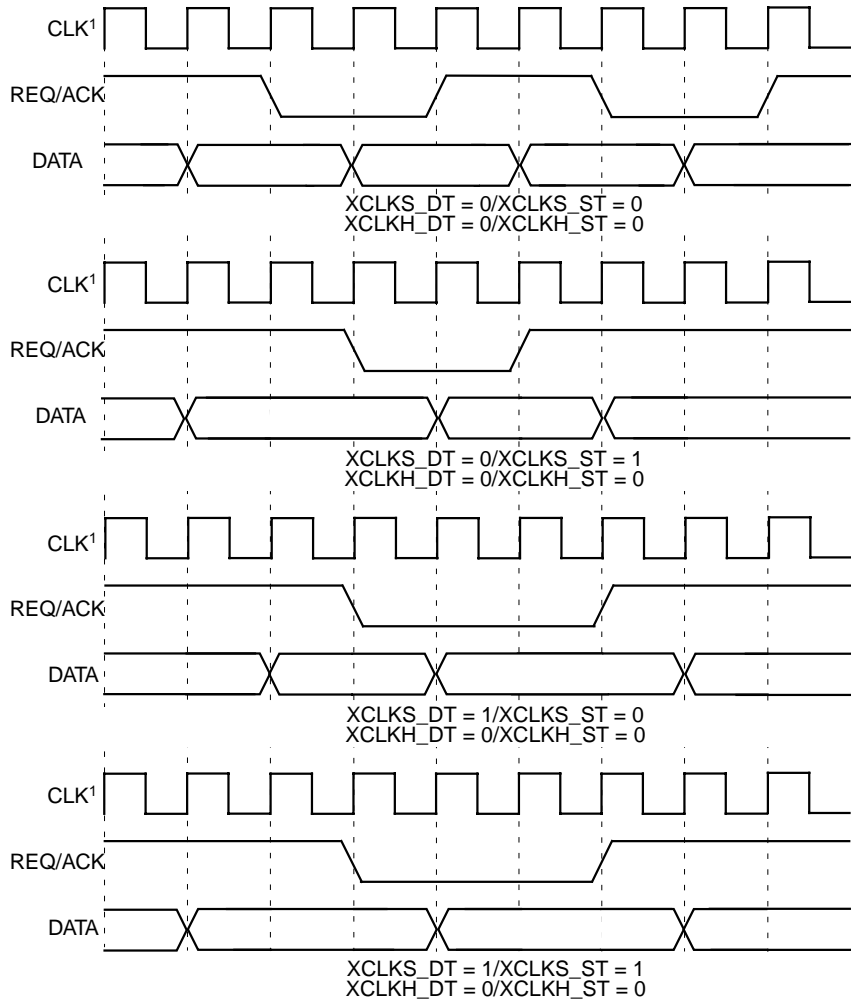
1. CLK = SCLK/SCF Divisor

Figure 4.3   Double Transition Transfer Waveforms (XCLKH Examples)

XCLKS_DT = 0 / XCLKS_ST = 0
XCLKH_DT = 1 / XCLKH_ST = 0

XCLKS_DT = 0 / XCLKS_ST = 0
XCLKH_DT = 0 / XCLKH_ST = 1

XCLKS_DT = 0 / XCLKS_ST = 0
XCLKH_DT = 1 / XCLKH_ST = 1

XCLKS_DT = 1 / XCLKS_ST = 1
XCLKH_DT = 1 / XCLKH_ST = 1
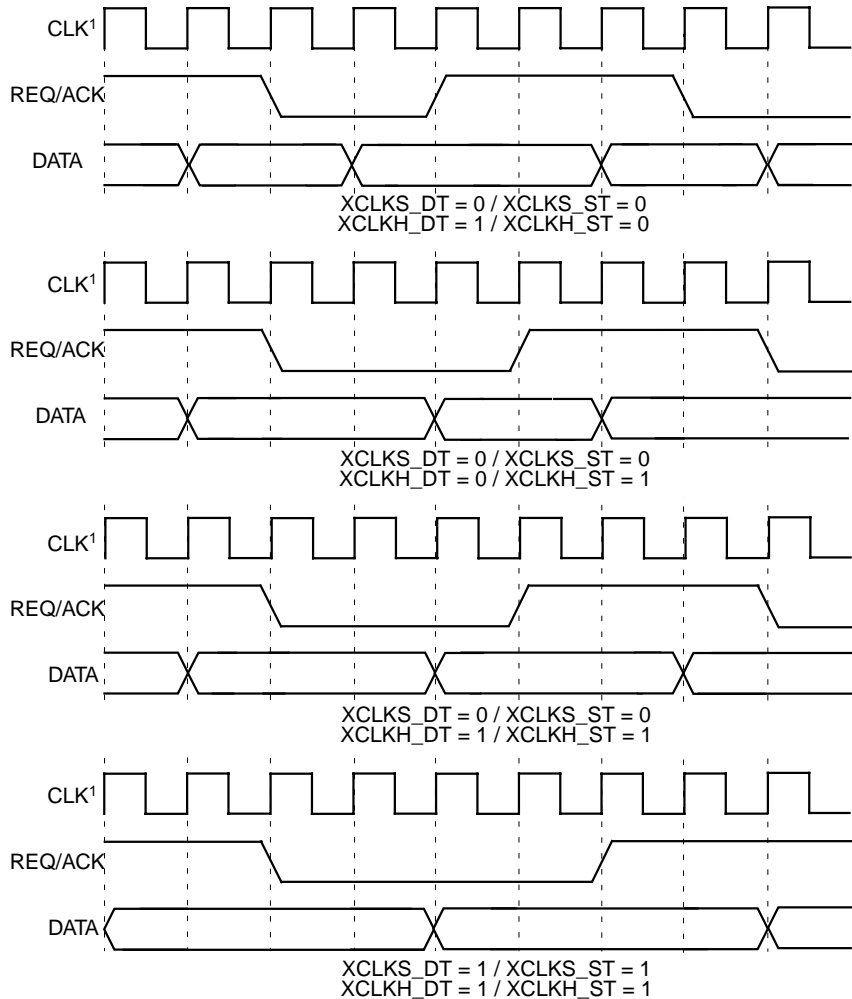
1. CLK = SCLK/SCF Divisor

Table 4.4   Double Transition Transfer Rates

Clock (MHz)	Divisor	Number Xclks[1]	Base Period (ns)	Receive Rate (Megatransfers/s)	Send Rate (Megatransfers/s)
160	1	0	6.25	80.00	80.00
160	1	1	6.25	80.00	64.00
160	1	2	6.25	80.00	53.33
160	1	3	6.25	80.00	45.71
160	1	4	6.25	80.00	40.00
160	1.5	0	9.38	53.33	53.33
160	1.5	1	9.38	53.33	42.67
160	1.5	2	9.38	53.33	35.56
160	1.5	3	9.38	53.33	30.48
160	1.5	4	9.38	53.33	26.67
160	2	0	12.50	40.00	40.00
160	2	1	12.50	40.00	32.00
160	2	2	12.50	40.00	26.67
160	2	3	12.50	40.00	22.86
160	2	4	12.50	40.00	20.00
160	3	0	18.75	26.67	26.67
160	3	1	18.75	26.67	21.33
160	3	2	18.75	26.67	17.78
160	3	3	18.75	26.67	15.24
160	3	4	18.75	26.67	13.33
160	4	0	25.00	20.00	20.00
160	4	1	25.00	20.00	16.00
160	4	2	25.00	20.00	13.33
160	4	3	25.00	20.00	11.43
160	4	4	25.00	20.00	10.00
160	6	0	37.50	13.33	13.33
160	6	1	37.50	13.33	10.67
160	6	2	37.50	13.33	8.89
160	6	3	37.50	13.33	7.62

Table 4.4   Double Transition Transfer Rates (Cont.)

Clock (MHz)	Divisor	Number Xclks[1]	Base Period (ns)	Receive Rate (Megatransfers/s)	Send Rate (Megatransfers/s)
160	6	4	37.50	13.33	6.67
160	8	0	50.00	10.00	10.00
160	8	1	50.00	10.00	8.00
160	8	2	50.00	10.00	6.67
160	8	3	50.00	10.00	5.71
160	8	4	50.00	10.00	5.00
40	1	0	25.00	20.00	20.00
40	1	1	25.00	20.00	16.00
40	1	2	25.00	20.00	13.33
40	1	3	25.00	20.00	11.43
40	1	4	25.00	20.00	10.00
40	1.5	0	37.50	13.33	13.33
40	1.5	1	37.50	13.33	10.67
40	1.5	2	37.50	13.33	8.89
40	1.5	3	37.50	13.33	7.62
40	1.5	4	37.50	13.33	6.67
40	2	0	50.00	10.00	10.00
40	2	1	50.00	10.00	8.00
40	2	2	50.00	10.00	6.67
40	2	3	50.00	10.00	5.71
40	2	4	50.00	10.00	5.00
40	3	0	75.00	6.67	6.67
40	3	1	75.00	6.67	5.33
40	3	2	75.00	6.67	4.44
40	3	3	75.00	6.67	3.81
40	3	4	75.00	6.67	3.33
40	4	0	100.00	5.00	5.00
40	4	1	100.00	5.00	4.00
40	4	2	100.00	5.00	3.33

Table 4.4   Double Transition Transfer Rates (Cont.)

Clock (MHz)	Divisor	Number Xclks[1]	Base Period (ns)	Receive Rate (Megatransfers/s)	Send Rate (Megatransfers/s)
40	4	3	100.00	5.00	2.86
40	4	4	100.00	5.00	2.50
40	8	0	200.00	2.50	2.50
40	8	1	200.00	2.50	2.00
40	8	2	200.00	2.50	1.67
40	8	3	200.00	2.50	1.43
40	8	4	200.00	2.50	1.25

1.   Number Xclks = XCLKS_DT + XCLKS_ST + XCLKH_DT + XCLKH_ST

Table 4.5   Single Transition Transfer Rates

Clock (MHz)	Divisor	Number Xclks[1]	Base Period (ns)	Receive Rate (Megatransfers/s)	Send Rate (Megatransfers/s)
160	1	0	6.25	40.00	40.00
160	1	1	6.25	40.00	32.00
160	1	2	6.25	40.00	26.67
160	1.5	0	9.38	26.67	26.67
160	1.5	1	9.38	26.67	21.33
160	1.5	2	9.38	26.67	17.78
160	2	0	12.50	20.00	20.00
160	2	1	12.50	20.00	16.00
160	2	2	12.50	20.00	13.33
160	3	0	18.75	13.33	13.33
160	3	1	18.75	13.33	10.67
160	3	2	18.75	13.33	8.89
160	4	0	25.00	10.00	10.00
160	4	1	25.00	10.00	8.00
160	4	2	25.00	10.00	6.67
160	6	0	37.50	6.67	6.67
160	6	1	37.50	6.67	5.33

Table 4.5   Single Transition Transfer Rates (Cont.)

Clock (MHz)	Divisor	Number Xclks[1]	Base Period (ns)	Receive Rate (Megatransfers/s)	Send Rate (Megatransfers/s)
160	6	2	37.50	6.67	4.44
160	8	0	50.00	5.00	5.00
160	8	1	50.00	5.00	4.00
160	8	2	50.00	5.00	3.33
40	1	0	25.00	10.00	10.00
40	1	1	25.00	10.00	8.00
40	1	2	25.00	10.00	6.67
40	1.5	0	37.50	6.67	6.67
40	1.5	1	37.50	6.67	5.33
40	1.5	2	37.50	6.67	4.44
40	2	0	50.00	5.00	5.00
40	2	1	50.00	5.00	4.00
40	2	2	50.00	5.00	3.33
40	3	0	75.00	3.33	3.33
40	3	1	75.00	3.33	2.67
40	3	2	75.00	3.33	2.22
40	4	0	100.00	2.50	2.50
40	4	1	100.00	2.50	2.00
40	4	2	100.00	2.50	1.67
40	6	0	150.00	1.67	1.67
40	6	1	150.00	1.67	1.33
40	6	2	150.00	1.67	1.11
40	8	0	200.00	1.25	1.25
40	8	1	200.00	1.25	1.00
40	8	2	200.00	1.25	0.83

1. Number Xclks = XCLKS_ST + XCLKH_ST

Register: 0xBD
Reserved

	7							0
				R				
x	x	x	x	x	x	x	x

This register is reserved.

Register: 0xBE
AIP Control Zero (AIPCNTL0)
Read Only

7				3	2	1	0
		R			AIPERR_LIVE	AIPERR	PARITYERR
0	0	0	0	0	0	0	0

R   **Reserved**   **[7:3]**

AIPERR_LIVE

>   **AIP Error Status Live**   **2**
>   This bit represents the live error status for the AIP
>   checking logic. A high indicates an error while low
>   indicates no error. This is not a latched value; therefore,
>   an error could have occurred previously and not be
>   indicated by this bit.
>
>   This bit indicates the AIP error status whether or not AIP
>   checking is enabled. Therefore, only use this bit when
>   AIP checking is enabled. This bit may indicate false
>   errors and should not be used except for diagnostic
>   purposes.

AIPERR   **AIP Error Status**   **1**
            This bit represents the error status for the AIP checking
            logic. This bit is set upon an AIP error and cleared either
            when the interrupt is cleared or the RAIPER bit is set in
            the AIP Control One (AIPCNTL1) register.

            This bit indicates the AIP error status whether or not AIP
            checking is enabled. Therefore, only use this bit when
            AIP checking is enabled.

PARITYERR   Parity Error Status   0
This bit represents the error status for the parity error.
This bit is set upon a parity error and clears when the
interrupt clears.

Register: 0xBF
AIP Control One (AIPCNTL1)
Read/Write

7			4	3	2	1	0
		R		DISAIP	RAIPERR	FBAIP	RSQ
0	0	0	0	0	0	0	0

R   Reserved   [7:4]

DISAIP   Disable AIP Code Generation   3
When set, this bit disables AIP code generation on the
SCSI bus. By default, AIP codes are generated on the
SCSI bus during all asynchronous transfers.

RAIPERR   Reset AIP Error   2
This bit allows an AIP error condition to be reset
manually. Setting this bit clears the AIP error status in
bit 1 of AIP Control Zero (AIPCNTL0). Setting this bit
does not clear the live AIP error status in bit 0 of AIP
Control Zero (AIPCNTL0). The RAIPERR bit is not
self-clearing. It must be written back to zero.

FBAIP   Force Bad AIP Value   1
When set, this bit causes bad AIP values to be sent over
the SCSI bus.

RSQ   Reset AIP Sequence Value   0
When set, this bit causes the sequence value used in the
calculation of the protection code to be reset.

Registers: 0xC0–0xC3
Phase Mismatch Jump Address One (PMJAD1)
Read/Write

31   0

PMJAD1

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PMJAD1   **Phase Mismatch Jump Address One**   **[31:0]**
This register contains the 32-bit address that is jumped to upon a phase mismatch. Depending upon the state of the PMJCTL bit, this address is either used during an outbound (Data-Out, Command, Message-Out) phase mismatch (PMJCTL = 0) or when the WSR bit is cleared (PMJCTL = 1). This register is loaded with the address of a SCRIPTS routine that updates the memory data structures of the BMOV that was executing when the phase mismatch occurred.

Registers: 0xC4–0xC7
Phase Mismatch Jump Address Two (PMJAD2)
Read/Write

31   0

PMJAD2

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PMJAD2   **Phase Mismatch Jump Address Two**   **[31:0]**
This register contains the 32-bit address that is jumped to upon a phase mismatch. Depending upon the state of the PMJCTL bit, this address is either used during an inbound (Data-In, Status, Message-In) phase mismatch (PMJCTL = 0) or when the WSR bit is set (PMJCTL = 1). This register is loaded with the address of a SCRIPTS routine that updates the memory data structures of the BMOV that was executing when the phase mismatch occurred.

Registers: 0xC8–0xCB
Remaining Byte Count (RBC)
Read/Write

															RBC															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

RBC   **Remaining Byte Count**   **[31:0]**

This register contains the byte count that remains for the BMOV that was executing when the phase mismatch occurred. In the case of Direct or Indirect BMOV instructions, the upper byte of this register also contains the opcode of the BMOV that was executing. In the case of a Table Indirect BMOV instruction, the upper byte contains the upper byte of the Table Indirect entry that was fetched.

In the case of a SCSI data receive, this byte count reflects all data received from the SCSI bus, including any byte in SCSI Wide Residue (SWIDE). There is no data remaining in the part that must be flushed to memory with the exception of a possible byte in the SWIDE register. That byte must be flushed to memory manually in SCRIPTS.

In the case of a SCSI data send, this byte count reflects all data sent out onto the SCSI bus. Any data left in the part from the phase mismatch is ignored and automatically cleared from the FIFOs.

Registers: 0xCC–0xCF
Updated Address (UA)
Read/Write

UA

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
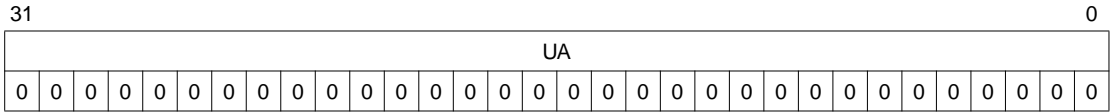
UA   **Updated Address**   **[31:0]**

This register contains the updated data address for the BMOV that was executing when the phase mismatch occurred.

In the case of a SCSI data receive, if there is a byte in the SCSI Wide Residue (SWIDE) register then this address points to the location where that byte must be stored. The SWIDE byte must be manually written to memory and this address must be incremented prior to updating any scatter/gather entry.

In the case of a SCSI data receive, if there is not a byte in the SWIDE register then this address is the next location that should be written to when this I/O restarts. No manual flushing will be necessary.

In the case of a SCSI data send, all data sent to the SCSI bus will be accounted for and any data left in the part is ignored and is automatically cleared from the FIFOs.

Registers: 0xD0–0xD3
Entry Storage Address (ESA)
Read/Write

31   0

															ESA																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ESA **Entry Storage Address** **[31:0]**
This register's value depends on the type of BMOV being executed. The three types of BMOVs are:

Direct BMOV: In the case of a direct BMOV, this register contains the address the BMOV was fetched from when the phase mismatch occurred.

Indirect BMOV: In the case of an indirect BMOV, this register contains the address the BMOV was fetched from when the phase mismatch occurred.

Table Indirect BMOV: In the case of a Table Indirect BMOV, this register contains the address of the Table Indirect entry being used when the phase mismatch occurred.

Registers: 0xD4–0xD7
Instruction Address (IA)
Read/Write

31   0

															IA																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

IA **Instruction Address** **[31:0]**
This register always contains the address of the BMOV instruction that was executing when the phase mismatch occurred. This value will always match the value in the Entry Storage Address (ESA) except in the case of a Table Indirect BMOV in which case the ESA will have the address of the Table Indirect entry and this register points to the address of the BMOV instruction.

Registers: 0xD8–0xDA
SCSI Byte Count (SBC)
Read Only

23																							0
										SBC													
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SBC **SCSI Byte Count** **[23:0]**
This register contains the count of the number of bytes transferred to or from the SCSI bus during any given BMOV. This value is used in calculating the information placed into the Remaining Byte Count (RBC) and Updated Address (UA) registers and should not need to be used in normal operations.

There are several conditions for which the byte count does not match the number of bytes transferred. If a BMOV transfers an odd number of bytes across a wide bus, the byte count at the end of the BMOV is one byte greater than the number of bytes sent. This also occurs in an odd byte count wide receive case. Lastly, when a wide send occurs and a chain byte from a previous transfer is present, the byte count does not reflect the chain byte sent across the bus during that BMOV. To determine the correct address to start fetching data from after a phase mismatch, this byte is not counted for this BMOV. It is included in the previous BMOV's byte count.

Register: 0xDB
Reserved

7							0
			R				
x	x	x	x	x	x	x	x

This register is reserved.

Registers: 0xDC–0xDF
Cumulative SCSI Byte Count (CSBC)
Read/Write

31																															0
															CSBC																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CSBC   **Cumulative SCSI Byte Count**   **[31:0]**

This loadable register contains a cumulative count of the number of bytes transferred across the SCSI bus during data phases. It does not count bytes sent in command, status, Message-In or Message-Out phases. It counts bytes as long as the phase mismatch enable bit (ENPMJ) in the Chip Control Zero (CCNTL0) register is set. Unlike the SCSI Byte Count (SBC), this count is not cleared on each BMOV instruction but continues to count across multiple BMOV instructions. This register can be loaded with any arbitrary start value.

Registers: 0xE0–0xE1
CRC Pad Byte Value (CRCPAD)
Read/Write

15															0
						CRCPBV									
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CRCPBV   **CRC Pad Byte Value**   **[15:0]**

This register contains the value placed onto the bus for the CRC pad bytes.

Register: 0xE2
CRC Control Zero (CRCCNTL0)
Read/Write

7	6	5					0
DCRCC	DCRCPC	R					
0	0	0	0	0	0	0	0

DCRCC   **Disable CRC Checking**   **7**

Setting this bit causes the internal logic not to check or report CRC errors during Ultra160 transfers. The LSI53C1010R continues to calculate and send CRCs as requested by the target according to the SPI-3 specification.

DCRCPC   **Disable CRC Protocol Checking**   **6**

Setting this bit causes the internal logic to neither check nor report CRC protocol errors during Ultra160 transfers. The LSI53C1010R continues to calculate and send CRCs as requested by the target according to the SPI-3 specification but does not set a SGE interrupt if a CRC protocol error occurs. This bit should not be set in normal operations.

R   **Reserved**   **[5:0]**

Register: 0xE3
CRC Control One (CRCCNTL1)
Read/Write

7	6	5	4	3	2	1	0
CRCERR	R	ENAS	TSTSD	TSTCHK	TSTADD	CRCDSEL	
0	0	0	0	0	0	0	0

CRCERR   **CRC Error**   **7**

This bit indicates whether or not a CRC error has been detected during a DT Data-In SCSI transfer. This bit is set independent of the DCRCC bit. To clear this condition, either write this bit to a 1 or read the SIST0 and SIST1 registers. When CRC Checking and the Parity/CRC/AIP Error Interrupt are enabled, this error condition is also indicated as a Parity/CRC/AIP error (bit 0 of the SIST0 register).

R	Reserved	6

ENAS — **Enable CRC Auto Seed** — **5**

Setting this bit causes the CRC logic to automatically reseed after every CRC check performed during DT Data-In SCSI transfers. When this bit is cleared, the SCSI control logic controls when the reseeding occurs.

TSTSD — **Test CRC Seed** — **4**

Setting this bit causes the CRC logic to immediately reseed itself. This bit should never be set during normal operation as it may cause corrupt CRCs to be generated.

TSTCHK — **Test CRC Check** — **3**

Setting this bit causes the CRC logic to initiate a CRC check. This bit should never be set during normal operation as it results in spurious CRC errors.

TSTADD — **Test CRC Accumulate** — **2**

Setting this bit causes the CRC block to take the value in its input register and add it into the current CRC calculation, resulting in a new output CRC value. This bit should not be set during normal operation as it results in corrupt CRC values.

CRCDSEL — **CRC Data Register Selector** — **[1:0]**

These bits control the data that is visible in the CRC Data (CRCDATA) register.

Registers: 0xE4–0xE7
CRC Data (CRCD)
Read/Write

31																														0
															CRCD																
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

The value in this register is dependent on the setting of the CRCDSEL bits in the CRC Control One (CRCCNTL1) register.
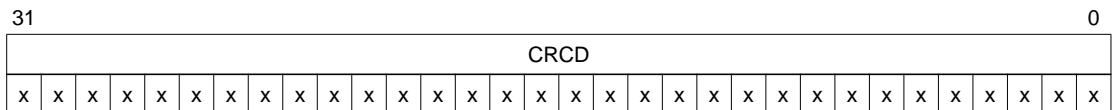
> Note: Data written to this register may not be available for immediate read back due to synchronization between the PCI and SCSI clock domains. After a write, wait at least 16 PCI clock cycles before reading this register.

CRCD   **CRC Data**   **[31:0]**

If CRCDSEL = 0b00, this register represents the current CRC value. After sending data during the DT Data-Out phase, this register contains the CRC calculation for that data, if no CRC request occurred during the transfer. In this mode, this register is read only.

If CRCDSEL = 0b01, this register represents the CRC Input register and contains its current value. It normally contains the SCSI data transferred to or from the SCSI bus during a DT transfer phase. In this mode, this register can be written to in order to manually alter the input data used for CRC calculation. For normal operations, this register should never be written to.

If CRCDSEL = 0b10, this register represents the CRC Accumulator and contains its current value. In this mode, this register can be written to in order to manually modify the value in the accumulator. This register should not be written to during normal operation as corrupt CRC values result.

If CRCDSEL = 0b11, this register contains the saved bad CRC value that was calculated when a CRC error was detected. After a CRC error is detected, this register is not overwritten until the error condition is cleared.

Registers: 0xE8–0xEF
Reserved

31																														0
														R																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This register is reserved.

Registers: 0xF0–0xF1
DMA FIFO Byte Count (DFBC)
Read Only

15															0
DFBC															
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

DFBC   **DMA FIFO Byte Count**   **[15:0]**
This 16-bit read only register contains the actual number of bytes contained in the DMA FIFO. This register is not stable while data is actually being transferred. This register can be used during error recovery.

Registers: 0xF2–0xF3
Reserved

15															0
R															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This register is reserved.

Registers: 0xF4–0xFF
Reserved

31																															0
R																															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This register is reserved.

4.3 SCSI Shadow Registers

Note: For more information concerning shadow registers, refer to the Chip Test Four (CTEST4), Scratch Register A (SCRATCHA), Chip Control Two (CCNTL2), Scratch Register B (SCRATCHB), Memory Move Read Selector (MMRS), Memory Move Write Selector (MMWS), and SCRIPT Fetch Selector (SFS) register descriptions.

Registers: 0x34–0x37
Shadowed Scratch Register A (SCRATCHA)
Read/Write

31   0

															SCRATCHA																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SCRATCHA   **Scratch Register A**   **[31:0]**

When the Configuration Info Enable bit in the Chip Test Two (CTEST2) register is set, SCRATCH Register A is placed in the shadowed mode and returns bits [31:10] of the PCI Base Address Register One (BAR1) (MEMORY) in bits [31:10]. Bits [9:0] of SCRATCH A will always return zero in this mode. Writes to the SCRATCHA register have no effect. Clearing the PCI Configuration Info Enable bit causes the SCRATCH A register to return to normal operation.

Register: 0x42
Shadowed SCSI SGE Status 0
Read/Write

7	6	5	4	3	2	1	0
SRP	DFP	RD	PCO	OO	OU	R	
0	0	0	0	0	0	0	0

This register contains the individual status bits which cause a SGE SCSI interrupt. These bits correspond to the SGE conditions described in the SIST0 register description. Unlike the other registers in the device, these bits must be set to one to clear the condition. This register is shadowed behind the SCSI Interrupt Status Zero (SIST0) register. It can be accessed by setting bit 7, the Enable Shadowed SGE Register (ShSGE) bit, in the Chip Control Two (CCNTL2) register.

SRP   **SCRIPTS RAM Parity**   **7**

DFP   **DMA FIFO Parity**   **6**

RD   **Residual Data in SCSI FIFO**   **5**

PCO   **Phase Change with outstanding Offset**   **4**

OO	**Offset Overflow**	**3**
OU	**Offset Underflow**	**2**
R	**Reserved**	**[1:0]**

Register: 0x43
Shadowed SCSI Interrupt Status One (SIST1)
Read Only

7	6	5	4	3	2	1	0
R		PNCRC	FCRC	DTST	NFCRC	MCRC	R
0	0	0	0	0	0	0	0

This register contains the individual status bits which cause a SGE SCSI interrupt. These bits correspond to the SGE conditions described in the SIST0 register description. Unlike the other registers in the device, these bits must be set to one to clear the condition. This register is shadowed behind the SCSI Interrupt Status One (SIST1) register. It can be accessed by setting bit 7, the Enable Shadowed SGE Register (ShSGE) bit, in the Chip Control Two (CCNTL2) register.

R	**Reserved**	**[7:6]**
PNCRC	**Pad Request with no CRC Request Following**	**5**
FCRC	**Force CRC**	**4**
DTST	**Switch from DT to ST timings during a transfer**	**3**
NFCRC	**Phase Change with no final CRC Request**	**2**
MCRC	**Multiple CRC Requests with the same offset**	**1**
R	**Reserved**	**0**

Registers: 0x5C–0x5F
Shadowed Scratch Register B (SCRATCHB)
Read/Write

31   0

SCRATCHB

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SCRATCHB   **Scratch Register B**   **[31:0]**

When the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register is set, SCRATCH Register B is placed in the shadow mode. When read in this mode, bits [31:13] of the Scratch Register B (SCRATCHB) register return bits [31:13] of the PCI Base Address Register Three (BAR3) (SCRIPTS RAM) and bits [12:0] of SCRATCH B return zeros. Writes to the SCRATCH B register have no effect. Resetting the PCI Configuration Info Enable bit causes the SCRATCH B register to return to normal operation.

Registers: 0xA0–0xA3
Shadowed Memory Move Read Selector (MMRS)
Read/Write

31   0

MMRS

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MMRS   **Shadowed Memory Move Read Selector**   **[31:0]**

When the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register is set, the MMRS register is placed in the shadow mode. When read in this mode, the Memory Move Read Selector (MMRS) register returns bits [31:0] of the memory mapped operating register, PCI Base Address Register Two (BAR2) (MEMORY). Writes to the MMRS register have no effect. Clearing the PCI Configuration Info Enable bit causes the MMRS register to return to normal operation.

Registers: 0xA4–0xA7
Shadowed Memory Move Write Selector (MMWS)
Read/Write

31																															0
															MMWS																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MMWS   **Shadowed Memory Move Write Selector   [31:0]**
When the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register is set, the MMWS register is placed in the shadow mode. When read in this mode, the MMWS register returns bits [31:0] of the SCRIPT RAM PCI Base Address Register Four (BAR4) (SCRIPTS RAM) in bits [31:0] of the MMWS register. Writes to the MMWS register have no effect. Clearing the PCI Configuration Info Enable bit causes the MMWS register to return to normal operation.

Registers: 0xA8–0xAB
Shadowed SCRIPT Fetch Selector (SFS)
Read/Write

31																															0
															SFS																
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SFS   **Shadowed SCRIPT Fetch Selector   [31:0]**
When the PCI Configuration Info Enable bit in the Chip Test Two (CTEST2) register is set, the SCRIPT Fetch Selector register is placed in shadow mode. When read in this mode, bits [23:16] of this register return the PCI Revision ID (RID) register value and bits [15:0] return the PCI Device ID register value. Writes to the SCRIPT Fetch Selector (SFS) register have no effect. Clearing the PCI Configuration Info Enable bit causes the SFS register to return to normal operation.

Chapter 5
SCSI SCRIPTS Instruction Set

After power-up and initialization, the LSI53C1010R can operate in the low level register interface mode, or use SCSI SCRIPTS.

With the low level register interface, the user has access to the DMA control logic and the SCSI bus control logic. An external processor has access to the SCSI bus signals and the low level DMA signals, which allow creation of complicated board level test algorithms. The low level interface is useful for backward compatibility with SCSI devices that require certain unique timings or bus sequences to operate properly.

The following sections describe the benefits and use of SCSI SCRIPTS.

- Section 5.1, "SCSI SCRIPTS"
- Section 5.2, "Block Move Instructions"
- Section 5.3, "I/O Instructions"
- Section 5.4, "Read/Write Instructions"
- Section 5.5, "Transfer Control Instructions"
- Section 5.6, "Memory Move Instructions"
- Section 5.7, "Load and Store Instructions"

5.1 SCSI SCRIPTS

To operate in the SCSI SCRIPTS mode, the LSI53C1010R requires only a SCRIPTS start address. The start address must be at a Dword (four byte) boundary. This aligns all the following SCRIPTS at a Dword boundary since all SCRIPTS are 8 or 12 bytes long. Instructions are fetched until an interrupt instruction is encountered, or until an unexpected event (such as a hardware error) causes an interrupt to the external processor.

Once an interrupt is generated, the LSI53C1010R halts all operations until the interrupt is serviced. Then, the start address of the next SCRIPTS instruction is written to the DMA SCRIPTS Pointer (DSP) register to restart the automatic fetching and execution of instructions.

In the SCSI SCRIPTS mode the LSI53C1010R is allowed to make decisions based on the status of the SCSI bus, which frees the microprocessor from servicing the numerous interrupts inherent in I/O operations.

Given the rich set of SCSI oriented features included in the instruction set, and the ability to re-enter the SCSI algorithm at any point, this high level interface is all that is required for both normal and exception conditions. Switching to the low level mode for error recovery is not required.

The following types of SCRIPTS instructions are implemented in the LSI53C1010R:

- Block Move—used to move data between the SCSI bus and memory.
- I/O or Read/Write—causes the LSI53C1010R to trigger common SCSI hardware sequences, or to move registers.
- Transfer Control—allows SCRIPTS instructions to make decisions based on real time SCSI bus conditions.
- Memory Move—causes the LSI53C1010R to execute block moves between different parts of main memory.
- Load/Store—provides a more efficient way to move data to/from memory from/to an internal register in the chip without using the Memory Move instruction.

Each instruction consists of two or three 32-bit words. The first 32-bit word is always loaded into the DMA Command (DCMD) and DMA Byte Counter (DBC) registers, the second into the DMA SCRIPTS Pointer Save (DSPS) register. The third word, used only by Memory Move instructions, is loaded into the Temporary (TEMP) shadow register. In an indirect I/O or Move instruction, the first two 32-bit opcode fetches are followed by one or two more 32-bit fetch cycles.

5.1.1 Sample Operation

The following example describes execution of a SCRIPTS Block Move instruction.

- The host CPU, through programmed I/O, gives the DMA SCRIPTS Pointer (DSP) register (in the Operating register file) the starting address in main memory that points to a SCSI SCRIPTS program for execution.

- Loading the DMA SCRIPTS Pointer (DSP) register causes the LSI53C1010R to fetch its first instruction at the address just loaded. This fetch is from main memory or the internal RAM, depending on the address.

- The LSI53C1010R typically fetches two Dwords (64 bits) and decodes the high order byte of the first Dword as a SCRIPTS instruction. If the instruction is a Block Move, the lower three bytes of the first Dword are stored and interpreted as the number of bytes to move. The second Dword is stored and interpreted as the 32-bit beginning address in main memory to which the move is directed.

- For a SCSI send operation, the LSI53C1010R waits until there is enough space in the DMA FIFO to transfer a programmable size block of data. For a SCSI receive operation, it waits until enough data is collected in the DMA FIFO for transfer to memory. At this point, the LSI53C1010R requests use of the PCI bus again to transfer the data.

- When the LSI53C1010R is granted the PCI bus, it executes (as a bus master) a burst transfer (programmable size) of data, decrements the internally stored remaining byte count, increments the address pointer, and then releases the PCI bus. The LSI53C1010R stays off the PCI bus until the FIFO can again hold (for a write) or has collected (for a read) enough data to repeat the process.

The process repeats until the internally stored byte count has reached zero. The LSI53C1010R releases the PCI bus and then performs another SCRIPTS instruction fetch cycle, using the incremented stored address maintained in the DMA SCRIPTS Pointer (DSP) register. Execution of SCRIPTS instructions continues until an error condition occurs or an interrupt SCRIPTS instruction is received. At this point, the LSI53C1010R interrupts the host CPU and waits for further servicing by

the host system. It can execute independent Block Move instructions specifying new byte counts and starting locations in main memory. In this manner, the LSI53C1010R performs scatter/gather operations on data without requiring help from the host program, generating a host interrupt, or programming of an external DMA controller.

Figure 5.1 provides an overview of SCRIPTS operation.

Figure 5.1   SCRIPTS Overview
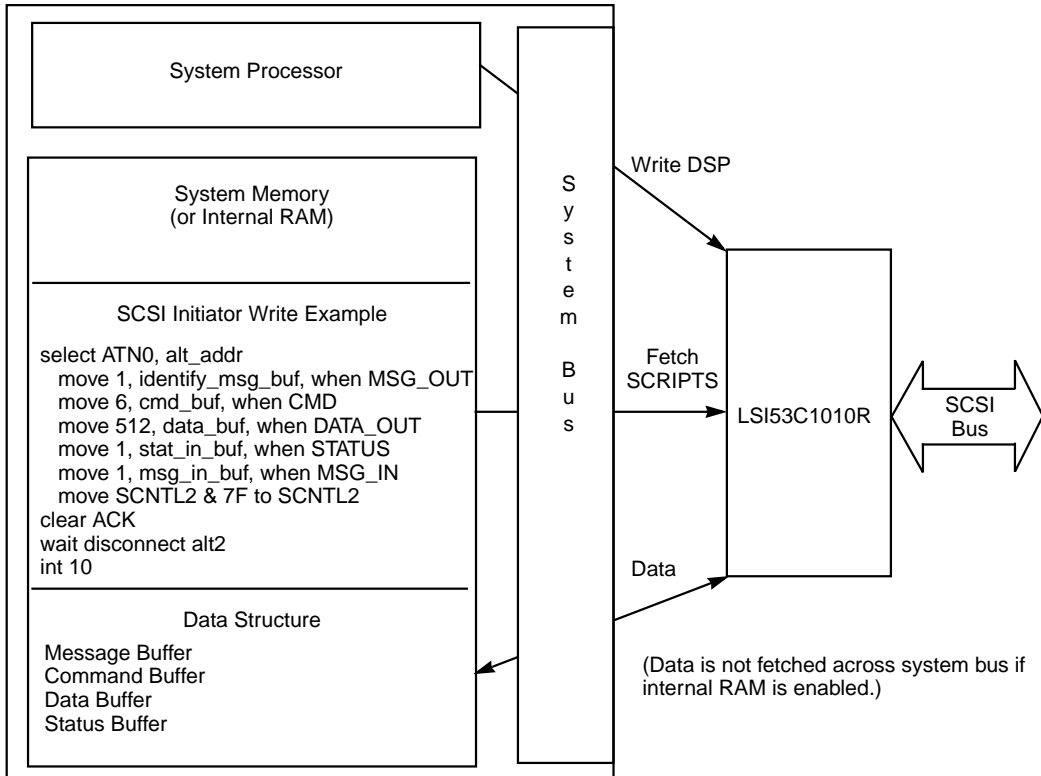
5.2 Block Move Instructions

For Block Move instructions, bits 5 and 4 (SIOM and DIOM) in the DMA Mode (DMODE) register determine whether the source/destination address resides in memory or I/O space. When data is moved onto the SCSI bus, SIOM controls whether that data comes from the I/O or memory space. When data is moved off of the SCSI bus, DIOM controls whether that data goes to the I/O or memory space.

5.2.1 First Dword

This section describes the structure of the first SCSI SCRIPTS Dword. Bits [31:24] are loaded into the DMA Command register while bits [23:0] are loaded into the DBC Register.

Figure 5.2   Block Move Instruction - First Dword

31	30	29	28	27	26	24	23	0
DCMD Register							DBC Register	
IT[1:0]		IA	TIA	OPC	SCSIP[2:0]		TC[23:0]	

IT[1:0]   **Instruction Type - Block Move**   **[31:30]**
The configuration of these two bits define the SCRIPTS instruction type. The Block Move Instruction is 0b00.

IA   **Indirect Addressing**   **29**
When this bit is cleared, user data is moved to or from the 32-bit data start address for the Block Move instruction. The value is loaded into the chip's address register and incremented as data is transferred. The address of the data to move is in the second Dword of this instruction.

When the EN64DBMV bit in Chip Control One (CCNTL1) is set, a third Dword is fetched to provide the upper Dword of a 64-bit address. The upper Dword address is fetched along with the instruction and loaded into the Dynamic Block Move Selector (DBMS) register.

If the EN64DBMV bit is cleared, the upper Dword address is copied from the Static Block Move Selector (SBMS) register.

Direct Addressing

The byte count and absolute address are as follows:

Command	Byte Count
Lower Dword Address of Data	
Upper Dword address of data (EN64DBMV = 1)	

Indirect

When set, the 32-bit user data start address for the Block Move is the address of a pointer to the actual data buffer address. The value at the 32-bit start address is loaded into the chip's DMA Next Address (DNAD) register using a third Dword fetch (4-byte transfer across the host computer bus).

Use the fetched byte count, but fetch the data address from the address in the instruction.

If 64-bit addressing is desired, the upper Dword of the address is stored in the Static Block Move Selector (SBMS) register. When the value in SBMS is 0x0, 32-bit addressing is assumed.

Command	Byte Count
Address of Pointer to Data	

Once the data pointer address is loaded, it is executed as when the chip operates in the direct mode. This indirect feature allows specification of a table of data buffer addresses. Using the SCSI SCRIPTS compiler, the table offset is placed in the SCRIPT at compile time. Then at the actual data transfer time, the offsets are added to the base address of the data address table by the external processor. The logical I/O driver builds a structure of addresses for an I/O rather than treating each address individually.

Note: Using indirect and table indirect addressing simultaneously is not permitted; use only one addressing method at a time.

When this bit is set, the 24-bit signed value in the start address of the move is treated as a relative displacement from the value in the Data Structure Address (DSA) register. Both the transfer count and the source/destination address are fetched from this location.

Use the signed integer offset in bits [23:0] of the second four bytes of the instruction, added to the value in the Data Structure Address (DSA) register, to fetch first the byte count and then the data address. The signed value is combined with the data structure base address to generate the physical address used to fetch values from the data structure. Sign-extended values of all ones for negative values are allowed, but bits [31:24] are ignored.

Command	Not Used
Don't Care	Table Offset

Note: Using indirect and table indirect addressing simultaneously is not permitted; use only one addressing method at a time.

Prior to the start of an I/O, load the Data Structure Address (DSA) register with the base address of the I/O data structure. Any address on a Dword boundary is allowed.

After a Table Indirect opcode is fetched, the Data Structure Address (DSA) is added to the 24-bit signed offset value from the opcode to generate the address of the required data; both positive and negative offsets are allowed. A subsequent fetch from that address brings the data values into the chip.

For a MOVE instruction, the 24-bit byte count is fetched from system memory. Then the 32-bit physical address is brought into the LSI53C1010R. Execution of the move begins at this point.

SCRIPTS can directly execute operating system I/O data structures, saving time at the beginning of an I/O operation. The I/O data structure can begin on any Dword boundary and may cross system segment boundaries.

There are two restrictions on the placement of pointer data in system memory:

- The eight bytes of data in the MOVE instruction must be contiguous.

- Indirect data fetches are not available during execution of a Memory-to-Memory DMA operation.

00	Byte Count
Physical Data Address	

64-Bit Addressing

If the Enable 64-bit Table Indirect Block Move (EN64TIBMV) bit is cleared, table indirect block moves remain as 2 Dword opcodes plus a 2 Dword table entry. The upper 32 bits of the address are copied from the Static Block Move Selector (SBMS) when performing data transfers during block move operations. The SBMS register must be loaded manually.

If the Enable 64-bit Table Indirect Block Move (EN64TIBMV) bit is set and the 64-bit Table Indirect Index Mode (64TIMOD) bit is cleared, bits [28:24] of the first Dword of the table entry (where the byte count is located) select one of the 16 scratch registers or any of the six 64-bit selector registers as a selector for the upper 32-bit address. Please see the Table Indirect Index mode mapping table for a breakdown of index values and the corresponding registers selected. The selected address is automatically loaded into the DMA Next Address 64 (DNAD64) register.

Note: If EN64TIBMV is set and 64TIMOD is set, bits [31:24] of the first Dword of the table entry (where the byte count is located) are loaded directly into DMA Next Address 64 (DNAD64) to provide a 40-bit address.

The format for the table indirect entries for each mode is shown below. The table for Table Indirect block moves upper 32-bit address locations summarizes the available modes for table indirect block moves.

Index Mode 0 (64TIMOD clear) table entry format:

31	29 28		24 23		0
R	Sel Index		Byte Count		
Source/Destination Address [31:0]					

Index Mode 1 (64TIMOD set) table entry format:

31	24	23	0
Src/Dest Addr [39:32]		Byte Count	
Source/Destination Address [31:0]			

Table Indirect block moves upper 32-bit address locations:

EN64TIBMV	64TIMOD	Upper 32-Bit Data Address Comes From
0	0	SBMS
0	1	SBMS
1	0	ScratchC–J, MMWS, MMRS, SFS, DRS, SBMS, DBMS
1	1	1st Table Entry Dword bits [31:24] (40-bit addressing only)

Table Indirect Index mode mapping:

Index Value	Selector Used
0x00	Scratch C
0x01	Scratch D
0x02	Scratch E
0x03	Scratch F
0x04	Scratch G
0x05	Scratch H
0x06	Scratch I
0x07	Scratch J
0x08	Scratch K
0x09	Scratch L
0x0A	Scratch M
0x0B	Scratch N
0x0C	Scratch O
0x0D	Scratch P
0x0E	Scratch Q
0x0F	Scratch R
0x10	MMRS

Index Value	Selector Used
0x11	MMWS
0x12	SFS
0x13	DRS
0x14	SBMS
0x15	SBMS
0x16–0x1F	Illegal (Results in an IID interrupt)

OPC   **Opcode**   **27**

This 1-bit field defines the instruction to execute as a block move (MOVE).

Target Mode

OPC	Instruction Defined
0	MOVE/MOVE64
1	CHMOV/CHMOV64

The LSI53C1010R verifies that it is connected to the SCSI bus as a target before executing this instruction.

The LSI53C1010R asserts the SCSI phase signals (SMSG/, SC_D/, and SI_O/) as defined by the Phase Field bits in the instruction.

If the instruction is for the command phase, the LSI53C1010R receives the first command byte and decodes its SCSI Group Code.

- If the SCSI Group Code is either Group 0, Group 1, Group 2, or Group 5, then the LSI53C1010R overwrites the DMA Byte Counter (DBC) register with the length of the Command Descriptor Block: 6, 10, or 12 bytes.

- If the Vendor Unique Enhancement 0 (VUE0) bit (SCSI Control Two (SCNTL2), bit 1) is cleared and the SCSI group code is a vendor unique code, the LSI53C1010R overwrites the DMA Byte Counter (DBC) register with the length of the Command Descriptor Block: 6, 10, or 12 bytes. If the VUE0 bit is set, the LSI53C1010R receives the number of bytes in the byte count regardless of the group code.

- If any other Group Code is received, the DMA Byte Counter (DBC) register is not modified and the LSI53C1010R requests the number of bytes specified in the DMA Byte Counter (DBC) register. If the DBC register contains 0x000000, an illegal instruction interrupt is generated.

The LSI53C1010R transfers the number of bytes specified in the DMA Byte Counter (DBC) register starting at the address specified in the DMA Next Address (DNAD) register. If the Opcode bit is set and a data transfer ends on an odd byte boundary, the LSI53C1010R stores the last byte in the SCSI Wide Residue (SWIDE) register during a receive operation. This byte is combined with the first byte from the subsequent transfer so that a wide transfer can complete.

If the SATN/ signal is asserted by the initiator or a parity error occurred during the transfer, it is possible to halt the transfer and generate an interrupt. The Disable Halt on Parity Error or ATN bit in the SCSI Control One (SCNTL1) register controls whether the LSI53C1010R halts on these conditions immediately, or waits until completion of the current Move.

Initiator Mode

OPC	Instruction Defined
0	CHMOV/CHMOV64
1	MOVE/MOVE64

The LSI53C1010R verifies that it is connected to the SCSI bus as an initiator before executing this instruction.

The LSI53C1010R waits for an unserviced phase to occur. An unserviced phase is defined as any phase (with SREQ/ asserted) for which the LSI53C1010R has not yet transferred data by responding with a SACK/.

The LSI53C1010R compares the SCSI phase bits in the DMA Command (DCMD) register with the latched SCSI phase lines stored in the SCSI Status One (SSTAT1) register. These phase lines are latched when SREQ/ is asserted.

If the SCSI phase bits match the value stored in the SCSI Status One (SSTAT1) register, the LSI53C1010R transfers the number of bytes specified in the DMA Byte Counter (DBC) register starting at the address pointed to by the DMA Next Address (DNAD) register. If the opcode bit is cleared and a data transfer ends on an odd byte boundary, the LSI53C1010R stores the last byte in the SCSI Wide Residue (SWIDE) register during a receive operation, or in the SCSI Output Data Latch (SODL) register during a send operation. This byte is combined with the first byte from the subsequent transfer so that a wide transfer can complete.

If the SCSI phase bits do not match the value stored in the SCSI Status One (SSTAT1) register, the LSI53C1010R generates a phase mismatch interrupt and the instruction is not executed.

During a Message-Out phase, after the LSI53C1010R has performed a select with Attention (or SATN/ is manually asserted with a Set ATN instruction), the LSI53C1010R deasserts SATN/ during the final SREQ/SACK/ handshake.

When the LSI53C1010R is performing a block move for Message-In phase, it does not deassert the SACK/ signal for the last SREQ/SACK/ handshake. Clear the SACK/ signal using the Clear SACK I/O instruction.

SCSIP[2:0] **SCSI Phase**   **[26:24]**
This field defines the desired SCSI information transfer phase. When the LSI53C1010R operates in the initiator mode, these bits are compared with the latched SCSI phase bits in the SCSI Status One (SSTAT1) register. When the LSI53C1010R operates in the target mode, it asserts the phase defined in this field. The following table describes the possible combinations and the corresponding SCSI phase.

MSG	C_D	I_O	SCSI Phase
0	0	0	ST Data-Out
0	0	1	ST Data-In
0	1	0	Command
0	1	1	Status
1	0	0	DT Data-Out
1	0	1	DT Data-In
1	1	0	Message-Out
1	1	1	Message-In

TC[23:0]   **Transfer Counter**   **[23:0]**

This 24-bit field specifies the number of data bytes to be moved between the LSI53C1010R and system memory. The field is stored in the DMA Byte Counter (DBC) register. When the LSI53C1010R transfers data to/from memory, the DBC register is decremented by the number of bytes transferred. In addition, the DMA Next Address (DNAD) register is incremented by the number of bytes transferred. This process is repeated until the DBC register is decremented to zero. At this time, the LSI53C1010R fetches the next instruction.

If bit 28 is set, indicating table indirect addressing, this field is not used. The byte count is instead fetched from a table pointed to by the Data Structure Address (DSA) register.

5.2.2 Second Dword

This section describes the structure of the second SCSI SCRIPTS Dword.

Figure 5.3   Block Move Instruction - Second Dword

31	24 23	16 15	8 7	0
		DSPS Register		
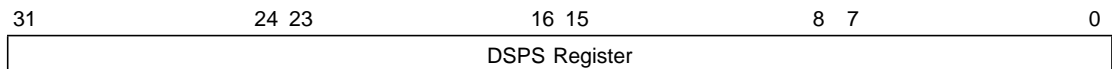
Start Address   **[31:0]**

This 32-bit field specifies the starting address of the data to move to/from memory. This field is copied to the DMA Next Address (DNAD) register. When the LSI53C1010R

transfers data to or from memory, the DNAD register is incremented by the number of bytes transferred.

When bit 29 is set, indicating indirect addressing, this address is a pointer to an address in memory that points to the data location. When bit 28 is set, indicating table indirect addressing, the value in this field is an offset into a table pointed to by the Data Structure Address (DSA). The table entry contains byte count and address information.

5.2.3 Third Dword

This section describes the structure of the third SCSI SCRIPTS Dword.

Figure 5.4   Block Move Instruction - Third Dword

31	24 23	16 15	8 7	0
DBMS Register				
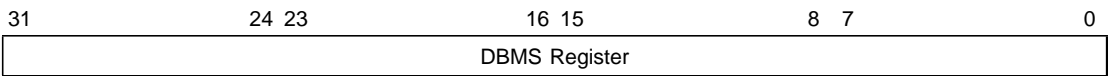
Start Address   **[63:32]**
This 32-bit field specifies the upper Dword of a 64-bit starting address of data to move to/from memory. This field is copied to the Dynamic Block Move Selector (DBMS) register. The EN64DBMV bit in the Chip Control One (CCNTL1) register must be set for this Dword to be fetched.

5.3 I/O Instructions

This section contains information about the I/O Instruction register. It is divided into First Dword and Second Dword.

5.3.1 First Dword

This section describes the first Dword of the I/O Instruction register.

Figure 5.5   First 32 bit Word of the I/O Instruction

31 30 29	27 26 25 24 23	20 19	16 15	11 10	9	8 7	6 5 4	3 2	0
DCMD Register			DBC Register						
IT[1:0] | OPC[2:0] | RA | TI | Sel	R	ENDID[3:0]	R	CA | TM	R	A	R	ATN	R
0 1 | x x x | x | x | x	0 0 0 0	x x x x	0 0 0 0 0	x | x	0 0	x	0 0	x	0 0 0

IT[1:0]	**Instruction Type - I/O Instruction**	**[31:30]**
OPC[2:0]	**Opcode**	**[29:27]**

The following Opcode bits have different meanings, depending on whether the LSI53C1010R is operating in the initiator or target mode. Opcode selections 0b101–0b111 are considered Read/Write instructions, and are described in Section 5.4, "Read/Write Instructions."

Target Mode

OPC2	OPC1	OPC0	Instruction Defined
0	0	0	Reselect
0	0	1	Disconnect
0	1	0	Wait Select
0	1	1	Set
1	0	0	Clear

Reselect Instruction

The LSI53C1010R arbitrates for the SCSI bus by asserting the SCSI ID stored in the SCSI Chip ID (SCID) register. If it loses arbitration, it tries again during the next available arbitration cycle without reporting any lost arbitration status.

If the LSI53C1010R wins arbitration, it attempts to reselect the SCSI device whose ID is defined in the destination ID field of the instruction. Once the LSI53C1010R wins arbitration, it fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register. This way the SCRIPTS can move on to the next instruction before the reselection completes. It continues executing SCRIPTS until a SCRIPT that requires a response from the initiator is encountered.

If the LSI53C1010R is selected or reselected before winning arbitration, it fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register. Manually set the LSI53C1010R to the initiator mode if it is reselected, or to the target mode if it is selected.

Disconnect Instruction

The LSI53C1010R disconnects from the SCSI bus by deasserting all SCSI signal outputs.

Wait Select Instruction

If the LSI53C1010R is selected, it fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register.

If reselected, the LSI53C1010R fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register. Manually set the LSI53C1010R to the initiator mode when it is reselected.

If the CPU sets the SIGP bit in the Interrupt Status Zero (ISTAT0) register, the LSI53C1010R aborts the Wait Select instruction and fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register.

Set Instruction

When the SACK/ or SATN/ bits are set, the corresponding bits in the SCSI Output Control Latch (SOCL) register are set. Do not set SACK/ or SATN/ except for testing purposes. When the target bit is set, the corresponding bit in the SCSI Control Zero (SCNTL0)

register is also set. When the carry bit is set, the corresponding bit in the Arithmetic Logic Unit (ALU) is set.

Note: None of the signals are set on the SCSI bus in target mode.

Clear Instruction

When the SACK/ or SATN/ bits are cleared, the corresponding bits are cleared in the SCSI Output Control Latch (SOCL) register. Do not set SACK/ or SATN/ except for testing purposes. When the target bit is cleared, the corresponding bit in the SCSI Control Zero (SCNTL0) register is cleared. When the carry bit is cleared, the corresponding bit in the ALU is cleared.

Note: None of the signals are cleared on the SCSI bus in the target mode.

Initiator Mode

OPC2	OPC1	OPC0	Instruction Defined
0	0	0	Select
0	0	1	Wait Disconnect
0	1	0	Wait Reselect
0	1	1	Set
1	0	0	Clear

Select Instruction

The LSI53C1010R arbitrates for the SCSI bus by asserting the SCSI ID stored in the SCSI Chip ID (SCID) register. If it loses arbitration, it tries again during the next available arbitration cycle without reporting any lost arbitration status.

If the LSI53C1010R wins arbitration, it attempts to select the SCSI device whose ID is defined in the destination ID field of the instruction. Once the LSI53C1010R wins arbitration, it fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register. This way the SCRIPTS can move to the next instruction before the selection completes. It continues executing SCRIPTS until a SCRIPT that requires a response from the target is encountered.

If the LSI53C1010R is selected or reselected before winning arbitration, it fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register. Manually set the LSI53C1010R to the initiator mode if it is reselected, or to the target mode if it is selected.

If the Select with SATN/ field is set, the SATN/ signal is asserted during the selection phase.

Wait Disconnect Instruction

The LSI53C1010R waits for the target to perform a "legal" disconnect from the SCSI bus. A "legal" disconnect occurs when SBSY/ and SSEL/ are inactive for a minimum of one Bus Free delay (400 ns), after the LSI53C1010R receives a Disconnect Message or a Command Complete Message.

Wait Reselect Instruction

If the LSI53C1010R is selected before being reselected, it fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register. Manually set the LSI53C1010R to the target mode when it is selected.

If the LSI53C1010R is reselected, it fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register.

If the CPU sets the SIGP bit in the Interrupt Status Zero (ISTAT0) register, the LSI53C1010R aborts the Wait Reselect instruction and fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DMA Next Address (DNAD) register.

Set Instruction

When the SACK/ or SATN/ bits are set, the corresponding bits in the SCSI Output Control Latch (SOCL) register are set. When the target bit is set, the corresponding bit in the SCSI Control Zero (SCNTL0) register is also set. When the carry bit is set, the corresponding bit in the ALU is set.

Clear Instruction

When the SACK/ or SATN/ bits are cleared, the corresponding bits are cleared in the SCSI Output Control Latch (SOCL) register. When the target bit is cleared, the corresponding bit in the SCSI Control Zero (SCNTL0) register is cleared. When the carry bit is cleared, the corresponding bit in the ALU is cleared.

RA	**Relative Addressing Mode**	**26**

When this bit is set, the 24-bit signed value in the DMA Next Address (DNAD) register is used as a relative displacement from the current DMA SCRIPTS Pointer (DSP) address. Use this bit only in conjunction with the Select, Reselect, Wait Select, and Wait Reselect instructions. The Select and Reselect instructions can contain an absolute alternate jump address or a relative transfer address.

TI	**Table Indirect Mode**	**25**

When this bit is set, the 24-bit signed value in the DMA Byte Counter (DBC) register is added to the value in the Data Structure Address (DSA) register, and used as an offset relative to the value in the Data Structure Address (DSA) register. The SCSI Control Three (SCNTL3) value, SCSI ID, synchronous offset and synchronous period are loaded from this address. Prior to the start of an I/O, load the Data Structure Address (DSA) with the base address of the I/O data structure. Any address on a Dword boundary is allowed. After a Table Indirect opcode is fetched, the Data Structure Address (DSA) is added to the 24-bit signed offset value from the opcode to generate the address of the required data. Both positive and negative offsets are allowed. A subsequent fetch from that address brings the data values into the chip.

SCRIPTS can directly execute operating system I/O data structures, saving time at the beginning of an I/O operation. The I/O data structure can begin on any Dword boundary and may cross system segment boundaries. There are two restrictions on the placement of data in system memory:

- The I/O data structure must lie within the 8 Mbytes above or below the base address.

- An I/O command structure must have all four bytes contiguous in system memory, as shown below. The offset/period bits are ordered as in the SCSI Transfer (SXFER) register. The configuration bits are ordered as in the SCSI Control Three (SCNTL3) register.

Config	ID	Offset/period	00

Use this bit only in conjunction with the Select, Reselect, Wait Select, and Wait Reselect instructions. It is allowable to set bits 25 and 26 individually or in combination:

	Bit 25	Bit 26
Direct	0	0
Table Indirect	0	1
Relative	1	0
Table Relative	1	1

Direct

Uses the device ID and physical address in the instruction.

Command	ID	Not Used	Not Used
Absolute Alternate Address			

Table Indirect

Uses the physical jump address, but fetches data using the table indirect method.

Command	Table Offset
Absolute Alternate Address	

Relative

Uses the device ID in the instruction, but treats the alternate address as a relative jump.

Command	ID	Not Used	Not Used
Absolute Jump Offset			

Table Relative

Treats the alternate jump address as a relative jump and fetches the device ID, synchronous offset, and synchronous period indirectly. The value in bits [23:0] of the first four bytes of the SCRIPTS instruction is added to the data structure base address to form the fetch address.

Command	Table Offset
Absolute Jump Offset	

Sel　　　　　**Select with ATN/**　　　　　**24**

This bit specifies whether SATN/ is asserted during the selection phase when the LSI53C1010R is executing a Select instruction. When operating in the initiator mode, set this bit for the Select instruction. If this bit is set on any other I/O instruction, an illegal instruction interrupt is generated.

R　　　　　**Reserved**　　　　　**[23:20]**

ENDID[3:0]　　　**Encoded SCSI Destination ID**　　　**[19:16]**

This 4-bit field specifies the destination SCSI ID for an I/O instruction.

R　　　　　**Reserved**　　　　　**[15:11]**

CA　　　　　**Set/Clear Carry**　　　　　**10**

This bit is used in conjunction with a Set or Clear instruction to set or clear the Carry bit. Setting this bit with a Set instruction asserts the Carry bit in the ALU. Clearing this bit with a Clear instruction deasserts the Carry bit in the ALU.

TM　　　　　**Set/Clear Target Mode**　　　　　**9**

This bit is used in conjunction with a Set or Clear instruction to set or clear the target mode. Setting this bit with a Set instruction configures the LSI53C1010R as a target device (this sets bit 0 of the SCSI Control Zero (SCNTL0) register). Clearing this bit with a Clear instruction configures the LSI53C1010R as an initiator device (this clears bit 0 of the SCNTL0 register).

R	Reserved	[8:7]

A   **Set/Clear SACK/**   **6**

This bit is used in conjunction with a Set or Clear instruction to assert or deassert SACK/.

The Set instruction is used to assert SACK/ on the SCSI bus. The Clear instruction is used to deassert SACK/ on the SCSI bus. The corresponding bit in the SCSI Output Control Latch (SOCL) register is set or cleared depending on the instruction used. Since SACK/ is an initiator signal, it is not asserted on the SCSI bus unless the LSI53C1010R is operating as an initiator.

The Set/Clear SCSI ACK/, ATN/ instructions are used after message phase Block Move operations to give the initiator the opportunity to assert attention before acknowledging the last message byte. For example, if the initiator wishes to reject a message, it issues an Assert SCSI ATN instruction before a Clear SCSI ACK instruction.

R	Reserved	[5:4]

ATN   **Set/Clear SATN/**   **3**

This bit is used in conjunction with a Set or Clear instruction to assert or deassert SATN/.

The Set instruction is used to assert SATN/ on the SCSI bus. The Clear instruction is used to deassert SATN/ on the SCSI bus. The corresponding bit in the SCSI Output Control Latch (SOCL) register will be set or cleared depending on the instruction used. Since SATN/ is an initiator signal, it is not asserted on the SCSI bus unless the LSI53C1010R is operating as an initiator.

The Set/Clear SCSI ACK/, ATN/ instructions are used after message phase Block Move operations to give the initiator the opportunity to assert attention before acknowledging the last message byte. For example, if the initiator wishes to reject a message, it issues an Assert SCSI ATN instruction before a Clear SCSI ACK instruction.

R	Reserved	[2:0]

5.3.2 Second Dword

This section describes the second Dword of the I/O Instruction register.

Figure 5.6   Second 32-Bit Word of the I/O Instruction

31	24 23	16 15	8 7	0
DSPS Register				

SA	**Start Address**		**[31:0]**

This 32-bit field contains the memory address to fetch the next instruction if the selection or reselection fails.

If relative or table relative addressing is used, this value is a 24-bit signed offset relative to the current DMA SCRIPTS Pointer (DSP) register value.

5.4 Read/Write Instructions

The Read/Write instruction supports addition, subtraction, and comparison of two separate values within the chip. It performs the desired operation on the specified register and the SCSI First Byte Received (SFBR) register and stores the result back to the specified register or to the SFBR. If the COM bit (DMA Control (DCNTL), bit 0) is cleared, Read/Write instructions cannot be used.

5.4.1 First Dword

This section describes the first Dword of the Read/Write Instruction register.

Figure 5.7   Read/Write Instruction - First Dword

31 30 29		27 26		24 23 22			16 15								8 7 6							0
DCMD Register					DBC Register																	
IT[1:0]	OPC[2:0]			O[2:0]		D8	Register Address [6:0]								Immediate Data							A7	R						
0	1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	0	0	0	0	0	0

IT[1:0] **Instruction Type - Read/Write Instruction** **[31:30]**
The Read/Write instruction uses operator bits [26:24] in conjunction with the opcode bits to determine which instruction is currently selected.

OPC[2:0] **Opcode** **[29:27]**
These bits determine if the instruction is a Read/Write or an I/O instruction. Opcodes 0b000 through 0b100 are considered I/O instructions.

O[2:0] **Operator** **[26:24]**
The Operator bits are used in conjunction with the opcode bits to determine which instruction is currently selected. Refer to Table 5.1 for field definitions.

D8 **Use data8/SFBR** **23**
When this bit is set, SCSI First Byte Received (SFBR) is used, instead of the data8 value, during a Read-Modify-Write instruction (see Table 5.1 on page 5-26). This allows the user to add two register values.

A[6:0] **Register Address - A[6:0]** **[22:16]**
It is possible to change register values from SCRIPTS in read-modify-write cycles or move to/from SCSI First Byte Received (SFBR) cycles. A[6:0] selects an 8-bit source/destination register within the LSI53C1010R.

IMMD **Immediate Data** **[15:8]**
This 8-bit value is used as a second operand in logical and arithmetic functions.

A7 **Upper Register Address Line [A7]** **7**
This bit is used to access registers 0x80–0xFF.

R **Reserved** **[6:0]**
Must be 0.

5.4.2 Second Dword

This section describes the second Dword of the Read/Write Instruction register.

Figure 5.8   Read/Write Instruction - Second Dword

31	24 23	16 15	8 7	0
		DSPS Register		

DA   **Destination Address**   **[31:0]**
This field contains the 32-bit destination address where the data is to move.
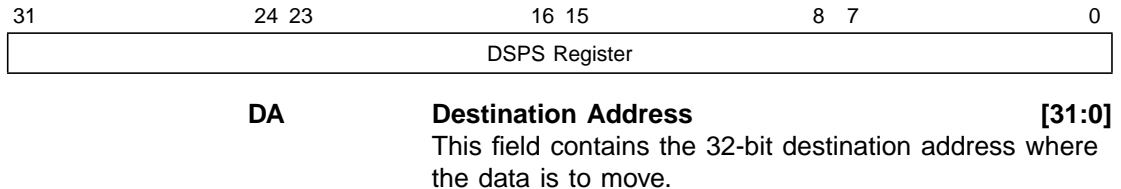
5.4.3 Read-Modify-Write Cycles

During these cycles the register is read, the selected operation is performed, and the result is written back to the source register.

The Add operation is used to increment or decrement register values (or memory values if used in conjunction with a Memory-to-Register Move operation) for use as loop counters.

Subtraction is not available when SCSI First Byte Received (SFBR) is used instead of data8 in the instruction syntax. To subtract one value from another when using SFBR, first XOR the value to subtract (subtrahend) with 0xFF, and add 1 to the resulting value. This creates the 2's complement of the subtrahend. The two values are then added to obtain the difference.

5.4.4 Move To/From SFBR Cycles

All operations are read-modify-writes. However, two registers are involved, one of which is always the SCSI First Byte Received (SFBR). The possible functions of this instruction are:

- Write one byte (value contained within the SCRIPTS instruction) into any chip register.

- Move to/from the SCSI First Byte Received (SFBR) from/to any other register.

- Alter the value of a register with AND, OR, ADD, XOR, SHIFT LEFT, or SHIFT RIGHT operators.

- After moving values to the SCSI First Byte Received (SFBR), the compare and jump, call, or similar instructions are used to check the value.

- A Move-to-SFBR followed by a Move-from-SFBR is used to perform a register to register move.

Table 5.1   Read/Write Instructions[1]

Operator	Opcode 111 Read Modify Write	Opcode 110 Move to SFBR	Opcode 101 Move from SFBR
000	Move data into register. Syntax: "Move data8 to RegA"	Move data into SCSI First Byte Received (SFBR) register. Syntax: "Move data8 to SFBR"	Move data into register. Syntax: "Move data8 to RegA"
001[2]	Shift register one bit to the left and place the result in the same register. Syntax: "Move RegA SHL RegA"	Shift register one bit to the left and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA SHL SFBR"	Shift the SFBR register one bit to the left and place the result in the register. Syntax: "Move SFBR SHL RegA"
010	OR data with register and place the result in the same register. Syntax: "Move RegA | data8 to RegA"	OR data with register and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA | data8 to SFBR"	OR data with SFBR and place the result in the register. Syntax: "Move SFBR | data8 to RegA"
011	XOR data with register and place the result in the same register. Syntax: "Move RegA XOR data8 to RegA"	XOR data with register and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA XOR data8 to SFBR"	XOR data with SFBR and place the result in the register. Syntax: "Move SFBR XOR data8 to RegA"
100	AND data with register and place the result in the same register. Syntax: "Move RegA & data8 to RegA"	AND data with register and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA & data8 to SFBR"	AND data with SFBR and place the result in the register. Syntax: "Move SFBR & data8 to RegA"

Table 5.1   Read/Write Instructions[1] (Cont.)

Operator	Opcode 111 Read Modify Write	Opcode 110 Move to SFBR	Opcode 101 Move from SFBR
101[2]	Shift register one bit to the right and place the result in the same register. Syntax: "Move RegA SHR RegA"	Shift register one bit to the right and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA SHR SFBR"	Shift the SFBR register one bit to the right and place the result in the register. Syntax: "Move SFBR SHR RegA"
110	Add data to register without carry and place the result in the same register. Syntax: "Move RegA + data8 to RegA"	Add data to register without carry and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA + data8 to SFBR"	Add data to SFBR without carry and place the result in the register. Syntax: "Move SFBR + data8 to RegA"
111	Add data to register with carry and place the result in the same register. Syntax: "Move RegA + data8 to RegA with carry"	Add data to register with carry and place the result in the SCSI First Byte Received (SFBR) register. Syntax: "Move RegA + data8 to SFBR with carry"	Add data to SFBR with carry and place the result in the register. Syntax: "Move SFBR + data8 to RegA with carry"

1. Substitute the desired register name or address for "RegA" in the syntax examples.
    data8 indicates eight bits of data. Use SFBR instead of data8 to add two register values.
2. Data is shifted through the Carry bit and the Carry bit is shifted into the data byte.

5.5 Transfer Control Instructions

This section describes transfer control instructions for the first Dword, second Dword, and third Dword.

5.5.1 First Dword

This section describes the first Dword of the Transfer Control Instruction register.

Figure 5.9   Transfer Control Instructions - First Dword

31 30 29	27 26	24	23 22 21 20 19 18 17 16 15									8	7	0
DCMD Register			DBC Register											
IT[1:0]	OPC[2:0]	SCSIP[2:0]	RA	J	CT	IF	TF	CD	CP	VP		MC		DC
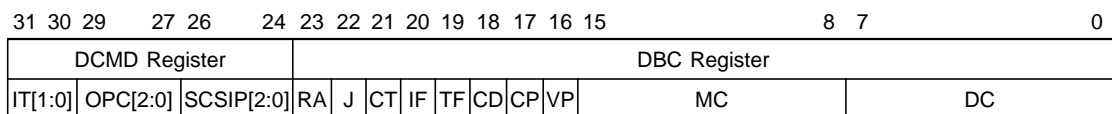
| IT[1:0] | Instruction Type - | |
| | **Transfer Control Instruction** | **[31:30]** |

OPC [2:0]   **Opcode**   **[29:27]**

This 3-bit field specifies the type of transfer control instruction to execute. All transfer control instructions can be conditional. They can be dependent on a true/false comparison of the ALU Carry bit, or a comparison of the SCSI information transfer phase with the Phase field, and/or a comparison of the First Byte Received with the Data Compare field. Each instruction can operate in the initiator or target mode.

OPC2	OPC1	OPC0	Instruction Defined
0	0	0	Jump
0	0	1	Call
0	1	0	Return
0	1	1	Interrupt
1	x	x	Reserved

Jump Instruction

The LSI53C1010R can do a true/false comparison of the ALU carry bit, or compare the phase and/or data as defined by the Phase Compare, Data Compare and True/False bit fields. If the comparisons are true, it loads the DMA SCRIPTS Pointer (DSP) register with the contents of the DMA SCRIPTS Pointer Save (DSPS) register. The DSP register now contains the address of the next instruction.

If the comparisons are false, the LSI53C1010R fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register, leaving the instruction pointer unchanged.

When the JUMP64 instruction is used, a third Dword is fetched and loaded into the Script Fetch Selector (SFS) register. Bit 22 indicates whether the jump is to a 32-bit address (0) or a 64-bit address (1). All combinations of jumps are still valid for JUMP64.

Call Instruction

The LSI53C1010R can do a true/false comparison of the ALU carry bit, or compare the phase and/or data as defined by the Phase Compare, Data Compare, and True/False bit fields. If the comparisons are true, it loads the DMA SCRIPTS Pointer (DSP) register with the contents of the DMA SCRIPTS Pointer Save (DSPS) register and that address value becomes the address of the next instruction.

When the LSI53C1010R executes a Call instruction, the instruction pointer contained in the DMA SCRIPTS Pointer (DSP) register is stored in the Temporary (TEMP) register. Since the TEMP register is not a stack and can only hold one Dword, nested call instructions are not allowed.

If the comparisons are false, the LSI53C1010R fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register and the instruction pointer is not modified.

Return Instruction

The LSI53C1010R can do a true/false comparison of the ALU carry bit, or compare the phase and/or data as defined by the Phase Compare, Data Compare, and True/False bit fields. If the comparisons are true, it loads the DMA SCRIPTS Pointer (DSP) register with the contents of the DMA SCRIPTS Pointer Save (DSPS) register. That address value becomes the address of the next instruction.

When a Return instruction is executed, the value stored in the Temporary (TEMP) register is returned to the DMA SCRIPTS Pointer (DSP) register. The LSI53C1010R does not check to see whether the Call instruction has already been executed. It does not generate an interrupt if a Return instruction is executed without previously executing a Call instruction.

If the comparisons are false, the LSI53C1010R fetches the next instruction from the address pointed to by the DMA SCRIPTS Pointer (DSP) register and the instruction pointer is not modified.

Interrupt Instruction

The LSI53C1010R can do a true/false comparison of the ALU carry bit, or compare the phase and/or data as defined by the Phase Compare, Data Compare, and True/False bit fields. If the comparisons are true, the LSI53C1010R generates an interrupt by asserting the IRQ/ signal.

The 32-bit address field stored in the DMA SCRIPTS Pointer Save (DSPS) register can contain a unique interrupt service vector. When servicing the interrupt, this unique status code allows the Interrupt Service Routine to quickly identify the point at which the interrupt occurred.

The LSI53C1010R halts and the DMA SCRIPTS Pointer (DSP) register must be written to before starting any further operation.

Interrupt-on-the-Fly Instruction

The LSI53C1010R can do a true/false comparison of the ALU carry bit or compare the phase and/or data as defined by the Phase Compare, Data Compare, and True/False bit fields. If the comparisons are true, and the Interrupt-on-the-Fly bit (Interrupt Status Zero (ISTAT0), bit 2) is set, the LSI53C1010R asserts the Interrupt-on-the-Fly bit.

SCSIP[2:0]   **SCSI Phase**   **[26:24]**

This 3-bit field corresponds to the three SCSI bus phase signals that are compared with the phase lines latched when SREQ/ is asserted. Comparisons can be performed to determine the SCSI phase actually being driven on the SCSI bus. The following table describes the possible combinations and their corresponding SCSI phase. These bits are only valid when the LSI53C1010R is operating in the initiator mode. Clear these bits when the LSI53C1010R is operating in the target mode.

MSG	C/D	I/O	SCSI Phase
0	0	0	ST Data-Out
0	0	1	ST Data-In
0	1	0	Command
0	1	1	Status
1	0	0	DT Data-Out
1	0	1	DT Data-In
1	1	0	Message-Out
1	1	1	Message-In

RA **Relative Addressing Mode** **23**

When this bit is set, the 24-bit signed value in the DMA SCRIPTS Pointer Save (DSPS) register is used as a relative offset from the current DMA SCRIPTS Pointer (DSP) address, which is pointing to the next instruction and not the one currently executing. The relative mode does not apply to Return and Interrupt SCRIPTS.

Jump/Call an Absolute Address

Start execution at the new absolute address.

Command	Condition Codes
Absolute Alternate Address	

Jump/Call a Relative Address

Start execution at the current address plus (or minus) the relative offset.

Command	Condition Codes
Don't Care	Alternate Jump Offset

The SCRIPTS program counter is a 32-bit value pointing to the SCRIPTS currently under execution by the LSI53C1010R. The next address is formed by adding the 32-bit program counter to the 24-bit signed value of the last 24 bits of the Jump or Call instruction. Because it is signed (2's complement), the jump can be forward or backward.

A relative transfer can be to any address within a 16 Mbyte segment. The program counter is combined with the 24-bit signed offset (using addition or subtraction) to form the new execution address.

SCRIPTS programs may contain a mixture of direct jumps and relative jumps to provide maximum versatility when writing SCRIPTS. For example, major sections of code can be accessed with far calls using the 32-bit physical address, then local labels can be called using relative transfers. If a SCRIPT is written using only relative transfers it does not require any run time alteration of physical addresses, and can be stored in and executed from a PROM.

J   **32/64-Bit Jump**   **22**

When this bit is cleared, the jump address is 32-bits wide. When this bit is set, the jump address is 64-bits wide.

CT   **Carry Test**   **21**

When this bit is set, decisions based on the ALU carry bit can be made. True/False comparisons are legal, but Data Compare and Phase Compare are illegal.

IF   **Interrupt-on-the-Fly**   **20**

When this bit is set, the interrupt instruction does not halt the SCRIPTS processor. Once the interrupt occurs, the Interrupt-on-the-Fly bit (Interrupt Status Zero (ISTAT0), bit 2) is asserted.

TF   **Jump If True/False**   **19**

This bit determines whether the LSI53C1010R branches when a comparison is true or when a comparison is false. This bit applies to phase compares, data compares, and carry tests. If both the Phase Compare and Data Compare bits are set, then both compares must be true to branch on a true condition. Both compares must be false to branch on a false condition.

Bit 19	Result of Compare	Action
0	False	Jump Taken
0	True	No Jump
1	False	No Jump
1	True	Jump Taken

CD   **Compare Data**   **18**

When this bit is set, the first byte received from the SCSI data bus (contained in the SCSI First Byte Received (SFBR) register) is compared with the Data to be Compared Field in the Transfer Control instruction. The Wait for Valid Phase bit controls when this compare occurs. The Jump if True/False bit determines the condition (true or false) to branch on.

CP   **Compare Phase**   **17**

When the LSI53C1010R is in the initiator mode, this bit controls phase compare operations. When this bit is set, the SCSI phase signals (latched by SREQ/) are compared to the Phase Field in the Transfer Control instruction. If they match, the comparison is true. The Wait for Valid Phase bit controls when the compare occurs. When the LSI53C1010R is operating in the target mode and this bit is set it tests for an active SCSI SATN/ signal.

VP   **Wait For Valid Phase**   **16**

If the Wait for Valid Phase bit is set, the LSI53C1010R waits for a previously unserviced phase before comparing the SCSI phase and data.

If the Wait for Valid Phase bit is cleared, the LSI53C1010R compares the SCSI phase and data immediately.

MC   **Data Compare Mask**   **[15:8]**

The Data Compare Mask allows a SCRIPT to test certain bits within a data byte. During the data compare, if any mask bits are set, the corresponding bit in the SCSI First Byte Received (SFBR) data byte is ignored. For instance, a mask of 0b01111111 and data compare value of 0b1XXXXXXX allows the SCRIPTS processor to determine whether or not the high order bit is set while ignoring the remaining bits.

DC   **Data Compare Value**   **[7:0]**

This 8-bit field is the data compared against the SCSI First Byte Received (SFBR) register. These bits are used in conjunction with the Data Compare Mask Field to test for a particular data value. If the COM bit (DMA Control (DCNTL), bit 0) is cleared, the value in the SFBR register may not be stable. In this case, do not use instructions using this data compare value.

5.5.2 Second Dword

This section describes the second Dword of the Transfer Control Instruction register.

Figure 5.10 Transfer Control Instructions - Second Dword

31	24 23	16 15	8 7	0
DSPS Register				
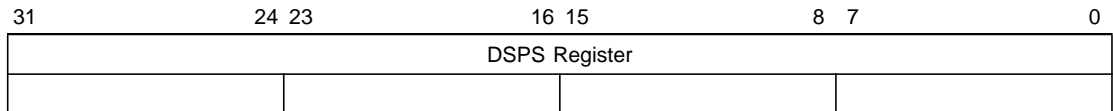
Jump Address   **[31:0]**

This 32-bit field contains the address of the next instruction to fetch when a jump is taken. Once the LSI53C1010R fetches the instruction from the address pointed to by these 32 bits, this address is incremented by 4, loaded into the DMA SCRIPTS Pointer (DSP) register and becomes the current instruction pointer.

5.5.3 Third Dword

This section describes the third Dword of the Transfer Control Instruction register.

Figure 5.11 Transfer Control Instructions - Third Dword

31	24 23	16 15	8 7	0
SFS Register (Used for JUMP64 Instruction)				
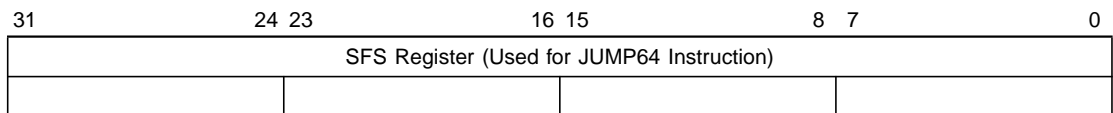
JUMP64 Address   **[31:0]**

This 32-bit field contains the upper Dword of a 64-bit address of the next instruction to fetch when a JUMP64 is taken.

5.6 Memory Move Instructions

For Memory Move instructions, bits 5 and 4 (SIOM and DIOM) in the DMA Mode (DMODE) register determine whether the source or destination addresses reside in memory or I/O space. By setting these bits appropriately, data may be moved within memory space, within I/O space, or between the two address spaces.

The Memory Move instruction is used to copy the specified number of bytes from the source address to the destination address.

For memory moves where the data read is from the 64-bit address space, the upper Dword of the address resides in the Memory Move Read Selector (MMRS) register. For memory moves where the data is written to the 64-bit address space, the upper Dword of the address resides in the Memory Move Write Selector (MMWS) register.

Allowing the LSI53C1010R to perform memory moves frees the system processor for other tasks and moves data at higher speeds than available from current DMA controllers. Up to 16 Mbytes may be transferred with one instruction. There are two restrictions:

- Both the source and destination addresses must start with the same address alignment (A[1:0] must be the same). If the source and destination are not aligned, then an illegal instruction interrupt occurs. For the PCI Cache Line Size (CLS) register setting to take effect, the source and destination must be the same distance from a cache line boundary.

- Indirect addresses are not allowed. A burst of data is fetched from the source address, put into the DMA FIFO and then written out to the destination address. The move continues until the byte count decrements to zero, then another SCRIPT is fetched from system memory.

The DMA SCRIPTS Pointer Save (DSPS) and Data Structure Address (DSA) registers are additional holding registers used during the Memory Move. However, the contents of the Data Structure Address (DSA) register are preserved.

Figure 5.12 Memory Move Instructions - First Dword

31	29 28	25 24 23	16 15	8 7	0
DCMD Register			DBC Register		
IT[2:0]	R	NF	TC[23:0]		

IT[2:0]	**Instruction Type - Memory Move**	**[31:29]**
R	**Reserved**	**[28:25]**
	These bits are reserved and must be zero. If any of these bits are set, an illegal instruction interrupt occurs.	
NF	**No Flush**	**24**
	When this bit is set, the LSI53C1010R performs a Memory Move without flushing the prefetch unit. When this bit is cleared, the Memory Move instruction automatically flushes the prefetch unit. Use the No Flush option if the source and destination are not within four instructions of the current Memory Move instruction.	

> Note: This bit has no effect unless the Prefetch Enable bit in the DMA Control (DCNTL) register is set. For information on SCRIPTS instruction prefetching, see Chapter 2, "Functional Description."

TC[23:0]	**Transfer Count**	**[23:0]**
	The number of bytes to transfer is stored in the lower 24 bits of the first instruction word.	

5.6.1 Read/Write System Memory from a SCRIPT

By using the Memory Move instruction, single or multiple register values are transferred to or from system memory.

Because the LSI53C1010R responds to addresses as defined in the Base Address Register Zero (BAR0) (I/O) or Base Address Register One (BAR1) (MEMORY) registers, the device can be accessed during a Memory Move operation if the source or destination address decodes to within the chip's register space. If this occurs, the register indicated by the lower seven bits of the address is taken as the data source or destination. In this way, register values are saved to system memory and later restored, and SCRIPTS can make decisions based on data values in system memory.

The SCSI First Byte Received (SFBR) is not writable using the CPU, and therefore not by a Memory Move. However, it can be loaded using SCRIPTS Read/Write operations. To load the SFBR with a byte stored in system memory, first move the byte to an intermediate LSI53C1010R register (for example, a SCRATCH register), and then to the SCSI First Byte Received (SFBR).

The same address alignment restrictions apply to register access operations as to normal memory-to-memory transfers.

5.6.2 Second Dword

This section describes the second Dword of the Memory Move Instruction register.

Figure 5.13 Memory Move Instructions - Second Dword

31	24	23	16	15	8	7	0
			DSPS Register				
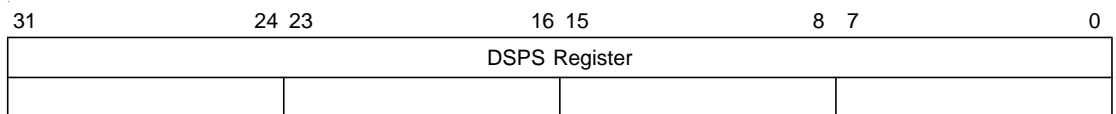
DSPS Register   **[31:0]**
These bits contain the source address of the Memory Move.

If the source address is in the 64-bit address space, the bits will be contained in the Memory Move Read Selector (MMRS) register.

31	24	23	16	15	8	7	0
			MMRS Register				
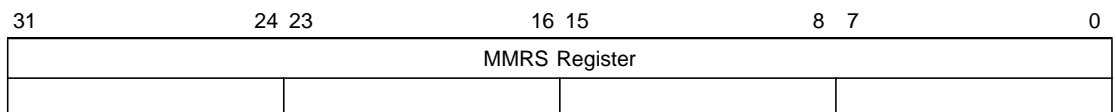
5.6.3 Third Dword

This section describes the third Dword of the Memory Move Instruction register.

Figure 5.14 Memory Move Instructions - Third Dword

31	24 23	16 15	8 7	0
		TEMP Register		

<table>
<tr><td>31</td><td>24 23</td><td>16 15</td><td>8 7</td><td>0</td></tr>
</table>
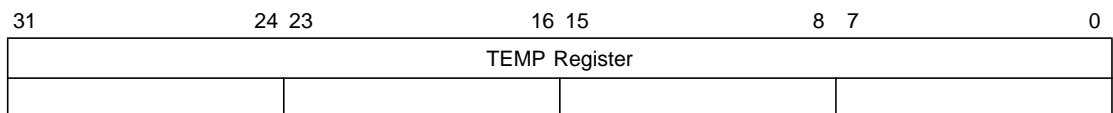
TEMP Register   **[31:0]**

These bits contain the destination address for the Memory Move.

If the destination address is in the 64-bit address space, the bits will be contained in the Memory Move Write Selector (MMWS) register.

31	24 23	16 15	8 7	0
		MMWS Register		
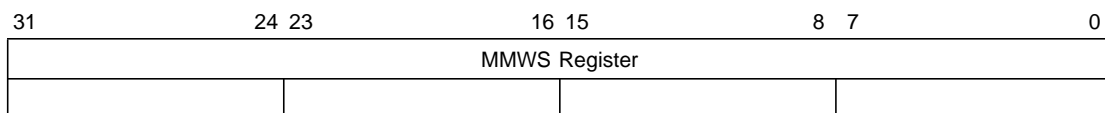
5.7 Load and Store Instructions

The Load and Store instructions provide a more efficient way to move data from/to memory to/from an internal register in the chip without using the normal memory move instruction.

The load and store instructions are represented by two Dword opcodes. The first Dword contains the DMA Command (DCMD) and DMA Byte Counter (DBC) register values. The second Dword contains the DMA SCRIPTS Pointer Save (DSPS) value. This is either the actual memory location of where to load/store, or the offset from the Data Structure Address (DSA), depending on the value of bit 28 (DSA Relative).

For load operations where the data is read from the 64-bit address space, the upper Dword of address resides in the Memory Move Read Selector (MMRS) register. For store operations where the data is written to the 64-bit address space, the upper Dword of address resides in the Memory Move Write Selector (MMWS) register.

A maximum of 4 bytes may be moved with these instructions. The register address and memory address must have the same byte alignment, and the count set such that it does not cross Dword boundaries. The memory address may not map back to the chip,

excluding RAM and ROM. If it does, a PCI read/write cycle occurs (the data does not actually transfer to/from the chip), and the chip issues an interrupt (Illegal Instruction Detected) immediately following.

Bits A1, A0	Number of Bytes Allowed to Load/Store
00	One, two, three or four
01	One, two, or three
10	One or two
11	One

The SIOM and DIOM bits in the DMA Mode (DMODE) register determine whether the destination or source address of the instruction is in Memory space or I/O space, as illustrated in the following table. The Load/Store utilizes the PCI commands for I/O read and I/O write to access the I/O space.

Bit	Source	Destination
SIOM (Load)	Memory	Register
DIOM (Store)	Register	Memory

5.7.1 First Dword

This section describes the first Dword of the Load and Store Instruction register.

Figure 5.15 Load and Store Instruction - First Dword

31		29	28	27	26	25	24	23						16	15													3	2		0
DCMD Register								DBC Register																							
IT[2:0]			DSA	R		NF	LS	A[7:0]							R														BC		
1	1	1	x	0	0	x	x	x	x	x	x	x	x	x	x	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x

IT[2:0]   **Instruction Type**   **[31:29]**
These bits should be 0b111, indicating the Load and Store instruction.

DSA   **DSA Relative**   **28**

When this bit is cleared, the value in the DMA SCRIPTS Pointer Save (DSPS) is the actual 32-bit memory address used to perform the Load/Store to/from. When this bit is set, the chip determines the memory address to perform the Load/Store to/from by adding the 24-bit signed offset value in the DMA SCRIPTS Pointer Save (DSPS) to the Data Structure Address (DSA).

R   **Reserved**   **[27:26]**

NF   **No Flush (Store instruction only)**   **25**

When this bit is set, the LSI53C1010R performs a Store without flushing the prefetch unit. When this bit is cleared, the Store instruction automatically flushes the prefetch unit. Use No Flush if the source and destination are not within four instructions of the current Store instruction. This bit has no effect on the Load instruction.

Note: This bit has no effect unless the Prefetch Enable bit in the DMA Control (DCNTL) register is set. For information on SCRIPTS instruction prefetching, see Chapter 2, "Functional Description."

LS   **Load/Store**   **24**

When this bit is set, the instruction is a Load. When cleared, it is a Store.

A[7:0]   **Register Address**   **[23:16]**

A[7:0] selects the register to load/store to/from within the LSI53C1010R.

R   **Reserved**   **[15:3]**

BC   **Byte Count**   **[2:0]**

This value is the number of bytes to load/store.

5.7.2 Second Dword

This section describes the second Dword of the Load and Store Instruction register.

Figure 5.16 Load and Store Instructions - Second Dword

31	24 23	16 15	8 7	0
DSPS Register - Memory I/O Address/DSA Offset				

31	24 23	16 15	8 7	0
MMRS/MMWS Register				
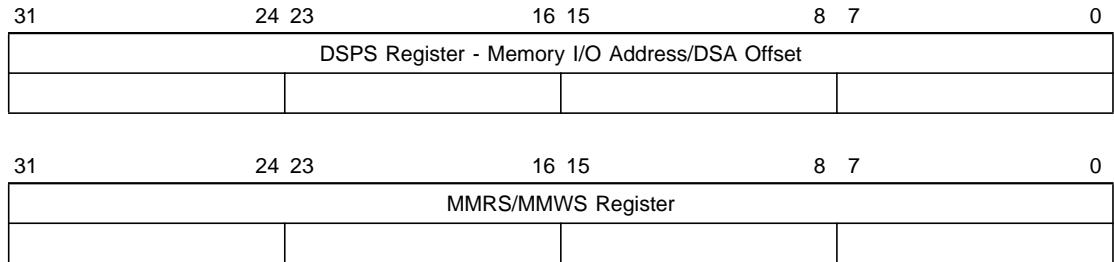
Memory I/O Address / DSA Offset   [31:0]
This is the actual memory location of where to load/store, or the offset from the Data Structure Address (DSA) register value.

Chapter 6
Specifications

This chapter specifies the LSI53C1010R electrical and mechanical characteristics. It is divided into the following sections:

- Section 6.1, "DC Characteristics"
- Section 6.2, "TolerANT Technology Electrical Characteristics"
- Section 6.3, "AC Characteristics"
- Section 6.4, "PCI and External Memory Interface Timing Diagrams"
- Section 6.5, "SCSI Timing Diagrams"
- Section 6.6, "Package Drawings"

6.1 DC Characteristics

This section describes the LSI53C1010R DC characteristics. Tables 6.1 through 6.12 give current and voltage specifications. Figures 6.1 and 6.2 are driver schematics.

Table 6.1   Absolute Maximum Stress Ratings

Symbol	Parameter	Min	Max[1]	Unit	Test Conditions
T_{STG}	Storage temperature	−55	150	°C	–
V_{DD}	Supply voltage	−0.5	4.5	V	–
V_{IN}	Input voltage	−0.3	5.55	V	–
V_{IN-PCI}	Input voltage PCI pins	−5.5	11.0	V	–
I_{LP}[2]	Latch-up current	±150	–	mA	–
T	Lead temperature	–	250	°C	<10 seconds
ESD[3]	Electrostatic discharge	–	2 K	V	MIL-STD 883C, Method 3015.7

1. Stresses beyond those listed above may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions beyond those indicated in the Operating Conditions section of the manual is not implied.
2. −2 V < VPIN < 8 V.
3. SCSI pins only.

Table 6.2   Operating Conditions

Symbol	Parameter	Min	Max[1]	Unit	Test Conditions
V_{DD}	Supply voltage	3.13	3.47	V	–
I_{DD-AVG}	Average Supply Current (dynamic)	–	800	mA	–
$I_{DD-PEAK}$	Peak Supply Current (dynamic)	–	1.2	A	–
T_A	Operating free air	0	70	°C	–
θ_{JA}	Thermal resistance (junction to ambient air)	–	20	°C/W	–

1. Conditions that exceed the operating limits may cause the device to function incorrectly.

Table 6.3   LVD Driver SCSI Signals[1] – SD[15:0], SDP[1:0], SREQ/, SACK/, SMSG/, SIO/, SCD/, SATN/, SBSY/, SSEL/, SRST/

Symbol	Parameter	Min	Max	Units	Test Conditions
I_O+	Source (+) current	−9.6	−14.4	mA	Asserted state
I_O-	Sink (−) current	9.6	14.4	mA	Asserted state
I_O+	Source (+) current	−6.4	−9.6	mA	Negated state
I_O-	Sink (−) current	6.4	9.6	mA	Negated state
I_{OZ}	3-state leakage	–	20	µA	–

1. V_{CM} = 0.7–1.8 V (Common Mode, nominal ~1.2V), R_L = 0–110 Ω, R_{bias} = 10.0 kΩ

Figure 6.1   LVD Driver
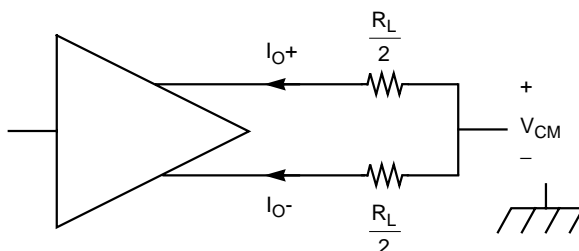
Table 6.4   LVD Receiver SCSI Signals[1] – SD[15:0], SDP[1:0], SREQ/, SACK/, SMSG/, SIO/, SCD/, SATN/, SBSY/, SSEL/, SRST/

Symbol	Parameter	Min	Max	Units	Test Conditions
V_I	LVD receiver voltage asserting	60	–	mV	Differential voltage
V_I	LVD receiver voltage negating	−60	–	mV	Differential voltage

1. V_{CM} = 0.7–1.8 V (Common Mode Voltage, nominal ~1.2 V.)

Figure 6.2   LVD Receiver
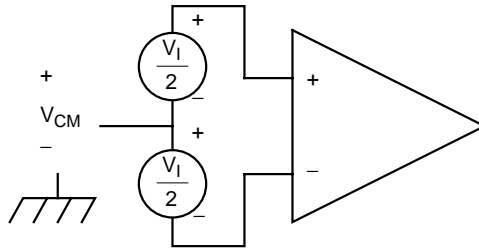
Table 6.5   A and B DIFFSENS SCSI Signals

Symbol	Parameter	Min	Max	Unit	Test Conditions
V_{IH}	HVD sense voltage	2.4	5.05	V	Note 1
V_S	LVD sense voltage	0.7	1.9	V	Note 1
V_{IL}	SE sense voltage	$V_{SS} - 0.35$	0.5	V	Note 1
I_{OZ}	3-state leakage	−10	10	µA	0 V_{DD} = 3 Max

1. Functional test specified V_{IH}/V_{IL} for each mode.

Table 6.6   Input Capacitance

Symbol	Parameter	Min	Max	Unit	Test Conditions
C_I	Input capacitance of input pads	–	7	pF	Guaranteed by design
C_{IO}	Input capacitance of I/O pads	–	15	pF	Guaranteed by design
C_{PCI}	Input capacitance of PCI pads	–	8	pF	Guaranteed by design
C_{LVD}	Input capacitance of LVD pads	–	8	pF	6.5 pf Pad 1.5 pf Package

Table 6.7 **8 mA Bidirectional Signals – GPIO0_FETCH/, GPIO1_MASTER/, GPIO2, GPIO3, GPIO4[1]**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V_{IH}	Input high voltage	2.0	5.55	V	–
V_{IL}	Input low voltage	–0.3	0.8	V	–
V_{OH}	Output high voltage	2.4	V_{DD}	V	–8 mA
V_{OL}	Output low voltage	V_{SS}	0.4	V	8 mA
I_{OZ}	3-state leakage	–10	10	µA	–
I_{PULL}	Pull up current	25	–	µA	–

1. For channels A and B (except MAD[7:0]).

Table 6.8 **4 mA Bidirectional Signals – MAD[7:0]**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V_{IH}	Input high voltage	2.0	5.55	V	–
V_{IL}	Input low voltage	–0.3	0.8	V	–
V_{OH}	Output high voltage	2.4	V_{DD}	V	–4 mA
V_{OL}	Output low voltage	V_{SS}	0.4	V	4 mA
I_{OZ}	3-state leakage	–10	10	µA	–
I_{PULL}	Pull down current	25	–	µA	–

Table 6.9 **4 mA Output Signals – MAS[1:0]/, MCE/, MOE/_TESTOUT[1], MWE/, TDO**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V_{OH}	Output high voltage	2.4	V_{DD}	V	–4 mA
V_{OL}	Output low voltage	V_{SS}	0.4	V	4 mA
I_{OZ}	3-state leakage	–10	10	µA	–

1. MOE/_TESTOUT is not tested for 3-state leakage. It cannot be 3-stated.

Table 6.10   8 mA PCI Bidirectional Signals – AD[63:0], C_BE[7:0]/, FRAME/, IRDY/, TRDY/, DEVSEL/, STOP/, PERR/, PAR, PAR64, REQ64/, ACK64/

Symbol	Parameters	Min	Max	Unit	Test Conditions
V_{IH}	Input high voltage	0.5 V_{DD}	V_{DD} + 0.5	V	–
V_{IL}	Input low voltage	–0.5	0.3 V_{DD}	V	–
V_{OH}	Output high voltage	0.9 V_{DD}	V_{DD}	V	–8 mA
V_{OL}	Output low voltage	V_{SS}	0.1 V_{DD}	V	8 mA
I_{OZ}	3-state leakage	–10	10	µA	–
$I_{PULL-DOWN}$	Pull down current[1]	25	–	µA	–

1. Pull-down text does not apply to AD[31:0] and C_BE[3:0]/.

Table 6.11   Input Signals[1] – CLK, GNT/, IDSEL, RST/, SCLK, TCK, TDI, TEST_HSC, TEST_RST/, TMS

Symbol	Parameters	Min	Max	Unit	Test Conditions
V_{IH}	Input high voltage	2.0	5.55	V	–
V_{IL}	Input low voltage	–0.3	0.8	V	–
I_{IN}	3-state leakage	–10	10	µA	–
$I_{PULL-UP}$	Pull current	25	–	µA	–

1. Pull text does not apply to CKL, GNT/, IDSEL, RST/, and SCLK.

Table 6.12   8 mA Output Signals[1] – INTA/, INTB,/ ALT_INTA/, ALT_INTB/, REQ/, SERR/

Symbol	Parameters	Min	Max	Unit	Test Conditions
V_{OH}	Output high voltage	0.9 V_{DD}	V_{DD}	V	–8 mA
V_{OL}	Output low voltage	V_{DD}	0.1 V_{DD}	V	8 mA
I_{OZ}	3-state leakage	–10	10	µA	–
$I_{PULL-UP}$	Pull current	25	–	µA	–

1. Pull text does not apply to REQ/ and SERR/.

6.2 TolerANT Technology Electrical Characteristics

The LSI53C1010R features TolerANT technology, which includes active negation on the SCSI drivers and input signal filtering on the SCSI receivers. Active negation actively drives the SCSI Request, Acknowledge, Data, and Parity signals HIGH rather than allowing them to be passively pulled up by terminators. Table 6.13 provides electrical characteristics for SE SCSI signals. Figures 6.3 through 6.7 provide reference information for testing SCSI signals.

Table 6.13   TolerANT Technology Electrical Characteristics for SE SCSI Signals[1]

Symbol	Parameter	Min	Max	Units	Test Conditions
V_{OH}[2]	Output high voltage	2.2	3.7	V	I_{OH} = 7 mA
V_{OL}	Output low voltage	0.0	0.5	V	I_{OL} = 48 mA
V_{IH}	Input high voltage	2.0	–	V	–
V_{IL}	Input low voltage	–	0.8	V	Referenced to V_{SS}
V_{IK}	Input clamp voltage	–0.66	–0.77	V	V_{pp} = 4.75 V; I_1 = -20 mA
V_{TH}	Threshold, HIGH to LOW	1.15	1.25	V	–
V_{TL}	Threshold, LOW to HIGH	1.55	1.65	V	–
V_{TH} - V_{TL}	Hysteresis	300	500	mV	–
I_{OH}[2]	Output high current	0	7	mA	V_{OH} = 2.2 V
I_{OL}	Output low current	48	–	mA	V_{OL} = 0.5 V
I_{OSH}[2]	Short-circuit output high current	48	–	mA	Short to V_{DD}[3]
I_{OSL}	Short-circuit output low current	22	–	mA	Short to V_{SS}
I_{LH}	Input high leakage	–	20	μA	–0.5 < V_{DD} < 5.25 V_{PIN} = 2.7 V
I_{LL}	Input low leakage	–	20	μA	–0.5 < V_{DD} < 5.25 V_{PIN} = 0.5 V
R_I	Input resistance	20	–	MΩ	SCSI pins

Table 6.13 TolerANT Technology Electrical Characteristics for SE SCSI Signals[1] (Cont.)

Symbol	Parameter	Min	Max	Units	Test Conditions
C_P	Capacitance per pin	–	8	pF	PQFP
t_R[2]	Rise time, 10% to 90%	6.7	14.7	ns	Figure 6.3
t_F	Fall time, 90% to 10%	5.7	17.2	ns	Figure 6.3
dV_H/dt	Slew rate LOW to HIGH	100	470	mV/ns	Figure 6.3
dV_L/dt	Slew rate HIGH to LOW	110	440	mV/ns	Figure 6.3
ESD	Electrostatic discharge	2	–	KV	MIL-STD-883C; 3015-7
	Latch-up	100	–	mA	–
	Filter delay	20	30	ns	Figure 6.4
	Ultra filter delay	10	15	ns	Figure 6.4
	Ultra2 filter delay	5	8	ns	Figure 6.4
	Extended filter delay	40	60	ns	Figure 6.4

1. These values are guaranteed by periodic characterization; they are not 100% tested on every device.
2. Active negation outputs only: Data, Parity, SREQ/, SACK/. SCSI mode only (minus pins).

Figure 6.3   Rise and Fall Time Test Condition
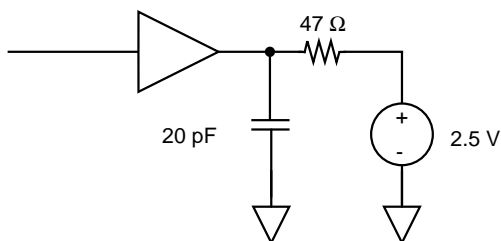
Figure 6.4   SCSI Input Filtering

Note: t_1 is the input filtering period.

Figure 6.5   Hysteresis of SCSI Receivers
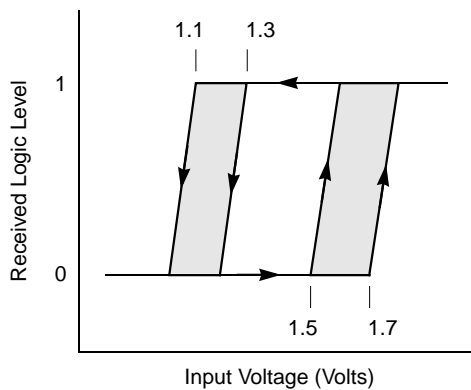
Figure 6.6   Input Current as a Function of Input Voltage
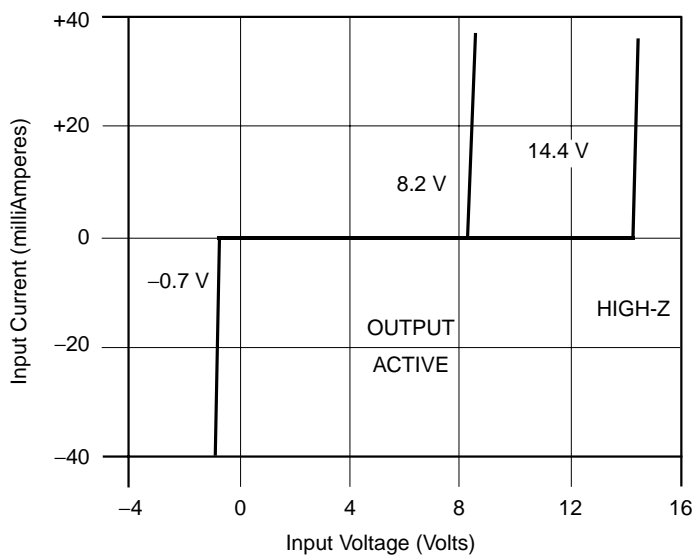
Figure 6.7   Output Current as a Function of Output Voltage
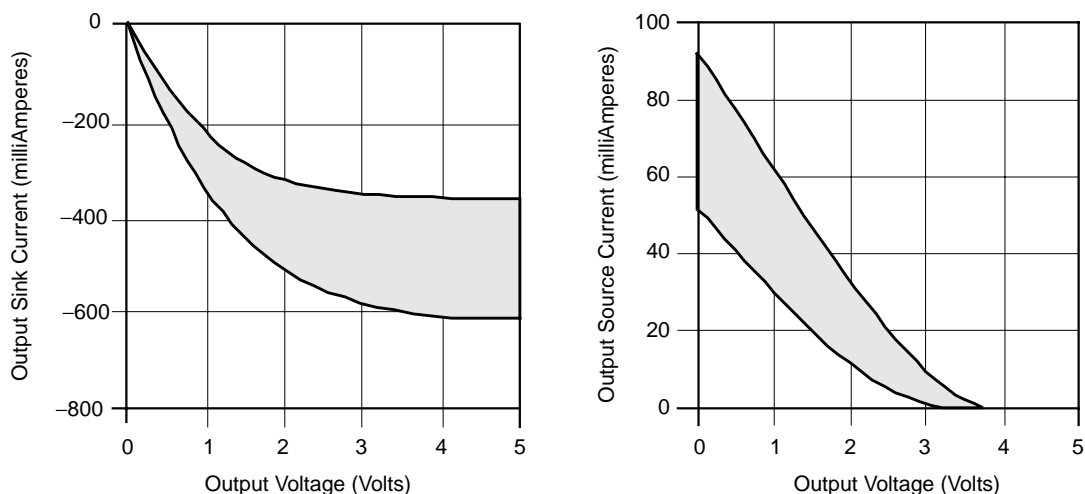
6.3 AC Characteristics

The AC characteristics described in this section apply over the entire range of operating conditions (refer to Section 6.1, "DC Characteristics"). Chip timing is based on simulation at worst case voltage, temperature, and processing. Timing was developed with a load capacitance of 50 pF. Table 6.14 and Figure 6.8 provide external clock timing data.

Table 6.14   External Clock

Symbol	Parameter	66 MHz PCI		33 MHz PCI[1]		Units
		Min	Max	Min	Max	
t_1	PCI Bus clock period	15	30	30	30	ns
	SCSI clock period	25	25	25	25	ns
t_2	PCI CLK LOW time[2]	6	–	11	–	ns
	SCLK LOW time	10	15	10	15	ns
t_3	PCI CLK HIGH time	6	–	11	–	ns
	SCLK HIGH time	10	15	10	15	ns

Table 6.14   External Clock (Cont.)

Symbol	Parameter	66 MHz PCI		33 MHz PCI[1]		Units
		Min	**Max**	**Min**	**Max**	
t_4	PCI CLK slew rate	1.5	4	1	4	V/ns

1. The minimum PCI Clock frequency is 33 MHz.
2. Duty cycle not to exceed 60/40.

Figure 6.8   External Clock
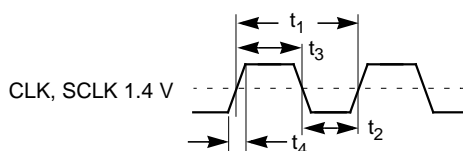
Table 6.15 and Figure 6.9 provide Reset Input timing data.

Table 6.15   Reset Input

Symbol	Parameter	Min	Max	Units
t_1	Reset pulse width	10	–	t_{CLK}
t_2	Reset deasserted setup to CLK HIGH	0	–	ns
t_3	MAD setup time to CLK HIGH (for configuring the MAD bus only)	20	–	ns
t_4	MAD hold time from CLK HIGH (for configuring the MAD bus only)	20	–	ns

Figure 6.9   Reset Input
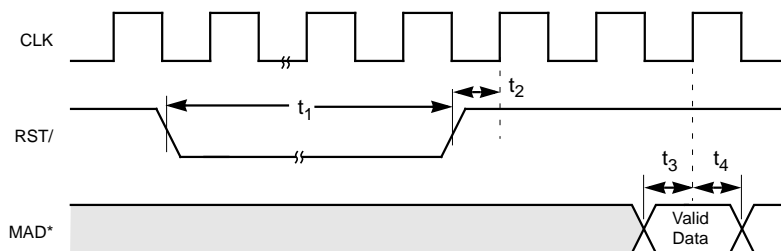
*When enabled

Table 6.16 and Figure 6.10 provide Interrupt Output timing data.

Table 6.16 Interrupt Output

Symbol	Parameter	Min	Max	Units
t_1	CLK HIGH to IRQ/ LOW	2	11	ns
t_2	CLK HIGH to IRQ/ HIGH	2	11	ns
t_3	IRQ/ deassertion time	3	–	CLK

Figure 6.10 Interrupt Output
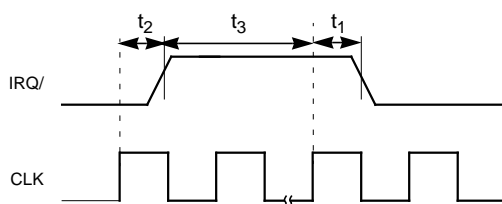
6.4 PCI and External Memory Interface Timing Diagrams

Tables 6.17 through 6.38 and figures 6.11 through 6.34 represent signal activity when the LSI53C1010R accesses the PCI bus. This section includes timing diagrams for access to three groups of memory configurations. The first group applies to Target Timing. The second group applies to Initiator Timing. The third group applies to External Memory Timing.

Note: Multiple byte accesses to the external memory bus increase the read or write cycle by 11 clocks for each additional byte.

Timing diagrams included in this section are:

- Target Timing
    - PCI Configuration Register Read
    - PCI Configuration Register Write
    - Operating Registers/SCRIPTS RAM Read, 32 Bits
    - Operating Register/SCRIPTS RAM Read, 64 Bits

6.4.1 Target Timing

Tables 6.17 through 6.22 and figures 6.11 through 6.16 describe Target timing.

Table 6.17   PCI Configuration Register Read

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.11   PCI Configuration Register Read
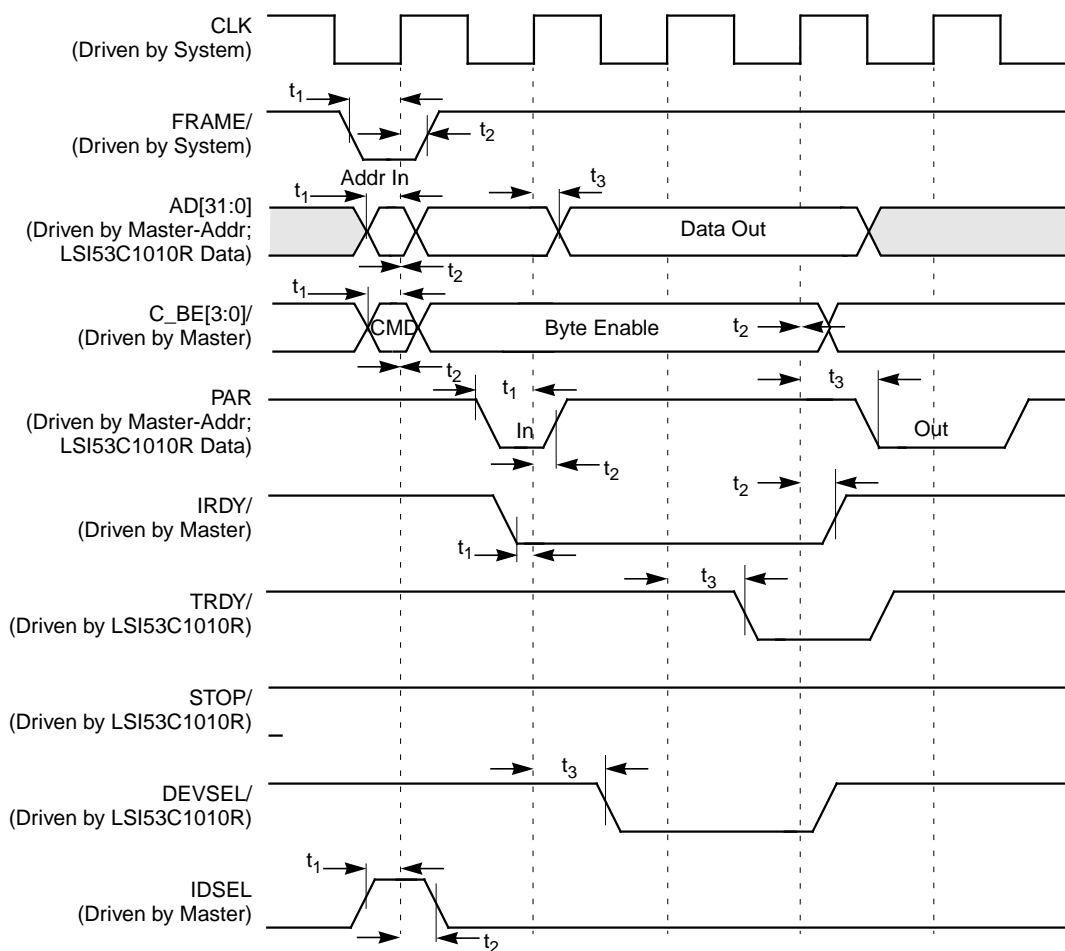
Table 6.18 PCI Configuration Register Write

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	**Max**	**Min**	**Max**	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.12 PCI Configuration Register Write
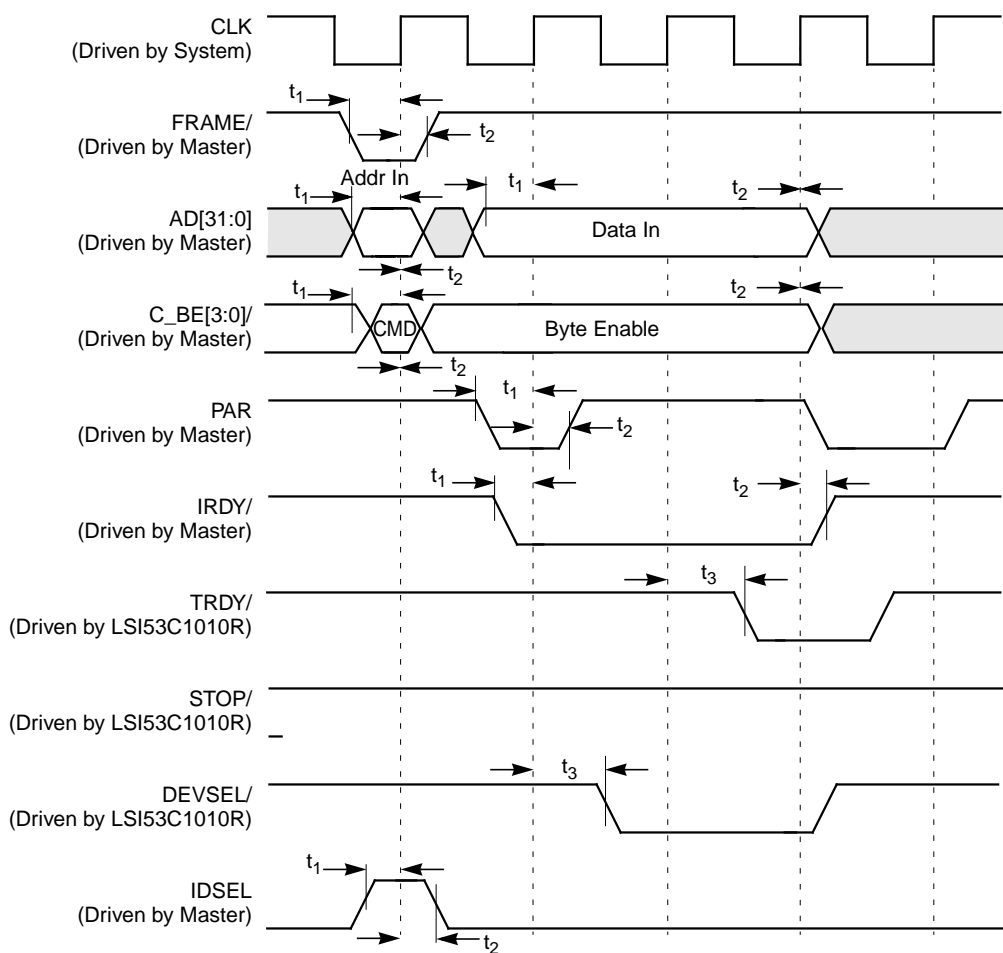
Table 6.19   Operating Register/SCRIPTS RAM Read, 32 Bits

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.13 Operating Registers/SCRIPTS RAM Read, 32 Bits
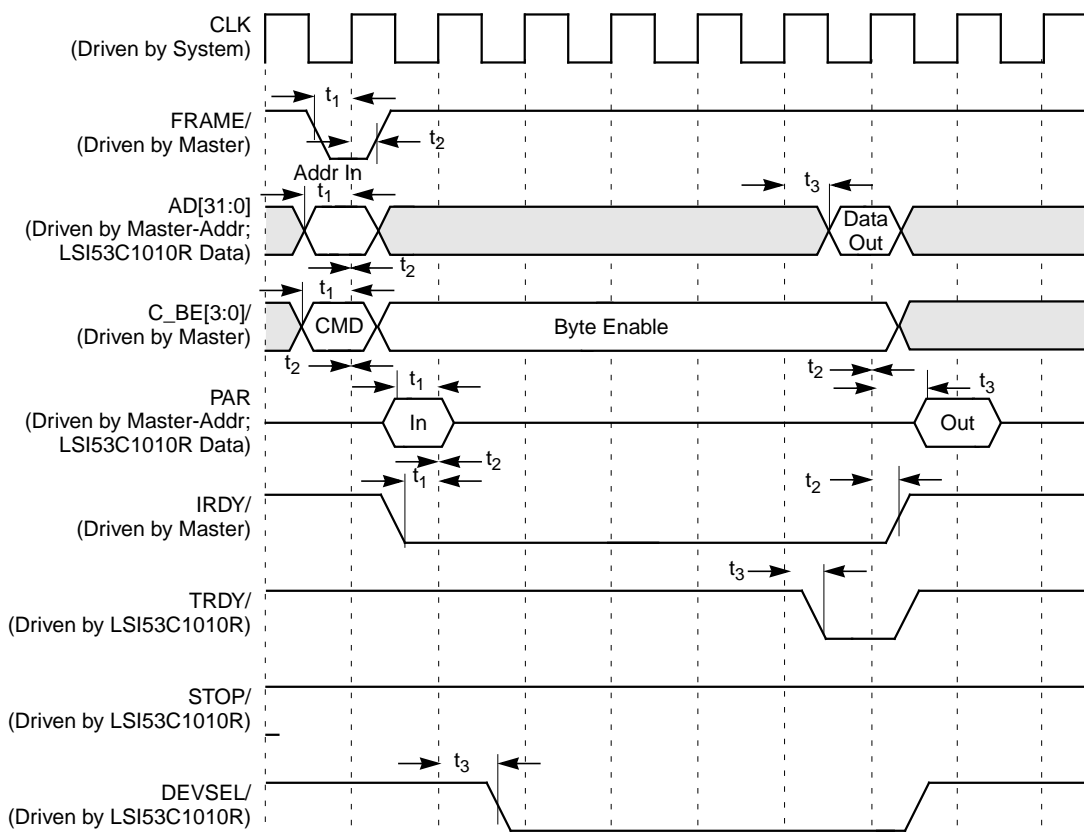
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Table 6.20 Operating Register/SCRIPTS RAM Read, 64 Bits

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.14 Operating Register/SCRIPTS RAM Read, 64 Bits
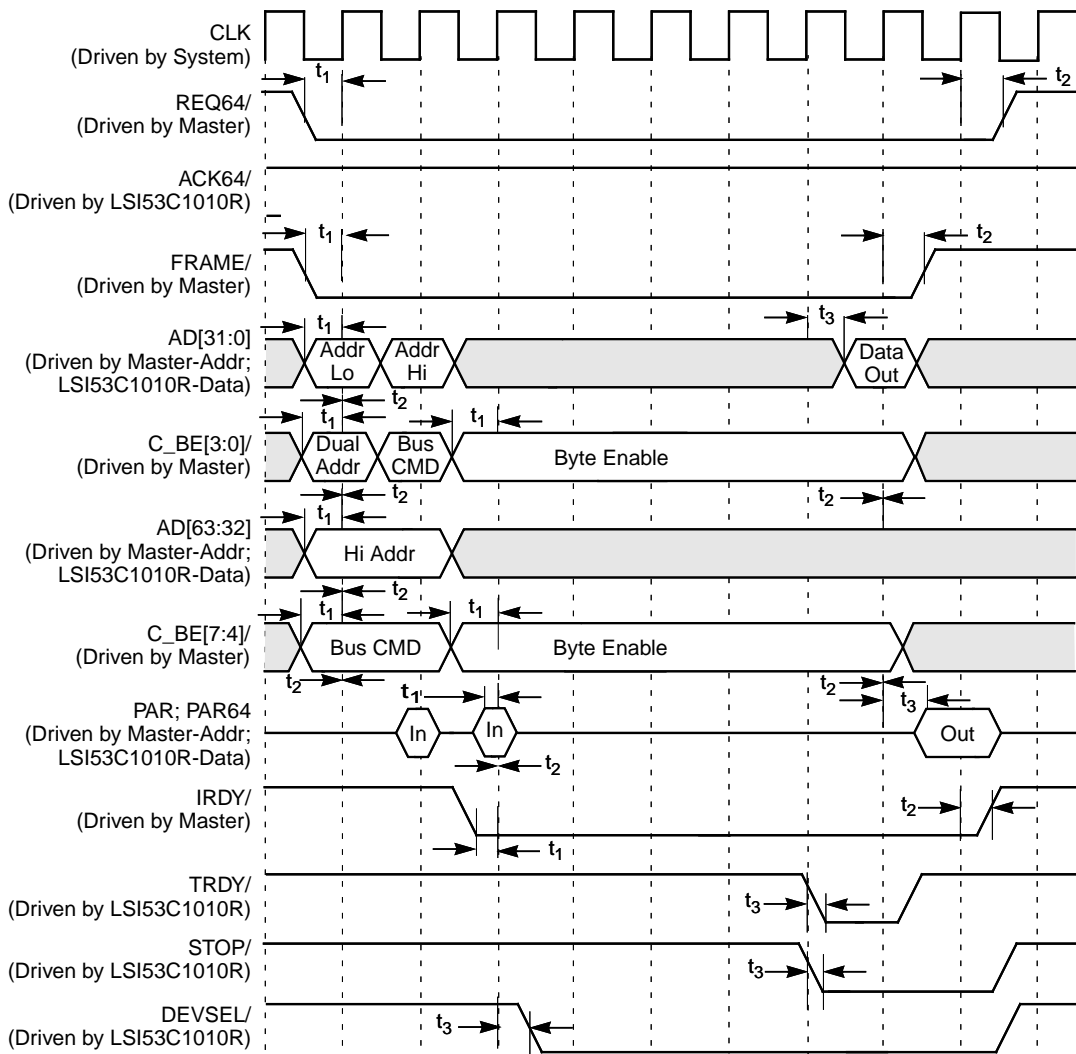
Table 6.21   Operating Register/SCRIPTS RAM Write, 32 Bits

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.15 Operating Register/SCRIPTS RAM Write, 32 Bits
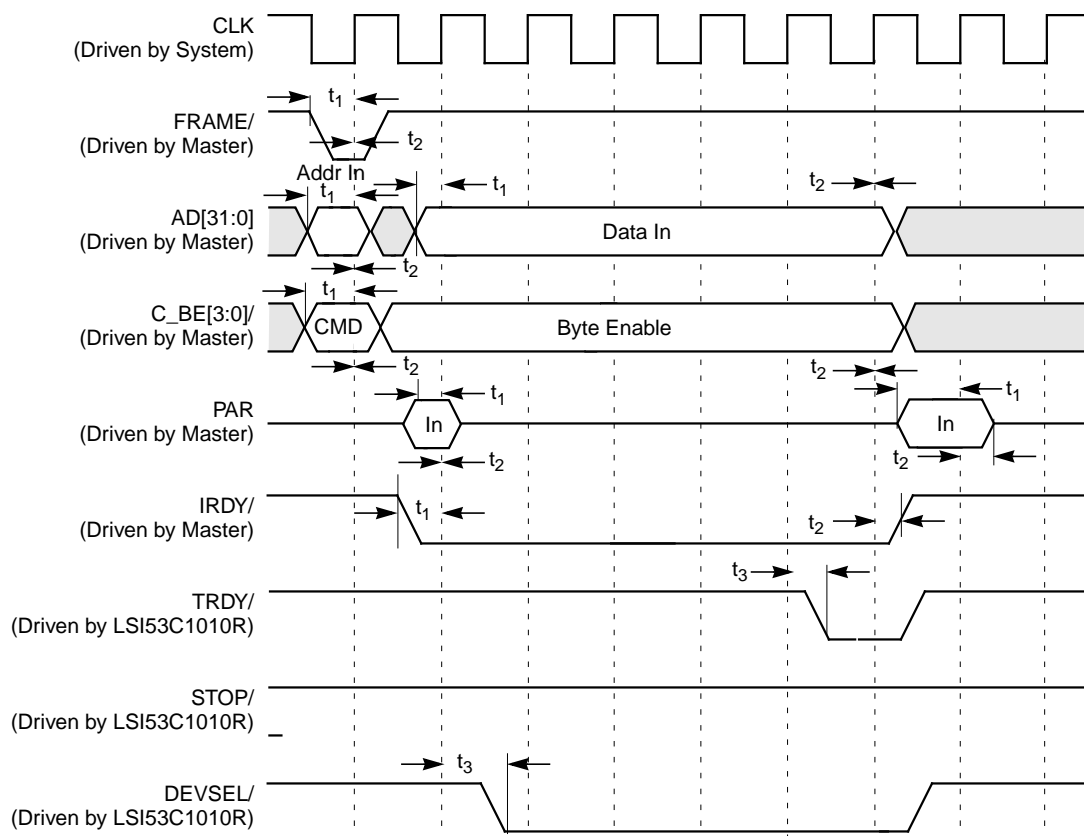
Table 6.22   Operating Register/SCRIPTS RAM Write, 64 Bits

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.16 Operating Register/SCRIPTS RAM Write, 64 Bits
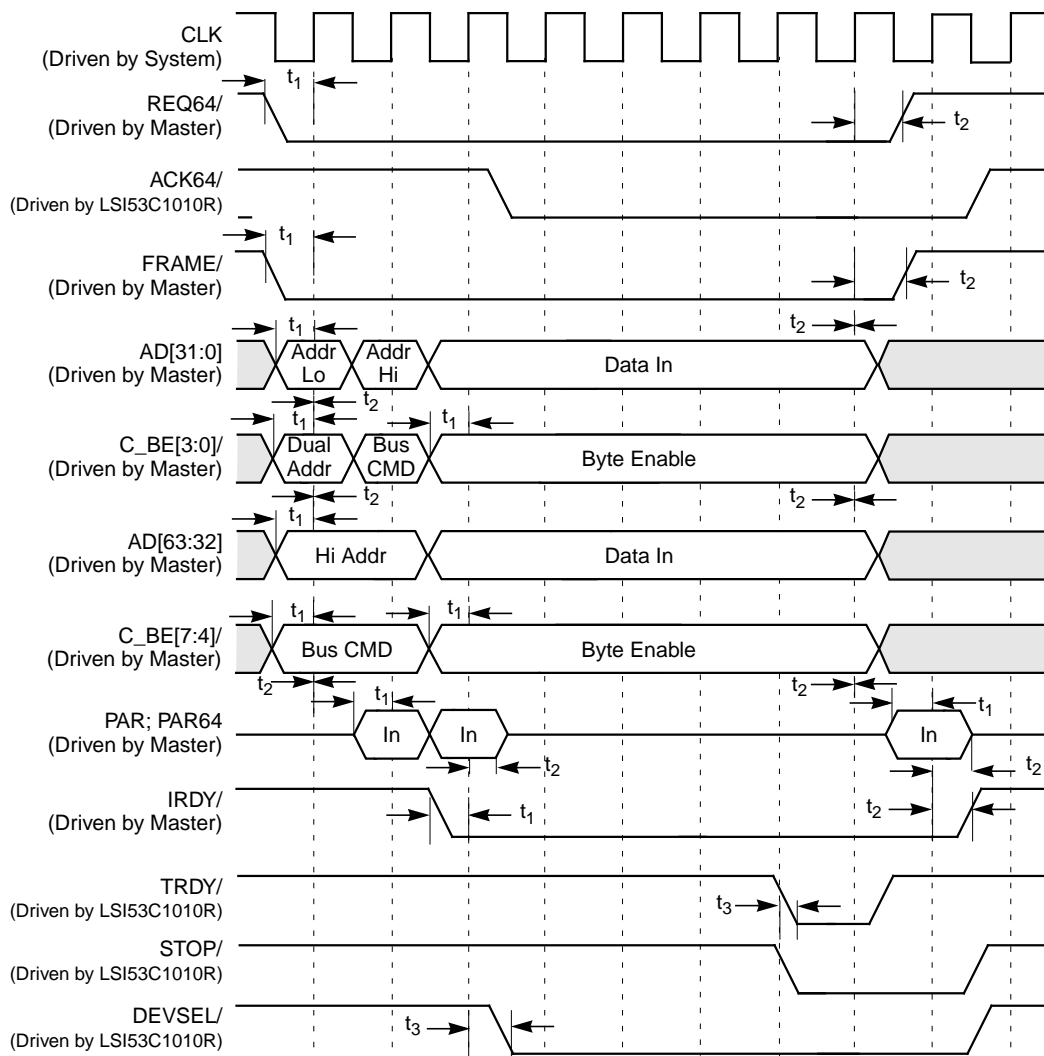
6.4.2 Initiator Timing

Tables 6.23 through 6.30 and figures 6.17 and 6.24 describe Initiator timing.

Table 6.23   Nonburst Opcode Fetch, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_4	Side signal input setup time	5	–	10	–	ns
t_5	Side signal input hold time	0	–	0	–	ns
t_6	CLK to side signal output valid	2	6	2	12	ns

Figure 6.17 Nonburst Opcode Fetch, 32-Bit Address and Data
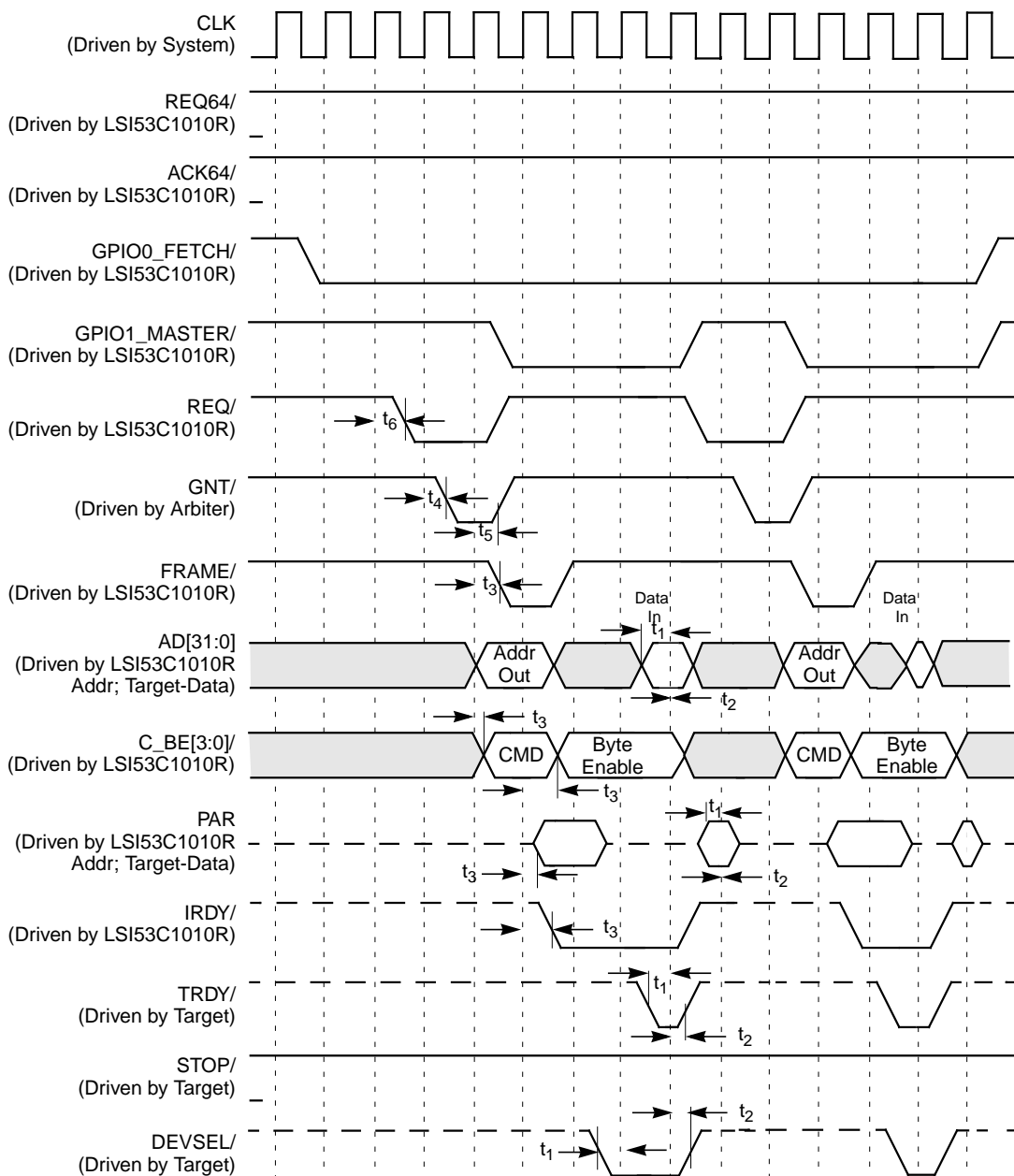
Table 6.24 Burst Opcode Fetch, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_4	Side signal input setup time	5	–	10	–	ns
t_5	Side signal input hold time	0	–	0	–	ns
t_6	CLK to side signal output valid	2	6	2	12	ns

Figure 6.18 Burst Opcode Fetch, 32-Bit Address and Data
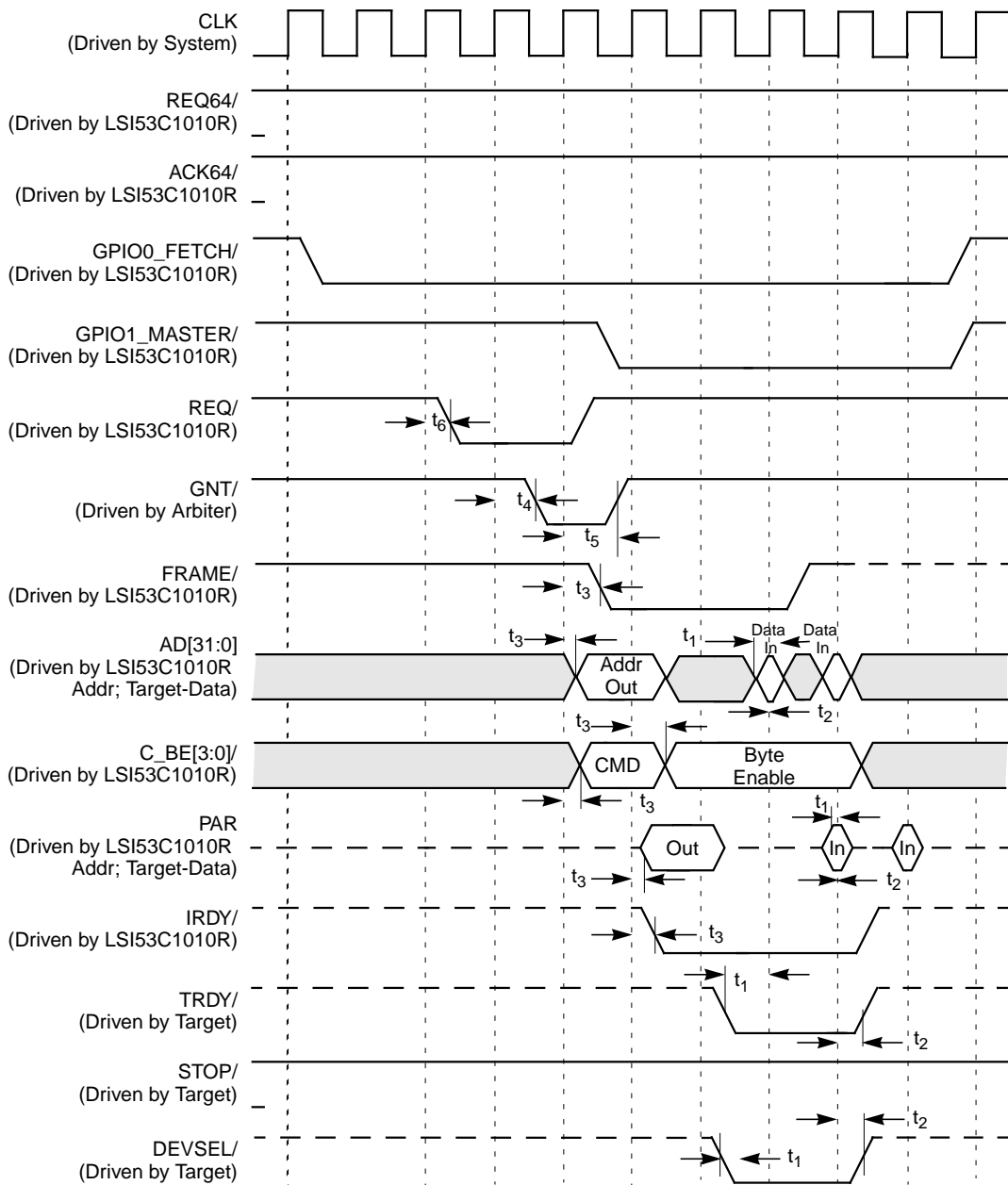
Table 6.25   Back to Back Read, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	**Max**	**Min**	**Max**	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_4	Side signal input setup time	5	–	10	–	ns
t_5	Side signal input hold time	0	–	0	–	ns
t_6	CLK to side signal output valid	2	6	2	12	ns

Figure 6.19 Back to Back Read, 32-Bit Address and Data
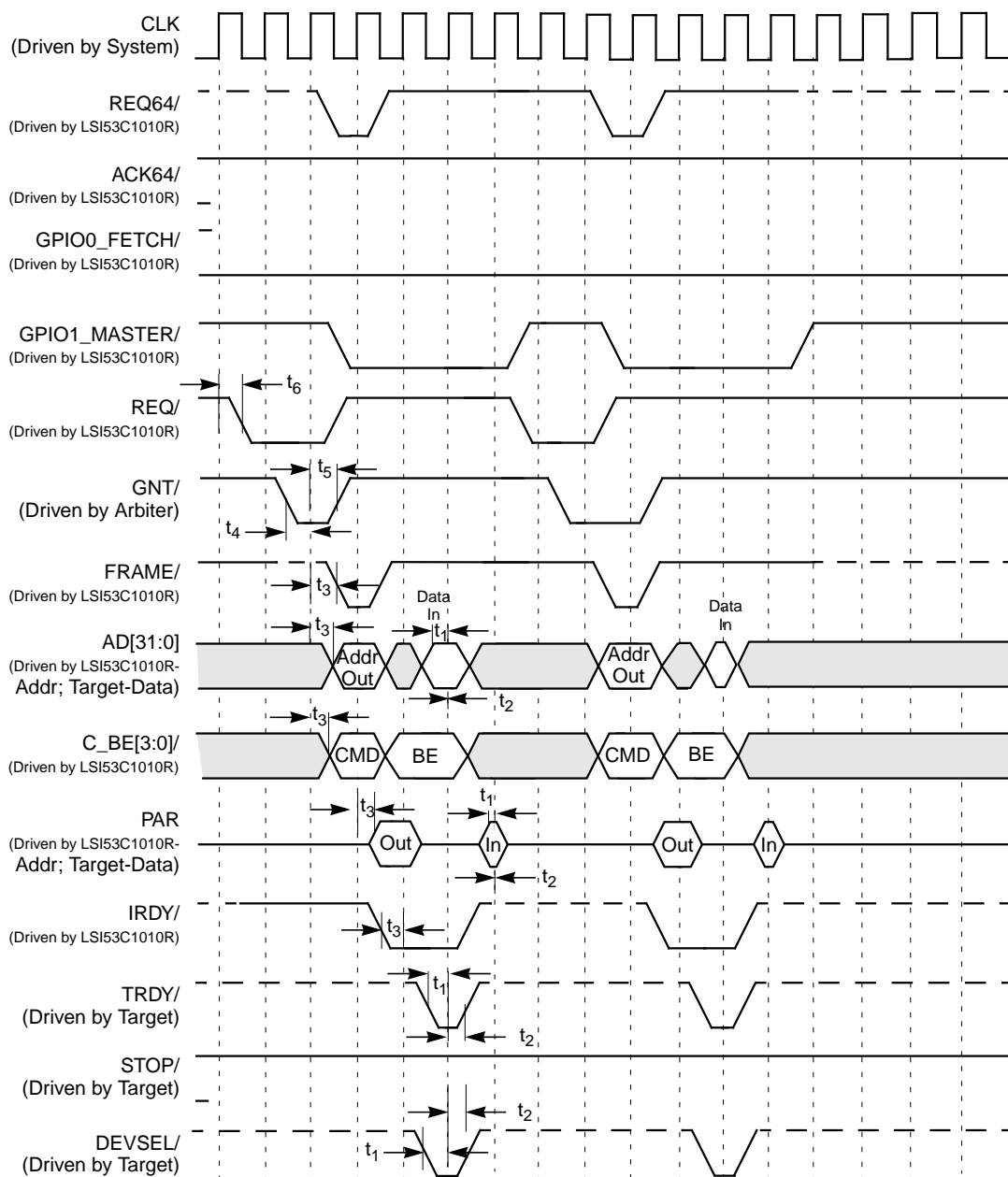
Table 6.26 Back to Back Write, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	**Max**	**Min**	**Max**	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_4	Side signal input setup time	5	–	10	–	ns
t_5	Side signal input hold time	0	–	0	–	ns
t_6	CLK to side signal output valid	2	6	2	12	ns

Figure 6.20 Back to Back Write, 32-Bit Address and Data
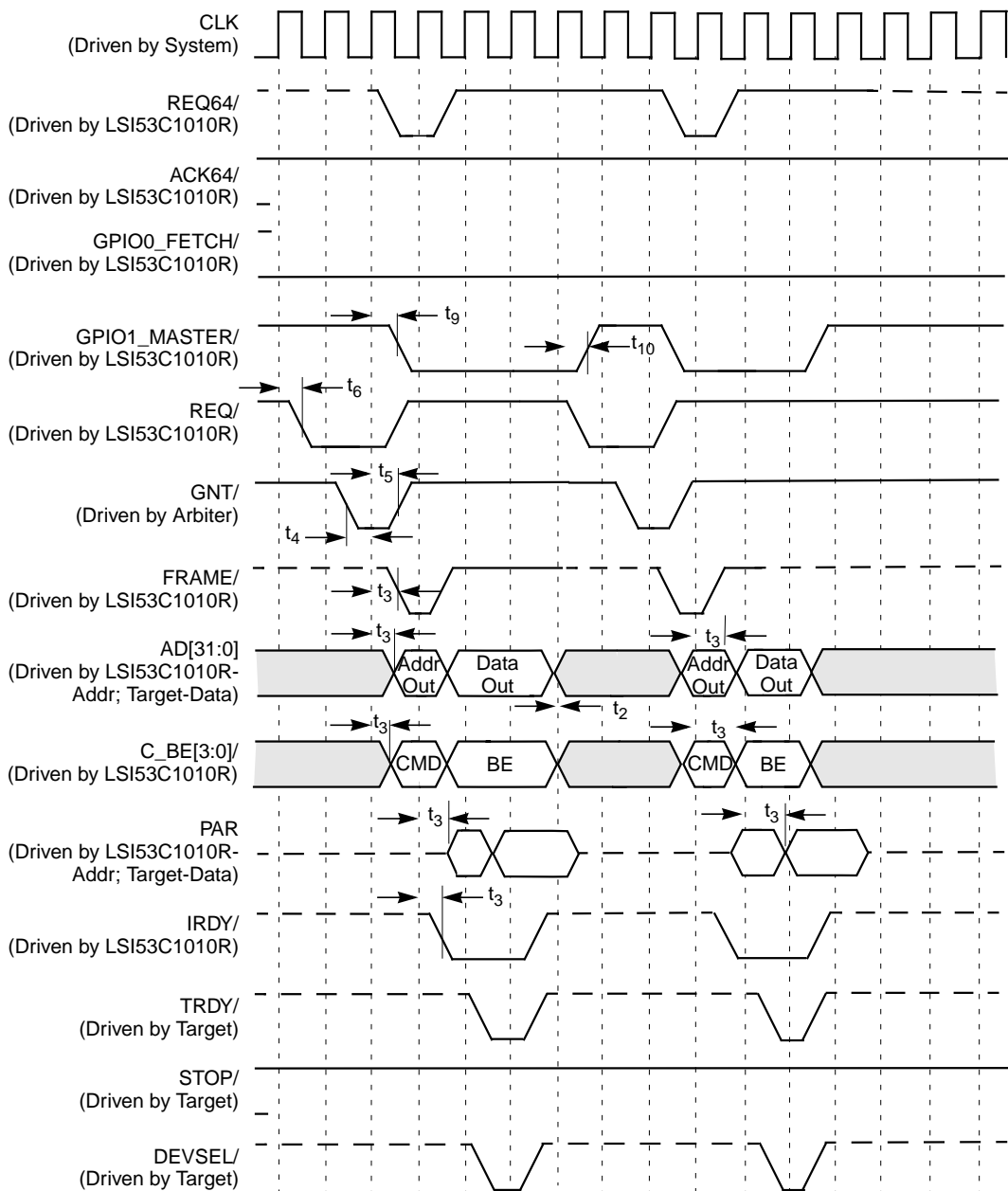
Table 6.27 Burst Read, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.21 Burst Read, 32-Bit Address and Data
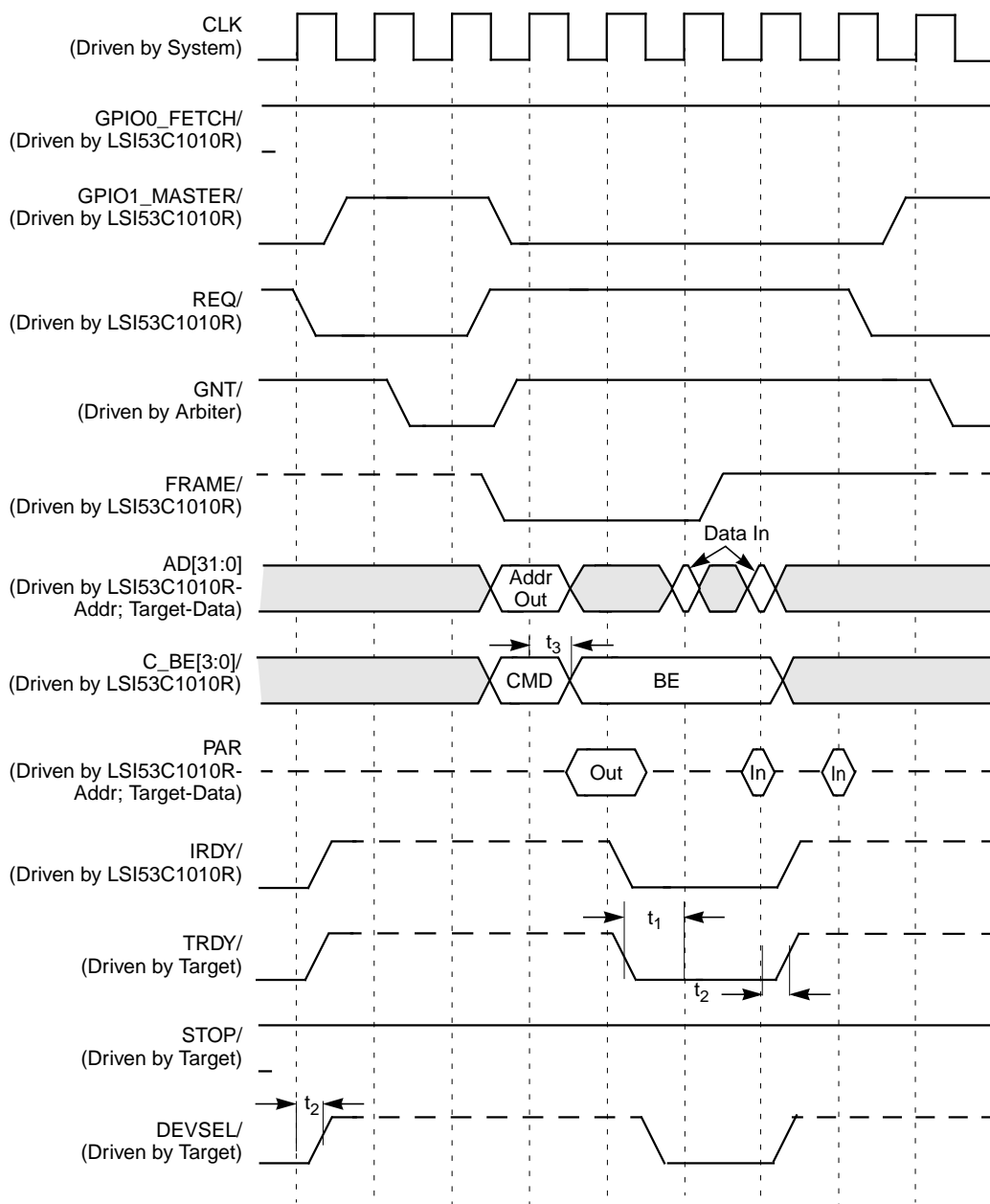
Table 6.28   Burst Read, 64-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.22 Burst Read, 64-Bit Address and Data
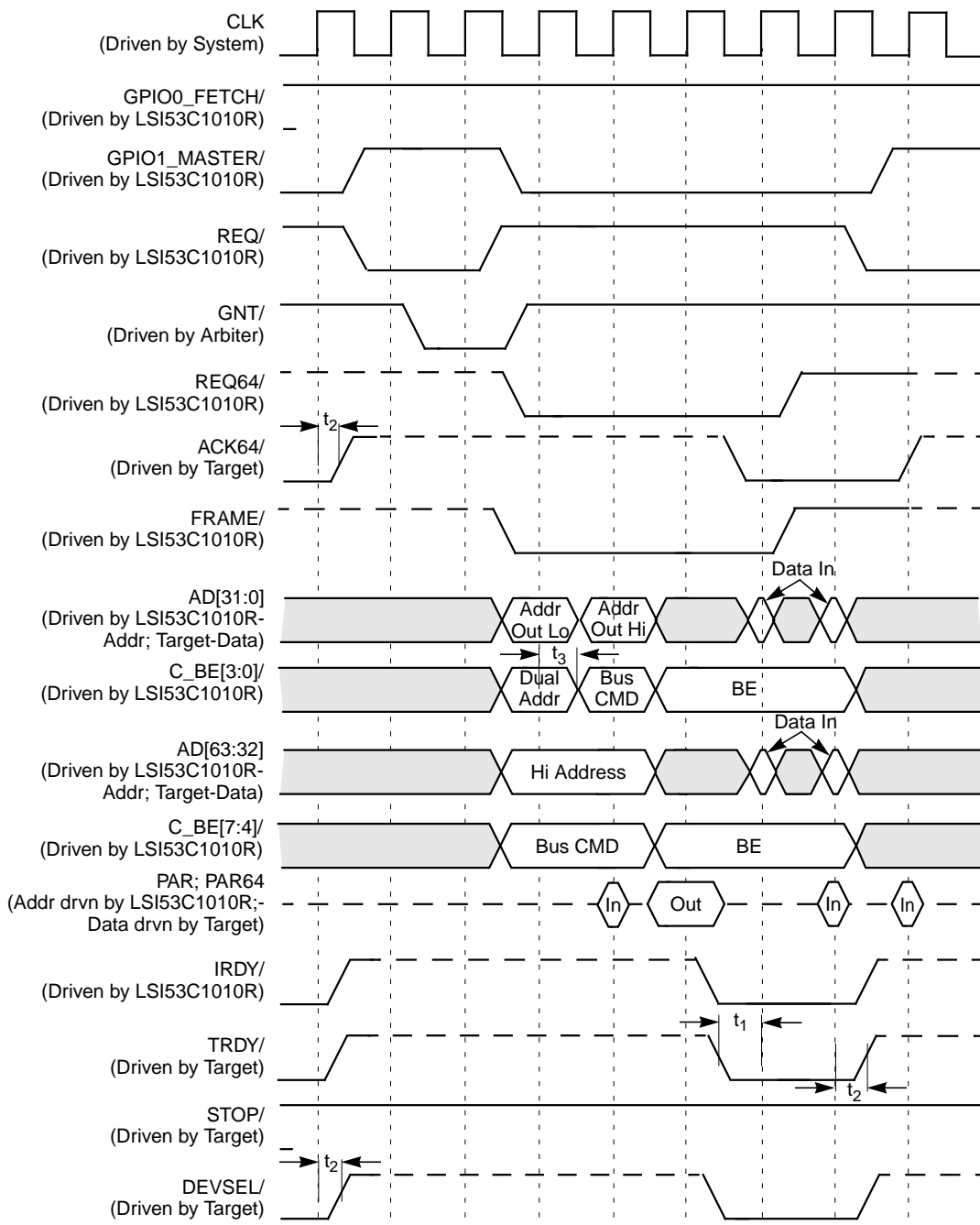
Table 6.29   Burst Write, 32-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.23 Burst Write, 32-Bit Address and Data
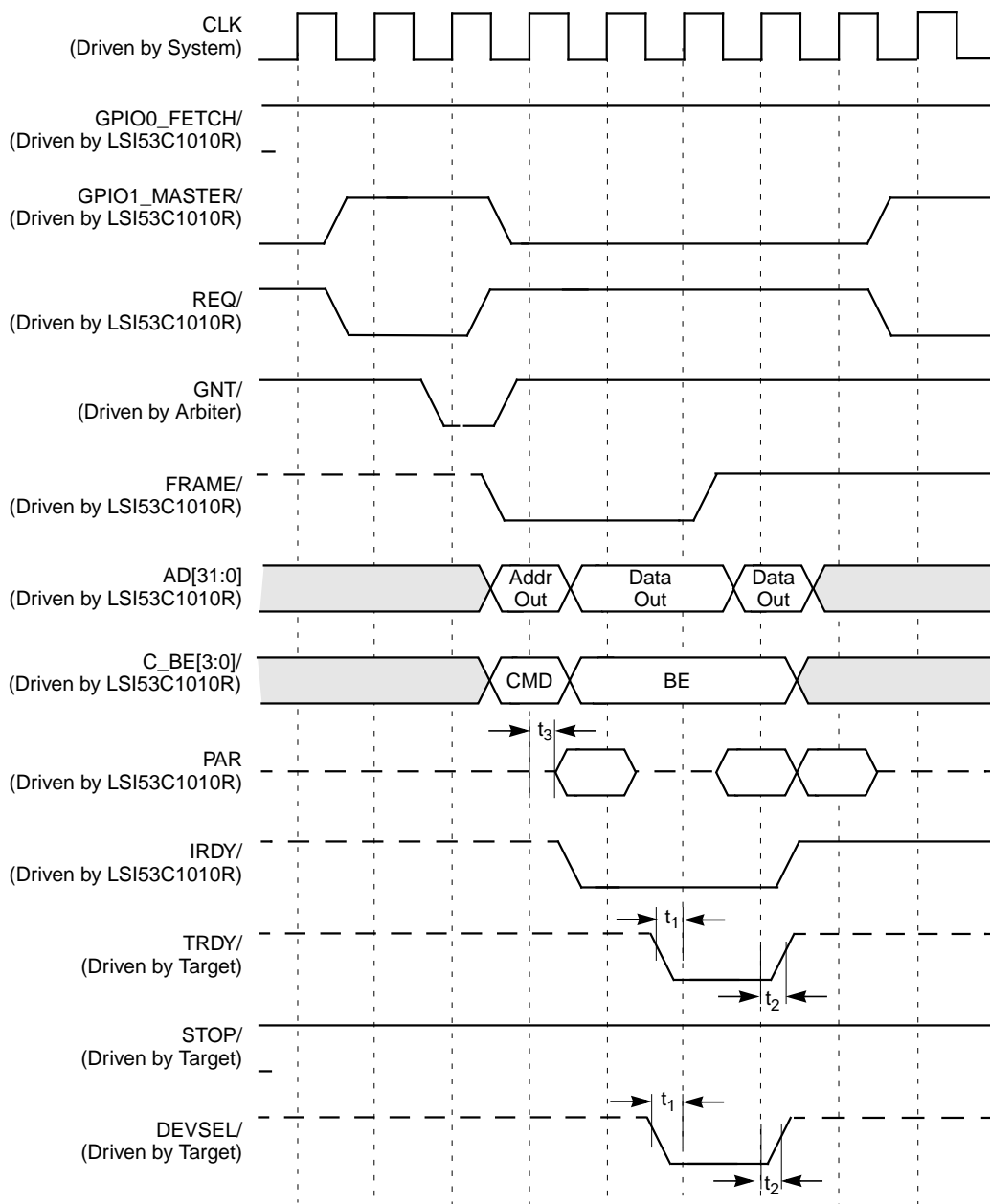
Table 6.30   Burst Write, 64-Bit Address and Data

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns

Figure 6.24 Burst Write, 64-Bit Address and Data
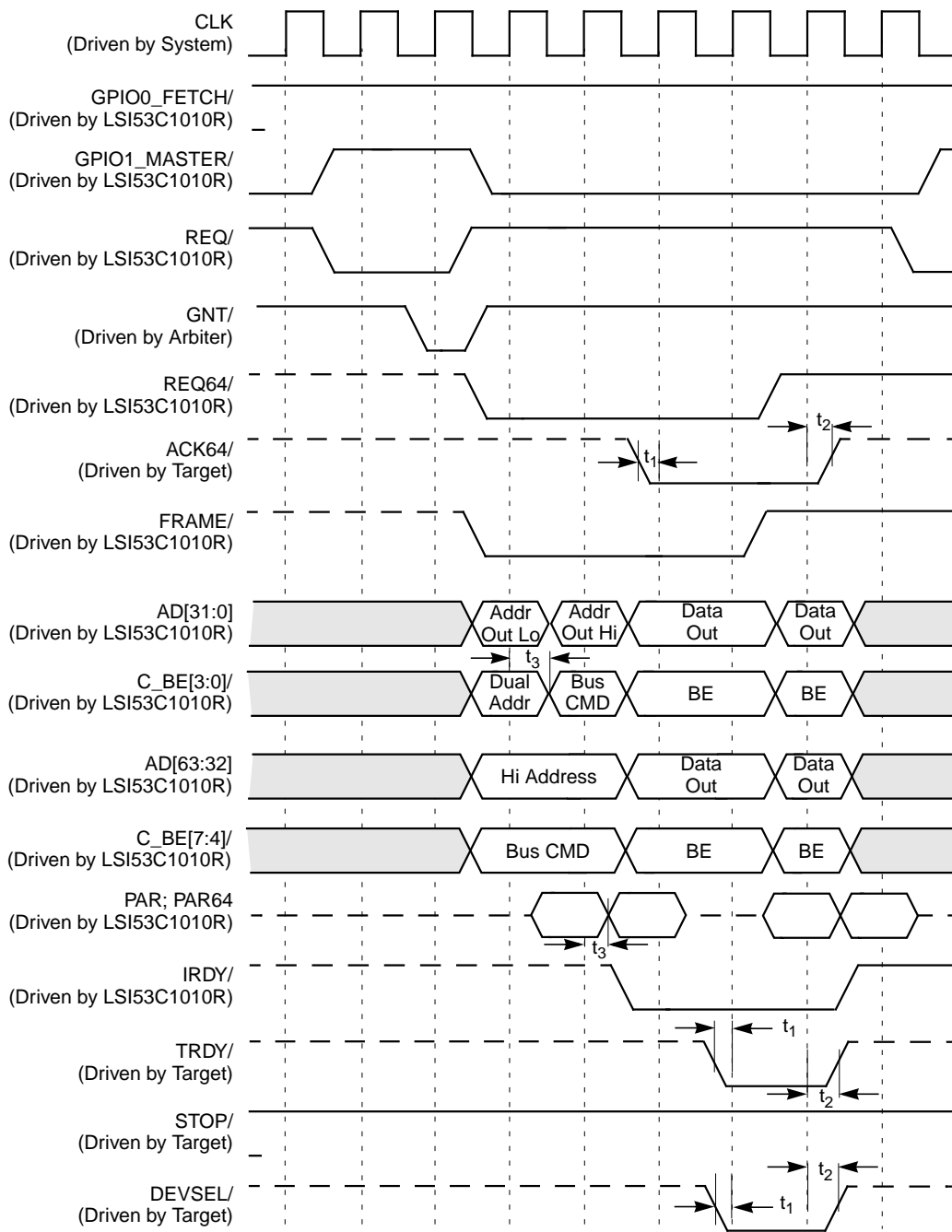
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6.4.3 External Memory Timing

Tables 6.31 through 6.38 and figures 6.25 through 6.34 describe External Memory timing.

Table 6.31 External Memory Read

Symbol	Parameter	66 MHz PCI		33 MHz PCI		Unit
		Min	Max	Min	Max	
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_{11}	Address setup to MAS/ HIGH	25	–	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	15	–	ns
t_{13}	MAS/ pulse width	25	–	25	–	ns
t_{14}	MCE/ LOW to data clocked in	150	–	150	–	ns
t_{15}	Address valid to data clocked in	205	–	205	–	ns
t_{16}	MOE/ LOW to data clocked in	100	–	100	–	ns
t_{17}	Data hold from address, MOE/, MCE/ change	0	–	0	–	ns
t_{19}	Data setup to CLK HIGH	5	–	5	–	ns

Figure 6.25 External Memory Read
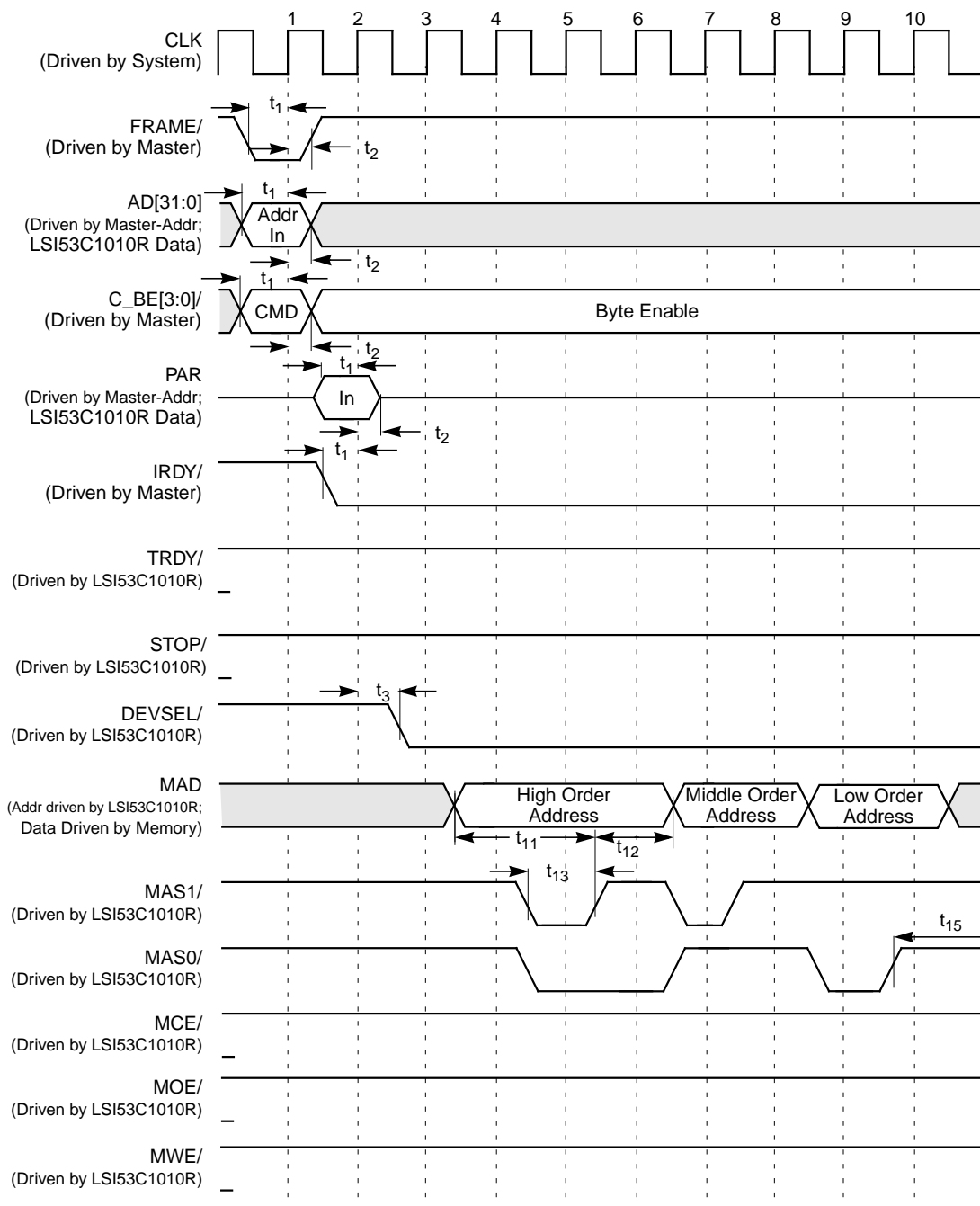
Figure 6.25 External Memory Read (Cont.)
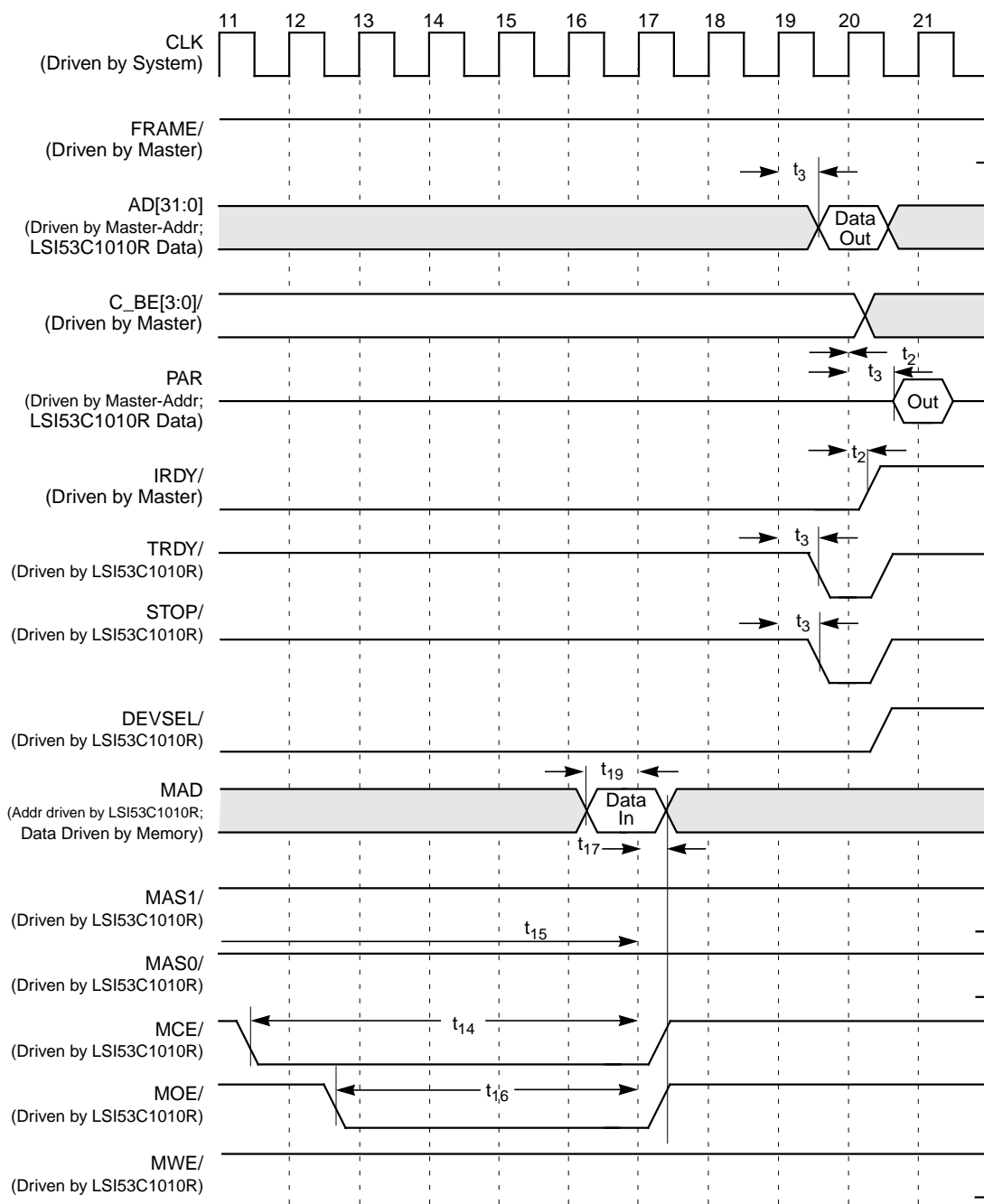
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Table 6.32   External Memory Write

Symbol	Parameter	Min	Max	Min	Max	Unit
t_1	Shared signal input setup time	3	–	7	–	ns
t_2	Shared signal input hold time	0	–	0	–	ns
t_3	CLK to shared signal output valid	2	6	2	11	ns
t_{11}	Address setup to MAS/ HIGH	25	–	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	15	–	ns
t_{13}	MAS/ pulse width	25	–	25	–	ns
t_{20}	Data setup to MWE/ LOW	30	–	30	–	ns
t_{21}	Data hold from MWE/ HIGH	20	–	20	–	ns
t_{22}	MWE/ pulse width	100	–	100	–	ns
t_{23}	Address setup to MWE/ LOW	60	–	60	–	ns
t_{24}	MCE/ LOW to MWE/ HIGH	120	–	120	–	ns
t_{25}	MCE/ LOW to MWE/ LOW	25	–	25	–	ns
t_{26}	MWE/ HIGH to MCE/ HIGH	25	–	25	–	ns

Figure 6.26 External Memory Write
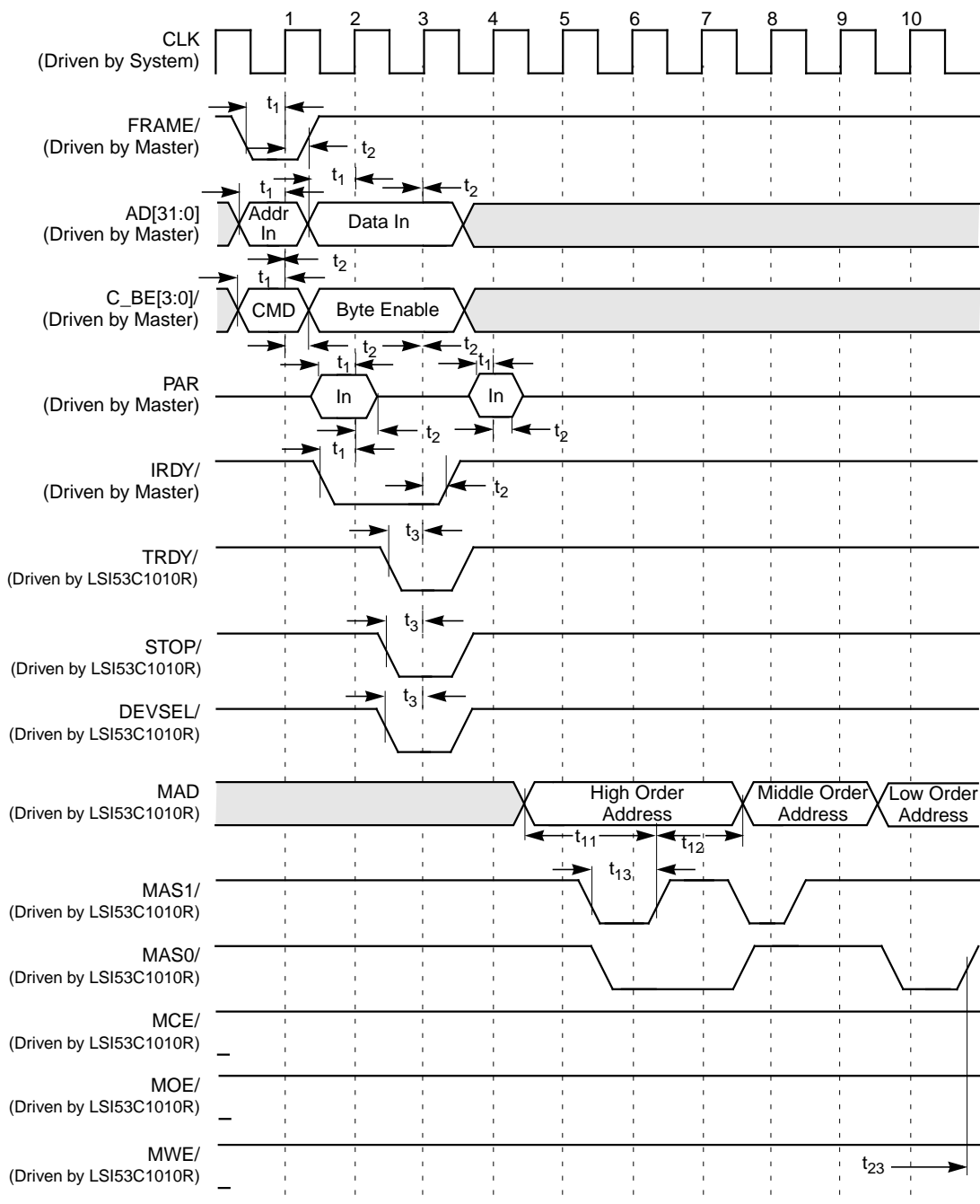
Figure 6.26 External Memory Write (Cont.)
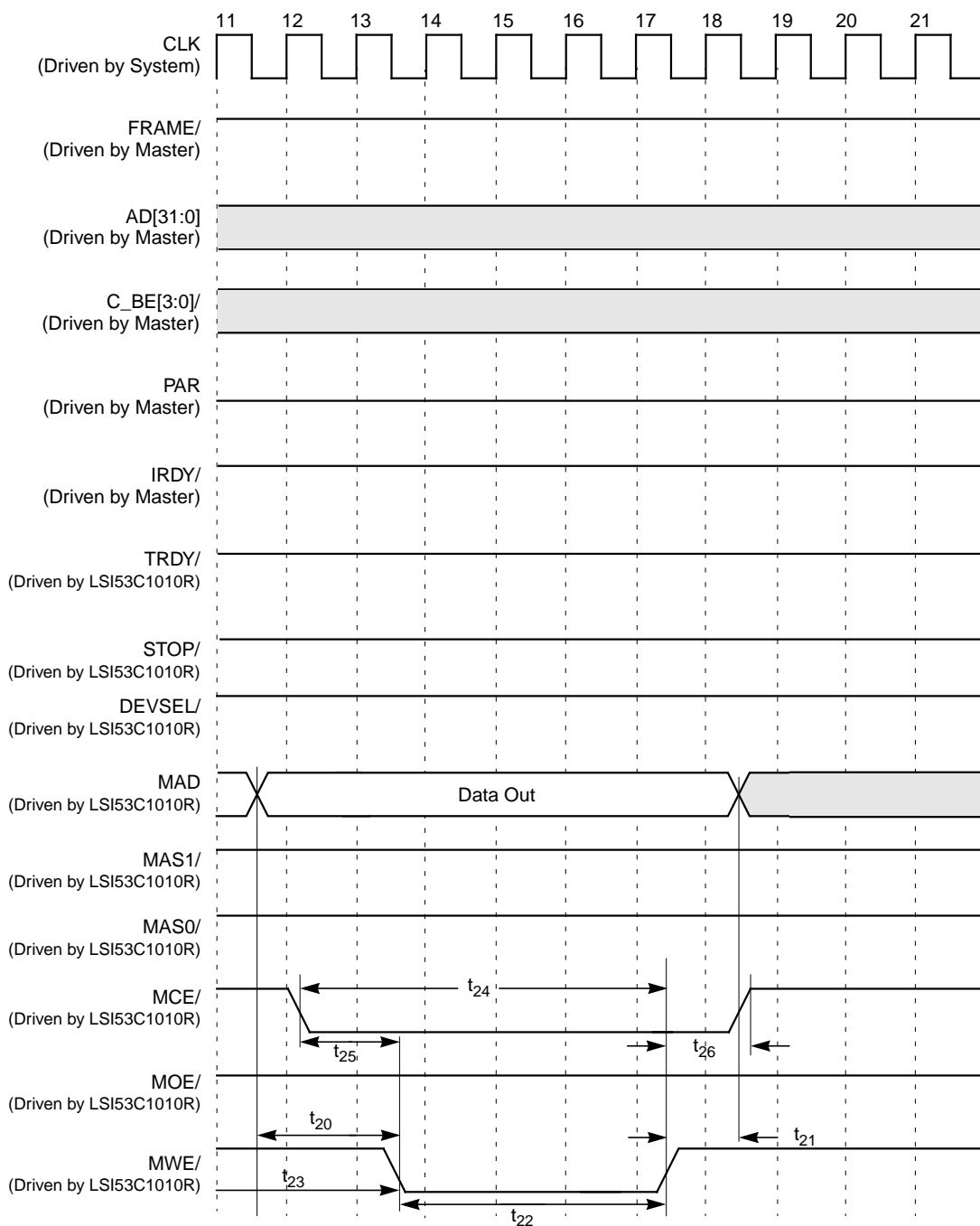
Table 6.33   Normal/Fast Memory ($\geq$ 128 Kbytes) Single Byte Access Read Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ high	25	–	ns
t_{12}	Address hold from MAS/ high	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{14}	MCE/ LOW to data clocked in	150	–	ns
t_{15}	Address valid to data clocked in	205	–	ns
t_{16}	MOE/ LOW to data clocked in	100	–	ns
t_{17}	Data hold from address, MOE/, MCE/ change	0	–	ns
t_{18}	Address out from MOE/, MCE/ HIGH	50	–	ns
t_{19}	Data setup to CLK HIGH	5	–	ns

Figure 6.27 Normal/Fast Memory ($\geq$ 128 Kbytes) Single Byte Access Read Cycle
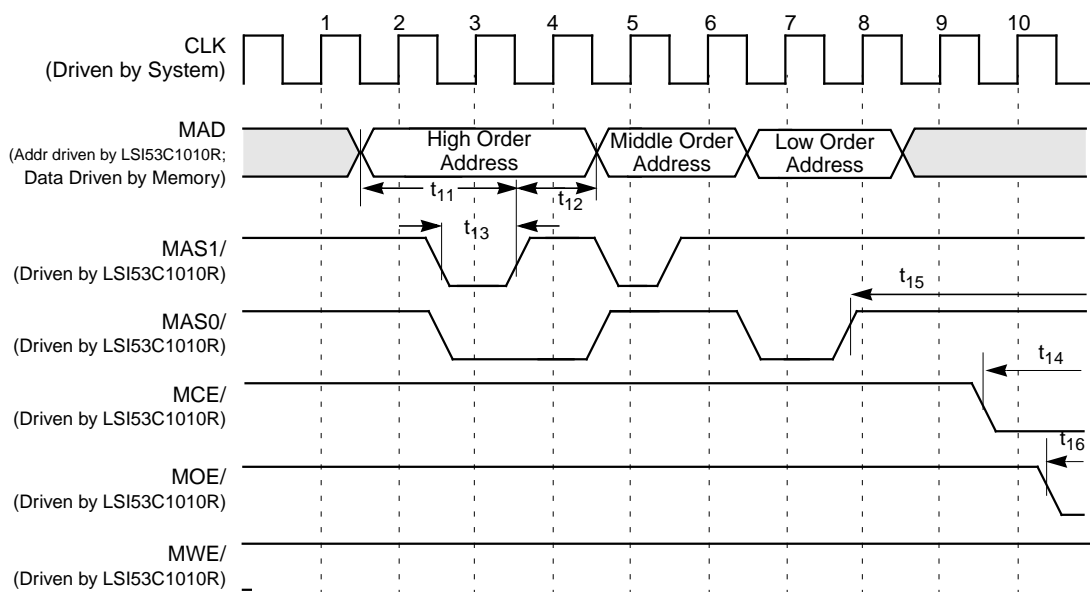
Figure 6.27 Normal/Fast Memory (≥ 128 Kbytes) Single Byte Access Read Cycle (Cont.)
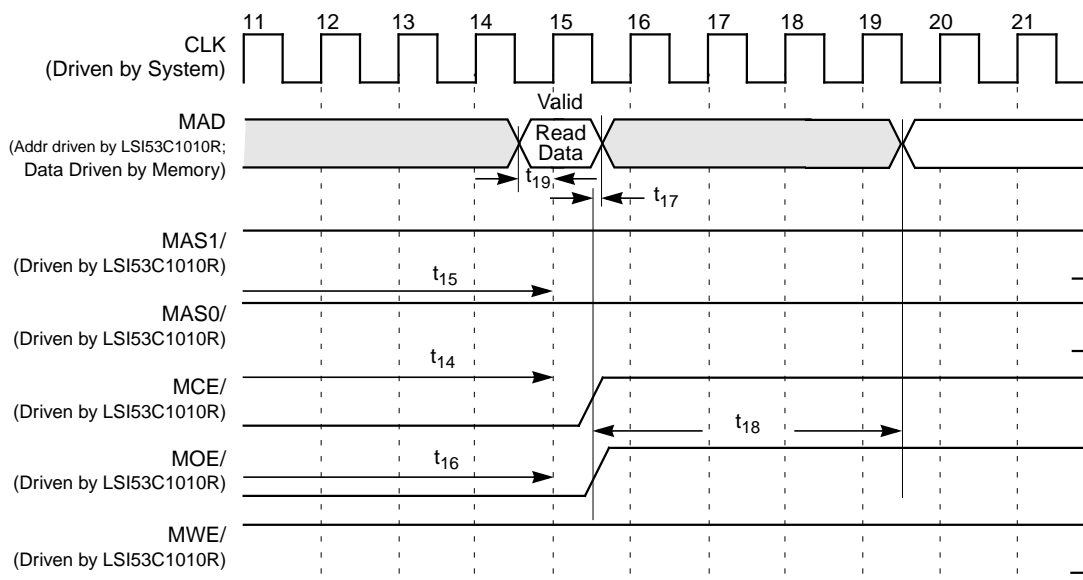
Table 6.34   Normal/Fast Memory ($\geq$ 128 Kbytes) Single Byte Access Write Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ HIGH	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{20}	Data setup to MWE/ LOW	30	–	ns
t_{21}	Data hold from MWE/ HIGH	20	–	ns
t_{22}	MWE/ pulse width	100	–	ns
t_{23}	Address setup to MWE/ LOW	60	–	ns
t_{24}	MCE/ LOW to MWE/ HIGH	120	–	ns
t_{25}	MCE/ LOW to MWE/ LOW	25	–	ns
t_{26}	MWE/ HIGH to MCE/ HIGH	25	–	ns

Figure 6.28 Normal/Fast Memory ($\geq$ 128 Kbytes) Single Byte Access Write Cycle
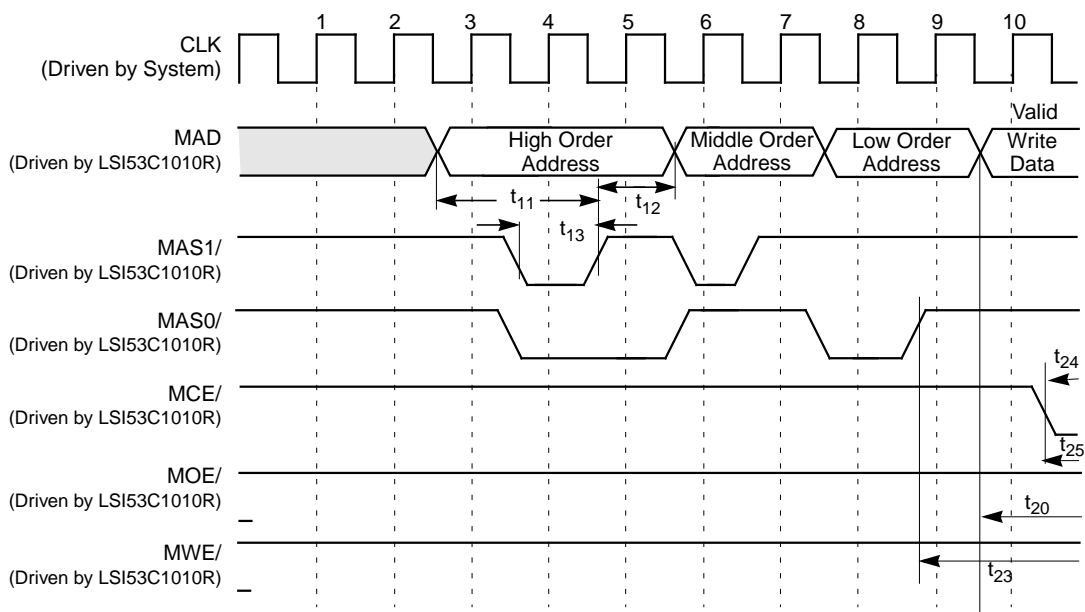
Figure 6.28 Normal/Fast Memory (≥ 128 Kbytes) Single Byte Access Write Cycle (Cont.)
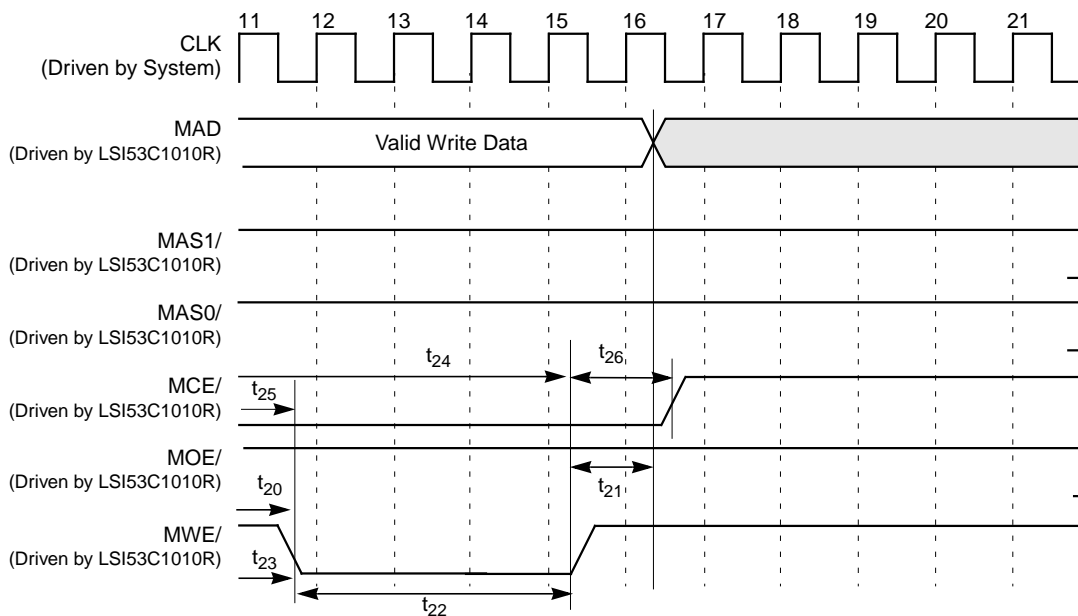
Figure 6.29 Normal/Fast Memory (≥ 128 Kbytes) Multiple Byte Access Read Cycle
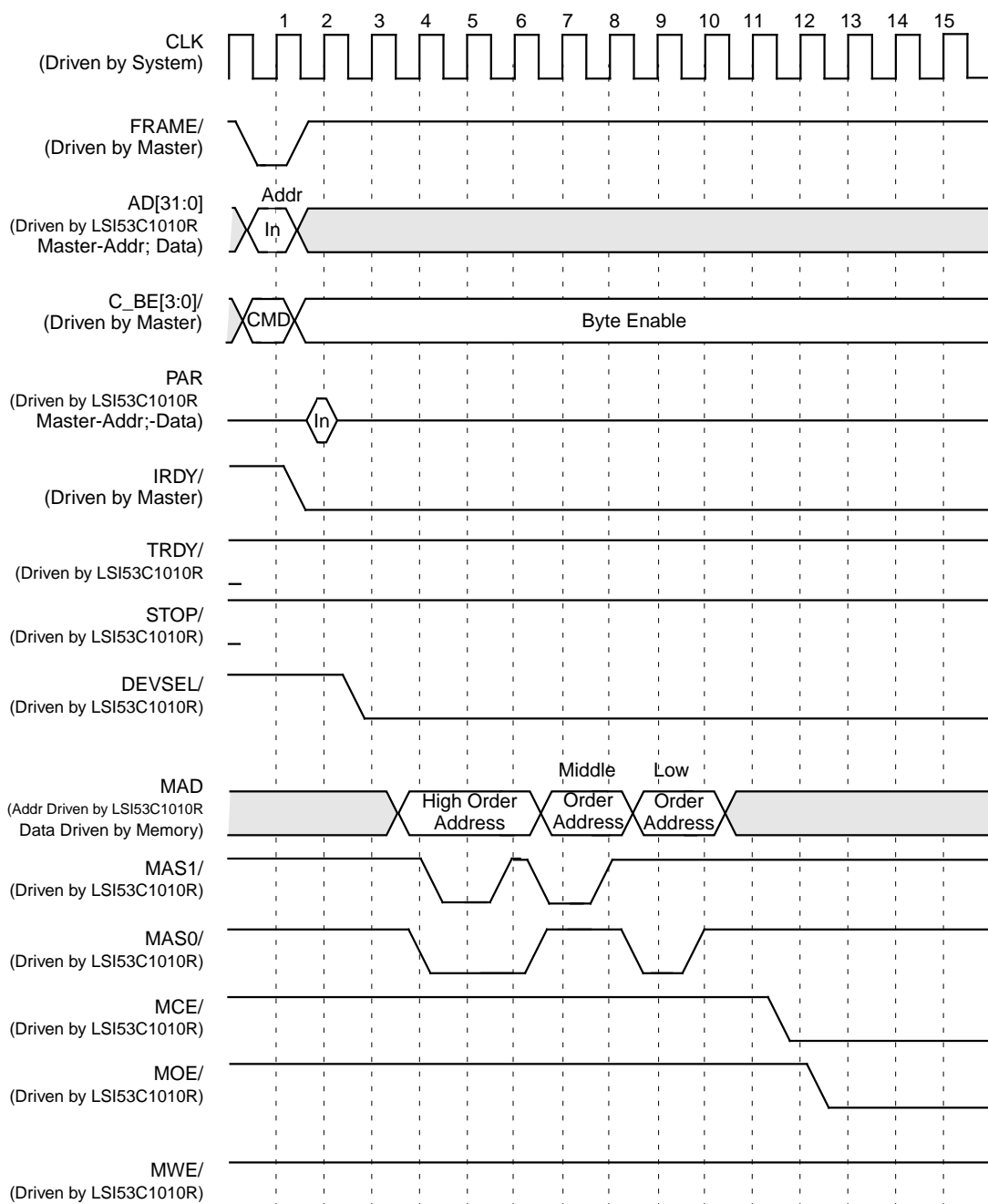
Figure 6.29 Normal/Fast Memory (≥ 128 Kbytes) Multiple Byte Access Read Cycle (Cont.)
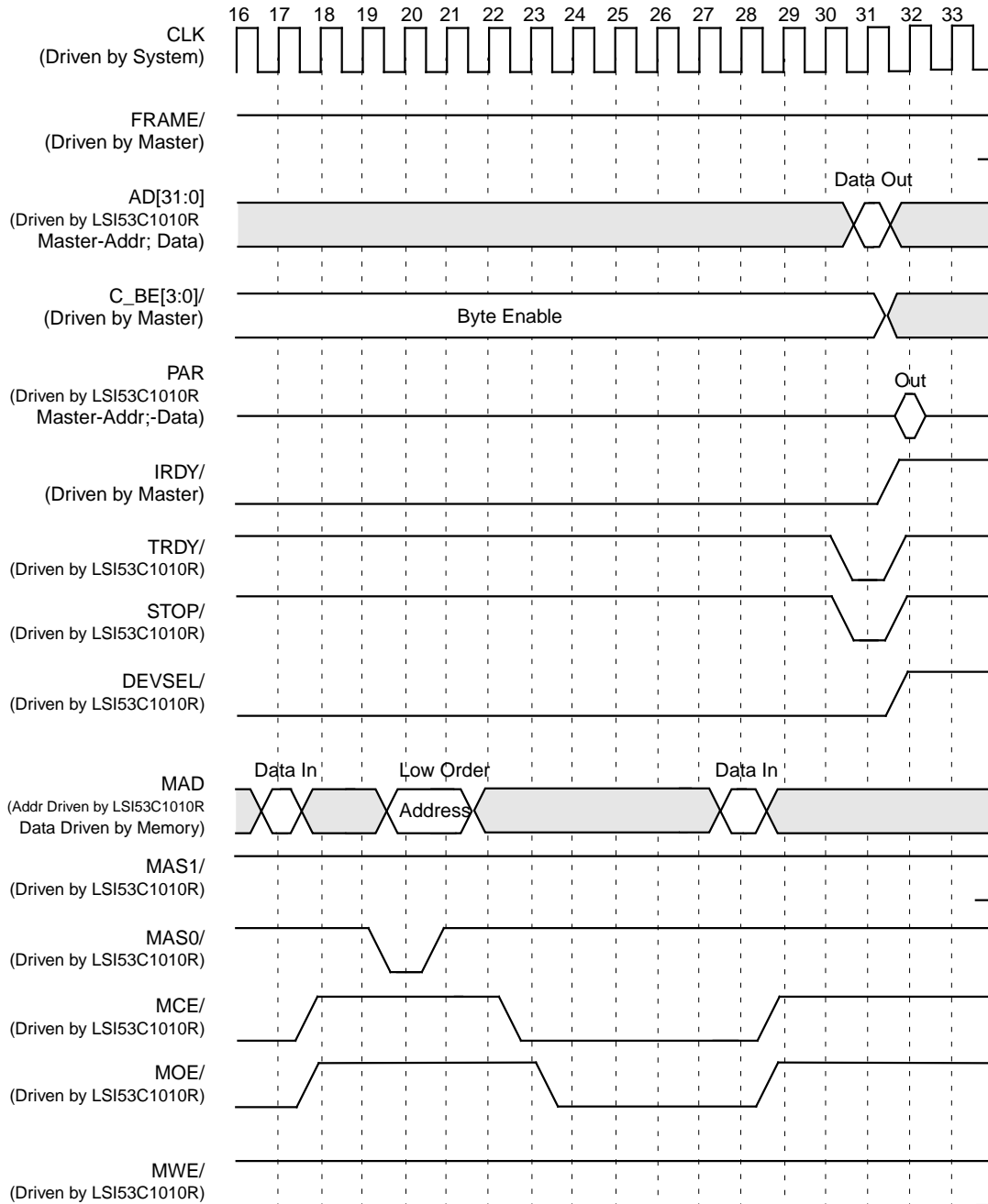
Figure 6.30 Normal/Fast Memory (≥ 128 Kbytes) Multiple Byte Access Write Cycle
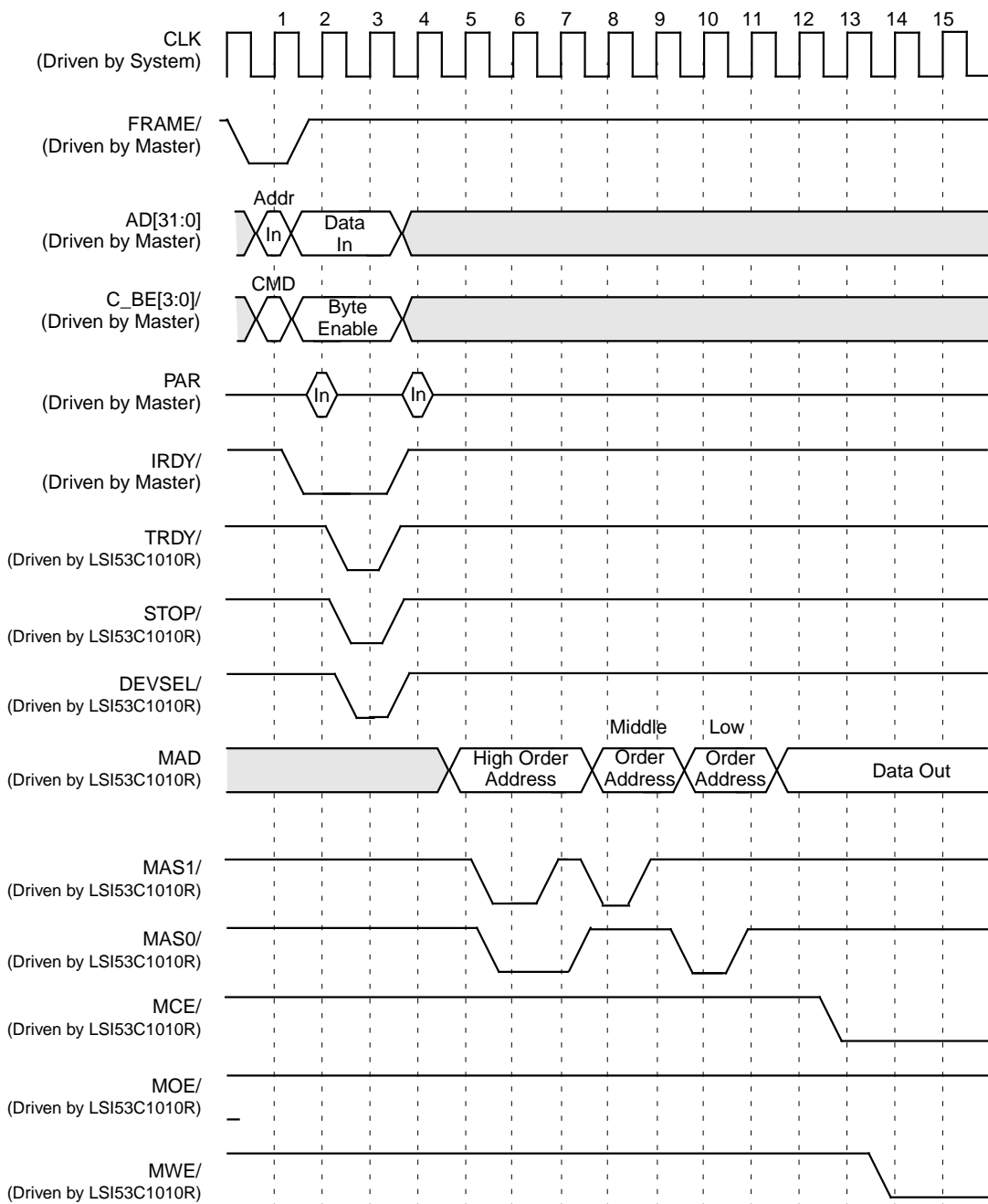
Figure 6.30 Normal/Fast Memory (≥ 128 Kbytes) Multiple Byte Access Write Cycle (Cont.)
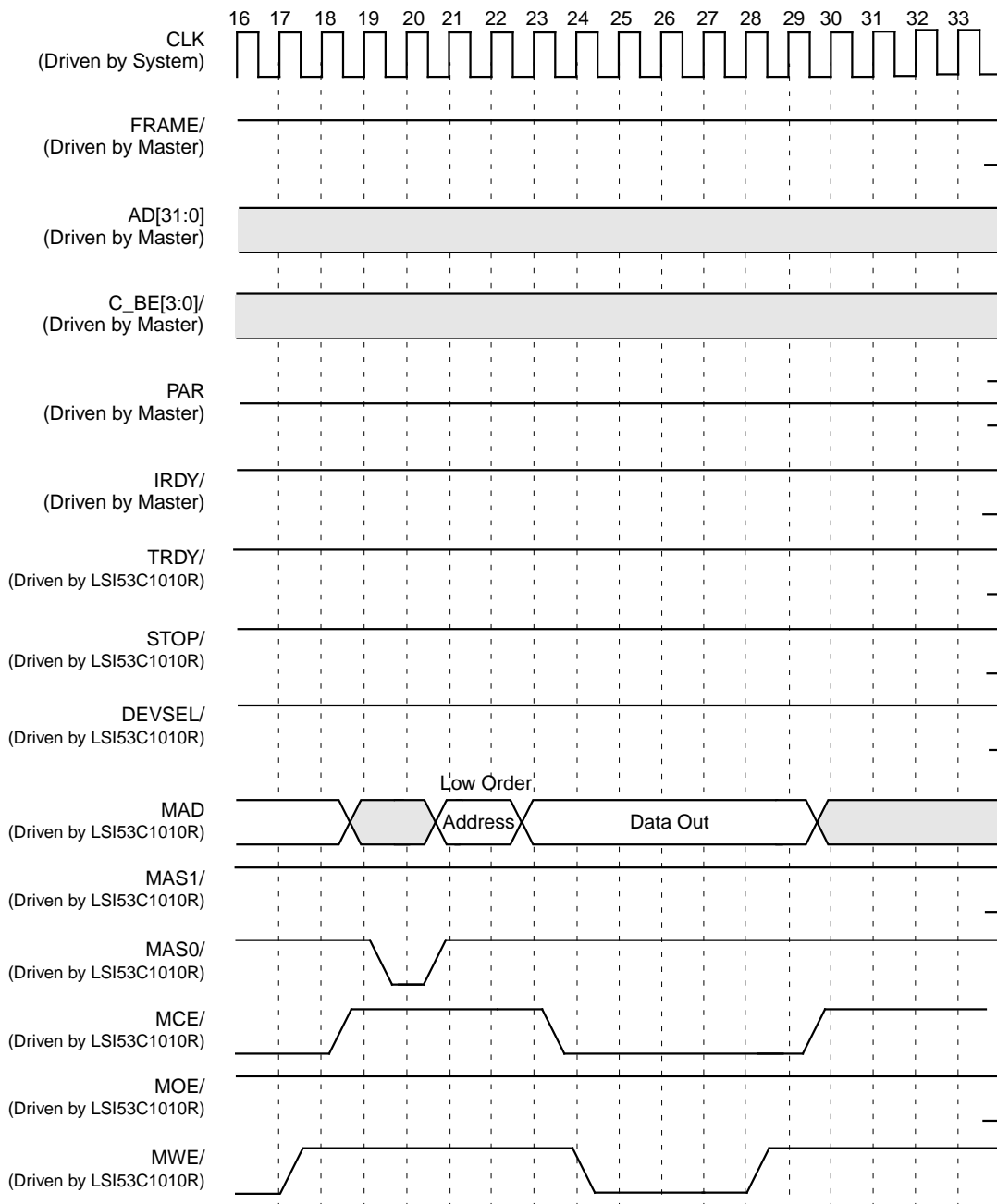
Table 6.35   Slow Memory ($\geq$ 128 Kbytes) Read Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ HIGH	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{14}	MCE/ LOW to data clocked in	150	–	ns
t_{15}	Address valid to data clocked in	205	–	ns
t_{16}	MOE/ LOW to data clocked in	100	–	ns
t_{17}	Data hold from address, MOE/, MCE/ change	0	–	ns
t_{18}	Address out from MOE/, MCE/ HIGH	50	–	ns
t_{19}	Data setup to CLK HIGH	5	–	ns

Figure 6.31 Slow Memory ($\geq$ 128 Kbytes) Read Cycle
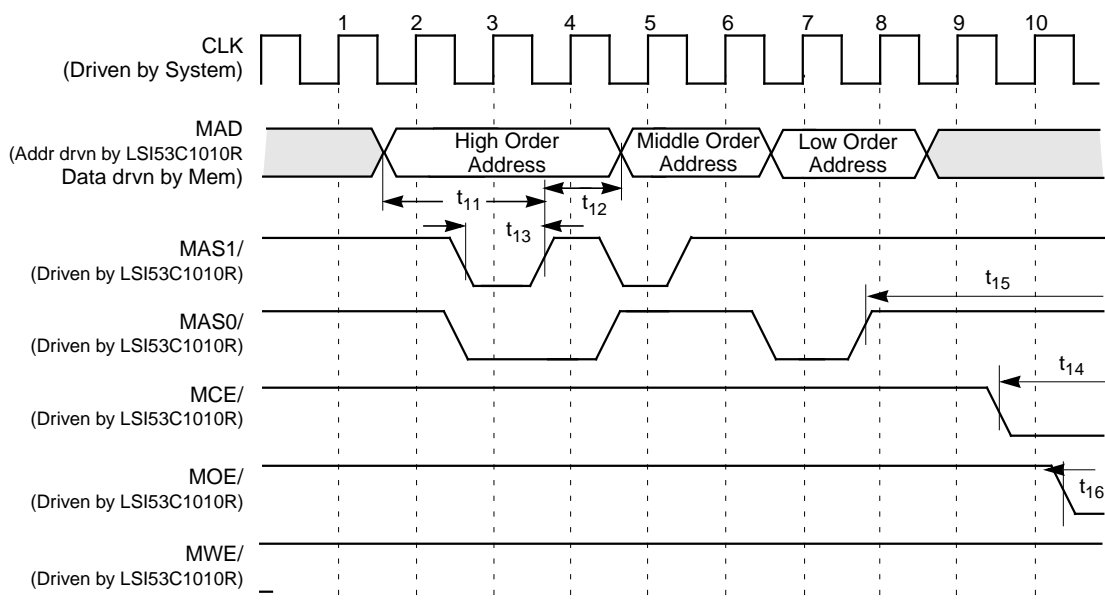
Figure 6.31 Slow Memory (≥ 128 Kbytes) Read Cycle (Cont.)
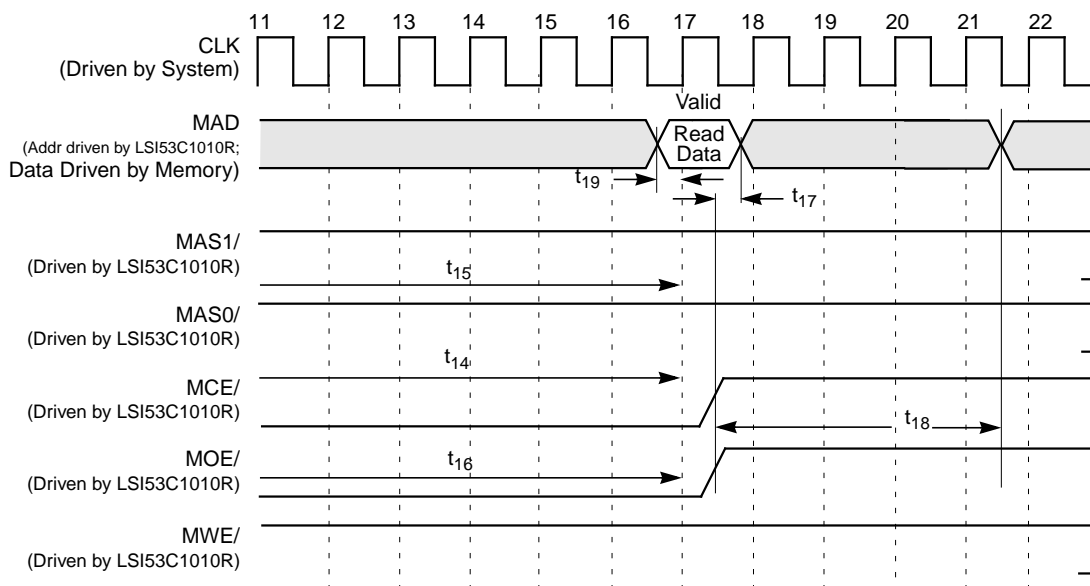
Table 6.36 Slow Memory ($\geq$ 128 Kbytes) Write Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ HIGH	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{20}	Data setup to MWE/ LOW	30	–	ns
t_{21}	Data hold from MWE/ HIGH	20	–	ns
t_{22}	MWE/ pulse width	100	–	ns
t_{23}	Address setup to MWE/ LOW	60	–	ns
t_{24}	MCE/ LOW to MWE/ HIGH	120	–	ns
t_{25}	MCE/ LOW to MWE/ LOW	25	–	ns
t_{26}	MWE/ HIGH to MCE/ HIGH	25	–	ns

Figure 6.32 Slow Memory ($\geq$ 128 Kbytes) Write Cycle
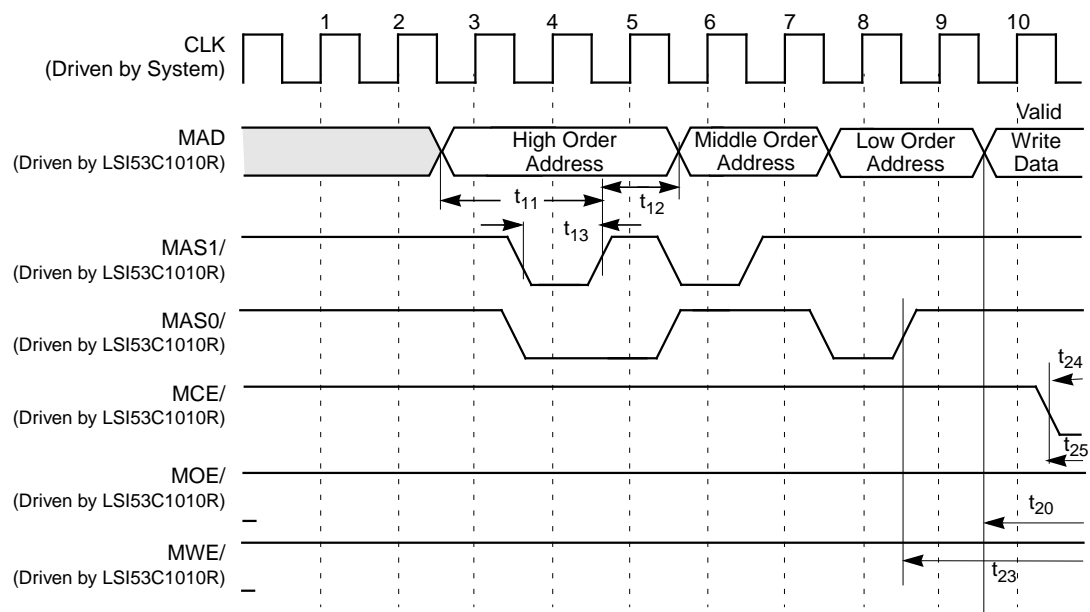
Figure 6.32 Slow Memory (≥ 128 Kbytes) Write Cycle (Cont.)
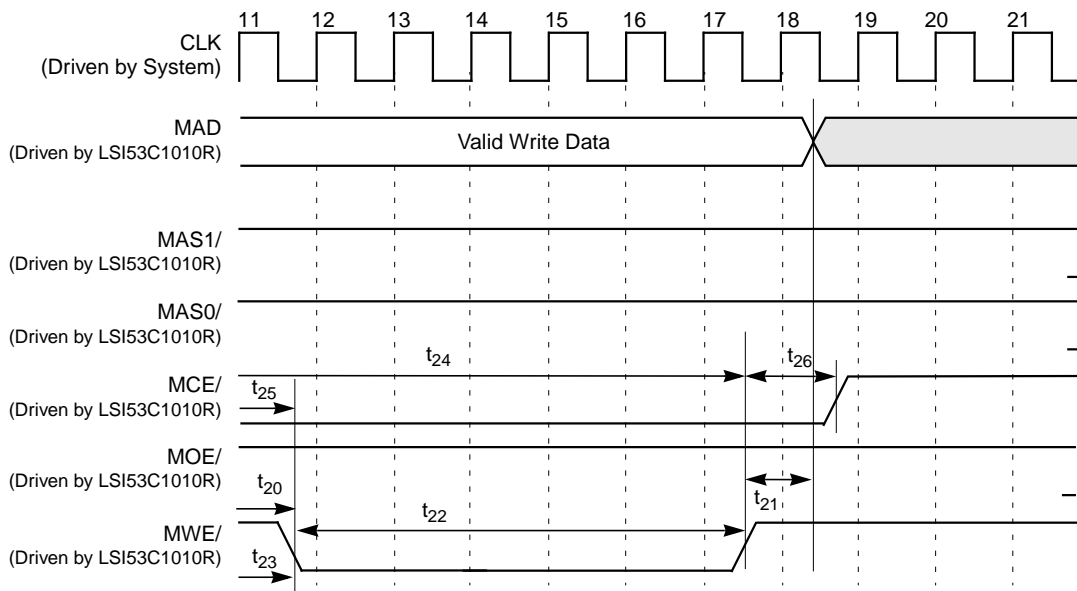
Table 6.37 ≤ 64 Kbytes ROM Read Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ HIGH	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{14}	MCE/ LOW to data clocked in	150	–	ns
t_{15}	Address valid to data clocked in	205	–	ns
t_{16}	MOE/ LOW to data clocked in	100	–	ns
t_{17}	Data hold from address, MOE/, MCE/ change	0	–	ns
t_{18}	Address out from MOE/, MCE/ HIGH	50	–	ns
t_{19}	Data setup to CLK HIGH	5	–	ns

Figure 6.33 ≤ 64 Kbytes ROM Read Cycle
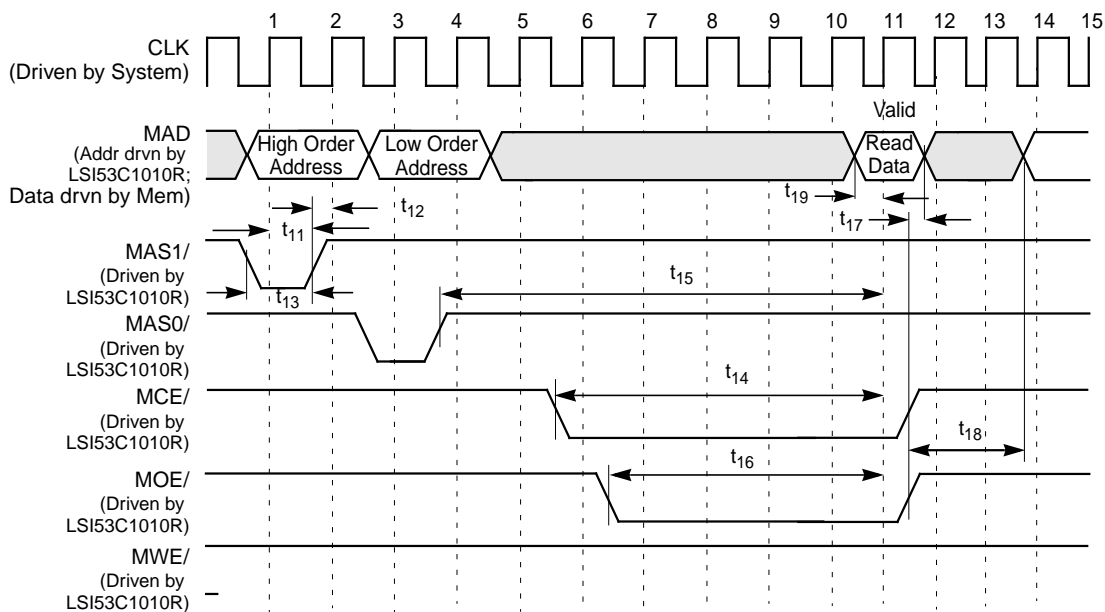
Table 6.38 $\leq$ 64 Kbytes ROM Write Cycle

Symbol	Parameter	Min	Max	Unit
t_{11}	Address setup to MAS/ HIGH	25	–	ns
t_{12}	Address hold from MAS/ HIGH	15	–	ns
t_{13}	MAS/ pulse width	25	–	ns
t_{20}	Data setup to MWE/ LOW	30	–	ns
t_{21}	Data hold from MWE/ HIGH	20	–	ns
t_{22}	MWE/ pulse width	100	–	ns
t_{23}	Address setup to MWE/ LOW	60	–	ns
t_{24}	MCE/ LOW to MWE/ HIGH	120	–	ns
t_{25}	MCE/ LOW to MWE/ LOW	25	–	ns
t_{26}	MWE/ HIGH to MCE/ HIGH	25	–	ns

Figure 6.34 $\leq$ 64 Kbytes ROM Write Cycle
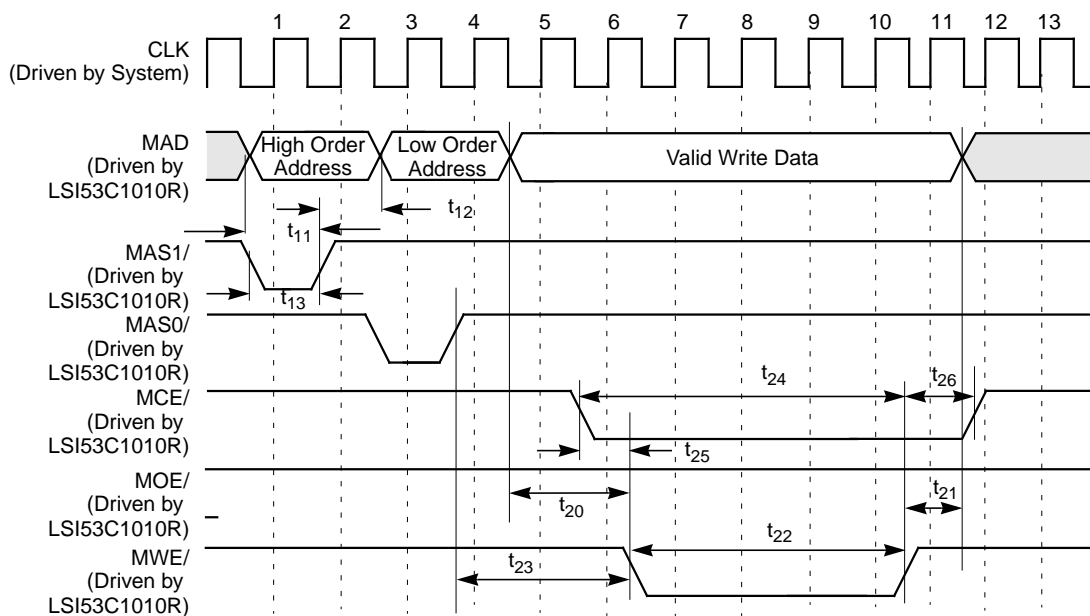
6.5 SCSI Timing Diagrams

Tables 6.39 through 6.50 and figures 6.35 through 6.40 and describe the LSI53C1010R SCSI timing.

Table 6.39   Initiator Asynchronous Send

Symbol	Parameter	Min	Max	Units
t_1	SACK/ asserted from SREQ/ asserted	5	–	ns
t_2	SACK/ deasserted from SREQ/ deasserted	5	–	ns
t_3	Data setup to SACK/ asserted	55	–	ns
t_4	Data hold from SREQ/ deasserted	0	–	ns

Figure 6.35 Initiator Asynchronous Send
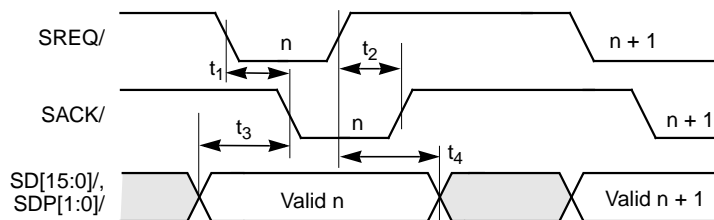
Table 6.40　Initiator Asynchronous Receive

Symbol	Parameter	Min	Max	Units
t_1	SACK/ asserted from SREQ/ asserted	5	–	ns
t_2	SACK/ deasserted from SREQ/ deasserted	5	–	ns
t_3	Data setup to SREQ/ asserted	0	–	ns
t_4	Data hold from SACK/ asserted	0	–	ns

Figure 6.36　Initiator Asynchronous Receive
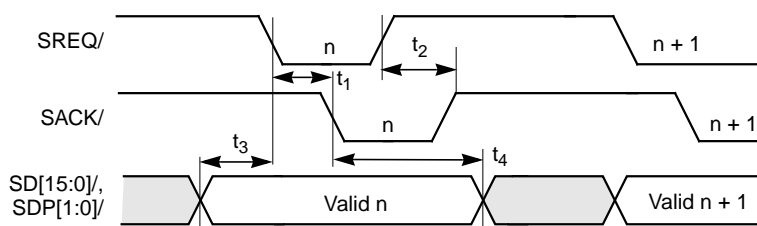
Table 6.41　Target Asynchronous Send

Symbol	Parameter	Min	Max	Units
t_1	SREQ/ deasserted from SACK/ asserted	5	–	ns
t_2	SREQ/ asserted from SACK/ deasserted	5	–	ns
t_3	Data setup to SREQ/ asserted	55	–	ns
t_4	Data hold from SACK/ asserted	0	–	ns

Figure 6.37　Target Asynchronous Send
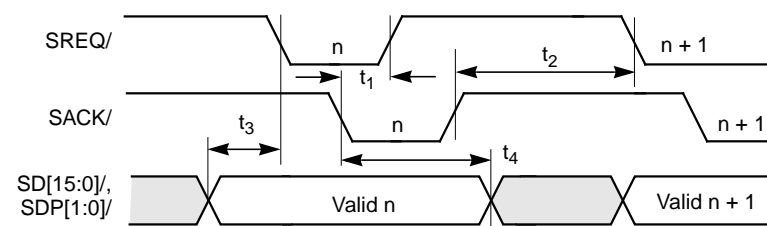
Table 6.42   Target Asynchronous Receive

Symbol	Parameter	Min	Max	Units
t_1	SREQ/ deasserted from SACK/ asserted	5	–	ns
t_2	SREQ/ asserted from SACK/ deasserted	5	–	ns
t_3	Data setup to SACK/ asserted	0	–	ns
t_4	Data hold from SREQ/ deasserted	0	–	ns

Figure 6.38   Target Asynchronous Receive
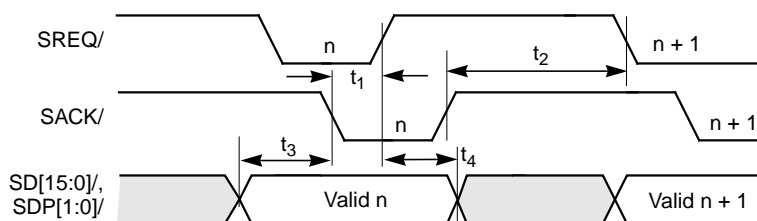
Table 6.43   SCSI-1 Transfers (SE 5.0 Mbytes)

Symbol	Parameter	Min	Max	Units
t_{ST1}	Send SREQ/ or SACK/ assertion pulse width	80	–	ns
t_{ST2}	Send SREQ/ or SACK/ deassertion pulse width	80	–	ns
t_{ST1}	Receive SREQ/ or SACK/ assertion pulse width	70	–	ns
t_{ST2}	Receive SREQ/ or SACK/ deassertion pulse width	70	–	ns
t_{ST3}	Send data setup to SREQ/ or SACK/ asserted	24	–	ns
t_{ST4}	Send data hold from SREQ/ or SACK/ asserted	54	–	ns
t_{ST5}	Receive data setup to SREQ/ or SACK/ asserted	14	–	ns
t_{ST6}	Receive data hold from SREQ/ or SACK/ asserted	24	–	ns

Table 6.44   SCSI-2 Fast Transfers 10.0 Mbytes (8-Bit Transfers) or 20.0 Mbytes (16-Bit Transfers) 40 MHz Clock

Symbol	Parameter	Min	Max	Units
t_{ST1}	Send SREQ/ or SACK/ assertion pulse width	30	–	ns
t_{ST2}	Send SREQ/ or SACK/ deassertion pulse width	30	–	ns
t_{ST1}	Receive SREQ/ or SACK/ assertion pulse width	22	–	ns
t_{ST2}	Receive SREQ/ or SACK/ deassertion pulse width	22	–	ns
t_{ST3}	Send data setup to SREQ/ or SACK/ asserted	24	–	ns
t_{ST4}	Send data hold from SREQ/ or SACK/ asserted	34	–	ns
t_{ST5}	Receive data setup to SREQ/ or SACK/ asserted	14	–	ns
t_{ST6}	Receive data hold from SREQ/ or SACK/ asserted	24	–	ns

Table 6.45   Ultra SCSI SE Transfers 20.0 Mbytes (8-Bit Transfers) or 40.0 Mbytes (16-Bit Transfers) Quadrupled 40 MHz Clock[1]

Symbol	Parameter	Min	Max	Unit
t_{ST1}	Send SREQ/ or SACK/ assertion pulse width	15	–	ns
t_{ST2}	Send SREQ/ or SACK/ deassertion pulse width	15	–	ns
t_{ST1}	Receive SREQ/ or SACK/ assertion pulse width	11	–	ns
t_{ST2}	Receive SREQ/ or SACK/ deassertion pulse width	11	–	ns
t_{ST3}	Send data setup to SREQ/ or SACK/ asserted	12	–	ns
t_{ST4}	Send data hold from SREQ/ or SACK/ asserted	17	–	ns
t_{ST5}	Receive data setup to SREQ/ or SACK/ asserted	6	–	ns
t_{ST6}	Receive data hold from SREQ/ or SACK/ asserted	11	–	ns

1. Note: for fast SCSI, set the TolerANT Enable bit (bit 7 in SCSI Test Three (STEST3)).

**Table 6.46   Ultra2 SCSI Transfers 40.0 Mbyte (8-Bit Transfers) or
80.0 Mbyte (16-Bit Transfers) Quadrupled 40 MHz Clock**

Symbol	Parameter	Min	Max	Unit
t_{ST1}	Send SREQ/ or SACK/ assertion pulse width	8	–	ns
t_{ST2}	Send SREQ/ or SACK/ deassertion pulse width	8	–	ns
t_{ST1}	Receive SREQ/ or SACK/ assertion pulse width	6.5	–	ns
t_{ST2}	Receive SREQ/ or SACK/ deassertion pulse width	6.5	–	ns
t_{ST3}	Send data setup to SREQ/ or SACK/ asserted	9.5	–	ns
t_{ST4}	Send data hold from SREQ/ or SACK/ asserted	9.5	–	ns
t_{ST5}	Receive data setup to SREQ/ or SACK/ asserted	4.5	–	ns
t_{ST6}	Receive data hold from SREQ/ or SACK/ asserted	4.5	–	ns

Figure 6.39   Initiator and Target ST Synchronous Transfer
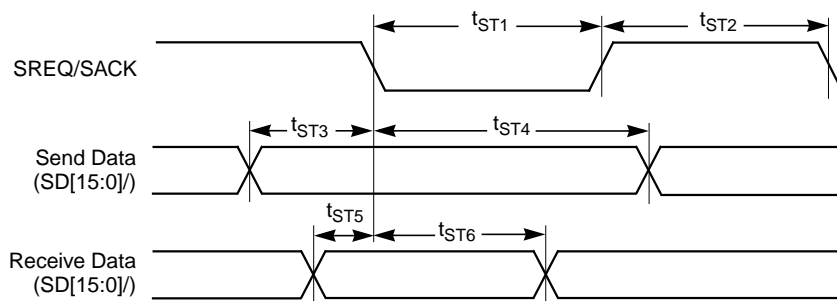
**Table 6.47   SCSI-2 Fast Transfers 10.0 Mbytes (8-Bit Transfers) or
20.0 Mbytes (16-Bit Transfers) 40 MHz Clock**

Symbol	Parameter	Min	Max	Unit
t_{DT1}	Send SREQ/ assertion pulse width	92	–	ns
t_{DT2}	Send SREQ/ deassertion pulse width	92	–	ns
t_{DT1}	Receive SREQ/ assertion pulse width	80	–	ns
t_{DT2}	Receive SREQ/ deassertion pulse width	80	–	ns
t_{DT3}	Send data setup to SREQ/ transition	40	–	ns
t_{DT4}	Send data hold from SREQ/ transition	40	–	ns
t_{DT5}	Receive data setup to SREQ/ transition	10	–	ns
t_{DT6}	Receive data hold from SREQ/ transition	10	–	ns
t_{DT7}	Send CRC Request Setup to SREQ/ transition	50	–	ns
t_{DT8}	Send CRC Request Hold to SREQ/ transition	40	–	ns
t_{DT9}	Receive CRC Request Setup to SREQ/ transition	17	–	ns
t_{DT10}	Receive CRC Request Hold to SREQ/ transition	10	–	ns

**Table 6.48   Ultra SCSI SE Transfers 20.0 Mbytes (8-Bit Transfers) or
40.0 Mbytes (16-Bit Transfers) Quadrupled 40 MHz Clock**

Symbol	Parameter	Min	Max	Unit
t_{DT1}	Send SREQ/ assertion pulse width	46	–	ns
t_{DT2}	Send SREQ/ deassertion pulse width	46	–	ns
t_{DT1}	Receive SREQ/ assertion pulse width	40	–	ns
t_{DT2}	Receive SREQ/ deassertion pulse width	40	–	ns
t_{DT3}	Send data setup to SREQ/ transition	20	–	ns
t_{DT4}	Send data hold from SREQ/ transition	20	–	ns

**Table 6.48   Ultra SCSI SE Transfers 20.0 Mbytes (8-Bit Transfers) or
40.0 Mbytes (16-Bit Transfers) Quadrupled 40 MHz Clock (Cont.)**

Symbol	Parameter	Min	Max	Unit
t_{DT5}	Receive data setup to SREQ/ transition	5	–	ns
t_{DT6}	Receive data hold from SREQ/ transition	5	–	ns
t_{DT7}	Send CRC Request Setup to SREQ/ transition	30	–	ns
t_{DT8}	Send CRC Request Hold to SREQ/ transition	20	–	ns
t_{DT9}	Receive CRC Request Setup to SREQ/ transition	12	–	ns
t_{DT10}	Receive CRC Request Hold to SREQ/ transition	5	–	ns

**Table 6.49   Ultra2 SCSI Transfers 40.0 Mbyte (8-Bit Transfers) or
80.0 Mbyte (16-Bit Transfers) Quadrupled 40 MHz Clock**

Symbol	Parameter	Min	Max	Unit
t_{DT1}	Send SREQ/ assertion pulse width	23	–	ns
t_{DT2}	Send SREQ/ deassertion pulse width	23	–	ns
t_{DT1}	Receive SREQ/ assertion pulse width	20	–	ns
t_{DT2}	Receive SREQ/ deassertion pulse width	20	–	ns
t_{DT3}	Send data setup to SREQ/ transition	10	–	ns
t_{DT4}	Send data hold from SREQ/ transition	10	–	ns
t_{DT5}	Receive data setup to SREQ/ transition	2.5	–	ns
t_{DT6}	Receive data hold from SREQ/ transition	2.5	–	ns
t_{DT7}	Send CRC Request Setup to SREQ/ transition	20	–	ns
t_{DT8}	Send CRC Request Hold to SREQ/ transition	10	–	ns
t_{DT9}	Receive CRC Request Setup to SREQ/ transition	9.5	–	ns
t_{DT10}	Receive CRC Request Hold to SREQ/ transition	2.5	–	ns

Table 6.50 Ultra160 SCSI Transfers 160 Mbyte (16-Bit Transfers) Quadrupled 40 MHz Clock

Symbol	Parameter	Min	Max	Unit
t_{DT1}	Send SREQ/ assertion pulse width	11.5	–	ns
t_{DT2}	Send SREQ/ deassertion pulse width	11.5	–	ns
t_{DT1}	Receive SREQ/ assertion pulse width	10	–	ns
t_{DT2}	Receive SREQ/ deassertion pulse width	10	–	ns
t_{DT3}	Send data setup to SREQ/ transition	5	–	ns
t_{DT4}	Send data hold from SREQ/ transition	5	–	ns
t_{DT5}	Receive data setup to SREQ/ transition	1.25	–	ns
t_{DT6}	Receive data hold from SREQ/ transition	1.25	–	ns
t_{DT7}	Send CRC Request Setup to SREQ/ transition	15	–	ns
t_{DT8}	Send CRC Request Hold to SREQ/ transition	5	–	ns
t_{DT9}	Receive CRC Request Setup to SREQ/ transition	8.25	–	ns
t_{DT10}	Receive CRC Request Hold to SREQ/ transition	1.25	–	ns

Figure 6.40 Initiator and Target DT Synchronous Transfer
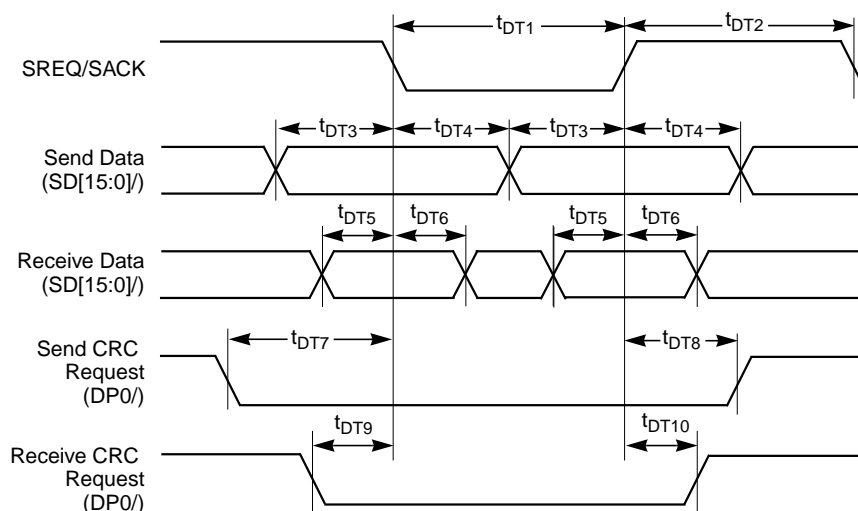
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6.6 Package Drawings

Figure 6.41 illustrates the signal locations on the 456 Ball Grid Array (BGA). Table 6.51, Table 6.51, Table 6.52, and Table 6.52 list all the signal names alphabetically and by BGA position. Figure 6.42 is the mechanical drawing for the LSI53C1010R.

Figure 6.41 LSI53C1010R 456 BGA Chip - Top View

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	VDD_IO	VDD_IO	B_SD12−	B_SD12+	VSS_IO	VDD_IO	B_SDP1−	B_SD0+	VSS_IO	VDD_IO	B_RBIAS	B_SD6−	VSS_IO
B	VSS_IO	NC	NC	VSSC	B_SD13+	B_SD14+	B_SD15+	B_SD0−	B_SD1+	B_SD4−	B_SD5−	B_SD6+	B_VDDBIAS
C	VDDA	NC	NC	VSS_IO	NC	B_SD13−	VDD_IO	VSS_IO	B_SD2−	B_SD4+	VDD_IO	VSS_IO	B_SDP0+
D	A_SD11+	VDDC	VDD_IO	NC	NC	VDDC	TEST_HSC	B_SD15−	B_SD1−	B_SD3−	B_SD5+	B_SDP0−	B_SATN+
E	VSS_IO	A_DIFFSENS	NC	NC	NC	NC	SCAN_MODE	B_SD14−	B_SDP1+	B_SD2+	B_SD3+	B_SD7+	B_SD7−
F	VDD_IO	A_SD11−	SCLK	NC	NC								
G	A_SD10+	A_SD10−	VSS_IO	VSSC	NC								
H	A_SD8−	A_SD8+	VDD_IO	A_SD9+	VSSA								
J	VSS_IO	A_SREQ−	A_SREQ+	A_SD9−	A_SIO+								
K	VDD_IO	A_SSEL+	A_SCD−	A_SCD+	A_SIO−								
L	A_SMSG+	A_SMSG−	VSS_IO	A_SSEL−	A_SACK+						VSS_IO	VSS_IO	VSS_IO
M	A_SRST−	A_SRST+	VDD_IO	A_SATN−	A_SACK−						VSS_IO	VSS_IO	VSS_IO
N	VSS_IO	NC	A_SBSY−	A_SBSY+	A_SATN+						VSS_IO	VSS_IO	VSS_IO
P	VDD_IO	NC	A_SD7+	A_SDP0−	A_SDP0+						VSS_IO	VSS_IO	VSS_IO
R	NC	A_SD5+	VSS_IO	A_SD7−	A_SD6+						VSS_IO	VSS_IO	VSS_IO
T	A_VDDBIAS	A_SD5−	VDD_IO	A_SD4+	A_SD6−						VSS_IO	VSS_IO	VSS_IO
U	VSS_IO	A_SD4−	A_SD2+	A_SD3+	A_SD3−								
V	VDD_IO	A_SD2−	A_SD0+	A_SD1−	A_SD1+								
W	A_SDP1+	A_SDP1−	VSS_IO	A_SD0−	A_SD15+								
Y	A_SD15−	A_SD14+	VDD_IO	IDDTN	NC								
AA	VSS_IO	A_SD14−	A_SD13+	NC	NC								
AB	VDD_IO	A_SD13−	NC	NC	NC	VSSA	VSSC	VSSC	ALT_INTB/	RST/	AD28	AD24	C_BE3/
AC	A_SD12+	ENABLE66	VSS_IO	NC	M66EN	TCK_CHIP	VDDC	INTA/	CLK	NC	AD27	AD23	IDSEL
AD	A_SD12−	NC	NC	VDD_IO	TEST_RST/	TDO_CHIP	VSS_IO	VDD_IO	NC	REQ/	VSS_IO	VDD_IO	AD22
AE	VSS_IO	VDDA	VDDC	TMS_CHIP	NC	NC	INTB/	GNT/	AD31	AD29	AD26	AD25	AD21
AF	VDD_IO	VSS_IO	TDI_CHIP	NC	VDD_IO	VSS_IO	ALT_INTA/	AD30	VDD_IO	VSS_IO	AD20	NC	VDD_IO

Figure 6.41 LSI53C1010R 456 BGA Chip - Top View (Cont.)

	14	15	16	17	18	19	20	21	22	23	24	25	26
A	VDD_IO	B_SBSY−	B_SRST+	VSS_IO	VDD_IO	B_SD8−	B_SD9+	VSS_IO	VDD_IO	B_SD11+	NC	VSS_IO	VDD_IO
B	B_SATN-	B_SBSY+	B_SMSG−	B_SSEL−	B_SREQ−	B_SD8+	B_SD10+	B_SD11−	B_DIFFSENS	NC	NC	NC	VSS_IO
C	NC	VDD_IO	VSS_IO	B_SSEL+	B_SREQ+	VDD_IO	VSS_IO	VSSC	NC	VDD_IO	NC	NC	VSSC
D	B_SACK−	NC	B_SMSG+	B_SCD+	B_SIO+	B_SD10−	NC	NC	NC	NC	VSS_IO	MAD2	MAD7
E	B_SACK+	B_SRST−	B_SCD−	B_SIO−	B_SD9−	VDDC	NC	NC	NC	NC	NC	MAD6	VDD_IO
F									NC	MAD1	MAD4	VSSC	VSS_IO
G									MAD0	MAD3	VDD_IO	MCE/	MOE/
H									MAD5	MWE/	VSS_IO	A_GPIO3	A_GPIO0
J									VDDC	A_GPIO4	MAS1/	A_GPIO1	VDD_IO
K									MAS0/	B_GPIO4	A_GPIO2	B_GPIO3	VSS_IO
L	VSS_IO	VSS_IO	VSS_IO						VSSC	B_GPIO2	VDD_IO	B_GPIO1	AD34
M	VSS_IO	VSS_IO	VSS_IO						VDDC	NC	VSS_IO	B_GPIO0	AD35
N	VSS_IO	VSS_IO	VSS_IO						SCANEN	NC	AD32	AD33	VDD_IO
P	VSS_IO	VSS_IO	VSS_IO						AD42	AD41	AD39	AD38	VSS_IO
R	VSS_IO	VSS_IO	VSS_IO						AD43	AD40	VDD_IO	AD44	AD36
T	VSS_IO	VSS_IO	VSS_IO						AD47	AD46	VSS_IO	AD45	AD37
U									AD55	AD49	AD52	AD48	VDD_IO
V									AD56	AD53	AD54	AD51	VSS_IO
W									AD63	AD59	VDD_IO	NC	AD50
Y									NC	C_BE5/	VSS_IO	AD58	AD57
AA									NC	C_BE7/	PAR64	AD60	VDD_IO
AB	C_BE2/	FRAME/	STOP/	AD12	AD11	AD5	ACK64/	NC	NC	VSSC	VSSC	AD62	VSS_IO
AC	AD16	AD17	DEVSEL/	SERR/	AD13	AD8	AD2	AD0	NC	NC	VDD_IO	C_BE6/	AD61
AD	NC	VSS_IO	VDD_IO	AD15	NC	VSS_IO	VDD_IO	AD4	REQ64/	VSS_IO	NC	VDDC	C_BE4/
AE	AD18	IRDY/	TRDY/	PERR/	C_BE1/	AD14	AD9	C_BE0/	AD6	AD1	VDDC	NC	VDD_IO
AF	VSS_IO	NC	AD19	VDD_IO	VSS_IO	PAR	AD10	VDD_IO	VSS_IO	AD7	AD3	VDD_IO	VSS_IO

Table 6.51 Alphanumeric List by BGA Position

Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos
A1	VDD_IO	B22	B_DIFFSENS	D17	B_SCD+	G2	A_SD10–	L14	VSS_IO
A2	VDD_IO	B23	NC	D18	B_SIO+	G3	VSS_IO	L15	VSS_IO
A3	B_SD12–	B24	NC	D19	B_SD10–	G4	VSSC	L16	VSS_IO
A4	B_SD12+	B25	NC	D20	NC	G5	NC	L22	VSSC
A5	VSS_IO	B26	VSS_IO	D21	NC	G22	MAD0	L23	B_GPIO2
A6	VDD_IO	C1	VDDA	D22	NC	G23	MAD3	L24	VDD_IO
A7	B_SDP1–	C2	NC	D23	NC	G24	VDD_IO	L25	B_GPIO1
A8	B_SD0+	C3	NC	D24	VSS_IO	G25	MCE/	L26	AD34
A9	VSS_IO	C4	VSS_IO	D25	MAD2	G26	MOE/	M1	A_SRST–
A10	VDD_IO	C5	NC	D26	MAD7	H1	A_SD8–	M2	A_SRST+
A11	B_RBIAS	C6	B_SD13–	E1	VSS_IO	H2	A_SD8+	M3	VDD_IO
A12	B_SD6–	C7	VDD_IO	E2	A_DIFFSENS	H3	VDD_IO	M4	A_SATN–
A13	VSS_IO	C8	VSS_IO	E3	NC	H4	A_SD9+	M5	A_SACK–
A14	VDD_IO	C9	B_SD2–	E4	NC	H5	VSSA	M11	VSS_IO
A15	B_SBSY–	C10	B_SD4+	E5	NC	H22	MAD5	M12	VSS_IO
A16	B_SRST+	C11	VDD_IO	E6	NC	H23	MWE/	M13	VSS_IO
A17	VSS_IO	C12	VSS_IO	E7	SCAN_MODE	H24	VSS_IO	M14	VSS_IO
A18	VDD_IO	C13	B_SDP0+	E8	B_SD14–	H25	A_GPIO3	M15	VSS_IO
A19	B_SD8–	C14	NC	E9	B_SDP1+	H26	A_GPIO0	M16	VSS_IO
A20	B_SD9+	C15	VDD_IO	E10	B_SD2+	J1	VSS_IO	M22	VDDC
A21	VSS_IO	C16	VSS_IO	E11	B_SD3+	J2	A_SREQ–	M23	NC
A22	VDD_IO	C17	B_SSEL+	E12	B_SD7+	J3	A_SREQ+	M24	VSS_IO
A23	B_SD11+	C18	B_SREQ+	E13	B_SD7–	J4	A_SD9–	M25	B_GPIO0
A24	NC	C19	VDD_IO	E14	B_SACK+	J5	A_SIO+	M26	AD35
A25	VSS_IO	C20	VSS_IO	E15	B_SRST–	J22	VDDC	N1	VSS_IO
A26	VDD_IO	C21	VSSC	E16	B_SCD–	J23	A_GPIO4	N2	NC
B1	VSS_IO	C22	NC	E17	B_SIO–	J24	MAS1/	N3	A_SBSY–
B2	NC	C23	VDD_IO	E18	B_SD9–	J25	A_GPIO1	N4	A_SBSY+
B3	NC	C24	NC	E19	VDDC	J26	VDD_IO	N5	A_SATN+
B4	VSSC	C25	NC	E20	NC	K1	VDD_IO	N11	VSS_IO
B5	B_SD13+	C26	VSSC	E21	NC	K2	A_SSEL+	N12	VSS_IO
B6	B_SD14+	D1	A_SD11+	E22	NC	K3	A_SCD–	N13	VSS_IO
B7	B_SD15+	D2	VDDC	E23	NC	K4	A_SCD+	N14	VSS_IO
B8	B_SD0–	D3	VDD_IO	E24	NC	K5	A_SIO–	N15	VSS_IO
B9	B_SD1+	D4	NC	E25	MAD6	K22	MAS0/	N16	VSS_IO
B10	B_SD4–	D5	NC	E26	VDD_IO	K23	B_GPIO4	N22	SCANEN
B11	B_SD5–	D6	VDDC	F1	VDD_IO	K24	A_GPIO2	N23	NC
B12	B_SD6+	D7	TEST_HSC	F2	A_SD11–	K25	B_GPIO3	N24	AD32
B13	B_VDDBIAS	D8	B_SD15–	F3	SCLK	K26	VSS_IO	N25	AD33
B14	B_SATN–	D9	B_SD1–	F4	NC	L1	A_SMSG+	N26	VDD_IO
B15	B_SBSY+	D10	B_SD3–	F5	NC	L2	A_SMSG–		
B16	B_SMSG–	D11	B_SD5–	F22	NC	L3	VSS_IO		
B17	B_SSEL–	D12	B_SDP0–	F23	MAD1	L4	A_SSEL–		
B18	B_SREQ–	D13	B_SATN+	F24	MAD4	L5	A_SACK+		
B19	B_SD8+	D14	B_SACK–	F25	VSSC	L11	VSS_IO		
B20	B_SD10+	D15	NC	F26	VSS_IO	L12	VSS_IO		
B21	B_SD11–	D16	B_SMSG+	G1	A_SD10+	L13	VSS_IO		

Table 6.51   Alphanumeric List by BGA Position (Cont.)

Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos
P1	VDD_IO	T26	AD37	AA23	C_BE7/	AC18	AD13	AE13	AD21
P2	NC	U1	VSS_IO	AA24	PAR64	AC19	AD8	AE14	AD18
P3	A_SD7+	U2	A_SD4–	AA25	AD60	AC20	AD2	AE15	IRDY/
P4	A_SDP0–	U3	A_SD2+	AA26	VDD_IO	AC21	AD0	AE16	TRDY/
P5	A_SDP0+	U4	A_SD3+	AB1	VDD_IO	AC22	NC	AE17	PERR/
P11	VSS_IO	U5	A_SD3–	AB2	A_SD13–	AC23	NC	AE18	C_BE1/
P12	VSS_IO	U22	AD55	AB3	NC	AC24	VDD_IO	AE19	AD14
P13	VSS_IO	U23	AD49	AB4	NC	AC25	C_BE6/	AE20	AD9
P14	VSS_IO	U24	AD52	AB5	NC	AC26	AD61	AE21	C_BE0/
P15	VSS_IO	U25	AD48	AB6	VSSA	AD1	A_SD12–	AE22	AD6
P16	VSS_IO	U26	VDD_IO	AB7	VSSC	AD2	NC	AE23	AD1
P22	AD42	V1	VDD_IO	AB8	VSSC	AD3	NC	AE24	VDDC
P23	AD41	V2	A_SD2–	AB9	ALT_INTB/	AD4	VDD_IO	AE25	NC
P24	AD39	V3	A_SD0+	AB10	RST/	AD5	TEST_RST/	AE26	VDD_IO
P25	AD38	V4	A_SD1–	AB11	AD28	AD6	TDO_CHIP	AF1	VDD_IO
P26	VSS_IO	V5	A_SD1+	AB12	AD24	AD7	VSS_IO	AF2	VSS_IO
R1	NC	V22	AD56	AB13	C_BE3/	AD8	VDD_IO	AF3	TDI_CHIP
R2	A_SD5+	V23	AD53	AB14	C_BE2/	AD9	NC	AF4	NC
R3	VSS_IO	V24	AD54	AB15	FRAME/	AD10	REQ/	AF5	VDD_IO
R4	A_SD7–	V25	AD51	AB16	STOP/	AD11	VSS_IO	AF6	VSS_IO
R5	A_SD6+	V26	VSS_IO	AB17	AD12	AD12	VDD_IO	AF7	ALT_INTA/
R11	VSS_IO	W1	A_SDP1+	AB18	AD11	AD13	AD22	AF8	AD30
R12	VSS_IO	W2	A_SDP1–	AB19	AD5	AD14	NC	AF9	VDD_IO
R13	VSS_IO	W3	VSS_IO	AB20	ACK64/	AD15	VSS_IO	AF10	VSS_IO
R14	VSS_IO	W4	A_SD0–	AB21	NC	AD16	VDD_IO	AF11	AD20
R15	VSS_IO	W5	A_SD15+	AB22	NC	AD17	AD15	AF12	NC
R16	VSS_IO	W22	AD63	AB23	VSSC	AD18	NC	AF13	VDD_IO
R22	AD43	W23	AD59	AB24	VSSC	AD19	VSS_IO	AF14	VSS_IO
R23	AD40	W24	VDD_IO	AB25	AD62	AD20	VDD_IO	AF15	NC
R24	VDD_IO	W25	NC	AB26	VSS_IO	AD21	AD4	AF16	AD19
R25	AD44	W26	AD50	AC1	A_SD12+	AD22	REQ64/	AF17	VDD_IO
R26	AD36	Y1	A_SD15–	AC2	ENABLE66	AD23	VSS_IO	AF18	VSS_IO
T1	A_VDDBIAS	Y2	A_SD14+	AC3	VSS_IO	AD24	NC	AF19	PAR
T2	A_SD5–	Y3	VDD_IO	AC4	NC	AD25	VDDC	AF20	AD10
T3	VDD_IO	Y4	IDDTN	AC5	M66EN	AD26	C_BE4/	AF21	VDD_IO
T4	A_SD4+	Y5	NC	AC6	TCK_CHIP	AE1	VSS_IO	AF22	VSS_IO
T5	A_SD6–	Y22	NC	AC7	VDDC	AE2	VDDA	AF23	AD7
T11	VSS_IO	Y23	C_BE5/	AC8	INTA/	AE3	VDDC	AF24	AD3
T12	VSS_IO	Y24	VSS_IO	AC9	CLK	AE4	TMS_CHIP	AF25	VDD_IO
T13	VSS_IO	Y25	AD58	AC10	NC	AE5	NC	AF26	VSS_IO
T14	VSS_IO	Y26	AD57	AC11	AD27	AE6	NC		
T15	VSS_IO	AA1	VSS_IO	AC12	AD23	AE7	INTB/		
T16	VSS_IO	AA2	A_SD14–	AC13	IDSEL	AE8	GNT/		
T22	AD47	AA3	A_SD13+	AC14	AD16	AE9	AD31		
T23	AD46	AA4	NC	AC15	AD17	AE10	AD29		
T24	VSS_IO	AA5	NC	AC16	DEVSEL/	AE11	AD26		
T25	AD45	AA22	NC	AC17	SERR/	AE12	AD25		

Table 6.52 Alphanumeric List by Signal Name

Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos
ACK64/	AB20	AD46	T23	A_SD6+	R5	B_SCD–	E16	B_SSEL+	C17
AD0	AC21	AD47	T22	A_SD7–	R4	B_SCD+	D17	B_VDDBIAS	B13
AD1	AE23	AD48	U25	A_SD7+	P3	B_SD0–	B8	C_BE0/	AE21
AD2	AC20	AD49	U23	A_SD8–	H1	B_SD0+	A8	C_BE1/	AE18
AD3	AF24	AD50	W26	A_SD8+	H2	B_SD1–	D9	C_BE2/	AB14
AD4	AD21	AD51	V25	A_SD9–	J4	B_SD1+	B9	C_BE3/	AB13
AD5	AB19	AD52	U24	A_SD9+	H4	B_SD2–	C9	C_BE4/	AD26
AD6	AE22	AD53	V23	A_SD10–	G2	B_SD2+	E10	C_BE5/	Y23
AD7	AF23	AD54	V24	A_SD10+	G1	B_SD3–	D10	C_BE6/	AC25
AD8	AC19	AD55	U22	A_SD11–	F2	B_SD3+	E11	C_BE7/	AA23
AD9	AE20	AD56	V22	A_SD11+	D1	B_SD4–	B10	CLK	AC9
AD10	AF20	AD57	Y26	A_SD12–	AD1	B_SD4+	C10	DEVSEL/	AC16
AD11	AB18	AD58	Y25	A_SD12+	AC1	B_SD5–	B11	ENABLE66	AC2
AD12	AB17	AD59	W23	A_SD13–	AB2	B_SD5+	D11	FRAME/	AB15
AD13	AC18	AD60	AA25	A_SD13+	AA3	B_SD6–	A12	GNT/	AE8
AD14	AE19	AD61	AC26	A_SD14–	AA2	B_SD6+	B12	IDDTN	Y4
AD15	AD17	AD62	AB25	A_SD14+	Y2	B_SD7–	E13	IDSEL	AC13
AD16	AC14	AD63	W22	A_SD15–	Y1	B_SD7+	E12	INTA/	AC8
AD17	AC15	A_DIFFSENS	E2	A_SD15+	W5	B_SD8–	A19	INTB/	AE7
AD18	AE14	A_GPIO0	H26	A_SDP0–	P4	B_SD8+	B19	IRDY/	AE15
AD19	AF16	A_GPIO1	J25	A_SDP0+	P5	B_SD9–	E18	M66EN	AC5
AD20	AF11	A_GPIO2	K24	A_SDP1–	W2	B_SD9+	A20	MAD0	G22
AD21	AE13	A_GPIO3	H25	A_SDP1+	W1	B_SD10–	D19	MAD1	F23
AD22	AD13	A_GPIO4	J23	A_SIO–	K5	B_SD10+	B20	MAD2	D25
AD23	AC12	ALT_INTA/	AF7	A_SIO+	J5	B_SD11–	B21	MAD3	G23
AD24	AB12	ALT_INTB/	AB9	A_SMSG–	L2	B_SD11+	A23	MAD4	F24
AD25	AE12	A_SACK–	M5	A_SMSG+	L1	B_SD12–	A3	MAD5	H22
AD26	AE11	A_SACK+	L5	A_SREQ–	J2	B_SD12+	A4	MAD6	E25
AD27	AC11	A_SATN–	M4	A_SREQ+	J3	B_SD13–	C6	MAD7	D26
AD28	AB11	A_SATN+	N5	A_SRST–	M1	B_SD13+	B5	MAS0/	K22
AD29	AE10	A_SBSY–	N3	A_SRST+	M2	B_SD14–	E8	MAS1/	J24
AD30	AF8	A_SBSY+	N4	A_SSEL–	L4	B_SD14+	B6	MCE/	G25
AD31	AE9	A_SCD–	K3	A_SSEL+	K2	B_SD15–	D8	MOE/	G26
AD32	N24	A_SCD+	K4	A_VDDBIAS	T1	B_SD15+	B7	MWE/	H23
AD33	N25	A_SD0–	W4	B_DIFFSENS	B22	B_SDP0–	D12		
AD34	L26	A_SD0+	V3	B_GPIO0	M25	B_SDP0+	C13		
AD35	M26	A_SD1–	V4	B_GPIO1	L25	B_SDP1–	A7		
AD36	R26	A_SD1+	V5	B_GPIO2	L23	B_SDP1+	E9		
AD37	T26	A_SD2–	V2	B_GPIO3	K25	B_SIO–	E17		
AD38	P25	A_SD2+	U3	B_GPIO4	K23	B_SIO+	D18		
AD39	P24	A_SD3–	U5	B_RBIAS	A11	B_SMSG–	B16		
AD40	R23	A_SD3+	U4	B_SACK–	D14	B_SMSG+	D16		
AD41	P23	A_SD4–	U2	B_SACK+	E14	B_SREQ–	B18		
AD42	P22	A_SD4+	T4	B_SATN–	B14	B_SREQ+	C18		
AD43	R22	A_SD5–	T2	B_SATN+	D13	B_SRST–	E15		
AD44	R25	A_SD5+	R2	B_SBSY–	A15	B_SRST+	A16		
AD45	T25	A_SD6–	T5	B_SBSY+	B15	B_SSEL–	B17		

Table 6.52 Alphanumeric List by Signal Name (Cont.)

Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos	Signal Name	BGA Pos
NC	A24	NC	AB21	VDD_IO	A1	VSSA	AB6	VSS_IO	N12
NC	B2	NC	AB22	VDD_IO	A2	VSSC	B4	VSS_IO	N13
NC	B3	NC	AC4	VDD_IO	A6	VSSC	C21	VSS_IO	N14
NC	B23	NC	AC10	VDD_IO	A10	VSSC	C24	VSS_IO	N15
NC	B24	NC	AC22	VDD_IO	A14	VSSC	F25	VSS_IO	N16
NC	B25	NC	AC23	VDD_IO	A18	VSSC	G4	VSS_IO	P11
NC	C2	NC	AD2	VDD_IO	A22	VSSC	L22	VSS_IO	P12
NC	C3	NC	AD3	VDD_IO	A26	VSSC	AB7	VSS_IO	P13
NC	C5	NC	AD9	VDD_IO	C7	VSSC	AB8	VSS_IO	P14
NC	C14	NC	AD14	VDD_IO	C11	VSSC	AB23	VSS_IO	P15
NC	C22	NC	AD18	VDD_IO	C15	VSSC	AB24	VSS_IO	P16
NC	C24	NC	AD24	VDD_IO	C19	VSS_IO	A5	VSS_IO	P26
NC	C25	NC	AE5	VDD_IO	C23	VSS_IO	A9	VSS_IO	R3
NC	D4	NC	AE6	VDD_IO	D3	VSS_IO	A13	VSS_IO	R11
NC	D5	NC	AE25	VDD_IO	E26	VSS_IO	A17	VSS_IO	R12
NC	D15	NC	AF4	VDD_IO	F1	VSS_IO	A21	VSS_IO	R13
NC	D20	NC	AF12	VDD_IO	G24	VSS_IO	A25	VSS_IO	R14
NC	D21	NC	AF15	VDD_IO	H3	VSS_IO	B1	VSS_IO	R15
NC	D22	PAR	AF19	VDD_IO	J26	VSS_IO	B26	VSS_IO	R16
NC	D23	PAR64	AA24	VDD_IO	K1	VSS_IO	C4	VSS_IO	T11
NC	E3	PERR/	AE17	VDD_IO	L24	VSS_IO	C8	VSS_IO	T12
NC	E4	REQ/	AD10	VDD_IO	M3	VSS_IO	C12	VSS_IO	T13
NC	E5	REQ64/	AD22	VDD_IO	N26	VSS_IO	C16	VSS_IO	T14
NC	E6	RST/	AB10	VDD_IO	P1	VSS_IO	C20	VSS_IO	T15
NC	E20	SCAN_MODE	E7	VDD_IO	R24	VSS_IO	D24	VSS_IO	T16
NC	E21	SCANEN	N22	VDD_IO	T3	VSS_IO	E1	VSS_IO	T24
NC	E22	SCLK	F3	VDD_IO	U26	VSS_IO	F26	VSS_IO	U1
NC	E23	SERR/	AC17	VDD_IO	V1	VSS_IO	G3	VSS_IO	V26
NC	E24	STOP/	AB16	VDD_IO	W24	VSS_IO	H24	VSS_IO	W3
NC	F4	TCK_CHIP	AC6	VDD_IO	Y3	VSS_IO	J1	VSS_IO	Y24
NC	F5	TDI_CHIP	AF3	VDD_IO	AA26	VSS_IO	K26	VSS_IO	AA1
NC	F22	TDO_CHIP	AD6	VDD_IO	AB1	VSS_IO	L3	VSS_IO	AB26
NC	G5	TEST_HSC	D7	VDD_IO	AC24	VSS_IO	L11	VSS_IO	AC3
NC	M23	TMS_CHIP	AE4	VDD_IO	AD4	VSS_IO	L12	VSS_IO	AD7
NC	N2	TRDY/	AE16	VDD_IO	AD8	VSS_IO	L13	VSS_IO	AD11
NC	N23	TEST_RST/	AD5	VDD_IO	AD12	VSS_IO	L14	VSS_IO	AD15
NC	P2	VDDA	C1	VDD_IO	AD16	VSS_IO	L15	VSS_IO	AD19
NC	R1	VDDA	AE2	VDD_IO	AD20	VSS_IO	L16	VSS_IO	AD23
NC	W25	VDDC	D2	VDD_IO	AE26	VSS_IO	M11	VSS_IO	AE1
NC	Y5	VDDC	D6	VDD_IO	AF1	VSS_IO	M12	VSS_IO	AF2
NC	Y22	VDDC	E19	VDD_IO	AF5	VSS_IO	M13	VSS_IO	AF6
NC	AA4	VDDC	J22	VDD_IO	AF9	VSS_IO	M14	VSS_IO	AF10
NC	AA5	VDDC	M22	VDD_IO	AF13	VSS_IO	M15	VSS_IO	AF14
NC	AA22	VDDC	AC7	VDD_IO	AF17	VSS_IO	M16	VSS_IO	AF18
NC	AB3	VDDC	AD25	VDD_IO	AF21	VSS_IO	M24	VSS_IO	AF22
NC	AB4	VDDC	AE3	VDD_IO	AF25	VSS_IO	N1	VSS_IO	AF26
NC	AB5	VDDC	AE24	VSSA	H5	VSS_IO	N11		

Figure 6.42 LSI53C1010R 456 BGA Mechanical Drawing
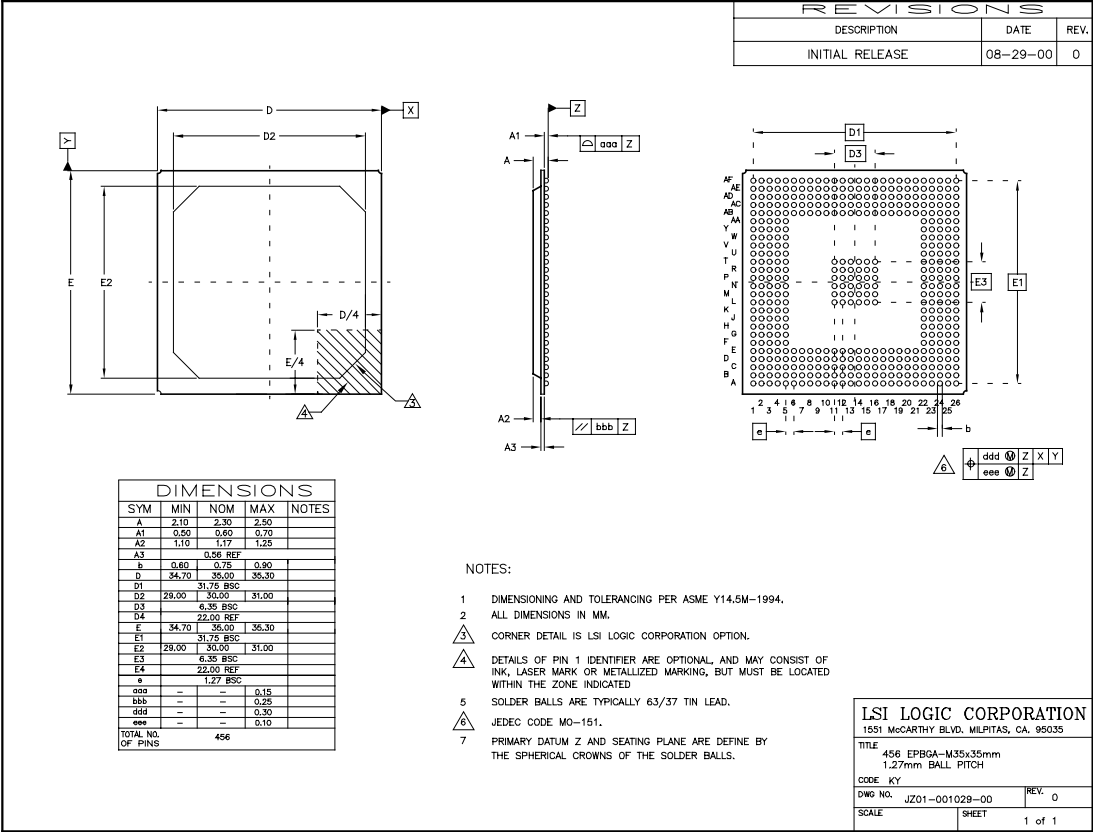
Important: This drawing may not be the latest version. For board layout and manufacturing, obtain the most recent engineering drawings from your LSI Logic marketing representative by requesting the outline drawing for package code KY.

Appendix A
Register Summary

Table A.1 lists the LSI53C1010R PCI registers by register name.

Table A.1   LSI53C1010R PCI Register Map

Register Name	Address	Read/Write	Page
PCI Registers			
Base Address Register Four (BAR4) (SCRIPTS RAM)	0x20–0x23	Read/Write	4-11
Base Address Register One (BAR1) (MEMORY)	0x14–0x17	Read/Write	4-9
Base Address Register Three (BAR3) (SCRIPTS RAM)	0x1C–0x1F	Read/Write	4-10
Base Address Register Two (BAR2) (MEMORY)	0x18–0x1B	Read/Write	4-10
Base Address Register Zero (BAR0) (I/O)	0x10–0x13	Read/Write	4-9
Bridge Support Extensions (PMCSR_BSE)	0x46	Read Only	4-20
Cache Line Size (CLS)	0x0C	Read/Write	4-7
Capabilities Pointer (CP)	0x34	Read Only	4-15
Capability ID (CID)	0x40	Read Only	4-18
Class Code (CC)	0x09–0x0B	Read Only	4-7
Command	0x04–0x05	Read/Write	4-3
Data	0x47	Read Only	4-21
Device ID	0x02–0x03	Read Only	4-3
Expansion ROM Base Address (ERBA)	0x30–0x33	Read/Write	4-14
Header Type (HT)	0x0E	Read Only	4-8
Interrupt Line (IL)	0x3C	Read/Write	4-16
Interrupt Pin (IP)	0x3D	Read Only	4-16

Table A.1   LSI53C1010R PCI Register Map (Cont.)

Register Name	Address	Read/Write	Page
Latency Timer (LT)	0x0D	Read/Write	4-8
Max_Lat (ML)	0x3F	Read Only	4-17
Min_Gnt (MG)	0x3E	Read Only	4-17
Next Item Pointer (NIP)	0x41	Read Only	4-18
Power Management Capabilities (PMC)	0x42–0x43	Read Only	4-18
Power Management Control/Status (PMCSR)	0x44–0x45	Read/Write	4-19
Reserved	0x0F	–	4-9
Reserved	0x24–0x27	–	4-11
Reserved	0x28–0x2B	–	4-11
Reserved	0x35–0x37	–	4-15
Reserved	0x38–0x3B	–	4-15
Revision ID (RID)	0x08	Read Only	4-6
Status	0x06–0x07	Read/Write	4-5
Subsystem ID (SID)	0x2E–0x2F	Read Only	4-13
Subsystem Vendor ID (SVID)	0x2C–0x2D	Read Only	4-12
Vendor ID	0x00–0x01	Read Only	4-2

Table A.2 lists the LSI53C1010R SCSI registers, Phase Mismatch Jump registers, and Shadow registers by register name.

Table A.2   LSI53C1010R SCSI Register Map

Register Name	Address	Read/Write	Page
SCSI Registers			
Adder Sum Output (ADDER)	0x3C–0x3F	Read Only	4-69
AIP Control One (AIPCNTL1)	0xBF	Read/Write	4-112
AIP Control Zero (AIPCNTL0)	0xBE	Read Only	4-111
Chip Control One (CCNTL1)	0x57	Read/Write	4-92
Chip Control Three (CCNTL3)	0x5B	Read/Write	4-95
Chip Control Two (CCNTL2)	0x5A	Read/Write	4-95
Chip Control Zero (CCNTL0)	0x56	Read/Write	4-90
Chip Test Five (CTEST5)	0x22	Read/Write	4-57
Chip Test Four (CTEST4)	0x21	Read/Write	4-56
Chip Test One (CTEST1)	0x19	Read Only	4-52
Chip Test Six (CTEST6)	0x23	Read/Write	4-58
Chip Test Three (CTEST3)	0x1B	Read/Write	4-54
Chip Test Two (CTEST2)	0x1A	Read Only (bit 3 write)	4-53
Chip Test Zero (CTEST0)	0x18	Read/Write	4-52
Current Inbound SCSI Offset (CSO)	0x53	Read Only	4-89
Data Structure Address (DSA)	0x10–0x13	Read/Write	4-46
DMA Byte Counter (DBC)	0x24–0x26	Read/Write	4-59
DMA Command (DCMD)	0x27	Read/Write	4-60
DMA Control (DCNTL)	0x3B	Read/Write	4-66
DMA Interrupt Enable (DIEN)	0x39	Read/Write	4-65
DMA Mode (DMODE)	0x38	Read/Write	4-62
DMA Next Address (DNAD)	0x28–0x2B	Read/Write	4-60

Table A.2   LSI53C1010R SCSI Register Map (Cont.)

Register Name	Address	Read/Write	Page
DMA Next Address 64 (DNAD64)	0xB8–0xBB	Read/Write	4-100
DMA SCRIPTS Pointer (DSP)	0x2C–0x2F	Read/Write	4-61
DMA SCRIPTS Pointer Save (DSPS)	0x30–0x33	Read/Write	4-61
DMA Status (DSTAT)	0x0C	Read Only	4-40
DSA Relative Selector (DRS)	0xAC–0xAF	Read/Write	4-99
Dynamic Block Move Selector (DBMS)	0xB4–0xB7	Read/Write	4-100
General Purpose (GPREG)	0x07	Read/Write	4-36
General Purpose Pin Control (GPCNTL)	0x47	Read/Write	4-78
Interrupt Status One (ISTAT1)	0x15	Read/Write	4-50
Interrupt Status Zero (ISTAT0)	0x14	Read/Write	4-47
Mailbox One (MBOX1)	0x17	Read/Write	4-51
Mailbox Zero (MBOX0)	0x16	Read/Write	4-51
Memory Move Read Selector (MMRS)	0xA0–0xA3	Read/Write	4-97
Memory Move Write Selector (MMWS)	0xA4–0xA7	Read/Write	4-98
Reserved	0x20	–	4-56
Reserved	0x44	–	4-77
Reserved	0x46	–	4-77
Reserved	0xBD	–	4-111
Response ID One (RESPID1)	0x4B	Read/Write	4-82
Response ID Zero (RESPID0)	0x4A	Read/Write	4-82
Scratch Byte Register (SBR)	0x3A	Read/Write	4-66
Scratch Register A (SCRATCHA)	0x34–0x37	Read/Write	4-62
Scratch Register B (SCRATCHB)	0x5C–0x5F	Read/Write	4-96
Scratch Registers C–R (SCRATCHC–SCRATCHR)	0x60–0x9F	Read/Write	4-97
SCRIPT Fetch Selector (SFS)	0xA8–0xAB	Read/Write	4-98

Table A.2   LSI53C1010R SCSI Register Map (Cont.)

Register Name	Address	Read/Write	Page
SCSI Bus Control Lines (SBCL)	0x0B	Read Only	4-39
SCSI Bus Data Lines (SBDL)	0x58–0x59	Read Only	4-94
SCSI Chip ID (SCID)	0x04	Read/Write	4-33
SCSI Control Four (SCNTL4)	0xBC	Read/Write	4-101
SCSI Control One (SCNTL1)	0x01	Read/Write	4-28
SCSI Control Three (SCNTL3)	0x03	Read/Write	4-32
SCSI Control Two (SCNTL2)	0x02	Read/Write	4-30
SCSI Control Zero (SCNTL0)	0x00	Read/Write	4-24
SCSI Destination ID (SDID)	0x06	Read/Write	4-36
SCSI First Byte Received (SFBR)	0x08	Read/Write	4-37
SCSI Input Data Latch (SIDL)	0x50–0x51	Read Only	4-88
SCSI Interrupt Enable One (SIEN1)	0x41	Read/Write	4-71
SCSI Interrupt Enable Zero (SIEN0)	0x40	Read/Write	4-69
SCSI Interrupt Status One (SIST1)	0x43	Read Only	4-76
SCSI Interrupt Status Zero (SIST0)	0x42	Read Only	4-73
SCSI Output Control Latch (SOCL)	0x09	Read/Write	4-38
SCSI Output Data Latch (SODL)	0x54–0x55	Read/Write	4-90
SCSI Selector ID (SSID)	0x0A	Read Only	4-39
SCSI Status One (SSTAT1)	0x0E	Read Only	4-44
SCSI Status Two (SSTAT2)	0x0F	Read Only	4-45
SCSI Status Zero (SSTAT0)	0x0D	Read Only	4-43
SCSI Test Four (STEST4)	0x52	Read Only	4-89
SCSI Test One (STEST1)	0x4D	Read/Write	4-84
SCSI Test Three (STEST3)	0x4F	Read/Write	4-87
SCSI Test Two (STEST2)	0x4E	Read/Write	4-85

Table A.2   LSI53C1010R SCSI Register Map (Cont.)

Register Name	Address	Read/Write	Page
SCSI Test Zero (STEST0)	0x4C	Read Only	4-83
SCSI Timer One (STIME1)	0x49	Read/Write	4-80
SCSI Timer Zero (STIME0)	0x48	Read/Write	4-79
SCSI Transfer (SXFER)	0x05	Read/Write	4-34
SCSI Wide Residue (SWIDE)	0x45	Read/Write	4-77
Static Block Move Selector (SBMS)	0xB0–0xB3	Read/Write	4-99
Temporary (TEMP)	0x1C–0x1F	Read/Write	4-55
Phase Mismatch Jump Registers			
CRC Control One (CRCCNTL1)	0xE3	Read/Write	4-119
CRC Control Zero (CRCCNTL0)	0xE2	Read/Write	4-119
CRC Data (CRCD)	0xE4–0xE7	Read/Write	4-120
CRC Pad Byte Value (CRCPAD)	0xE0–0xE1	Read/Write	4-118
Cumulative SCSI Byte Count (CSBC)	0xDC–0xDF	Read/Write	4-118
DMA FIFO Byte Count (DFBC)	0xF0–0xF1	Read Only	4-122
Entry Storage Address (ESA)	0xD0–0xD3	Read/Write	4-116
Instruction Address (IA)	0xD4–0xD7	Read/Write	4-116
Phase Mismatch Jump Address One (PMJAD1)	0xC0–0xC3	Read/Write	4-113
Phase Mismatch Jump Address Two (PMJAD2)	0xC4–0xC7	Read/Write	4-113
Remaining Byte Count (RBC)	0xC8–0xCB	Read/Write	4-114
Reserved	0xDB	–	4-117
Reserved	0xE8–0xEF	–	4-121
Reserved	0xF2–0xF3	–	4-122
Reserved	0xF4–0xFF	–	4-122
SCSI Byte Count (SBC)	0xD8–0xDA	Read Only	4-117
Updated Address (UA)	0xCC–0xCF	Read/Write	4-115

Table A.2   LSI53C1010R SCSI Register Map (Cont.)

Register Name	Address	Read/Write	Page
Shadow Registers			
Shadowed Memory Move Read Selector (MMRS)	0xA0–0xA3	Read/Write	4-125
Shadowed Memory Move Write Selector (MMWS)	0xA4–0xA7	Read/Write	4-126
Shadowed Scratch Register A (SCRATCHA)	0x34–0x37	Read/Write	4-123
Shadowed Scratch Register B (SCRATCHB)	0x5C–0x5F	Read/Write	4-125
Shadowed SCRIPT Fetch Selector (SFS)	0xA8–0xAB	Read/Write	4-126
Shadowed SCSI Interrupt Status One (SIST1)	0x43	Read Only	4-124
Shadowed SCSI SGE Status 0	0x42	Read/Write	4-123

Appendix B
External Memory
Interface Diagram
Examples

Appendix B has example external memory interface diagrams.

Figure B.1   16 Kbyte Interface with 200 ns Memory

Note: MAD[3:1] pulled LOW internally. MAD bus sense logic enabled for 16 Kbyte of slow memory (200 ns devices @ 66 MHz).

Figure B.2 64 Kbyte Interface with 150 ns Memory
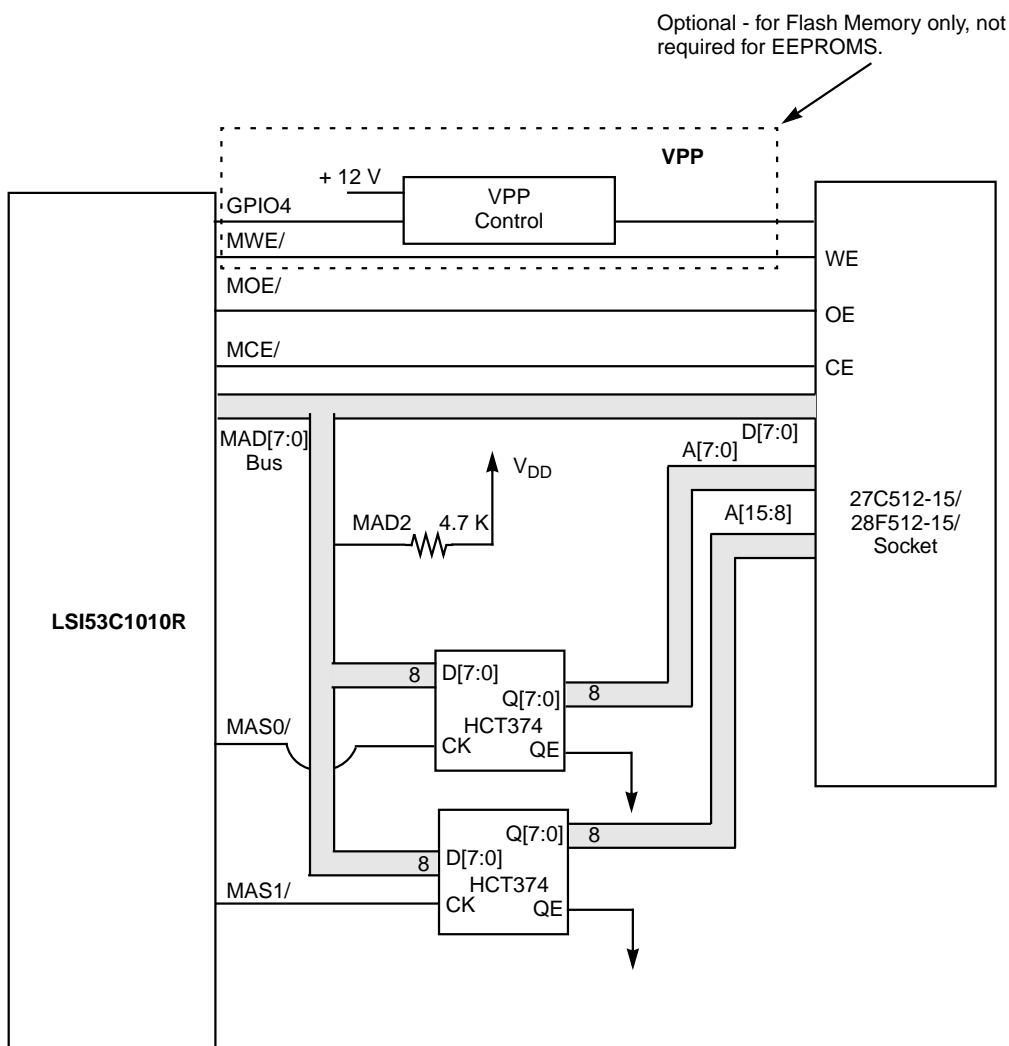
Note: MAD 3, 1, 0 pulled LOW internally. MAD bus sense logic enabled for 64 Kbyte of fast memory (150 ns devices @ 66 MHz).

Figure B.3 128, 256, 512 Kbyte or 1 Mbyte Interface with 150 ns Memory

Optional - for Flash Memory only, not required for EEPROMS.

VPP

+ 12 V

GPIO4

VPP Control

MWE/ → WE

MOE/ → OE

MCE/ → CE

LSI53C1010R

MAD[7:0] Bus

V_{DD}

MAD3   4.7 K

D[7:0]

A[7:0]

A[15:8]

A[19:16]

27C020-15/ 28F020-15/ Socket

MAS0/

8 D[7:0]   Q[7:0] 8
HCT374
CK   QE

MAS1/

Q[7:0] 8
8 D[7:0]
HCT374
CK   QE

MAD[3:0] Bus

Q[3:0] 4
4 D[3:0]
HCT377
CK   QE
Ē
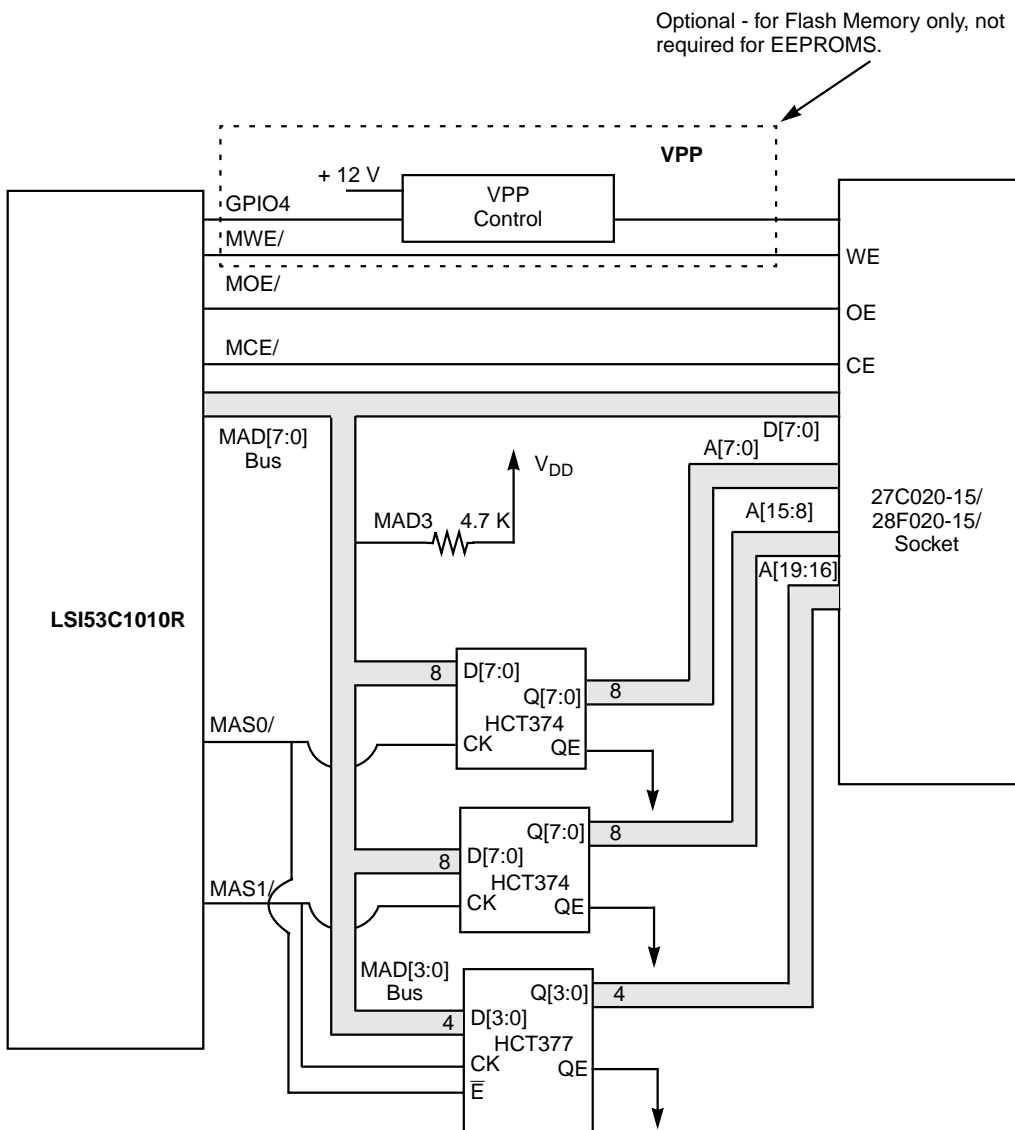
Note: MAD[2:0] pulled LOW internally. MAD bus sense logic enabled for 128, 256, 512 Kbytes, or 1 Mbyte of fast memory (150 ns devices @ 66 MHz). The HCT374s may be replaced with HCT377s.

Figure B.4 512 Kbyte Interface with 150 ns Memory

Note: MAD2 pulled LOW internally. MAD bus sense logic enabled for 512 Kbytes of slow memory (150 ns devices, additional time required for HCT139 @ 66 MHz). The HCT374s may be replaced with HCT377s.

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Numerics

A

S

X

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