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SHARP

SPEC No.	EL154080B
ISSUE:	Oct. 2, 2003

To;

SPECIFICATIONS

Product Type 64Mbit Flash Memory

LH28F640SPHT—PTL12

Model No. (LHF64P01)

If you have any objections, please contact us before issuing purchasing order.

* This specifications contains 40 pages including the cover and appendix.
  Refer to LH28F640SP series Appendix (FUM03201).

CUSTOMERS ACCEPTANCE

DATE:

BY:

PRESENTED

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SHARP CORPORATION

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LH28F640SPHT-PTL12
64Mbit (4Mbit×16/8Mbit×8)
Page Mode Flash MEMORY

■ 64-Mbit Density
- Bit Organization ×8/×16

■ High Performance Page Mode Reads for Memory Array
- 120/25ns 4-Word/ 8-Byte Page Mode

■ V_{CC}=2.7V-3.6V Operation
- V_{CCQ} for Input/Output Power Supply Isolation
- Automatic Power Savings Mode reduces I_{CCR} in Static Mode

■ OTP (One Time Program) Block
- 4-Word/ 8-Byte Factory-Programmed Area
- 3963-Word/ 7926-Byte User-Programmable Area

■ High Performance Program with Page Buffer
- 16-Word/ 32-Byte Page Buffer
- Page Buffer Program Time 12.5µs/byte (Typ.)

■ Operating Temperature -40°C to +85°C

■ Symmetrically-Blocked Architecture
- Sixty-four 64-KWord/ 128-KByte Blocks

■ Enhanced Data Protection Features
- Individual Block Lock
- Absolute Protection with $V_{PEN} \leq V_{PENLK}$
- Block Erase, (Page Buffer) Program Lockout during Power Transitions

■ Automated Erase/Program Algorithms
- Program Time 210µs (Typ.)
- Block Erase Time 1s (Typ.)

■ Cross-Compatible Command Support
- Basic Command Set
- Common Flash Interface (CFI)

■ Extended Cycling Capability
- Minimum 100,000 Block Erase Cycles

■ 56-Lead TSOP (Normal Bend)

■ CMOS Process (P-type silicon substrate)

■ ETOX^{TM*} Flash Technology

■ Not designed or rated as radiation hardened

The product, which is Page Mode Flash memory, is a high density, low cost, nonvolatile read/write storage solution for a wide range of applications. The product can operate at V_{CC}=2.7V-3.6V and V_{PEN}=2.7V-3.6V

The product supports high performance page mode. It allows code execution directly from Flash, thus eliminating time consuming wait states.

Fast program capability is provided through the use of high speed Page Buffer Program.

The block locking scheme is available for memory array and this scheme provides maximum flexibility for safe nonvolatile code and data storage.

OTP (One Time Program) block provides an area to store security code and to protect its code.

* ETOX is a trademark of Intel Corporation.

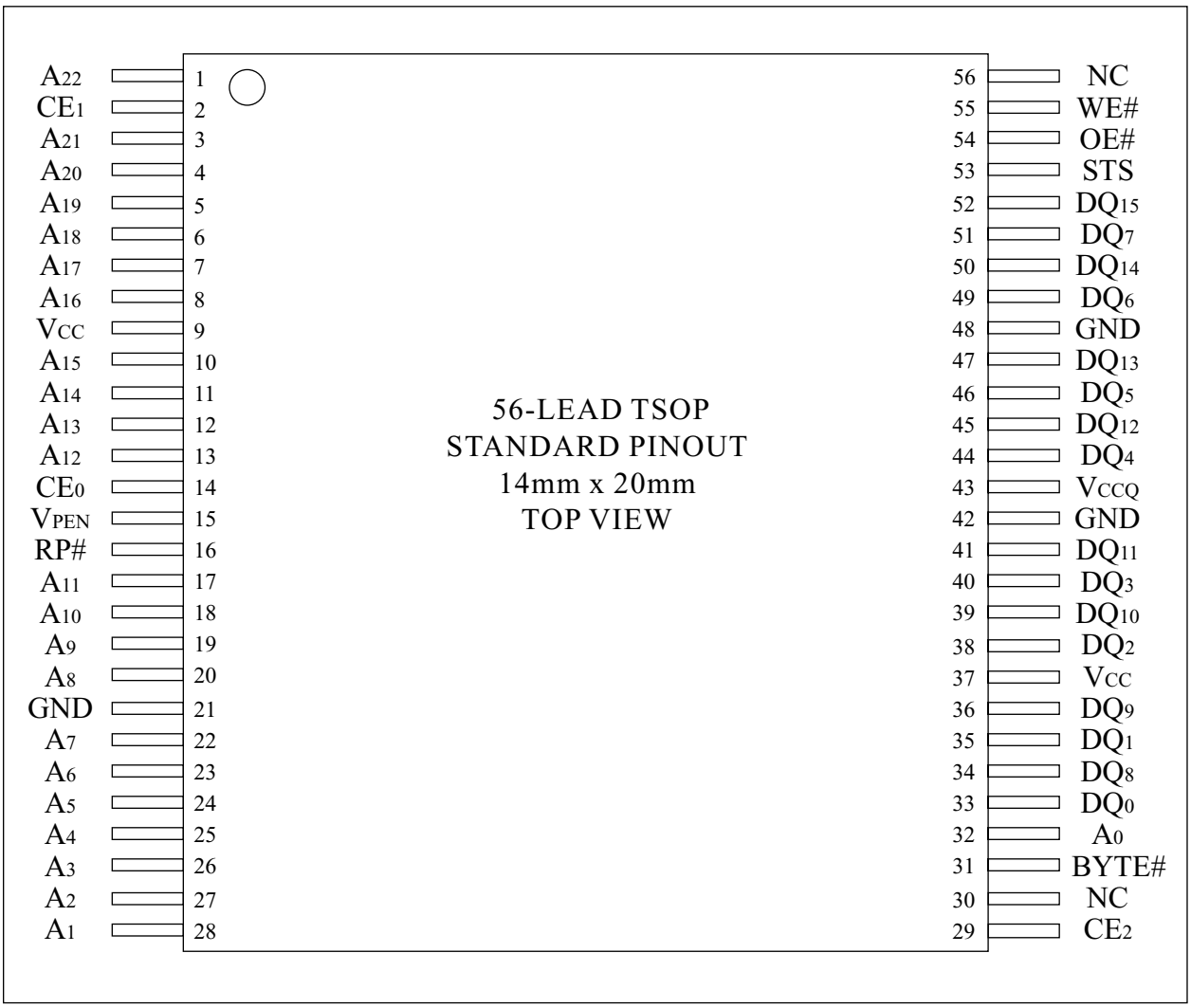

Figure 1. 56-Lead TSOP (Normal Bend) Pinout

Table 1. Pin Descriptions

Symbol	Type	Name and Function
A_0	INPUT	ADDRESS INPUTS: Lowest address input in byte mode (BYTE#=V_{IL} : ×8 bit). Address is internally latched during an erase or a program cycle. This pin is not used in word mode (BYTE#=V_{IH} : ×16 bit)
A_{22}-A_1	INPUT	ADDRESS INPUTS: Inputs for addresses during read, erase and program operations. Addresses are internally latched during an erase or a program cycle.
DQ_{15}-DQ_0	INPUT/ OUTPUT	DATA INPUTS/OUTPUTS: Inputs data and commands during CUI (Command User Interface) write cycles, outputs data during memory array, status register, query code, identifier code reads. Data pins float to high-impedance (High Z) when the chip or outputs are deselected. Data is internally latched during an erase or program cycle. DQ_{15}-DQ_8 pins are not used in byte mode (BYTE#=V_{IL} : ×8 bit).
CE_0, CE_1, CE_2	INPUT	CHIP ENABLE: Activates the device's control logic, input buffers, decoders and sense amplifiers. When the device is de-selected, power consumption reduces to standby levels. Refer to Table 2 to determine whether the device is selected or de-selected depending on the state of CE_0, CE_1 and CE_2.
RP#	INPUT	RESET: When low (V_{IL}), RP# resets internal automation and inhibits erase and program operations, which provides data protection. RP#-high (V_{IH}) enables normal operation. After power-up or reset mode, the device is automatically set to read array mode. RP# must be low during power-up/down.
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 first edge of CE_0, CE_1 or CE_2 that disables the device or the rising edge of WE# (whichever occurs first).
STS	OPEN DRAIN OUTPUT	STATUS: Indicates the status of the internal WSM (Write State Machine). When configured in level mode (default mode), STS acts as a RY/BY# pin (STS is V_{OL} when the WSM is executing internal erase or program algorithms). When configured in one of its pulse modes, STS can pulse to indicate erase/program completion. Refer to Table 9 for STS configuration.
BYTE#	INPUT	BYTE ENABLE: BYTE# V_{IL} places the device in byte mode (×8). In this mode, DQ_{15}-DQ_8 is floated (High Z) and A_0 is the lowest address input. BYTE# V_{IH} places the device in word mode (×16) and A_1 is the lowest address input.
V_{PEN}	INPUT	MONITORING POWER SUPPLY VOLTAGE: V_{PEN} is not used for power supply pin. With $V_{PEN} \leq V_{PENLK}$, block erase, (page buffer) program, block lock configuration and OTP program cannot be executed and should not be attempted.
V_{CC}	SUPPLY	DEVICE POWER SUPPLY (2.7V-3.6V): With $V_{CC} \leq V_{LKO}$, all write attempts to the flash memory are inhibited. Device operations at invalid V_{CC} voltage (refer to DC Characteristics) produce spurious results and should not be attempted.
V_{CCQ}	SUPPLY	INPUT/OUTPUT POWER SUPPLY (2.7V-3.6V): Power supply for all input/output pins.
GND	SUPPLY	GROUND: Do not float any ground pins.
NC		NO CONNECT: Lead is not internally connected; it may be driven or floated.

Table 2. CE_0, CE_1, CE_2 Truth Table [1]

CE_2	CE_1	CE_0	Device
V_{IL}	V_{IL}	V_{IL}	Enabled
V_{IL}	V_{IL}	V_{IH}	Disabled
V_{IL}	V_{IH}	V_{IL}	Disabled
V_{IL}	V_{IH}	V_{IH}	Disabled
V_{IH}	V_{IL}	V_{IL}	Enabled
V_{IH}	V_{IL}	V_{IH}	Enabled
V_{IH}	V_{IH}	V_{IL}	Enabled
V_{IH}	V_{IH}	V_{IH}	Disabled

NOTE:
1. For single-chip applications, CE_1 and CE_2 can be connected to GND.

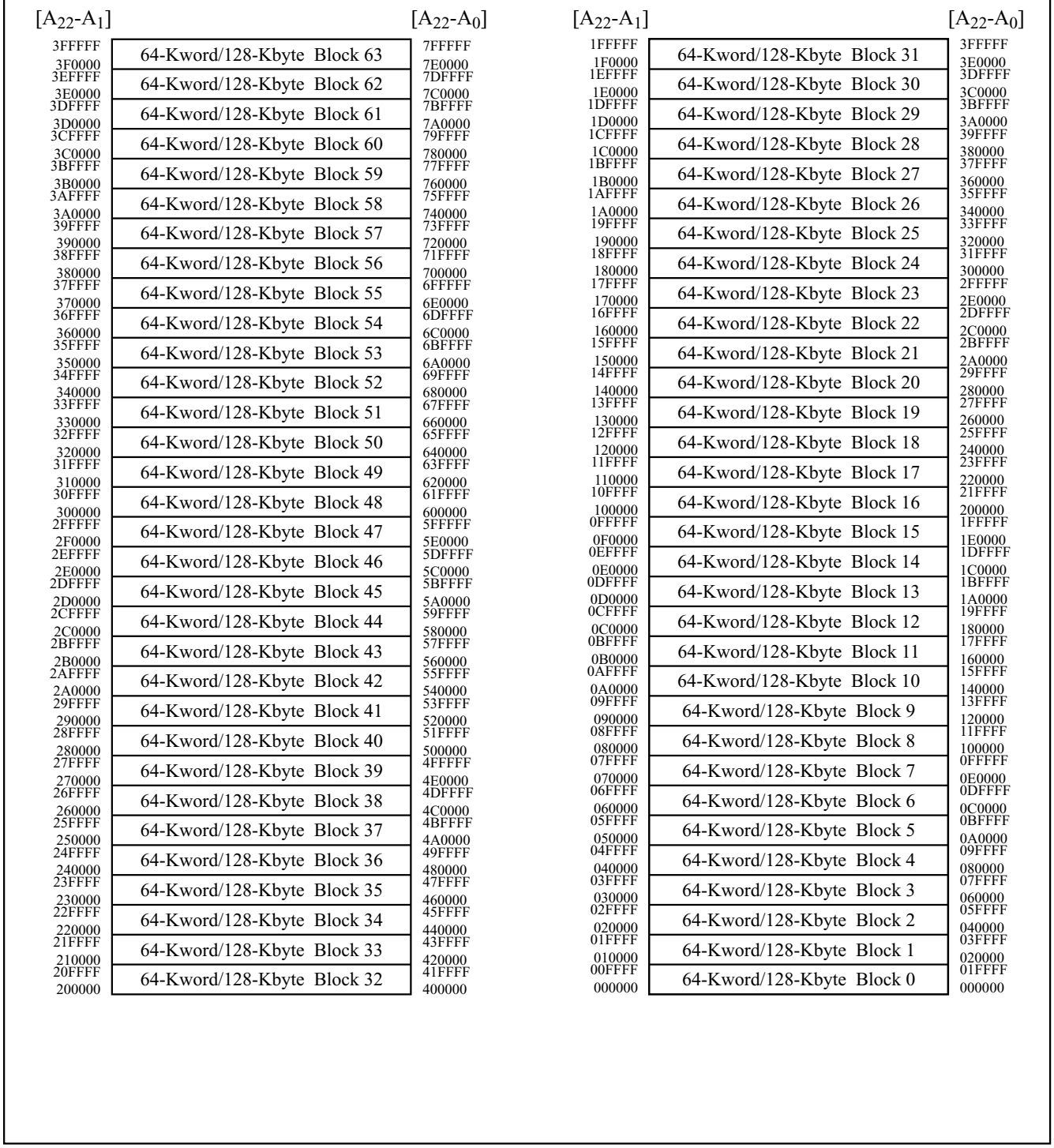

Figure 2. Memory Map

Table 3. Identifier Codes Address

	Code	Address $[A_{22}\text{-}A_1]$ (1)	Data $[DQ_7\text{-}DQ_0]$	Notes
Manufacturer Code	Manufacturer Code	000000H	B0H	2
Device Code	Device Code	000001H	17H	2
Block Lock Configuration Code	Block is Unlocked	Block Address + 2	$DQ_0 = 0$	3
	Block is Locked		$DQ_0 = 1$	3

NOTES:
1. The address A_0 don't care.
2. "00H" is presented on DQ_{15}-DQ_8 in word mode (BYTE#=V_{IH} : ×16 bit).
3. Block Address = The beginning location of a block address. DQ_{15}-DQ_1 are reserved for future implementation.

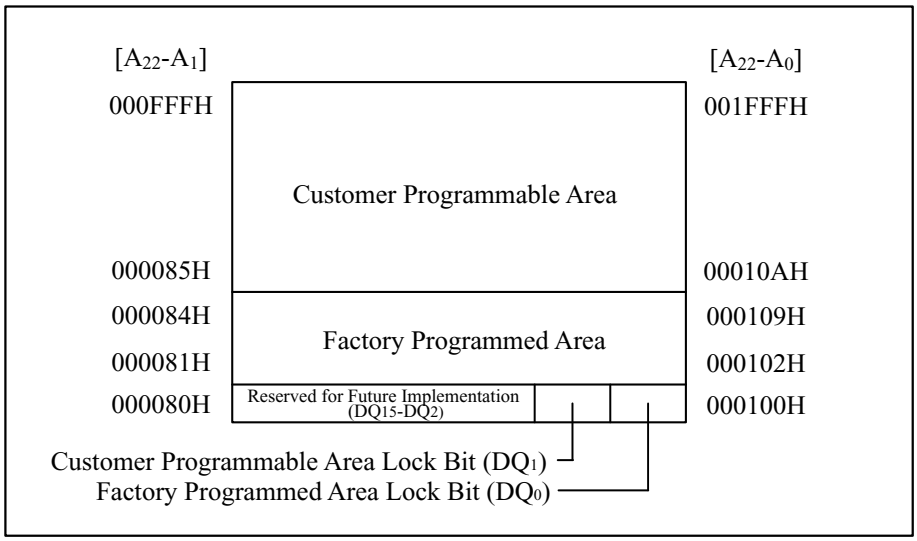

Figure 3. OTP Block Address Map
(The area not specified in the above figure cannot be used.)

Table 4. Bus Operation(1, 2)

Mode	Notes	RP#	$CE_{0,1,2}$ (3)	OE#	WE#	Address	V_{PEN}	DQ (4)	STS (10)
Read Array	8	V_{IH}	Enabled	V_{IL}	V_{IH}	X	X	D_{OUT}	X
Output Disable		V_{IH}	Enabled	V_{IH}	V_{IH}	X	X	High Z	X
Standby		V_{IH}	Disabled	X	X	X	X	High Z	X
Reset	5	V_{IL}	X	X	X	X	X	High Z	High Z
Read Identifier Codes/OTP	8	V_{IH}	Enabled	V_{IL}	V_{IH}	Refer to Table 3	X	Refer to Table 3	X
Read Query	8,9	V_{IH}	Enabled	V_{IL}	V_{IH}	See Appendix	X	See Appendix	X
Write	6,7,8	V_{IH}	Enabled	V_{IH}	V_{IL}	X	X	D_{IN}	X

NOTES:
1. Refer to DC Characteristics. When $V_{PEN} \leq V_{PENLK}$, memory contents can be read, but cannot be altered.
2. X can be V_{IL} or V_{IH} for control pins and addresses, and V_{PENLK} or V_{PENH} for V_{PEN}.
   Refer to DC Characteristics for V_{PENLK} and V_{PENH} voltages.
3. Refer to Table 2 to determine whether the device is selected or de-selected depending on the state of CE_0, CE_1 and CE_2.
4. DQ refers to DQ_{15}-DQ_0 in word mode (BYTE#=V_{IH} : ×16 bit) and DQ_7-DQ_0 in byte mode (BYTE#=V_{IL} : ×8 bit).
5. RP# at GND±0.2V ensures the lowest power consumption.
6. Command writes involving block erase, (page buffer) program, block lock configuration or OTP program are reliably executed when V_{PEN}=V_{PENH} and V_{CC}=2.7V-3.6V.
7. Refer to Table 5 for valid D_{IN} during a write operation.
8. Never hold OE# low and WE# low at the same timing.
9. Refer to Appendix of LH28F640SP series for more information about query code.
10. STS is V_{OL} when the WSM (Write State Machine) is executing internal block erase, (page buffer) program or OTP program algorithms. It is High Z during when the WSM is not busy, in block erase suspend mode (with program and page buffer program inactive), (page buffer) program suspend mode, or reset mode.

Table 5. 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	1		Write	X	FFH			
Read Identifier Codes/OTP	≥ 2	4	Write	X	90H	Read	IA or OA	ID or OD
Read Query	≥ 2	4	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	2	5	Write	BA	20H	Write	BA	D0H
Program	2	5,6	Write	X	40H or 10H	Write	WA	WD
Page Buffer Program	≥ 4	5,7	Write	BA	E8H	Write	BA	N-1
Block Erase and (Page Buffer) Program Suspend	1	8	Write	X	B0H			
Block Erase and (Page Buffer) Program Resume	1	8	Write	X	D0H			
STS Configuration	2		Write	X	B8H	Write	X	CC
Set Block Lock Bit	2		Write	X	60H	Write	BA	01H
Clear Block Lock Bits	2	9	Write	X	60H	Write	X	D0H
OTP Program	2		Write	X	C0H	Write	OA	OD

NOTES:
1. Bus operations are defined in Table 4.
2. X=Any valid address within the device.
   IA=Identifier codes address (Refer to Table 3).
   QA=Query codes address. Refer to Appendix of LH28F640SP series for details.
   BA=Address within the block for block erase, page buffer program or set block lock bit.
   WA=Address of memory location for the Program command.
   OA=Address of OTP block to be read or programmed (Refer to Figure 3).
3. The upper byte of the data bus (DQ_{15}-DQ_8) during command writes is ignored in word mode (BYTE#=V_{IH} : ×16 bit).
   ID=Data to be read from identifier codes. (Refer to Table 3).
   QD=Data to be read from query database. Refer to Appendix of LH28F640SP series for details.
   SRD=Data to be read from status register. Refer to Table 7 for a description of the status register bits.
   WD=Data to be programmed at location WA. Data is latched on the first edge of CE_0, CE_1 or CE_2 that disables the device or the rising edge of WE# (whichever occurs first) during command write cycles.
   N-1=N is the number of the words /bytes to be loaded into a page buffer.
   OD=Data within OTP block. Data is latched on the first edge of CE_0, CE_1 or CE_2 that disables the device or the rising edge of WE# (whichever occurs first) during command write cycles.
   CC= STS configuration code (Refer to Table 9).
4. Following the Read Identifier Codes/OTP command, read operations access manufacturer code, device code, block lock configuration code and the data within OTP block (Refer to Table 3).
   The Read Query command is available for reading CFI (Common Flash Interface) information.
5. Block erase or (page buffer) program cannot be executed when the selected block is locked. Unlocked block can be erased or programmed when RP# is V_{IH}.
6. Either 40H or 10H are recognized by the CUI (Command User Interface) as the program setup.
7. Following the third bus cycle, write the program sequential address and data of "N" times. Finally, write the any valid address within the block to be programmed and the confirm command (D0H).

Refer to Appendix of LH28F640SP series for details.

8. If both block erase operation and (page buffer) program operation are suspended, the suspended (page buffer) program operation is resumed when writing the Block Erase and (Page Buffer) Program Resume (D0H) command.
9. Following the Clear Block Lock Bits command, all the blocks are unlocked at a time.
10. Commands other than those shown above are reserved by SHARP for future device implementations and should not be used.

Table 6. Functions of Block Lock (1), (2)

DQ_0 (3)	State Name	Erase/Program Allowed (4)
0	Unlocked	Yes
1	Locked	No

NOTES:
1. Selected block is locked by the Set Block Lock Bit command. Following the Clear Block Lock Bits command, all the blocks are unlocked at a time.
2. Locked and unlocked states remain unchanged even after power-up/down and device reset.
3. After writing the Read Identifier Codes/OTP command, read operation outputs the block lock bit status on DQ_0 (refer to Table 3).
4. Erase and program are general terms, respectively, to express: block erase and (page buffer) program operations.

Table 7. Status Register Definition

R	R	R	R	R	R	R	R
15	14	13	12	11	10	9	8
WSMS	BESS	BECBLS	PBPOPSBLS	VPENS	PBPSS	DPS	R
7	6	5	4	3	2	1	0

	NOTES:
SR.15 - SR.8 = RESERVED FOR FUTURE ENHANCEMENTS (R)	
SR.7 = WRITE STATE MACHINE STATUS (WSMS) 1 = Ready 0 = Busy	Check SR.7 or STS to determine block erase, (page buffer) program, block lock configuration or OTP program completion. SR.6 - SR.1 are invalid while SR.7="0".
SR.6 = BLOCK ERASE SUSPEND STATUS (BESS) 1 = Block Erase Suspended 0 = Block Erase in Progress/Completed	
SR.5 = BLOCK ERASE AND CLEAR BLOCK LOCK BITS STATUS (BECBLS) 1 = Error in Block Erase or Clear Block Lock Bits 0 = Successful Block Erase or Clear Block Lock Bits	If both SR.5 and SR.4 are "1"s after a block erase, page buffer program, block lock configuration, STS configuration attempt, an improper command sequence was entered.
SR.4 = (PAGE BUFFER) PROGRAM, OTP PROGRAM AND SET BLOCK LOCK BIT STATUS (PBPOPSBLS) 1 = Error in (Page Buffer) Program, OTP Program or Set Block Lock Bit 0 = Successful (Page Buffer) Program, OTP Program or Set Block Lock Bit	
SR.3 = V_{PEN} STATUS (VPENS) 1 = V_{PEN} LOW Detect, Operation Abort 0 = V_{PEN} OK	SR.3 does not provide a continuous indication of V_{PEN} level. The WSM interrogates and indicates the V_{PEN} level only after Block Erase, (Page Buffer) Program, Set Block Lock Bit, Clear Block Lock Bits or OTP Program command sequences. SR.3 is not guaranteed to report accurate feedback when $V_{PEN} \neq V_{PENH}$ or V_{PENLK}.
SR.2 = (PAGE BUFFER) PROGRAM SUSPEND STATUS (PBPSS) 1 = (Page Buffer) Program Suspended 0 = (Page Buffer) Program in Progress/Completed	
SR.1 = DEVICE PROTECT STATUS (DPS) 1 = Erase or Program Attempted on a Locked Block, Operation Abort 0 = Unlocked	SR.1 does not provide a continuous indication of block lock bit. The WSM interrogates the block lock bit only after Block Erase, (Page Buffer) Program or OTP Program command sequences. It informs the system, depending on the attempted operation, if the block lock bit is set. Reading the block lock configuration codes after writing the Read Identifier Codes/ OTP command indicates block lock bit status.
SR.0 = RESERVED FOR FUTURE ENHANCEMENTS (R)	SR.15 - SR.8 and SR.0 are reserved for future use and should be masked out when polling the status register.

Table 8. Extended Status Register Definition

R	R	R	R	R	R	R	R
15	14	13	12	11	10	9	8
SMS	R	R	R	R	R	R	R
7	6	5	4	3	2	1	0

XSR.15-8 = RESERVED FOR FUTURE ENHANCEMENTS (R)

XSR.7 = STATE MACHINE STATUS (SMS)
1 = Page Buffer Program available
0 = Page Buffer Program not available

XSR.6-0 =RESERVED FOR FUTURE ENHANCEMENTS (R)

NOTES:

After issue a Page Buffer Program command (E8H), XSR.7="1" indicates that the entered command is accepted. If XSR.7 is "0", the command is not accepted and a next Page Buffer Program command (E8H) should be issued again to check if page buffer is available or not.

XSR.15-8 and XSR.6-0 are reserved for future use and should be masked out when polling the extended status register.

Table 9. STS Configuration Definition (1)

R	R	R	R	R	R	R	R
15	14	13	12	11	10	9	8
R	R	R	R	R	R	CC	CC
7	6	5	4	3	2	1	0

DQ_{15}-DQ_2 = RESERVED FOR FUTURE ENHANCEMENTS (R)

DQ_1-DQ_0 = STS CONFIGURATION CODE (CC)
- 00 = level mode: RY/BY# indication. (Default)
- 01 = pulse mode on erase complete.
- 10 = pulse mode on program complete.
- 11 = pulse mode on erase or program complete.

In STS configuration = "00", STS is V_{OL} when the WSM is executing internal erase or program algorithms.

STS configuration codes "01", "10" and "11" are all pulse modes such that the STS pin pulses low then high when the operation indicated by the configuration code is completed.

NOTES:

After power-up or device reset, STS configuration is set to "00".

STS configuration 00
The output of the STS pin is the control signal to prevent accessing a flash memory while the internal WSM is busy (SR.7="0").

STS configuration 01
The output of the STS pin is the control signal to indicate that the erase operation is completed and the flash memory is available for the next operation.

STS configuration 10
The output of the STS pin is the control signal to indicate that the program operation is completed and the flash memory is available for the next operation.

STS configuration 11
The output of the STS pin is the control signal to indicate that the erase or program operation is completed and the flash memory is available for the next operation.

NOTE:
1. When the device is configured in one of the pulse modes, the STS pin pulses low with a typical pulse width of 250ns.

1 Electrical Specifications

1.1 Absolute Maximum Ratings*

Operating Temperature

During Read, Erase and Program ...-40°C to +85°C (1)

Storage Temperature

During under Bias..... -40°C to +85°C

During non Bias..... -65°C to +125°C

Voltage On Any Pin (except V_{CC}, V_{CCQ} and V_{PEN})

.....-0.5V to V_{CCQ}+0.5V (2)

V_{CC} and V_{CCQ} Supply Voltage ..... -0.2V to +3.9V (2)

V_{PEN} Supply Voltage..... -0.2V to +3.9V (2)

Output Short Circuit Current.....100mA (3)

**WARNING:* Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

NOTES:

1. Operating temperature is for extended temperature product defined by this specification.
2. All specified voltages are with respect to GND. Minimum DC voltage is -0.5V on input/output pins and -0.2V on V_{CC}, V_{CCQ} and V_{PEN} pins. During transitions, this level may undershoot to -2.0V for periods <20ns. Maximum DC voltage on input/output pins is V_{CC}+0.5V which, during transitions, may overshoot to V_{CC}+2.0V for periods <20ns.
3. Output shorted for no more than one second. No more than one output shorted at a time.

1.2 Operating Conditions

Symbol	Parameter	Notes	Min.	Typ.	Max.	Unit	Test Conditions
T_A	Operating Temperature		-40	+25	+85	°C	Ambient Temperature
V_{CC}	V_{CC} Supply Voltage	1, 2	2.7	3.0	3.6	V	
V_{CCQ}	I/O Supply Voltage	1, 2	2.7	3.0	3.6	V	
V_{PENH}	V_{PEN} Voltage	1	2.7	3.0	3.6	V	
	Block Erase Cycling: V_{PEN}=V_{PENH}		100,000			Cycles	

NOTES:

1. Refer to DC Characteristics tables for voltage range-specific specification.
2. V_{CC} and V_{CCQ} should be the same voltage.

1.2.1 Capacitance (1) (T_A=+25°C, f=1MHz)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
C_{IN}	Input Capacitance		6	8	pF	V_{IN}=0.0V
C_{OUT}	Output Capacitance		8	12	pF	V_{OUT}=0.0V

NOTE:
1. Sampled, not 100% tested.

1.2.2 AC Input/Output Test Conditions

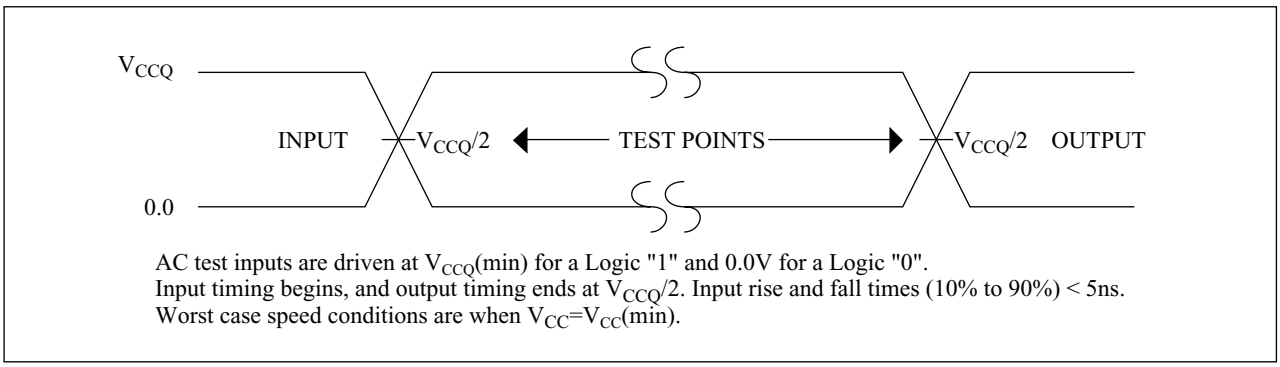

Figure 4. Transient Input/Output Reference Waveform for V_{CC}=2.7V-3.6V

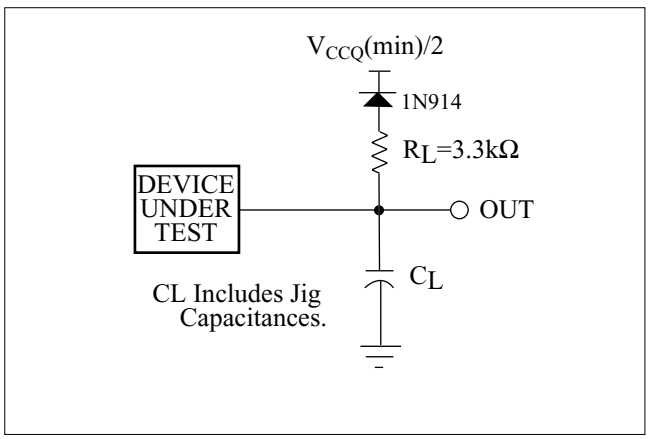

Figure 5. Transient Equivalent Testing Load Circuit

Table 10. Configuration Capacitance Loading Value

Test Configuration	C_L (pF)
V_{CC}=2.7V-3.6V	30

1.2.3 DC Characteristics

V_{CC}=2.7V-3.6V

Symbol	Parameter		Notes	Min.	Typ.	Max.	Unit	Test Conditions
I_{LI}	Input Load Current		1	-1		+1	µA	V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., V_{IN}/V_{OUT}=V_{CCQ} or GND
I_{LO}	Output Leakage Current		1	-10		+10	µA	
I_{CCS}	V_{CC} Standby Current		1, 2, 8		50	120	µA	CMOS Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is disabled (refer to Table 2), RP#=V_{CCQ}±0.2V
					0.71	2	mA	TTL Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is disabled (refer to Table 2), RP#=V_{IH}
I_{CCAS}	V_{CC} Automatic Power Savings Current		1, 2, 5		50	120	µA	CMOS Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is enabled (refer to Table 2)
I_{CCD}	V_{CC} Reset Current		1		50	120	µA	RP#=GND±0.2V I_{OUT} (STS)=0mA
I_{CCR}	Average V_{CC} Page Mode Read Current	4 word/ 8 byte read	1, 2		15	20	mA	CMOS Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is enabled (refer to Table 2), f=5MHz, I_{OUT}=0mA
			1, 2		24	29	mA	CMOS Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is enabled (refer to Table 2), f=33MHz, I_{OUT}=0mA
	Average V_{CC} Read Current	1 word/ 1 byte read	1, 2		40	50	mA	CMOS Inputs, V_{CC}=V_{CC}Max., V_{CCQ}=V_{CCQ}Max., Device is enabled (refer to Table 2), f=5MHz, I_{OUT}=0mA
I_{CCW}	V_{CC} (Page Buffer) Program, Set Block Lock Bit Current		1, 2, 6		35	60	mA	CMOS Inputs, V_{PEN}=V_{PENH}
			1, 2, 6		40	70	mA	TTL Inputs, V_{PEN}=V_{PENH}

DC Characteristics (Continued)

V_{CC}=2.7V-3.6V

Symbol	Parameter	Notes	Min.	Typ.	Max.	Unit	Test Conditions
I_{CCE}	V_{CC} Block Erase, Clear Block Lock Bits Current	1, 2, 6		35	70	mA	CMOS Inputs, $V_{PEN}=V_{PENH}$
		1, 2, 6		40	80	mA	TTL Inputs, $V_{PEN}=V_{PENH}$
I_{CCWS} I_{CCES}	V_{CC} (Page Buffer) Program or Block Erase Suspend Current	1, 3			10	mA	Device is disabled (refer to Table 2).
V_{IL}	Input Low Voltage	6	-0.5		0.8	V	
V_{IH}	Input High Voltage	6	2.0		V_{CCQ} + 0.5	V	
V_{OL}	Output Low Voltage	6, 8			0.4	V	$V_{CC}=V_{CC}$Min., $V_{CCQ}=V_{CCQ}$Min., I_{OL}=2mA
					0.2	V	$V_{CC}=V_{CC}$Min., $V_{CCQ}=V_{CCQ}$Min., I_{OL}=100µA
V_{OH}	Output High Voltage	6, 8	0.85× V_{CCQ}			V	$V_{CC}=V_{CC}$Min., $V_{CCQ}=V_{CCQ}$Min., I_{OH}=-1.5mA
			V_{CCQ} -0.2			V	$V_{CC}=V_{CC}$Min., $V_{CCQ}=V_{CCQ}$Min., I_{OH}=-100µA
V_{PENLK}	V_{PEN} Lockout Voltage during Normal Operations	4, 6, 7			1.0	V	
V_{PENH}	V_{PEN} Voltage during Block Erase, (Page Buffer) Program, Set Block Lock Bit, Clear Block Lock Bits or OTP Program Operations	4, 7	2.7	3.0	3.6	V	
V_{LKO}	V_{CC} Lockout Voltage	4	2.0			V	

NOTES:

1. All currents are in RMS unless otherwise noted. Typical values are the reference values at V_{CC}=3.0V, V_{CCQ}=3.0V and T_A=+25°C unless V_{CC} is specified.
2. CMOS inputs are either V_{CCQ}±0.2V or GND±0.2V. TTL inputs are either V_{IL} or V_{IH}.
3. I_{CCWS} and I_{CCES} are specified with the device de-selected. If read or (page buffer) program is executed while in block erase suspend mode, the device's current draw is the sum of I_{CCES} and I_{CCR} or I_{CCW}. If read is executed while in (page buffer) program suspend mode, the device's current draw is the sum of I_{CCWS} and I_{CCR}.
4. Block erase, (page buffer) program, block lock configuration and OTP program operations are inhibited when $V_{PEN}\leq V_{PENLK}$ or $V_{CC}\leq V_{LKO}$. These operations are not guaranteed outside the specified voltage (V_{CC}=2.7V-3.6V and V_{PEN}=2.7V-3.6V).
5. The Automatic Power Savings (APS) feature automatically places the device in power save mode after read cycle completion. Standard address access timings (t_{AVQV}) provide new data when addresses are changed.
6. Sampled, not 100% tested.
7. V_{PEN} is not used for power supply pin. With $V_{PEN}\leq V_{PENLK}$, block erase, (page buffer) program, block lock configuration and OTP program operations are inhibited.
8. Includes STS.

1.2.4 AC Characteristics - Read-Only Operations (1)

T_A=-40°C to +85°C

		V_{CC}	3.0V-3.6V		2.7V-3.6V		
		V_{CCQ}	3.0V-3.6V		2.7V-3.6V		
Symbol	Parameter	Notes	Min.	Max.	Min.	Max.	Unit
t_{AVAV}	Read Cycle Time		120		120		ns
t_{AVQV}	Address to Output Delay			120		120	ns
t_{ELQV}	CE_X to Output Delay	3, 4		120		120	ns
t_{APA}	Page Address Access Time			25		30	ns
t_{GLQV}	OE# to Output Delay	3		25		30	ns
t_{PHQV}	RP# High to Output Delay			180		180	ns
t_{ELQX}	CE_X to Output in Low Z	2, 4	0		0		ns
t_{GLQX}	OE# to Output in Low Z	2	0		0		ns
t_{EHQZ}	CE_X to Output in High Z	2, 5		35		35	ns
t_{GHQZ}	OE# to Output in High Z	2		15		15	ns
t_{OH}	Output Hold from First Occurring Address, CE_X or OE# change	2, 5	0		0		ns
t_{ELFL}/t_{ELFH}	CEx Setup to BYTE# Going Low or High	2, 4		10		10	ns
t_{FLQV}/t_{FHQV}	BYTE# to Output Delay			1000		1000	ns
t_{FLQZ}/t_{FHQZ}	BYTE# to Output in High Z	2		1000		1000	ns

NOTES:
1. Refer to AC input/output reference waveform for timing measurements and maximum allowable input slew rate.
2. Sampled, not 100% tested.
3. OE# may be delayed up to $t_{ELQV} - t_{GLQV}$ after the first edge of CE_0, CE_1 or CE_2 that enables the device (refer to Table 2) without impact to t_{ELQV}.
4. The timing is defined from the first edge of CE_0, CE_1 or CE_2 that enables the device.
5. The timing is defined from the first edge of CE_0, CE_1 or CE_2 that disables the device.

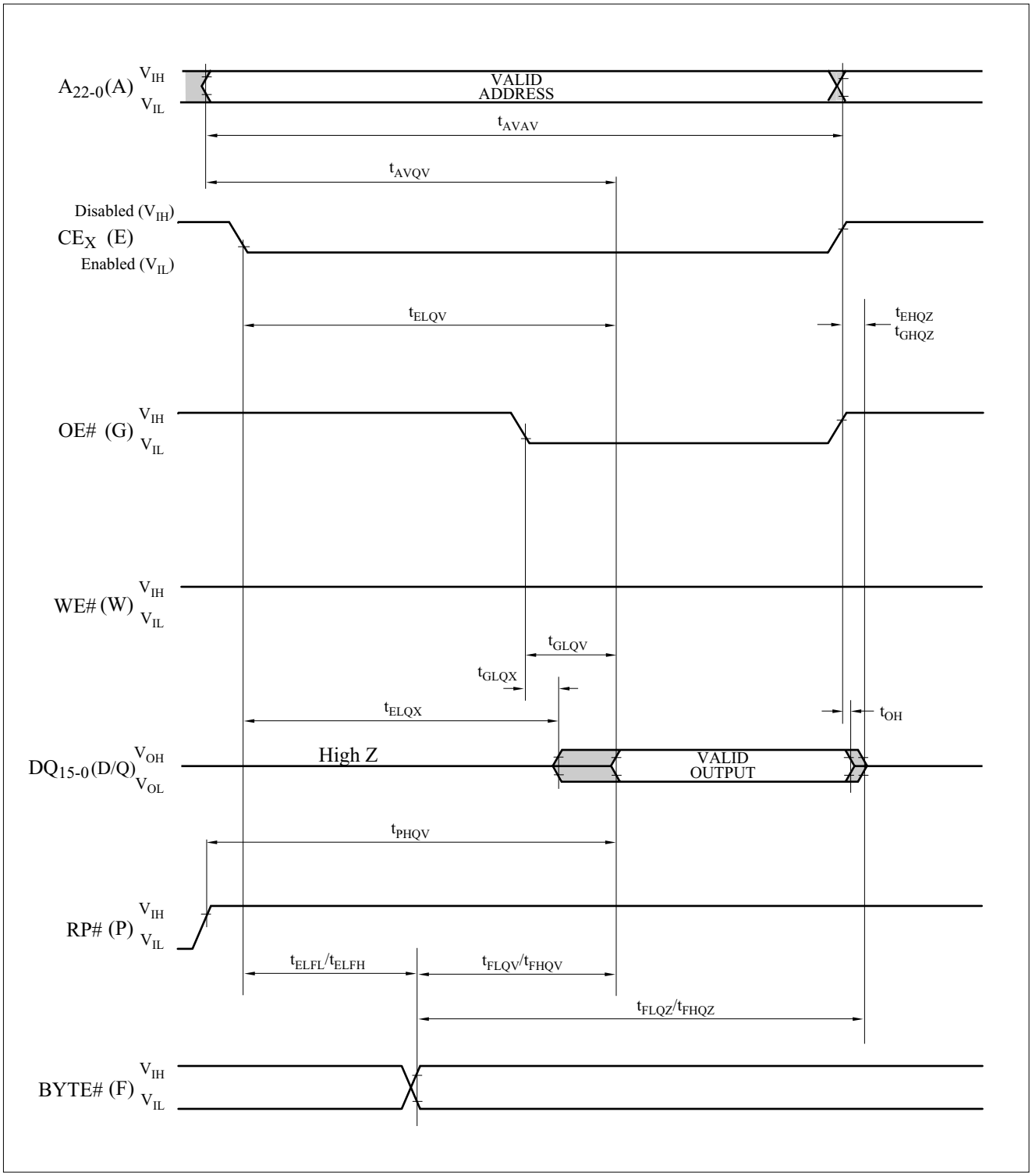

Figure 6. AC Waveform for 1-Word/ 1-Byte Read Operations
(Status Register, Identifier Codes, OTP Block or Query Code)

NOTE:
1. Status register, identifier codes, OTP block and query code can only be read in 1-word/ 1-byte read operations.

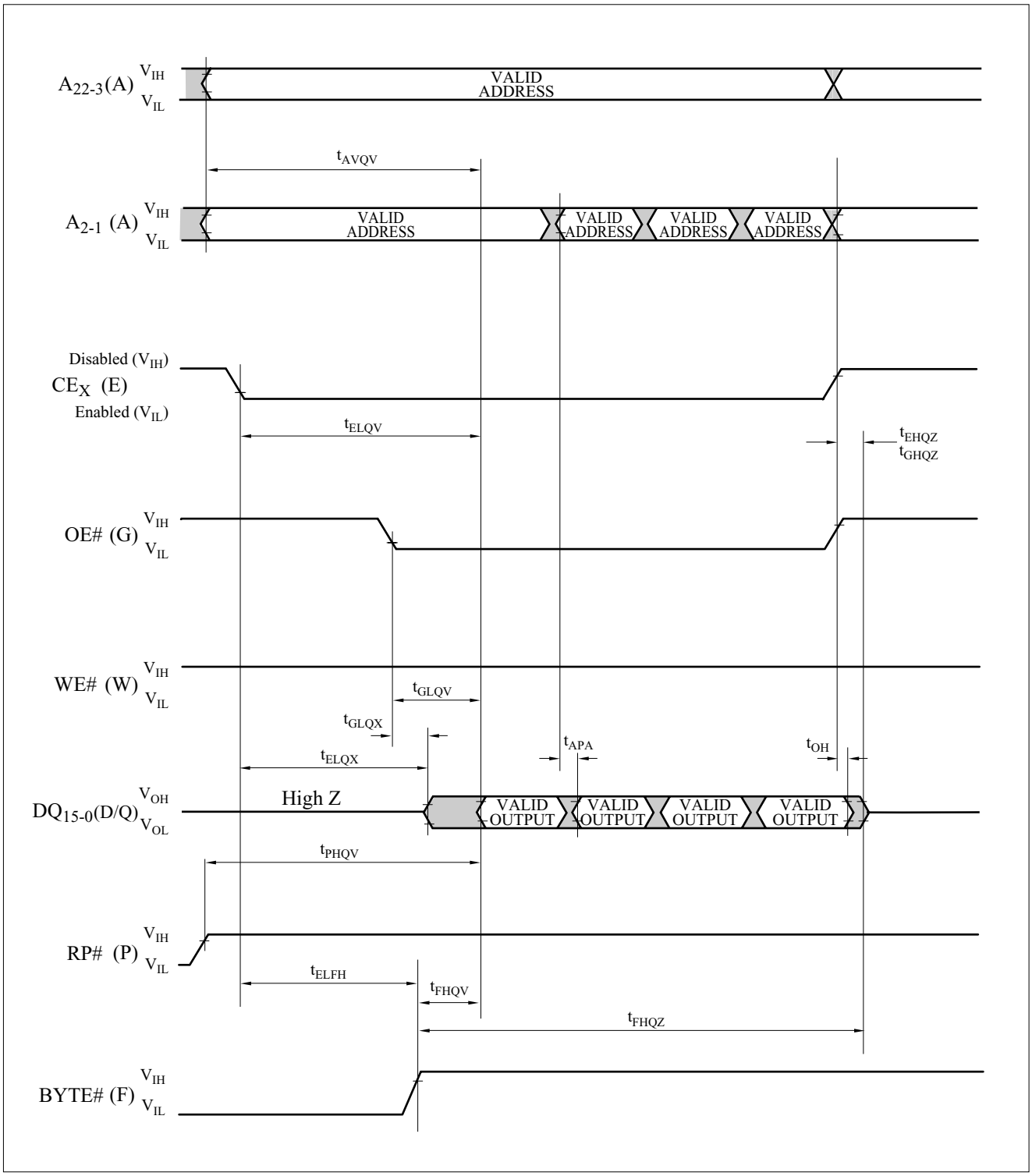

Figure 7. AC Waveform for 4-Word Page Mode Read Operations (Memory Array)

NOTE:
1. Memory array supports page mode read operations.

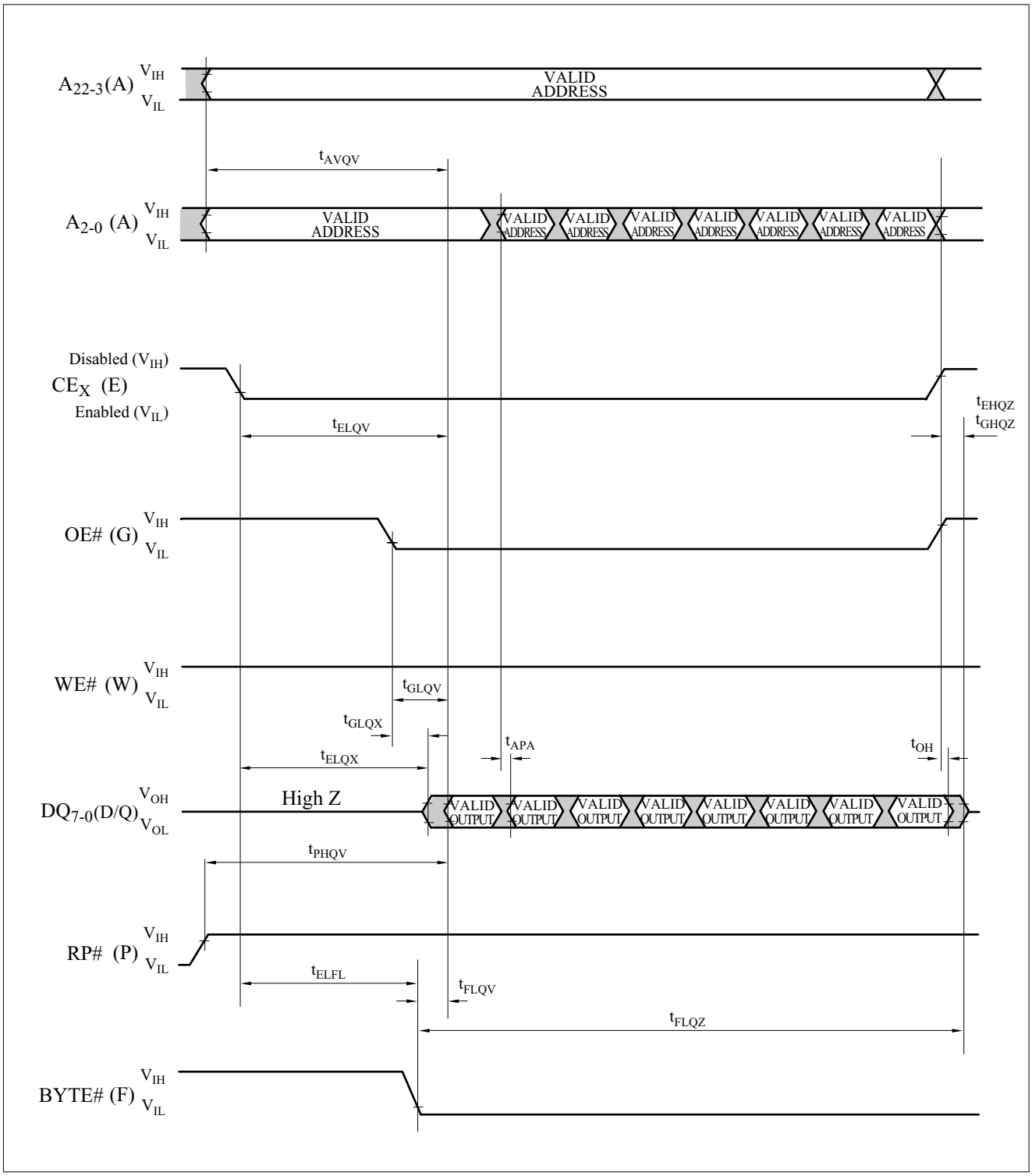

Figure 8. AC Waveform for 8-Byte Page Mode Read Operations
(Memory Array)

NOTE:
1. Memory array supports page mode read operations.