General Description

The EM39LV088 is an 8M bits Flash memory organized as 1M x 8 bits. The EM39LV088 uses 2.7-3.6V power supply for Program and Erase. Featuring high performance Flash memory technology, the EM39LV088 provides a typical Byte-Program time of 14 µsec and a typical Sector/Block-Erase time of 18 ms. The device uses Toggle Bit or Data# Polling to detect the completion of the Program or Erase operation. To protect against inadvertent write, the device has on-chip hardware and software data protection schemes. The device offers typical 100,000 cycles endurance and a greater than 10 years data retention. The EM39LV088 conforms to JEDEC standard pin outs for x16 memories. The EM39LV088 is offered in package types of 48-pin TSOP, and known good dice (KGD). For KGD, please contact ELAN Microelectronics or its representatives for detailed information (see Appendix at the bottom of this specification for Ordering Information).

The EM39LV088 devices are developed for applications that require memories with convenient and economical updating of program, data or configuration, e.g., DVD player, DVD R/W, WLAN, Router, Set-Top Box, etc.

Features

- **Single Power Supply**
  Full voltage range from 2.7 to 3.6 volts for both read and write operations
- **Sector-Erase Capability**
  Uniform 4Kbyte sectors
- **Block-Erase Capability**
  Uniform 64Kbyte blocks
- **Read Access Time**
  Access time: 70 and 90 ns
- **Power Consumption**
  Active current: 15 mA (Typical)
  Standby current: 2 µA (Typical)
- **Erase/Program Features**
  Sector-Erase Time: 18 ms (Typical)
  Block-Erase Time: 18 ms (Typical)
  Chip-Erase Time: 45 ms (Typical)
  Byte-Program Time: 14µs (Typical)
  Chip Rewrite Time: 15 seconds (Typical)
- **Automatic Write Timing**
  Internal V_{PP} Generation
- **End-of-Program or End-of-Erase Detection**
  Data# Polling
  Toggle Bit
- **CMOS I/O Compatibility**
- **JEDEC Standard**
  Pin-out and software command sets compatible with single-power supply Flash memory
- **High Reliability**
  Endurance cycles: 100K (Typical)
  Data retention: 10 years
- **Package Option**
  48-pin TSOP

Functional Block Diagram

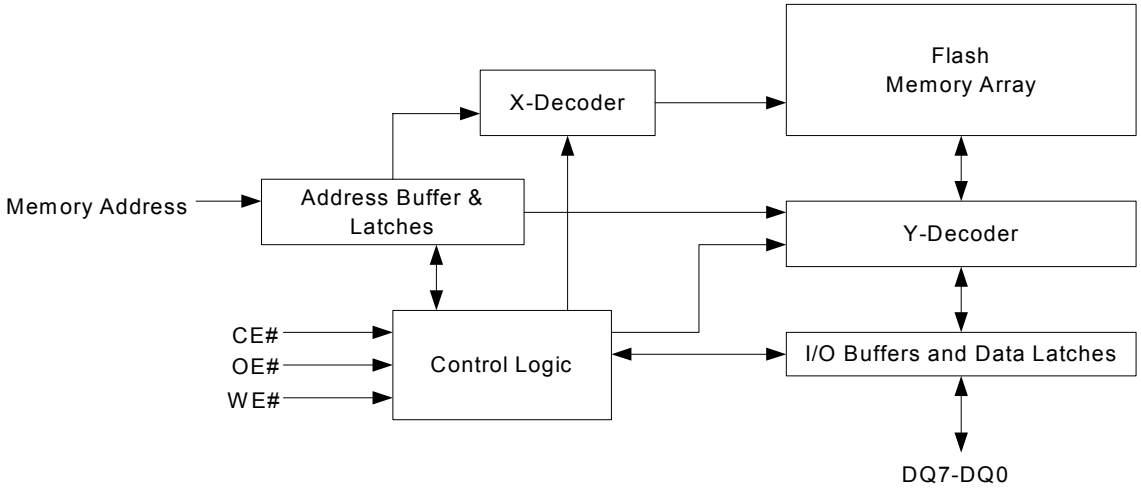


Figure 0a: *Functional Block Diagram*

Pin Assignments

TSOP

Figure 0b: *TSOP Pin Assignments*

Pin Description

Pin Name	Function
A0–A19	20 addresses
DQ7–DQ0	Data inputs/outputs
CE#	Chip enable
OE#	Output enable
WE#	Write enable
V_{DD}	2.7-3.6 volt single power supply
V_{SS}	Device ground
NC	Pin not connected internally

Table 1: *Pin Description*

Device Operation

The EM39LV088 uses Commands to initiate the memory operation functions. The Commands are written to the device by asserting WE# Low while keeping CE# Low. The address bus is latched on the falling edge of WE# or CE#, whichever occurs last. The data bus is latched on the rising edge of WE# or CE#, whichever occurs first.

Read

The Read operation of the EM39LV088 is controlled by CE# and OE#. Both have to be Low for the system to obtain data from the outputs. CE# is used for device selection. When CE# is high, the chip is deselected and only standby power is consumed. OE# is the output control and is used to gate data from the output pins. The data bus is in high impedance state when either CE# or OE# is high. Refer to the Read Cycle Timing Diagram in Figure 1 for further details.

Byte Program

The EM39LV088 is programmed on a byte-by-byte basis. Before programming, the sector where the byte is located; must be erased completely. The Program operation is accomplished in three steps**:**

- The first step is a three-byte load sequence for Software Data Protection.
- The second step is to load byte address and byte data. During the Byte Program operation, the addresses are latched on the falling edge of either CE# or WE#, whichever occurs last; and the data is latched on the rising edge of either CE# or WE#, whichever occurs first.
- The third step is the internal Program operation which is initiated after the rising edge of the fourth WE# or CE#, whichever occurs first. The Program operation, once initiated, will be completed within 20 µs. See Figures 2 and 3 for WE# and CE# controlled Program operation timing diagrams respectively and Figure 12 for flowchart.

During the Program operation, the only valid reads are Data# Polling and Toggle Bit. During the internal Program operation, the host is free to perform additional tasks. Any command issued during the internal Program operation is ignored.

EM39LV088 Device Operation

Operation	CE#	OE#	WE#	DQ	Address
Read	V_{IL}	V_{IL}	V_{IH}	D_{OUT}	A_{IN}
Program	V_{IL}	V_{IH}	V_{IL}	D_{IN}	A_{IN}
Erase	V_{IL}	V_{IH}	V_{IL}	X*	Sector or Block address, XXH for Chip-Erase
Standby	V_{IH}	X	X	High Z	X
Write Inhibit	X	V_{IL}	X	High Z/D_{OUT}	X
Write Inhibit	X	X	V_{IH}	High Z/D_{OUT}	X
Software Mode	V_{IL}	V_{IL}	V_{IH}		See Table 3
Product Identification					

** X can be V_{IL} or V_{IH}, but no other value.*

Table 2: *EM39LV088 Device Operation*

Write Command/Command Sequence

The EM39LV088 provides two software methods to detect the completion of a Program or Erase cycle in order to optimize the system write cycle time. The software detection includes two status bits**:** Data# Polling (DQ7) and Toggle Bit (DQ6). The End-of-Write detection mode is enabled after the rising edge of WE#, which initiates the internal Program or Erase operation. The actual completion of the write operation is asynchronous with the system; therefore, either a Data# Polling or Toggle Bit read may be simultaneous with the completion of the write cycle. If this occurs, the system may possibly get an erroneous result, i.e., valid data may appear to conflict with either DQ7 or DQ6. In order to prevent such spurious rejection, when an erroneous result occurs, the software routine should include an additional two times loop to read the accessed location. If both reads are valid, then the device has completed the write cycle, otherwise the rejection is valid.

Chip Erase

The EM39LV088 provides Chip-Erase feature, which allows the entire memory array to be erased to logic “1” state. The Chip-Erase operation is initiated by executing a six-byte command sequence with Chip-Erase command (10H) at address AAAH in the last byte sequence. The Erase operation begins with the rising edge of the sixth WE# or CE#, whichever occurs first. During the Erase operation, the only valid reads are Toggle Bit and Data# Polling. See Table 3 for the command sequence, Figure 6 for timing diagram, and Figure 15 for the flowchart. Any commands issued during the Chip-Erase operation are ignored.

Sector/Block Erase

The EM39LV088 offers both Sector-Erase and Block-Erase modes. The Sector- (or Block-) Erase operation allows the system to erase the device on a sector-by-sector (or block-by-block) basis. The sector architecture is based on uniform sector size of 4 KByte. The Block architecture is based on uniform block size of 64 KByte. The Sector-Erase operation is initiated by executing a six-byte command sequence with Sector-Erase command (30H) and sector address (SA) in the last bus cycle. The Block-Erase operation is initiated by executing a six-byte command sequence with Block-Erase command (50H) and block address (BA) in the last bus cycle. The sector or block address is latched on the falling edge of the sixth WE# pulse, while the command (30H or 50H) is latched on the rising edge of the sixth WE# pulse. The internal Erase operation begins after the sixth WE# pulse. The End-of-Erase operation can be determined by using either Data# Polling or Toggle Bit method. See Figures 7 and 8 for timing waveforms. Any commands issued during the Sector or Block Erase operation are ignored.

Data# Polling (DQ7)

When the EM39LV088 is in the internal Program operation, any attempt to read DQ7 will produce the complement of the true data. Once the Program operation is completed, DQ7 will produce the true data. Note that even though DQ7 may have valid data immediately following the completion of an internal Program operation, the remaining data outputs may still be invalid (valid data on the entire data bus will appear in subsequent successive Read cycles after an interval of 1 μs). During internal Erase operation, any attempt to read DQ7 will produce a “0”. Once the internal Erase operation is completed, DQ7 will produce a “1”. The Data# Polling is valid after the rising edge of fourth WE# (or CE#) pulse for Program operation. For Sector-Erase, Block-Erase, or Chip-Erase, the Data# Polling is valid after the rising edge of sixth WE# (or CE#) pulse. See Figure 4 for Data# Polling timing diagram and Figure 13 for a flowchart.

Toggle Bit (DQ6)

During the internal Program or Erase operation, any consecutive attempts to read DQ6 will produce alternating 1s and 0s, i.e., toggling between 1 and 0. When the internal Program or Erase operation is completed, the DQ6 bit will stop toggling. The device is then ready for the next operation. The Toggle Bit is valid after the rising edge of fourth WE# (or CE#) pulse for Program operation. For Sector-Erase, Block-Erase or Chip-Erase, the Toggle Bit is valid after the rising edge of sixth WE# (or CE#) pulse. See Figure 5 for Toggle Bit timing diagram and Figure 13 for a flowchart.

Data Protection

The EM39LV088 provides both hardware and software features to protect the data from inadvertent write.

Hardware Data Protection

Noise/Glitch Protection: A WE# or CE# pulse of less than 5 ns will not initiate a write cycle.

V_{DD} Power Up/Down Detection: The Write operation is inhibited when V_{DD} is less than 1.5V.

Write Inhibit Mode: Forcing OE# Low, CE# High, or WE# High will inhibit the Write operation. This prevents inadvertent write during power-up or power-down.

Software Data Protection (SDP)

The EM39LV088 provides the JEDEC approved Software Data Protection (SDP) scheme for Program and Erase operations. Any Program operation requires the inclusion of the three-byte sequence. The three-byte load sequence is used to initiate the Program operation, providing optimal protection from inadvertent Write operations, especially during the system power-up or power-down transition. Any Erase operation requires the inclusion of six-byte sequence. See Table 3 for the specific software command codes. During SDP command sequence, invalid commands will abort the device to Read mode within T_{RC}. The contents of DQ7-DQ0 can be V_{IL} or V_{IH}, but no other value, during any SDP command sequence.

Software Command Sequence

Command Sequence	1st Bus Write Cycle		2nd Bus Write Cycle		3rd Bus Write Cycle		4th Bus Write Cycle		5th Bus Write Cycle		6th Bus Write Cycle	
	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]
Byte Program	AAAH	AAH	555H	55H	AAAH	A0H	WA[3]	Data				
Sector Erase	AAAH	AAH	555H	55H	AAAH	80H	AAAH	AAH	555H	55H	SA_X[4]	30H
Block Erase	AAAH	AAH	555H	55H	AAAH	80H	AAAH	AAH	555H	55H	BA_X[4]	50H
Chip Erase	AAAH	AAH	555H	55H	AAAH	80H	AAAH	AAH	555H	55H	AAAH	10H
Software ID Entry[5,6]	AAAH	AAH	555H	55H	AAAH	90H						
Manufacture ID	AAAH	AAH	555H	55H	AAAH	90H	00H	7FH				
Manufacture ID	AAAH	AAH	555H	55H	AAAH	90H	07H	7FH				
Manufacture ID	AAAH	AAH	555H	55H	AAAH	90H	80H	01FH				
Device ID	AAAH	AAH	555H	55H	AAAH	90H	01H	21FH				
Software ID Exit[7]	XXH	F0H										
Software ID Exit[7]	AAAH	AAH	555H	55H	AAAH	F0H						

Notes:

1. *Address format A14-A0 (Hex), Addresses A19-A15 can be V_{IL} or V_{IH}, but no other value, for the Command sequence.*
2. *DQ7-DQ0 can be V_{IL} or V_{IH}, but no other value, for the Command sequence.*
3. *WA = Program byte address.*
4. *SA_X for Sector-Erase; uses A19-A12 address lines.*
   BA_X for Block-Erase; uses A18-A16 address lines.
5. *The device does not remain in Software Product ID mode if powered down.*
6. *Both Software ID Exit operations are equivalent.*
7. *Refer to Figure 9 for more information.*

Table 3: *Software Command Sequence*

Absolute Maximum Ratings

NOTE

Applied conditions greater than those listed under these ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this specification, are not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

Temperature Under Bias ..... –55°C to 125°C

Storage Temperature ..... –65°C to 150°C

D.C. Voltage on Any Pin to Ground Potential ..... –0.5 V to V_{DD}+0.5V

Transient Voltage (<20ns) on Any Pin to Ground Potential ..... –2.0V to V_{DD} +2.0V

Voltage on A9 Pin to Ground Potential ..... –0.5 V to 13.2V

Package Power Dissipation Capability (Ta=25°C)..... 1.0W

Surface Mount Lead Soldering Temperature (3 Seconds)..... 240°C

Output Short Circuit Current * 50mA

* *Output shorted for no more than one second. No more than one output shorted at a time.*

Operating Range

Model Name	Ambient Temperature	V_{DD}
EM39LV088	0°C to +70°C	2.7~3.6V

Table 4: *Operating Range*

AC Conditions of Test

Input Rise/Fall Time 5ns

Output Load ..... CL=30pF for 55Rns

Output Load ..... CL=100pF for 70ns/90ns

See Figures 14 and 15

DC CHARACTERISTICS (CMOS Compatible)

Parameter	Description	Test Conditions	Min	Max	Unit
I_{DD}	Power Supply Current	Address Input =V_{IL}/V_{IH}, at f=1/T_{RC} Min, $V_{DD}=V_{DD}$ Max			
	Read	CE#=OE#=V_{IL}, WE#=V_{IH}, all I/Os open		30	mA
	Program and Erase	CE#=WE#=V_{IL}, OE#=V_{IH},		30	mA
I_{SB}	Standby V_{DD} Current	CE#=V_{IHC}, $V_{DD}=V_{DD}$ Max		20	μA
I_{LI}	Input Leakage Current	V_{IN}=GND to V_{DD}, $V_{DD}=V_{DD}$ Max		1	μA
I_{LO}	Output Leakage Current	V_{OUT}=GND to V_{DD}, $V_{DD}=V_{DD}$ Max		10	μA
V_{IL}	Input Low Voltage	$V_{DD}=V_{DD}$ Min		0.8	V
V_{IH}	Input High Voltage	$V_{DD}=V_{DD}$ Max	0.7 V_{DD}		V
V_{IHC}	Input High Voltage (CMOS)	$V_{DD}=V_{DD}$ Max	V_{DD}-0.3		V
V_{OL}	Output Low Voltage	I_{OL}=100μA, $V_{DD}=V_{DD}$ Min		0.2	V
V_{OH}	Output High Voltage	I_{OH}=-100μA, $V_{DD}=V_{DD}$ Min	V_{DD}-0.2		V

Table 5: *DC Characteristics (Cmos Compatible)*

Recommended System Power-up Timing

Parameter	Description	Min	Unit
$T_{PU-READ}$*	Power-up to Read Operation	100	μs
$T_{PU-WRITE}$*	Power-up to Program/Erase Operation	100	μs

***** *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 6: *Recommended System Power-up Timing*

Capacitance (Ta=25°C, f=1Mhz, other pins open)

Parameter	Description	Test Conditons	Max
$C_{I/O}$*	I/O Pin Capacitance	$V_{I/O}$=0V	12pF
C_{IN}*	Input Capacitance	V_{IN}=0V	6pF

***** *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 7: *Capacitance (Ta=25°C, f=1Mhz, Other Pins Open)*

Reliability Characteristics

Symbol	Parameter	Min Specification	Unit	Test Method
N_{END}*	Endurance	10,000	Cycles	JEDEC Standard A117
T_{DR}*	Data Retention	10	Years	JEDEC Standard A103
I_{LTH}*	Latch Up	100+I_{DD}	mA	JEDEC Standard 78

***** *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 8: *Reliability Characteristics*

AC Characteristics

Read Cycle Timing Parameters

Symbol	Parameter	70REC		90REC		Unit
		Min	Max	Min	Max	
T_{RC}	Read Cycle Time	70		90		ns
T_{CE}	Chip Enable Access Time		70		90	ns
T_{AA}	Address Access Time		70		90	ns
T_{OE}	Output Enable Access Time		35		45	ns
T_{CLZ}*	CE# Low to Active Output	0		0		ns
T_{OLZ}*	OE# Low to Active Output	0		0		ns
T_{CHZ}*	CE# High to High-Z Output		20		30	ns
T_{OHZ}*	OE# High to High-Z Output		20		30	ns
T_{OH}*	Output Hold from Address Change	0		0		ns

* *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 9a: *Read Cycle Timing Parameters*

Symbol	Parameter	70EC		90EC		Unit
		Min	Max	Min	Max	
T_{RC}	Read Cycle Time	70		90		ns
T_{CE}	Chip Enable Access Time		70		90	ns
T_{AA}	Address Access Time		70		90	ns
T_{OE}	Output Enable Access Time		35		45	ns
T_{CLZ}*	CE# Low to Active Output	0		0		ns
T_{OLZ}*	OE# Low to Active Output	0		0		ns
T_{CHZ}*	CE# High to High-Z Output		20		30	ns
T_{OHZ}*	OE# High to High-Z Output		20		30	ns
T_{OH}*	Output Hold from Address Change	0		0		ns

* *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 9b: *Read Cycle Timing Parameters*

Program/Erase Cycle Timing Parameter

Symbol	Parameter	Min	Max	Unit
T_{BP}	Byte-Program Time		20	μs
T_{AS}	Address Setup Time	0		ns
T_{AH}	Address Hold Time	30		ns
T_{CS}	WE# and CE# Setup Time	0		ns
T_{CH}	WE# and CE# Hold Time	0		ns
T_{OES}	OE# High Setup Time	0		ns
T_{OEH}	OE# High Hold Time	10		ns
T_{CP}	CE# Pulse Width	45		ns
T_{WP}	WE# Pulse Width	45		ns
T_{WPH}^{*}	WE# Pulse Width High	30		ns
T_{CPH}^{*}	CE# Pulse Width High	30		ns
T_{DS}	Data Setup Time	45		ns
T_{DH}^{*}	Data Hold Time	0		ns
T_{IDA}^{*}	Software ID Access and Exit Time		150	ns
T_{SE}	Sector Erase		30	ms
T_{BE}	Block Erase		30	ms
T_{SCE}	Chip Erase		60	ms

***** *This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.*

Table 10: *Program/Erase Cycle Timing Parameter*

Timing Diagrams

Read Cycle Timing Diagram

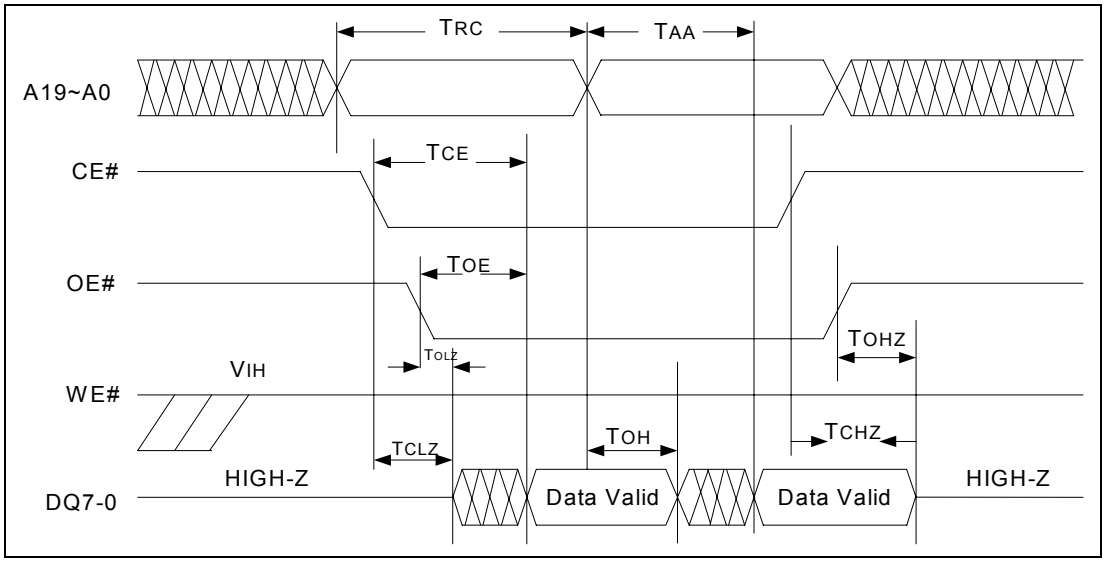


Figure 1: *Read Cycle Timing Diagram*

WE# Controlled Program Cycle Timing Diagram

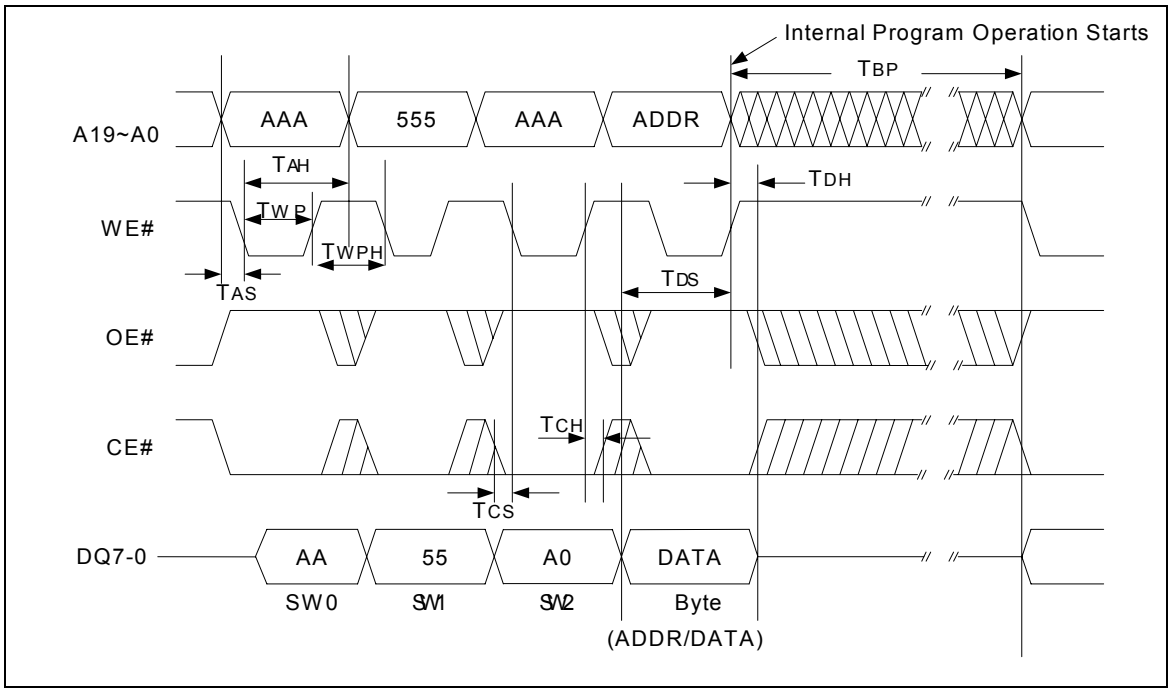


Figure 2: *WE# Controlled Program Cycle Timing Diagram*

CE# Controlled Program Cycle Timing Diagram

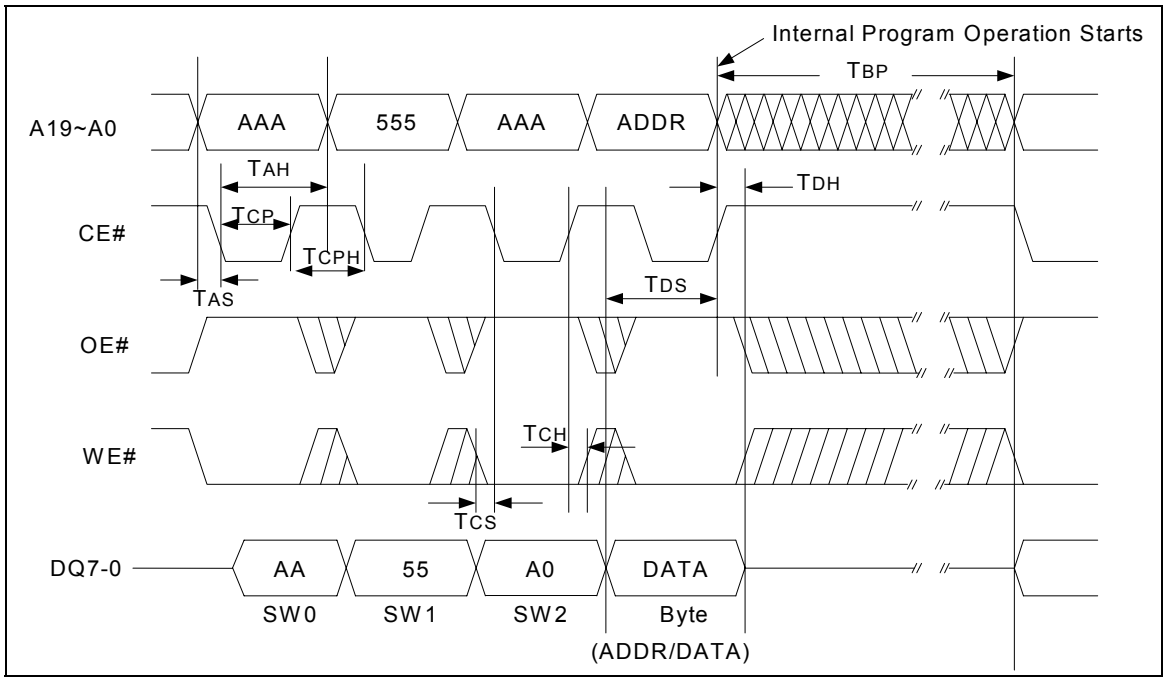


Figure 3: *CE# Controlled Program Cycle Timing Diagram*

Data# Polling Timing Diagram

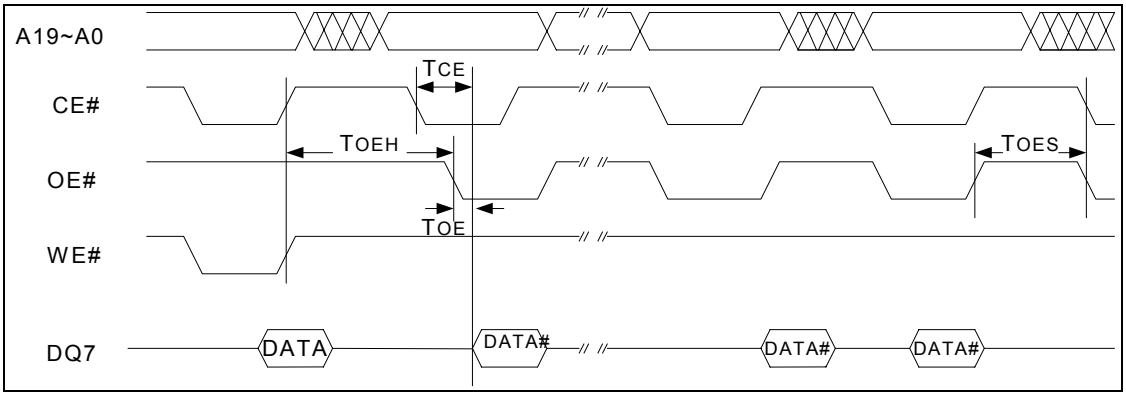


Figure 4: *Data# Polling Timing Diagram*

Toggle Bit Timing Diagram

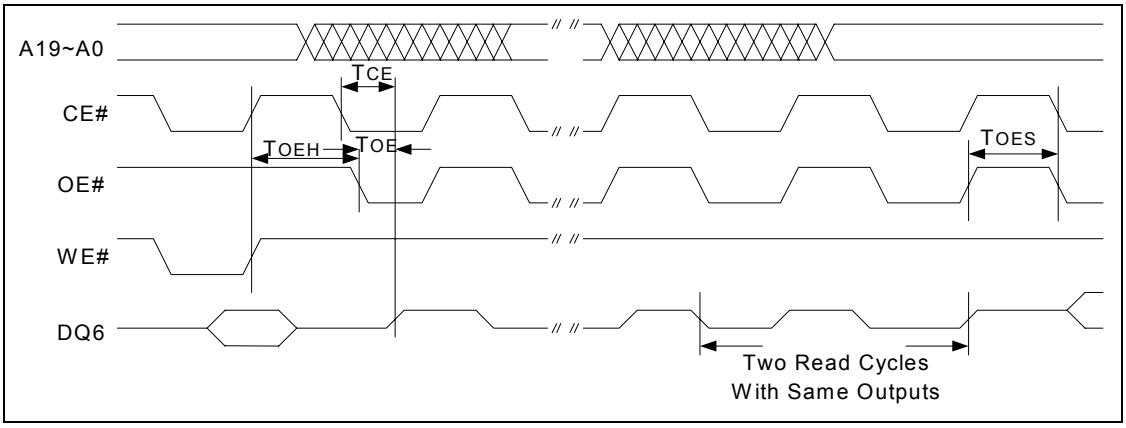
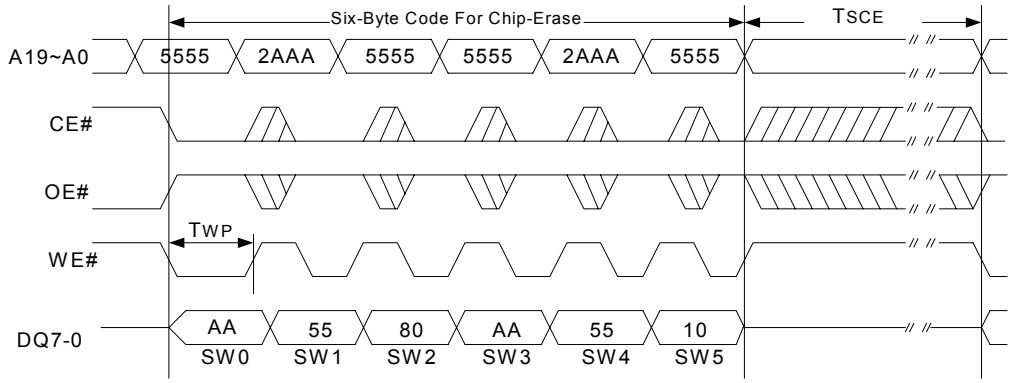


Figure 5: *Toggle Bit Timing Diagram*

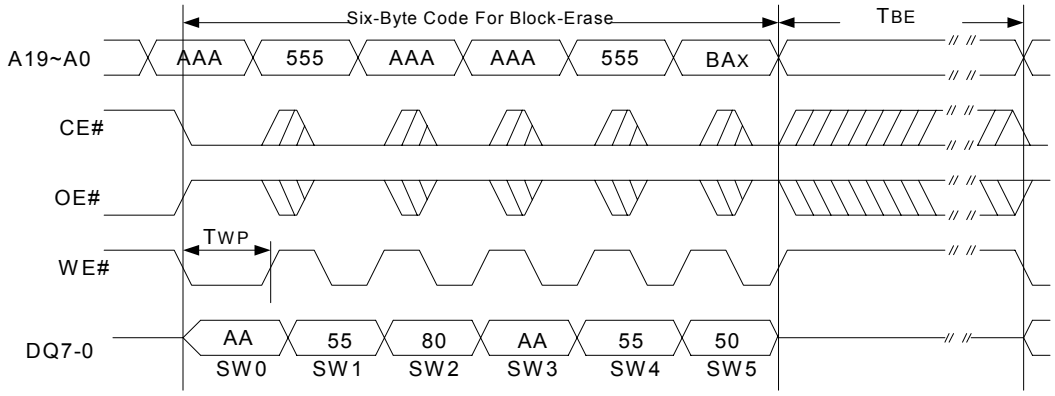
WE# Controlled Chip-Erase Timing Diagram



Note: This device also supports CE# controlled Chip-Erase operation. The WE#and CE# signals are interchageable as long as minimum timings are met (See Table 13).

Figure 6: *WE# Controlled Chip-Erase Timing Diagram*

WE# Controlled Block-Erase Timing Diagram



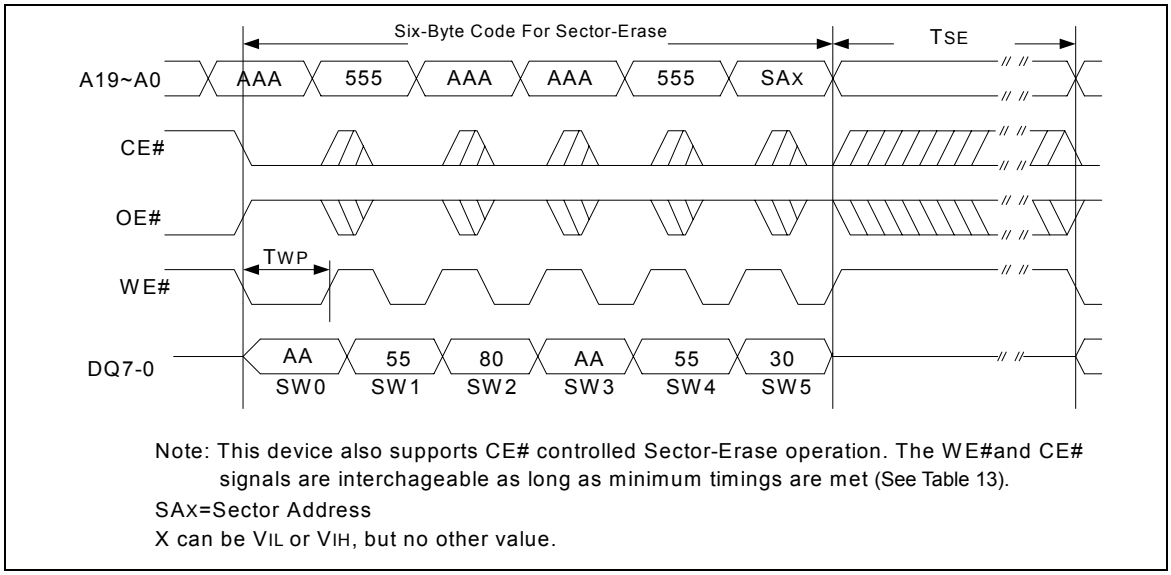
Note: This device also supports CE# controlled Block-Erase operation. The WE#and CE# signals are interchageable as long as minimum timings are met (See Table 13).

BAX=Block Address

X can be VIL or VIH, but no other value.

Figure 7: *WE# Controlled Block-Erase Timing Diagram*

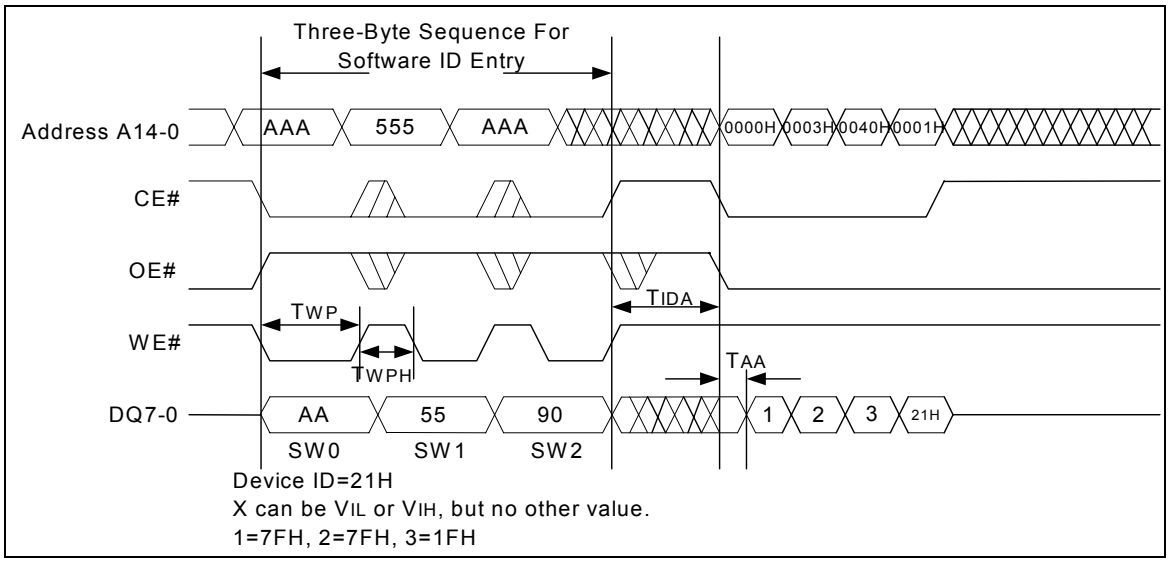
WE# Controlled Sector-Erase Timing Diagram



Note: This device also supports CE# controlled Sector-Erase operation. The WE#and CE# signals are interchageable as long as minimum timings are met (See Table 13).
SAx=Sector Address
X can be VIL or VIH, but no other value.

Figure 8: *WE# Controlled Sector-Erase Timing Diagram*

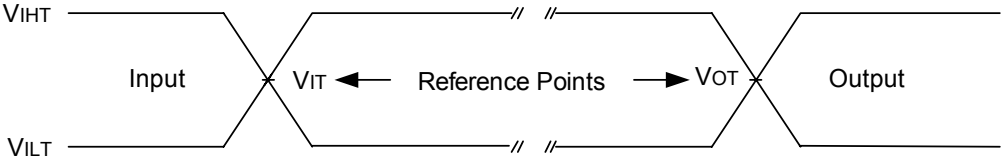
Software ID Entry and Read



Device ID=21H
X can be VIL or VIH, but no other value.
1=7FH, 2=7FH, 3=1FH

Figure 9: *Software ID Entry and Read*

AC Input/Output Reference Waveforms



AC test inputs are driven at V_{IHT} (0.9 V_{DD}) for a logic "1" and V_{ILT}(0.1 V_{DD}) for a logic "0". Measurement reference points for inputs and outpputs are V_{IT}(0.5 V_{DD}) and V_{OT}(0.5 V_{DD}). Input rise and fall times(10% - 90%) are <5ns

Note: V_{IT} = Vinput Test
V_{OT} = Voutput Test
V_{IHT} = Vinput HIGH Test
V_{ILT} = Vinput LOW Test

Figure 10: *AC Input/Output Reference Waveforms*

A Test Load Example

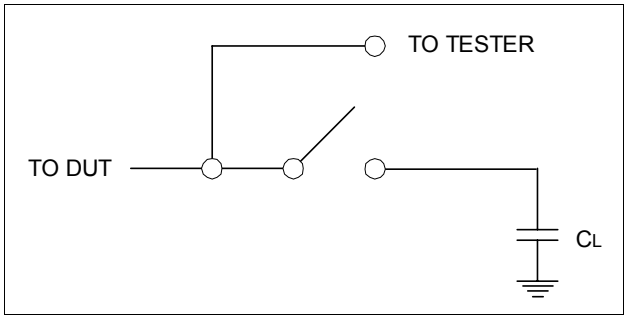


Figure 11: *A Test Load Example*

Flow Charts

Byte-Program Algorithm

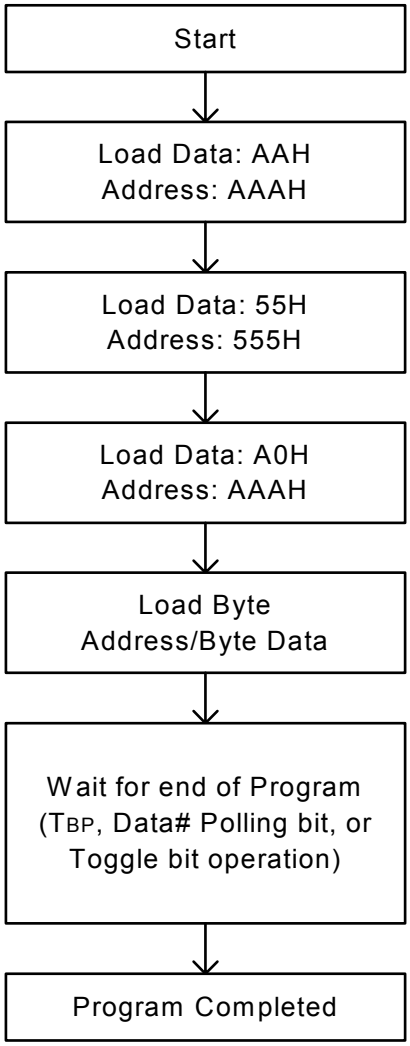


Figure 12: *Byte-Program Algorithm*

Wait Options

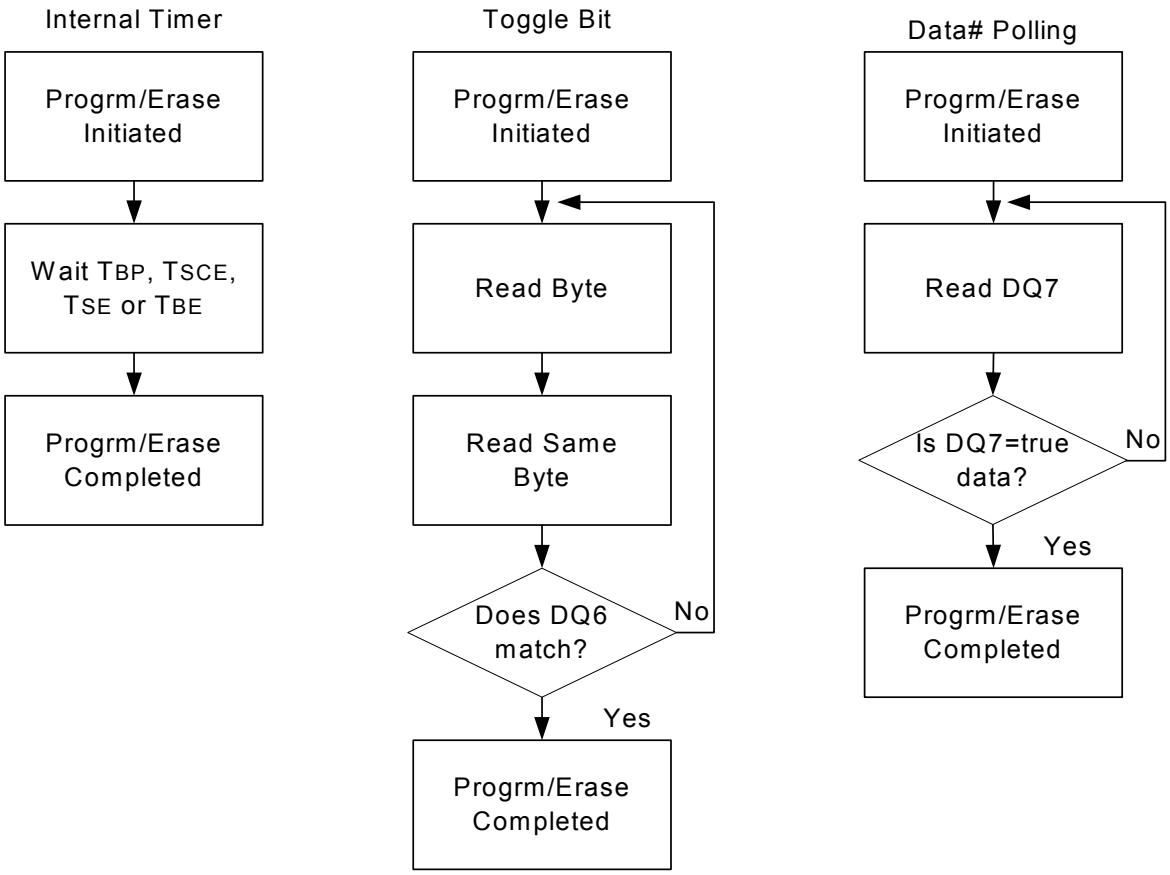


Figure 13: *Wait Options*

Software ID Command Flowcharts

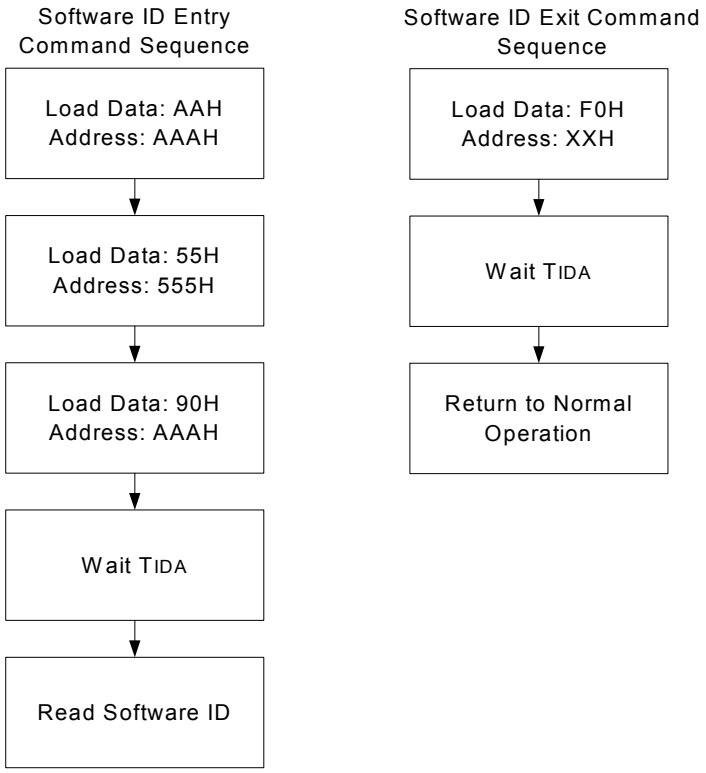
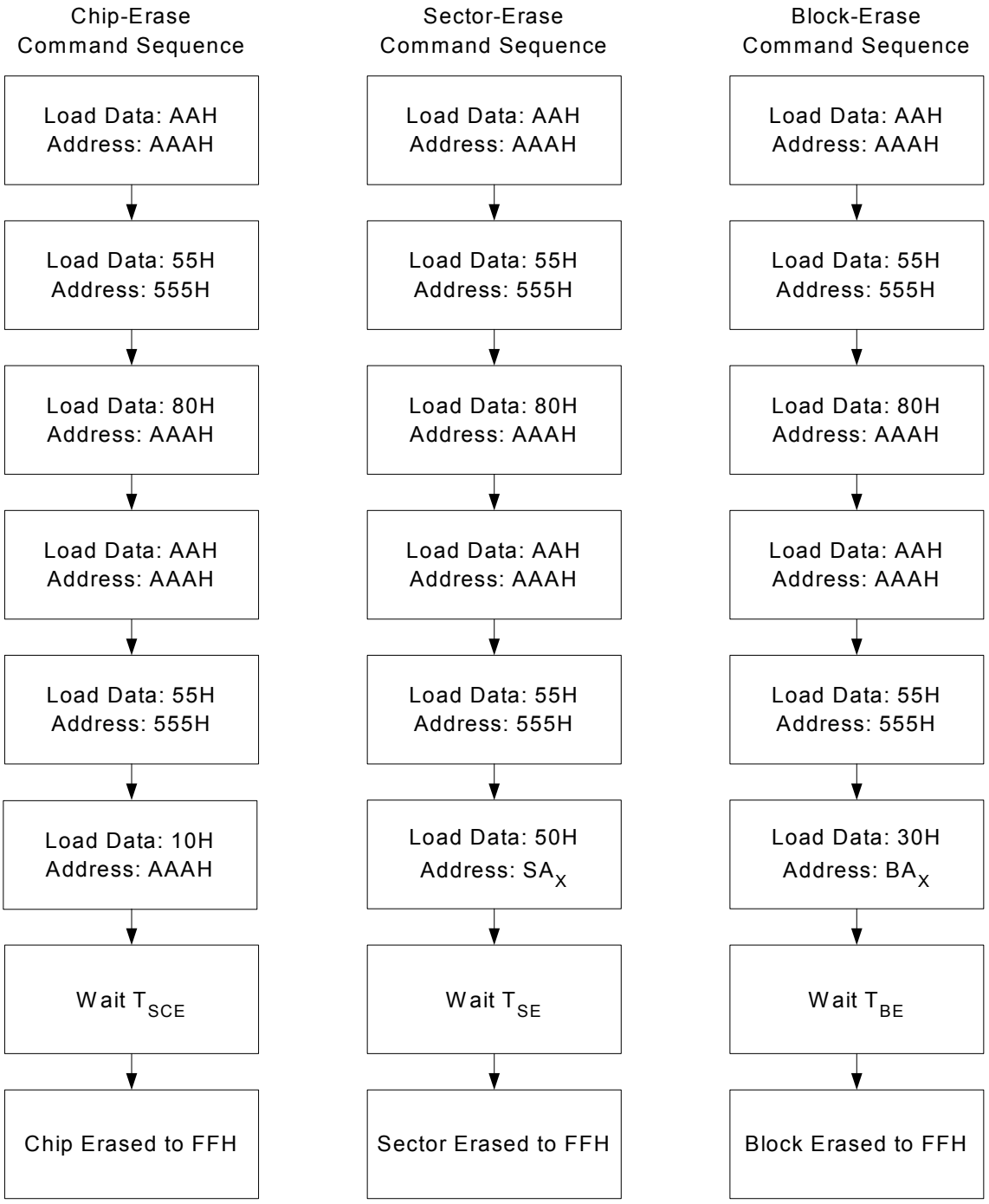


Figure 14: *Software ID Command Flowcharts*

Erase Command Sequence



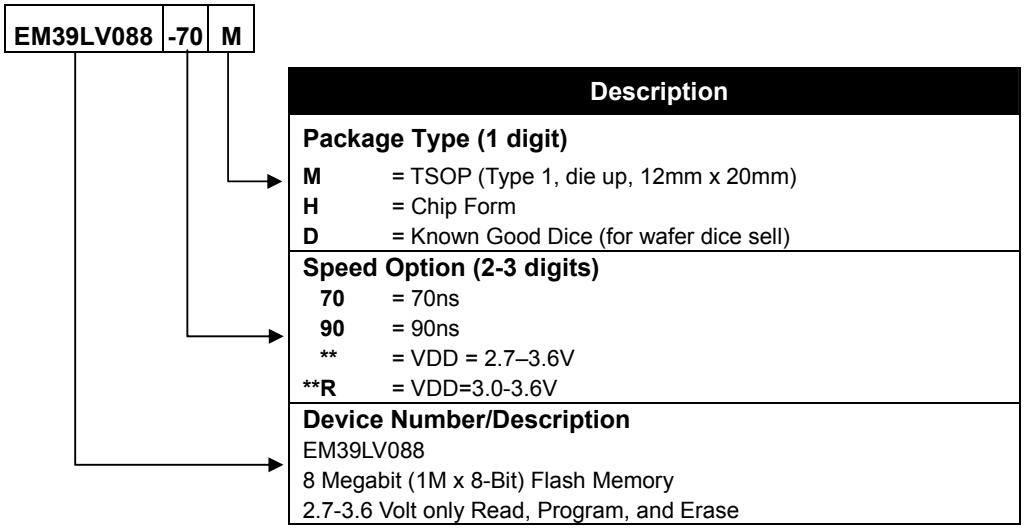
X can be VIL or VIH, but no other value.

Figure 15: *Erase Command Sequence*

Appendix

ORDERING INFORMATION (Standard Products)

The order number is defined by a combination of the following elements.



Description
Package Type (1 digit) **M** = TSOP (Type 1, die up, 12mm x 20mm) **H** = Chip Form **D** = Known Good Dice (for wafer dice sell)
Speed Option (2-3 digits) **70** = 70ns **90** = 90ns ****** = VDD = 2.7–3.6V ****R** = VDD=3.0-3.6V
Device Number/Description EM39LV088 8 Megabit (1M x 8-Bit) Flash Memory 2.7-3.6 Volt only Read, Program, and Erase

ORDERING INFORMATION (Non-Standard Products)

For Know Good Dice (KGD), please contact ELAN Microelectronics at the following contact information or its representatives.

ELAN MICROELECTRONICS CORPORATION

Headquarters:

No. 12, Innovation Road 1
Science-based Industrial Park
Hsinchu, Taiwan, R.O.C. 30077
Tel: +886 3 563-9977
Fax: +886 3 563-9966
http://www.emc.com.tw

Hong Kong:

Elan (HK) Microelectronics Corporation, Ltd.
Rm. 1005B, 10/F Empire Centre
68 Mody Road, Tsimshatsui
Kowloon , HONG KONG
Tel: +852 2723-3376
Fax: +852 2723-7780
elanhk@emc.com.hk

USA:

Elan Information Technology Group
1821 Saratoga Ave., Suite 250
Saratoga, CA 95070
USA
Tel: +1 408 366-8223
Fax: +1 408 366-8220

Europe:

Elan Microelectronics Corp. (Europe)
Dubendorfstrasse 4
8051 Zurich, SWITZERLAND
Tel: +41 43 299-4060
Fax: +41 43 299-4079
http://www.elan-europe.com

Shenzhen:

Elan (Shenzhen) Microelectronics Corp., Ltd.
SSMEC Bldg., 3F, Gaoxin S. Ave.
Shenzhen Hi-Tech Industrial Park
Shenzhen, Guandong, CHINA
Tel: +86 755 2601-0565
Fax: +86 755 2601-0500

Shanghai:

Elan Electronics (Shanghai) Corporation, Ltd.
23/Bldg. #115 Lane 572, Bibo Road
Zhangjiang Hi-Tech Park
Shanghai, CHINA
Tel: +86 021 5080-3866
Fax: +86 021 5080-4600