



**SYM53C860  
PCI-SCSI I/O  
Processor  
With Fast-20**

DATA  
MANUAL

REVISION 1.0

***Fast20***

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## SCSI Engineering Note July, 95 Addendum to 53C860 Data Manual

The SYM53C860 Data Manual Rev. 1.0, published in July 1995 listed some of the pin numbers incorrectly in Chapter 4, "Signal Descriptions." The pin diagram in the manual, Figure 4-1, contains the correct pin information. This engineering note contains the accurate pin listings for Table 4-3 and Table 4-7.

### **C\_BE(3-0) pins**

These signals are on pins 96, 10, 21, and 34.

### **SD(7-0) pins**

These signals are on pins 67, 69, 70, 71, 72, 74, 75, 76, and 66.

### **SCTRL/ pins**

These signals are on the following pins:

SC_D/	57
SI_O/	55
SMSG/	60
SREQ/	56
SACK/	62
SBSY/	64
SATN/	65
SRST/	61
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These changes will be reflected in Rev. 2.0 of the SYM53C860 Data Manual.

## Preface

### SCSI and PCI Reference Information

This manual assumes some prior knowledge of current and proposed SCSI and PCI standards. For background information, 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) 792-2184 (outside U.S.)  
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*

#### Prentice Hall

Englewood Cliffs, NJ 07632  
(201) 767-5937  
Ask for document number ISBN 0-13-796855-8, *SCSI: Understanding the Small Computer System Interface*

#### Symbios Logic Electronic Bulletin Board

(719) 573-3562

#### SCSI Electronic Bulletin Board

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#### Symbios Logic Internet Anonymous FTP Site

[ftp.symbios.com](ftp:symbios.com) (204.131.200.1)

Directory: [pub/netchips/scsi](ftp://pub/netchips/scsi)

#### PCI Special Interest Group

P.O. Box 10470  
Portland, OR 97214  
(800) 433-5177; (503) 797-4201 (International); FAX (503) 234-6762

#### SYM53C8XX Family Programming Guide

## Revision Record

Page No.	Date	Remarks
n/a	6/95	Rev 1.0

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## Chapter 1 Introduction

### What is Covered in This Manual

This manual provides reference information on the SYM53C860 PCI-SCSI I/O Processor. It is intended for system designers and programmers who are using this device to design a SCSI port for PCI-based personal computers, workstations, or embedded applications.

This chapter includes general information about the SYM53C860 and other members of the SYM53C8XX family of PCI-SCSI I/O Processors. Chapter 2 describes the main functional areas of the chip in more detail, including the interfaces to the SCSI bus. Chapter 3 describes the chip's connection to the PCI bus, including the PCI commands and configuration registers supported. Chapter 4 contains the pin diagrams and definitions of each signal. Chapter 5 describes each bit in the operating registers, organized by address. Chapter 6 defines all of the SCSI SCRIPTS instructions that are supported by the SYM53C860. Chapter 7 contains the electrical characteristics and AC timings for the chip. The appendixes contain a register summary and a mechanical drawing of the SYM53C860.

This data manual assumes the user is familiar with the current and proposed standards for SCSI and PCI. For additional background information on these topics, please refer to the list of reference materials provided in the Preface of this document.

### General Description

The SYM53C860 PCI-SCSI I/O Processor brings high-performance I/O solutions to host adapter, workstation, and general computer designs, making it easy to add SCSI to any PCI system.

The SYM53C860 is a pin-for-pin replacement for the SYM53C810 PCI-SCSI I/O processor. It performs Fast-20 SCSI transfers or fast 8-bit SCSI transfers in single ended mode, and improves performance by optimizing PCI bus utilization. A system diagram showing the connections of the SYM53C860 in a PCI system is pictured in Figure 1-1. A block diagram of the SYM53C860 is pictured in Figure 1-2.

The SYM53C860 integrates a high-performance SCSI core, a PCI bus master DMA core, and the SYMSCSI SCRIPTS™ processor to meet the flexibility requirements of SCSI-1, SCSI-2, and Fast-20 SCSI standards. It is designed to implement multi-threaded I/O algorithms with a minimum of processor intervention, solving the protocol overhead problems of previous intelligent and non-intelligent adapter designs.

The SYM53C860 is fully supported by the Symbios SCSI Device Management System (SDMS™), a software package that supports the Advanced SCSI Protocol Interface (ASPI) and the ANSI Common Access Method (CAM). SDMS provides BIOS and driver support for hard disk, tape, removable media products, and CD-ROM under the major PC operating systems.

The SYM53C860 is packaged in a compact rectangular 100-pin PQFP package to minimize board space requirements. It operates the SCSI bus at 5 MB/s asynchronously or up to 20 MB/s synchronously, and bursts data to the host at full PCI speeds. The SYM53C860 increases SCRIPTS performance and reduces PCI bus overhead by allowing instruction prefetches of four or eight dwords.

Software development tools are available to developers who use the SCSI SCRIPTS language to create customized SCSI software applications. The SYM53C860 allows easy firmware upgrades and is supported by advanced SCRIPTS commands.

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## Benefits of Fast-20

Fast-20 is an extension of the SCSI-3 standard that expands the bandwidth of the SCSI bus and allows faster synchronous SCSI transfer rates. When enabled, Fast-20 performs 20 megatransfers during an I/O operation, which results in approximately doubling the synchronous transfer rates of fast SCSI-2. The SYM53C860 can perform 8-bit, Fast-20 synchronous transfers as fast as 20 MB/s. This advantage is most noticeable in heavily loaded systems, or large-block size applications such as video on-demand and image processing.

One advantage of Fast-20 is that it significantly improves SCSI bandwidth while preserving existing hardware and software investments. The SYM53C860 is compatible with all existing SYM53C810A software; the only changes required are to enable the chip to perform synchronous negotiations for Fast-20 rates. The SYM53C860 can use the same board socket as an SYM53C810, with the addition of an 80MHz SCLK. Some changes to existing cabling or system designs may be needed to maintain signal integrity at Fast-20 synchronous transfer rates. These design issues are discussed in Chapter 2.

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## TolerANT Technology

All Symbios Logic Fast-SCSI devices feature TolerANT<sup>®</sup> 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. Active negation is enabled by setting bit 7 in the STRST3 register in the SYM53C8XX family products.

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, the single biggest reliability issue with SCSI operations. TolerANT input signal filtering is a built in feature of all Symbios Logic fast SCSI devices. On the SYM53C8XX family products, the user may select a filtering period of 30 or 60 ns, with bit 1 in the STST2 register. During Fast-20 SCSI transfers, the filtering period is automatically set at 15 ns; this period cannot be extended with the Extend SREQ/SACK Filtering bit.

The benefits of TolerANT include increased immunity to noise when the signal is going 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, so other devices on the bus are also protected from data corruption. TolerANT is compatible with both the Alternative One and Alternative Two termination schemes proposed by the American National Standards Institute.

## SYM53C860 Benefits Summary

### SCSI Performance

- Performs Fast-20 SCSI synchronous transfers as fast as 20 MB/s
- Supports variable block size and scatter/gather data transfers
- Minimizes SCSI I/O start latency
- Performs complex bus sequences without interrupts, including restore data pointers
- Reduces ISR overhead through a unique interrupt status reporting method
- Performs fast SCSI bus transfers in single-ended mode
  - up to 7 MB/s asynchronous
  - 10 MB/s synchronous, or 20 MB/s synchronous with Fast-20
- New Load and Store SCRIPTS instruction increases performance of data transfers to and from the chip registers
- Support for target to disconnect and later reselect with no interrupt to the system processor
- Supports execution of multi-threaded I/O algorithms in SCSI SCRIPTS with fast I/O context switching

### PCI Performance

- Bursts 2, 4, 8, or 16 dwords across PCI bus with 80-byte DMA FIFO
- Pre-fetches up to 8 dwords of SCRIPTS instructions
- Supports 32-bit word data bursts with variable burst lengths.
- Bursts SCRIPTS op code fetches across the PCI bus
- Performs zero wait-state bus master data bursts faster than 110 MB/s (i.e. 33 MHz)
- Supports PCI Cache Line Size Register

### Integration

- 3.3V/5 V PCI Interface
- Full 32 bit PCI DMA bus master
- DMA controller using Memory to Memory Move instructions
- High performance SCSI core
- Integrated SCRIPTS processor
- Compact 100-pin PQFP packaging

### Ease of Use

- Direct PCI-to-SCSI connection
- Reduced SCSI development effort
- Support for the Advanced SCSI Protocol Interface (ASPI) or the ANSI Common Access Method (CAM) software standards via SDMS software
- Compatibility with existing SYM53C7XX and 53C8XX family SCRIPTS
- Direct connection to PCI, and SCSI single-ended bus
- Development tools and sample SCSI SCRIPTS

- Maskable and pollable interrupts
- Three programmable SCSI timers: **Select**, **Reselect**, **Handshake-to-Handshake**, and **General Purpose**. The time-out period is programmable from 100  $\mu$ s to greater than 1.6 seconds
- SDMS software for complete PC-based operating system support
- Support for relative jumps
- New SCSI Selected As ID bits for use when responding with multiple IDs

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### Flexibility

- High level programming interface (SCSI SCRIPTS)
- Support for execution of tailored SCSI sequences from main system RAM
- Flexible programming interface to tune I/O performance or to adapt to unique SCSI devices
- Flexibility to accommodate 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
- Support for indirect fetching of DMA address and byte counts so that SCRIPTS can be placed in a PROM
- Separate SCSI and system clocks
- Selectable IRQ pin disable bit
- Ability to route system clock to SCSI clock

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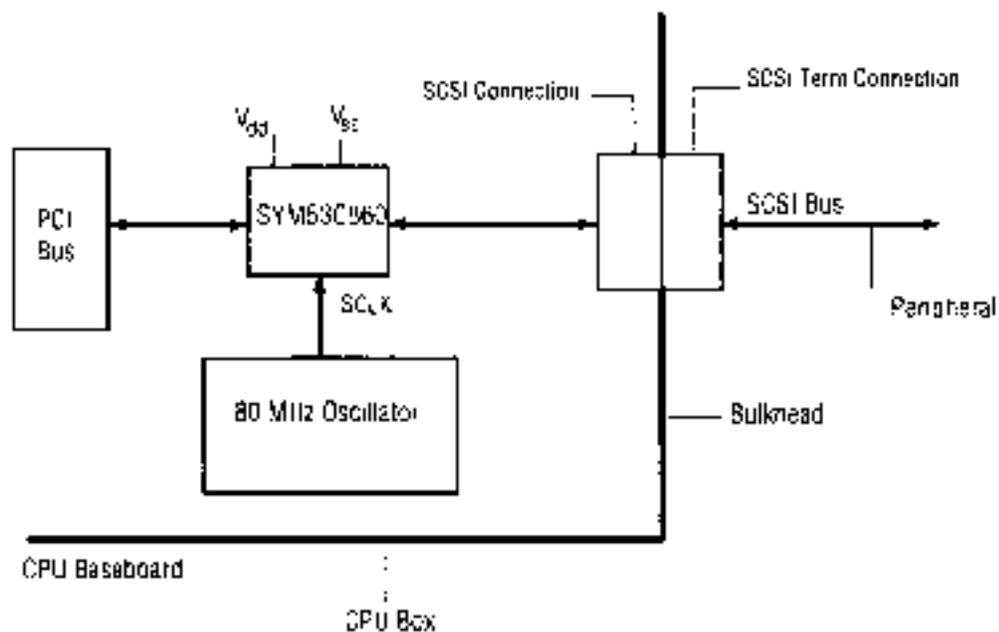
### Reliability

- 2 KV ESD protection on SCSI signals
- Typical 300 mV SCSI bus hysteresis
- Average operating supply current of 50 mA
- 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)
- 25% of pins power and ground
- Power and ground isolation of I/O pads and internal chip logic
- SYM TolerANT technology with:
  - 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.

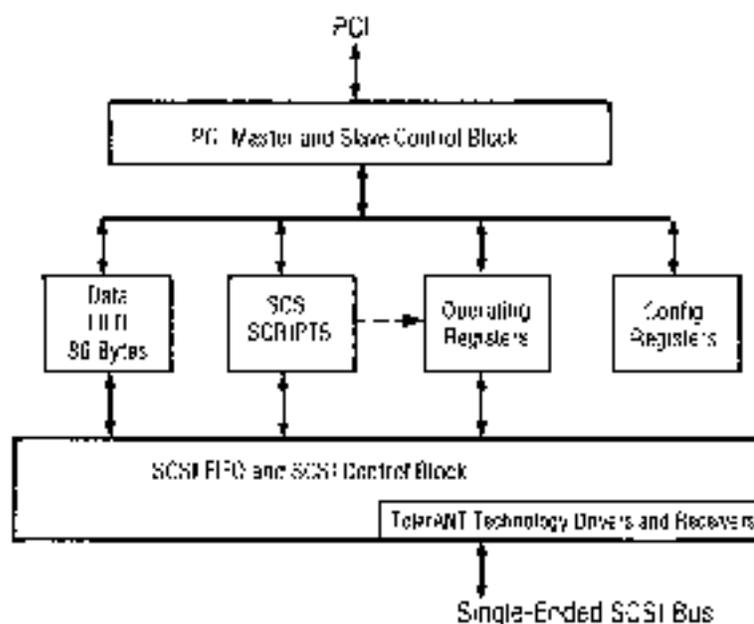
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### Testability

- Access to all SCSI signals through programmed I/O
- SCSI loopback diagnostics
- SCSI bus signal continuity checking
- Single-step mode operation
- Test mode (AND tree) to check pin continuity to the board



**Figure 1-1: SYM53C860 System Diagram**



**Figure 1-2: SYM53C860 Chip Diagram**



## Chapter 2

# Functional Description

The SYM53C860 contains three functional blocks: the SCSI Core, the DMA Core, and the SCRIPTS Processor. The SYM53C860 is fully supported by the SCSI Device Management System (SDMS), a complete software package that supports the Symbios Logic product line of SCSI processors and controllers.

## SCSI Core

The SCSI core supports Fast-20 synchronous transfer rates up to 20 MB/s, Fast SCSI-2 synchronous transfer rates up to 10 MB/s, and asynchronous transfer rates up to 7 MB/s on an 8 bit SCSI bus. The SCSI core can be programmed with SCSI SCRIPTS, making it easy to fine tune the system for specific mass storage devices or advanced SCSI requirements.

The SCSI core offers low-level register access or a high-level control interface. Like first generation SCSI devices, the SYM53C860 SCSI core can be accessed as a register-oriented device. The ability to sample and/or assert any signal on the SCSI bus can be used in error recovery and diagnostic procedures. In support of loopback diagnostics, the SCSI core can perform a self-selection and operate as both an initiator and a target.

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

## DMA Core

The DMA core is a bus master DMA device that attaches directly to the industry standard PCI Bus. The DMA core is tightly coupled to the SCSI core through the SCRIPTS processor, which supports uninterrupted scatter/gather memory operations.

The SYM53C860 supports 32 bit memory and automatically supports misaligned DMA transfers. An 80-byte FIFO allows two, four, eight, or sixteen dword bursts across the PCI bus interface to run efficiently without throttling the bus during PCI bus latency.

## SCRIPTS Processor

The SCSI SCRIPTS processor allows both DMA and SCSI commands to be fetched from host memory. Algorithms written in SCSI SCRIPTS control the actions of the SCSI and DMA cores and are executed from 32-bit system RAM. The SCRIPTS processor executes complex SCSI bus sequences independently of the host CPU.

The SCRIPTS processor can begin a SCSI I/O operation in approximately 500 ns. This compares with 2-8 ms required for traditional intelligent host adapters. Algorithms may be designed to tune SCSI bus performance, to adjust to new bus device types (such as scanners, communication gateways, etc.), or to incorporate changes in the SCSI-2 or SCSI-3 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.

A complete set of development tools is available for writing custom drivers with SCSI SCRIPTS. For more information on SCSI SCRIPTS instructions supported by the SYM53C860, see Chapter 6.

## SDMS: The Total SCSI Solution

For users who do not need to develop custom drivers, Symbios Logic provides a total SCSI solution in PC environments with the SCSI Device Management System (SDMS). SDMS provides BIOS and driver support for hard disk, tape, and removable media peripherals for the major PC-based operating systems.

SDMS includes a SCSI BIOS to manage all SCSI functions related to the device. It also provides a series of SCSI device drivers that support most major operating systems. SDMS supports a multi-threaded I/O application programming interface (API) for user developed SCSI applications. SDMS supports both the ASPI and CAM SCSI software specifications.

## Designing a Fast-20 SCSI System

Migrating an existing single-ended SCSI design from SCSI-2 to Fast-20 requires minor software modifications as well as consideration for some hardware design guidelines. Since Fast-20 is based on existing SCSI standards, it can use existing software programs as long as the software is able to negotiate for Fast-20 synchronous transfer rates.

In the area of hardware, the primary area of concern in single-ended systems is to maintain signal integrity at high data transfer rates. To assure reliable operation at Fast-20 transfer speeds, follow the system design parameters recommended in the SCSI-3 Fast-20 Parallel Interface draft standard, which is available from the SCSI BBS referenced at the beginning of this manual. Chapter 7 contains Fast-20 SCSI timing information. In addition to the guidelines in the draft standard, make the following hardware and software adjustments to accommodate Fast-20 SCSI transfers.

- Set the **Fast-20 Enable** bit to enable Fast-20 transfers.
- Set the **TolerANT Enable** bit, bit 7 in the **STEST3** register whenever the Fast-20 Enable bit is set.
- Do not extend the **SREQ/SACK** filtering period with **STEST2** bit 1.
- Use an 80MHz **SCLK**.

## Prefetching SCRIPTS Instructions

When enabled (by setting the **Prefetch Enable** bit in the **DCNTL** register), the prefetch logic in the SYM53C860 fetches 4 or 8 dwords of instructions. The prefetch logic automatically determines the maximum burst size that it can perform, based on the burst length as determined by the values in the **DMODE** register and the **PCI Cache Line Size** register (if cache mode is enabled). If the unit cannot perform bursts of at least four dwords, it will disable itself.

The SYM53C860 may flush the contents of the prefetch unit under certain conditions, listed below, to ensure that the chip always operates from the most current version of the software. When one of these conditions apply, the contents of the prefetch unit are flushed automatically.

1. On every **Memory Move** instruction. The **Memory Move (MMOV)** instruction is often used to place modified code directly into memory. To make sure that the chip executes all recent modifications, the prefetch unit flushes its contents and loads the modified code every time a **MMOV** instruction is issued. To avoid inadvertently flushing the prefetch unit contents, use the **No Flush Memory to Memory Move (NFMMOV)** instruction for all **MMOV** operations that do not modify code within the next 4 to 8 dwords. For more information on this instruction, refer to Chapter 6.

2. 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.
3. On every write to the DSP register
4. On all Transfer Control instructions when the transfer conditions are met. This is necessary because the next instruction to be executed is not the sequential next instruction in the prefetch unit.
5. When the Pre-Fetch Flush bit (DCNTL bit 5) is set. The unit flushes whenever this bit is set. The bit is self-clearing.

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### Op Code Fetch Burst Capability

Setting the Burst Op Code Fetch Enable bit in the DMODE register (38h) causes the SYM53C860 to burst in the first two dwords of all instruction fetches. If the instruction is a memory-to-memory move, the third dword will be accessed in a separate ownership. If the instruction is an indirect type, the additional dword will be accessed in a subsequent bus ownership. If the instruction is a table indirect Block Move, the SYM53C860 will use two accesses to obtain the four dwords required, in two bursts of two dwords each.

Note: this feature can only be used if SCRIPTS pre-fetching is disabled.

## PCI Cache Mode

The SYM53C860 supports the PCI specification for an 8-bit Cache Line Size register located in PCI configuration space. The Cache Line Size register provides the ability to sense and react to non-aligned addresses corresponding to cache line boundaries. In conjunction with the Cache Line Size register, the PCI commands Read Line, Read Multiple, and Write and Invalidate are each software enabled or disabled to allow the user full flexibility in using these commands. For more information on PCI cache mode operations, refer to Chapter 3.

## Load/Store Instructions

The SYM53C860 supports the Load/Store instruction type, which simplifies the movement of data between memory and the internal chip registers. It also enables the SYM53C860 to transfer bytes to addresses relative to the DSA register. For more information on the Load and Store instructions, refer to Chapter 6.

## 3.3 Volt/5 Volt PCI Interface

The SYM53C860 can attach directly to a 3.3 Volt or a 5 Volt PCI interface, due to separate  $V_{DD}$  pins for the PCI bus drivers. This allows the devices to be used on the universal board recommended by the PCI Special Interest Group.

## Loopback Mode

The SYM53C860 loopback mode allows testing of both initiator and target functions and, in effect, lets the chip communicate with itself. When the Loopback Enable bit is set in the STEST1 register, the SYM53C860 allows control of all SCSI signals, whether it is operating in initiator or target mode. For more information on this mode of operation, refer to the *SYM53C8XX Family Programming Guide*.

## Parity Options

The SYM53C860 implements a flexible parity scheme that allows control of the parity sense, allows parity checking to be turned on or off, and has the ability to deliberately send a byte with bad parity over the SCSI bus to test parity error recovery procedures. Table 2-1 defines the bits that are involved in parity control and observation.

Table 2-2 describes the parity control function of the Enable Parity Checking and Assert SCSI Even Parity bits in the SCNTL0 register. Table 2-3 describes the options available when a parity error occurs.

Table 2-1: Bits Used for Parity Control and Observation

Bit Name	Location	Description
Assert SAIN <sub>N</sub> on Parity Errors	SCNTL0, Bit 1	Causes the SYM53C860 to automatically assert SAIN <sub>N</sub> when it detects a parity error while operating on the SCSI bus as an initiator.
Enable Parity Checking	SCNTL0, Bit 3	Enables the SYM53C860 to check for parity errors on the SCSI bus. The SYM53C860 checks for odd parity.
Assert Even SCSI Parity	SCNTL1, Bit 2	Determines the SCSI parity sense generated by the SYM53C860 to the SCSI bus.
Disable Halt on SAIN <sub>N</sub> or a Parity Error (Target Mode Only)	SCNTL1, Bit 5	Causes the SYM53C860 not to halt operations when a SCSI parity error is detected in target mode.
Enable Parity Error Interrupt	SIEN0, Bit 0	Determines whether the SYM53C860 will generate an interrupt when it detects a SCSI parity error.
Parity Error	SIST0, Bit 0	This status bit is set whenever the SYM53C860 has detected a parity error on the SCSI bus.
Status of SCSI Parity Signal	SSTAT0, Bit 0	This status bit represents the live SCSI Parity Signal (SDP).
Latched SCSI Parity	SSTAT1, Bit 3	This bit reflects the SCSI odd parity signal corresponding to the data latched into the SIDL register.
Master Parity Error Enable	CTESTA, Bit 3	Enables PCI parity checking during master data phases.
Master Data Parity Error	DSTAT, Bit 6	Set when the SYM53C860 as a PCI master detects that a target device has signalled a parity error during a data phase.
Master Data Parity Error Interrupt Enable	DIEN, Bit 6	By clearing this bit, a Master Data Parity Error will not cause IRQ <sub>N</sub> to be asserted, but the status bit will be set in the DSTAT register.

Table 2-2: SCSI Parity Control

EPC	AESP	Description
0	0	Will not check for parity errors. Parity is generated when sending SCSI data. Asserts odd parity when sending SCSI data.
0	1	Will not check for parity errors. Parity is generated when sending SCSI data. Asserts even parity when sending SCSI data.
1	0	Checks for odd parity on SCSI data received. Parity is generated when sending SCSI data. Asserts odd parity when sending SCSI data.
1	1	Checks for odd parity on SCSI data received. Parity is generated when sending SCSI data. Asserts even parity when sending SCSI data.

Key:

EPC = Enable Parity Checking (bit 1 SCNTL0)

AESP = Assert SCSI Even Parity (bit 2 SCNTL0)

Table 2-3: SCSI Parity Errors and Interrupts

DHP	PAR	Description
0	0	Will halt when a parity error occurs in target or initiator mode and will NOT generate an interrupt.
0	1	Will halt when a parity error occurs in target mode and will generate an interrupt in target or initiator mode.
1	0	Will not halt in target mode when a parity error occurs until the end of the transfer. An interrupt will not be generated.
1	1	Will not halt in target mode when a parity error occurs until the end of the transfer. An interrupt will be generated.

Key: DHP = Disable Halt on SATN or Parity Error (bit 5 SCNTL1) PAR = Parity Error (bit 9 SLEN0)

This table only applies when the Enable Parity Checking bit is set.

## DMA FIFO

The DMA FIFO is 4 bytes wide by 20 transfers deep. It is divided into four sections, each one byte wide and 20 transfers deep. The DMA FIFO is illustrated in Figure 2-1.

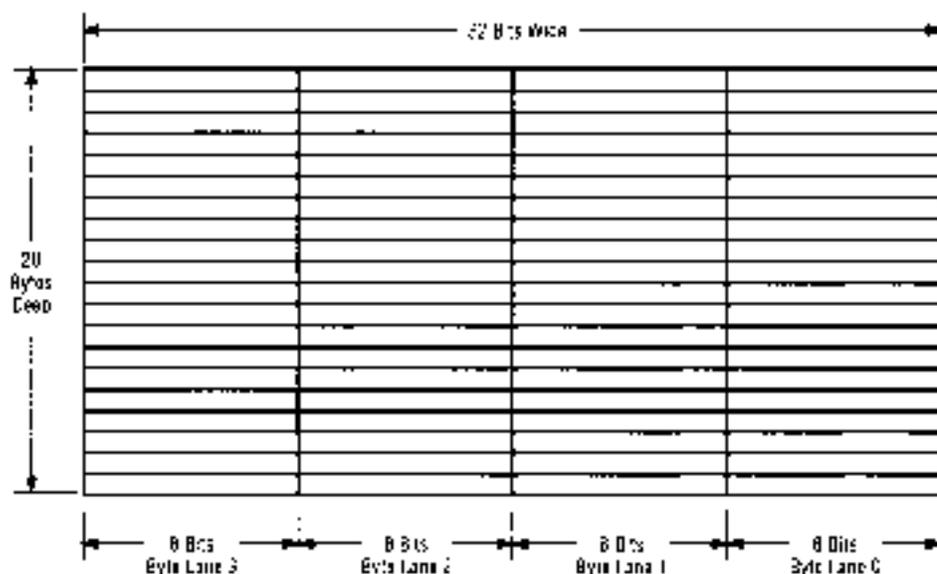


Figure 2-1: DMA FIFO Sections

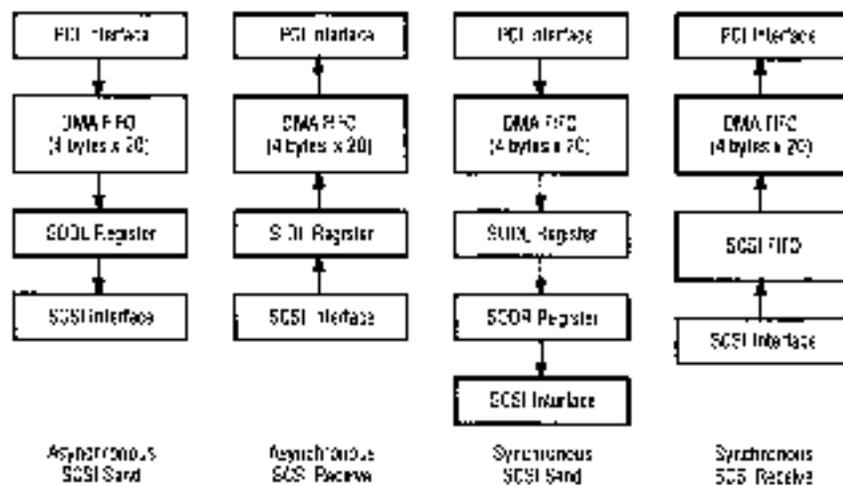


Figure 2-2: SYM53C860 Host Interface Data Paths

## Data Paths

The data path through the SYM53C860 is dependent on whether data is being moved into or out of the chip, and whether SCSI data is being transferred asynchronously or synchronously.

Figure 2-2 shows how data is moved to/from the SCSI bus in each of the different modes.

The following steps determine if any bytes remain in the data path when the chip halts an operation:

### Asynchronous SCSI Send

1. Look at the DFIFO and DBC registers and calculate if there are bytes left in the DMA FIFO. To make this calculation, subtract the seven least significant bits of the DBC register from the 7-bit value of the DFIFO register. AND the result with 7Fh for a byte count between zero and 80.
2. Read bit 5 in the SSTAT0 register to determine if any bytes are left in the SODL register. If bit 5 is set in SSTAT0, then the SODL register is full.

### Synchronous SCSI Send

1. Look at the DFIFO and DBC registers and calculate if there are bytes left in the DMA FIFO. To make this calculation, subtract the seven least significant bits of the DBC register from the 7-bit value of the DFIFO register. AND the result with 7Fh for a byte count between zero and 80.
2. Read bit 5 in the SSTAT0 register to determine if any bytes are left in the SODL register. If bit 5 is set in SSTAT0, then the SODL register is full.
3. Read bit 6 in the SSTAT0 register to determine if any bytes are left in the SODR register. If bit 6 is set in SSTAT0, then the SODR register is full.

### Asynchronous SCSI Receive

1. Look at the DFIFO and DBC registers and calculate if there are bytes left in the DMA FIFO. To make this calculation, subtract the seven least significant bits of the DBC register from the 7-bit value of the DFIFO register. AND the result with 7Fh for a byte count between 0 and 80.
2. Read bit 7 in the SSTAT0 register to determine if any bytes are left in the SIDL register. If bit 7 is set in SSTAT0, then the SIDL register is full.

### Synchronous SCSI Receive

1. Subtract the seven least significant bits of the DBC register from the 7-bit value of the DFIFO register. AND the result with 7Fh for a byte count between 0 and 80.
2. Read the SSTAT1 register and examine bits 7-4, the binary representation of the number of valid bytes in the SCSI FIFO, to determine if any bytes are left in the SCSI FIFO.

## SCSI Bus Interface

The SYM53C860 supports single-ended operation only. All SCSI signals are active low. The SYM53C860 contains the single-ended output drivers and can be connected directly to the SCSI bus. Each output is isolated from the power supply to ensure that a powered-down SYM53C860 has no effect on an active SCSI bus (CMOS "voltage feed-through" phenomena). TolerANT technology provides signal filtering at the inputs of SREQ/ and SACK/ to increase immunity to signal reflections.

### Terminator Networks

The terminator networks provide the biasing needed to pull signals to an inactive voltage level, and to 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 installed and active. SCSI host adapters should provide a means of accommodating terminators. The terminators should be socketed, so that if not needed they may be removed, or there should be a means of disabling them with software.

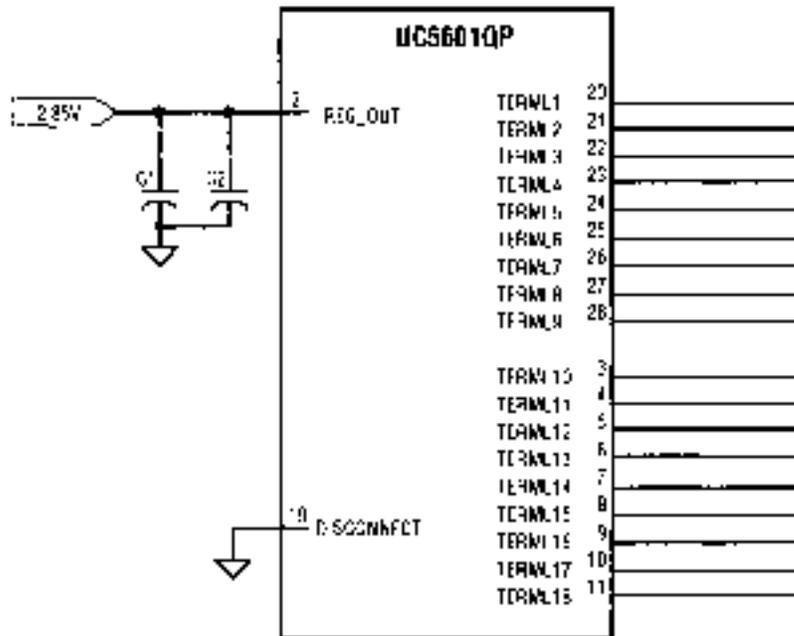
Single-ended cables can use a 220  $\Omega$  pull-up to the terminator power supply (Term-Power) line and a 330  $\Omega$  pull-down to Ground. Symbios recommends active or regulated termination (also known as Alt-2 or Alternative Two termination) to maximize the high performance of the SYM53C860. Figure 2-3 shows a Unitrode active terminator for regulated termination. For additional information, refer to the SCSI-2 Specification. TolerANT active negation can be used with any ANSI-approved termination network.

Note: active termination is required in Fast-20 systems.

### (Re)Select During (Re)Selection

In multi-threaded 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 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, the initiator SCRIPTS should start with a Set Initiator instruction or the target SCRIPTS should start with a Set Target instruction. The Selection and Reselection Enable bits (SCID bits 5 and 6, respectively) should both be set so that the SYM53C860 may respond as an initiator or as a target. If only selection is enabled, the SYM53C860 cannot be reselected as an initiator. There are also status and interrupt bits in the SIST0 and SINT0 registers, respectively, indicating that the SYM53C860 has been selected (bit 5) or reselected (bit 4).

**Key**

C1	10 $\mu$ F SMT
C2	0.1 $\mu$ F SMT
J1	68-pin, high density "P" connector

Figure 2-3: Active or Regulated Termination

## Synchronous Operation

The SYM53C860 can transfer synchronous SCSI data in both initiator and target modes. The SXFER register controls both the synchronous offset and the transfer period. It may be loaded by the CPU before SCRIPTS execution begins, from within SCRIPTS via a Table Indirect I/O instruction, or with a Read-Modify-Write instruction.

The SYM53C860 can receive data from the SCSI bus at a synchronous transfer period as short as 50 ns, regardless of the transfer period used to send data. The SYM53C860 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 SYM53C860 can send synchronous data at intervals as short as 50 ns for Fast-20 SCSI, 100 ns for fast SCSI-2 and 200 ns for SCSI-1.

### Determining the Data Transfer Rate

Synchronous data transfer rates are controlled by bits in two different registers of the SYM53C860. A brief description of the bits is provided below. Figure 2-4 illustrates the clock division factors used in each register, and the role of the register bits in determining the transfer rate.

#### SCNTL3 Register, bits 6-4 (SCF2-0)

The SCF2-0 bits select the factor by which the frequency of SCLK is divided before being presented to the synchronous SCSI control logic. The output from this divider controls the rate at which data can be received; this rate must not exceed 80 MHz. The receive rate is 1/4 of the divider output. For example, if SCLK is 80 MHz and the SCF value is set to divide by two, then the maximum rate at which data can be received is 10 MHz ( $80 / (2 * 4) = 10$ ).

#### SCNTL3 Register, bits 2-0 (CCF2-0)

The CCF2-0 bits select the factor by which the frequency of SCLK is divided before being presented to the asynchronous SCSI core logic. This divider must be set according to the input clock frequency in the table.

#### SXFER Register, bits 7-5 (TP2-0)

The TP2-0 bits determine the SCSI synchronous transfer period when sending synchronous SCSI data in either initiator or target mode.

### Fast-20

#### Synchronous Data Transfers

Fast-20 is simply an extension of current Fast SCSI-2 synchronous transfer specifications. It allows synchronous transfer periods to be negotiated down as low as 50 ns, which is half the 100 ns period allowed under Fast SCSI-2. This will allow a maximum transfer rate of 20 MB/s on an 8-bit SCSI bus. The NCR 53C860 requires an 80MHz SCSI clock input to perform Fast-20 transfers. In addition, the following bit values affect the chip's ability to support Fast-20 synchronous transfer rates:

1. Clock Conversion Factor bits, SCNTL3 register bits 2-0 and Synchronous Clock Conversion Factor bits, SCNTL3 register bits 6-4. These fields now support a value of 101 (binary), allowing the SCLK frequency to be divided down by 4. This allows systems with an 80 MHz clock to operate at Fast SCSI-2 transfer rates as well as Fast-20 rates, if needed.
2. Fast-20 Mode Enable bit, SCNTL3 register bit 7. Setting this bit enables Fast-20 synchronous transfers in systems that have an 80MHz clock.

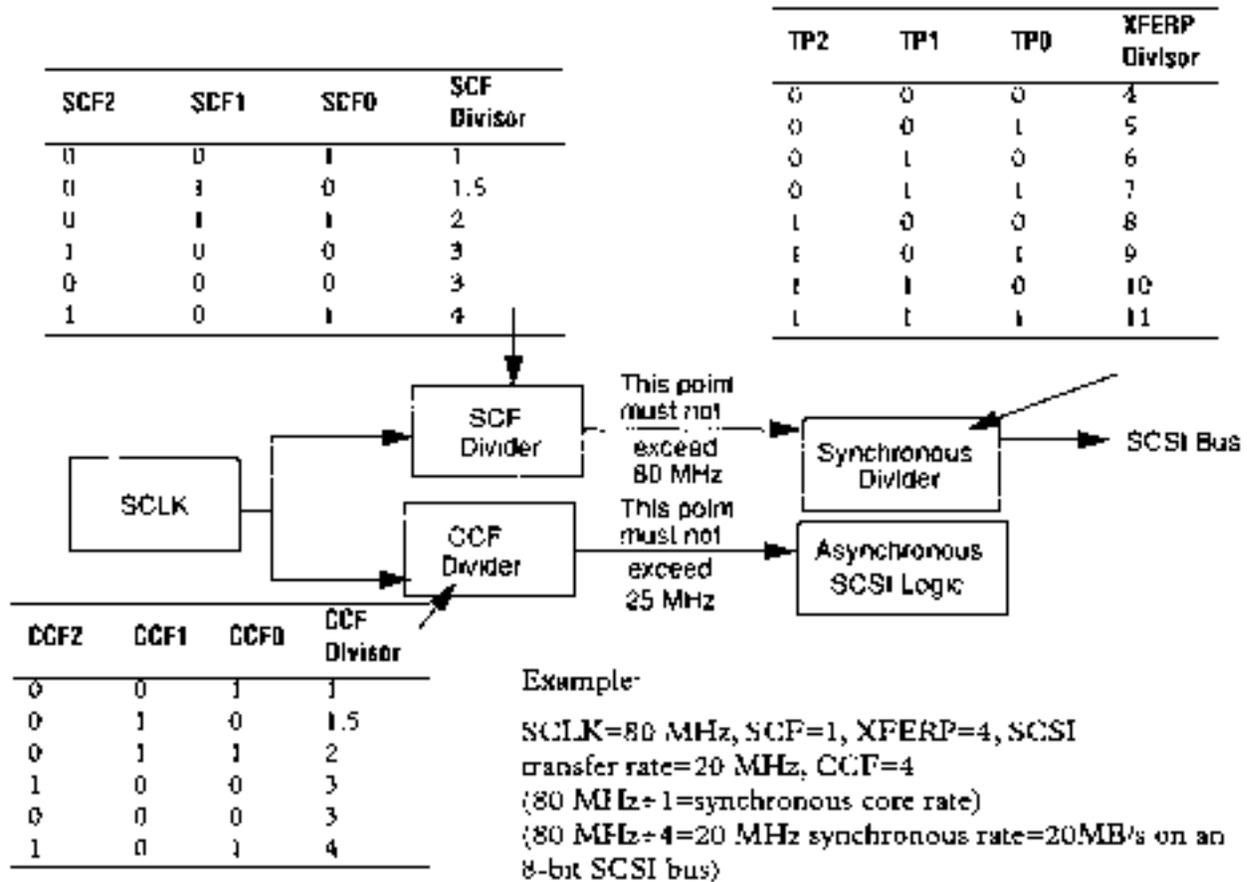


Figure 2-4: Determining the Synchronous Transfer Rate

## Interrupt Handling

The SCRIPTS processor in the SYM53C860 performs 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 SYM53C860.

### 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 set that indicates an interrupt. This method is the fastest, but it wastes CPU time that could be used for other system tasks. The preferred method of detecting interrupts in most systems is hardware interrupts. In this case, the SYM53C860 will assert the Interrupt Request (IRQ) line that will interrupt the microprocessor, causing the microprocessor to execute an interrupt service routine. A hybrid approach would use hardware interrupts for long waits, and use polling for short waits.

### Registers

The registers in the SYM53C860 that are used for detecting or defining interrupts are the ISTAT, SIST0, SIST1, DSTAT, SIEN0, SIEN1, DCNTL, and DIEN.

#### ISTAT

The ISTAT is the only register that can be accessed as a slave during 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 when the IRQ pin has been asserted in association with a hardware interrupt. The INIF (Interrupt on the Fly) bit should be the first interrupt serviced. It must be written to one to be cleared. This interrupt must be cleared before servicing any other interrupts. If the SIP bit in the

ISTAT register is set, then a SCSI-type interrupt has occurred and the SIST0 and SIST1 registers should be read. If the DIP bit in the ISTAT register is set, then a DMA-type interrupt has occurred and the 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.

#### SIST0 and SIST1

The SIST0 and SIST1 registers contain the SCSI-type interrupt bits. Reading these registers will determine which condition or conditions caused the SCSI-type interrupt, and will clear that SCSI interrupt condition. If the SYM53C860 is receiving data from the SCSI bus and a fatal interrupt condition occurs, the SYM53C860 will attempt to send the contents of the DMA FIFO to memory before generating the interrupt. If the SYM53C860 is sending data to the SCSI bus and a fatal SCSI interrupt condition occurs, data could be left in the DMA FIFO. Because of this the DMA FIFO Empty (DFE) bit in DSTAT should be checked. If this bit is clear, set the CLF (Clear DMA FIFO) and CSF (Clear SCSI FIFO) bits before continuing. The CLF bit is bit 2 in CTEST3. The CSF bit is bit 1 in STEST3.

#### DSTAT

The DSTAT register contains the DMA-type interrupt bits. Reading this register will determine which condition or conditions caused the DMA-type interrupt, and will clear that DMA interrupt condition. The DFE bit, bit 7 in DSTAT, is purely a status bit; it will not generate an interrupt under any circumstances and will not be cleared when read. DMA interrupts will flush neither the DMA nor SCSI FIFOs before generating the interrupt, so the DFE bit in the DSTAT register should be checked after any DMA interrupt. If the DFE bit is clear, then the FIFOs must be cleared by setting the CLF (Clear DMA FIFO) and CSF (Clear SCSI FIFO) bits, or flushed by setting the FLF (Flush DMA FIFO) bit.

## SIEN0 and SIEN1

The SIEN0 and SIEN1 registers are the interrupt enable registers for the SCSI interrupts in SIST0 and SIST1.

## DIEN

The DIEN register is the interrupt enable register for DMA interrupts in DSTAT.

## DCNTL

When bit 1 in this register is set, the IRQ<sub>i</sub> pin will not be asserted when an interrupt condition occurs. The interrupt is not lost or ignored, but merely masked at the pin. Clearing this bit when an interrupt is pending will immediately cause the IRQ<sub>i</sub> pin to assert. As with any register other than ISTAT, this register cannot be accessed except by a SCRIPTS instruction during SCRIPTS execution.

## Fatal vs. Non-Fatal Interrupts

A fatal interrupt, as the name implies, always causes SCRIPTS to stop running. A non-fatal interrupt causes SCRIPTS to stop running only if it is not masked. For more information on interrupt masking, see the discussion on masking later in this section. All DMA interrupts (indicated by the DIP bit in ISTAT and one or more bits in DSTAT being set) are fatal.

Some SCSI interrupts (indicated by the SIP bit in the ISTAT and one or more bits in SIST0 or SIST1 being set) are non-fatal. When the SYM53C860 is operating in initiator role, only the Function Complete (CMP), Selected (SEL), Reselected (RSL), General Purpose Timer Expired (GEN), and Handshake to Handshake Timer Expired (HTH) interrupts are non-fatal. When operating in target role CMP, SHI, RSI, Target mode: SATN<sub>i</sub> active (M/A), GEN, and HTH are non-fatal. Refer to the description for the Disable Halt on a Parity Error or SATN<sub>i</sub> active (Target Mode Only) (DHP) bit in the SCNTL1 register to configure the chip's behavior when the SATN<sub>i</sub>

interrupt is enabled during target role operation. The interrupt on the Fly interrupt is also non-fatal, since SCRIPTS can continue when it occurs.

The reason for non-fatal interrupts is to prevent 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 SYM53C860 has been selected or reselected (SEL or RSL set), when the initiator has asserted ATN (target mode: SATN<sub>i</sub> active), or when the General Purpose or Handshake to Handshake timers expire. These interrupts do not require CPU intervention during high-level SCRIPTS operation.

## Masking

Masking an interrupt means disabling or ignoring that interrupt. Interrupts can be masked by clearing bits in the SIEN0 and SIEN1 (for SCSI interrupts) registers or the DIEN (for DMA interrupts) register. How the chip will respond to masked interrupts depends on: whether polling or hardware interrupts are being used; whether the interrupt is fatal or non-fatal; and whether the chip is operating in initiator or target role.

If a non-fatal interrupt is masked and that condition occurs, SCRIPTS will not stop, the appropriate bit in the SIST0 or SIST1 will still be set, the SIP bit in the ISTAT will not be set, and the IRQ<sub>i</sub> pin will not be asserted. See the section on non-fatal vs. fatal interrupts for a list of the non-fatal interrupts.

If a fatal interrupt is masked and that condition occurs, then SCRIPTS will still stop, the appropriate bit in the DSTAT, SIST0, or SIST1 register will be set, and the SIP or DIP bits in the ISTAT will be set, but the IRQ<sub>i</sub> pin will not be asserted.

When the chip is initialized, enable all fatal interrupts if you are using hardware interrupts. If a fatal interrupt is disabled and that interrupt condition occurs, SCRIPTS will halt and the system will never know it unless it times out and checks the ISTAT after a certain period of inactivity.

If you are polling the ISTAT instead of using hardware interrupts, then masking a fatal interrupt will make no difference since the SIP and DIP bits in the ISTAT inform the system of interrupts, not the IRQ<sup>o</sup> pin.

Masking an interrupt after IRQ<sup>o</sup> is asserted will not cause IRQ<sup>o</sup> to be deasserted.

---

### Stacked Interrupts

The SYM53C860 stacks interrupts if they occur one after another. If the SIP or DIP bits in the ISTAT register are set (first level), then there is already at least one pending interrupt, and any future interrupts will be stacked in extra registers behind the SIST0, SIST1, and DSTAT registers (second level). When two interrupts have occurred and the two levels of the stack are full, any further interrupts will set additional bits in the extra registers behind SIST0, SIST1, and DSTAT. When the first level of interrupts are cleared, all the interrupts that came in afterward will move into the SIST0, SIST1, and DSTAT. After the first interrupt is cleared by reading the appropriate register, the IRQ<sup>o</sup> pin will be deasserted for a minimum of three CLKs; the stacked interrupt(s) will move into the SIST0, SIST1, or DSTAT; and the IRQ<sup>o</sup> pin will be asserted once again.

Since a masked non-fatal interrupt will not set the SIP or DIP bits, interrupt stacking will not occur. A masked, non-fatal interrupt will still post the interrupt in SIST0, but will not assert the IRQ<sup>o</sup> pin. Since no interrupt is generated, future interrupts will move right into the SIST0 or SIST1 instead of being stacked behind another interrupt. When another condition occurs that generates an interrupt, the bit corresponding to the earlier masked non-fatal interrupt will still be 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 will not be 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 will not attempt to flush the FIFOs before generating the interrupt. It is important to set 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 will not be posted until the DMA FIFO is clear of data. These 'locked out' SCSI interrupts will be posted as soon as the DMA FIFO is empty.

---

### Halting in an Orderly Fashion

When an interrupt occurs, the SYM53C860 will attempt to halt in an orderly fashion.

- If the interrupt occurs in the middle of an instruction fetch, the fetch will be completed, except in the case of a Bus Fault. Execution will not begin, but the DSP will point 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 SYM53C860 will attempt to flush the DMA FIFO to memory before halting. Under any other circumstances only the current cycle will be completed before halting, so the DFE bit in DSTAT should be checked to see if any data remains in the DMA FIFO.
- SCSI SREQ/SACK handshakes that have begun will be completed before halting.
- The SYM53C860 will attempt to clean up any outstanding synchronous offset before halting.
- In the case of Transfer Control Instructions, once instruction execution begins it will continue to completion before halting.
- If the instruction is a JUMP/CALL WHEN/IF <phase>, the DSP will be updated to the transfer address before halting.
- All other instructions may halt before completion.

---

### Sample Interrupt Service Routine

The following is a sample of an interrupt service routine for the SYM53C860. It can be repeated if polling is used, or should be called when the IRQ<sub>n</sub> pin is asserted if hardware interrupts are used.

1. Read ISTAT.
2. If the INTF bit is set, it must be written to a one to clear this status.
3. If only the SIP bit is set, read SIST0 and SIST1 to clear the SCSI interrupt condition and get the SCSI interrupt status. The bits in the SIST0 and SIST1 tell which SCSI interrupt(s) occurred and determine what action is required to service the interrupt(s).
4. If only the DIP bit is set, read the DSTAT to clear the interrupt condition and get the DMA interrupt status. The bits in the DSTAT will tell which DMA interrupt(s) occurred and determine what action is required to service the interrupt(s).
5. If both the SIP and DIP bits are set, read SIST0, SIST1, and DSTAT to clear the SCSI and DMA interrupt condition and get the interrupt status. If using 8-bit reads of the SIST0, SIST1, and DSTAT registers to clear interrupts, insert a 12 CLK 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 ISR. It is recommended that the DMA interrupt be 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 interrupt service routine, in case any stacked interrupts moved in when the first interrupt was cleared. When using hardware interrupts, the IRQ<sub>n</sub> pin will be asserted again if there are any stacked interrupts. This should cause the system to re-enter the interrupt service routine.



## Chapter 3

# PCI Functional Description

## PCI Addressing

There are three types of PCI-defined address space:

- Configuration space
- Memory space
- I/O space

Configuration space is a contiguous 256-byte set of addresses dedicated to each "slot" or "stub" on the bus. Decoding C\_BE/(3-0) determines if a PCI cycle is intended to access configuration register space. The IDSEL bus signal is a chip select that allows access to the configuration register space only. Any attempt to access configuration space will be ignored unless IDSEL is asserted. The eight lower order address lines and byte enables are used to select a specific 8-bit register. The host processor uses this configuration space to initialize the SYM53C860. Figure 3-1 contains a list of the PCI configuration registers supported in the SYM53C860.

The lower 128 bytes of the SYM53C860 configuration space hold system parameters while the upper 128 bytes map into the SYM53C860 operating registers. For all PCI cycles except configuration cycles, the SYM53C860 registers are located on the 256-byte block boundary defined by the base address assigned through the configured register. The SYM53C860 operating registers are available in both the upper and lower 128-byte portions of the 256-byte space selected.

At initialization time, each PCI device is assigned a base address (in the case of the SYM53C860, the upper 24 bits of the address are used) for memory accesses and I/O accesses. On

every access, the SYM53C860 compares its assigned base addresses with the value on the Address/Data bus during the PCI address phase. If there is a match of the upper 24 bits, the access is for the SYM53C860 and the low order eight bits define the register to be accessed. A decode of C\_BE/(3-0) determines which registers and what type of access is to be performed.

PCI defines memory space as a contiguous 32-bit memory address that is shared by all system resources, including the SYM53C860. Base Address Register One determines which 256-byte memory area this device will occupy.

PCI defines I/O space as a contiguous 32 bit I/O address that is shared by all system resources, including the SYM53C860. Base Address Register Zero determines which 256 byte I/O area this device will occupy.

## 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 command encoding and types appear in Table 3-1.

The I/O Read command is used to read data from an agent mapped in I/O address space. All 32 address bits are decoded.

The I/O Write command is used to write data to an agent when mapped in I/O address space. All 32 address bits are decoded.

The Memory Read, Memory Read Multiple, and Memory Read Line commands are used to read data from an agent mapped in memory address space. All 32 address bits are decoded.

The Memory Write and Memory Write and Invalidate commands are used to write data to an agent when mapped in memory address space. All 32 address bits are decoded.

## PCI Cache Mode

The SYM53C860 supports the PCI specification for an 8-bit Cache Line Size register located in PCI configuration space. The Cache Line Size register provides the ability to sense and react to non-aligned addresses corresponding to cache line boundaries. In conjunction with the Cache Line Size register, the PCI commands Read Line, Read Multiple, and Write and Invalidate are each software enabled or disabled to allow the user full flexibility in using these commands.

### Support for PCI Cache Line Size Register

The SYM53C860 supports the PCI specification for an 8-bit Cache Line Size register in PCI configuration space; it can sense and react to non-aligned addresses corresponding to cache line boundaries.

### Selection of Cache Line Size

The cache logic will select a cache line size based on the values for the burst size in the DMODE register and the PCI Cache Line Size register.

**Note:** the SYM53C860 will not automatically use the value in the PCI Cache Line Size register as the cache line size value. The chip scales the value of the Cache Line Size register down to the nearest binary burst size allowed by the chip (2, 4, 8 or 16), compares this value to the DMODE burst size, then selects the smallest as the value for the cache line size. The SYM53C860 will use this value for all burst data transfers.

### Alignment

The SYM53C860 uses the calculated burst size value to monitor the current address for alignment to the cache line size. When it is not aligned the chip disables bursting, allowing only single dword transfers until a cache line boundary is reached. When the chip is aligned, bursting is re-enabled it will burst in increments specified by the Cache Line Size register as explained above. If the Cache Line Size register is not set (default = 00h), the DMODE burst size is automatically used as the cache line size.

### MMOV Misalignment

The SYM53C860 will not operate in a cache alignment mode when a MMOV instruction is issued and the read and write addresses are different distances from the nearest cache line boundary. For example, if the read address is 0x21F and the write address is 0x42F, and the cache line size is eight (8), the addresses are byte aligned, but they are not the same distance from the nearest cache boundary. The read address is 1 byte from the cache boundary 0x220 and the write address is 17 bytes from the cache boundary 0x440. In this situation, the chip will not align to cache boundaries and will operate as an SYM53C810.

### Memory Write and Invalidate Command

The Memory Write and Invalidate command is identical to the Memory Write command, except that it additionally guarantees a minimum transfer of one complete cache line; i.e., 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 register at address 0Ch in PCI configuration space. The SYM53C860 enables Memory Write and Invalidate cycles when bit 0 in the CTEST3 register (WRIE) and bit 4 in the PCI Command register

are set. This will cause Memory Write and Invalidate commands to be issued when the following conditions are met.

1. The CLSE bit, WRIE bit, and PCI Config Command register, bit 3 must be set.
2. The cache line size register must contain a legal burst size (2, 4, 8 or 16) value AND that value must be less than or equal to the DMODE burst size.
3. The chip must have enough bytes in the DMA FIFO to complete at least one full cache line burst.
4. The chip must be aligned to a cache line boundary.

When these conditions have been met, the SYM53C860 will issue a Write and Invalidate command instead of a Memory Write command during all PCI write cycles.

### Multiple Cache Transfers

When multiple cache lines of data have been read in during a MMIOV instruction (See the description for the Read Multiple command), the SYM53C860 will issue a Write and Invalidate command using the burst size necessary to transfer all the data in one transfer. For example, if the cache line size is 4, and the chip read in 16 dwords of data using a Read Multiple command, the chip will switch the burst size to 16, and issue a Write and Invalidate to transfer all 16 dwords in one bus ownership.

### Latency

In accordance with the PCI specification, the chip's latency timer will be ignored when issuing a Write and Invalidate command such that when a latency time-out has occurred, the SYM53C860 will continue to transfer up until a cache line boundary. At that point, the chip will relinquish the bus, and finish the transfer at a later time using another bus ownership. If the chip is transferring multiple cache lines it will continue to transfer until the next cache boundary is reached.

### PCI Target Retries

During a Write and Invalidate transfer, if the target device issues a retry (STOP with no TRY, indicating that no data was transferred), the SYM53C860 will relinquish the bus and immediately try to finish the transfer on another bus ownership. The chip will issue another Write and Invalidate command on the next ownership, in accordance with the PCI specification.

### PCI Target Disconnect

During a Write and Invalidate transfer, if the target device issues a disconnect the SYM53C860 will relinquish the bus and immediately try to finish the transfer on another bus ownership. The chip will not issue another Write and Invalidate command on the next ownership.

---

### Memory Read Line Command

This command is identical to the Memory Read command, except that it additionally indicates that the master intends to fetch a complete cache line. This command is intended to be used with bulk sequential data transfers where the memory system and the requesting master might gain some performance advantage by reading up to a cache line boundary rather than a single memory cycle. The Read Line Mode function that exists in the previous SYM53C8XX chips has been modified in the SYM53C860 to reflect the PCI cache line size register specifications. The functionality of the Enable Read Line bit (bit 3 in DMODE) has been modified to more resemble the Write and Invalidate mode in terms of conditions that must be met before a Read Line command will be issued. However, the Read Line option will operate exactly like the previous SYM53C8XX chips when cache mode has been disabled by a CLSE bit reset or when certain conditions exist in the chip (explained below).

The Read Line mode is enabled by setting bit 3 in the DMODE register. If cache mode has been disabled, Read Line commands will be issued on every read data transfer, except op code fetches, as in previous SYM53C8XX chips.

If cache mode has been enabled, a Read Line command will be issued on all read cycles, except op code fetches, when the following conditions have been met.

1. The CLSE and Enable Read Line bits must be set.
2. The Cache Line Size register must contain a legal burst size value (2, 4, 8 or 16) AND that value must be less than or equal to the DMODE burst size.
3. The number of bytes to be transferred at the time a cache boundary has been reached must be equal to or greater than a full cache line size.
4. The chip must be aligned to a cache line boundary.

When these conditions have been met, the chip will issue a Read Line command instead of a Memory Read during all PCI read cycles. Otherwise, it will issue a normal Memory Read command.

---

### Memory Read Multiple Command

This command is identical to the Memory read command except that it additionally indicates that the master may intend to fetch more than one cache line before disconnecting. The SYM53C860 supports PCI Read Multiple functionality and will issue Read Multiple commands on the PCI bus when the Read Multiple Mode is enabled. This mode is enabled by setting bit 2 of the DMODE register (ERMP). The command will be issued when certain conditions have been met.

If cache mode has been enabled, a Read Multiple command will be issued on all read cycles, except op code fetches, when the following conditions have been met:

1. The CLSE and ERMP bits must be set.
2. The Cache Line Size register must contain a legal burst size value (2, 4, 8 or 16) AND that value must be less than or equal to the DMODE burst size.
3. The number of bytes to be transferred at the time a cache boundary has been reached must be equal to or greater than the DMODE burst size.
4. The chip must be aligned to a cache line boundary.

When these conditions have been met, the chip will issue a 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 in a single bus ownership. The number of cache lines to be read is determined by the DMODE burst size bits. In other words, the chip will switch its normal operating burst size to reflect the DMODE burst size settings for the Read Multiple command. For example, if the cache line size is 4, and the DMODE burst size is 16, the chip will switch the current burst size from 4 to 16, and issue a Read Multiple. After the transfer, the chip will then switch the burst size back to the normal operating burst size of 4.

### Read Multiple with Read Line Enabled

When both the Read Multiple and Read Line modes have been enabled, the Read Line command will not be issued if the above conditions are met. Instead, a Read Multiple command will be issued, even though the conditions for Read Line have been met.

If the Read Multiple mode is enabled and the Read Line mode has been disabled, Read Multiple commands will still be issued if the Read Multiple conditions are met.

## Unsupported PCI Commands

The SYM53C860 does not respond to reserved commands, special cycle, dual address cycle, or interrupt acknowledge commands as a slave. It will never generate these commands as a master.

Table 3-1: 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 Cycle	Yes	Yes
0011	I/O Write Cycle	Yes	Yes
0100	Reserved	n/a	
0101	Reserved	n/a	
0110	Memory Read	Yes	Yes
0111	Memory Write	Yes	Yes
1000	Reserved	n/a	
1001	Reserved	n/a	
1010	Configuration Read	No	Yes
1011	Configuration Write	No	Yes
1100	Memory Read Multiple	Yes	No (defaults to 0110)
1101	Dual Address Cycle	No	No
1110	Memory Read Line	Yes	No (defaults to 0110)
1111	Memory Write and Invalidate	Yes	No (defaults to 0111)

## Configuration Registers

The Configuration registers are accessible only by system BIOS during PCI configuration cycles, and are not available to the user at any time. No other cycles, including SCRIPTS operations, can access these registers.

The lower 128 bytes hold configuration data while the upper 128 bytes hold the SYM53C860 operating registers, which are described in Chapter Five, "Operating Registers." The operating registers can be accessed by SCRIPTS or the host processor.

**Note:** the configuration register descriptions are provided for general information only, to indicate which PCI configuration addresses are supported in the SYM53C860. For detailed information, refer to the PCI Specification.

Figure 3-1 shows the PCI configuration registers implemented by the SYM53C860. Addresses 40h through 7Fh are not defined.

All PCI-compliant devices, such as the SYM53C860, must support the Vendor ID, Device ID, Command, and Status Registers. Support of other PCI-compliant registers is optional. In the SYM53C860, registers that are not supported are not writable and return all zeroes when read. Only those registers and bits that are currently supported by the SYM53C860 are described in this chapter. For more detailed information on PCI registers, please see the PCI Specification.

31	16	15	0	
Device ID = 0006h		Vendor ID = 1000h		00h
Status		Command		04h
Class Code = 010000h			Rev ID = 0Xh	08h
Not Supported	Header Type	Latency Timer	Cache Line Size	0Ch
Base Address Zero (I/O)*				10h
Base Address One (Memory)**				14h
Not Supported				18h
Not Supported				1Ch
Not Supported				20h
Not Supported				24h
Reserved				28h
Reserved				28h
Reserved				30h
Reserved				34h
Reserved				38h
Mux_Lat	Min_Gnt	Interrupt Pin	Interrupt Line	3Ch

**Figure 3-1: PCI Configuration Register Map**

\*I/O Base is supported

\*\*Memory Base is supported

*Note:* Addresses 40h to 7Fh are not defined. All unsupported registers are not writable and will return all zeroes when read. Reserved registers will also return zeroes when read.

**Register 00h**

Vendor ID

Read Only

This field identifies the manufacturer of the device. Symbios Logic Vendor ID is 1000h.

**Register 02h**

Device ID

Read Only

This field identifies the particular device. The SYM53C860 device ID is 0006h.

**Register 04h**

Command

Read/Write

The Command Register, illustrated in Figure 3-2, provides coarse control over a device's ability to generate and respond to PCI cycles. When a zero is written to this register, the SYM53C860 is logically disconnected from the PCI bus for all accesses except configuration accesses.

In the SYM53C860, bits 3, 5, 7, and 9 are not implemented. Bits 10 through 15 are reserved.

**Bits 15-10 Reserved****Bit 8 SERR Enable**

This bit enables the SERR driver. SERR is disabled when this bit is clear. The default value of this bit is zero. This bit and bit 6 must be set to report address parity errors.

**Bit 6 Enable Parity Error Response**

This bit allows the SYM53C860 to detect parity errors on the PCI bus and report these errors to the system. Only data parity checking is enabled. The SYM53C860 always generates parity for the PCI bus.

**Bit 4 Write and Invalidate Mode**

This bit, when set, will cause Memory Write and Invalidate cycles to be issued on the PCI bus after certain conditions have been met. For more information on these conditions, refer to the section "Memory Write and Invalidate Command". To enable Write and Invalidate Mode, bit 0 in the CTEST3 register (Operating registers) must also be set.

**Bit 2 Enable Bus Mastering**

This bit controls the SYM53C860's ability to act as a master on the PCI bus. A value of zero disables the device from generating PCI bus master accesses. A value of one allows the SYM53C860 to behave as a bus master. The SYM53C860 must be a bus master in order to fetch SCRIPTS instructions and transfer data.

**Bit 1 Enable Memory Space**

This bit controls the SYM53C860's response to memory space accesses. A value of zero disables the device response. A value of one allows the SYM53C860 to respond to memory space accesses at the address specified by Base Address One.

**Bit 0 Enable I/O Space**

This bit controls the SYM53C860's response to I/O space accesses. A value of zero disables the response. A value of one allows the SYM53C860 to respond to I/O space accesses at the address specified in Base Address Zero.

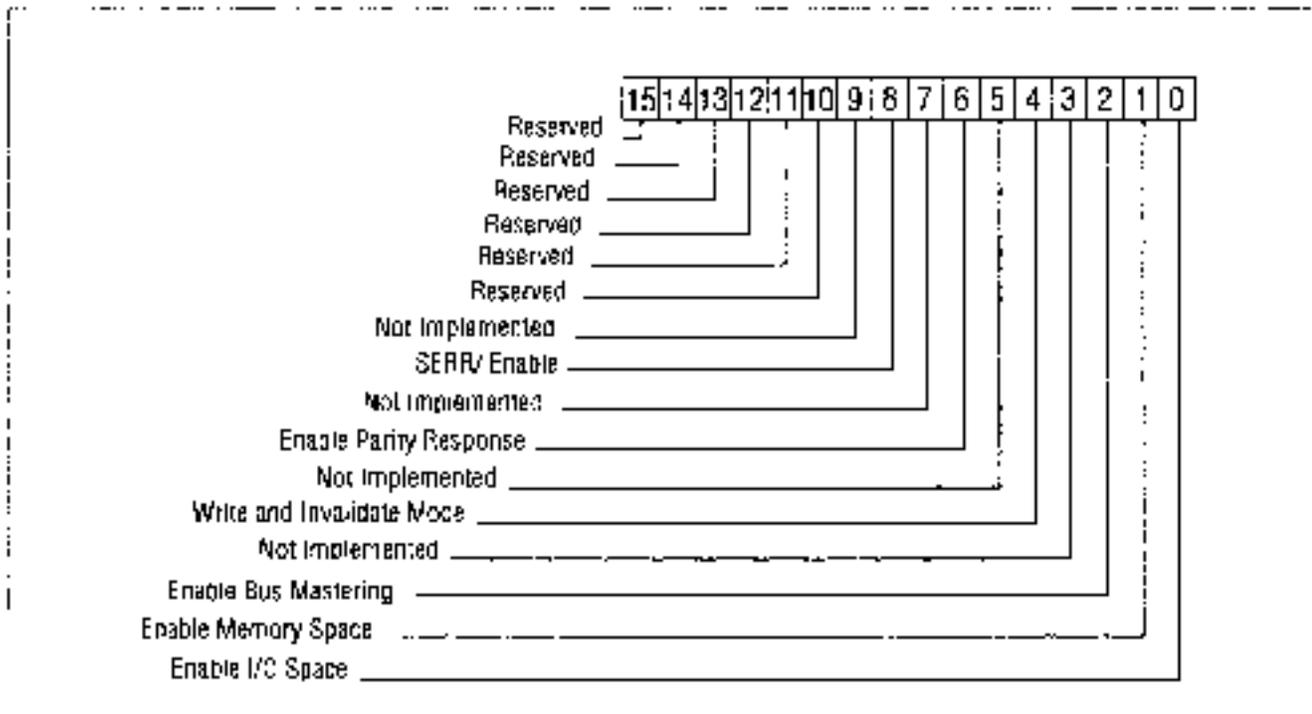


Figure 3-2: Command Register Layout

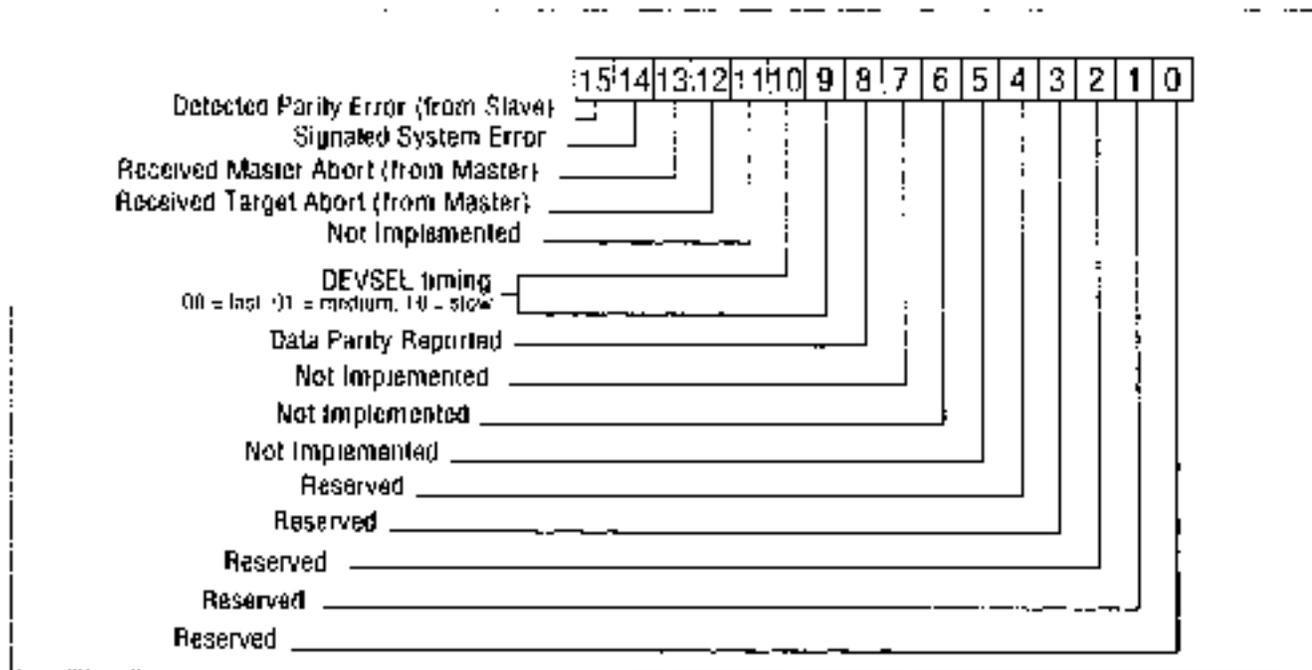


Figure 3-3: Status Register Layout

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**Register 06h****Status****Read/Write**

The Status Register, illustrated in Figure 3-3, is used to record status information for PCI bus-related events.

In the SYM53C860, bits 0 through 4 are reserved and bits 5, 6, 7, and 11 are not implemented by the SYM53C860.

Reads to this register behave normally. Writes are slightly different in that bits can be reset, but not set. A bit is reset whenever the register is written, and the data in the corresponding bit location is a one. For instance, to clear bit 15 and not affect any other bits, write the value 8000h to the register.

**Bit 15 Detected Parity Error (from Slave)**

This bit will be set by the SYM53C860 whenever it detects a data parity error, even if parity error handling is disabled.

**Bit 14 Signaled System Error**

This bit is set whenever a device asserts the SERR# signal.

**Bit 13 Master Abort (from Master)**

This bit should be set by a master device whenever its transaction (except for Special Cycle) is terminated with master-abort. All master devices should implement this bit.

**Bit 12 Received Target Abort (from Master)**

This bit should be set by a master device whenever its transaction is terminated with a target abort. All master devices should implement this bit.

**Bits 10-9 DEVSEL/Timing**

These bits encode the timing of DEVSEL#. These are encoded as 00b for fast, 01b for medium, 10b for slow, and 11b reserved. These bits are read only and should indicate the slowest time that a device asserts DEVSEL# for any bus command except Configuration Read and Configuration Write. The SYM53C860 supports 01b.

**Bit 8 Data Parity Reported**

This bit is set when the following three conditions are met: 1) The bus agent asserted PERR# itself or observed PERR# asserted; 2) The agent setting this bit acted as the bus master for the operation in which the error occurred; and 3) The Parity Error Response bit in the Command register is set.

---

**Register 08h****Revision ID****Read Only**

This register specifies a device specific revision identifier. The revision level of the SYM53C860 is located in the lower nibble of this byte. The upper nibble will be used to identify future SYM53C860-compatible parts.

---

**Register 09h****Class Code****Read Only**

This register is used to identify 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 010000h, which indicates a SCSI controller.

---

**Register 0Ch****Cache Line Size****Read/Write**

This register specifies the system cache line size in units of 32-bit words. Cache mode is enabled and disabled by the Cache Line Size Enable (CLSE) bit, bit 7 in the DCNTL register. Setting this bit causes the SYM53C860 to align to cache line boundaries before allowing any bursting, except during MMIOs in which the read and write addresses are Burst Size boundary misaligned. For more information on use of this register, see the section titled "Support for PCI Cache Line Size Register".

---

**Register 0Dh**  
**Latency Timer**  
**Read/Write**

The Latency Timer register specifies, in units of PCI bus clocks, the value of the Latency Timer for this PCI bus master. The SYM53C860 supports 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 SYM53C860:

$$\text{Latency} = 2 + (\text{Burst Size} * (\text{typical wait states} + 1)).$$

Values greater than optimum are also acceptable.

---

**Register 0Eh**  
**Header Type**  
**Read Only**

This register identifies the layout of bytes 10h through 3Fh in configuration space and also whether or not the device contains multiple functions. The value of this register is 00h.

---

**Register 10h**  
**Base Address Zero (I/O)**  
**Read/Write**

This 32-bit register has bit zero hardwired to one. Bit 1 is reserved and must return a zero on all reads, and the other bits are used to map the device into I/O space.

---

**Register 14h**  
**Base Address One (Memory)**  
**Read/Write**

This register has bit 0 hardwired to zero. For detailed information on the operation of this register, refer to the PCI Specification.

---

**Register 3Ch**  
**Interrupt Line**  
**Read/Write**

This register is used to communicate interrupt line routing information. POST software will write the routing information into this register as it initiates and configures the system. The value in this register tells which input of the system interrupt controller(s) has been connected to the device's interrupt pin. Values in this register are specified by system architecture.

---

**Register 3Dh**  
**Interrupt Pin**  
**Read Only**

This register tells which interrupt pin the device uses. Its value is set to 01h, for the INTA' signal.

---

**Register 3Eh**  
**Min\_Gnt**  
**Read Only**

---

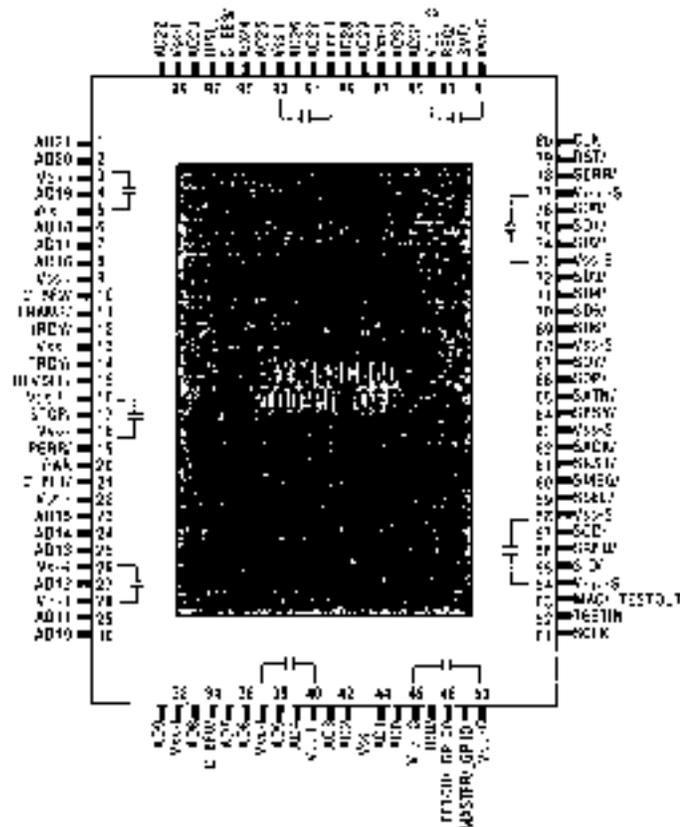
**Register 3Fh**  
**Max\_Lat**  
**Read Only**

These registers are used to specify the desired settings for Latency Timer values. Min\_Gnt is used to specify how long a burst period the device needs. Max\_Lat is used to specify how often the device needs to gain access to the PCI bus. The value specified in these registers is in units of 0.25 microseconds. Values of zero indicate that the device has no major requirements for the settings of Latency Timers. The SYM53C860 sets the Min\_Gnt register to 08h and the Max\_Lat register to 40h.

## Chapter 4

# Signal Descriptions

This chapter presents the SYM53C860 pin configuration and signal definitions using tables and illustrations. Figure 4-1 is the pin diagram and Figure 4-2 is a functional signal grouping. The pin definitions are presented in Table 4-1 through Table 4-8. The SYM53C860 is pin for pin compatible with the SYM53C810.



**Figure 4-1: SYM53C860 Pin Diagram**

*The decoupling capacitor arrangement shown above is recommended to maximize the benefits of the internal split ground system. Capacitor values between 0.01 and 0.1  $\mu$ F should provide adequate noise isolation. Because of the number of high current drivers on the SYM53C860, a multi-layer PC board with power and ground planes is required.*

The PCI/SCSI pin definitions are organized into the following functional groups: Power and Ground, System, Address/Data, Interface Control, Arbitration, Error Reporting, SCSI, and Optional Interface. A slash (/) at the end of the signal name indicates that the active state occurs when the signal is at a low voltage. When the slash is absent, the signal is active at a high voltage.

There are four signal type definitions:

I	Input, a standard input-only signal
O	Totem Pole Output, a standard output driver
I/S	Tri-State, a bi-directional, tri-state input/output pin
S/T/S	Sustained Tri-state, an active low tri-state signal owned and driven by one and only one agent at a time

Table 4-1: Power and Ground Pins

Symbol	Pin No.	Description
V <sub>SS-I</sub>	5, 9, 13, 18, 22, 26, 32, 37, 43, 87, 93, 99	Power supplies to the PCI I/O pins
V <sub>DD-I*</sub>	3, 16, 28, 40, 90	Power supplies to the PCI I/O pins
V <sub>SS-S</sub>	58, 63, 68, 73	Power supplies to the SCSI bus I/O pins
V <sub>DD-S</sub>	54, 77	Power supplies to the SCSI bus I/O pins
V <sub>SS-C</sub>	50, 81	Power supplies to the internal logic core
V <sub>DD-C</sub>	46, 84	Power supplies to the internal logic core

\*These pins can accept a V<sub>DD</sub> source of 3.3 or 5 Vdc. All other V<sub>DD</sub> pins must be supplied 5 Vdc.

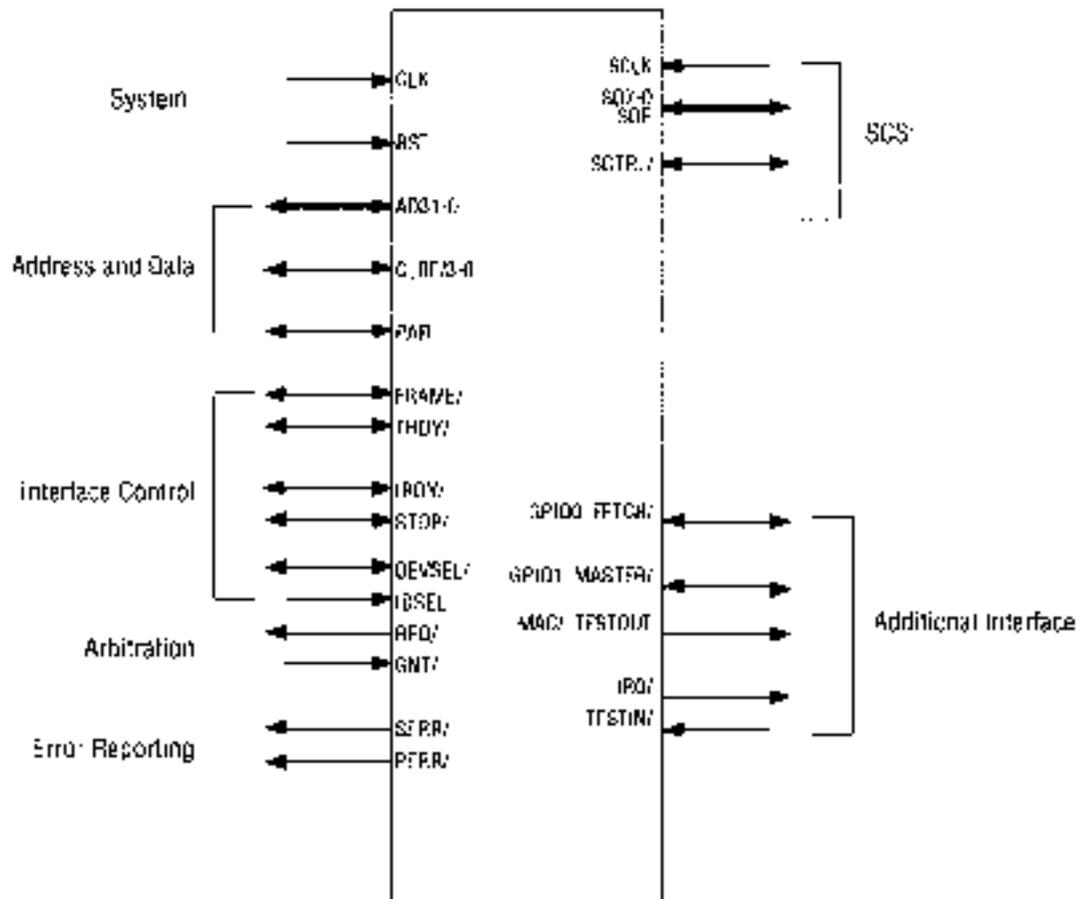


Figure 4-2: Functional Signal Grouping

Table 4-2: System Pins

Symbol	Pin No.	Type	Description
CLK	80	I	<i>Clock.</i> Clock provides timing for all transactions on the PCI bus and is an input to every PCI device. All other PCI signals are sampled on the rising edge of CLK, and other timing parameters are defined with respect to this edge. This clock can optionally be used as the SCSI core clock; however, the SYM53C860 will not achieve fast SCSI transfer rates.
RST $\overline{}$	79	I	<i>Reset.</i> Reset forces the PCI sequencer of each device to a known state. All <i>o/s</i> and <i>a/s</i> signals are forced to a high impedance state, and all internal logic is reset. The RST $\overline{}$ input is synchronized internally to the rising edge of CLK. The CLK input must be active while RST $\overline{}$ is active to properly reset the device.

Table 4-3: Address and Data Pins

Symbol	Pin No.	Type	Description
AD(31-0)	85, 86, 88, 89, 91, 92, 94, 95, 98, 100, 1, 2, 4, 6, 7, 8, 23, 24, 25, 27, 29, 30, 31, 33, 35, 36, 38, 39, 41, 42, 44, 45	T/S	<i>Address/Data.</i> Physical dword address and data are multiplexed on the same PCI pins. During the first clock of a transaction, AD(31-0) contain a physical byte address. During subsequent clocks, AD(31-0) contain data. A bus transaction consists of an address phase, followed by one or more data phases. PCI supports both read and write bursts. AD(7-0) define the least significant byte, and AD(31-24) define the most significant byte.
C_BE(3-0)	96, 10, 21, 24	T/S	<i>Command/Byte Enable.</i> 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. During the data phase, C_BE(3-0) are used as byte enables. The byte enables determine which byte lanes carry meaningful data. C_BE(0) applies to byte lane 0, and C_BE(3) to byte lane 3.
PAR	20	T/S	<i>Parity.</i> Parity is the even parity bit that protects the AD(31-0) and C_BE(3-0) lines. During address phase, both the address and command bits are covered. During data phase, both data and byte enables are covered.

Table 4-4: Interface Control Pins

Symbol	Pin No.	Type	Description
FRAME <sup>o</sup>	11	S/T/S	<i>Cycle Frame.</i> Cycle Frame is driven by the current master to indicate the beginning and duration of an access. FRAME <sup>o</sup> is asserted to indicate a bus transaction is beginning. While FRAME <sup>o</sup> is asserted, data transfers continue. When FRAME <sup>o</sup> is deasserted, the transaction is in the final data phase or the bus is idle.
TRDY <sup>o</sup>	14	S/T/S	<i>Target Ready.</i> Target Ready indicates the target agent's (selected device's) ability to complete the current data phase of the transaction. TRDY <sup>o</sup> is used with IRDY <sup>o</sup> . A data phase is completed on any clock when both TRDY <sup>o</sup> and IRDY <sup>o</sup> are sampled asserted. During a read, TRDY <sup>o</sup> indicates that valid data is present on AD(31-0). During a write, it indicates the target is prepared to accept data. Wait cycles are inserted until both IRDY <sup>o</sup> and TRDY <sup>o</sup> are asserted together.
IRDY <sup>o</sup>	12	S/T/S	<i>Initiator Ready.</i> Initiator Ready indicates the initiating agent's (bus master's) ability to complete the current data phase of the transaction. This signal is used with TRDY <sup>o</sup> . A data phase is completed on any clock when both IRDY <sup>o</sup> and TRDY <sup>o</sup> are sampled asserted. During a write, IRDY <sup>o</sup> indicates that valid data is present on AD(31-0). During a read, it indicates the master is prepared to accept data. Wait cycles are inserted until both IRDY <sup>o</sup> and TRDY <sup>o</sup> are asserted together.
STOP <sup>o</sup>	17	S/T/S	<i>Stop.</i> Stop indicates that the selected target is requesting the master to stop the current transaction.
DEVSEL <sup>o</sup>	15	S/T/S	<i>Device Select.</i> 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	97	I	<i>Initialization Device Select.</i> Initialization Device Select is used as a chip select in place of the upper 24 address lines during configuration read and write transactions.

Table 4-5: Arbitration Pins

Symbol	Pin No.	Type	Description
REQ <sup>o</sup>	83	O	<i>Request.</i> Request indicates to the arbiter that this agent desires to use the PCI bus. This is a point-to-point signal. Every master has its own REQ <sup>o</sup> .
GNT <sup>o</sup>	82	I	<i>Grant.</i> Grant indicates to the agent that access to the PCI bus has been granted. This is a point-to-point signal. Every master has its own GNT <sup>o</sup> .

Table 4-6: Error Reporting Pins

Symbol	Pin No.	Type	Description
PERR <sub>/</sub>	19	S/T/S	<i>Parity Error.</i> Parity Error may be pulsed active by an agent that detects a parity error. PERR <sub>/</sub> can be used by any agent to signal data corruptions. However, on detection of a PERR <sub>/</sub> pulse, the central resource may generate a non-maskable interrupt to the host CPU, which often implies the system will be unable to continue operation once error processing is complete.
SERR <sub>/</sub>	78	O	<i>System Error.</i> This open drain output pin is used to report address parity errors.

Table 4-7: SCSI Pins

Symbol	Pin No.	Type	Description
SCLK	51	1	<i>SCSI Clock.</i> SCLK is used to derive all SCSI-related timings. The speed of this clock is determined by the application's requirements; in some applications SCLK may be sourced internally from the PCI bus clock (CLK). If SCLK is internally sourced, then the SCLK pin should be tied low. To achieve Fast-20 transfer rates with the NCR 53C860, the input clock frequency must be doubled to 80MHz.
SD(7-0), SDP	55, 56, 57, 59, 60, 61, 62, 64, 65	I/O	<i>SCSI Data.</i> SCSI Data includes the following data lines and parity signals: SD(7-0) (8-bit SCSI data bus), and SDP (SCSI data parity bit).
SCTRL <sub>/</sub>	74, 72, 77, 73, 79, 81, 82, 78, 76	I/O	<i>SCSI Control.</i> SCSI Control includes the following signals: SC_D <sub>/</sub> SCSI phase line, command/data SI_O <sub>/</sub> SCSI phase line, input/output MSG <sub>/</sub> SCSI phase line, message SREQ <sub>/</sub> Data handshake signal from target device SACK <sub>/</sub> Data handshake signal from initiator device SBSY <sub>/</sub> SCSI bus arbitration signal, busy SATN <sub>/</sub> SCSI Attention, the initiator is requesting a message out phase SRST <sub>/</sub> SCSI bus reset SSEL <sub>/</sub> SCSI bus arbitration signal, select device

Table 4-8: Additional Interface Pins

Symbol	Pin No.	Type	Description
TESTIN <sup>0</sup>	52	I	<i>Test In</i> . When this pin is driven low, the SYM53C860 connects all inputs and outputs to an "AND tree." The SCSI control signals and data lines are not connected to the "AND tree." The output of the "AND tree" is connected to the Test Out pin. This allows manufacturers to verify chip connectivity and determine exactly which pins are not properly attached. When the TESTIN pin is driven low, internal pull-ups are enabled on all input, output, and bidirectional pins, all outputs and bidirectional signals will be tri-stated, and the MAC/ TESTOUT pin will be enabled. Connectivity can be tested by driving one of the SYM53C860 pins low. The MAC/ TESTOUT pin should respond by also driving low.
FETCH/ _GPI00	48	I/O	<i>Fetch/General Purpose I/O</i> . Optionally, when driven low, indicates that the next bus request will be for an op code fetch. This pin powers up as a general purpose input.
MASTER/ _GPI01	51	I/O	<i>Master/General Purpose I/O</i> . Optionally, when driven low, indicates that the SYM53C860 is bus master. This pin powers up as a general purpose input.
MAC_ TESTOUT	57	T/S	<i>Memory Access Control/Test Out</i> . This pin can be programmed to indicate local or system memory accesses (non PCI applications). It is also used to test the connectivity of the SYM53C860 signals using an "AND tree" scheme. The MAC/ TESTOUT pin is only driven as the Test Out function when the TESTIN <sup>0</sup> pin is driven low.
IRQ <sup>0</sup>	47	O	<i>Interrupt</i> . This signal, when asserted low, indicates that an interrupting condition has occurred and that service is required from the host CPU. The output drive of this pin is programmed as either open drain with an internal weak pull-up or, optionally, as a totem pole driver. Refer to the description of DCNTL Register, bit 3, for additional information.



## Chapter 5

# Operating Registers

This section contains descriptions of all SYM53C860 operating registers. Table 5-1 summarizes the SYM53C860 operating register set. Figure 5-1, the register map, lists registers by operating and configuration addresses. The terms “set” and “assert” are used to refer to bits that are programmed to a binary one. Similarly, the terms “deassert,” “clear” and “reset” are used to refer to bits that are programmed to a binary zero. Any bits marked as reserved should always be written to zero; mask all information read from them. Reserved bit functions may be changed at any time. Unless otherwise indicated, all bits in registers are active

high, that is, the feature is enabled by setting the bit. The bottom row of every register diagram shows the default register values, which are enabled after the chip is powered on or reset.

**Note:** the only register that the host CPU can access while the SYM53C860 is executing SCRIPTS is the ISTAT register; attempts to access other registers will 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.

**Table 5-1: Operating Register Addresses and Descriptions**

Memory or I/O Address	Config Memory or I/O	Read/Write	Label	Description
00	80	R/W	SCNTL0	SCSI Control 0
01	81	R/W	SCNTL1	SCSI Control 1
02	82	R/W	SCNTL2	SCSI Control 2
03	83	R/W	SCNTL3	SCSI Control 3
04	84	R/W	SCID	SCSI Chip ID
05	85	R/W	SXFER	SCSI Transfer
06	86	R/W	SDID	SCSI Destination ID
07	87	R/W	GPREG	General Purpose Bits
08	88	R/W	SFRR	SCSI First Byte Received
09	89	R/W	SOCL	SCSI Output Control Latch
0A	8A	R	SSID	SCSI Selector ID
0B	8B	R/W	SBCL	SCSI Bus Control Lines
0C	8C	R	DSTAT	DMA Status
0D	8D	R	SSTAT0	SCSI Status 0
0E	8E	R	SSTAT1	SCSI Status 1

Table 5-1: Operating Register Addresses and Descriptions (Continued)

Memory or I/O Address	Config Memory or I/O	Read/Write	Label	Description
0F	8F	R	SSTAT2	SCSI Status 2
10-13	90-93	R/W	DSA	Data Structure Address
14	94	R/W	ISTAT	Interrupt Status
15-17	95-97		Reserved	
18	98	R/W	CTEST0	Reserved
19	99	R/W	CTEST1	Chip Test 1
1A	9A	R	CTEST2	Chip Test 2
1B	9B	R	CTEST3	Chip Test 3
1C-1F	9C-9F	R/W	TEMP	Temporary Stack
20	A0	R/W	DMIFO	DMA FIFO
21	A1	R/W	CTEST4	Chip Test 4
22	A2	R/W	CTEST5	Chip Test 5
23	A3	R/W	CTEST6	Chip Test 6
24-26	A4-A6	R/W	DBC	DMA Byte Counter
27	A7	R/W	DCMD	DMA Command
28-2B	A8-AB	R/W	DNAD	DMA Next Address for Data
2C-2F	AC-AF	R/W	DSP	DMA SCRIPTS Pointer
30-33	B0-B3	R/W	DSPS	DMA SCRIPTS Pointer Save
34-37	B4-B7	R/W	SCRATCHA	General Purpose Scratch Pad A
38	B8	R/W	DMODE	DMA Mode
39	B9	R/W	DIEN	DMA Interrupt Enable
3A	BA	R/W	SBR	Scratch Byte Register
3B	BB	R/W	DCN1L	DMA Control
3C-3F	BC-BF	R	ADDER	Sum output of internal adder
40	C0	R/W	SIEN0	SCSI Interrupt Enable 0
41	C1	R/W	SIEN1	SCSI Interrupt Enable 1
42	C2	R	SIST0	SCSI Interrupt Status 0
43	C3	R	SIST1	SCSI Interrupt Status 1
44	C4	R/W	SLPAR	SCSI Longitudinal Parity
45	C5		Reserved	
46	C6	R/W	MACNTL	Memory Access Control
47	C7	R/W	GPCN1L	General Purpose Control
48	C8	R/W	STIME0	SCSI Timer 0
49	C9	R/W	STIME1	SCSI Timer 1

Table 5-1: Operating Register Addresses and Descriptions (Continued)

Memory or I/O Address	Config Memory or I/O	Read/Write	Label	Description
4A	CA	R/W	RESPID	Response ID
4B	CB		Reserved	
4C	CC	R	STEST0	SCSI Test 0
4D	CD	R	STEST1	SCSI Test 1
4E	CE	R/W	STEST2	SCSI Test 2
4F	CF	R/W	STEST3	SCSI Test 3
50	D0	R	SIDL	SCSI Input Data Latch
51-53	D1-D3		Reserved	
54	D4	R/W	SODL	SCSI Output Data Latch
55-57	D5-D7		Reserved	
58	D8	R	SBDL	SCSI Bus Data Lanes
59-5B	D9-DB		Reserved	
5C-5F	DC-DF	R/W	SCRATCHB	General Purpose Scratch Pad B

				Mem I/O	Config
SCNTL3	SCNTL2	SCNTL1	SCNTL0	00	80
GPREG	SDID	SXFER	SCID	04	84
SBCL	SSID	SOCL	SFBR	08	88
SSTAT2	SSTAT1	SSTAT0	DSTAT	0C	8C
DSA				10	90
RESERVED			ISTAT	14	94
CTEST3	CTEST2	CTEST1	RESERVED	18	98
TEMP				1C	9C
CTEST6	CTEST5	CTEST4	DFIFO	20	A0
DCMD	DBC			24	A4
DNAD				28	A8
DSP				2C	AC
DSPS				30	B0
SCRATCH A				34	B4
DCNTL	SBR	DJEN	DMODE	38	B8
ADDER				3C	BC
SIST1	SIST0	SIEN1	SIEN0	40	C0
GPCNTL	MACNTL	RESERVED	SLPAR	44	C4
RESERVED	RESPID	STIME1	STIME0	48	C8
STEST3	STEST2	STEST1	STEST0	4C	CC
RESERVED			SIDL	50	D0
RESERVED			SODL	54	D4
RESERVED			SBDL	58	D8
SCRATCH B				5C	DC

Figure 5-1: SYM53C860 Register Address Map

**Register 00 (80)****SCSI Control Zero (SCNTL0)**

Read/Write

ARB1	ARB0	START	WATV	ESC	PCS	AMP	TOG
7	6	5	4	3	2	1	0
Default(s)							
1	1	0	0	0	X	0	0

**Bit 7 ARB1 (Arbitration mode bit 1)****Bit 6 ARB0 (Arbitration mode bit 0)**

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

**Simple Arbitration**

1. The SYM53C860 waits for a bus free condition to occur.
2. It asserts **SBSY<sub>i</sub>** and its SCSI ID (contained in the SCID register) onto the SCSI bus. If the **SSEL<sub>i</sub>** signal is asserted by another SCSI device, the SYM53C860 will deassert **SBSY<sub>i</sub>**, deassert its ID and set the Lost Arbitration bit (bit 3) in the SSTAT0 register.
3. After an arbitration delay, the CPU should read the SBDL 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 SYM53C860 has won arbitration.
4. Once the SYM53C860 has won arbitration, **SSEL<sub>i</sub>** must be asserted via the SOCL for a bus clear plus a bus settle delay (1.2  $\mu$ s) before a low level selection can be performed.

**Full Arbitration, Selection/Reselection**

1. The SYM53C860 waits for a bus free condition.
2. It asserts **SBSY<sub>i</sub>** and its SCSI ID (stored in the SCID register) onto the SCSI bus.
3. If the **SSEL<sub>i</sub>** signal is asserted by another SCSI device or if the SYM53C860 detects a higher priority ID, the SYM53C860 will deassert **SBSY<sub>i</sub>**, deassert its ID, and wait until the next bus free state to try arbitration again.
4. The SYM53C860 repeats arbitration until it wins control of the SCSI bus. When it has won, the Won Arbitration bit is set in the SSTAT0 register, bit 2.
5. The SYM53C860 performs selection by asserting the following onto the SCSI bus: **SSEL<sub>i</sub>**, the target's ID (stored in the SDID register), and the SYM53C860's ID (stored in the SCID register).
6. After a selection is complete, the Function Complete bit is set in the SIST0 register, bit 6.
7. If a selection time-out occurs, the Selection Time-Out bit is set in the SIST1 register, bit 2.

**Bit 5 START (Start sequence)**

When this bit is set, the SYM53C860 will start 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. An arbitration sequence should not be started if the connected (CON) bit in the SCNTL1 register, bit 4, indicates that the SYM53C860 is already connected to the SCSI bus. This bit is automatically cleared when the arbitration sequence is complete. If a sequence is aborted, bit 4 in the SCNTL1 register should be checked to verify that the SYM53C860 did not connect to the SCSI bus.

**Bit 4 WAIN (Select with SATN<sup>l</sup> on a start sequence)**

When this bit is set and the SYM53C860 is in initiator mode, the SATN<sup>l</sup> signal will be asserted during SYM53C860 selection of a SCSI target device. This is to inform the target that the SYM53C860 has a message to send. If a selection time-out occurs while attempting to select a target device, SATN<sup>l</sup> will be deasserted at the same time SSEL<sup>l</sup> is deasserted. When this bit is clear, the SATN<sup>l</sup> signal will not be asserted during selection. When executing SCSI SCRIPTS, this bit is controlled by the SCRIPTS processor, but it may be set manually in low level mode.

**Bit 3 EPC (Enable parity checking)**

When this bit is set, the SCSI data bus is checked for odd parity when data is received from the SCSI bus in either initiator or target mode. If a parity error is detected, bit 0 of the SIST0 register is set and an interrupt may be generated.

If the SYM53C860 is operating in initiator mode and a parity error is detected, SATN<sup>l</sup> can optionally be asserted, but the transfer continues until the target changes phase. When this bit is cleared, parity errors are not reported.

**Bit 2 Reserved****Bit 1 AAP (Assert SATN<sup>l</sup> on parity error)**

When this bit is set, the SYM53C860 automatically asserts the SATN<sup>l</sup> signal upon detection of a parity error. SATN<sup>l</sup> is only asserted in initiator mode. The SATN<sup>l</sup> signal is asserted before deasserting SACK<sup>l</sup> during the byte transfer with the parity error. The Enable Parity Checking bit must also be set for the SYM53C860 to assert SATN<sup>l</sup> in this manner. A parity error is detected on data received from the SCSI bus.

If the Assert SATN<sup>l</sup> on Parity Error bit is cleared or the Enable Parity Checking bit is cleared, SATN<sup>l</sup> will not be automatically asserted on the SCSI bus when a parity error is received.

**Bit 0 TRG (Target role)**

This bit determines the default operating role of the SYM53C860. The user must manually set target or initiator role. This can be done using the SCRIPTS language (SET TARGET or CLEAR TARGET). When this bit is set, the chip is a target device by default. When this bit is cleared, the SYM53C860 is an initiator device by default.

**CAUTION:**

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

**Register 01 (81)**  
**SCSI Control One (SCNTL1)**  
 Read/Write

EXC	ADB	DHP	CON	RST	AFSP	IARR	SPT
7	6	5	4	3	2	1	0
Data Bus							
:	0	0	:	:	0	0	:

**Bit 7 EXC (Extra clock cycle of data setup)**

When this bit is set, an extra clock period of data setup is added to each SCSI data send transfer. The extra data setup time can provide additional system design margin, though it will affect the SCSI transfer rates. Clearing this bit disables the extra clock cycle of data setup time. Setting this bit only affects SCSI send operations.

**Bit 6 ADB (Assert SCSI data bus)**

When this bit is set, the SYM53C860 drives the contents of the SCSI Output Data Latch Register (SODL) onto the SCSI data bus. When the SYM53C860 is an initiator, the SCSI I/O signal must be inactive to assert the SODL contents onto the SCSI bus. When the SYM53C860 is a target, the SCSI I/O signal must be active for the SODL contents to be asserted onto the SCSI bus. The contents of the SODL register can be asserted at any time, even before the SYM53C860 is connected to the SCSI bus. This bit should be cleared when executing SCSI SCRIPTS. It is normally used only for diagnostics testing or operation at low level mode.

**Bit 5 DHP (Disable Halt on Parity Error or ATN) (Target Only)**

The DHP bit is only defined for target role. When this bit is cleared, the SYM53C860 halts the SCSI data transfer when a parity error is detected or when the SATN<sup>0</sup> signal is asserted. If SATN<sup>0</sup> or a parity error is received in the middle of a data transfer, the SYM53C860 may transfer up to three additional bytes before halting to synchronize between internal core

cells. During synchronous operation, the SYM53C860 transfers data until there are no outstanding synchronous offsets. If the SYM53C860 is receiving data, any data residing in the DMA FIFO is sent to memory before halting.

When this bit is set, the SYM53C860 does not halt the SCSI transfer when SATN<sup>0</sup> or a parity error is received.

**Bit 4 CON (Connected)**

This bit is automatically set any time the SYM53C860 is connected to the SCSI bus as an initiator or as a target. It is set after the SYM53C860 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 clear, the SYM53C860 is not connected to the SCSI bus.

The CPU can force a connected or disconnected condition by setting or clearing this bit. This feature would be used primarily during loopback mode.

**Bit 3 RST (Assert SCSI RST<sup>0</sup> signal)**

Setting this bit asserts the SRST<sup>0</sup> signal. The SRST<sup>0</sup> output remains asserted until this bit is cleared. The 25  $\mu$ s minimum assertion time defined in the SCSI specification must be timed out by the controlling microprocessor or a SCRIPTS loop.

**Bit 2 AFSP (Assert even SCSI parity (force bad parity))**

When this bit is set, the SYM53C860 asserts even parity. It forces a SCSI parity error on each byte sent to the SCSI bus from the SYM53C860. If parity checking is enabled, then the SYM53C860 checks data received for odd parity. This bit is used for diagnostic testing and should be clear for normal operation. It can be used to generate parity errors to test error handling functions.

**Bit 1 IARB (Immediate Arbitration)**

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 multi-threaded applications. The ARB1-0 bits in SCNTL0 should be set for full arbitration and selection before setting this bit.

Arbitration will be re-tried until won. At that point, the SYM53C860 will hold BSY and SEL asserted, and wait for a select or reselect sequence to be requested. The Immediate Arbitration bit will be reset automatically when the selection or reselection sequence is completed, or times out. Interrupts will not occur until after this bit is reset.

An unexpected disconnect condition will clear IARB without attempting arbitration. See the SCSI Disconnect Unexpected bit (SCNTL2, bit 7) for more information on expected versus unexpected disconnects.

An immediate arbitration sequence can be aborted. First, the Abort bit in the ISTAT register should be set. Then one of two things will eventually happen:

1. The Won Arbitration bit (SSTAT0 bit 2) will be set. In this case, the Immediate Arbitration bit needs to be reset. This will complete the abort sequence and disconnect the SYM53C860 from the SCSI bus. If it is not acceptable to go to Bus Free phase immediately following the arbitration phase, a low level selection may be performed instead.
2. The abort will complete because the SYM53C860 loses arbitration. This can be detected by the Immediate Arbitration bit being cleared. The Lost Arbitration bit (SSTAT0 bit 3) should not be used to detect this condition. No further action needs to be taken in this case.

**Bit 0 SST (Start SCSI Transfer)**

This bit is automatically set during SCRIPTS execution, and should not be used. It causes the SCSI core to begin a SCSI transfer, including SREQ/SACK handshaking. The determination of whether the transfer is a send or receive is made according to the value written to the I/O bit in SOCL. This bit is self-resetting. It should not be set for low level operation.

**CAUTION:**

Writing to this register while not connected may cause the loss of a selection/reselection by resetting the Connected bit.

**Register 02 (82)**  
**SCSI Control Two (SCNTL2)**  
 Read/Write

SCL	RFS						
7	6	5	4	3	2	1	0
Default:							
0	X	X	X	X	X	X	X

**Bit 7 SDU (SCSI Disconnect Unexpected)**

This bit is valid in 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 will be generated (see the Unexpected Disconnect bit in the 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 reset with a register write (*MOVE 0X7F to SCNTL2 TO 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.

**Bits 6-0 Reserved**

**Register 03 (83)**  
**SCSI Control Three (SCNTL3)**  
 Read/Write

F20	SCF7	SCF1	SCF0	RFS	CF7	CF1	CCF0
7	6	5	4	3	2	1	0
Default:							
X	0	0	0	X	0	0	0

**Bit 7 F20 (Fast-20 Enable)**

Setting this bit enables Fast-20 synchronous SCSI transfers in systems that have an 80MHz clock. The default value of this bit is 0. This bit should remain cleared in systems that have a 40MHz clock.

When this bit is set, the signal filtering period for SREQ/ and SACK/ automatically changes to 15 ns, regardless of the value of the Extend REQ/ACK Filtering bit in the STRBST2 register.

**Bits 6-4 SCF2-0 (Synchronous Clock Conversion Factor)**

These bits select a factor by which the frequency of SCLK is divided before being presented to the synchronous SCSI control logic. They should be written to the same value as the Clock Conversion Factor bits below unless fast SCSI operation is desired. See the SCSI Transfer (SXFER) register description for examples of how the SCF bits are used to calculate synchronous transfer periods. See the table under the description of bits 7-5 of the SXFER register for the valid combinations.

**Note:** to migrate from a Fast SCSI-2 system with a 40MHz clock, divide the clock by a factor of two or more to achieve the same synchronous transfer rate in a system with an 80MHz clock.

**Note:** for additional information on how the synchronous transfer rate is determined, refer to Chapter 2.

**Bit 3 Reserved**

**Bits 2-0 CCF2-0 (Clock Conversion Factor)**

These bits select a factor by which the frequency of SCLK is divided before being presented to the SCSI core. The bits are encoded as follows. All other combinations are reserved and should never be used. Also note that the synchronous portion of the SCSI core can be run at a different clock rate for fast SCSI, using the synchronous clock conversion factor bits. Table 5-2, "SCSI Clock Rates," on page 10 shows the values for the CCF and SCF bits, and the associated clock dividers to operate at various SCSI clock rates.

**Table 5-2: SCSI Clock Rates**

SCF2 CCF2	SCF1 CCF1	SCF0 CCF0	Factor Frequency	SCSI Clock (MHz)
0	0	0	SCLK/3	50.01-66.00
0	0	1	SCLK/1	16.67-25.00
0	1	0	SCLK/1.5	25.01-37.50
0	1	1	SCLK/2	37.51-50.00
1	0	0	SCLK/3	50.01-66.00
1	0	1	SCLK/4	75.01-80.00
1	1	0	Reserved	
1	1	1	Reserved	

**Note:** it is important that these bits be set to the proper values to guarantee that the SYM53C860 meets the SCSI timings as defined by the ANSI specification.

**Note:** for additional information on how the synchronous transfer rate is determined, refer to Chapter 2, "Functional Description."

**Note:** to migrate from a Fast SCSI-2 system with a 40MHz clock, divide the clock by a factor of two or more to achieve the same synchronous transfer rate in a system with an 80MHz clock.

**Register 04 (84)  
SCSI Chip ID (SCID)  
Read/Write**

RES 7	RRE 6	SRE 5	RES 4	RRE 3	END2 2	END1 1	END0 0
Default:							
X	0	0	X	X	0	0	0

**Bit 7 Reserved**

**Bit 6 RRE (Enable Response to Reselection)**

When this bit is set, the SYM53C860 is enabled to respond to bus-initiated reselection at the chip ID in the RESPID register. Note that the SYM53C860 will not automatically reconfigure itself to initiator mode as a result of being reselected.

**Bit 5 SRE (Enable Response to Selection)**

When this bit is set, the SYM53C860 is able to respond to bus-initiated selection at the chip ID in the RESPID register. Note that the SYM53C860 will not automatically reconfigure itself to target mode as a result of being selected.

**Bit 4-3 Reserved**

**Bits 2-0 Encoded SYM53C860 Chip SCSI ID, bits 2-0**

These bits are used to store the SYM53C860 encoded SCSI ID. This is the ID which the chip will assert when arbitrating for the SCSI bus. The IDs that the SYM53C860 will respond to when being selected or reselected are configured in the RESPID register. The priority of the 8 possible IDs, in descending order is:

Highest							Lowest
7	6	5	4	3	2	1	0

**Register 05 (85)**  
**SCSI Transfer (XFER)**  
 Read/Write

TP2	TP1	TP0	RES	MC1	MC2	MC1	MC0
7	6	5	4	3	2	1	0
Default: 000X0000							
0	0	0	X	0	0	0	0

**Note:** when using Table Indirect I/O commands, bits 7-0 of this register will be loaded from the I/O data structure.

**Note:** for additional information on how the synchronous transfer rate is determined, refer to Chapter 2, "Functional Description."

**Bits 7-5 TP2-0 (SCSI Synchronous Transfer Period)**

These bits determine the SCSI synchronous transfer period (XFERP) used by the SYM53C860 when sending synchronous SCSI data in either initiator or target mode. These bits control the programmable dividers in the chip.

**Note:** for Fast 20 SCSI transfers, the ideal transfer period is 4, and 5 is acceptable. Setting the transfer period to a value greater than 5 is not recommended.

TP2	TP1	TP0	XFERP
0	0	0	4
0	0	1	5
0	1	0	6
0	1	1	7
1	0	0	8
1	0	1	9
1	1	0	10
1	1	1	11

The synchronous transfer period the SYM53C860 should use when transferring SCSI data is found as in the following example:

The SYM53C860 is connected to a hard disk which can transfer data at 10 MB/s synchronously. The SYM53C860's SCLK is running at 40 MHz. The synchronous transfer period (XFERP) is found as follows:

$$XFERP = \text{Period} / \text{SSCP} + \text{ExtCC}$$

$$\text{Period} = 1 / \text{Frequency} = 1 / 10 \text{ MB/s} = 100 \text{ ns}$$

$$\text{SSCP} = 1 / \text{SSCF} = 1 / 40 \text{ MHz} = 25 \text{ ns}$$

(This SCSI synchronous core clock is determined in SCNTL3 bits 6-4.

**ExtCC = 1** if SCNTLi bit 7 is asserted and the SYM53C860 is sending data.

**ExtCC = 0** if the SYM53C860 is receiving data)

$$XFERP = 100 / 25 + 1$$

**Key:**

XFERP = Synchronous transfer period

SSCP = SCSI Synchronous core period

SSCF = SCSI Synchronous core frequency

ExtCC = External clock output of 240 MHz

**Table 5-3: Example Synchronous Transfer Periods for SCSI-1 Transfer Rates**

CLK (MHz)	SCSI CLK + SCNTL3 bits 6-4	XFERP	Synch. Transfer Period (ns)	Synch. Transfer Rate (MB/s)
80	+3	5	187.5	5.33
80	+4	4	200	5.0
80	+4	5	250	4.0
66.67	+3	4	180	5.55
66.67	+3	5	225	4.44
50	+2	4	160	6.25
50	+2	5	200	5
40	+2	4	200	5
37.50	+1.5	4	160	6.25
33.33	+1.5	4	180	5.55
25	+1	4	160	6.25
20	+1	4	200	5
16.67	+1	4	240	4.17

**Table 5-4: Example Transfer Periods for Fast SCSI-2 and Fast-20 Transfer Rates**

Data In and Data Out phases only, all other information transfers will occur asynchronously.

CLK (MHz)	SCSI CLK + SCNTL3 bits 6-4	XFERP	Synch. Transfer Period (ns)	Synch. Transfer Rate (MB/s)					Synchronous Offset
					M03	M02	M01	M00	
					0	0	0	0	0-Asynchronous
80	+1	4	50	20.0	0	0	0	1	1
80	+1	5	62.5	16.0	0	0	1	0	2
80	+2	4	100	10.0	0	0	1	1	3
66.67	+1.5	4	90	11.11	0	1	0	0	4
66.67	+1.5	5	112.5	8.88	0	1	0	1	5
50	+1	4	80	12.5	0	1	1	0	6
50	+1	5	100	10.0	0	1	1	1	7
40	+1	4	100	10.0	1	0	0	0	8
37.50	+1	4	106.67	9.375	1	X	X	1	Reserved
33.33	+1	4	120	8.33	1	X	1	X	Reserved
25	+1	4	160	6.25	1	1	X	X	Reserved
20	+1	4	200	5					
16.67	+1	4	240	4.17					

**Bit 4 Reserved**

**Bits 3-0 M03-M00 (Max SCSI synchronous offset)**

These bits describe the maximum SCSI synchronous offset used by the SYM53C860 when transferring synchronous SCSI data in either initiator or target mode. The following table describes the possible combinations and their relationship to the synchronous data offset used by the SYM53C860. These bits determine the SYM53C860's method of transfer for

**Register 06 (86)****SCSI Destination ID (SDID)**

Read/Write

RFS	RES	FFS	RFS	FFS	ENC0	ENC1	ENC2
7	6	5	4	3	2	1	0
Default:							
X	X	X	X	X	0	0	0

**Bits 7-3 Reserved****Bits 2-0 Encoded destination SCSI ID**

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 should be the binary-encoded ID value. The priority of the 8 possible IDs, in descending order, is:

Higher	7	6	5	4	3	2	1	0	Lower

**Register 07 (87)****General Purpose (GPREG)**

Read/Write

RFS	RES	FFS	FFS	RFS	FFS	GPIO1	GPIO0
7	6	5	4	3	2	1	0
Default:							
X	X	X	X	X	X	1	0

**Bits 7-2 Reserved****Bits 1-0 GPIO1-GPIO0 (General Purpose)**

These bits can be programmed through the GPCNTL Register to become inputs, outputs, or special functions. As an output, these pins can be used to enable or disable external terminators. These signals can also be programmed as live inputs and sensed through a SCRIPTS Register to Register Move Instruction. GPIO(1-0) default as inputs. When configured as inputs, an internal pull-up is enabled.

**Register 08 (88)****SCSI First Byte Received (SFBR)**

Read/Write

187	185	183	184	185	182	181	180
7	6	5	4	3	2	1	0

Default →

0 0 0 0 0 0 0 0

This register contains the first byte received in any asynchronous information transfer phase. For example, when the SYM53C860 is operating in initiator role, this register contains the first byte received in Message In, Status Phase, Reserved In and Data In.

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 SFBR as the destination. This allows bit testing after an operation.

The SFBR is not writable via the CPU, and therefore not by a Memory Move. However, it can be loaded via SCRIPTS Read/Write operations. To load the SFBR with a byte stored in system memory, the byte must first be moved to an intermediate SYM53C860 register (such as the SCRATCH register), and then to the SFBR.

This register will also contain the state of the lower eight bits of the SCSI data bus during the selection phase if the COM bit in the DCNTL register is clear.

**Register 09 (89)****SCSI Output Control Latch (SOCL)**

Read/Write

180	180	185	181	183	185	183	180
7	6	5	4	3	2	1	0

Default →

0 0 0 0 0 0 0 0

**Bit 7 REQ(Assert SCSI REQ/ signal)****Bit 6 ACK(Assert SCSI ACK/ signal)****Bit 5 BSY(Assert SCSI BSY/ signal)****Bit 4 SEL(Assert SCSI SEL/ signal)****Bit 3 ATN(Assert SCSI ATN/ signal)****Bit 2 MSG(Assert SCSI MSG/ signal)****Bit 1 C/D(Assert SCSI C, D/ signal)****Bit 0 I/O(Assert SCSI I, O/ signal)**

This register is used primarily for diagnostic testing or programmed I/O operation. It is controlled by the SCRIPTS processor when executing SCSI SCRIPTS. SOCL should only be used when transferring data via programmed I/O. Some bits are set (1) or reset (0) when executing SCSI SCRIPTS. Do not write to the register once the SYM53C860 starts executing normal SCSI SCRIPTS.

**Register 0A (09)**  
**SCSI Selector ID (SSID)**  
 Read Only

VAL	RFS	RFS	RFS	RFS	FMID	FMID	FMID
7	6	5	4	3	2	1	0
Default							
0	X	X	X	X	0	0	0

**Bit 7 VAL (SCSI Valid Bit)**

If VAL is asserted, the two SCSI IDs were 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 was present and the contents of the encoded destination ID are meaningless.

**Bits 6-3 Reserved**

**Bits 2-0 Encoded Destination SCSI ID**

Reading the SSID register immediately after the SYM53C860 has been 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 can be detected by examining the VAL bit above.

**Register 0B (8B)**  
**SCSI Bus Control Lines (SBCL)**  
 Read Only

REQ	ACK	BSY	SPI	ATN	MSG	C/D	I/O
7	6	5	4	3	2	1	0
Default							
X	X	X	X	X	0	X	X

**Bit 7 REQ (SREQ/ status)**

**Bit 6 ACK (SACK/ status)**

**Bit 5 BSY (SBSY/ status)**

**Bit 4 SEL (SSEL/ status)**

**Bit 3 ATN (SATN/ status)**

**Bit 2 MSG (SMSG/ status)**

**Bit 1 C/D (SC\_ID/ status)**

**Bit 0 I/O (SI\_O/ status)**

When read, this register returns the SCSI control line status. A bit will be 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 can be used for diagnostics testing or operation in low level mode.

**Register 0C (8C)**  
**DMA Status (DSTAT)**  
 Read Only

DFE	MDPE	BF	ABRT	SSI	SIR	RFS	IID
7	6	5	4	3	2	1	0
Data bus							
1	0	0	0	0	0	X	0

Reading this register will clear any bits that are set at the time the register is read, but will not necessarily clear the register because additional interrupts may be pending (the SYM53C860 stacks interrupts). The DIP bit in the ISTAT register will also be cleared. DMA interrupt conditions may be individually masked through the DIEN register.

When performing consecutive 8-bit reads of the DSTAT, S1ST0 and S1ST1 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.

**Bit 7 DFE (DMA FIFO empty)**

This status bit is set when the DMA FIFO is empty. It may be used 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 will not cause an interrupt.

**Bit 6 MDPE (Master Data Parity Error)**

This bit is set when the SYM53C860 as a master detects a data parity error, or 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 CTBST4).

**Bit 5 BF (Bus fault)**

This bit is set when a PCI bus fault condition is detected. A PCI bus fault can only occur when the SYM53C860 is bus master. A PCI bus fault occurs when a cycle ends with a Bad Address or Target Abort Condition.

**Bit 4 ABRT (Aborted)**

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 ISTAT register.

**Bit 3 SSI (Single step interrupt)**

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

**Bit 2 SIR (SCRIPTS interrupt instruction received)**

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

**Bit 1 Reserved**

**Bit 0 IID (Illegal instruction detected)**

This status bit is set any time an illegal instruction is detected, whether the SYM53C860 is operating in single-step mode or automatically executing SCSI SCRIPTS. This bit will also be set if one of the following conditions occurs:

1. If the SYM53C860 is executing a Wait Disconnect instruction and the SCSI REQ line is asserted without a disconnect occurring.
2. If a Move, Chained Move, or Memory Move command with a byte count of zero is fetched.
3. If a Load/Store memory address maps back into chip register space.

**Register 0D (8D)**  
**SCSI Status Zero (SSTAT0)**  
 Read Only

ILF	LPF	OLF	AIP	LOA	WOA	RST	SDP <sup>0</sup>
7	6	5	4	3	2	1	0
Data Bits							
:	0	0	:	:	0	0	0

**Bit 7 ILF (SIDL full)**

This bit is set when the SCSI Input Data Latch register (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 SIDL register contains SCSI data received asynchronously. Synchronous data received does not flow through this register.

**Bit 6 ORF (SODR full)**

This bit is set when the SCSI Output Data Register (SODR, a hidden buffer register which is not accessible) contains data. The SODR register is used by the SCSI logic as a second storage register when sending data synchronously. It cannot be read or written by the user. This bit can be used to determine how many bytes reside in the chip when an error occurs.

**Bit 5 OLF (SODL full)**

This bit is set when SCSI Output Data Latch (SODL) contains data. The SODL register is the interface between the DMA logic and the SCSI bus. In synchronous mode, data is transferred from the host bus to the SODL register, and then to the SCSI Output Data Register (SODR, a hidden buffer register which is not accessible) before being sent to the SCSI bus. In asynchronous mode, data is transferred from the host bus to the SODL register, and then to the SCSI bus. The SODR buffer register is not used for asynchronous transfers. This bit can be used to determine how many bytes reside in the chip when an error occurs.

**Bit 4 AIP (Arbitration in progress)**

Arbitration in Progress (AIP = 1) indicates that the SYM53C860 has detected a Bus Free condition, asserted BSY, and asserted its SCSI ID onto the SCSI bus.

**Bit 3 LOA (Lost arbitration)**

When set, LOA indicates that the SYM53C860 has detected a bus free condition, arbitrated for the SCSI bus, and lost arbitration due to another SCSI device asserting the SEL<sup>0</sup> signal.

**Bit 2 WOA (Won arbitration)**

When set, WOA indicates that the SYM53C860 has detected a Bus Free condition, arbitrated for the SCSI bus and won arbitration. The arbitration mode selected in the SCNTL0 register must be full arbitration and selection for this bit to be set.

**Bit 1 RST<sup>0</sup> (SCSI RST<sup>0</sup> signal)**

This bit reports the current status of the SCSI RST<sup>0</sup> signal, and the SRST bit (bit 6) in the ISTAT register.

**Bit 0 SDP<sup>0</sup> (SCSI SDP<sup>0</sup> parity signal)**

This bit represents the active high current status of the SCSI SDP<sup>0</sup> parity signal.

**Register 0E (8E)**  
**SCSI Status One (SSTAT1)**  
 Read Only

FF3	FF2	FF1	FF0	SDPL	MSG	C/D	I/O
7	6	5	4	3	2	1	0
Default							
0	0	0	0	X	X	X	X

**Bits 7-4 FF3-FF0 (FIFO flags)**

FF3	FF2	FF1	FF0	Bytes in the SCSI FIFO
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

These four bits define the number of bytes that currently reside in the SYM53C860's SCSI synchronous data FIFO. These bits are not latched and they will change as data moves through the FIFO. Because the FIFO can only hold nine bytes, values over nine will not occur.

**Bit 3 SDPL (Latched SCSI parity)**

This bit reflects the SCSI parity signal (SDP), corresponding to the data latched in the SCSI Input Data Latch register (SIDL). It changes when a new byte is latched into the SIDL register. This bit is active high, in other words, it is set when the parity signal is active.

**Bit 2 MSG (SCSI MSG/ signal)**

**Bit 1 C/D (SCSI C\_D/ signal)**

**Bit 0 I/O (SCSI I\_O/ signal)**

These SCSI phase status bits are latched on the asserting edge of SREQ/ when operating in either initiator or target mode. These bits are set when the corresponding signal is active. They are useful when operating in low level mode.

**Register 0F (8F)**  
**SCSI Status Two (SS'IA12)**  
 (Read Only)

RES	RES	RES	RES	RES	RES	LDSC	RES
7	6	5	4	3	2	1	0
Default >>							
X	X	X	X	X	X		X

**Bits 7-2 Reserved**

**Bit 1 LDSC (Last Disconnect)**

This bit is used in conjunction with the Connected (CON) bit in SCNTL1. It allows the user to detect the case in which a target device disconnects, and then some SCSI device selects or reselects the SYM53C860. If the Connected bit is asserted and the LDSC bit is asserted, a disconnect has occurred. This bit is set when the Connected bit in SCNTL1 is clear. This bit is cleared when a Block Move instruction executes while the Connected bit in SCNTL1 is on.

**Bit 0 Reserved**

**Registers 10-13 (90-93)**  
**Data Structure Address (DSA)**  
 Read/Write

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 Move operation, the contents of this register are preserved. The power-up value of this register is indeterminate.

**Register 14 (94)**  
**Interrupt Status (ISTAT)**  
 (Read/Write)

ABRT	SRST	SIGP	SEM	DDA	INTP	DIP	DIP
7	6	5	4	3	2	1	0
Default: 00000000							
0	0	0	0	0	0	0	0

This is the only register that can be accessed by the host CPU while the SYM53C860 is executing SCRIPTS (without interfering in the operation of the SYM53C860). It may be used to poll for interrupts if hardware interrupts are disabled. There may be stacked interrupts pending; read this register after servicing an interrupt to check for stacked interrupts. For more information on interrupt handling refer to Chapter 2, "Functional Description."

**Bit 7 ABRT (Abort operation)**

Setting this bit aborts the current operation being executed by the SYM53C860. If this bit is set and an interrupt is received, reset this bit before reading the 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 ISTAT register.
4. If the SCSI Interrupt Pending bit is set, then read the SIST0 or SIST1 register to determine the cause of the SCSI Interrupt and go back to Step 2.
5. If the SCSI Interrupt Pending bit is clear, and the DMA Interrupt Pending bit is set, then write 00h value to this register.
6. Read the DSTAT register to verify the aborted interrupt and to see if any other interrupting conditions have occurred.

**Bit 6 SRST (Software reset)**

Setting this bit resets the SYM53C860. All operating registers are cleared to their default values and all SCSI signals are deasserted. Setting this bit does not cause the SCSI RST/ signal to be asserted. This reset will 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 will also clear this bit).

**Bit 5 SIGP (Signal process)**

SIGP is a R/W bit that can be written at any time, and polled and reset via CTEST2. The SIGP bit can be 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 this bit causes that 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 may be used at any time and is not restricted to the wait for selection/ reselection condition.

**Bit 4 SEM (Semaphore)**

This bit can be set by the SCRIPTS processor using a SCRIPTS register write instruction. The bit may also be set by an external processor while the SYM53C860 is executing a SCRIPTS operation. This bit enables the SYM53C860 to notify an external processor of a predefined condition while SCRIPTS are running. The external processor may also notify the SYM53C860 of a predefined condition and the SCRIPTS processor may take action while SCRIPTS are executing.

**Bit 3 CON (Connected)**

This bit is automatically set any time the SYM53C860 is connected to the SCSI bus as an initiator or as a target. It will be set after successfully completing selection or when the SYM53C860 has responded to a bus-initiated selection or reselection. It will also be set after the SYM53C860 wins arbitration when operating in low level mode. When this bit is clear, the SYM53C860 is not connected to the SCSI bus.

**Bit 2 INTF (Interrupt on the Fly)**

This bit is asserted by an INTFLY instruction during SCRIPTS execution. SCRIPTS programs will 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 ISTAT register is read it will not automatically be cleared. To clear this bit, it must be written to a one. 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 interrupt must be cleared before servicing any other interrupts indicated by SIP or DIP.

**Note:** this bit must be written to one in order to clear it after it has been set.

**Bit 1 SIP (SCSI Interrupt pending)**

This status bit is set when an interrupt condition is detected in the SCSI portion of the SYM53C860. The following conditions will cause a SCSI interrupt.

- A phase mismatch occurs (initiator mode) or SATN/ becomes active (target mode)
- An arbitration sequence completes
- A selection or reselection time-out occurs
- The SYM53C860 was selected
- The SYM53C860 was reselected
- A SCSI gross error occurs
- An unexpected disconnect occurs
- A SCSI reset occurs
- A parity error is detected
- The handshake-to-handshake timer is expired
- The general purpose timer is expired

To determine exactly which condition(s) caused the interrupt, read the SIST0 and SIST1 registers.

**Bit 0 DIP (DMA Interrupt pending)**

This status bit is set when an interrupt condition is detected in the DMA portion of the SYM53C860. The following conditions will cause a DMA interrupt.

- A PCI parity error is detected
- A bus fault is detected
- An abort condition is detected
- A SCRIPTS instruction is executed in 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 ISTAT register.

**Register 18 (98)****Chip Test Zero (CTEST0)****Read/Write**

This was a general purpose read/write register in previous SYM53C8XX family chips. Although it is still a read/write register, Symbios reserves the right to use these bits for future 53C8XX family enhancements.

**Register 19 (99)****Chip Test One (CTEST1)****Read Only**

FMT3	FMT2	FMT1	FMT0	FFL3	FFL2	FFL1	FFL0
7	6	5	4	3	2	1	0
Default							
1	1	1	1	0	0	0	0

**Bits 7-4 FMT3-0 (Byte empty in DMA FIFO)**

These bits identify the bottom 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 FMT3 will be set. Since the FMT flags indicate the status of bytes at the bottom of the FIFO, if all FMT bits are set, the DMA FIFO is empty.

**Bits 3-0 FFL3-0 (Byte full in DMA FIFO)**

These status bits identify the top 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 FFL3 will be set. Since the FFL flags indicate the status of bytes at the top of the FIFO, if all FFL bits are set, the DMA FIFO is full.

**Register 1A (9A)**  
**Chip Test Two (CTEST2)**  
**Read Only**

DIR	SIGP	CIO	CM	RES	TEOP	DREQ	DACK
7	6	5	4	3	2	1	0
Default							
0	0	X	X	0	0	0	1

**Bit 7 DDIR (Data transfer direction)**

This status bit indicates which direction data is being transferred. When this bit is set, the data will be transferred from the SCSI bus to the host bus. When this bit is clear, the data will be transferred from the host bus to the SCSI bus.

**Bit 6 SIGP (Signal process)**

This bit is a copy of the SIGP bit in the ISTAT register (bit 5). The SIGP bit is used to signal a running SCRIPTS instruction. When this register is read, the SIGP bit in the ISTAT register is cleared.

**Bit 5 CIO (Configured as I/O)**

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.

Note: both bits 4 and 5 may be set if the chip is dual-mapped.

**Bit 4 CM (Configured as memory)**

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: both bits 4 and 5 may be set if the chip is dual-mapped.

**Bit 3 Reserved**

**Bit 2 TEOP (SCSI true end of process)**

This bit indicates the status of the SYM53C860's internal TEOP signal. The TEOP signal acknowledges the completion of a transfer through the SCSI portion of the SYM53C860. When this bit is set, TEOP is active. When this bit is clear, TEOP is inactive.

**Bit 1 DREQ (Data request status)**

This bit indicates the status of the SYM53C860's internal Data Request signal (DREQ). When this bit is set, DREQ is active. When this bit is clear, DREQ is inactive.

**Bit 0 DACK (Data acknowledge status)**

This bit indicates the status of the SYM53C860's internal Data Acknowledge signal (DACK). When this bit is set, DACK/ is inactive. When this bit is clear, DACK/ is active.

**Register 1B (9B)****Chip Test Three (CTEST3)**

Read/Write

V3	V2	V1	V0	FLF	CLF	FM	WRIE
7	6	5	4	3	2	1	0
00000000							
x	x	x	x	0	0	0	0

**Bits 7-4 V3-V0 (Chip revision level)**

These bits identify the chip revision level for software purposes.

**Bit 3 FLF (Flush DMA FIFO)**

When this bit is set, data residing in the DMA FIFO is transferred to memory, starting at the address in the DNAD register. The internal DMAWR signal, controlled by the CTEST5 register, determines the direction of the transfer. This bit is not self-clearing; once the SYM53C860 has successfully transferred the data, this bit should be reset.

Note: polling of FIFO flags is allowed during flush operations.

**Bit 2 CLF (Clear DMA FIFO)**

When this bit is set, all data pointers for the DMA FIFO are cleared. Any data in the FIFO is lost. This bit automatically resets after the SYM53C860 has successfully cleared the appropriate FIFO pointers and registers.

Note: this bit does not clear the data visible at the bottom of the FIFO.

**Bit 1 FM (Fetch pin mode)**

When set, this bit causes the FETCH/ pin to deassert during indirect and table indirect read operations. FETCH/ will only be active during the op code portion of an instruction fetch. This allows SCRIPTS to be stored in a PROM while data tables are stored in RAM.

If this bit is not set, FETCH/ will be asserted for all bus cycles during instruction fetches.

**Bit 0 WRIE (Write and Invalidate Enable)**

This bit, when set, causes Memory Write and Invalidate commands to be issued on the PCI bus after certain conditions have been met. These conditions are described in more detail in Chapter 3.

**Registers 1C-1F (9C-9F)****Temporary (TEMP)****Read/Write**

This 32-bit register stores the **Remain** instruction address pointer from the **Call** instruction. The address pointer stored in this register is loaded into the **DSP** register when a **Return** instruction is executed. This address points to the next instruction to be executed. Do not write to this register while the **SYM53C860** is executing **SCRIPTS**.

During any **Memory-to-Memory Move** operation, the contents of this register are preserved. The power-up value of this register is indeterminate.

**Register 20 (A0)****DMA FIFO (DFIFO)****Read/Write**

0E0	006	005	004	003	002	001	000
7	6	5	4	3	2	1	0
Bits [7:0]							
x	0	0	0	0	0	0	0

**Bit 7**      **Reserved**

**Bits 6-0 BO6-BO0 (Byte offset counter)**

These bits indicate the amount of data transferred between the **SCSI** core and the **DMA** core. It may be used to determine the number of bytes in the **DMA FIFO** when an interrupt occurs. These bits are unstable while data is being transferred between the two cores, once the chip has stopped transferring data, these bits are stable.

Since the **DFIFO** register counts the number of bytes transferred between the **DMA** core and the **SCSI** core, and the **DBC** register counts the number of bytes transferred across the host bus, the difference between these two counters represents the number of bytes remaining in the **DMA FIFO**.

The following steps will determine how many bytes are left in the **DMA FIFO** when an error occurs, regardless of the direction of the transfer:

1. Subtract the seven least significant bits of the **DBC** register from the 7-bit value of the **DFIFO** register.
2. **AND** the result with **7Fh** for a byte count between zero and 64.

**Note:** to calculate the total number of bytes in both the **DMA FIFO** and **SCSI** logic, see the section on **Data Paths** in Chapter Two, "Functional Description."

**Register 21 (A1)****Chip Test Four (CTEST4)**

Read/Write

BDIS	ZMOD	ZSD	SPTM	MPEE	FBL2	FBL1	FBL0
7	6	5	4	3	2	1	0

00000000

0 0 0 0 0 0 0 0

**Bit 7 BDIS (Burst Disable)**

When set, this bit will cause the SYM53C860 to perform back to back cycles for all transfers. When reset, the SYM53C860 performs back to back transfers for op code fetches and burst transfers for data moves. The handling of op code fetches is dependent on the setting of the Burst Op Code Fetch bit in the DMODE register.

**Bit 6 ZMOD (High impedance mode)**

Setting this bit causes the SYM53C860 to place all output and bidirectional pins into a high-impedance state. In order to read data out of the SYM53C860, this bit must be cleared. This bit is intended for board-level testing only. Do not set this bit during normal system operation.

**Bit 5 ZSD (SCSI Data High Impedance)**

Setting this bit causes the SYM53C860 to place the SCSI data bus SD(7-0) and the parity line (SDP) in a high-impedance state. In order to transfer data on the SCSI bus, this bit must be cleared.

**Bit 4 SPTM (Shadow Register Test Mode)**

Setting this bit allows access to the shadow registers used by Memory-to-Memory Move operations. When this bit is set, register accesses to the TEMP and DSA registers are directed to the shadow copies STEMP (Shadow TEMP) and SDSA (Shadow DSA). The registers are shadowed to prevent them from being overwritten during a Memory-to-Memory Move operation. The DSA and TEMP registers contain the base address used

for table indirect calculations, and the address pointer for a call or return instruction, respectively. This bit is intended for manufacturing diagnostics only and should not be set during normal operations.

**Bit 3 MPEE (Master Parity Error Enable)**

Setting this bit enables parity checking during master data phases. A parity error during a bus master read is detected by the SYM53C860. A parity error during a bus master write is detected by the target, and the SYM53C860 is informed of the error by the PERR/ pin being asserted by the target. When this bit is reset, the SYM53C860 will not interrupt if a master parity error occurs. This bit is reset at power up.

**Bits 2-0 FBL2-FBL0 (FIFO byte control)**

FBL2	FBL1	FBL0	DMA FIFO Byte lane	Pins
0	X	X	Disabled	n/a
1	0	0	0	D(7-0)
1	0	1	1	D(15-8)
1	1	0	2	D(23-16)
1	1	1	3	D(31-24)

These bits steer the contents of the CTEST6 register to the appropriate byte lane of the 32-bit DMA FIFO. If the FBL2 bit is set, then FBL1 and FBL0 determine which of four byte lanes can be read or written. When cleared, the byte lane read or written is determined by the current contents of the DNAD and DBC registers. Each of the four bytes that make up the 32-bit DMA FIFO can be accessed by writing these bits to the proper value. For normal operation, FBL2 must equal zero.

**Register 22 (A2)**  
**Chip Test Five (CTEST5)**  
 Read/Write

ADCK	BBCK	RES	MASR	DDIR	RFS	RES	RFE
7	6	5	4	3	2	1	0
Default/0x							
0	0	X	0	0	X	X	X

**Bit 7 ADCK (Clock address incrementor)**

Setting this bit increments the address pointer contained in the DNAD register. The DNAD register is incremented based on the DNAD contents and the current DBC value. This bit automatically clears itself after incrementing the DNAD register.

**Bit 6 BBCK (Clock byte counter)**

Setting this bit decrements the byte count contained in the 24-bit DBC register. It is decremented based on the DBC contents and the current DNAD value. This bit automatically clears itself after decrementing the DBC register.

**Bit 5 Reserved**

**Bit 4 MASR (Master control for set or reset pulses)**

This bit controls the operation of bit 3. When this bit is set, bit 3 asserts the corresponding signals. When this bit is reset, bit 3 deasserts the corresponding signals. This bit and bit 3 should not be changed in the same write cycle.

**Bit 3 DDIR (DMA direction)**

Setting this bit either asserts or deasserts the internal DMA Write (DMAWR) direction signal depending on the current status of the MASR bit in this register. Asserting the DMAWR signal indicates that data will be transferred from the SCSI bus to the host bus. Deasserting the DMAWR signal transfers data from the host bus to the SCSI bus.

**Bits 2-0 Reserved**

**Register 23 (A3)**  
**Chip Test Six (CTEST6)**  
 Read/Write

DF7	DF6	DF5	DF4	DF3	DF2	DF1	DF0
7	6	5	4	3	2	1	0
Default/0x							
0	0	0	0	0	0	0	0

**Bits 7-0 DF7-DF0 (DMA FIFO)**

Writing to this register writes data to the appropriate byte lane of the DMA FIFO as determined by the FBL bits in the 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 operation. This register should only be written when testing the DMA FIFO using the CTEST4 register. Writes to this register while the test mode is not enabled will have unexpected results.

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**Registers 24-26 (A4-A6)**  
**DMA Byte Counter (DBC)**  
Read/Write

This 24-bit register determines the number of bytes to be 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 SYM53C860. The DBC counter is decremented each time that data is transferred on the PCI bus. It is decremented by an amount equal to the number of bytes that were transferred.

The maximum number of bytes that can be transferred in any one Block Move command is 16,777,215 bytes. The maximum value that can be loaded into the DBC register is FFFFFFFh. If the instruction is a Block Move and a value of 000000h is loaded into the DBC register, an illegal instruction interrupt will occur if the SYM53C860 is not in target role, Command phase.

The 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 Six, "Instruction Set of the I/O Processor." The power-up value of this register is indeterminate.

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**Register 27 (A7)**  
**DMA Command (DCMD)**  
Read/Write

This 8-bit register determines the instruction for the SYM53C860 to execute. This register has a different format for each instruction. For a complete description, see Chapter Six, "Instruction Set of the I/O Processor."

**Registers 28-2B (A8-AB)****DMA Next Address (DNAD)****Read/Write**

This 32-bit register contains the general purpose address pointer. At the start of some SCRIPTS operations, its value is copied from the DSPS register. Its value may not be valid except in certain abort conditions. The default value of this register is zero.

**Registers 2C-2F (AC-AF)****DMA SCRIPTS Pointer (DSP)****Read/Write**

The CPU writes the address of the first SCRIPTS instruction to this register to begin SCSI SCRIPTS operation. In normal SCRIPTS operation, once the starting address of the first SCRIPTS instruction is written to this register, SCRIPTS instructions are automatically fetched and executed until an interrupt condition occurs.

In single-step mode, there is a single step interrupt after each instruction is executed. The DSP register does not need to be written with the next address, but the Start DMA bit (bit 2, DCNTL register) must be set each time the step interrupt occurs to fetch and execute the next SCRIPTS command. When writing this register eight bits at a time, writing the upper eight bits begins execution of the SCSI SCRIPTS. The default value of this register is zero.

**Registers 30-33 (B0-B3)****DMA SCRIPTS Pointer Save (DSPS)****Read/Write**

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 34-37 (B4-B7)****Scratch Register A (SCRATCH A)****Read/Write**

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 will alter its contents. The power-up value of this register is indeterminate.

**Register 38 (R8)**  
**DMA Mode (DMODE)**  
 Read/Write

BL1	BL0	SIOM	DIOM	ERMP	BOF	MAPI
7	6	5	4	3	2	1
Default						
0	0	0	0	0	0	0

**Bit 7-6 BL1-BL0 (Burst length)**

BL1	BL0	Burst Length
0	0	2-transfer burst
0	1	4-transfer burst
1	0	8-transfer burst
1	1	16-transfer burst

These bits control the maximum number of transfers performed per bus ownership, regardless of whether the transfers are back-to-back, burst, or a combination of both. The SYM53C860 asserts the Bus Request (REQ<sub>0</sub>) output when the DMA FIFO can accommodate a transfer of at least one burst size of data. Bus Request (REQ<sub>0</sub>) is also asserted during start-of-transfer and end-of-transfer cleanup and alignment, even though less than a full burst of transfers may be performed. The SYM53C860 inserts a "fairness delay" of four CLKs between burst-length transfers (as set in BL1-0) 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.

**Bit 5 SIOM (Source I/O-Memory Enable)**

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; and if reset, then the source address is in memory space.

This function is useful for register-to-memory operations using the Memory Move instruction when the SYM53C860 is I/O mapped.

Bits 4 and 5 of the CTEST2 register can be used to determine the configuration status of the SYM53C860.

**Bit 4 DIOM (Destination I/O-Memory Enable)**

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; and if reset, then the destination address is in memory space.

This function is useful for memory-to-register operations using the Memory Move instruction when the SYM53C860 is I/O mapped. Bits 4 and 5 of the CTEST2 register can be used to determine the configuration status of the SYM53C860.

**Bit 3 ERL (Enable Read Line)**

This bit enables a PCI Read Line command. If PCI cache mode is enabled by setting bits in the PCI Cache Line Size register, the chip issues a Read Line command on all read cycles if other conditions are met. For more information on these conditions, refer to Chapter 3.

**Bit 2 ERMP (Enable Read Multiple)**

This bit, when set, will cause Read Multiple commands to be issued on the PCI bus after certain conditions have been met. These conditions are described in Chapter 3.

**Bit 1 BOF (Burst Op Code Fetch Enable)**

Setting this bit causes the SYM53C860 to fetch instructions in burst mode, if the Burst Disable bit (CTEST4, bit7) is cleared. Specifically, the chip will burst in the first two dwords of all instructions using a single bus ownership. If the instruction is a memory-to-memory move type, the third dword will be accessed in a subsequent bus ownership. If the instruction is an indirect type, the additional dword will be accessed in a subsequent bus ownership. If the instruction is a table indirect block move type, the chip will access the remaining two dwords in a subsequent bus ownership, thereby fetching the four dwords required in two bursts of two dwords each.

**Bit 0 MAN (Manual Start Mode)**

Setting this bit prevents the SYM53C860 from automatically fetching and executing SCSI SCRIPTS when the DSP register is written. When this bit is set, the Start DMA bit in the DCNTL register must be set to begin SCRIPTS execution. Clearing this bit causes the SYM53C860 to automatically begin fetching and executing SCSI SCRIPTS when the DSP register is written. This bit is not normally used for SCSI SCRIPTS operations.

**Register 39 (B9)****DMA Interrupt Enable (DIEN)**

Read/Write

7	6	5	4	3	2	1	0
MDPE	BF	ABRT	SSI	SIR	RES	RES	IID
Default							
1	0	0	0	0	0	0	0

This register contains the interrupt mask bits corresponding to the interrupting conditions described in the DSTAT register. An interrupt is masked by clearing the appropriate mask bit. Masking an interrupt prevents IRQ<sub>i</sub> from being asserted for the corresponding interrupt, but the status bit will still be set in the DSTAT register. Masking an interrupt will not prevent the ISTAT DIP from being set. All DMA interrupts are considered fatal, therefore SCRIPTS will stop running when a DMA interrupt occurs, whether or not the interrupt is masked. Setting a mask bit enables the assertion of IRQ<sub>i</sub> for the corresponding interrupt. (A masked non-fatal interrupt will not prevent un-masked or fatal interrupts from getting through; interrupt stacking begins when either the ISTAT SIP or DIP bit is set.)

The SYM53C860 IRQ<sub>i</sub> output is latched; once asserted, it will remain asserted until the interrupt is cleared by reading the appropriate status register. Masking an interrupt after the IRQ<sub>i</sub> output is asserted will not cause IRQ<sub>i</sub> to be deasserted.

For more information on interrupts, see Chapter Two, "Functional Description."

**Bit 7** Reserved

**Bit 6** MDPE (Master Data Parity Error)

**Bit 5** BF (Bus fault)

**Bit 4** ABRT (Aborted)

**Bit 3** SSI (Single step interrupt)

**Bit 2** SIR (SCRIPTS interrupt instruction received)

**Bit 1** Reserved

**Bit 0** IID (Illegal instruction detected)

**Register 3A (BA)**  
**Scratch Byte Register (SBR)**  
 Read/Write

This is a general purpose register. Apart from CPU access, only Register Read/Write and Memory Moves into this register will alter its contents. The default value of this register is zero. This register was called the DMA Watchdog Timer on previous SYM53C8XX family products.

**Register 3B (HR)**  
**DMA Control (DCNTL)**  
 Read/Write

CLSE	PF	PFEN	SSM	IRQM	SLE	RWD	COM
7	5	5	4	3	2	1	0
Default							
0	0	0	0	0	0	0	0

**Bit 7 CLSE (Cache Line Size Enable)**

Setting this bit enables the SYM53C860 to sense and react to cache line boundaries set up by the DMODE or PCI Cache Line Size register, whichever contains the smaller value.

Clearing this bit disables the cache line size logic and the SYM53C860 monitors the cache line size via the DMODE register.

**Bit 6 PFF (Pre-Fetch Flush)**

Setting this bit will cause the pre-fetch unit to flush its contents. The bit will reset after the flush is complete.

**Bit 5 PFEN (Pre-fetch Enable)**

Setting this bit enables the pre-fetch unit if the burst size is equal to or greater than four. For more information on SCRIPTS instruction prefetching, see Chapter 2.

**Bit 4 SSM (Single-step mode)**

Setting this bit causes the SYM53C860 to stop after executing each SCRIPTS instruction, and generate a single step interrupt. When this bit is clear the SYM53C860 will not stop after each instruction; instead it continues fetching and executing instructions until an interrupt condition occurs. This bit should be clear for normal SCSI SCRIPTS operation. To restart the SYM53C860 after it generates a SCRIPTS Step interrupt, read the ISTAT and DSTAT registers to recognize and clear the interrupt; then set the START DMA bit in this register.

**Bit 3 IRQM (IRQ Mode)**

When set, this bit enables a totem pole driver for the IRQ pin. When reset, this bit enables an open drain driver for the IRQ pin with an internal weak pull-up. This bit is reset at power up.

**Bit 2 STD (Start DMA operation)**

The SYM53C860 fetches a SCSI SCRIPTS instruction from the address contained in the DSP register when this bit is set. This bit is required if the SYM53C860 is in one of the following modes:

1. Manual start mode – Bit 0 in the DMODE register is set
2. Single-step mode – Bit 4 in the DCTRL register is set

When the SYM53C860 is executing SCRIPTS in manual start mode, the Start DMA bit needs to be set to start instruction fetches. This bit will remain set until an interrupt occurs. When the SYM53C860 is in single-step mode, the Start DMA bit needs to be set to restart execution of SCRIPTS after a single-step interrupt.

**Bit 1 IRQD (IRQ Disable)**

Setting this bit tristates the IRQ pin; clearing the bit enables normal operation. When bit 1 in this register is set, the IRQ $\bar{}$  pin will not be asserted when an interrupt condition occurs. The interrupt is not lost or ignored, but merely masked at the pin. Clearing this bit when an interrupt is pending will immediately cause the IRQ $\bar{}$  pin to assert. As with any register other than ISTAT, this register cannot be accessed except by a SCRIPTS instruction during SCRIPTS execution.

**Bit 0 COM (53C700 compatibility)**

When this bit is clear, the SYM53C860 will behave in a manner compatible with the SYM53C700; selection/reselection IDs will be stored in both the SSID and SFBR registers.

When this bit is set, the ID will be stored only in the SSID register, protecting the SFBR from being overwritten if a selection/reselection occurs during a DMA register-to-register operation.

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**Register 3C-3F (BC-BF)  
Adder Sum Output (ADDER)  
Read Only**

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 40 (C0) SCSI Interrupt Enable Zero (SIEN0) Read/Write

MR	CMP	EPI	RE	SGE	INC	RST	PAR
7	6	5	4	3	2	1	0
Default:							
1	0	0	0	0	0	0	0

This register contains the interrupt mask bits that correspond to the interrupting conditions described in the SIST0 register. An interrupt is masked by clearing the appropriate mask bit. For more information on interrupts, see Chapter 2.

#### Bit 7 M/A (SCSI Phase Mismatch - Initiator Mode; SCSI ATN Condition - Target Mode)

In initiator mode, this bit controls whether an interrupt occurs when the SCSI phase asserted by the target and sampled during SREQ<sub>i</sub> does not match the expected phase in the SOCL register. This expected phase is automatically written by the SCSI SCRIPTS program. In target mode, this bit is set when the initiator has asserted SA1N<sub>i</sub>. See the Disable Halt on Parity Error or SATN<sub>i</sub> Condition bit in the SCNTL1 register for more information on when this status is actually raised.

#### Bit 6 CMP (Function Complete)

This bit controls whether an interrupt occurs when full arbitration and selection sequence has completed.

#### Bit 5 SEL (Selected)

This bit controls whether an interrupt occurs when the SYM53C860 has been selected by a SCSI target device. The Enable Response to Selection bit in the SCID register must be set for this to occur.

#### Bit 4 RSL (Reselected)

This bit controls whether an interrupt occurs when the SYM53C860 has been reselected by a SCSI initiator device. The Enable Response to Reselection bit in the SCID register must be set for this to occur.

#### Bit 3 SGE (SCSI Gross Error)

This bit controls whether an interrupt occurs when the SYM53C860 detects a SCSI Gross Error. The following conditions are considered SCSI Gross Errors:

1. Data underflow - the SCSI FIFO was read when no data was present.
2. Data overflow - the SCSI FIFO was written to while full.
3. Offset underflow - in target mode, a SACK<sub>i</sub> pulse was received before the corresponding SREQ<sub>i</sub> was sent.
4. Offset overflow - in initiator mode, an SREQ<sub>i</sub> pulse was received which caused the maximum offset (Defined by the MO3 6 bits in the SXFER register) to be exceeded.
5. In initiator mode, a phase change occurred with an outstanding SREQ<sub>i</sub>/SACK<sub>i</sub> offset
6. Residual data in SCSI FIFO - a transfer other than synchronous data receive was started with data left in the SCSI synchronous receive FIFO.

#### Bit 2 UDC (Unexpected Disconnect)

This bit controls whether an interrupt occurs in the case of an unexpected disconnect. This condition only occurs in initiator mode. It happens when the target to which the SYM53C860 is connected disconnects from the SCSI bus unexpectedly. See the SCSI Disconnect Unexpected bit in the SCNTL2 register for more information on expected versus unexpected disconnects. Any disconnect in low level mode causes this condition.

**Bit 1 RST (SCSI Reset Condition)**

This bit controls whether an interrupt occurs when the SRST $\overline{V}$  signal has been asserted by the SYM53C860 or any other SCSI device. Note that this condition is edge-triggered, so that multiple interrupts cannot occur because of a single SRST $\overline{V}$  pulse.

**Bit 0 PAR (SCSI Parity Error)**

This bit controls whether an interrupt occurs when the SYM53C860 detects a parity error while receiving or sending SCSI data. See the Disable Halt on Parity Error or SAIN $\overline{V}$  Condition bits in the SCNTL1 register for more information on when this condition will actually be raised.

**Register 41 (C1)****SCSI Interrupt Enable One (SIEN1)**

Read/Write

RES	RES	RES	RES	RES	STC	SEV	HTH
7	6	5	4	3	2	1	0
(00b;10>>)							
X	X	X	X	X	0	0	0

This register contains the interrupt mask bits corresponding to the interrupting conditions described in the SIST1 register. An interrupt is masked by clearing the appropriate mask bit. For more information on interrupts, refer to Chapter 2, "Functional Description."

**Bits 7-3 Reserved****Bit 2 STO (Selection or Reselection Timeout)**

This bit controls whether an interrupt occurs when the SCSI device which the SYM53C860 was attempting to select or reselect did not respond within the programmed time-out period. See the description of the STIME0 register bits 3-0 for more information on the time-out timer.

**Bit 1 GEN (General Purpose Timer Expired)**

This bit controls whether an interrupt occurs when the general purpose timer has expired. The time measured is the time between enabling and disabling of the timer. See the description of the STIME1 register, bits 3-0, for more information on the general purpose timer.

**Bit 0 HTH (Handshake to Handshake timer Expired)**

This bit controls whether an interrupt occurs when the handshake-to-handshake timer has expired. The time measured is the SCSI Request to Request (target) or Acknowledge to Acknowledge (initiator) period. See the description of the STIME0 register, bits 7-4, for more information on the handshake-to-handshake timer.

**Register 42 (C2)****SCSI Interrupt Status Zero (SIST0)**

Read Only

M/A	CMP	SEL	RSL	SGE	UOC	RST	RWF
7	6	5	4	3	2	1	0
Default: >>							
0	0	0	0	0	0	0	0

Reading the SIST0 register returns the status of the various interrupt conditions, whether or not they are enabled in the SIEN0 register. Each bit set indicates that the corresponding condition has occurred. Reading the SIST0 will clear the interrupt status.

Reading this register will clear any bits that are set at the time the register is read, but will not necessarily clear the register because additional interrupts may be pending (the SYM53C860 stacks interrupts). SCSI interrupt conditions may be individually masked through the SIEN0 register.

When performing consecutive 8-bit reads of the DSTAT, SIST0, and SIST1 registers (in any order), insert a delay equivalent to 12 CLK periods between the reads to ensure the interrupts clear properly. Also, if reading the registers when both the ISTAT SIP and DIP bits may not be set, the SIST0 and SIST1 registers should be read before the DSTAT register to avoid missing a SCSI interrupt. For more information on interrupts, refer to Chapter 2, "Functional Description."

**Bit 7 M/A (Initiator Mode: Phase Mismatch; Target Mode: SATN/ Active)**

In 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 target mode, this bit is set when the SATN/ signal is asserted by the initiator.

**Bit 6 CMP (Function Complete)**

This bit is set when an arbitration only or full arbitration sequence has completed.

**Bit 5 SEL (Selected)**

This bit is set when the SYM53C860 is selected by another SCSI device. The Enable Response to Selection bit must have been set in the SCID register (and the RESPID register must hold the chip's ID) for the SYM53C860 to respond to selection attempts.

**Bit 4 RSL (Reselected)**

This bit is set when the SYM53C860 is reselected by another SCSI device. The Enable Response to Reselection bit must have been set in the SCID register (and the RESPID register must hold the chip's ID) for the SYM53C860 to respond to reselection attempts.

**Bit 3 SGE (SCSI Gross Error)**

This bit is set when the SYM53C860 encounters a SCSI Gross Error Condition. The following conditions can result in a SCSI Gross Error Condition:

1. Data Underflow - the SCSI FIFO register was read when no data was present.
2. Data Overflow - too many bytes were written to the SCSI FIFO or the synchronous offset caused the SCSI FIFO to be overwritten.
3. Offset Underflow - the SYM53C860 is operating in target mode and a SACK/ pulse is received when the outstanding offset is zero.
4. Offset Overflow - the other SCSI device sent a SREQ/ or SACK/ pulse with data which exceeded the maximum synchronous offset defined by the SXFBR register.
5. A phase change occurred with an outstanding synchronous offset when the SYM53C860 was operating as an initiator.
6. Residual data in the Synchronous data FIFO - a transfer other than synchronous data receive was started with data left in the synchronous data FIFO.

**Bit 2 UDC (Unexpected Disconnect)**

This bit is set when the SYM53C860 is operating in initiator mode and the target device unexpectedly disconnects from the SCSI bus. This bit is only valid when the SYM53C860 operates in the initiator mode. When the SYM53C860 operates in low level mode, any disconnect will cause an interrupt, even a valid SCSI disconnect. This bit will also be set if a selection time-out occurs (it may occur before, at the same time, or stacked after the STO interrupt, since this is not considered an expected disconnect).

**Bit 1 RST (SCSI RST/ Received)**

This bit is set when the SYM53C860 detects an active SRST<sup>†</sup> signal, whether the reset was generated external to the chip or caused by the Assert SRST<sup>†</sup> bit in the SCNTL1 register. This SYM53C860 SCSI reset detection logic is edge-sensitive, so that multiple interrupts will not be generated for a single assertion of the SRST<sup>†</sup> signal.

**Bit 0 PAR (Parity Error)**

This bit is set when the SYM53C860 detects a parity error while receiving SCSI data. The Enable Parity Checking bit (bit 3 in the SCNTL0 register) must be set for this bit to become active. The SYM53C860 always generates parity when sending SCSI data.

**Register 43 (C3)****SCSI Interrupt Status One (SIST1)**

Read Only

RES	RES	RES	RES	RES	STO	GEN	HTH
7	6	5	4	3	2	-	0
(Data >>>)							
X	X	X	X	X	0	C	0

Reading the SIST1 register returns the status of the various interrupt conditions, whether or not they are enabled in the SIEN1 register. Each bit that is set indicates the corresponding condition has occurred.

Reading the SIST1 register will clear the interrupt condition.

**Bits 7-3 Reserved****Bit 2 STO (Selection or Reselection Time-out)**

This bit is set when the SCSI device which the SYM53C860 was attempting to select or reselect did not respond within the programmed time-out period. See the description of the STIME0 register, bits 3-0, for more information on the time-out timer.

**Bit 1 GEN (General Purpose Timer Expired)**

This bit is set when the general purpose timer has expired. The time measured is the time between enabling and disabling of the timer. See the description of the STIME1 register, bits 3-0, for more information on the general purpose timer.

**Bit 0 HTH (Handshake-to-Handshake Timer Expired)**

This bit is set when the handshake-to-handshake timer has expired. The time measured is the SCSI Request to Request (target) or Acknowledge to Acknowledge (initiator) period. See the description of the STIME0 register, bits 7-4, for more information on the handshake-to-handshake timer.

**Register 44 (C4)****SCSI Longitudinal Parity (SLPAR)  
Read/Write**

This register performs a bitwise longitudinal parity check on all SCSI data received or sent through the SCSI core. If one of the bytes received or sent (usually the last) is the set of correct even parity bits, SLPAR should go to zero (assuming it started at zero). As an example, suppose that the following three data bytes and one check byte are received from the SCSI bus (all signals are shown active high):

Data Bytes	Running SLPAR
-----	00000000
1. 11001100	11001100 (XOR of word 1)
2. 01010101	10011001 (XOR of word 1 and 2)
3. 00001111	10010110 (XOR of word 1, 2 and 3) Even Parity >>>10010110
4. 10010110	00000000
-----	-----

A one in any bit position of the final SLPAR value would indicate a transmission error.

The SLPAR register can also be used to generate the check bytes for SCSI send operations. If the SLPAR register contains all zeros prior to sending a block move, it will contain the appropriate check byte at the end of the block move. This byte must then be sent across the SCSI bus.

Note: writing any value to this register resets it to zero.

The longitudinal parity checks are meant to provide an added measure of SCSI data integrity and are entirely optional. This register does not latch SCSI selection/reselection IDs under any circumstances. The default value of this register is zero.

**Register 46 (C6)****Memory Access Control (MACNTL)  
Read/Write**

TYP3	TYP2	TYP1	TYP0	DWR	DRD	PSCPT	SCPTS
7	6	5	4	3	2	1	0
Default							
0	1	0	1	0	1	0	0

**Bits 7-4 TYP3-0 (Chip Type)**

These bits identify the chip type for software purposes. This data manual applies to devices that have these bits set to 05h.

Bits 3 through 0 of this register are used to determine if an external bus master access is to local or far memory. When bits 3 through 0 are set, the corresponding access is considered local and the MAC/TESTOUT pin is driven high. When these bits are clear, the corresponding access is to far memory and the MAC/TESTOUT pin is driven low. This function is enabled after a Transfer Control SCRIPTS instruction is executed.

**Bit 3 DWR (DataWR)**

This bit is used to define if a data write is considered local memory access.

**Bit 2 DRD (DataRD)**

This bit is used to define if a data read is considered local memory access.

**Bit 1 PSCPT (Pointer SCRIPTS)**

This bit is used to define if a pointer to a SCRIPTS indirect or table indirect fetch is considered local memory access.

**Bit 0 SCPTS (SCRIPTS)**

This bit is used to define if a SCRIPTS fetch is considered local memory access.

**Register 47 (C7)****General Purpose Pin Control (GPCNTL)**

Read/Write

MF	FE	RES	HES	PES	RES	GPIO1	GPIO0
7	6	5	4	3	2	1	0
Default							
0	0	0	0	1	1	1	1

This register is used to determine if the pins controlled by the General Purpose register (GPREG) are inputs or outputs. Bits 1-0 in GPCNTL correspond to bits 1-0 in the GPREG register. When the bits are enabled as inputs, an internal pull-up is also enabled.

**Bit 7 Master Enable**

The internal bus master signal will be presented on GPIO1 if this bit is set, regardless of the state of Bit 1 (GPIO1\_EN).

**Bit 6 Fetch Enable**

The internal op code fetch signal will be presented on GPIO0 if this bit is set, regardless of the state of Bit 0 (GPIO0\_EN).

**Bit 5 Reserved****Bits 1-0 GPIO1\_EN - GPIO0\_EN (GPIO Enable)**

These bits power up set, causing the GPIO1 and GPIO0 pins to become inputs. Resetting these bits causes GPIO1-0 to become outputs.

**Register 48 (C8)****SCSI Timer Zero (STIME0)**

Read/Write

HTH	HTH	HTH	HTH	SEL	SEL	SEL	SEL
7	6	5	4	3	2	1	0
Default							
0	0	0	0	0	0	0	0

**Bits 7-4 HTH (Handshake-to-Handshake Timer Period)**

These bits select the handshake-to-handshake time-out period, the maximum time between SCSI handshakes (SREQ<sup>+</sup> to SREQ<sup>+</sup> in target mode, or SACK<sup>+</sup> to SACK<sup>+</sup> in initiator mode). When this timing is exceeded, an interrupt is generated and the HTH bit in the 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 (STIME1 bits 3-0). For a more detailed explanation of interrupts, refer to Chapter 2, "Functional Description."

HTH 7-4, SEL 3-0, GEN 3-0	Minimum Time-out	
	40 MHz	50 MHz
0000	Disabled	Disabled
0001	125 $\mu$ s	100 $\mu$ s
0010	250 $\mu$ s	200 $\mu$ s
0011	500 $\mu$ s	400 $\mu$ s
0100	1 ms	800 $\mu$ s
0101	2 ms	1.6 ms
0110	4 ms	3.2 ms
0111	8 ms	6.4 ms
1000	16 ms	12.8 ms
1001	32 ms	25.6 ms
1010	64 ms	51.2 ms
1011	128 ms	102.4 ms
1100	256 ms	204.8 ms
1101	512 ms	409.6 ms
1110	1.024 sec	819.2 ms
1111	2.048 sec	1.6384 sec

*These values will be correct if the CUF bits in the SUNCTL register are set according to the valid combinations in the bit description.*

#### Bits 3-0 SEL (Selection Time-Out)

These bits select the SCSI selection/reselection time-out period. When this timing (plus the 200  $\mu$ s selection abort time) is exceeded, the STO bit in the SIST1 register is set. For a more detailed explanation of interrupts, refer to Chapter 2, "Functional Description."

#### Register 49 (C9) SCSI Timer One (STIME1) Read/Write

RES	RES	RES	RES	GEN3	GEN2	GEN1	GEN0
7	6	5	4	3	2	1	0
Default:							
X	X	X	X	0	0	0	0

#### Bits 7-4 Reserved

#### Bits 3-0 GEN3-0 (General Purpose Timer Period)

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 SIST1 register is set. Refer to the table under STIME0, bits 3-0, for the available time-out periods.

**Note:** to reset a timer before it has expired and to 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. See Chapter 2, "Functional Description," for an explanation of how interrupts are generated when the timers expire.

---

**Register 4A (CA)**  
**Response ID (RESPID)**  
 Read/Write

This register contains the IDs that the chip responds to on the SCSI bus. Each bit represents one possible ID with the most significant bit representing ID 7 and the least significant bit representing ID 0. The 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 RESPID register. However, the chip can arbitrate with only one ID value in the SCID register.

---

**Register 4C (CC)**  
**SCSI Test Zero (STEST0)**  
 Read Only

DLB	SSAID	SEAIT	SSAID	SLT	ART	SIZ	SOM
7	6	5	4	3	2	1	0
Default=							
X	X	X	X	0	X	1	1

**Bit 7 Reserved**

**Bits 6-4 SSAID (SCSI Selected As ID)**

These bits contain the encoded value of the SCSI ID that the SYM53C860 was selected or reselected as during a SCSI selection or reselection phase. These bits are read only and contain the encoded value of 0-7 possible IDs that could be used to select the SYM53C860. During a SCSI selection or reselection phase when a valid ID has been put on the bus, and the 53C860 responds to that ID, the "selected as" ID is written into these bits.

**Bit 3 SLT (Selection response logic test)**

This bit is set when the SYM53C860 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.

**Bit 2 ART (Arbitration Priority Encoder Test)**

This bit will always be set when the SYM53C860 exhibits the highest priority ID asserted on the SCSI bus during arbitration. It is primarily used for chip level testing, but it may be used during low level mode operation to determine if the SYM53C860 has won arbitration.

**Bit 1 SOZ (SCSI Synchronous Offset Zero)**

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, the SYM53C860, as an initiator, is waiting for the target to request data transfers. If the SYM53C860 is a target, then the initiator has sent the offset number of acknowledges.

**Bit 0 SOM (SCSI Synchronous Offset Maximum)**

This bit indicates that the current synchronous SREQ/SACK offset is the maximum specified by bits 3-0 in the SCSI Transfer register. 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, the SYM53C860, as a target, is waiting for the initiator to acknowledge the data transfers. If the SYM53C860 is an initiator, then the target has sent the offset number of requests.

**Register 4D (CD)****SCSI Test One (STEST1)**

Read/Write

FC	SISO	RFS	RFS	RFS	RFS	RFS	RFS
7	6	5	4	3	2	1	0
Default							
0	0	X	X	X	X	X	X

**Bit 7 SCLK**

This bit, when set, disables the external SCLK (SCSI Clock) pin, and causes the chip to use the PCI clock as the internal SCSI clock. If a transfer rate of 10 MB/s is to be achieved on the SCSI bus, this bit must be cleared and the chip must be connected to at least a 40 MHz external SCLK. To achieve Fast-20 synchronous SCSI transfer rates, this bit must be cleared and the chip must be connected to an 80MHz external SCLK.

**Bit 6 SISO (SCSI Isolation Mode)**

This bit allows the SYM53C860 to put the SCSI bi-directional and input pins into a low power mode when the SCSI bus is not in use. When this bit is set, the SCSI bus inputs are logically isolated from the SCSI bus.

**Bits 5-0 Reserved**

**Register 4E (CE)**  
**SCSI Test Two (STEST2)**  
 Read/Write

ROF	SDF	RFS	S.R	SZM	RFS	EXT	LOW
7	6	5	4	3	2	1	0
Default:							
0	0	0	0	0	0	0	0

**Bit 7 SCE (SCSI Control Enable)**

This bit, when set, allows all SCSI control and data lines to be asserted through the SODL and SODL registers regardless of whether the SYM53C860 is configured as a target or initiator.

**Note:** this bit should not be set during normal operation, since it could cause contention on the SCSI bus. It is included for diagnostic purposes only.

**Bit 6 ROF (Reset SCSI Offset)**

Setting this bit clears any outstanding synchronous SREQ/SACK offset. This bit should be set if a SCSI gross error condition occurs, to clear the offset when a synchronous transfer does not complete successfully. The bit automatically clears itself after resetting the synchronous offset.

**Bit 5 Reserved**

**Bit 4 SLB (SCSI Loopback Mode)**

Setting this bit allows the SYM53C860 to perform SCSI loopback diagnostics. That is, it enables the SCSI core to simultaneously perform as both initiator and target.

**Bit 3 SZM (SCSI High-Impedance Mode)**

Setting this bit places all the open drain 48 mA SCSI drivers into a high-impedance state. This is to allow internal loopback mode operation without affecting the SCSI bus.

**Bit 2 Reserved**

**Bit 1 EXT( Extend SREQ/SACK filtering)**

Symbios TolerANT SCSI receiver technology includes a special digital filter on the SREQ/ and SACK/ pins which will cause glitches on deasserting edges to be disregarded. Setting this bit will increase the filtering period from 30ns to 60ns on the deasserting edge of the SREQ/ and SACK/ signals.

**Note:** this bit must never be set during fast SCSI (greater than 5M transfers per second) operations, because a valid assertion could be treated as a glitch.

**Note:** this bit does not affect the filtering period when the Fast 20 Enable bit in the SCNTL3 register is set. When the SYM53C860 is executing Fast-20 SCSI transfers, the filtering period is automatically set at 15 ns.

**Bit 0 LOW (SCSI Low level Mode)**

Setting this bit places the SYM53C860 in 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 SCNTL0 register. SCSI bus transfers are performed by manually asserting and polling SCSI signals. Clearing this bit allows instructions to be executed in SCSI SCRIPTS mode.

**Note:** it is not necessary to set this bit for access to the SCSI bit-level registers (SODL, SBCL, and input registers).

**Register 4F (CF)****SCSI Test Three (STEST3)**

Read/Write

FE	SIH	HSC	ESI	R-S	TIM	CSF	STW
7	6	5	4	3	2	1	0
Data Bits							
0	1	1	0	x	0	1	0

**Bit 7 TH (TolerANT Enable)**

Setting this bit enables the active negation portion of 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 SYM53C860 is driving these signals. Active deassertion of these signals will occur only when the SYM53C860 is in an information transfer phase. TolerANT active negation should be enabled to improve setup and deassertion times at fast SCSI timings. Active negation is disabled after reset or when this bit is cleared. For more information on TolerANT technology, refer to Chapter 1.

Note: this bit must be set if the Enable Fast 20 bit in SCNTL3 is set.

**Bit 6 STR (SCSI FIFO Test Read)**

Setting this bit places the SCSI core into a test mode in which the SCSI FIFO can be easily read. Reading the SODL register will cause the FIFO to unload.

**Bit 5 HSC (Halt SCSI Clock)**

Asserting this bit causes the internal divided SCSI clock to come to a stop in a glitchless manner. This bit may be used for test purposes or to lower  $I_{DD}$  during a power down mode.

**Bit 4 DSI (Disable Single Initiator Response)**

If this bit is set, the SYM53C860 will ignore all bus-initiated selection attempts that employ the single-initiator option from SCSI-1. In order to select the SYM53C860 while this bit is set, the SYM53C860's SCSI ID and the initiator's SCSI ID must both be asserted. This bit should be asserted in SCSI-2 systems so that a single bit error on the SCSI bus will not be interpreted as a single initiator response.

**Bit 3 Reserved****Bit 2 TTM (Timer Test Mode)**

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 and, if the respective bits in the SIEN1 register are set, causes the SYM53C860 to generate interrupts at time-out. This bit is intended for internal manufacturing diagnosis and should not be used.

**Bit 1 CSF (Clear SCSI FIFO)**

Setting this bit will cause the "full flags" for the SCSI FIFO to be cleared. This empties the FIFO. This bit is self-resetting. In addition, the SCSI FIFO pointers, the SIDL, SODL, and SODR Full bits in the SSTAT0 register are cleared.

**Bit 0 STW (SCSI FIFO Test Write)**

Setting this bit places the SCSI core into a test mode in which the FIFO can easily be written. While this bit is set, writes to the SODL register will cause the entire word contained in this register to be loaded into the FIFO. Writing the least significant byte of the SODL register will cause the FIFO to load.

---

**Register 50 (D0)****SCSI Input Data Latch (SIDL)****Read Only**

This register is used primarily for diagnostic testing, programmed I/O operation or error recovery. Data received from the SCSI bus can be read from this register. Data can be written to the SODL register and then read back into the SYM53C860 by reading this register to allow loopback testing. When receiving SCSI data, the data will flow into this register and out to the host FIFO. This register differs from the SBDL register; SIDL contains latched data and the SBDL always contains exactly what is currently on the SCSI data bus. Reading this register causes the SCSI parity bit to be checked, and will cause a parity error interrupt if the data is not valid. The power-up values are indeterminate.

---

**Registers 54 (D4)****SCSI Output Data Latch (SODL)****Read/Write**

This register is used primarily for diagnostic testing or programmed I/O operation. Data written to this register is asserted onto the SCSI data bus by setting the Assert Data Bus bit in the SCNTL1 register. This register is used to send data via programmed I/O. Data flows through this register when sending data in any 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.

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**Registers 58 (D8)**  
**SCSI Bus Data Lines (SBDL)**  
**Read Only**

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 via programmed I/O. This register can also be used for diagnostic testing or in low level mode. The power-up value of this register is indeterminate.

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**Registers 5C-5F (DC-DF)**  
**Scratch Register B (SCRATCHB)**  
**(Read/Write)**

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.



## Chapter 6

# Instruction Set of the I/O Processor

After power up and initialization of the SYM53C860, the chip can operate in the low level register interface mode, or using 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 allows 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. Another feature allowed at the low level is loopback testing. In loopback mode, the SCSI core can be directed to talk to the DMA core to test internal data paths all the way out to the chip's pins.

## SCSI SCRIPTS

To operate in the SCSI SCRIPTS mode, the SYM53C860 requires only a SCRIPTS start address. The start address must be at a dword (four byte) boundary. This aligns the following SCRIPTS at a dword boundary, since all SCRIPTS are 8 or 12 bytes long. All instructions are fetched from external memory. The SYM53C860 fetches and executes its own instructions by becoming a bus master on the host bus and fetching two or three 32-bit words into its registers. 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 SYM53C860 halts all operations until the interrupt is serviced. Then, the start address of the next SCRIPTS

instruction may be written to the DMA SCRIPTS Pointer register to restart the automatic fetching and execution of instructions.

The SCSI SCRIPTS mode of execution allows the SYM53C860 to make decisions based on the status of the SCSI bus, so that the microprocessor does not have to service all of the 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. There is no need to switch to low level mode for error recovery.

Five types of SCRIPTS instructions are implemented in the SYM53C860:

- **Block Move**—used to move data between the SCSI bus and memory
- **I/O or Read/Write**—causes the SYM53C860 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 SYM53C860 to execute block moves between different parts of main memory
- **Load and 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 DCMD and DBC registers, the second into the DSPS register. The third word, used only by Memory Move instructions, is loaded into the TEMP shadow register. In an indirect I/O or Move instruction, the first two 32-bit op code fetches will be followed by one or two more 32-bit fetch cycles.

### Sample Operation

The following example describes execution of a SCRIPTS instruction. This sample operation is for a Block Move instruction. Figure 6-1 illustrates a SCRIPTS Initiator Write operation, which uses several Block Move instructions.

1. 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.
2. Loading the DSP register causes the SYM53C860 to request use of the PCI bus to fetch its first instruction from main memory at the address just loaded.
3. The SYM53C860 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 be moved. The second dword is stored and interpreted as the 32 bit beginning address in main memory to which the move is directed.
4. For a SCSI send operation, the SYM53C860 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.
5. SYM53C860 requests use of the PCI bus again, this time for data transfers.
6. When the SYM53C860 is again granted the PCI bus, it will execute (as a bus master) a burst transfer (programmable size) of data, decrement the internally stored remaining byte count, increment the address pointer, and then release the PCI bus. The SYM53C860 stays the PCI bus until the FIFO can again hold (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 SYM53C860 releases the PCI bus and then requests use of the PCI bus again for another SCRIPTS instruction fetch cycle, using the incremented stored address maintained in the DMA SCRIPTS Pointer register. Execution of SCRIPTS instructions continues until an error condition occurs or an interrupt SCRIPTS instruction is received. At this point, SYM53C860 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 SYM53C860 performs scatter/gather operations on data without requiring help from the host program, generating host interrupt, or requiring an external DMA controller to be programmed.

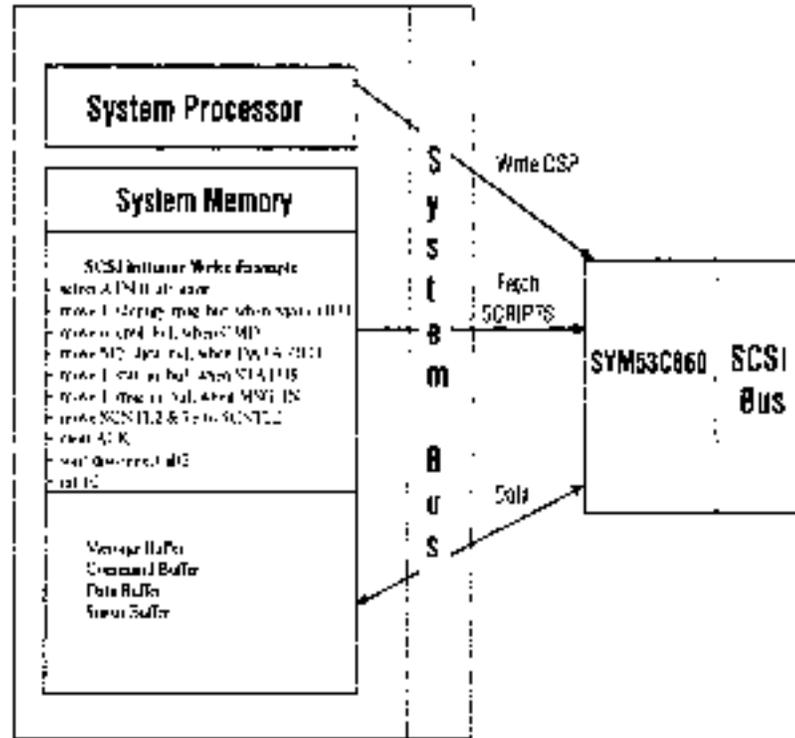


Figure 6-1: SCRIPTS Overview

## Block Move Instructions

The Block Move SCRIPTS instruction is used to move data between the SCSI bus and memory. For a Block Move instruction, the SYM53C860 operates much like a chaining DMA device with a SCSI controller attached. Figure 6-2 illustrates the register bit values that represent a Block Move instruction. In Block Move instructions, bits 5 and 4 (SIOM and DIOM) in the DMODE register determine whether the source/destination address resides in memory or I/O space. When data is being moved onto the SCSI bus, SIOM controls whether that data comes from I/O or memory space. When data is being moved off of the SCSI bus, DIOM controls whether that data goes to I/O or memory space.

### First Dword

#### Bits 31-30 Instruction Type-Block Move

##### Bit 29 Indirect Addressing

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 data to be moved is in the second dword of this instruction.

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 DNAD register via a third dword fetch (4-byte transfer across the host computer bus).

### Direct

The byte count and absolute address are as follows.

Command	Byte Count
Address of Data	

### Indirect

Use the fetched byte count, but fetch the data address from the address in the instruction.

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 a table of data buffer addresses to be specified. Using the SCSI SCRIPTS assembler, the table offset is placed in the SCRIPTS file when the program is assembled. 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. This feature makes it possible to locate SCSI SCRIPTS in a PROM.

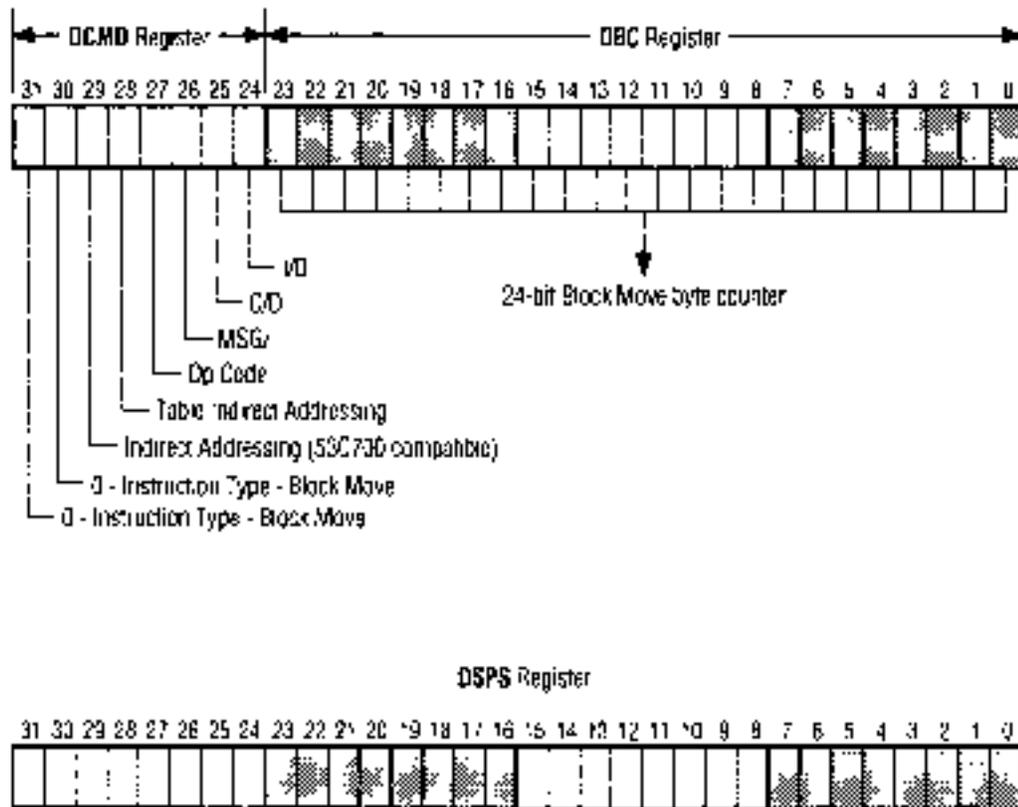
Note: indirect and table indirect addressing cannot be used simultaneously; only one addressing method can be used at a time.

##### Bit 28 Table Indirect

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 DSA register. Both the transfer count and the source/destination address are fetched from this address.

Command	Not Used
Don't Care	Table Offset

Use the signed integer offset in bits 23-0 of the second four bytes of the instruction, added to the value in the 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.



**Figure 6-2: Block Move Instruction Register**

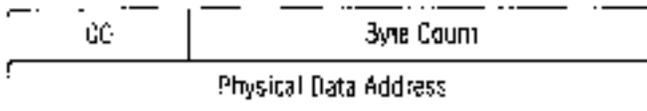
Prior to the start of an I/O, the Data Structure Base Address register (DSA) should be loaded with the base address of the I/O data structure. The address may be any address on a long word boundary.

After a Table Indirect op code is fetched, the DSA is added to the 24-bit signed offset value from the op code 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 SYM53C860. 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, as shown below; and indirect data fetches are not available during execution of a Memory to Memory DMA operation.



**Bit 27 Op Code**

This 1-bit field defines the instruction to be executed as a block move (MOVE).

**Target Mode**

OPC	Instruction Defined
0	MOVE
1	Reserved

1. The SYM53C860 verifies that it is connected to the SCSI bus as a target before executing this instruction.
2. The SYM53C860 asserts the SCSI phase signals (SMSG<sub>i</sub>, SC\_D<sub>i</sub>, and SI\_O<sub>i</sub>) as defined by the Phase Field bits in the instruction.
3. If the instruction is for the command phase, the SYM53C860 receives the first command byte and decodes its SCSI Group Code.
  - a) If the SCSI Group Code is either Group 0, Group 1, Group 2, or Group 5, then the SYM53C860 overwrites the DBC register with the length of the Command Descriptor Block: 6, 10, or 12 bytes.
  - b) If any other Group Code is received, the DBC register is not modified and the SYM53C860 will request the number of bytes specified in the DBC register. If the DBC register contains 000000h, an illegal instruction interrupt is generated.
4. The SYM53C860 transfers the number of bytes specified in the DBC register starting at the address specified in the DNAD register.
5. If the SATN<sub>i</sub> signal is asserted by the initiator or a parity error occurred during the transfer, the transfer can optionally be halted and an interrupt generated. The Disable Halt on Parity Error or ATN bit in the SCNTL1 register controls whether the SYM53C860 will halt on these conditions immediately, or wait until completion of the current Move.

**Initiator Mode**

OPC	Instruction Defined
0	Reserved
1	MOVE

1. The SYM53C860 verifies that it is connected to the SCSI bus as an initiator before executing this instruction.
2. The NCR53C860 waits for an unserviced phase to occur. An unserviced phase is defined as any phase (with SREQ/ asserted) for which the SYM53C860 has not yet transferred data by responding with a SACK/.
3. The SYM53C860 compares the SCSI phase bits in the DCMD register with the latched SCSI phase lines stored in the SSTAT1 register. These phase lines are latched when SREQ/ is asserted.
4. If the SCSI phase bits match the value stored in the SSTAT1 register, the SYM53C860 will transfer the number of bytes specified in the DBC register starting at the address pointed to by the DNAD register.
5. If the SCSI phase bits do not match the value stored in the SSTAT1 register, the SYM53C860 generates a phase mismatch interrupt and the instruction is not executed.
6. During a Message Out phase, after the SYM53C860 has performed a Select with Attention (or SATN/ has been manually asserted with a Set ATN instruction), the SYM53C860 will deassert SATN/ during the final SREQ/SACK handshake of the first move of Message Out bytes after SATN/ was set.
7. When the SYM53C860 is performing a block move for Message In phase, it will not deassert the SACK/ signal for the last SREQ/SACK handshake. The SACK signal must be cleared using the Clear SACK I/O instruction.

**Bits 26-24 SCSI Phase**

This 3-bit field defines the desired SCSI information transfer phase. When the SYM53C860 operates in initiator mode, these bits are compared with the latched SCSI phase bits in the SSTAT1 register. When the SYM53C860 operates in target mode, the SYM53C860 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	Data out
0	0	1	Data in
0	1	0	Command
0	1	1	Status
1	0	0	Reserved out
1	0	1	Reserved in
1	1	0	Message out
1	1	1	Message in

**Bits 23-0 Transfer Counter**

This 24-bit field specifies the number of data bytes to be moved between the SYM53C860 and system memory. The field is stored in the DBC register. When the SYM53C860 transfers data to/from memory, the DBC register is decremented by the number of bytes transferred. In addition, the DNAD register is incremented by the number of bytes transferred. This process is repeated until the DBC register has been decremented to zero. At that time, the SYM53C860 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 DSA register.

## Second Dword

### Bits 31-0 Start Address

This 32-bit field specifies the starting address of the data to be moved to/from memory. This field is copied to the DNAD register. When the SYM53C860 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 DSA. The table entry contains byte count and address information.

## I/O Instructions

The I/O SCRIPTS instruction causes the SYM53C860 to trigger common SCSI hardware sequences such as Set/Clear ACK, Set/Clear ATN, Set/Clear Target Mode, Select With ATN, or Wait for Reselect. Figure 6-3 illustrates the register bit values that represent an I/O instruction.

### First Dword

#### Bits 31-30 Instruction Type - I/O Instruction

#### Bits 29-27 Op Code

The following Op Code bits have different meanings, depending on whether the SYM53C860 is operating in initiator or target mode. Note: Op Code selections 101-111 are considered Read/Write instructions, and are described in that section.

### Target Mode

DPC2	DPC1	DPC0	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

1. The SYM53C860 arbitrates for the SCSI bus by asserting the SCSI ID stored in the SCID register. If the SYM53C860 loses arbitration, then it tries again during the next available arbitration cycle without reporting any lost arbitration status.
2. If the SYM53C860 wins arbitration, it attempts to reselect the SCSI device whose ID is defined in the destination ID field of the instruction. Once the SYM53C860 has won arbitration, it fetches the next instruction from the address pointed to by the DSP register.

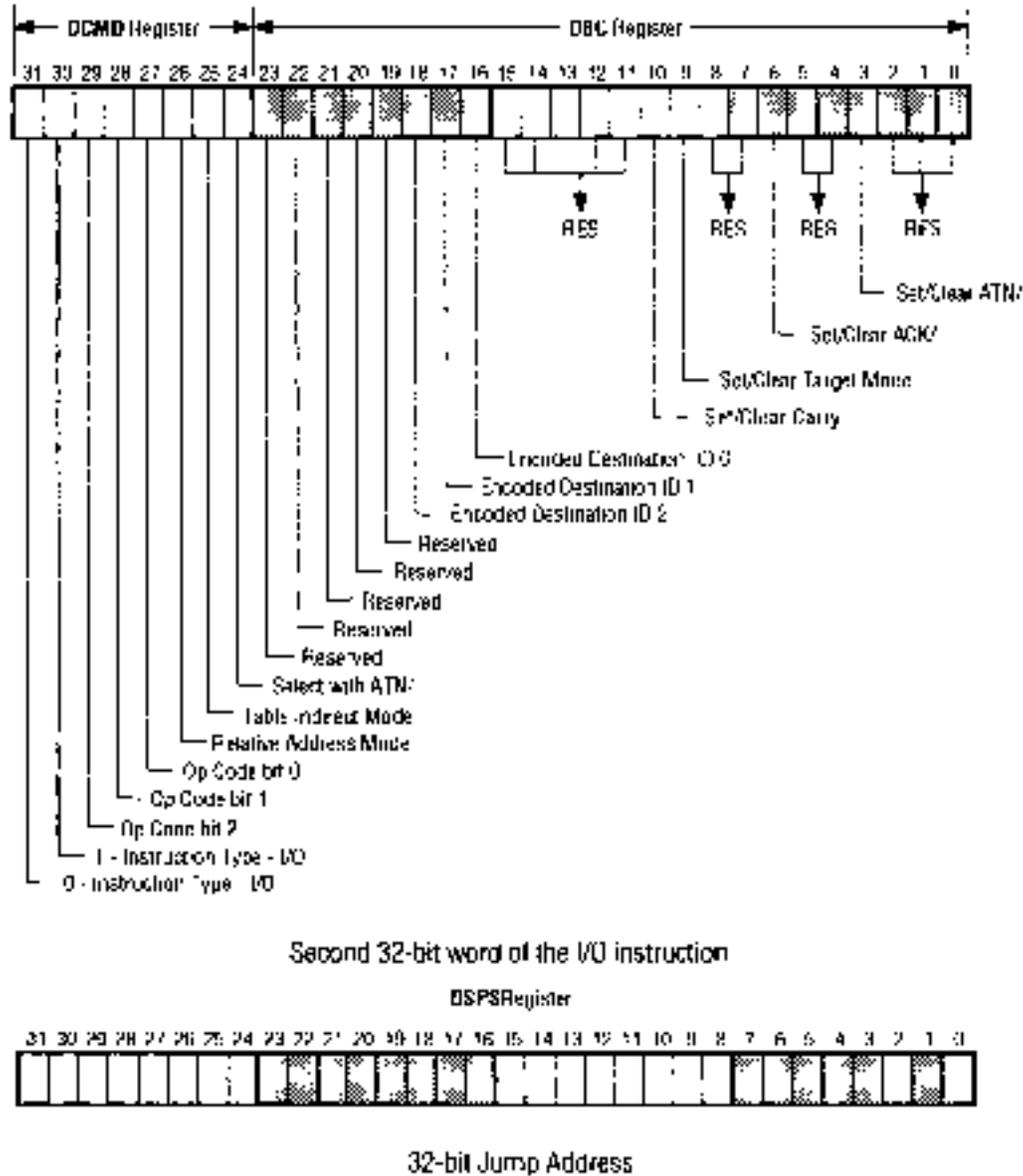


Figure 6-3: I/O Instruction Register

- Therefore, the SCRIPTS can move on to the next instructions before the reselection has completed. It will continue executing SCRIPTS until a SCRIPTS instruction that requires a response from the initiator is encountered.
- If the SYM53C860 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 DNAD register. The SYM53C860 should manually be set to initiator mode if it is reselected, or to target mode if it is selected.

#### Disconnect Instruction

The SYM53C860 disconnects from the SCSI bus by deasserting all SCSI signal outputs.

#### Wait Select Instruction

- If the SYM53C860 is selected, it fetches the next instruction from the address pointed to by the DSP register.
- If reselected, the SYM53C860 fetches the next instruction from the address pointed to by the 32-bit jump address field stored in the DNAD register. The SYM53C860 should manually be set to initiator mode when reselected.
- If the CPU sets the SIGP bit in the ISTAT register, the SYM53C860 will abort the Wait Select instruction and fetch the next instruction from the address pointed to by the 32-bit jump address field stored in the DNAD register.

#### Set Instruction

When the SACK $\bar{}$  or SATN $\bar{}$  bits are set, the corresponding bits in the SOCL register are set. SACK $\bar{}$  or SATN $\bar{}$  should not be set except for testing purposes. When the target bit is set, the corresponding bit in the SCNTLO 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 $\bar{}$  or SATN $\bar{}$  bits are set, the corresponding bits are cleared in the SOCL register. SACK $\bar{}$  or SATN $\bar{}$  should not be set except for testing purposes. When the target bit is set, the corresponding bit in the SCNTLO register is cleared. When the carry bit is set, the corresponding bit in the ALU is cleared.

Note: None of the signals are reset on the SCSI bus in 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 SYM53C860 arbitrates for the SCSI bus by asserting the SCSI ID stored in the SCID register. If the SYM53C860 loses arbitration, it tries again during the next available arbitration cycle without reporting any loss arbitration status.
- If the SYM53C860 wins arbitration, it attempts to select the SCSI device whose ID is defined in the destination ID field of the instruction. Once the SYM53C860 has won arbitration, it fetches the next instruction from the address pointed to by the DSP register. Therefore, the SCRIPTS program can move to the next instruction before the selection has completed. It will continue executing SCRIPTS until a SCRIPTS instruction that requires a response from the target is encountered.

3. If the SYM53C860 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 DNAD register. The SYM53C860 should manually be set to initiator mode if it is reselected, or to target mode if it is selected.
4. If the Select with SAIN $\bar{N}$  field is set, the SAIN $\bar{N}$  signal is asserted during the selection phase.

#### *Wait Disconnect Instruction*

1. The SYM53C860 waits for the target to perform a "legal" disconnect from the SCSI bus. A "legal" disconnect occurs when SBSY $\bar{N}$  and SSEL $\bar{N}$  are inactive for a minimum of one Bus Free delay (400 ns), after the SYM53C860 has received a Disconnect Message or a Command Complete Message.

#### *Wait Reselect Instruction*

1. If the SYM53C860 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 DNAD register. The SYM53C860 should be manually set to target mode when selected.
2. If the SYM53C860 is reselected, it fetches the next instruction from the address pointed to by the DSP register.
3. If the CPU sets the SIGP bit in the ISTAT register, the SYM53C860 will abort the Wait Reselect instruction and fetch the next instruction from the address pointed to by the 32-bit jump address field stored in the DNAD register.

#### *Set Instruction*

When the SACK $\bar{N}$  or SAIN $\bar{N}$  bits are set, the corresponding bits in the SOCL register are set. When the Target bit is set, the corresponding bit in the SCNTLO register is also set. When the Carry bit is set, the corresponding bit in the ALU is set.

#### *Clear Instruction*

When the SACK $\bar{N}$  or SAIN $\bar{N}$  bits are set, the corresponding bits are cleared in the SOCL register. When the Target bit is set, the corresponding bit in the SCNTLO register is cleared. When the Carry bit is set, the corresponding bit in the ALU is cleared.

#### **Bit 26 Relative Addressing Mode**

When this bit is set, the 24-bit signed value in the DNAD register is used as a relative displacement from the current DSP address. This bit should only be used 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.

#### **Bit 25 Table Indirect Mode**

When this bit is set, the 24-bit signed value in the DBC register is added to the value in the DSA register, used as an offset relative to the value in the Data Structure Base Address (DSA) register. The SCNTL3 value, SCSI ID, synchronous offset and synchronous period are loaded from this address. Prior to the start of an I/O, the DSA should be loaded with the base address of the I/O data structure. The address may be any address on a dword boundary. After a Table Indirect op code is fetched, the DSA is added to the 24-bit signed offset value from the op code 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:

1. The I/O data structure must lie within the 8 MB above or below the base address.

2. 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 SXFER register. The configuration bits are ordered as in the SCNTL3 register.

Config	I/O	Offset/period	(CC)
--------	-----	---------------	------

This bit should only be used in conjunction with the Select, Reselect, Wait Select, and Wait Reselect instructions. Bits 25 and 26 may be set 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	I/O	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	I/O	Not Used	Not Used
Alternate Jump Offset			

#### Table Relative

Treats the alternate jump address as a relative jump and fetches the device ID, synchronous offset, and synchronous period indirectly. Adds the value in bits 23-0 of the first four bytes of the SCRIPTS instruction to the data structure base address to form the fetch address.

Command	Table Offset
Alternate Jump Offset	

#### Bit 24 Select with ATN/

This bit specifies whether SATN/ will be asserted during the selection phase when the SYM53C860 is executing a Select instruction. When operating in 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.

#### Bits 18-16 Encoded SCSI Destination ID

This 3-bit field specifies the destination SCSI ID for an I/O instruction.

#### Bit 10 Set/Clear Carry

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. Setting this bit with a Clear instruction deasserts the Carry bit in the ALU.

#### Bit 9 Set/Clear Target Mode

This bit is used in conjunction with a Set or Clear instruction to set or clear target mode. Setting this bit with a Set instruction configures the SYM53C860 as a target device (this sets bit 0 of the SCNTL0 register). Clearing this bit with a Clear instruction configures the SYM53C860 as an initiator device (this clears bit 0 of the SCNTL0 register).

bit 6 **Set/Clear SACK/**

bit 3 **Set/Clear SATN/**

These two bits are used in conjunction with a Set or Clear instruction to assert or deassert the corresponding SCSI control signal. Bit 6 controls the SCSI SACK/ signal; bit 3 controls the SCSI SATN/ signal.

Setting either of these bits will set or reset the corresponding bit in the SOCL register, depending on the instruction used. The Set instruction is used to assert SACK/ and/or SATN/ on the SCSI bus. The Clear instruction is used to deassert SACK/ and/or SATN/ on the SCSI bus.

Since SACK/ and SATN/ are initiator signals, they will not be asserted on the SCSI bus unless the SYM53C860 is operating as an initiator or the SCSI Loopback Enable bit is set in the STRST2 register.

The Set/Clear SCSI ACK/ATN instruction would be 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, an Assert SCSI ATN instruction would be issued before a Clear SCSI ACK instruction.

bits 2-0 **Reserved**

---

## Second Dword

bits 31-0 **Start Address**

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 DSP register value.

## Read/Write Instructions

The Read/Write Instruction type moves the contents of one register to another, or performs arithmetic operations such as AND, OR, XOR, Addition, and Shift. Figure 6-4 illustrates the register bit values that represent a Read/Write instruction.

---

### First Dword

**Bits 31-30 Instruction Type - Read/Write Instruction**

The Read/Write instruction uses operator bits 26 through 24 in conjunction with the op code bits to determine which instruction is currently selected.

**Bits 29-27 Op Code**

The combinations of these bits determine if the instruction is a Read/Write or an I/O instruction. Op codes 000 through 100 are considered I/O instructions. Refer to Table 6-1 for field definitions.

**Bits 26-24 Operator**

These bits are used in conjunction with the op code bits to determine which instruction is currently selected. Refer to Table 6-1 for field definitions.

**Bits 22-16 Register Address - A(6-0)**

Register values may be changed from SCRIPTS in read-modify-write cycles or move to/from SFBR cycles. A(6-0) select an 8-bit source/destination register within the SYM53C860.

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### Second Dword

**Bits 31-0 Destination Address**

This field contains the 32-bit destination address where the data is to be moved.

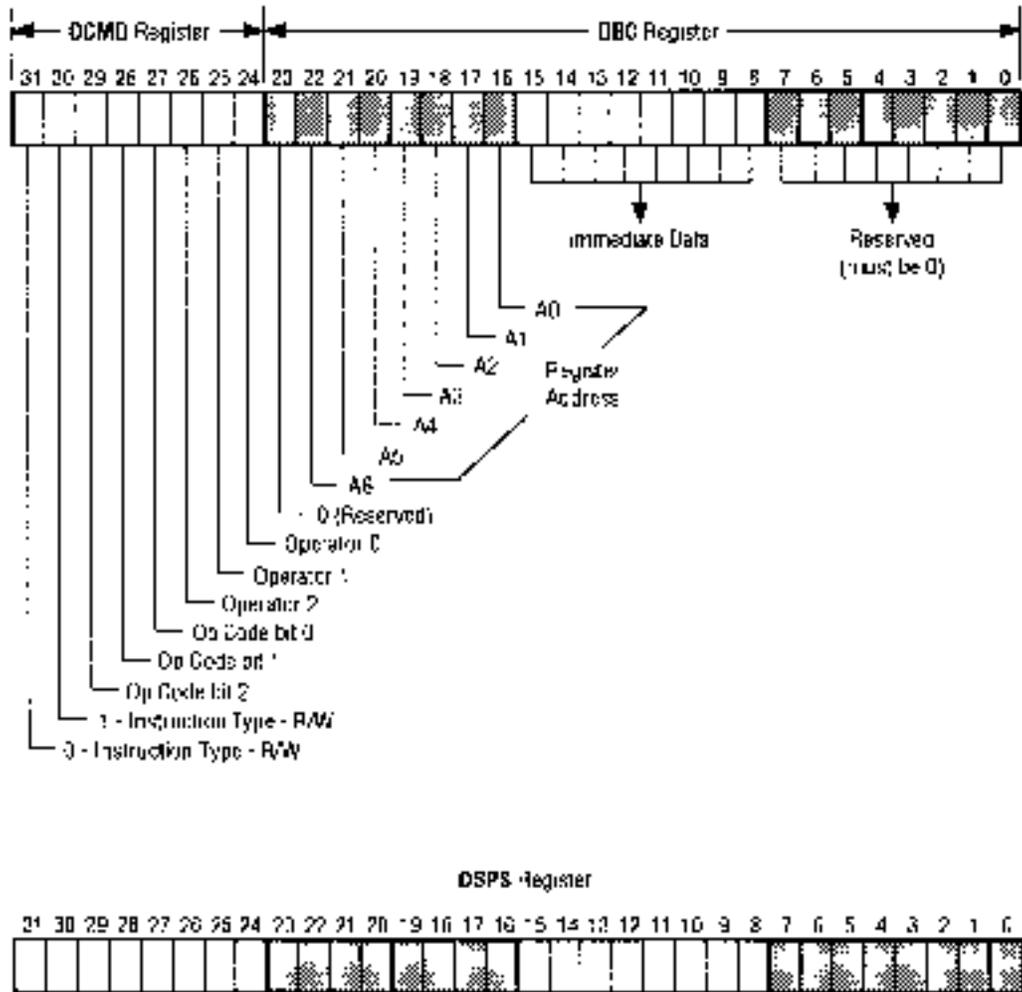


Figure 6-4: Read/Write Register Instruction

Table 6-1: Read/Write Instructions

Operator	Op Code 111 Read Modify Write	Op Code 110 Move to SFBR	Op Code 101 Move from SFBR
000	Move data into register Syntax: "Move data8 to RegA"	Move data into SFBR register Syntax: "Move data8 to SFBR"	Move data into register Syntax: "Move data8 to RegA"
001*	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 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 OR data8 to RegA"	OR data with register and place the result in the SFBR register. Syntax: "Move RegA OR data8 to SFBR"	OR data with SFBR and place the result in the register. Syntax: "Move SFBR OR 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 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 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"
101*	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 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 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 in RegA with carry"	Add data to register with carry and place the result in the SFBR register. Syntax: "Move RegA + data8 in SFBR with carry"	Add data to SFBR with carry and place the result in the register. Syntax: "Move SFBR + data8 to RegA with carry"

**Notes:**

1. Substitute the desired register name or address for "RegA" in the syntax examples.

2. data8 indicates eight bits of data.

\* Data is shifted through the Carry bit and the Carry bit is shifted into the data byte.

---

## 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 can be 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.

---

## Move to/from SFBR Cycles

All operations are read-modify-writes. However, two registers are involved, one of which is always the 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 SFBR from/to any other register.
- Alter the value of a register with AND/OR/ADD/XOR/SHIFT LEFT/SHIFT RIGHT operators.
- After moving values to the SFBR, the compare and jump, call, or similar instructions may be used to check the value.
- A Move-to-SFBR followed by a Move-from-SFBR can be used to perform a register to register move.

---

## Transfer Control Instructions

The Transfer Control, or Conditional Jump, instruction allows you to write SCRIPTS that make decisions based on real time conditions on the SCSI bus, such as phase or data. This instruction type includes Jump, Call, Return, and Interrupt instructions. Figure 6-5 illustrates the register bit values that represent a Transfer Control instruction.

---

### First Dword

#### Bits 31-30 Instruction Type - Transfer Control Instruction

#### Bits 29-27 Op Code

This 3-bit field specifies the type of transfer control instruction to be executed. 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 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

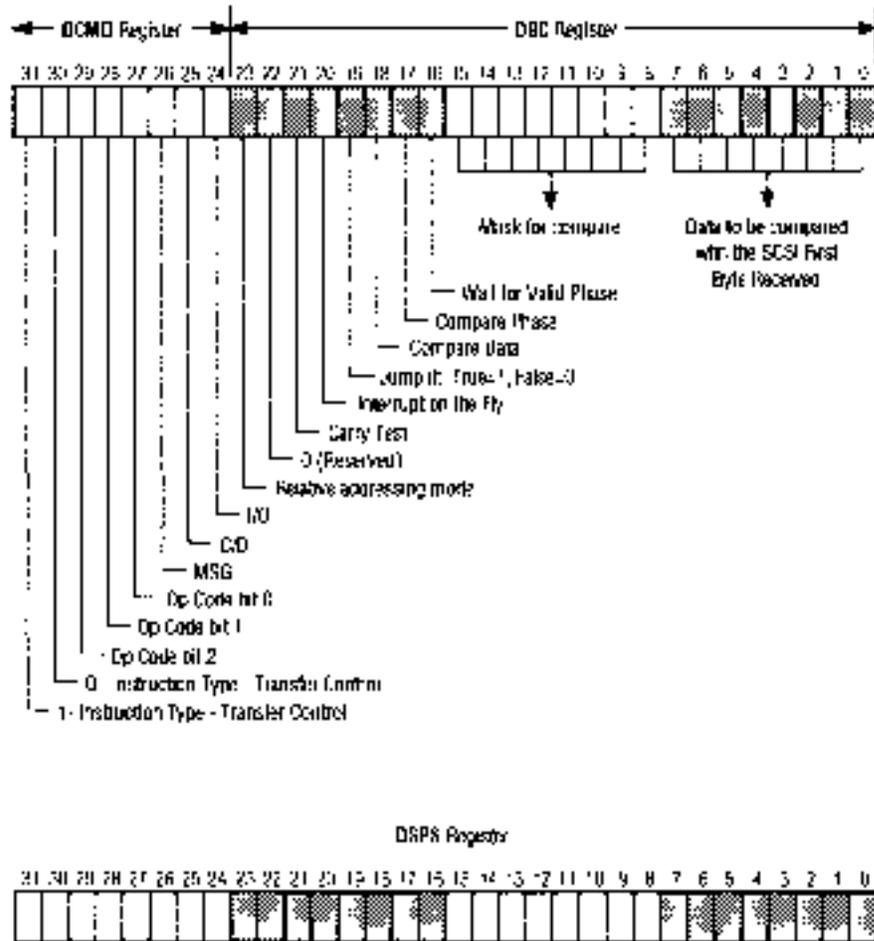


Figure 6-5: Transfer Control Instruction

### Jump Instruction

1. The SYM53C860 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 SYM53C860 loads the DSP register with the contents of the DSPS register. The DSP register now contains the address of the next instruction.
2. If the comparisons are false, the SYM53C860 fetches the next instruction from the address pointed to by the DSP register, leaving the instruction pointer unchanged.

### Call Instruction

1. The SYM53C860 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 SYM53C860 loads the DSP register with the contents of the DSPS register and that address value becomes the address of the next instruction.

When the SYM53C860 executes a Call instruction, the instruction pointer contained in the DSP register is stored in the TEMP register. Since the TEMP register is not a stack and can only hold one dword, nested call instructions are not allowed.

2. If the comparisons are false, the SYM53C860 fetches the next instruction from the address pointed to by the DSP register and the instruction pointer is not modified.

### Return Instruction

1. The SYM53C860 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, then the SYM53C860 loads the DSP register with the contents of the DSPS register. That address value becomes the address of the next instruction.

When a Return instruction is executed, the value stored in the TEMP register is returned to the DSP register. The SYM53C860 does not check to see whether the Call instruction has already been executed. It will not generate an interrupt if a Return instruction is executed without previously executing a Call instruction.

2. If the comparisons are false, then the SYM53C860 fetches the next instruction from the address pointed to by the DSP register and the instruction pointer will not be modified.

### Interrupt Instructions

#### *Interrupt*

- a) The SYM53C860 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, then the SYM53C860 generates an interrupt by asserting the IRQ<sub>i</sub> signal.
- b) The 32 bit address field stored in the DSPS register (not DNAD as in 53C700) can contain a unique interrupt service vector. When servicing the interrupt, this unique status code allows the ISR to quickly identify the point at which the interrupt occurred.
- c) The SYM53C860 halts and the DSP register must be written to start any further operation.

#### *Interrupt on-the-Fly*

- a) The SYM53C860 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 is set (bit 20), the SYM53C860 will assert the Interrupt on the Fly bit (ISTAT bit 2).

#### **Bits 26-24 SCSI Phase**

This 3-bit field corresponds to the three SCSI bus phase signals which are compared with the phase lines latched when SREQ<sub>i</sub> 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 SYM53C860 is operating in initiator mode, when the SYM53C860 is operating in the target mode, these bits should be cleared.

MSG	C/D	I/O	SCSI Phase
0	0	0	Data out
0	0	1	Data in
0	1	0	Command
0	1	1	Status
1	0	0	Reserved out
1	0	1	Reserved in
1	1	0	Message out
1	1	1	Message in

#### Bit 23 Relative Addressing Mode

When this bit is set, the 24-bit signed value in the DSPS register is used as a relative offset from the current DSP address (which is pointing to the next instruction, not the one currently executing). 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 instruction currently being executed by the SYM53C860. 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 (two's complement), the jump can be forward or backward.

A relative transfer can be to any address within a 16-MB 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 SCRIPTS instruction uses only relative transfers it would not require any run-time alteration of physical addresses, and could be stored in and executed from a PROM.

#### Bit 21 Carry Test

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.

#### Bit 20 Interrupt on the Fly

When this bit is set, the Interrupt instruction will not halt the SCRIPTS processor. Once the interrupt occurs, the Interrupt on the Fly bit (ISTAT bit 2) will be asserted.

#### Bit 19 Jump If True/False

This bit determines whether the SYM53C860 should branch 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

#### Bit 18 Compare Data

When this bit is set, the first byte received from the SCSI data bus (contained in 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 will occur. The Jump if True/False bit determines the condition (true or false) to branch on.

#### Bit 17 Compare Phase

When the SYM53C860 is in 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 will occur. When the SYM53C860 is operating in target mode this bit, when set, tests for an active SCSI SATN/ signal.

#### Bit 16 Wait For Valid Phase

If the Wait for Valid Phase bit is set, the SYM53C860 waits for a previously unserviced phase before comparing the SCSI phase and data. If the Wait for Valid Phase bit is clear, the SYM53C860 compares the SCSI phase and data immediately.

#### Bits 15-8 Data Compare Mask

The Data Compare Mask allows a SCRIPTS instruction to test certain bits within a data byte. During the data compare, any mask bits that are set cause the corresponding bit in the SFBR data byte to be ignored. For instance, a mask of 01111111b and data compare value of 1XXXXXXb allows the SCRIPTS processor to determine whether or not the high order bit is set while ignoring the remaining bits.

#### Bits 7-0 Data Compare Value

This 8-bit field is the data to be 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.

---

#### Second Dword

#### Bits 31-0 Jump Address

This 32-bit field contains the address of the next instruction to fetch when a jump is taken. Once the SYM53C860 has fetched the instruction from the address pointed to by these 32 bits, this address is incremented by 4, loaded into the DSP register and becomes the current instruction pointer.

## Memory Move Instructions

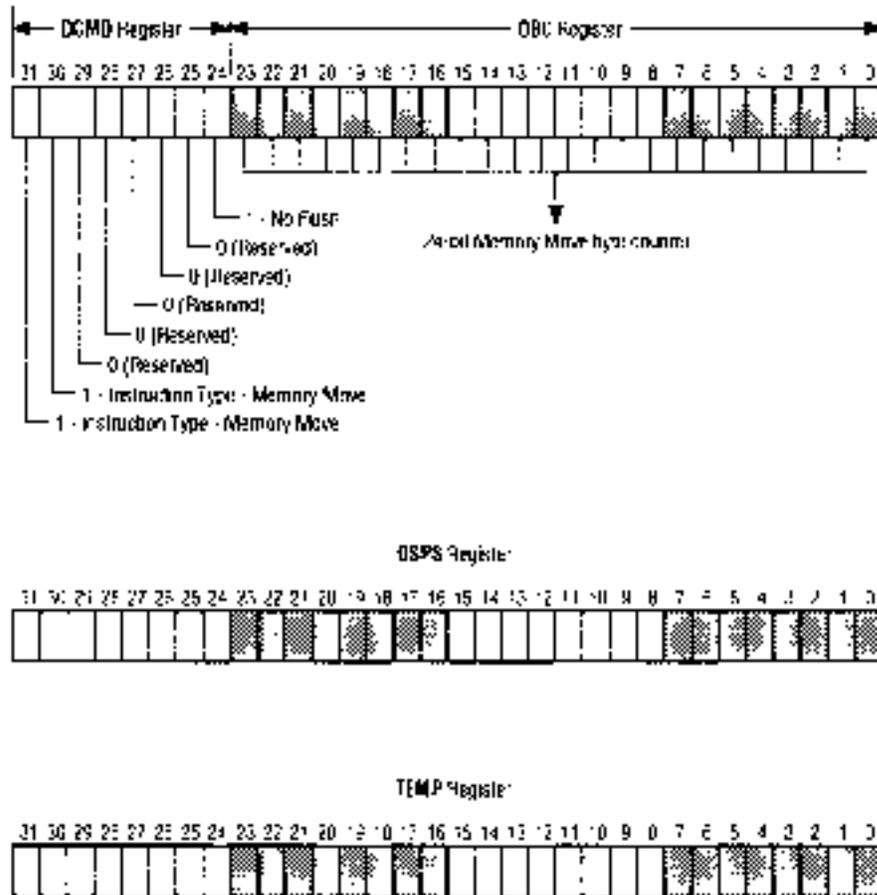
This SCRIPTS instruction allows the SYM53C860 to execute high performance block moves of 32-bit data from one part of main memory to another. In this mode, the SYM53C860 is an independent, high performance DMA controller irrespective of SCSI operations. Since the registers of the SYM53C860 can be mapped into system memory, this SCRIPTS instruction also moves an SYM53C860 register to or from memory or another SYM53C860 register. Figure 6-6 illustrates the register bit values that represent a Memory Move instruction.

For Memory Move instructions, bits 5 and 4 (SIOM and DIOM) in the 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.

Allowing the SYM53C860 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 MB may be transferred with one instruction. There are two restrictions:

1. Both the source and destination addresses must start with the same address alignment (A(1-0) must be the same). If source and destination are not aligned, then an illegal instruction interrupt will occur.



**Figure 6-6: Memory to Memory Move Instruction**

2. 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 SCRIPTS instruction is fetched from system memory.

The DSPS and DSA registers are additional holding registers used during the Memory Move; however, the contents of the DSA register are preserved.

#### Bits 29-25 Reserved

These bits are reserved and must be zero. If any of these bits is set, an illegal instruction interrupt will occur.

#### Bit 24 No Flush

**Note** this bit has no effect unless the Pre-fetch Enable bit in the DCNTL register is set. For information on SCRIPTS instruction prefetching, see Chapter 2.

When this bit is set, the SYM53C860 performs a Memory Move (MMOV) without flushing the prefetch unit (NFMMOV). When this bit is clear, the Memory Move instruction automatically flushes the prefetch unit. NFMMOV should be used if the source and destination are not within four instructions of the current MMOV instruction.

#### Bits 23-0 Transfer Count

The number of bytes to be transferred is stored in the lower 24 bits of the first instruction word.

---

### Read/Write System Memory from a SCRIPTS Instruction

By using the Memory Move instruction, single or multiple register values may be transferred to or from system memory.

Because the SYM53C860 will respond to addresses as defined in the Base I/O or Base Memory registers, it could 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 to be the data source or destination. In this way, register values can be saved to system memory and later restored, and SCRIPTS can make decisions based on data values in system memory.

The SFBR is not writable via the CPU, and therefore not by a Memory Move. However, it can be loaded via SCRIPTS Read/Write operations. To load the SFBR with a byte stored in system memory, the byte must first be moved to an intermediate SYM53C860 register (for example, a SCRATCH register), and then to the SFBR.

The same address alignment restrictions apply to register access operations as to normal memory-to-memory transfers.

## Load and Store Instructions

The Load and Store instruction provides 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 op codes. The first dword contains the DCMD and DBC register values. The second dword contains the DSPS value. This is either the actual memory location of where to load or store, or the offset from the DSA, depending on the value of Bit 28 (DSA Relative).

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. If it does, a PCI illegal read/write cycle will occur, and the chip will issue 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 DMODE register determine whether the destination or source address of the instruction is in Memory space or I/O space. The Load/Store utilizes the PCI commands for I/O READ and I/O WRITE to access the I/O space

---

### First Dword

#### Bit 31-29, Instruction Type

These bits should be 111, indicating the Load and Store instruction.

#### Bit 28, DSA Relative

When this bit is clear, the value in the DSPS is the actual 32-bit memory address 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 DSPS to the DSA

#### Bits 27-26, Reserved

#### Bit 25, No Flush (Store instruction only)

Note: this bit has no effect unless the Pre-fetch Enable bit in the DCNTL register is set. For information on SCRIPTS instruction prefetching, see Chapter 2.

When this bit is set, the SYM53C860 performs a Store without flushing the prefetch unit. When this bit is clear, the Store instruction automatically flushes the prefetch unit. No Flush should be used if the source and destination are not within four instructions of the current Store instruction.

#### Bit 24, Load/Store

When this bit is set, the instruction is a Load. When cleared, it is a Store.

#### Bit 23, Reserved

#### Bits 22-16, Register Address

A6-A0 select the register to load/store to/from within the SYM53C860.

#### Bits 15-3, Reserved

#### Bits 2-0, Byte Count

This value is the number of bytes to load/store.

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### Second Dword

#### Bits 31-0, Memory/I/O Address / DSA Offset

This is the actual memory location of where to load or store, or the offset from the DSA register value.

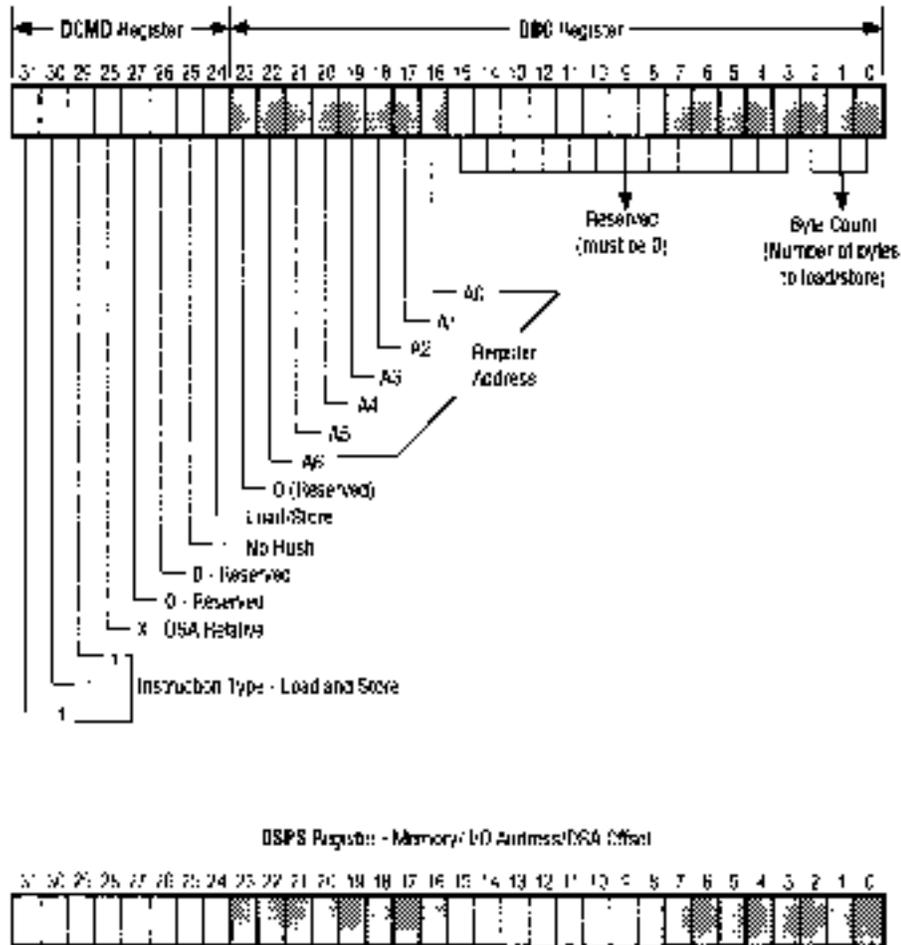


Figure 6-7: Load and Store Instruction Format

## Chapter 7

# Electrical Characteristics

This chapter presents electrical and timing information for the SYM53C860, using tables and timing diagrams. Table 7-1 through Table 7-11 list the stress ratings, operating conditions, and DC characteristics of the SYM53C860. Table 7-12 and Figure 7-1 through Figure 7-5 show the effect of ToierANT technology on the DC characteristics of the chip. The following section of this chapter presents the AC characteristics of the NCR 53C860. The chip timings are presented in two sections. The first is the PCI and external memory interface, followed by the SCSI interface timings.

## DC Characteristics

Table 7-1: Absolute Maximum Stress Ratings

Symbol	Parameter	Min	Max	Unit	Test Conditions
$T_{STG}$	Storage temperature	-55	150	°C	-
$V_{DD}$	Supply voltage	-0.5	7.0	V	-
$V_{IN}$	Input Voltage	$V_{SS} - 0.5$	$V_{DD} + 0.5$	V	-
$I_{LP}^*$	Latch-up current	-150	-	mA	-
ESD**	Electrostatic discharge	-	2K	V	MIL-STD 883C, Method 3015.7

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.

\*  $-2V < V_{DD} < 2V$

\*\* SCSI pins only

**Table 7-2: Operating Conditions**

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{DD}$	Supply voltage	4.75	5.25	V	-
$I_{DD}^*$	Supply current (dynamic)	-	130	mA	-
	Supply current (static)	-	1	mA	-
$T_A$	Operating free air	0	70	°C	-
$\theta_{JA}$	Thermal resistance (junction to ambient air)	-	67	°C/W	-

Conditions that exceed the operating limits may cause the device to function incorrectly.

\*Average operating supply current is 50 mA.

**Table 7-3: SCSI Signals – SD(7-0)!, SDP!, SREQ/ SACK!**

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{IH}$	Input high voltage	2.0	$V_{DD} + 0.5$	V	-
$V_{IL}$	Input low voltage	$V_{SS} - 0.5$	0.8	V	-
$V_{OH}^*$	Output high voltage	2.5	3.5	V	2.5 mA
$V_{OL}$	Output low voltage	$V_{SS}$	0.5	V	48 mA
$I_{IN}$	Input leakage	-10	10	μA	-
$I_{OZ}$	Tri-state leakage	-10	10	μA	-

\*Take  $\overline{ANT}$  active negotiation enabled

**Table 7-4: SCSI Signals – SMSG, SI O!, SC D!, SATN!, SBSY!, SSEL!, SRST!**

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{IH}$	Input high voltage	2.0	$V_{DD} + 0.5$	V	-
$V_{IL}$	Input low voltage	$V_{SS} - 0.5$	0.8	V	-
$V_{OL}$	Output low voltage	$V_{SS}$	0.5	V	48 mA

Table 7-4: SCST Signals - SMSG, SI\_OI, SC\_DI, SATN, SBSY, SSEL, SRST (Continued)

Symbol	Parameter	Min	Max	Unit	Test Conditions
$I_{IN}$	Input leakage (SRST/ only)	10	10	$\mu$ A	
		500	50	$\mu$ A	
$I_{OZ}$	Tristate leakage	-10	10	$\mu$ A	-

Table 7-5: Input Signals - CLK, SCLK, GNTI, IDSEL, RST, TESTIN

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{IH}$	Input high voltage	2.0	$V_{DD3} + 0.5$	V	-
$V_{IL}$	Input low voltage	$V_{CC} - 0.5$	0.8	V	-
$I_{IN}$	Input leakage	-1.0	1.0	$\mu$ A	-

Note: CLK, SCLK, GNTI, and IDSEL have 100 $\mu$ A pull-ups that are enabled when TESTIN is low. TESTIN has a 100 $\mu$ A pull-up that is always enabled.

Table 7-6: Capacitance

Symbol	Parameter	Min	Max	Unit	Test Conditions
$C_I$	Input capacitance of input pads	-	7	pF	-
$C_{IO}$	Input capacitance of IO pads	-	10	pF	-

Table 7-7: Output Signal - MACI, TESTOUT, REQI

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{OH}$	Output high voltage	2.4	$V_{DD1}$	V	-16 mA
$V_{OL}$	Output low voltage	$V_{SS}$	0.4	V	16 mA
$I_{OH}$	Output high current	-8	-	mA	$V_{IH} - 0.5$ V
$I_{OL}$	Output low current	16	-	mA	0.4 V
$I_{OZ}$	Tristate leakage	-10	10	$\mu$ A	-

Note: REQI has a 100 $\mu$ A pull-up that is enabled when TESTIN is low.

**Table 7-8: Output Signal - IRQ<sub>1</sub>**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V <sub>OH</sub>	Output high voltage	2.4	V <sub>DD</sub>	V	-8 mA
V <sub>OL</sub>	Output low voltage	V <sub>SS</sub>	0.4	V	8 mA
I <sub>OH</sub>	Output high current	-4	-	mA	V <sub>DD</sub> - 0.5V
I <sub>OL</sub>	Output low current	6	-	mA	0.4V
I <sub>OZ</sub>	Tristate leakage	-10	10	μA	-

Note: IRQ<sub>1</sub> has a 100 μA pull-up that is enabled when TESTIN is low. IRQ<sub>1</sub> can be enabled with a register bit as an open drain output with an internal 100 μA pull-up.

**Table 7-9: Output Signal - SFRR<sub>1</sub>**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V <sub>OL</sub>	Output low voltage	V <sub>SS</sub>	0.4	V	16 mA
I <sub>OL</sub>	Output low current	16	-	mA	0.4V
I <sub>OZ</sub>	Tristate leakage	-10	10	μA	-

**Table 7-10: Bidirectional Signals - AD(31-0), C\_BE(3-0), FRAME, IRDY<sub>1</sub>, TRDY<sub>1</sub>, DEVSSEL<sub>1</sub>, STOP<sub>1</sub>, PERR<sub>1</sub>, PAR**

Symbol	Parameter	Min	Max	Unit	Test Conditions
V <sub>IH</sub>	Input high voltage	2.0	V <sub>DD</sub> + 0.5	V	-
V <sub>IL</sub>	Input low voltage	V <sub>SS</sub> - 0.5	0.8	V	-
V <sub>OH</sub>	Output high voltage	2.4	V <sub>DD</sub>	V	16 mA
V <sub>OL</sub>	Output low voltage	V <sub>SS</sub>	0.4	V	16 mA
I <sub>OH</sub>	Output high current	-8	-	mA	V <sub>DD</sub> - 0.5
I <sub>OL</sub>	Output low current	16	-	mA	0.4V
I <sub>IN</sub>	Input leakage	-10	10	μA	V <sub>SS</sub> < V <sub>IN</sub> < V <sub>DD</sub>
I <sub>OZ</sub>	Tristate leakage	-10	10	μA	-

Note: All the signals in this table have 100 μA pull-ups that are enabled when TESTIN is low.

Table 7-11: Bidirectional Signals - GPIO0\_FETCH/, GPIO1\_MASTER/

Symbol	Parameter	Min	Max	Unit	Test Conditions
$V_{IH}$	Input high voltage	2.0	$V_{DD1} + 0.5$	V	-
$V_{IL}$	Input low voltage	$V_{SS} - 0.5$	0.8	V	-
$V_{OH}$	Output high voltage	2.4	$V_{DD1}$	V	-16 mA
$V_{OL}$	Output low voltage	$V_{SS}$	0.4	V	16 mA
$I_{OH}$	Output high current	-8	-	mA	2.4V
$I_{OL}$	Output low current	16	-	mA	0.4V
$I_{IS}$	Input leakage	-10	10	$\mu$ A	-
$I_{OZ}$	Tristate leakage	-10	10	$\mu$ A	-

Note: All the signals in this table have 100 $\mu$ A pull-ups that are enabled when TRISPIN is low

# TolerANT Technology

**Table 7-12: TolerANT Active Negation Technology Electrical Characteristics**

Symbol	Parameter	Min	Max	Units	Test Conditions
$V_{OH}^1$	Output high voltage	2.5	3.5	V	$I_{OH} = 2.5 \text{ mA}$
$V_{OL}$	Output low voltage	0.1	0.5	V	$I_{OL} = 48 \text{ mA}$
$V_{IH}$	Input high voltage	2.0	7.0	V	-
$V_{IL}$	Input low voltage	-0.5	0.8	V	Referenced to $V_{SS}$
$V_{IK}$	Input clamp voltage	0.66	-0.77	V	$V_{DD} = 4.75$ ; $I_1 = -20 \text{ mA}$
$V_{TH}$	Threshold, high to low	1.1	1.3	V	-
$V_{TL}$	Threshold, low to high	1.5	1.7	V	-
$V_{H1H}$ - $V_{L1L}$	Hysteresis	200	400	mV	-
$I_{OH}^1$	Output high current	2.5	24	mA	$V_{OH} = 2.5 \text{ V}$
$I_{OL}$	Output low current	100	200	mA	$V_{OL} = 0.5 \text{ V}$
$I_{OSH}^1$	Short-circuit output high current	-	625	mA	Output driving low, pin shorted to $V_{DD}$ supply <sup>2</sup>
$I_{OSL}$	Short-circuit output low current	-	95	mA	Output driving high, pin shorted to $V_{SS}$ supply
$I_{IH}$	Input high leakage	-	10	$\mu\text{A}$	$-0.5 < V_{DD} < 5.25$ $V_{IH} = 2.7 \text{ V}$
$I_{IL}$	Input low leakage	-	-10	$\mu\text{A}$	$-0.5 < V_{DD} < 5.25$ $V_{IL} = 0.5 \text{ V}$
$R_f$	Input resistance	20	-	M $\Omega$	SCSI pins <sup>3</sup>
$C_f$	Capacitance per pin	-	10	pF	PQFP
$t_R^1$	Rise time, 10% to 90%	9.7	18.5	ns	Figure 7-1

Note: These values are guaranteed by periodic characterization; they are not 100% tested on every device.

<sup>1</sup> A bus suspension output only: Data, Parity, SRRQ, SACK

<sup>2</sup> Single pin only, irreversible; damage may occur if sustained for one second

<sup>3</sup> SCSI RESET pin has 10 k $\Omega$  pull-up resistor

Table 7-12: TolerANT Active Negation Technology Electrical Characteristics (Continued)

Symbol	Parameter	Min	Max	Units	Test Conditions
$t_f$	Fall time, 90% to 10%	5.2	14.7	ns	Figure 7-1
$dV_{IH}/dt$	Slew rate, low to high	0.17	0.49	V/ns	Figure 7-1
$dV_L/dt$	Slew rate, high to low	0.19	0.52	V/ns	Figure 7-1
ESD	Electrostatic discharge	2	-	KV	MIL-STD-883C 3015-7
	Latch-up	100	-	mA	-
	Filter delay	20	30	ns	Figure 7-2
	Extended filter delay	40	60	ns	Figure 7-2

Note: These values are guaranteed by periodic characterization; they are not 100% tested on every device.

<sup>1</sup>Active negation outputs only: Data, Parity, SREQ, NACK

<sup>2</sup>Single pin only, irreparable damage may occur if misused for one second

<sup>3</sup>CS0/RESET pin has 10 kΩ pull-up resistor

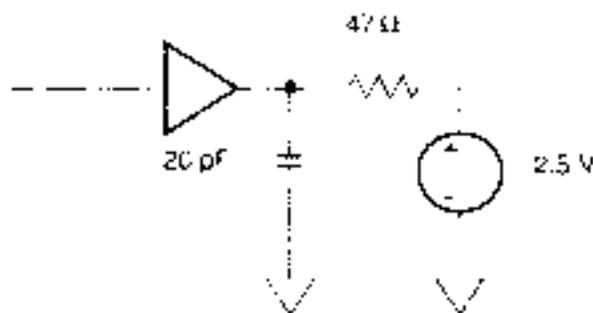


Figure 7-1: Rise and Fall Time Test Conditions

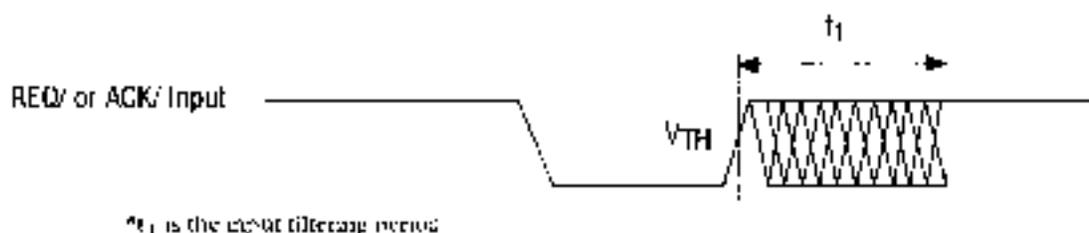


Figure 7-2: SCSI Input Filtering

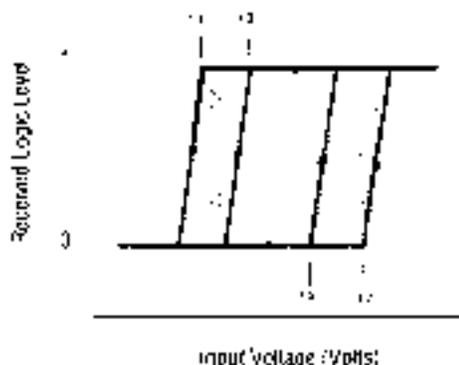


Figure 7-3: Hysteresis of SCSI Receiver

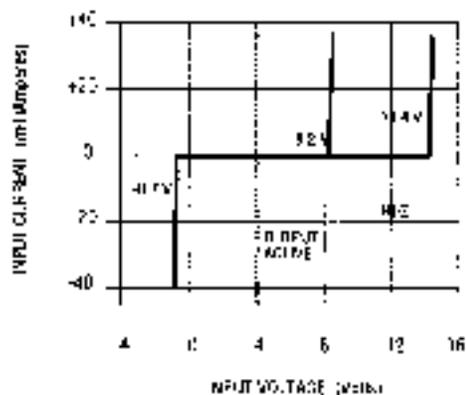


Figure 7-4: Input Current as a Function of Input Voltage

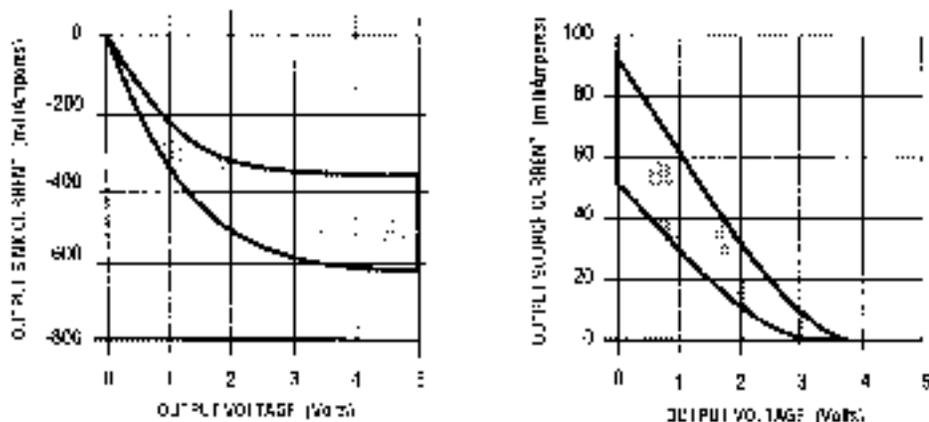


Figure 7-5: Output Current as a Function of Output Voltage

## AC Characteristics

The AC characteristics described in this section apply over the entire range of operating conditions (refer to the DC Characteristics section). Chip timings are based on simulation at worst case voltage, temperature, and processing. Timings were developed with a load capacitance of 50 pF.

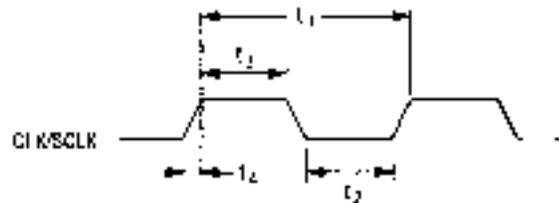


Figure 7-6: Clock Timing Waveform

Table 7-13: Clock Timing

Symbol	Parameter	Min	Max	Units
$t_1$	Bus clock cycle time	30	DC	ns
	SCSI clock cycle time (SCLK)*	12.5	60	ns
$t_2$	CLK low time**	12	-	ns
	SCLK low time**	6	33	ns
$t_3$	CLK high time**	12	-	ns
	SCLK high time**	6	33	ns
$t_4$	CLK slew rate	1	-	V/ns
	SCLK slew rate	1	-	V/ns

\* This parameter must be met to insure SCSI timing are within specification

\*\* Duty cycle not to exceed 60/40

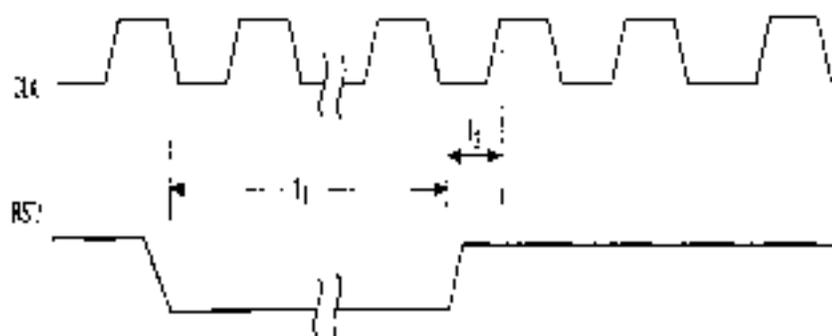


Figure 7-7: Reset Input Waveforms

Table 7-14: Reset Input Timings

Symbol	Parameter	Min	Max	Units
$t_1$	Reset pulse width	10	-	$t_{CLK}$
$t_2$	Reset deasserted setup to CLK high	0	-	ns

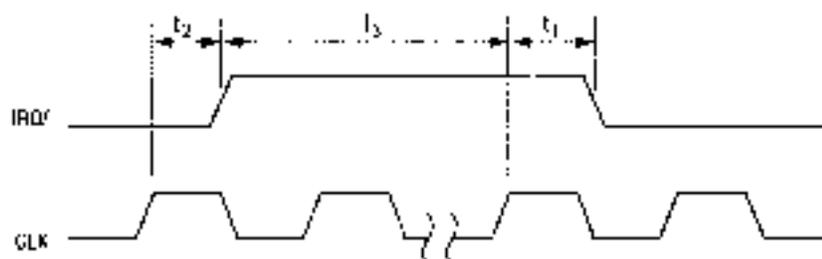


Figure 7-8: Interrupt Output Waveforms

Table 7-15: Interrupt Output Timings

Symbol	Parameter	Min	Max	Units
$t_1$	CLK high to IRQ# low	-	20	ns
$t_2$	CLK high to IRQ# high	-	40	ns
$t_3$	IRQ# deassertion time	3	-	CLKs

## PCI Interface Timing Diagrams

Figure 7-9 through Figure 7-18 represent signal activity when the SYM53C860 accesses the PCI bus. (The timings for the PCI bus interface are listed on page 7-22.)

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### Timing diagrams included in this section

- PCI configuration register read
- PCI configuration register write
- Target read
- Target write
- Op code fetch, non-burst
- Burst op code fetch
- Back-to-back read
- Back-to-back write
- Burst read
- Burst write

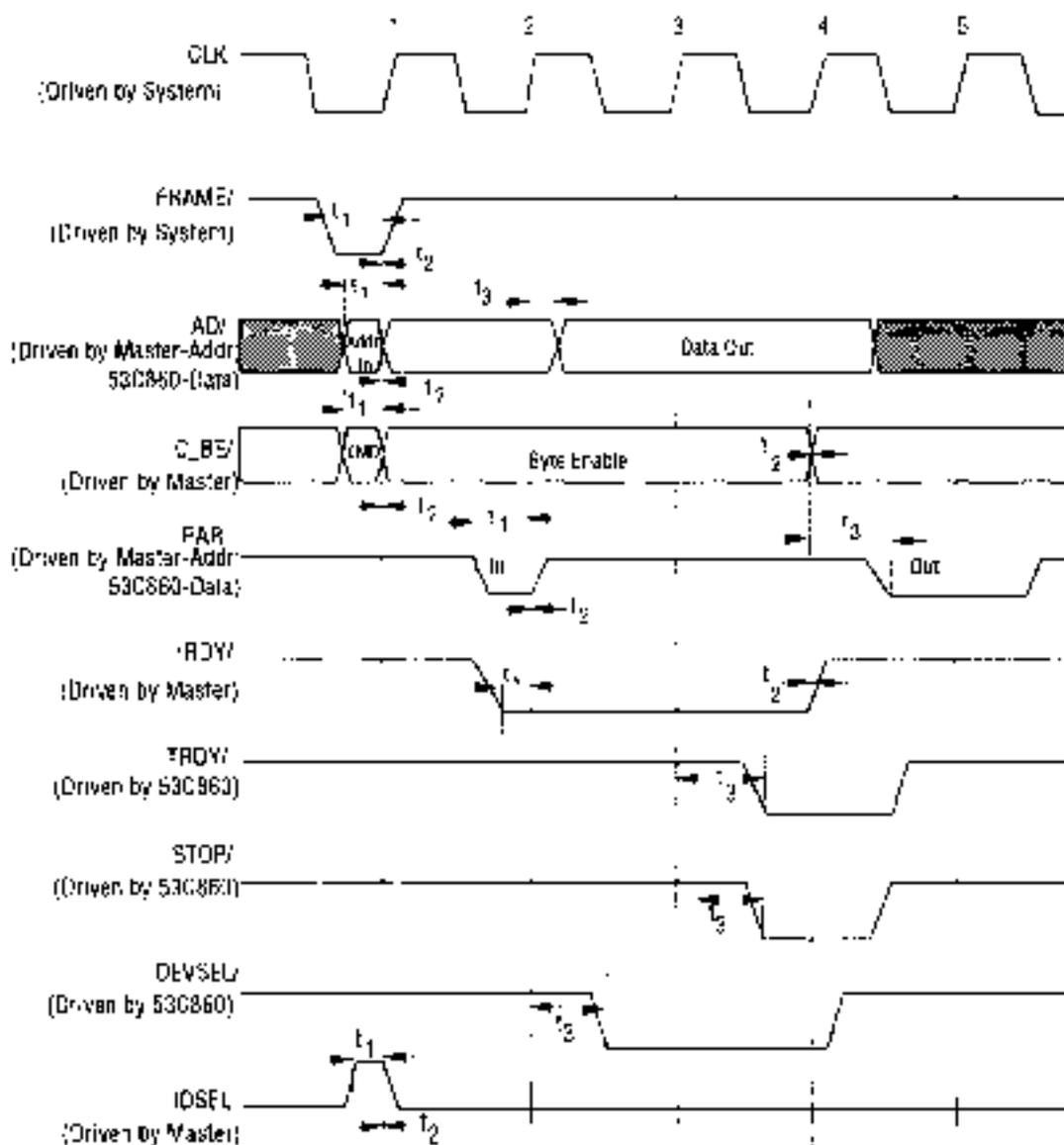


Figure 7-9: Configuration Register Read

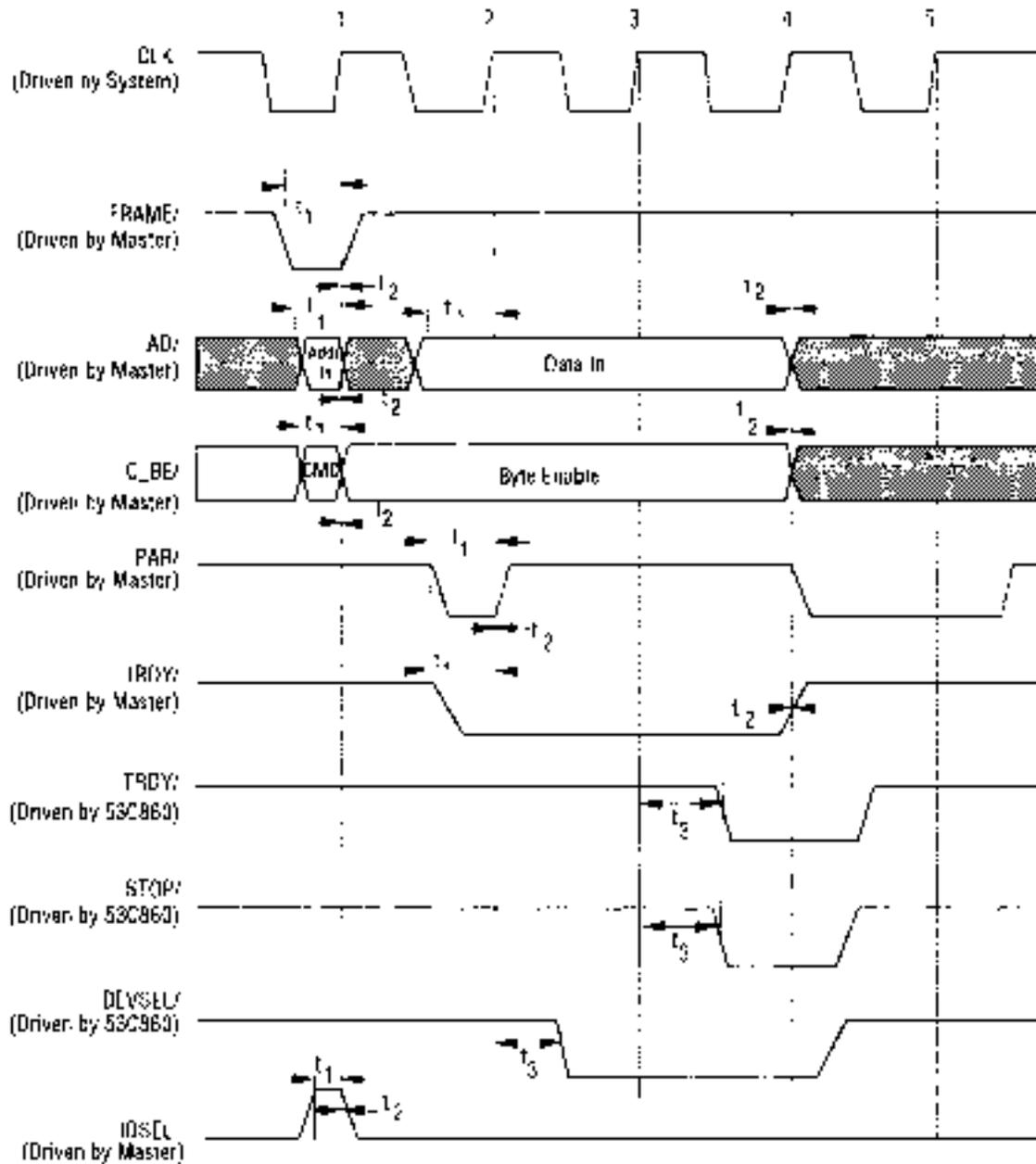


Figure 7-10: Configuration Register Write

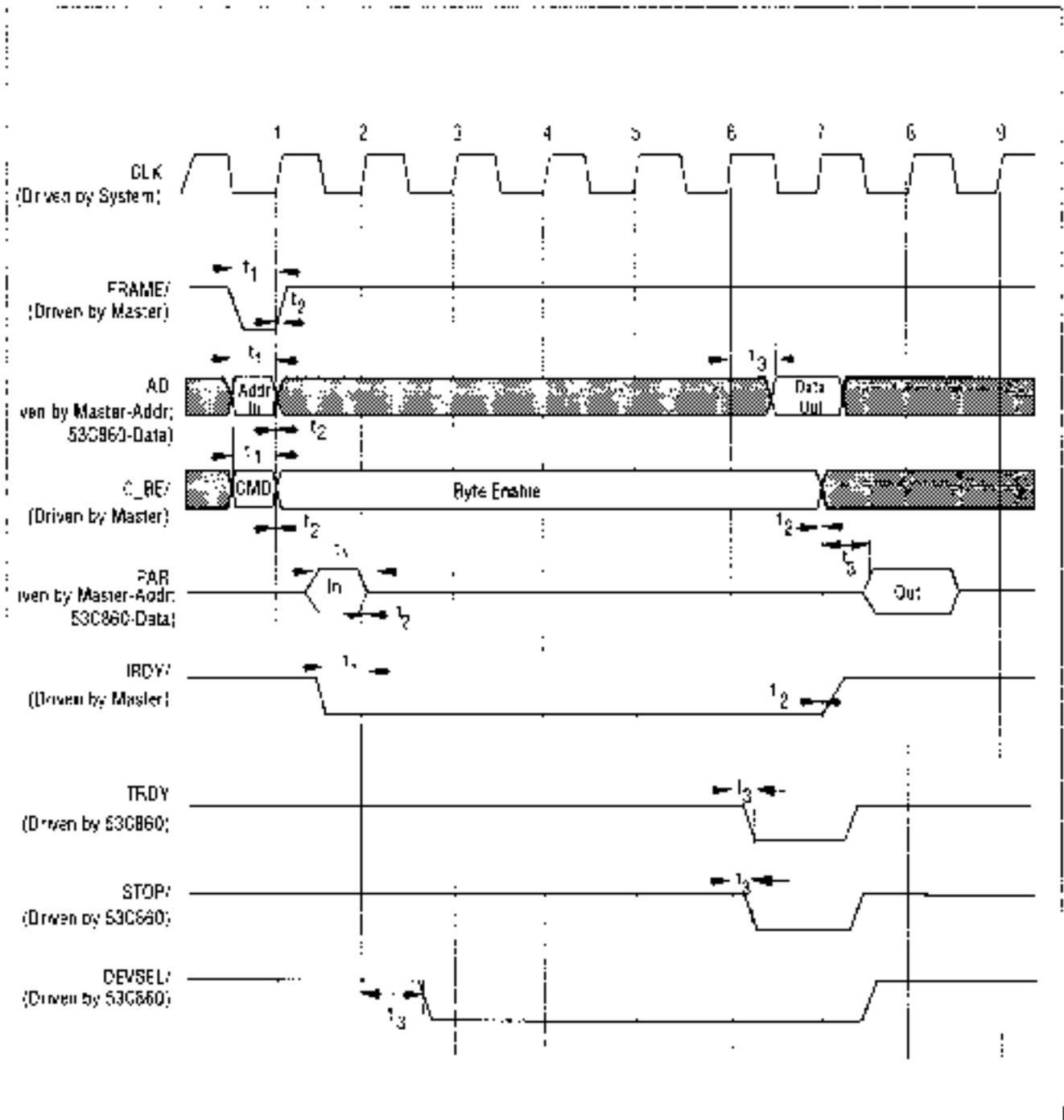


Figure 7-11: Target Read

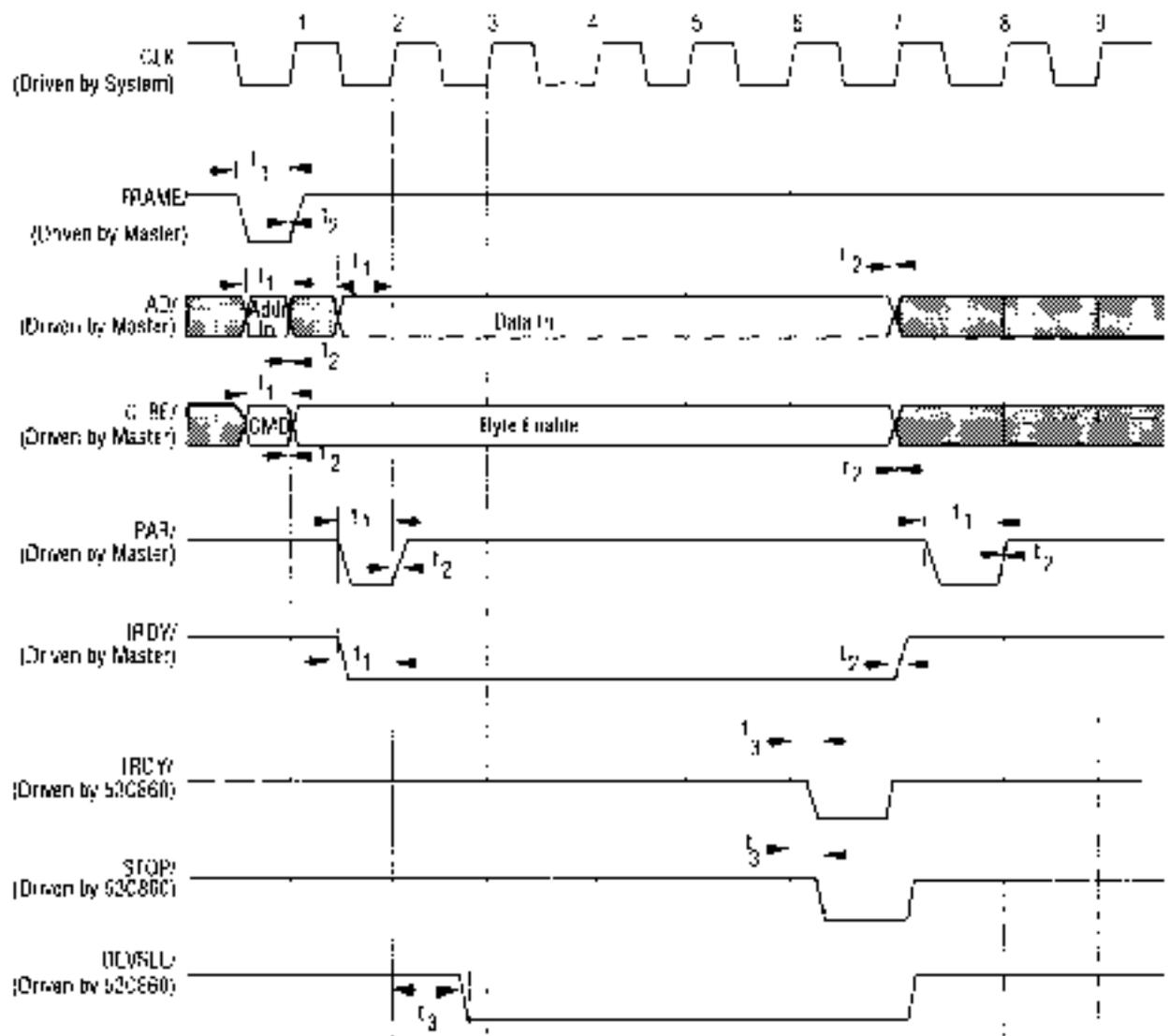


Figure 7-12: Target Write

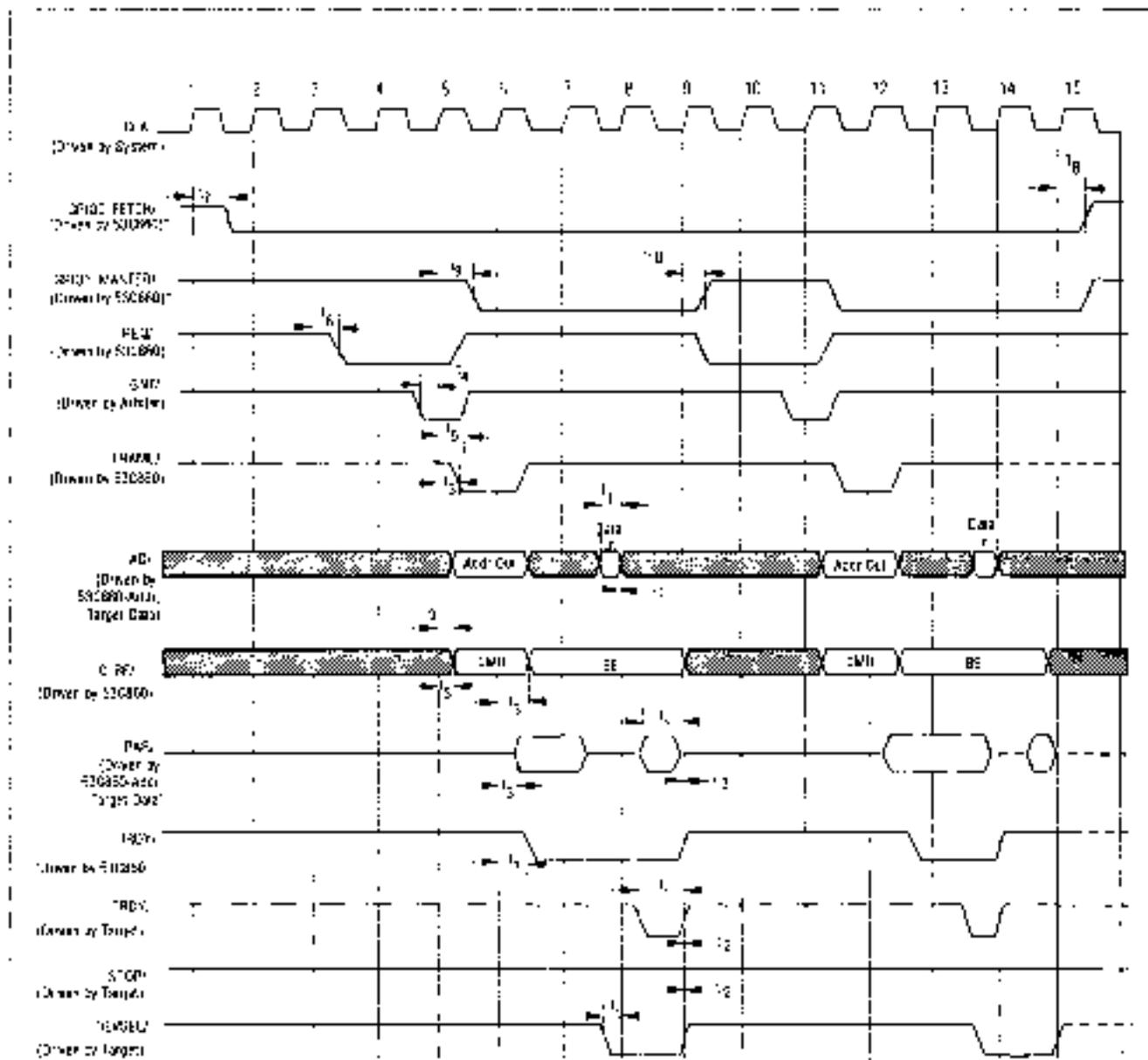


Figure 7-13: Op Code Fetch, non-burst

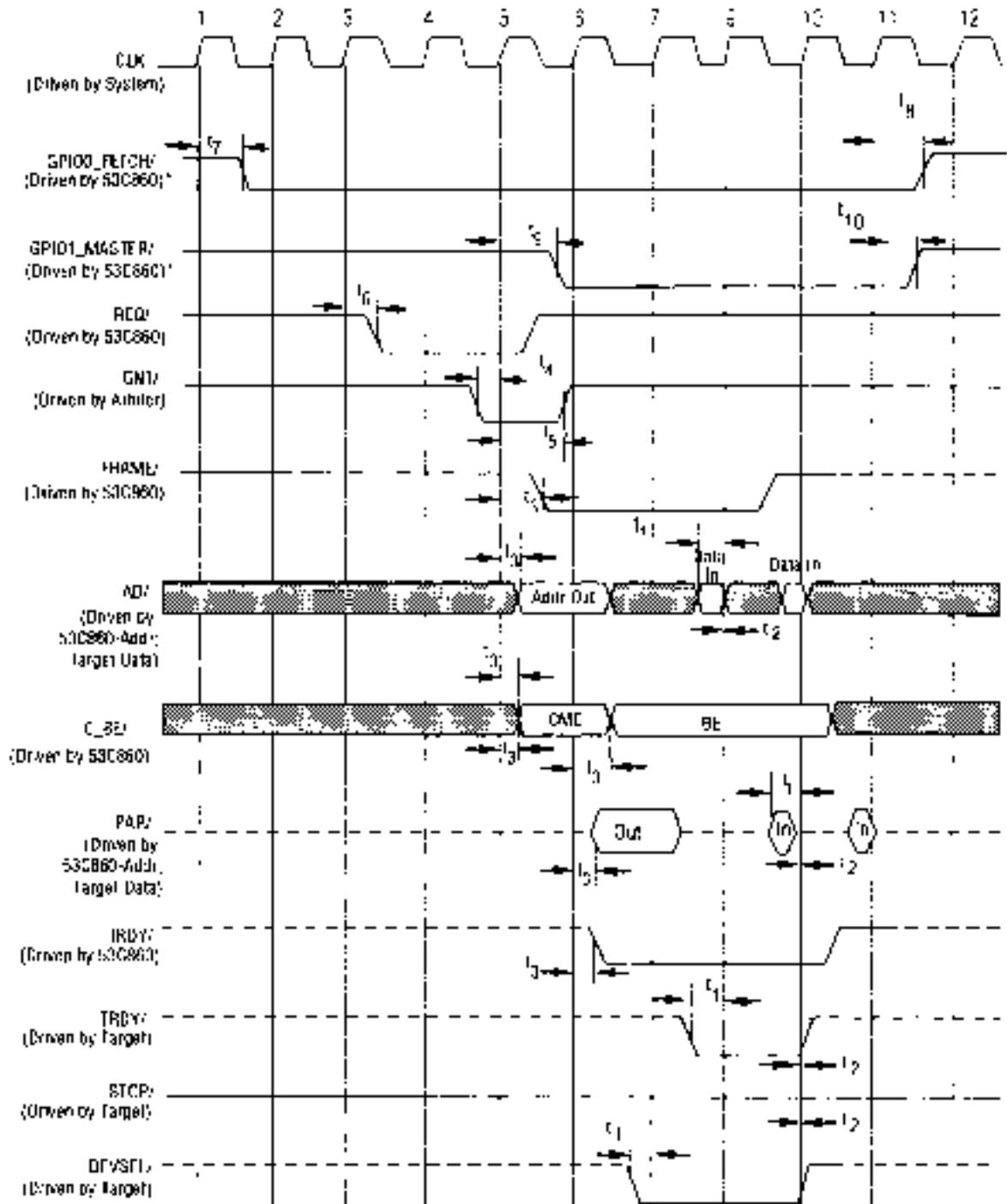


Figure 7-14: Burst Op Code Fetch

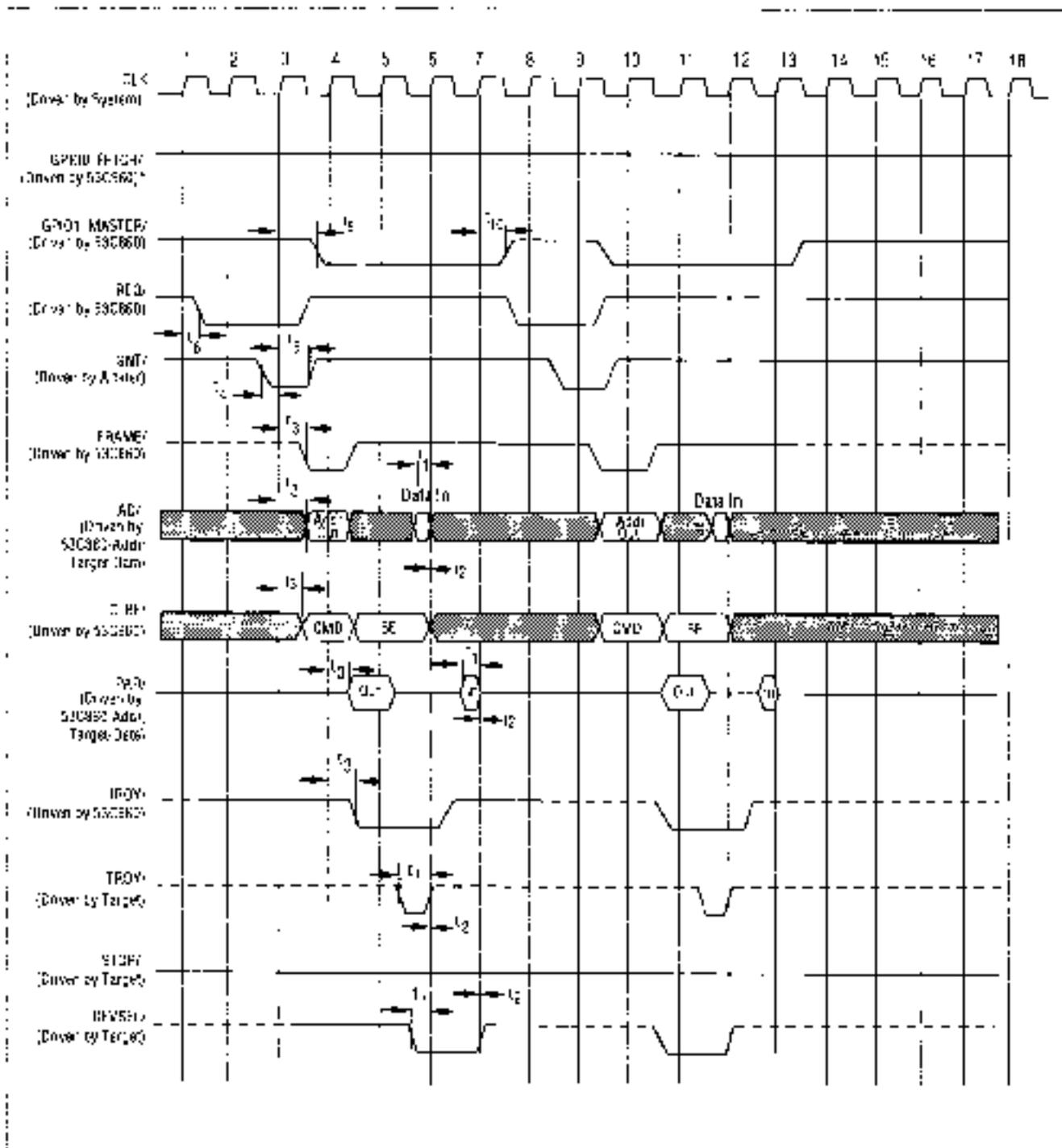


Figure 7-15: Back to Back Read

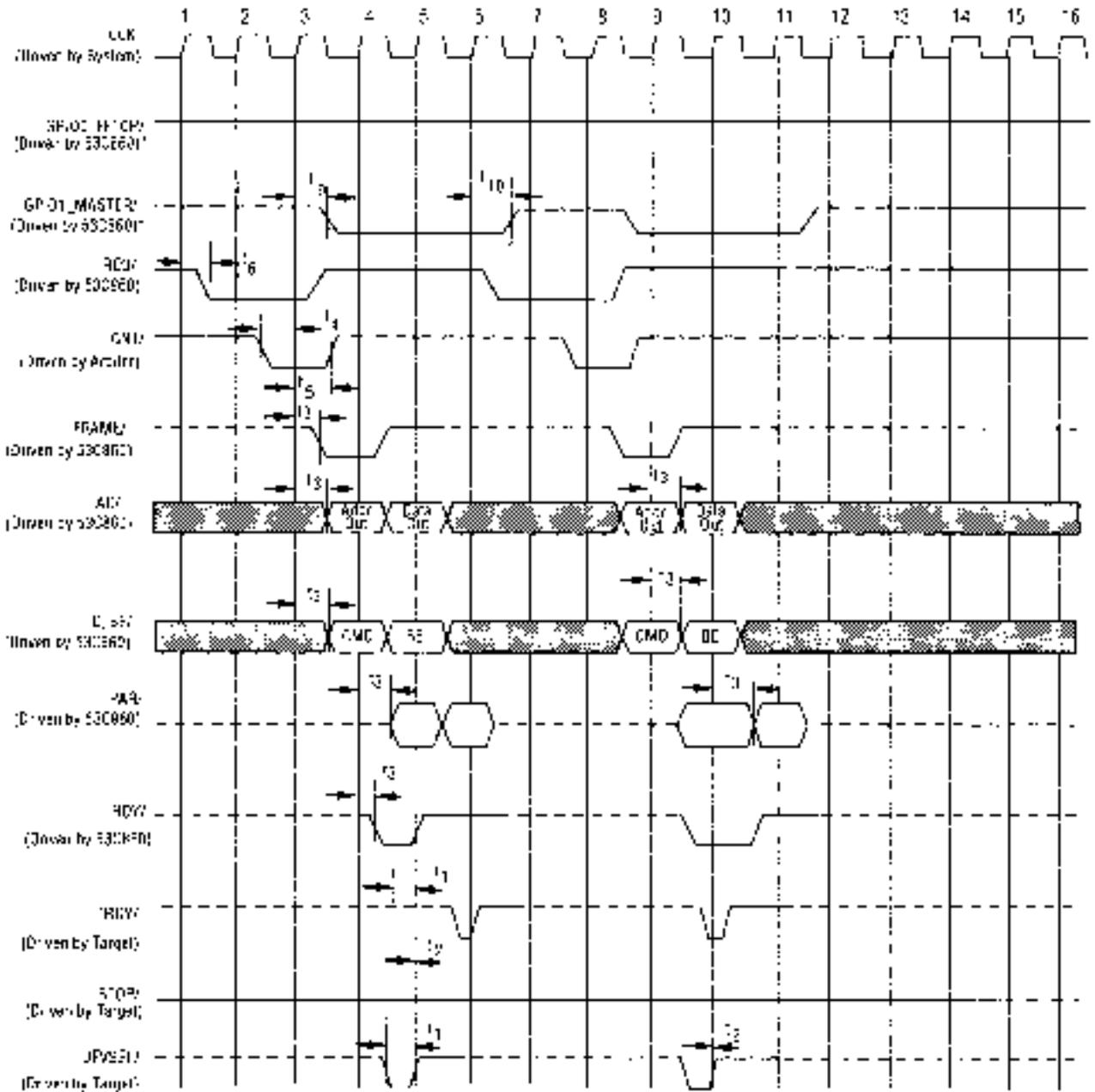


Figure 7-16: Back to Back Write

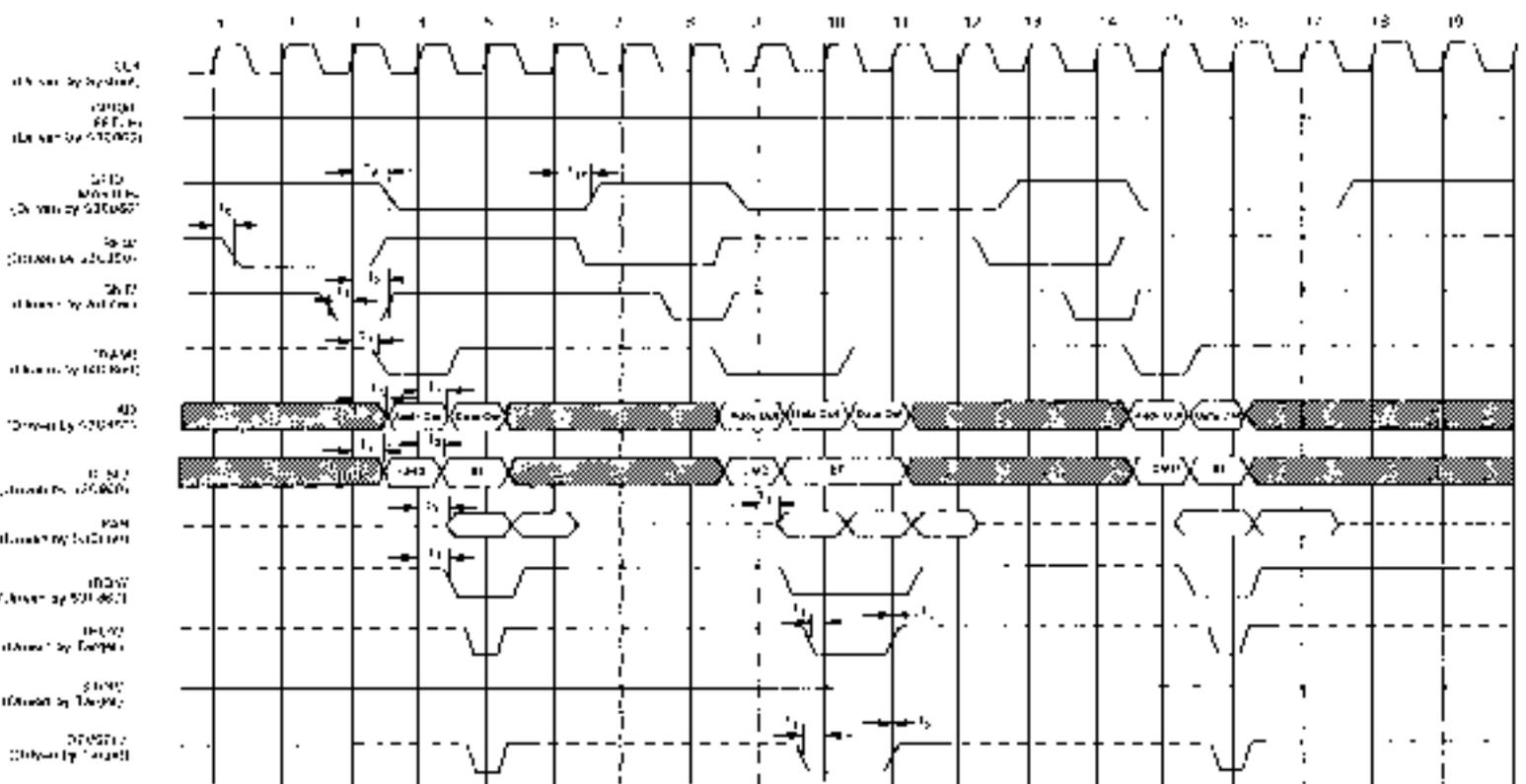


Figure 7-17: Burst Read

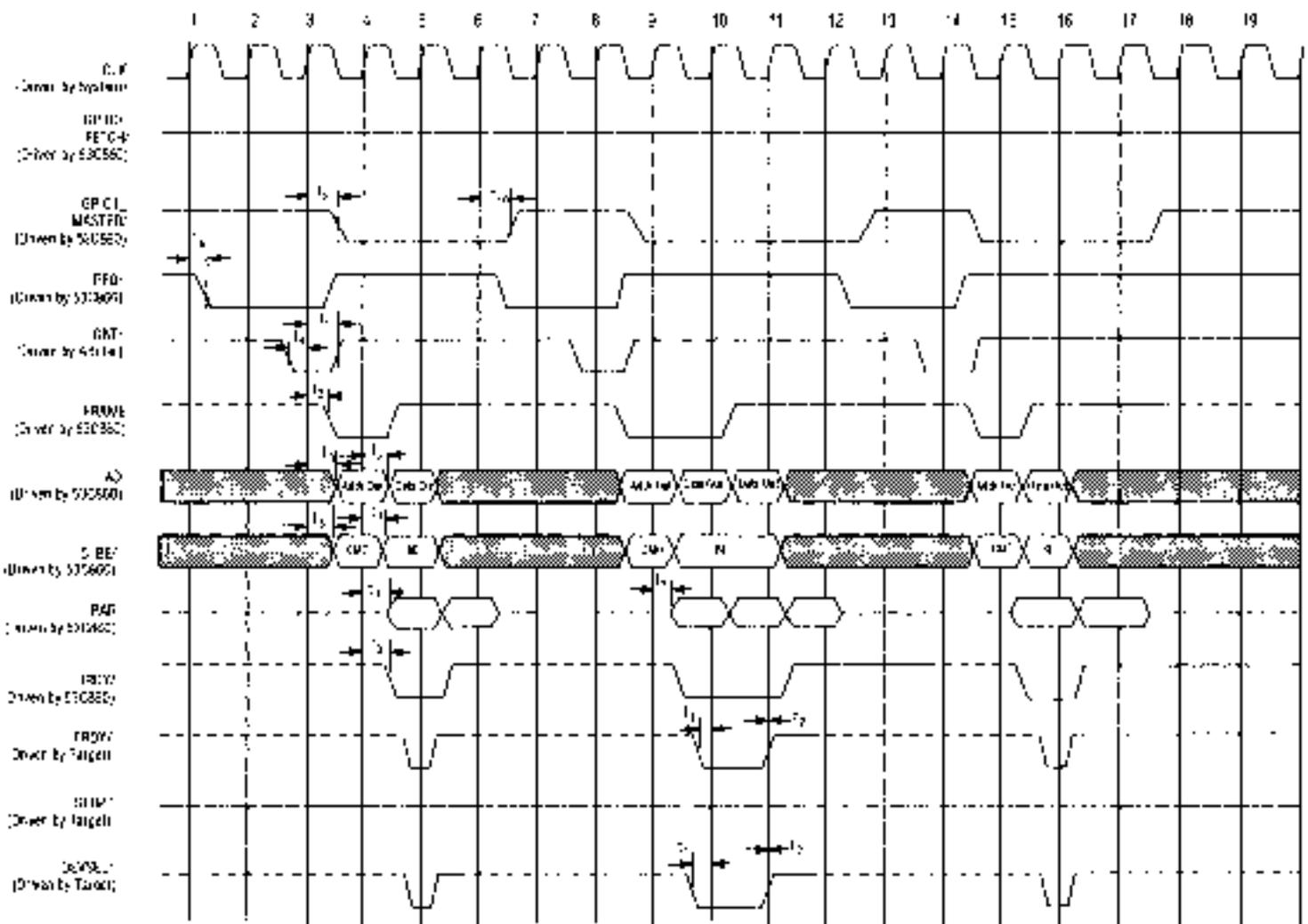


Figure 7-18: Burst Write

## PCI Interface Timings

Table 7-16: SYM53C860 PCI Timings

Symbol	Parameter	Min	Max	Unit
$t_1$	Shared signal input setup time	7	-	ns
$t_2$	Shared signal input hold time	0	-	ns
$t_3$	CLK to shared signal output valid	-	11	ns
$t_4$	Side signal input setup time	10	-	ns
$t_5$	Side signal input hold time	0	-	ns
$t_6$	CLK to side signal output valid	-	12	ns
$t_7$	CLK high to FETCH/ low	-	20	ns
$t_8$	CLK high to FETCH/ high	-	20	ns
$t_9$	CLK high to MASTER/ low	-	20	ns
$t_{10}$	CLK high to MASTER/ high	-	20	ns

## SCSI Timings

### Initiator Asynchronous Send

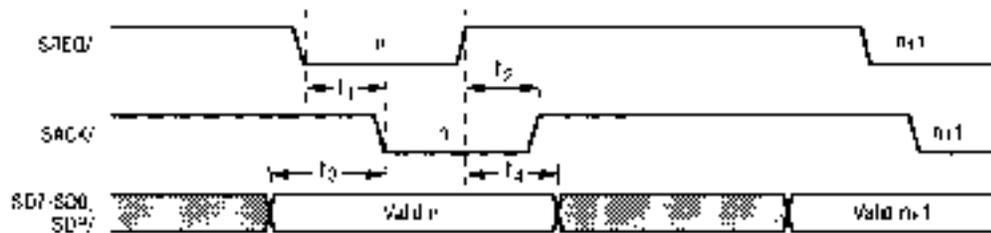


Figure 7-19: Initiator Asynchronous Send Waveforms

Table 7-17: Initiator Asynchronous Send Timings (5 MHz)

Symbol	Parameter	Min	Max	Units
$t_1$	SACK# asserted from SREQ# asserted	10	-	ns
$t_2$	SACK# deasserted from SREQ# deasserted	10	-	ns
$t_3$	Data setup to SACK# asserted	55	-	ns
$t_4$	Data hold from SREQ# deasserted	20	-	ns

**Initiator**  
**Asynchronous Receive**



**Figure 7-20: Initiator Asynchronous Receive Waveforms**

**Table 7-18: Initiator Asynchronous Receive Timings (5 MB/s)**

Symbol	Parameter	Min	Max	Units
$t_1$	SACK# asserted from SREQ# asserted	10	-	ns
$t_2$	SACK# deasserted from SREQ# deasserted	10	-	ns
$t_3$	Data setup to SREQ# asserted	0	-	ns
$t_4$	Data hold from SACK# asserted	0	-	ns

### Target Asynchronous Send

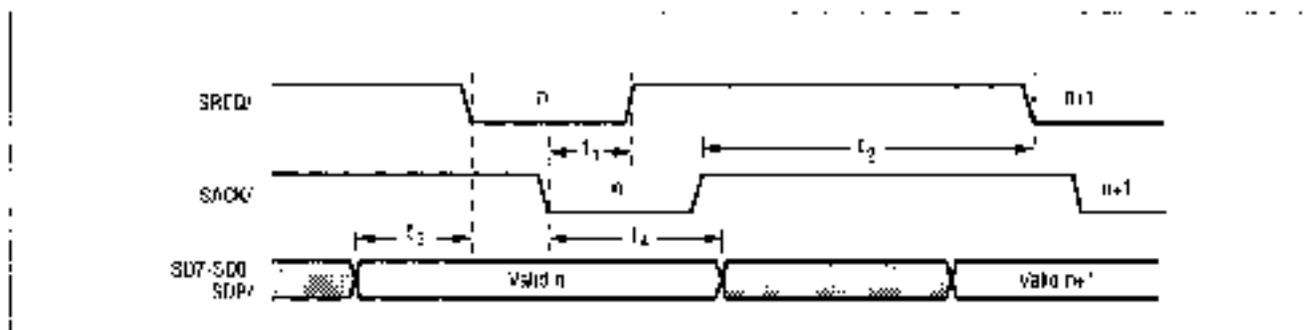


Figure 7-21: Target Asynchronous Send Waveforms

Table 7-19: Target Asynchronous Send Timings (5 MB/s)

Symbol	Parameter	Min	Max	Units
$t_1$	SREQ# deasserted from SACK# asserted	10	-	ns
$t_2$	SREQ# asserted from SACK# deasserted	10	-	ns
$t_3$	Data setup to SREQ# asserted	55	-	ns
$t_4$	Data hold from SACK# asserted	20	-	ns

**Target  
Asynchronous Receive**



Figure 7-22: Target Asynchronous Receive Waveforms

Table 7-20: Target Asynchronous Receive Timings (5 MB/s)

Symbol	Parameter	Min	Max	Units
$t_1$	SREQ/ deasserted from SACK/ asserted	10	-	ns
$t_2$	SREQ/ asserted from SACK/ deasserted	10	-	ns
$t_3$	Data setup to SACK/ asserted	0	-	ns
$t_4$	Data hold from SREQ/ deasserted	0	-	ns

## Initiator and Target Synchronous Transfers

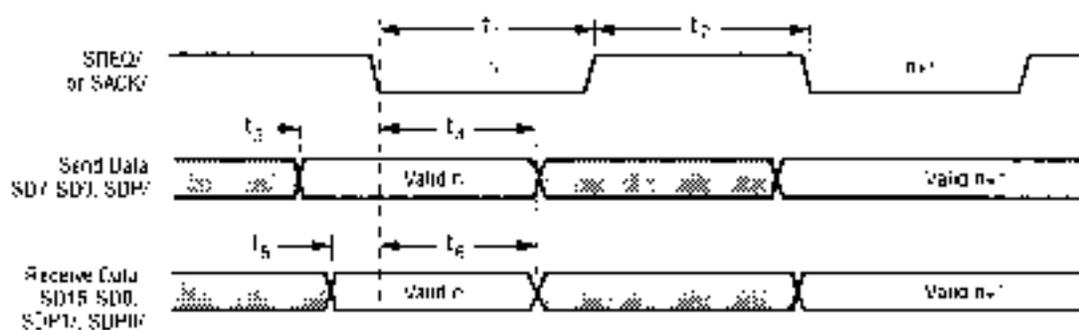


Figure 7-23: Initiator and Target Synchronous Transfers

Table 7-21: SCSI-1 Transfers (Single-Ended, 5.0 MB/s)

Symbol	Parameter	Min	Max	Units
$t_1$	Send SREQ/ or SACK/ assertion pulse width	90	-	ns
$t_2$	Send SREQ/ or SACK/ deassertion pulse width	90	-	ns
$t_1$	Receive SREQ/ or SACK/ assertion pulse width	90	-	ns
$t_2$	Receive SREQ/ or SACK/ deassertion pulse width	90	-	ns
$t_3$	Send data setup to SREQ/ or SACK/ asserted	55	-	ns
$t_4$	Send data hold from SREQ/ or SACK/ asserted	100	-	ns
$t_5$	Receive data setup to SREQ/ or SACK/ asserted	0	-	ns
$t_6$	Receive data hold from SREQ/ or SACK/ asserted	45	-	ns

**Table 7-22: SCSI-2 Fast Transfers (10.0 MB/s (8-bit transfers), 40 MHz clock)**

Symbol	Parameter	Min	Max	Units
t <sub>1</sub>	Send SREQ/ or SACK/ assertion pulse width	35	-	ns
t <sub>2</sub>	Send SREQ/ or SACK/ deassertion pulse width	35	-	ns
t <sub>1</sub>	Receive SREQ/ or SACK/ assertion pulse width	20	-	ns
t <sub>2</sub>	Receive SREQ/ or SACK/ deassertion pulse width	20	-	ns
t <sub>3</sub>	Send data setup to SREQ/ or SACK/ asserted	33	-	ns
t <sub>4</sub>	Send data hold from SREQ/ or SACK/ asserted	45	-	ns
t <sub>5</sub>	Receive data setup to SREQ/ or SACK/ asserted	0	-	ns
t <sub>6</sub>	Receive data hold from SREQ/ or SACK/ asserted	10	-	ns

**Table 7-23: SCSI-2 Fast Transfers (10.0 MB/s (8-bit transfers), 50 MHz clock)**

Symbol	Parameter	Min	Max	Unit
t <sub>1</sub>	Send SREQ/ or SACK/ assertion pulse width	35	-	ns
t <sub>2</sub>	Send SREQ/ or SACK/ deassertion pulse width	35	-	ns
t <sub>1</sub>	Receive SREQ/ or SACK/ assertion pulse width	20	-	ns
t <sub>2</sub>	Receive SREQ/ or SACK/ deassertion pulse width	20	-	ns
t <sub>3</sub>	Send data setup to SREQ/ or SACK/ asserted	33	-	ns
t <sub>4</sub>	Send data hold from SREQ/ or SACK/ asserted	40	-	ns
t <sub>5</sub>	Receive data setup to SREQ/ or SACK/ asserted	0	-	ns
t <sub>6</sub>	Receive data hold from SREQ/ or SACK/ asserted	10	-	ns

\*Transfer period bits (bits 6-4 in the SPTDR register) are set to zero and the Extra Clock Cycle of Data Setup bit (bit 7 in SUNIT1) is set.

Note: for fast SCSI, set the TolerANT Enable bit (bit 7 in SPTST3).

**Table 7-24: Fast-20 SCSI Transfers (20.0 MB/s (8-bit transfers), 80 MHz clock)**

Symbol	Parameter	Min	Max	Unit
t <sub>1</sub>	Send SREQ <sub>i</sub> or SACK <sub>i</sub> assertion pulse width	16	-	ns
t <sub>2</sub>	Send SREQ <sub>i</sub> or SACK <sub>i</sub> deassertion pulse width	16	-	ns
t <sub>1</sub>	Receive SREQ <sub>i</sub> or SACK <sub>i</sub> assertion pulse width	10	-	ns
t <sub>2</sub>	Receive SREQ <sub>i</sub> or SACK <sub>i</sub> deassertion pulse width	10	-	ns
t <sub>3</sub>	Send data setup to SREQ <sub>i</sub> or SACK <sub>i</sub> asserted	12	-	ns
t <sub>3</sub>	Send data hold from SREQ <sub>i</sub> or SACK <sub>i</sub> asserted	17	-	ns
t <sub>4</sub>	Receive data setup to SREQ <sub>i</sub> or SACK <sub>i</sub> asserted	0	-	ns
t <sub>4</sub>	Receive data hold from SREQ <sub>i</sub> or SACK <sub>i</sub> asserted	6	-	ns

\*Transfer period bits (bits 6-4 in the SXFER register) are set to zero and the Extra Clock Cycle of Data Setup bit (bit 7 in SCNTL1) is set

Note: for host SCSI, set the TolrANT Enable bit (bit 7 in STEN1). During Fast-20 transfers, the value of the Extend REQ/ACK Filtering bit (STPNT2, bit 1) has no effect



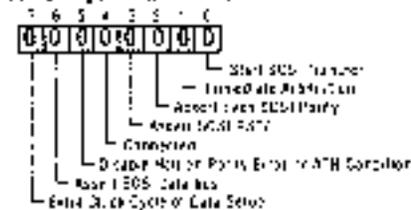
## Appendix A

# Register Summary

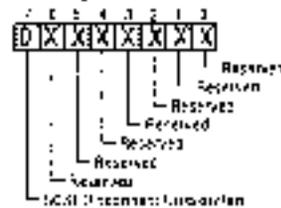
SCNF0 Register R/W 3Ch (8F)



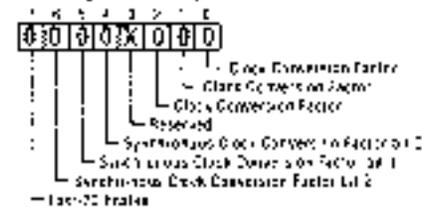
SCNF1 Register R/W 3Ch (9F)



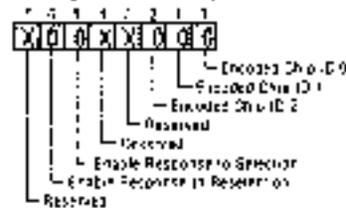
SCNF2 Register R/W 3Ch (32h)



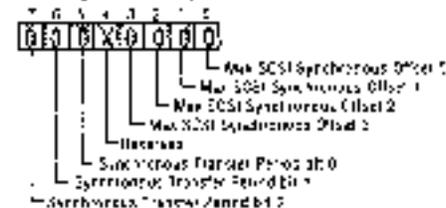
SCNF3 Register R/W 3Ch (33h)



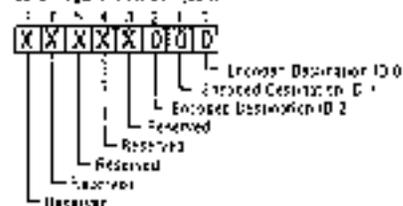
SCIC Register R/W 3Ch (44F)



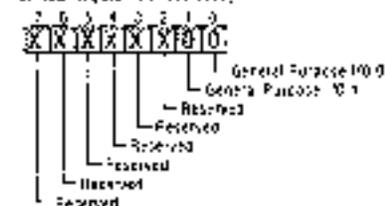
SCPE0 Register R/W 3Ch (55h)



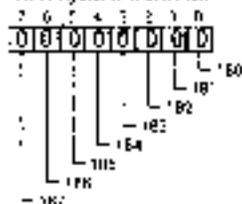
SDID Register R/W 3Ch (66h)



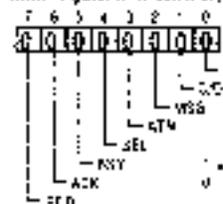
GPR00 Register R/W 3Ch (87F)



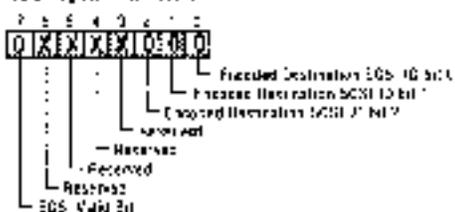
STAT0 Register (0x00000000)



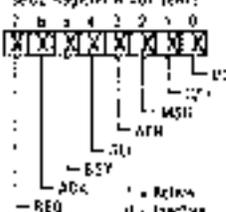
STAT1 Register (0x00000001)



STAT2 Register (0x00000002)



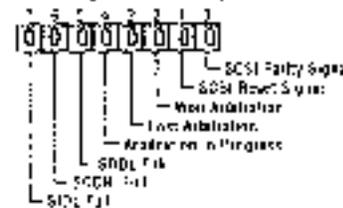
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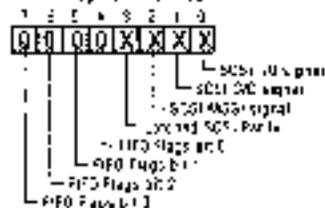
STAT4 Register (0x00000004)



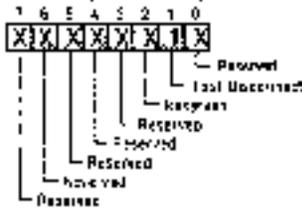
STAT5 Register (0x00000005)



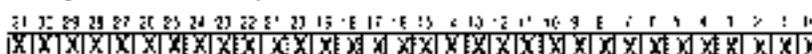
STAT6 Register (0x00000006)



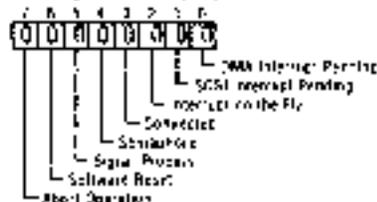
STAT7 Register (0x00000007)



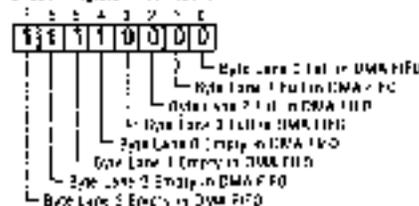
ISA Register: RAW 101 (0A-00A)



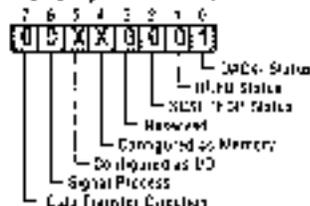
ISAT Register: RAW 140 (0AA)



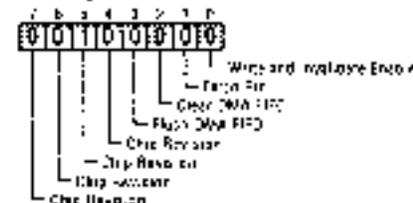
DTEST Register: P 19F (91A)



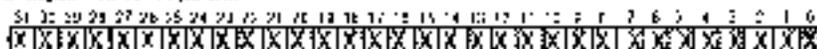
CI1512 Register: R 1A1 (9AA)



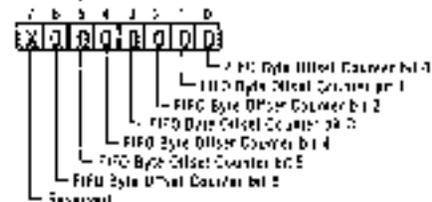
DTEST2 Register: RAW 1E1 (B5A)



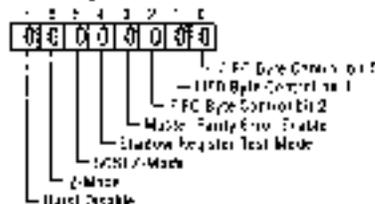
TEMP Register: RAW 1C1 (9A-00A)



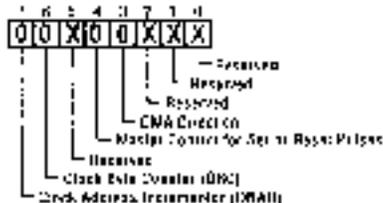
CFPC Register: RAW 20F (A0)



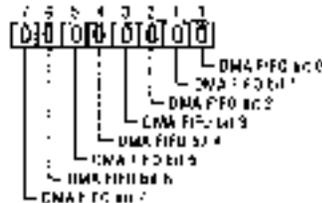
DTEST3 Register: A 211 (A1A)



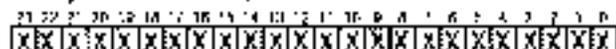
CTEST0 Register (RW 20h) (40h)



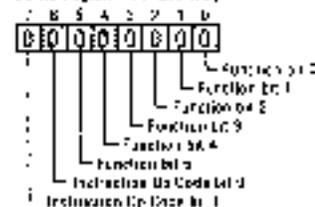
CTEST0 Register (RW 20h) (40h)



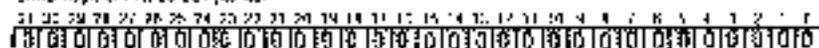
DMC Register (RW 24-26h) (44-46h)



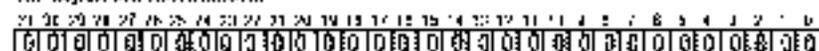
DDMD Register (RW 27h) (47h)



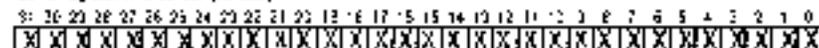
DMAD Register (RW 28-2Bh) (48-4Bh)



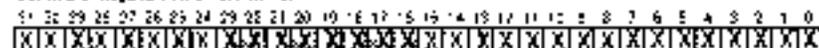
DMP Register (RW 2C-2Fh) (4C-4Fh)



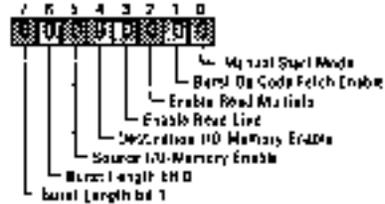
DSPA Register (RW 30-3Fh) (50-5Fh)



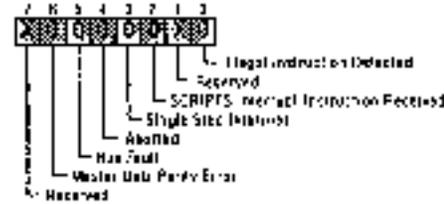
SCNATGM Register (RW 34-3Fh) (64-6Fh)



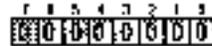
DMA0CE Register R/W 3Eh (3Eh)



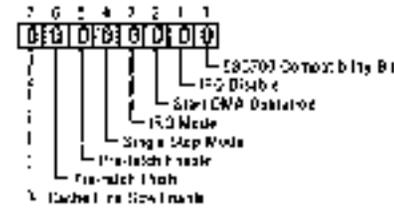
DIEM Flagset R/W 3Fh (3Fh)



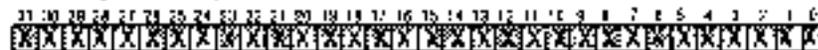
Scratch Byte Register R/W 30h (30h)



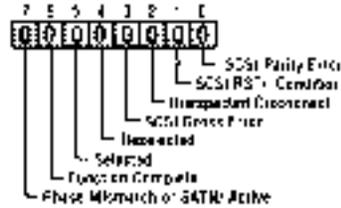
CCMFL Register R/W 30h (30h)



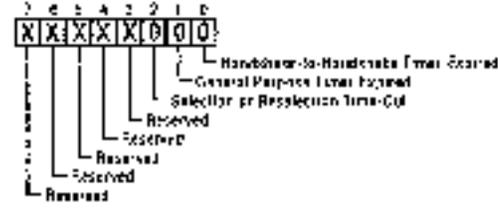
ADDR Register 0 3C-3F (8C-8Fh)



SIEMC Register R/W 40h (C0h)



SEMI Register R/W 41h (C1h)



SISFC Register RW 42h (02F)

7	6	5	4	3	2	1	0
0	1	0	0	0	0	1	0



SIST Register RW 43h (03F)

7	6	5	4	3	2	1	0
X	X	X	X	X	0	0	0



SLPAR Register RW 44h (04F)

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0



Memory Access Control Register RW 45h (05F)

7	6	5	4	3	2	1	0
0	1	0	1	0	0	0	0



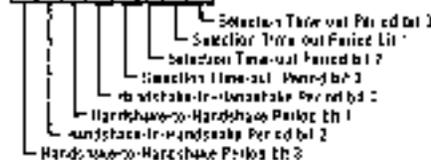
General Purpose Per Control Register RW 46h (06F)

7	6	5	4	3	2	1	0
0	0	X	X	X	X	1	1



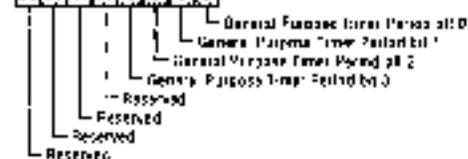
STIME3 Register RW 47h (07F)

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0

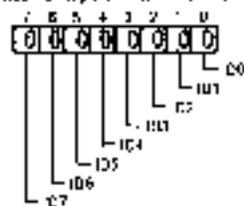


STIME1 Register RW 48h (08F)

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X	X	X	X	0	0	0	0



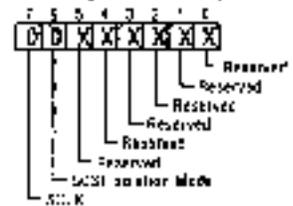
RESFD Register R/W 4Bh (04h)



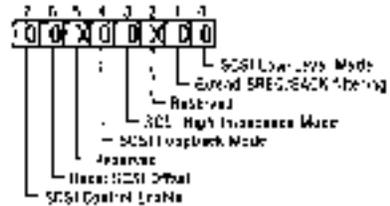
STEST0 Register R/W 4Ch (0Ch)



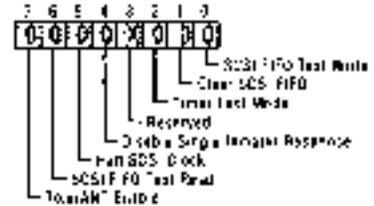
STFSF1 Register R/W 4C1h (0C1h)



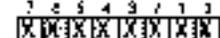
SCLEP5 Register R/W 4E5h (0E5h)



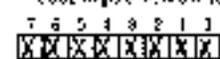
STEST3 Register R/W 4F3h (0F3h)



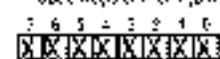
SIM Register R/W 50h (00h)



SCOL Register R/W 54h (04h)



SCCL Register R/W 5Fh (0Fh)



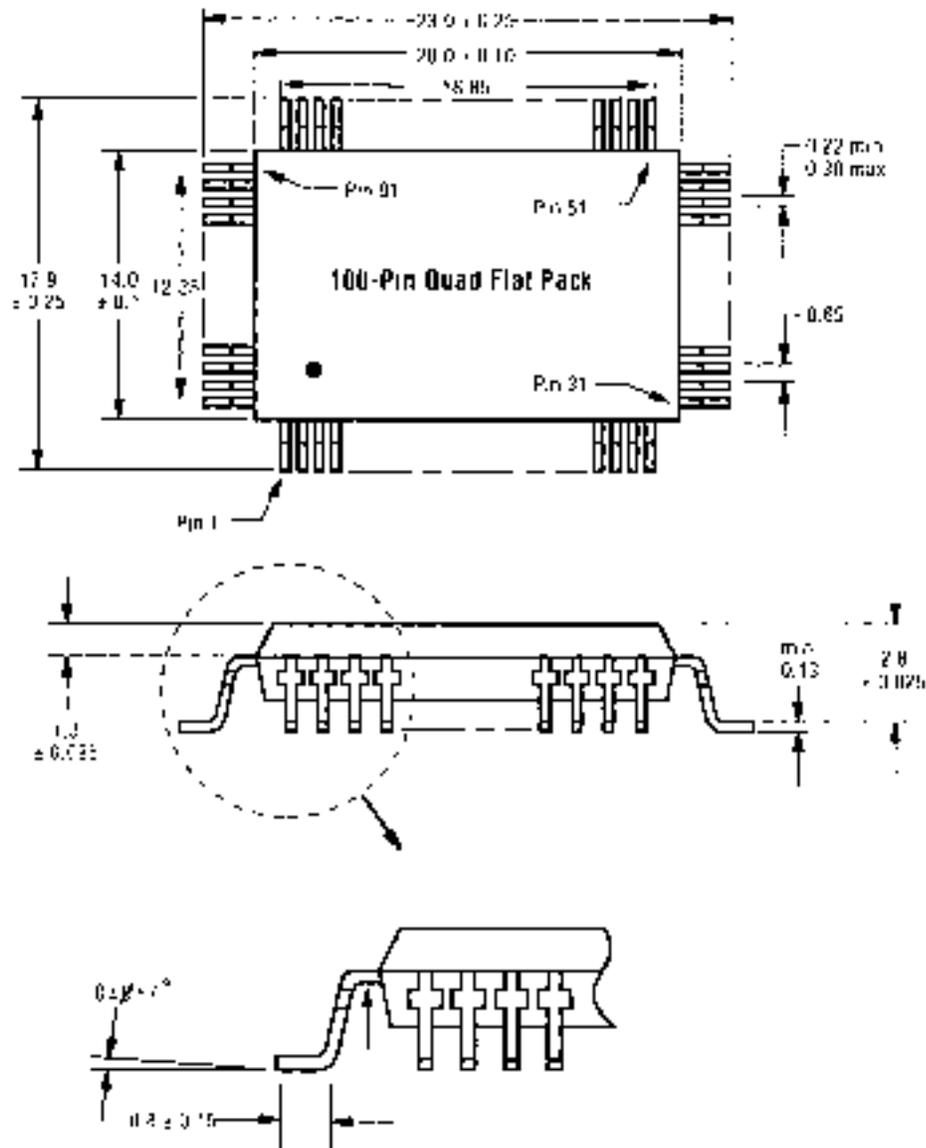
SDRAMCMB Register R/W 5D 5Fh (0D 0Fh)





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