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PRODUCT SPECIFICATIONS

SHARP®

Integrated Circuits Group

LH28F320S3HNS-L11

Flash Memory

16M (2MB × 8 / 1MB × 16)

(Model No.: LHF32K03)

Spec No.: EL108029A

Issue Date: December 17, 1998

SHARP

SPEC No.	EL108029A
ISSUE:	Dec. 17, 1998

To; ____________

SPECIFICATIONS

Product Type 32Mbit Flash Memory

LH28F320S3HNS-L11

Model No. (LHF32K03)

※This specifications contains 56 pages including the cover and appendix.
If you have any objections, please contact us before issuing purchasing order.

CUSTOMERS ACCEPTANCE

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BY: ____________

PRESENTED

BY: M. Okada

M. OKADA
Dept. General Manager

REVIEWED BY: PREPARED BY:

M. Kawaki T. Yoshida

Memory IC Engineering Dept. I
Systems LSI Development Center
Integrated Circuits Group
SHARP CORPORATION

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LH28F320S3HNS-L11
32-MBIT (4MBx8/2MBx16)
Smart 3 Flash MEMORY

- **Smart 3 Technology**
  - **2.7V or 3.3V V_{CC}**
  - **2.7V, 3.3V or 5V V_{PP}**
- **Common Flash Interface (CFI)**
  - **Universal & Upgradable Interface**
- **Scalable Command Set (SCS)**
- **High Speed Write Performance**
  - **32 Bytes x 2 plane Page Buffer**
  - **2.7 μs/Byte Write Transfer Rate**
- **High Speed Read Performance**
  - **110ns(3.3V±0.3V), 140ns(2.7V-3.6V)**
- **Operating Temperature**
  - **-40°C to +85°C**
- **High-Density Symmetrically-Blocked Architecture**
  - **Sixty-four 64-Kbyte Erasable Blocks**
- **Extended Cycling Capability**
  - **100,000 Block Erase Cycles**
  - **6.4 Million Block Erase Cycles/Chip**
- **Enhanced Automated Suspend Options**
  - **Write Suspend to Read**
  - **Block Erase Suspend to Write**
  - **Block Erase Suspend to Read**
- **Automated Write and Erase**
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- **User-Configurable x8 or x16 Operation**
- **Industry-Standard Packaging**
  - **56-Lead SSOP**
- **ETOX™* V Nonvolatile Flash Technology**
- **CMOS Process (P-type silicon substrate)**
- **Not designed or rated as radiation hardened**

SHARP's LH28F320S3HNS-L11 Flash memory with Smart 3 technology is a high-density, low-cost, nonvolatile, read/write storage solution for a wide range of applications. Its symmetrically-blocked architecture, flexible voltage and extended cycling provide for highly flexible component suitable for resident flash arrays, SIMMs and memory cards. Its enhanced suspend capabilities provide for an ideal solution for code + data storage applications. For secure code storage applications, such as networking, where code is either directly executed out of flash or downloaded to DRAM, the LH28F320S3HNS-L11 offers three levels of protection: absolute protection with V_{PP} at GND, selective hardware block locking, or flexible software block locking. These alternatives give designers ultimate control of their code security needs.

The LH28F320S3HNS-L11 is conformed to the flash Scalable Command Set (SCS) and the Common Flash Interface (CFI) specification which enable universal and upgradable interface, enable the highest system/device data transfer rates and minimize device and system-level implementation costs.

The LH28F320S3HNS-L11 is manufactured on SHARP's 0.4μm ETOX™* V process technology. It come in industry-standard package: the 56-Lead SSOP, ideal for board constrained applications.

*ETOX is a trademark of Intel Corporation.

1 INTRODUCTION

This datasheet contains LH28F320S3HNS-L11 specifications. Section 1 provides a flash memory overview. Sections 2, 3, 4, and 5 describe the memory organization and functionality. Section 6 covers electrical specifications.

1.1 Product Overview

The LH28F320S3HNS-L11 is a high-performance 32-Mbit Smart 3 Flash memory organized as 4MBx8/2MBx16. The 4MB of data is arranged in sixty-four 64-Kbyte blocks which are individually erasable, lockable, and unlockable in-system. The memory map is shown in Figure 3.

Smart 3 technology provides a choice of V_{CC} and V_{PP} combinations, as shown in Table 1, to meet system performance and power expectations. 2.7V V_{CC} consumes approximately one-fifth the power of 5V V_{CC}. V_{PP} at 2.7V and 3.3V eliminates the need for a separate 12V converter. In addition to flexible erase and program voltages, the dedicated V_{PP} pin gives complete data protection when $V_{PP} \leq V_{PPLK}$.

Table 1. V_{CC} and V_{PP} Voltage Combinations Offered by Smart 3 Technology

V_{CC} Voltage	V_{PP} Voltage
2.7V	2.7V, 3.3V, 5V
3.3V	3.3V, 5V

Internal V_{CC} and V_{PP} detection Circuitry automatically configures the device for optimized read and write operations.

A Command User Interface (CUI) serves as the interface between the system processor and internal operation of the device. A valid command sequence written to the CUI initiates device automation. An internal Write State Machine (WSM) automatically executes the algorithms and timings necessary for block erase, full chip erase, (multi) word/byte write and block lock-bit configuration operations.

A block erase operation erases one of the device's 64-Kbyte blocks typically within 0.41s (3.3V V_{CC}, 5V V_{PP}) independent of other blocks. Each block can be independently erased 100,000 times (6.4 million block erases per device). Block erase suspend mode allows system software to suspend block erase to read or write data from any other block.

A word/byte write is performed in byte increments typically within 12.95µs (3.3V V_{CC}, 5V V_{PP}). A multi word/byte write has high speed write performance of 2.7µs/byte (3.3V V_{CC}, 5V V_{PP}). (Multi) Word/byte write suspend mode enables the system to read data or execute code from any other flash memory array location.

Individual block locking uses a combination of bits and WP#, Sixty-four block lock-bits, to lock and unlock blocks. Block lock-bits gate block erase, full chip erase and (multi) word/byte write operations. Block lock-bit configuration operations (Set Block Lock-Bit and Clear Block Lock-Bits commands) set and cleared block lock-bits.

The status register indicates when the WSM's block erase, full chip erase, (multi) word/byte write or block lock-bit configuration operation is finished.

The STS output gives an additional indicator of WSM activity by providing both a hardware signal of status (versus software polling) and status masking (interrupt masking for background block erase, for example). Status polling using STS minimizes both CPU overhead and system power consumption. STS pin can be configured to different states using the Configuration command. The STS pin defaults to RY/BY# operation. When low, STS indicates that the WSM is performing a block erase, full chip erase, (multi) word/byte write or block lock-bit configuration. STS-High Z indicates that the WSM is ready for a new command, block erase is suspended and (multi) word/byte write are inactive, (multi) word/byte write are suspended, or the device is in deep power-down mode. The other 3 alternate configurations are all pulse mode for use as a system interrupt.

The access time is 110ns (t_{AVQV}) over the extended temperature range (-40°C to +85°C) and V_{CC} supply voltage range of 3.0V-3.6V. At lower V_{CC} voltage, the access time is 140ns (2.7V-3.6V).

The Automatic Power Savings (APS) feature substantially reduces active current when the device is in static mode (addresses not switching). In APS mode, the typical I_{CCR} current is 3 mA at 3.3V V_{CC}.

When either CE_0# or CE_1#, and RP# pins are at V_{CC}, the I_{CC} CMOS standby mode is enabled. When the RP# pin is at GND, deep power-down mode is enabled which minimizes power consumption and provides write protection during reset. A reset time (t_{PHQV}) is required from RP# switching high until outputs are valid. Likewise, the device has a wake time (t_{PHEL}) from RP#-high until writes to the CUI are recognized. With RP# at GND, the WSM is reset and the status register is cleared.

The device is available in 56-Lead SSOP (Shrink Small Outline Package). Pinout is shown in Figure 2.

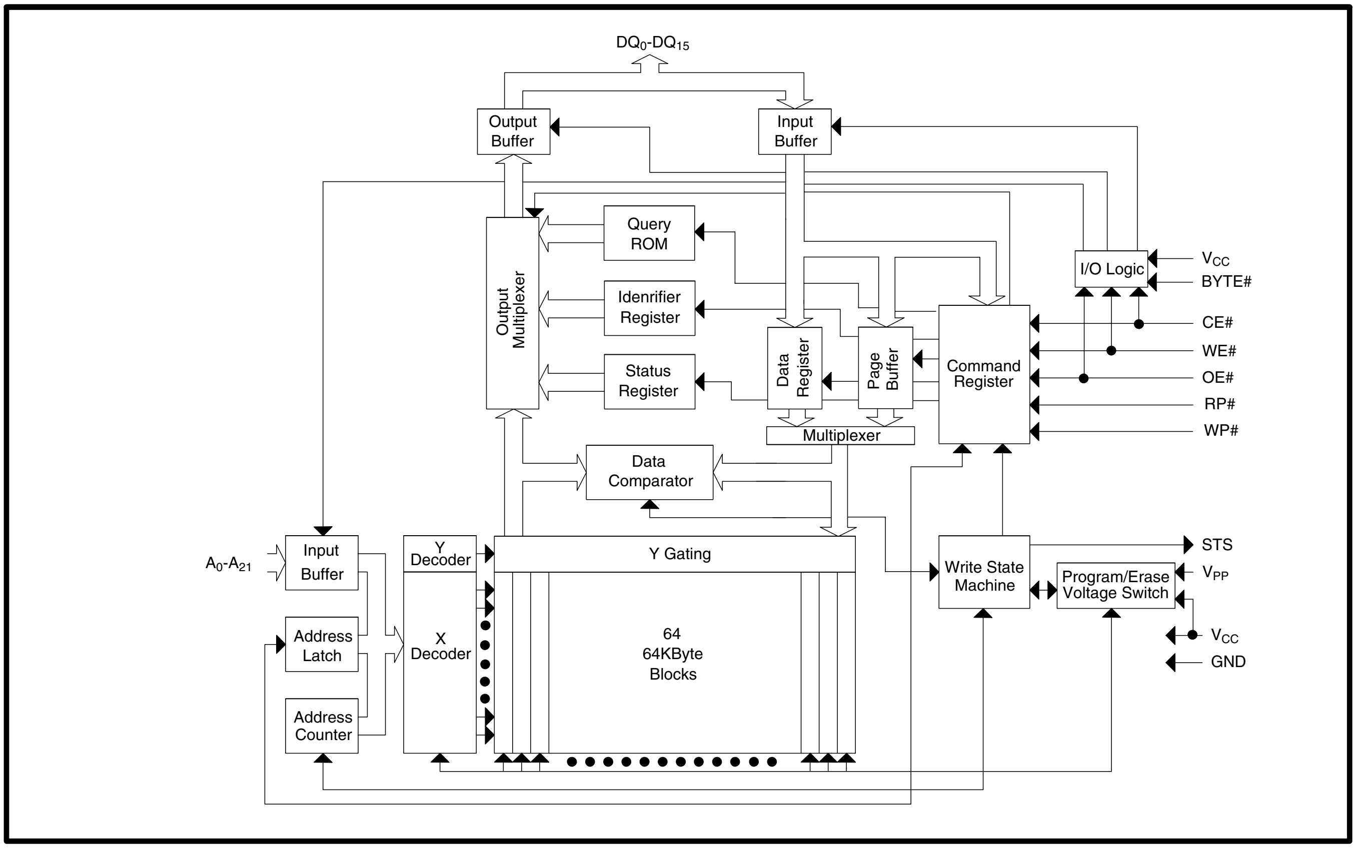


Figure 1. Block Diagram

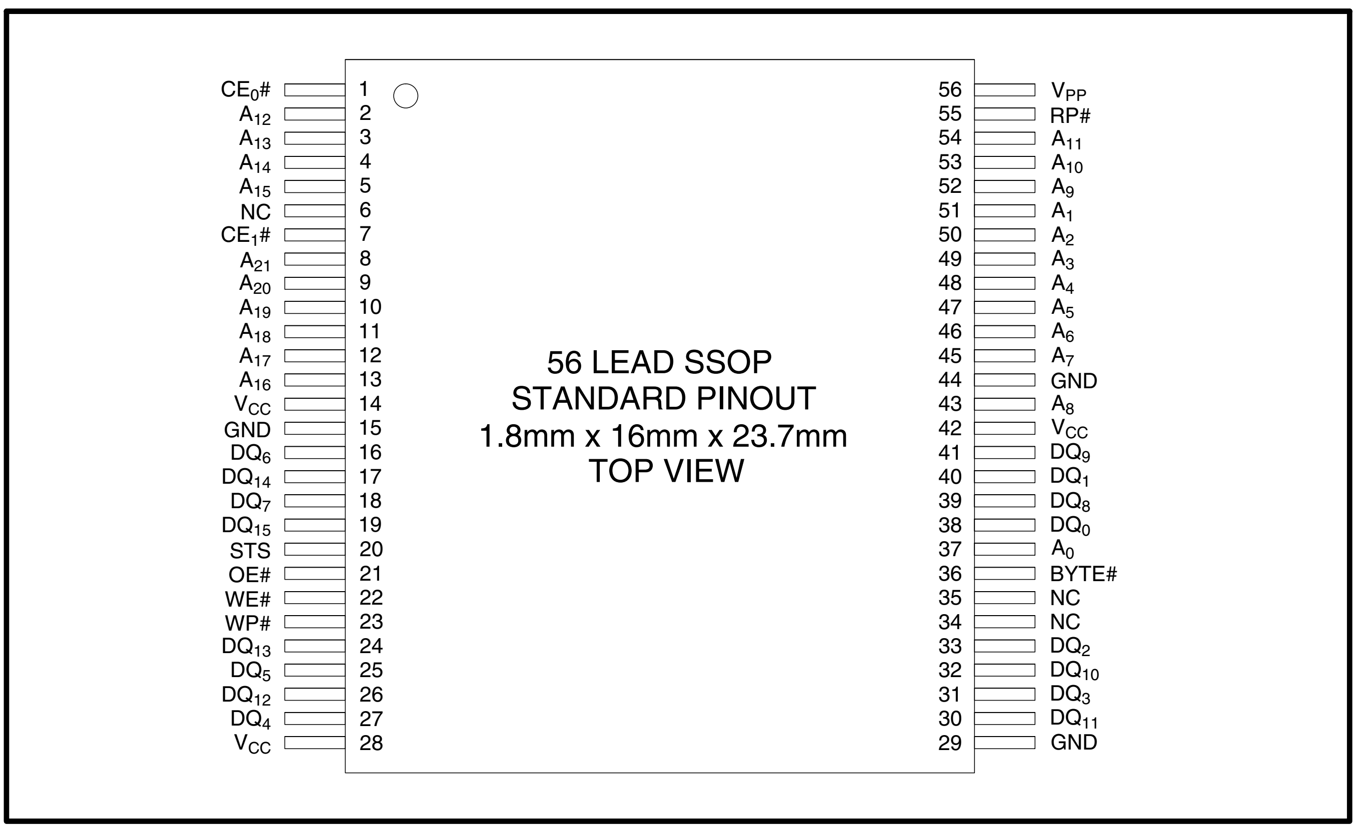


Figure 2. SSOP 56-Lead Pinout

Table 2. Pin Descriptions

Symbol	Type	Name and Function
A_0-A_{21}	INPUT	**ADDRESS INPUTS:** Inputs for addresses during read and write operations. Addresses are internally latched during a write cycle. A0: Byte Select Address. Not used in x16 mode(can be floated). A1-A4: Column Address. Selects 1 of 16 bit lines. A5-A15: Row Address. Selects 1 of 2048 word lines. A16-A21 : Block Address.
DQ_0-DQ_{15}	INPUT/ OUTPUT	**DATA INPUT/OUTPUTS:** DQ_0-DQ_7:Inputs data and commands during CUI write cycles; outputs data during memory array, status register, query, and identifier code read cycles. Data pins float to high-impedance when the chip is deselected or outputs are disabled. Data is internally latched during a write cycle. DQ_8-DQ_{15}:Inputs data during CUI write cycles in x16 mode; outputs data during memory array read cycles in x16 mode; not used for status register, query and identifier code read mode. Data pins float to high-impedance when the chip is deselected, outputs are disabled, or in x8 mode(Byte#=V_{IL}). Data is internally latched during a write cycle.
CE_0#, CE_1#	INPUT	**CHIP ENABLE:** Activates the device's control logic, input buffers decoders, and sense amplifiers. Either CE_0# or CE_1# V_{IH} deselects the device and reduces power consumption to standby levels. Both CE_0# and CE_1# must be V_{IL} to select the devices.
RP#	INPUT	**RESET/DEEP POWER-DOWN:** Puts the device in deep power-down mode and resets internal automation. RP# V_{IH} enables normal operation. When driven V_{IL}, RP# inhibits write operations which provides data protection during power transitions. Exit from deep power-down sets the device to read array mode.
OE#	INPUT	**OUTPUT ENABLE:** Gates the device's outputs during a read cycle.
WE#	INPUT	**WRITE ENABLE:** Controls writes to the CUI and array blocks. Addresses and data are latched on the rising edge of the WE# pulse.
STS	OPEN DRAIN OUTPUT	**STS (RY/BY#):** Indicates the status of the internal WSM. When configured in level mode (default mode), it acts as a RY/BY# pin. When low, the WSM is performing an internal operation (block erase, full chip erase, (multi) word/byte write or block lock-bit configuration). STS High Z indicates that the WSM is ready for new commands, block erase is suspended, and (multi) word/byte write is inactive, (multi) word/byte write is suspended or the device is in deep power-down mode. For alternate configurations of the STATUS pin, see the Configuration command.
WP#	INPUT	**WRITE PROTECT:** Master control for block locking. When V_{IL}, Locked blocks can not be erased and programmed, and block lock-bits can not be set and reset.
BYTE#	INPUT	**BYTE ENABLE:** BYTE# V_{IL} places device in x8 mode. All data is then input or output on DQ_{0-7}, and DQ_{8-15} float. BYTE# V_{IH} places the device in x16 mode , and turns off the A_0 input buffer.
V_{PP}	SUPPLY	**BLOCK ERASE, FULL CHIP ERASE, (MULTI) WORD/BYTE WRITE, BLOCK LOCK-BIT CONFIGURATION POWER SUPPLY:** For erasing array blocks, writing bytes or configuring block lock-bits. With $V_{PP} \leq V_{PPLK}$, memory contents cannot be altered. Block erase, full chip erase, (multi) word/byte write and block lock-bit configuration with an invalid V_{PP} (see DC Characteristics) produce spurious results and should not be attempted.
V_{CC}	SUPPLY	**DEVICE POWER SUPPLY:** Internal detection configures the device for 2.7V or 3.3V operation. To switch from one voltage to another, ramp V_{CC} down to GND and then ramp V_{CC} to the new voltage. Do not float any power pins. With $V_{CC} \leq V_{LKO}$, all write attempts to the flash memory are inhibited. Device operations at invalid V_{CC} voltage (see DC Characteristics) produce spurious results and should not be attempted.
GND	SUPPLY	**GROUND:** Do not float any ground pins.
NC		**NO CONNECT:** Lead is not internal connected; it may be driven or floated.

2 PRINCIPLES OF OPERATION

The LH28F320S3HNS-L11 Flash memory includes an on-chip WSM to manage block erase, full chip erase, (multi) word/byte write and block lock-bit configuration functions. It allows for: 100% TTL-level control inputs, fixed power supplies during block erase, full chip erase, (multi) word/byte write and block lock-bit configuration, and minimal processor overhead with RAM-Like interface timings.

After initial device power-up or return from deep power-down mode (see Bus Operations), the device defaults to read array mode. Manipulation of external memory control pins allow array read, standby, and output disable operations.

Status register, query structure and identifier codes can be accessed through the CUI independent of the V_{PP} voltage. High voltage on V_{PP} enables successful block erase, full chip erase, (multi) word/byte write and block lock-bit configuration. All functions associated with altering memory contents—block erase, full chip erase, (multi) word/byte write and block lock-bit configuration, status, query and identifier codes—are accessed via the CUI and verified through the status register.

Commands are written using standard microprocessor write timings. The CUI contents serve as input to the WSM, which controls the block erase, full chip erase, (multi) word/byte write and block lock-bit configuration. The internal algorithms are regulated by the WSM, including pulse repetition, internal verification, and margining of data. Addresses and data are internally latch during write cycles. Writing the appropriate command outputs array data, accesses the identifier codes, outputs query structure or outputs status register data.

Interface software that initiates and polls progress of block erase, full chip erase, (multi) word/byte write and block lock-bit configuration can be stored in any block. This code is copied to and executed from system RAM during flash memory updates. After successful completion, reads are again possible via the Read Array command. Block erase suspend allows system software to suspend a block erase to read or write data from any other block. Write suspend allows system software to suspend a (multi) word/byte write to read data from any other flash memory array location.

2.1 Data Protection

Depending on the application, the system designer may choose to make the V_{PP} power supply switchable (available only when block erase, full chip erase, (multi) word/byte write and block lock-bit configuration are required) or hardwired to $V_{PPH1/2/3}$. The device accommodates either design practice and encourages optimization of the processor-memory interface.

When $V_{PP} \leq V_{PPLK}$, memory contents cannot be altered. The CUI, with multi-step block erase, full chip erase, (multi) word/byte write and block lock-bit configuration command sequences, provides protection from unwanted operations even when high voltage is applied to V_{PP}. All write functions are disabled when V_{CC} is below the write lockout voltage V_{LKO} or when RP# is at V_{IL}. The device's block locking capability provides additional protection from inadvertent code or data alteration by gating block erase, full chip erase and (multi) word/byte write operations.

Address (top)	Address (bottom)	Block	Address (top)	Address (bottom)	Block
1FFFFF	1F0000	64-Kbyte Block 31	3FFFFF	3F0000	64-Kbyte Block 63
1EFFFF	1E0000	64-Kbyte Block 30	3EFFFF	3E0000	64-Kbyte Block 62
1DFFFF	1D0000	64-Kbyte Block 29	3DFFFF	3D0000	64-Kbyte Block 61
1CFFFF	1C0000	64-Kbyte Block 28	3CFFFF	3C0000	64-Kbyte Block 60
1BFFFF	1B0000	64-Kbyte Block 27	3BFFFF	3B0000	64-Kbyte Block 59
1AFFFF	1A0000	64-Kbyte Block 26	3AFFFF	3A0000	64-Kbyte Block 58
19FFFF	190000	64-Kbyte Block 25	39FFFF	390000	64-Kbyte Block 57
18FFFF	180000	64-Kbyte Block 24	38FFFF	380000	64-Kbyte Block 56
17FFFF	170000	64-Kbyte Block 23	37FFFF	370000	64-Kbyte Block 55
16FFFF	160000	64-Kbyte Block 22	36FFFF	360000	64-Kbyte Block 54
15FFFF	150000	64-Kbyte Block 21	35FFFF	350000	64-Kbyte Block 53
14FFFF	140000	64-Kbyte Block 20	34FFFF	340000	64-Kbyte Block 52
13FFFF	130000	64-Kbyte Block 19	33FFFF	330000	64-Kbyte Block 51
12FFFF	120000	64-Kbyte Block 18	32FFFF	320000	64-Kbyte Block 50
11FFFF	110000	64-Kbyte Block 17	31FFFF	310000	64-Kbyte Block 49
10FFFF	100000	64-Kbyte Block 16	30FFFF	300000	64-Kbyte Block 48
0FFFFF	0F0000	64-Kbyte Block 15	2FFFFF	2F0000	64-Kbyte Block 47
0EFFFF	0E0000	64-Kbyte Block 14	2EFFFF	2E0000	64-Kbyte Block 46
0DFFFF	0D0000	64-Kbyte Block 13	2DFFFF	2D0000	64-Kbyte Block 45
0CFFFF	0C0000	64-Kbyte Block 12	2CFFFF	2C0000	64-Kbyte Block 44
0BFFFF	0B0000	64-Kbyte Block 11	2BFFFF	2B0000	64-Kbyte Block 43
0AFFFF	0A0000	64-Kbyte Block 10	2AFFFF	2A0000	64-Kbyte Block 42
09FFFF	090000	64-Kbyte Block 9	29FFFF	290000	64-Kbyte Block 41
08FFFF	080000	64-Kbyte Block 8	28FFFF	280000	64-Kbyte Block 40
07FFFF	070000	64-Kbyte Block 7	27FFFF	270000	64-Kbyte Block 39
06FFFF	060000	64-Kbyte Block 6	26FFFF	260000	64-Kbyte Block 38
05FFFF	050000	64-Kbyte Block 5	25FFFF	250000	64-Kbyte Block 37
04FFFF	040000	64-Kbyte Block 4	24FFFF	240000	64-Kbyte Block 36
03FFFF	030000	64-Kbyte Block 3	23FFFF	230000	64-Kbyte Block 35
02FFFF	020000	64-Kbyte Block 2	22FFFF	220000	64-Kbyte Block 34
01FFFF	010000	64-Kbyte Block 1	21FFFF	210000	64-Kbyte Block 33
00FFFF	000000	64-Kbyte Block 0	20FFFF	200000	64-Kbyte Block 32

Figure 3. Memory Map

3 BUS OPERATION

The local CPU reads and writes flash memory in-system. All bus cycles to or from the flash memory conform to standard microprocessor bus cycles.

3.1 Read

Information can be read from any block, identifier codes, query structure, or status register independent of the V_{PP} voltage. RP# must be at V_{IH}.

The first task is to write the appropriate read mode command (Read Array, Read Identifier Codes, Query or Read Status Register) to the CUI. Upon initial device power-up or after exit from deep power-down mode, the device automatically resets to read array mode. Five control pins dictate the data flow in and out of the component: CE# (CE_0#, CE_1#), OE#, WE#, RP# and WP#. CE_0#, CE_1# and OE# must be driven active to obtain data at the outputs. CE_0#, CE_1# is the device selection control, and when active enables the selected memory device. OE# is the data output (DQ_0-DQ_{15}) control and when active drives the selected memory data onto the I/O bus. WE# and RP# must be at V_{IH}. Figure 17, 18 illustrates a read cycle.

3.2 Output Disable

With OE# at a logic-high level (V_{IH}), the device outputs are disabled. Output pins DQ_0-DQ_{15} are placed in a high-impedance state.

3.3 Standby

Either CE_0# or CE_1# at a logic-high level (V_{IH}) places the device in standby mode which substantially reduces device power consumption. DQ_0-DQ_{15} outputs are placed in a high-impedance state independent of OE#. If deselected during block erase, full chip erase, (multi) word/byte write and block lock-bit configuration, the device continues functioning, and consuming active power until the operation completes.

3.4 Deep Power-Down

RP# at V_{IL} initiates the deep power-down mode.

In read modes, RP#-low deselects the memory, places output drivers in a high-impedance state and turns off all internal circuits. RP# must be held low for a minimum of 100 ns. Time t_{PHQV} is required after return from power-down until initial memory access outputs are valid. After this wake-up interval, normal operation is restored. The CUI is reset to read array mode and status register is set to 80H.

During block erase, full chip erase, (multi) word/byte write or block lock-bit configuration modes, RP#-low will abort the operation. STS remains low until the reset operation is complete. Memory contents being altered are no longer valid; the data may be partially erased or written. Time t_{PHWL} is required after RP# goes to logic-high (V_{IH}) before another command can be written.

As with any automated device, it is important to assert RP# during system reset. When the system comes out of reset, it expects to read from the flash memory. Automated flash memories provide status information when accessed during block erase, full chip erase, (multi) word/byte write and block lock-bit configuration. If a CPU reset occurs with no flash memory reset, proper CPU initialization may not occur because the flash memory may be providing status information instead of array data. SHARP's flash memories allow proper CPU initialization following a system reset through the use of the RP# input. In this application, RP# is controlled by the same RESET# signal that resets the system CPU.

3.5 Read Identifier Codes Operation

The read identifier codes operation outputs the manufacturer code, device code, block status codes for each block (see Figure 4). Using the manufacturer and device codes, the system CPU can automatically match the device with its proper algorithms. The block status codes identify locked or unlocked block setting and erase completed or erase uncompleted condition.

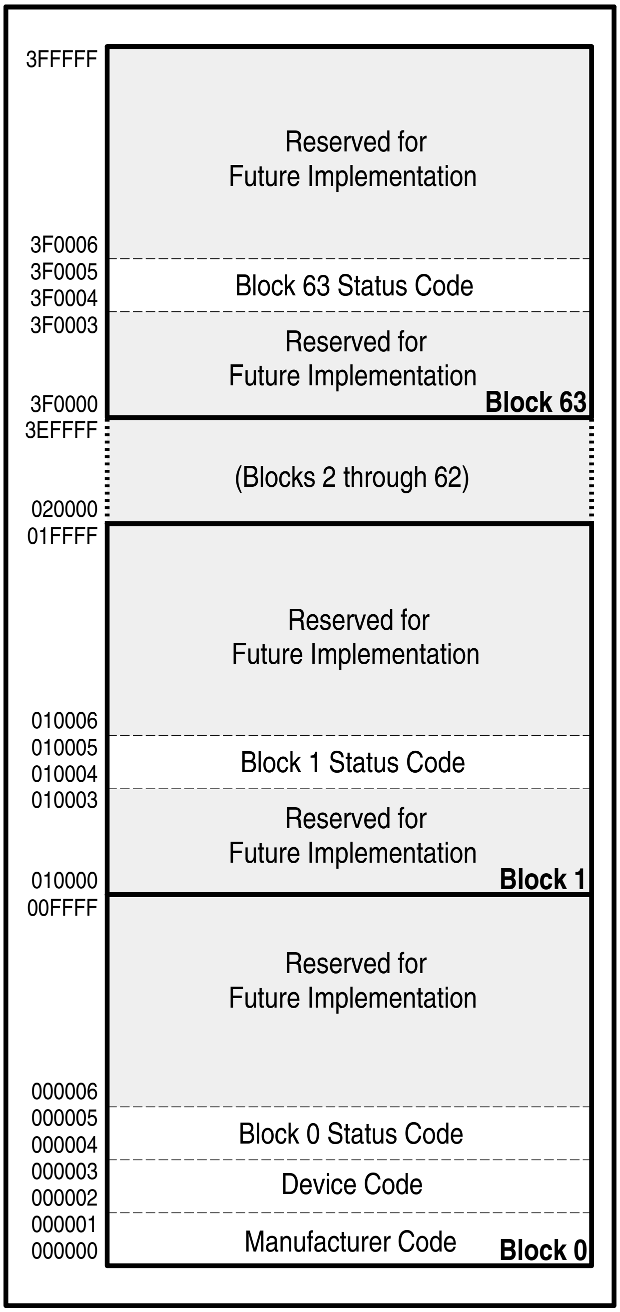


Figure 4. Device Identifier Code Memory Map

3.6 Query Operation

The query operation outputs the query structure. Query database is stored in the 48Byte ROM. Query structure allows system software to gain critical information for controlling the flash component. Query structure are always presented on the lowest-order data output (DQ_0-DQ_7) only.

3.7 Write

Writing commands to the CUI enable reading of device data and identifier codes. They also control inspection and clearing of the status register. When V_{CC}=$V_{CC1/2}$ and V_{PP}=$V_{PPH1/2/3}$, the CUI additionally controls block erase, full chip erase, (multi) word/byte write and block lock-bit configuration.

The Block Erase command requires appropriate command data and an address within the block to be erased. The Word/byte Write command requires the command and address of the location to be written. Set Block Lock-Bit command requires the command and block address within the device (Block Lock) to be locked. The Clear Block Lock-Bits command requires the command and address within the device.

The CUI does not occupy an addressable memory location. It is written when WE# and CE# are active. The address and data needed to execute a command are latched on the rising edge of WE# or CE# (whichever goes high first). Standard microprocessor write timings are used. Figures 19 and 20 illustrate WE# and CE#-controlled write operations.

4 COMMAND DEFINITIONS

When the V_{PP} voltage ≤ $V_{PPLK,}$ Read operations from the status register, identifier codes, query, or blocks are enabled. Placing $V_{PPH1/2/3}$ on V_{PP} enables successful block erase, full chip erase, (multi) word/byte write and block lock-bit configuration operations.

Device operations are selected by writing specific commands into the CUI. Table 4 defines these commands.

Table 3. Bus Operations(BYTE#=V_{IH})

Mode	Notes	RP#	CE_0#	CE_1#	OE#	WE#	Address	V_{PP}	DQ_{0-15}	STS
Read	1,2,3,9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	X	X	D_{OUT}	X
Output Disable	3	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IH}	X	X	High Z	X
Standby	3	V_{IH}	V_{IH} V_{IH} V_{IL}	V_{IH} V_{IL} V_{IH}	X	X	X	X	High Z	X
Deep Power-Down	4	V_{IL}	X	X	X	X	X	X	High Z	High Z
Read Identifier Codes	9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	See Figure 4	X	Note 5	High Z
Query	9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	See Table 7~11	X	Note 6	High Z
Write	3,7,8,9	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IL}	X	X	D_{IN}	X

Table 3.1. Bus Operations(BYTE#=V_{IL})

Mode	Notes	RP#	CE_0#	CE_1#	OE#	WE#	Address	V_{PP}	DQ_{0-7}	STS
Read	1,2,3,9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	X	X	D_{OUT}	X
Output Disable	3	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IH}	X	X	High Z	X
Standby	3	V_{IH}	V_{IH} V_{IH} V_{IL}	V_{IH} V_{IL} V_{IH}	X	X	X	X	High Z	X
Deep Power-Down	4	V_{IL}	X	X	X	X	X	X	High Z	High Z
Read Identifier Codes	9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	See Figure 4	X	Note 5	High Z
Query	9	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	See Table 7~11	X	Note 6	High Z
Write	3,7,8,9	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IL}	X	X	D_{IN}	X

NOTES:

1. Refer to DC Characteristics. When $V_{PP} \leq V_{PPLK}$, memory contents can be read, but not altered.
2. X can be V_{IL} or V_{IH} for control pins and addresses, and V_{PPLK} or $V_{PPH1/2/3}$ for V_{PP}. See DC Characteristics for V_{PPLK} and $V_{PPH1/2/3}$ voltages.
3. STS is V_{OL} (if configured to RY/BY# mode) when the WSM is executing internal block erase, full chip erase, (multi) word/byte write or block lock-bit configuration algorithms. It is floated during when the WSM is not busy, in block erase suspend mode with (multi) word/byte write inactive, (multi) word/byte write suspend mode, or deep power-down mode.
4. RP# at GND±0.2V ensures the lowest deep power-down current.
5. See Section 4.2 for read identifier code data.
6. See Section 4.5 for query data.
7. Command writes involving block erase, full chip erase, (multi) word/byte write or block lock-bit configuration are reliably executed when $V_{PP}=V_{PPH1/2/3}$ and $V_{CC}=V_{CC1/2}$.
8. Refer to Table 4 for valid D_{IN} during a write operation.
9. Don't use the timing both OE# and WE# are V_{IL}.

Table 4. Command Definitions(10)

Command	Bus Cycles Req'd	Notes	First Bus Cycle			Second Bus Cycle		
			Oper(1)	Addr(2)	Data(3)	Oper(1)	Addr(2)	Data(3)
Read Array/Reset	1		Write	X	FFH			
Read Identifier Codes	≥2	4	Write	X	90H	Read	IA	ID
Query	≥2		Write	X	98H	Read	QA	QD
Read Status Register	2		Write	X	70H	Read	X	SRD
Clear Status Register	1		Write	X	50H			
Block Erase Setup/Confirm	2	5	Write	BA	20H	Write	BA	D0H
Full Chip Erase Setup/Confirm	2		Write	X	30H	Write	X	D0H
Word/Byte Write Setup/Write	2	5,6	Write	WA	40H	Write	WA	WD
Alternate Word/Byte Write Setup/Write	2	5,6	Write	WA	10H	Write	WA	WD
Multi Word/Byte Write Setup/Confirm	≥4	9	Write	WA	E8H	Write	WA	N-1
Block Erase and (Multi) Word/byte Write Suspend	1	5	Write	X	B0H			
Confirm and Block Erase and (Multi) Word/byte Write Resume	1	5	Write	X	D0H			
Block Lock-Bit Set Setup/Confirm	2	7	Write	BA	60H	Write	BA	01H
Block Lock-Bit Reset Setup/Confirm	2	8	Write	X	60H	Write	X	D0H
STS Configuration Level-Mode for Erase and Write (RY/BY# Mode)	2		Write	X	B8H	Write	X	00H
STS Configuration Pulse-Mode for Erase	2		Write	X	B8H	Write	X	01H
STS Configuration Pulse-Mode for Write	2		Write	X	B8H	Write	X	02H
STS Configuration Pulse-Mode for Erase and Write	2		Write	X	B8H	Write	X	03H

NOTES:

1. BUS operations are defined in Table 3 and Table 3.1.
2. X=Any valid address within the device.
   IA=Identifier Code Address: see Figure 4.
   QA=Query Offset Address.
   BA=Address within the block being erased or locked.
   WA=Address of memory location to be written.
3. SRD=Data read from status register. See Table 14 for a description of the status register bits.
   WD=Data to be written at location WA. Data is latched on the rising edge of WE# or CE# (whichever goes high first).
   ID=Data read from identifier codes.
   QD=Data read from query database.
4. Following the Read Identifier Codes command, read operations access manufacturer, device and block status codes. See Section 4.2 for read identifier code data.
5. If the block is locked, WP# must be at V_{IH} to enable block erase or (multi) word/byte write operations. Attempts to issue a block erase or (multi) word/byte write to a locked block while RP# is V_{IH}.
6. Either 40H or 10H are recognized by the WSM as the byte write setup.
7. A block lock-bit can be set while WP# is V_{IH}.
8. WP# must be at V_{IH} to clear block lock-bits. The clear block lock-bits operation simultaneously clears all block lock-bits.
9. Following the Third Bus Cycle, inputs the write address and write data of 'N' times. Finally, input the confirm command 'D0H'.
10. Commands other than those shown above are reserved by SHARP for future device implementations and should not be used.

4.1 Read Array Command

Upon initial device power-up and after exit from deep power-down mode, the device defaults to read array mode. This operation is also initiated by writing the Read Array command. The device remains enabled for reads until another command is written. Once the internal WSM has started a block erase, full chip erase, (multi) word/byte write or block lock-bit configuration, the device will not recognize the Read Array command until the WSM completes its operation unless the WSM is suspended via an Erase Suspend and (Multi) Word/byte Write Suspend command. The Read Array command functions independently of the V_{PP} voltage and RP# must be V_{IH}.

4.2 Read Identifier Codes Command

The identifier code operation is initiated by writing the Read Identifier Codes command. Following the command write, read cycles from addresses shown in Figure 4 retrieve the manufacturer, device, block lock configuration and block erase status (see Table 5 for identifier code values). To terminate the operation, write another valid command. Like the Read Array command, the Read Identifier Codes command functions independently of the V_{PP} voltage and RP# must be V_{IH}. Following the Read Identifier Codes command, the following information can be read:

Table 5. Identifier Codes

Code	Address A_{21}-A_0	Data
Manufacture Code	000000 000001	B0
Device Code	000002 000003	D4
Block Status Code	X0004(1) X0005(1)	
•Block is Unlocked		DQ_0=0
•Block is Locked		DQ_0=1
•Last erase operation completed successfully		DQ_1=0
•Last erase operation did not completed successfully		DQ_1=1
•Reserved for Future Use		DQ_{2-7}

NOTE:
1. X selects the specific block status code to be read. See Figure 4 for the device identifier code memory map.

4.3 Read Status Register Command

The status register may be read to determine when a block erase, full chip erase, (multi) word/byte write or block lock-bit configuration is complete and whether the operation completed successfully(see Table 14). It may be read at any time by writing the Read Status Register command. After writing this command, all subsequent read operations output data from the status register until another valid command is written. The status register contents are latched on the falling edge of OE# or CE#(Either CE_0# or CE_1#), whichever occurs. OE# or CE#(Either CE_0# or CE_1#) must toggle to V_{IH} before further reads to update the status register latch. The Read Status Register command functions independently of the V_{PP} voltage. RP# must be V_{IH}.

The extended status register may be read to determine multi word/byte write availability(see Table 14.1). The extended status register may be read at any time by writing the Multi Word/Byte Write command. After writing this command, all subsequent read operations output data from the extended status register, until another valid command is written. Multi Word/Byte Write command must be re-issued to update the extended status register latch.

4.4 Clear Status Register Command

Status register bits SR.5, SR.4, SR.3 and SR.1 are set to "1"s by the WSM and can only be reset by the Clear Status Register command. These bits indicate various failure conditions (see Table 14). By allowing system software to reset these bits, several operations (such as cumulatively erasing or locking multiple blocks or writing several bytes in sequence) may be performed. The status register may be polled to determine if an error occurs during the sequence.

To clear the status register, the Clear Status Register command (50H) is written. It functions independently of the applied V_{PP} Voltage. RP# must be V_{IH}. This command is not functional during block erase, full chip erase, (multi) word/byte write block lock-bit configuration, block erase suspend or (multi) word/byte write suspend modes.

4.5 Query Command

Query database can be read by writing Query command (98H). Following the command write, read cycle from address shown in Table 7~11 retrieve the critical information to write, erase and otherwise control the flash component. A_0 of query offset address is ignored when X8 mode (BYTE#=V_{IL}).

Query data are always presented on the low-byte data output (DQ_0-DQ_7). In x16 mode, high-byte (DQ_8-DQ_{15}) outputs 00H. The bytes not assigned to any information or reserved for future use are set to "0". This command functions independently of the V_{PP} voltage. RP# must be V_{IH}.

Table 6. Example of Query Structure Output

Mode	Offset Address	Output	
		$DQ_{15\sim8}$	$DQ_{7\sim0}$
X8 mode	A_5, A_4, A_3, A_2, A_1, A_0		
	1 , 0 , 0 , 0 , 0 , 0 (20H)	High-Z	"Q"
	1 , 0 , 0 , 0 , 0 , 1 (21H)	High-Z	"Q"
	1, 0 , 0 , 0 , 1 , 0 (22H)	High-Z	"R"
	1 , 0 , 0 , 0 , 1 , 1 (23H)	High-Z	"R"
X16 mode	A_5, A_4, A_3, A_2, A_1		
	1 , 0 , 0 , 0 , 0 (10H)	00H	"Q"
	1 , 0 , 0 , 0 , 1 (11H)	00H	"R"

4.5.1 Block Status Register

This field provides lock configuration and erase status for the specified block. These informations are only available when device is ready (SR.7=1). If block erase or full chip erase operation is finished irregulary, block erase status bit will be set to "1". If bit 1 is "1", this block is invalid.

Table 7. Query Block Status Register

Offset (Word Address)	Length	Description
(BA+2)H	01H	Block Status Register bit0 Block Lock Configuration 0=Block is unlocked 1=Block is Locked bit1 Block Erase Status 0=Last erase operation completed successfully 1=Last erase operation not completed successfully bit2-7 reserved for future use

Note:
1. BA=The beginning of a Block Address.

4.5.2 CFI Query Identification String

The Identification String provides verification that the component supports the Common Flash Interface specification. Additionally, it indicates which version of the spec and which Vendor-specified command set(s) is(are) supported.

Table 8. CFI Query Identification String

Offset (Word Address)	Length	Description
10H,11H,12H	03H	Query Unique ASCII string "QRY" 51H,52H,59H
13H,14H	02H	Primary Vendor Command Set and Control Interface ID Code 01H,00H (SCS ID Code)
15H,16H	02H	Address for Primary Algorithm Extended Query Table 31H,00H (SCS Extended Query Table Offset)
17H,18H	02H	Alternate Vendor Command Set and Control Interface ID Code 0000H (0000H means that no alternate exists)
19H,1AH	02H	Address for Alternate Algorithm Extended Query Table 0000H (0000H means that no alternate exists)

4.5.3 System Interface Information

The following device information can be useful in optimizing system interface software.

Table 9. System Information String

Offset (Word Address)	Length	Description
1BH	01H	V_{CC} Logic Supply Minimum Write/Erase voltage 27H (2.7V)
1CH	01H	V_{CC} Logic Supply Maximum Write/Erase voltage 36H (3.6V)
1DH	01H	V_{PP} Programming Supply Minimum Write/Erase voltage 27H (2.7V)
1EH	01H	V_{PP} Programming Supply Maximum Write/Erase voltage 55H (5.5V)
1FH	01H	Typical Timeout per Single Byte/Word Write 04H (2^4=16µs)
20H	01H	Typical Timeout for Maximum Size Buffer Write (32 Bytes) 06H (2^6=64µs)
21H	01H	Typical Timeout per Individual Block Erase 09H (09H=9, 2^9=512ms)
22H	01H	Typical Timeout for Full Chip Erase 0FH (0FH=15, 2^{15}=32768ms)
23H	01H	Maximum Timeout per Single Byte/Word Write, 2^N times of typical. 04H (2^4=16, 16µsx16=256µs)
24H	01H	Maximum Timeout Maximum Size Buffer Write, 2^N times of typical. 04H (2^4=16, 64µsx16=1024µs)
25H	01H	Maximum Timeout per Individual Block Erase, 2^N times of typical. 04H (2^4=16, 1024msx16=16384ms)
26H	01H	Maximum Timeout for Full Chip Erase, 2^N times of typical. 04H (2^4=16, 32768msx16=524288ms)

4.5.4 Device Geometry Definition

This field provides critical details of the flash device geometry.

Table 10. Device Geometry Definition

Offset (Word Address)	Length	Description
27H	01H	Device Size 16H (16H=22, 2^{22}=4194304=4M Bytes)
28H,29H	02H	Flash Device Interface description 02H,00H (x8/x16 supports x8 and x16 via BYTE#)
2AH,2BH	02H	Maximum Number of Bytes in Multi-byte 05H,00H (2^5=32 Bytes)
2CH	01H	Number of Erase Block Regions within device 01H (symmetrically blocked)
2DH,2EH	02H	The Number of Erase Blocks 3FH,00H (3FH=63 ==> 63+1=64 Blocks)
2FH,30H	02H	The Number of "256 Bytes" cluster in a Erase block 00H,01H (0100H=256 ==>256 Bytes x 256= 64K Bytes in a Erase Block)

4.5.5 SCS OEM Specific Extended Query Table

Certain flash features and commands may be optional in a vendor-specific algorithm specification. The optional vendor-specific Query table(s) may be used to specify this and other types of information. These structures are defined solely by the flash vendor(s).

Table 11. SCS OEM Specific Extended Query Table

Offset (Word Address)	Length	Description
31H,32H,33H	03H	PRI 50H,52H,49H
34H	01H	31H (1) Major Version Number , ASCII
35H	01H	30H (0) Minor Version Number, ASCII
36H,37H, 38H,39H	04H	0FH,00H,00H,00H Optional Command Support bit0=1 : Chip Erase Supported bit1=1 : Suspend Erase Supported bit2=1 : Suspend Write Supported bit3=1 : Lock/Unlock Supported bit4=0 : Queued Erase Not Supported bit5-31=0 : reserved for future use
3AH	01H	01H Supported Functions after Suspend bit0=1 : Write Supported after Erase Suspend bit1-7=0 : reserved for future use
3BH,3CH	02H	03H,00H Block Status Register Mask bit0=1 : Block Status Register Lock Bit [BSR.0] active bit1=1 : Block Status Register Valid Bit [BSR.1] active bit2-15=0 : reserved for future use
3DH	01H	V_{CC} Logic Supply Optimum Write/Erase voltage(highest performance) 33H(3.3V)
3EH	01H	V_{PP} Programming Supply Optimum Write/Erase voltage(highest performance) 50H(5.0V)
3FH	reserved	Reserved for future versions of the SCS Specification

4.6 Block Erase Command

Block erase is executed one block at a time and initiated by a two-cycle command. A block erase setup is first written, followed by an block erase confirm. This command sequence requires appropriate sequencing and an address within the block to be erased (erase changes all block data to FFH). Block preconditioning, erase and verify are handled internally by the WSM (invisible to the system). After the two-cycle block erase sequence is written, the device automatically outputs status register data when read (see Figure 5). The CPU can detect block erase completion by analyzing the output data of the STS pin or status register bit SR.7.

When the block erase is complete, status register bit SR.5 should be checked. If a block erase error is detected, the status register should be cleared before system software attempts corrective actions. The CUI remains in read status register mode until a new command is issued.

This two-step command sequence of set-up followed by execution ensures that block contents are not accidentally erased. An invalid Block Erase command sequence will result in both status register bits SR.4 and SR.5 being set to "1". Also, reliable block erasure can only occur when $V_{CC}=V_{CC1/2}$ and $V_{PP}=V_{PPH1/2/3}$. In the absence of this high voltage, block contents are protected against erasure. If block erase is attempted while $V_{PP} \leq V_{PPLK}$, SR.3 and SR.5 will be set to "1". Successful block erase requires that the corresponding block lock-bit be cleared or if set, that WP#=V_{IH}. If block erase is attempted when the corresponding block lock-bit is set and WP#=V_{IL}, SR.1 and SR.5 will be set to "1".

4.7 Full Chip Erase Command

This command followed by a confirm command (D0H) erases all of the unlocked blocks. A full chip erase setup is first written, followed by a full chip erase confirm. After a confirm command is written, device erases the all unlocked blocks from block 0 to Block 63 block by block. This command sequence requires appropriate sequencing. Block preconditioning, erase and verify are handled internally by the WSM (invisible to the system). After the two-cycle full chip erase sequence is written, the device automatically outputs status register data when read (see Figure 6). The CPU can detect full chip erase completion by analyzing the output data of the STS pin or status register bit SR.7.

When the full chip erase is complete, status register bit SR.5 should be checked. If erase error is detected, the status register should be cleared before system software attempts corrective actions. The CUI remains in read status register mode until a new command is issued. If error is detected on a block during full chip erase operation, WSM stops erasing the block and begin to erase the next block. Reading the block valid status by issuing Read ID Codes command or Query command informs which blocks failed to its erase.

This two-step command sequence of set-up followed by execution ensures that block contents are not accidentally erased. An invalid Full Chip Erase command sequence will result in both status register bits SR.4 and SR.5 being set to "1". Also, reliable full chip erasure can only occur when $V_{CC}=V_{CC1/2}$ and $V_{PP}=V_{PPH1/2/3}$. In the absence of this high voltage, block contents are protected against erasure. If full chip erase is attempted while $V_{PP} \leq V_{PPLK}$, SR.3 and SR.5 will be set to "1". When WP#=V_{IH}, all blocks are erased independent of block lock-bits status. When WP#=V_{IL}, only unlocked blocks are erased. Full chip erase can not be suspended.

4.8 Word/Byte Write Command

Word/byte write is executed by a two-cycle command sequence. Word/Byte Write setup (standard 40H or alternate 10H) is written, followed by a second write that specifies the address and data (latched on the rising edge of WE#). The WSM then takes over, controlling the word/byte write and write verify algorithms internally. After the word/byte write sequence is written, the device automatically outputs status register data when read (see Figure 7). The CPU can detect the completion of the word/byte write event by analyzing the STS pin or status register bit SR.7.

When word/byte write is complete, status register bit SR.4 should be checked. If word/byte write error is detected, the status register should be cleared. The internal WSM verify only detects errors for "1"s that do not successfully write to "0"s. The CUI remains in read status register mode until it receives another command.

Reliable word/byte writes can only occur when $V_{CC}=V_{CC1/2}$ and $V_{PP}=V_{PPH1/2/3}$. In the absence of this high voltage, memory contents are protected against word/byte writes. If word/byte write is attempted while $V_{PP} \leq V_{PPLK}$, status register bits SR.3 and SR.4 will be set to "1". Successful word/byte write requires that the corresponding block lock-bit be cleared or, if set, that WP#=V_{IH}. If word/byte write is attempted when the corresponding block lock-bit is set and WP#=V_{IL}, SR.1 and SR.4 will be set to "1". Word/byte write operations with V_{IL}<WP#<V_{IH} produce spurious results and should not be attempted.

4.9 Multi Word/Byte Write Command

Multi word/byte write is executed by at least four-cycle or up to 35-cycle command sequence. Up to 32 bytes in x8 mode (16 words in x16 mode) can be loaded into the buffer and written to the Flash Array. First, multi word/byte write setup (E8H) is written with the write address. At this point, the device automatically outputs extended status register data (XSR) when read (see Figure 8, 9). If extended status register bit XSR.7 is 0, no Multi Word/Byte Write command is available and multi word/byte write setup which just has been written is ignored. To retry, continue monitoring XSR.7 by writing multi word/byte write setup with write address until XSR.7 transitions to 1. When XSR.7 transitions to 1, the device is ready for loading the data to the buffer. A word/byte count (N)-1 is written with write address. After writing a word/byte count(N)-1, the device automatically turns back to output status register data. The word/byte count (N)-1 must be less than or equal to 1FH in x8 mode (0FH in x16 mode). On the next write, device start address is written with buffer data. Subsequent writes provide additional device address and data, depending on the count. All subsequent address must lie within the start address plus the count. After the final buffer data is written, write confirm (D0H) must be written. This initiates WSM to begin copying the buffer data to the Flash Array. An invalid Multi Word/Byte Write command sequence will result in both status register bits SR.4 and SR.5 being set to "1". For additional multi word/byte write, write another multi word/byte write setup and check XSR.7. The Multi Word/Byte Write command can be queued while WSM is busy as long as XSR.7 indicates "1", because LH28F320S3HNS-L11 has two buffers. If an error occurs while writing, the device will stop writing and flush next multi word/byte write command loaded in multi word/byte write command. Status register bit SR.4 will be set to "1". No multi word/byte write command is available if either SR.4 or SR.5 are set to "1". SR.4 and SR.5 should be cleared before issuing multi word/byte write command. If a multi word/byte write command is attempted past an erase block boundary, the device will write the data to Flash Array up to an erase block boundary and then stop writing. Status register bits SR.4 and SR.5 will be set to "1".

Reliable multi byte writes can only occur when $V_{CC}=V_{CC1/2}$ and $V_{PP}=V_{PPH1/2/3}$. In the absence of this high voltage, memory contents are protected against multi word/byte writes. If multi word/byte write is attempted while $V_{PP} \leq V_{PPLK}$, status register bits SR.3 and SR.4 will be set to "1". Successful multi word/byte write requires that the corresponding block lock-bit be cleared or, if set, that WP#=V_{IH}. If multi byte write is attempted when the corresponding block lock-bit is set and WP#=V_{IL}, SR.1 and SR.4 will be set to "1".

4.10 Block Erase Suspend Command

The Block Erase Suspend command allows block-erase interruption to read or (multi) word/byte-write data in another block of memory. Once the block-erase process starts, writing the Block Erase Suspend command requests that the WSM suspend the block erase sequence at a predetermined point in the algorithm. The device outputs status register data when read after the Block Erase Suspend command is written. Polling status register bits SR.7 and SR.6 can determine when the block erase operation has been suspended (both will be set to "1"). STS will also transition to High Z. Specification t_{WHRH2} defines the block erase suspend latency.

At this point, a Read Array command can be written to read data from blocks other than that which is suspended. A (Multi) Word/Byte Write command sequence can also be issued during erase suspend to program data in other blocks. Using the (Multi) Word/Byte Write Suspend command (see Section 4.11), a (multi) word/byte write operation can also be suspended. During a (multi) word/byte write operation with block erase suspended, status register bit SR.7 will return to "0" and the STS (if set to RY/BY#) output will transition to V_{OL}. However, SR.6 will remain "1" to indicate block erase suspend status.

The only other valid commands while block erase is suspended are Read Status Register and Block Erase Resume. After a Block Erase Resume command is written to the flash memory, the WSM will continue the block erase process. Status register bits SR.6 and SR.7 will automatically clear and STS will return to V_{OL}. After the Erase Resume command is written, the device automatically outputs status register data when read (see Figure 10). V_{PP} must remain at $V_{PPH1/2/3}$ (the same V_{PP} level used for block erase) while block erase is suspended. RP# must also remain at V_{IH}. Block erase cannot resume until (multi) word/byte write operations initiated during block erase suspend have completed.

4.11 (Multi) Word/Byte Write Suspend Command

The (Multi) Word/Byte Write Suspend command allows (multi) word/byte write interruption to read data in other flash memory locations. Once the (multi) word/byte write process starts, writing the (Multi) Word/Byte Write Suspend command requests that the WSM suspend the (multi) word/byte write sequence at a predetermined point in the algorithm. The device continues to output status register data when read after the (Multi) Word/Byte Write Suspend command is written. Polling status register bits SR.7 and SR.2 can determine when the (multi) word/byte write operation has been suspended (both will be set to "1"). STS will also transition to High Z. Specification t_{WHRH1} defines the (multi) word/byte write suspend latency.

At this point, a Read Array command can be written to read data from locations other than that which is suspended. The only other valid commands while (multi) word/byte write is suspended are Read Status Register and (Multi) Word/Byte Write Resume. After (Multi) Word/Byte Write Resume command is written to the flash memory, the WSM will continue the (multi) word/byte write process. Status register bits SR.2 and SR.7 will automatically clear and STS will return to V_{OL}. After the (Multi) Word/Byte Write command is written, the device automatically outputs status register data when read (see Figure 11). V_{PP} must remain at $V_{PPH1/2/3}$ (the same V_{PP} level used for (multi) word/byte write) while in (multi) word/byte write suspend mode. WP# must also remain at V_{IH} or V_{IL}.

4.12 Set Block Lock-Bit Command

A flexible block locking and unlocking scheme is enabled via block lock-bits. The block lock-bits gate program and erase operations With WP#=V_{IH}, individual block lock-bits can be set using the Set Block Lock-Bit command. See Table 13 for a summary of hardware and software write protection options.

Set block lock-bit is executed by a two-cycle command sequence. The set block lock-bit setup along with appropriate block or device address is written followed by either the set block lock-bit confirm (and an address within the block to be locked). The WSM then controls the set block lock-bit algorithm. After the sequence is written, the device automatically outputs status register data when read (see Figure 12). The CPU can detect the completion of the set block lock-bit event by analyzing the STS pin output or status register bit SR.7.

When the set block lock-bit operation is complete, status register bit SR.4 should be checked. If an error is detected, the status register should be cleared. The CUI will remain in read status register mode until a new command is issued.

This two-step sequence of set-up followed by execution ensures that block lock-bits are not accidentally set. An invalid Set Block Lock-Bit command will result in status register bits SR.4 and SR.5 being set to "1". Also, reliable operations occur only when V_{CC}=$V_{CC1/2}$ and V_{PP}=$V_{PPH1/2/3}$. In the absence of this high voltage, block lock-bit contents are protected against alteration.

A successful set block lock-bit operation requires WP#=V_{IH}. If it is attempted with WP#=V_{IL}, SR.1 and SR.4 will be set to "1" and the operation will fail. Set block lock-bit operations with WP#<V_{IH} produce spurious results and should not be attempted.

4.13 Clear Block Lock-Bits Command

All set block lock-bits are cleared in parallel via the Clear Block Lock-Bits command. With WP#=V_{IH}, block lock-bits can be cleared using only the Clear Block Lock-Bits command. See Table 13 for a summary of hardware and software write protection options.

Clear block lock-bits operation is executed by a two-cycle command sequence. A clear block lock-bits setup is first written. After the command is written, the device automatically outputs status register data when read (see Figure 13). The CPU can detect completion of the clear block lock-bits event by analyzing the STS Pin output or status register bit SR.7.

When the operation is complete, status register bit SR.5 should be checked. If a clear block lock-bit error is detected, the status register should be cleared. The CUI will remain in read status register mode until another command is issued.

This two-step sequence of set-up followed by execution ensures that block lock-bits are not accidentally cleared. An invalid Clear Block Lock-Bits command sequence will result in status register bits SR.4 and SR.5 being set to "1". Also, a reliable clear block lock-bits operation can only occur when V_{CC}=$V_{CC1/2}$ and V_{PP}=$V_{PPH1/2/3}$. If a clear block lock-bits operation is attempted while $V_{PP} \leq V_{PPLK}$, SR.3 and SR.5 will be set to "1". In the absence of this high voltage, the block lock-bits content are protected against alteration. A successful clear block lock-bits operation requires WP#=V_{IH}. If it is attempted with WP#=V_{IL}, SR.1 and SR.5 will be set to "1" and the operation will fail. Clear block lock-bits operations with V_{IH}<RP# produce spurious results and should not be attempted.

If a clear block lock-bits operation is aborted due to V_{PP} or V_{CC} transitioning out of valid range or RP# active transition, block lock-bit values are left in an undetermined state. A repeat of clear block lock-bits is required to initialize block lock-bit contents to known values.

4.14 STS Configuration Command

The Status (STS) pin can be configured to different states using the STS Configuration command. Once the STS pin has been configured, it remains in that configuration until another configuration command is issued, the device is powered down or RP# is set to V_{IL}. Upon initial device power-up and after exit from deep power-down mode, the STS pin defaults to RY/BY# operation where STS low indicates that the WSM is busy. STS High Z indicates that the WSM is ready for a new operation.

To reconfigure the STS pin to other modes, the STS Configuration is issued followed by the appropriate configuration code. The three alternate configurations are all pulse mode for use as a system interrupt. The STS Configuration command functions independently of the V_{PP} voltage and RP# must be V_{IH}.

Table 12. STS Configuration Coding Description

Configuration Bits	Effects
00H	Set STS pin to default level mode (RY/BY#). RY/BY# in the default level-mode of operation will indicate WSM status condition.
01H	Set STS pin to pulsed output signal for specific erase operation. In this mode, STS provides low pulse at the completion of BLock Erase, Full Chip Erase and Clear Block Lock-bits operations.
02H	Set STS pin to pulsed output signal for a specific write operation. In this mode, STS provides low pulse at the completion of (Multi) Byte Write and Set Block Lock-bit operation.
03H	Set STS pin to pulsed output signal for specific write and erase operation. STS provides low pulse at the completion of Block Erase, Full Chip Erase, (Multi) Word/Byte Write and Block Lock-bit Configuration operations.

Table 13. Write Protection Alternatives

Operation	Block Lock-Bit	WP#	Effect
Block Erase, (Multi) Word/Byte Write	0	V_{IL} or V_{IH}	Block Erase and (Multi) Word/Byte Write Enabled
	1	V_{IL}	Block is Locked. Block Erase and (Multi) Word/Byte Write Disabled
		V_{IH}	Block Lock-Bit Override. Block Erase and (Multi) Word/Byte Write Enabled
Full Chip Erase	0,1	V_{IL}	All unlocked blocks are erased, locked blocks are not erased
	X	V_{IH}	All blocks are erased
Set Block Lock-Bit	X	V_{IL}	Set Block Lock-Bit Disabled
		V_{IH}	Set Block Lock-Bit Enabled
Clear Block Lock-Bits	X	V_{IL}	Clear Block Lock-Bits Disabled
		V_{IH}	Clear Block Lock-Bits Enabled

Table 14. Status Register Definition

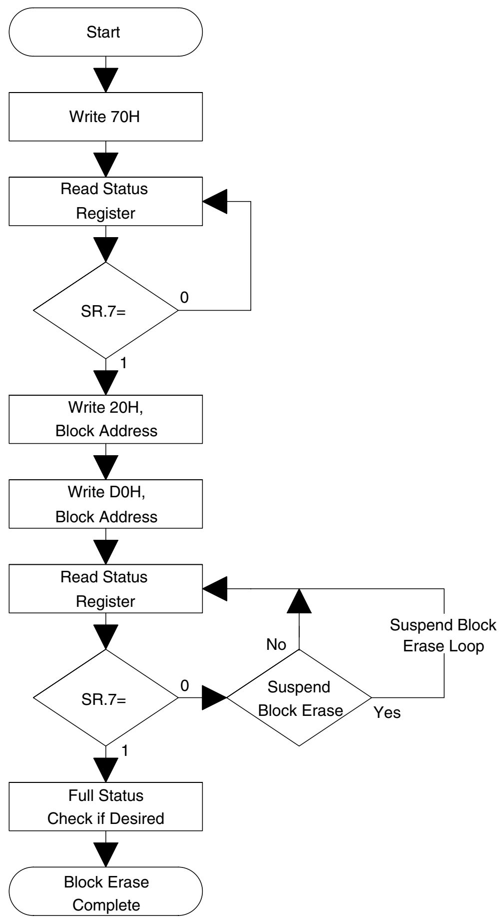
WSMS	BESS	ECBLBS	WSBLBS	VPPS	WSS	DPS	R
7	6	5	4	3	2	1	0

SR.7 = WRITE STATE MACHINE STATUS 1 = Ready 0 = Busy SR.6 = BLOCK ERASE SUSPEND STATUS 1 = Block Erase Suspended 0 = Block Erase in Progress/Completed SR.5 = ERASE AND CLEAR BLOCK LOCK-BITS STATUS 1 = Error in Erase or Clear Blocl Lock-Bits 0 = Successful Erase or Clear Block Lock-Bits SR.4 = WRITE AND SET BLOCK LOCK-BIT STATUS 1 = Error in Write or Set Block Lock-Bit 0 = Successful Write or Set Block Lock-Bit SR.3 = V_{PP} STATUS 1 = V_{PP} Low Detect, Operation Abort 0 = V_{PP} OK SR.2 = WRITE SUSPEND STATUS 1 = Write Suspended 0 = Write in Progress/Completed SR.1 = DEVICE PROTECT STATUS 1 = Block Lock-Bit and/or WP# Lock Detected, Operation Abort 0 = Unlock SR.0 = RESERVED FOR FUTURE ENHANCEMENTS	**NOTES:** Check STS or SR.7 to determine block erase, full chip erase, (multi) word/byte write or block lock-bit configuration completion. SR.6-0 are invalid while SR.7="0". If both SR.5 and SR.4 are "1"s after a block erase, full chip erase, (multi) word/byte write, block lock-bit configuration or STS configuration attempt, an improper command sequence was entered. SR.3 does not provide a continuous indication of V_{PP} level. The WSM interrogates and indicates the V_{PP} level only after block erase, full chip erase, (multi) word/byte write or block lock-bit configuration command sequences. SR.3 is not guaranteed to reports accurate feedback only when $V_{PP} \neq V_{PPH1/2/3}$. SR.1 does not provide a continuous indication of block lock-bit values. The WSM interrogates block lock-bit, and WP# only after block erase, full chip erase, (multi) word/byte write or block lock-bit configuration command sequences. It informs the system, depending on the attempted operation, if the block lock-bit is set and/or WP# is not V_{IH}. Reading the block lock configuration codes after writing the Read Identifier Codes command indicates block lock-bit status. SR.0 is reserved for future use and should be masked out when polling the status register.

Table 14.1. Extended Status Register Definition

SMS	R	R	R	R	R	R	R
7	6	5	4	3	2	1	0

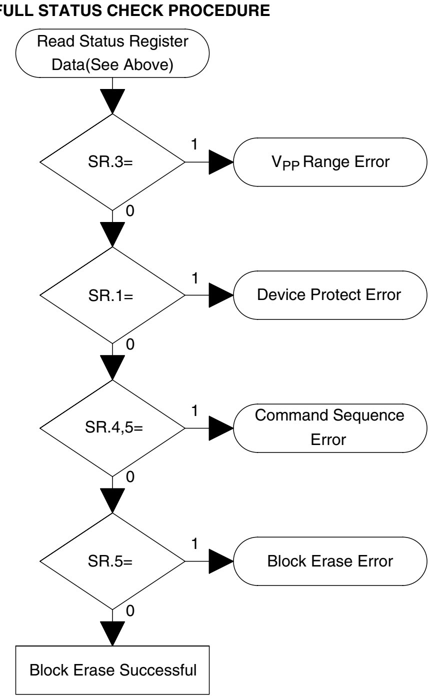
XSR.7 = STATE MACHINE STATUS 1 = Multi Word/Byte Write available 0 = Multi Word/Byte Write not available XSR.6-0=RESERVED FOR FUTURE ENHANCEMENTS	**NOTES:** After issue a Multi Word/Byte Write command: XSR.7 indicates that a next Multi Word/Byte Write command is available. XSR.6-0 is reserved for future use and should be masked out when polling the extended status register.



Bus Operation	Command	Comments
Write	Read Status Register	Data=70H Addr=X
Read		Status Register Data
Standby		Check SR.7 1=WSM Ready 0=WSM Busy
Write	Erase Setup	Data=20H Addr=Within Block to be Erased
Write	Erase Confirm	Data=D0H Addr=Within Block to be Erased
Read		Status Register Data
Standby		Check SR.7 1=WSM Ready 0=WSM Busy

Repeat for subsequent block erasures.
Full status check can be done after each block erase or after a sequence of block erasures.
Write FFH after the last operation to place device in read array mode.

FULL STATUS CHECK PROCEDURE



Bus Operation	Command	Comments
Standby		Check SR.3 1=V_{PP} Error Detect
Standby		Check SR.1 1=Device Protect Detect WP#=V_{IL},Block Lock-Bit is Set Only required for systems implementing lock-bit configuration
Standby		Check SR.4,5 Both 1=Command Sequence Error
Standby		Check SR.5 1=Block Erase Error

SR.5,SR.4,SR.3 and SR.1 are only cleared by the Clear Status Register Command in cases where multiple blocks are erased before full status is checked.
If error is detected, clear the Status Register before attempting retry or other error recovery.

Figure 5. Automated Block Erase Flowchart