MX26LV160AT/AB

Macronix NBit™ Memory Family

16M-BIT [2Mx8/1Mx16] CMOS SINGLE VOLTAGE 3V ONLY BOOT SECTOR HIGH SPEED eLiteFlash™ MEMORY

FEATURES

- Extended single - supply voltage range 3.0V to 3.6V
- 2,097,152 x 8 / 1,048,576 x 16 switchable
- Single power supply operation
  - 3.0V only operation for read, erase and program operation
- Fast access time: 55/70ns
- Low power consumption
  - 30mA maximum active current
  - 30uA typical standby current
- Command register architecture
  - Byte/word Programming (55us/70us typical)
  - Sector Erase (Sector structure 16K-Bytex1, 8K-Bytex2, 32K-Bytex1, and 64K-Byte x31)
- Auto Erase (chip & sector) and Auto Program
  - Automatically erase any combination of sectors with erase verify capability
  - Automatically program and verify data at specified address
- Status Reply
  - Data# polling & Toggle bit for detection of program and erase operation completion
- Ready/Busy# pin (RY/BY#)

- Provides a hardware method of detecting program or erase operation completion
- Sector protection
  - Hardware method to disable any combination of sectors from program or erase operations
  - Temporary sector unprotect allows code changes in previously locked sectors
- CFI (Common Flash Interface) compliant
  - Flash device parameters stored on the device and provide the host system to access
- 2K minimum erase/program cycles
- Latch-up protected to 100mA from -1V to VCC+1V
- Boot Sector Architecture
  - T = Top Boot Sector
  - B = Bottom Boot Sector
- Package type:
  - 44-pin SOP
  - 48-pin TSOP
  - 48-ball CSP
- Compatibility with JEDEC standard
  - Pinout and software compatible with single-power supply Flash
- 20 years data retention

GENERAL DESCRIPTION

The MX26LV160AT/AB is a 16-mega bit high speed Flash memory organized as 2M bytes of 8 bits or 1M words of 16 bits. MXIC's high speed Flash memories offer the most cost-effective and reliable read/write non-volatile random access memory. The MX26LV160AT/AB is packaged in 44-pin SOP, 48-pin TSOP, and 48-ball CSP. It is designed to be reprogrammed and erased in system or in standard EPROM programmers.

The standard MX26LV160AT/AB offers access time as fast as 55ns, allowing operation of high-speed microprocessors without wait states. To eliminate bus contention, the MX26LV160AT/AB has separate chip enable (CE#) and output enable (OE#) controls.

MXIC's high speed Flash memories augment EPROM functionality with in-circuit electrical erasure and programming. The MX26LV160AT/AB uses a command register to manage this functionality. The command register al-

lows for 100% TTL level control inputs and fixed power supply levels during erase and programming, while maintaining maximum EPROM compatibility.

MXIC high speed Flash technology reliably stores memory contents even after 2K erase and program cycles. The MXIC cell is designed to optimize the erase and programming mechanisms. In addition, the combination of advanced tunnel oxide processing and low internal electric fields for erase and program operations produces reliable cycling. The MX26LV160AT/AB uses a 3.0V~3.6V VCC supply to perform the High Reliability Erase and auto Program/Erase algorithms.

The highest degree of latch-up protection is achieved with MXIC's proprietary non-epi process. Latch-up protection is proved for stresses up to 100 milliamperes on address and data pin from -1V to VCC + 1V.
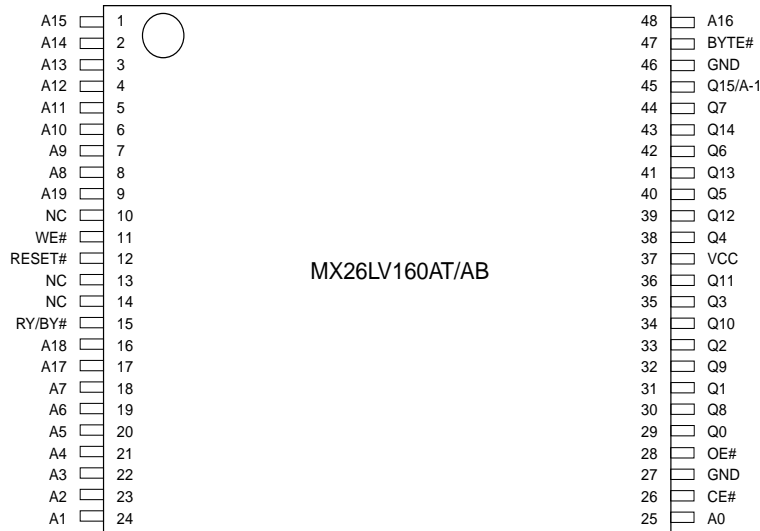
PIN CONFIGURATIONS

44 SOP
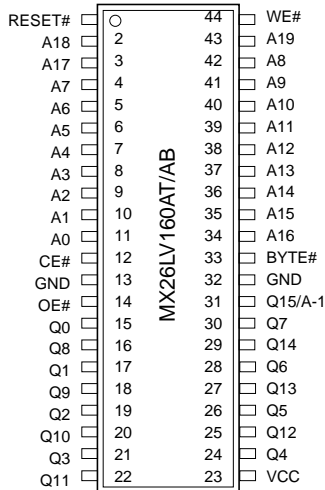
PIN DESCRIPTION

SYMBOL	PIN NAME
A0~A19	Address Input
Q0~Q14	Data Input/Output
Q15/A-1	Q15(Word mode)/LSB addr(Byte mode)
CE#	Chip Enable Input
WE#	Write Enable Input
BYTE#	Word/Byte Selection input
RESET#	Hardware Reset Pin
OE#	Output Enable Input
RY/BY#	Ready/Busy Output
VCC	Power Supply Pin (3.0V~3.6V)
GND	Ground Pin

48 TSOP (Standard Type) (12mm x 20mm)

48-Ball CSP Ball Pitch = 0.8 mm, Top View, Balls Facing Down

	A	B	C	D	E	F	G	H
6	A13	A12	A14	A15	A16	BYTE#	Q15/A-1	GND
5	A9	A8	A10	A11	Q7	Q14	Q13	Q6
4	WE#	RESET#	NC	A19	Q5	Q12	Vcc	Q4
3	RY/BY#	NC	A18	NC	Q2	Q10	Q11	Q3
2	A7	A17	A6	A5	Q0	Q8	Q9	Q1
1	A3	A4	A2	A1	A0	CE#	OE#	GND

BLOCK STRUCTURE

TABLE 1: MX26LV160AT SECTOR ARCHITECTURE

Sector	Sector Size		Address range		Sector Address							
	Byte Mode	Word Mode	Byte Mode(x8)	Word Mode(x16)	A19	A18	A17	A16	A15	A14	A13	A12
SA0	64Kbytes	32Kwords	000000-00FFFF	00000-07FFF	0	0	0	0	0	X	X	X
SA1	64Kbytes	32Kwords	010000-01FFFF	08000-0FFFF	0	0	0	0	1	X	X	X
SA2	64Kbytes	32Kwords	020000-02FFFF	10000-17FFF	0	0	0	1	0	X	X	X
SA3	64Kbytes	32Kwords	030000-03FFFF	18000-1FFFF	0	0	0	1	1	X	X	X
SA4	64Kbytes	32Kwords	040000-04FFFF	20000-27FFF	0	0	1	0	0	X	X	X
SA5	64Kbytes	32Kwords	050000-05FFFF	28000-2FFFF	0	0	1	0	1	X	X	X
SA6	64Kbytes	32Kwords	060000-06FFFF	30000-37FFF	0	0	1	1	0	X	X	X
SA7	64Kbytes	32Kwords	070000-07FFFF	38000-3FFFF	0	0	1	1	1	X	X	X
SA8	64Kbytes	32Kwords	080000-08FFFF	40000-47FFF	0	1	0	0	0	X	X	X
SA9	64Kbytes	32Kwords	090000-09FFFF	48000-4FFFF	0	1	0	0	1	X	X	X
SA10	64Kbytes	32Kwords	0A0000-0AFFFF	50000-57FFF	0	1	0	1	0	X	X	X
SA11	64Kbytes	32Kwords	0B0000-0BFFFF	58000-5FFFF	0	1	0	1	1	X	X	X
SA12	64Kbytes	32Kwords	0C0000-0CFFFF	60000-67FFF	0	1	1	0	0	X	X	X
SA13	64Kbytes	32Kwords	0D0000-0DFFFF	68000-6FFFF	0	1	1	0	1	X	X	X
SA14	64Kbytes	32Kwords	0E0000-0EFFFF	70000-77FFF	0	1	1	1	0	X	X	X
SA15	64Kbytes	32Kwords	0F0000-0FFFFF	78000-7FFFF	0	1	1	1	1	X	X	X
SA16	64Kbytes	32Kwords	100000-10FFFF	80000-87FFF	1	0	0	0	0	X	X	X
SA17	64Kbytes	32Kwords	110000-11FFFF	88000-8FFFF	1	0	0	0	1	X	X	X
SA18	64Kbytes	32Kwords	120000-12FFFF	90000-97FFF	1	0	0	1	0	X	X	X
SA19	64Kbytes	32Kwords	130000-13FFFF	98000-9FFFF	1	0	0	1	1	X	X	X
SA20	64Kbytes	32Kwords	140000-14FFFF	A0000-A7FFF	1	0	1	0	0	X	X	X
SA21	64Kbytes	32Kwords	150000-15FFFF	A8000-AFFFF	1	0	1	0	1	X	X	X
SA22	64Kbytes	32Kwords	160000-16FFFF	B0000-B7FFF	1	0	1	1	0	X	X	X
SA23	64Kbytes	32Kwords	170000-17FFFF	B8000-BFFFF	1	0	1	1	1	X	X	X
SA24	64Kbytes	32Kwords	180000-18FFFF	C0000-C7FFF	1	1	0	0	0	X	X	X
SA25	64Kbytes	32Kwords	190000-19FFFF	C8000-CFFFF	1	1	0	0	1	X	X	X
SA26	64Kbytes	32Kwords	1A0000-1AFFFF	D0000-D7FFF	1	1	0	1	0	X	X	X
SA27	64Kbytes	32Kwords	1B0000-1BFFFF	D8000-DFFFF	1	1	0	1	1	X	X	X
SA28	64Kbytes	32Kwords	1C0000-1CFFFF	E0000-E7FFF	1	1	1	0	0	X	X	X
SA29	64Kbytes	32Kwords	1D0000-1DFFFF	E8000-EFFFF	1	1	1	0	1	X	X	X
SA30	64Kbytes	32Kwords	1E0000-1EFFFF	F0000-F7FFF	1	1	1	1	0	X	X	X
SA31	32Kbytes	16Kwords	1F0000-1F7FFF	F8000-FBFFF	1	1	1	1	1	0	X	X
SA32	8Kbytes	4Kwords	1F8000-1F9FFF	FC000-FCFFF	1	1	1	1	1	1	0	0
SA33	8Kbytes	4Kwords	1FA000-1FBFFF	FD000-FDFFF	1	1	1	1	1	1	0	1
SA34	16Kbytes	8Kwords	1FC000-1FFFFF	FE000-FFFFF	1	1	1	1	1	1	1	X

Note: Byte mode: address range A19:A-1, word mode:address range A19:A0.

TABLE 2: MX26LV160AB SECTOR ARCHITECTURE

Sector	Sector Size		Address range		Sector Address							
	Byte Mode	Word Mode	Byte Mode (x8)	Word Mode (x16)	A19	A18	A17	A16	A15	A14	A13	A12
SA0	16Kbytes	8Kwords	000000-003FFF	00000-01FFF	0	0	0	0	0	0	0	X
SA1	8Kbytes	4Kwords	004000-005FFF	02000-02FFF	0	0	0	0	0	0	1	0
SA2	8Kbytes	4Kwords	006000-007FFF	03000-03FFF	0	0	0	0	0	0	1	1
SA3	32Kbytes	16Kwords	008000-00FFFF	04000-07FFF	0	0	0	0	0	1	X	X
SA4	64Kbytes	32Kwords	010000-01FFFF	08000-0FFFF	0	0	0	0	1	X	X	X
SA5	64Kbytes	32Kwords	020000-02FFFF	10000-17FFF	0	0	0	1	0	X	X	X
SA6	64Kbytes	32Kwords	030000-03FFFF	18000-1FFFF	0	0	0	1	1	X	X	X
SA7	64Kbytes	32Kwords	040000-04FFFF	20000-27FFF	0	0	1	0	0	X	X	X
SA8	64Kbytes	32Kwords	050000-05FFFF	28000-2FFFF	0	0	1	0	1	X	X	X
SA9	64Kbytes	32Kwords	060000-06FFFF	30000-37FFF	0	0	1	1	0	X	X	X
SA10	64Kbytes	32Kwords	070000-07FFFF	38000-3FFFF	0	0	1	1	1	X	X	X
SA11	64Kbytes	32Kwords	080000-08FFFF	40000-47FFF	0	1	0	0	0	X	X	X
SA12	64Kbytes	32Kwords	090000-09FFFF	48000-4FFFF	0	1	0	0	1	X	X	X
SA13	64Kbytes	32Kwords	0A0000-0AFFFF	50000-57FFF	0	1	0	1	0	X	X	X
SA14	64Kbytes	32Kwords	0B0000-0BFFFF	58000-5FFFF	0	1	0	1	1	X	X	X
SA15	64Kbytes	32Kwords	0C0000-0CFFFF	60000-67FFF	0	1	1	0	0	X	X	X
SA16	64Kbytes	32Kwords	0D0000-0DFFFF	68000-6FFFF	0	1	1	0	1	X	X	X
SA17	64Kbytes	32Kwords	0E0000-0EFFFF	70000-77FFF	0	1	1	1	0	X	X	X
SA18	64Kbytes	32Kwords	0F0000-0FFFFF	78000-7FFFF	0	1	1	1	1	X	X	X
SA19	64Kbytes	32Kwords	100000-10FFFF	80000-87FFF	1	0	0	0	0	X	X	X
SA20	64Kbytes	32Kwords	110000-11FFFF	88000-8FFFF	1	0	0	0	1	X	X	X
SA21	64Kbytes	32Kwords	120000-12FFFF	90000-97FFF	1	0	0	1	0	X	X	X
SA22	64Kbytes	32Kwords	130000-13FFFF	98000-9FFFF	1	0	0	1	1	X	X	X
SA23	64Kbytes	32Kwords	140000-14FFFF	A0000-A7FFF	1	0	1	0	0	X	X	X
SA24	64Kbytes	32Kwords	150000-15FFFF	A8000-AFFFF	1	0	1	0	1	X	X	X
SA25	64Kbytes	32Kwords	160000-16FFFF	B0000-B7FFF	1	0	1	1	0	X	X	X
SA26	64Kbytes	32Kwords	170000-17FFFF	B8000-BFFFF	1	0	1	1	1	X	X	X
SA27	64Kbytes	32Kwords	180000-18FFFF	C0000-C7FFF	1	1	0	0	0	X	X	X
SA28	64Kbytes	32Kwords	190000-19FFFF	C8000-CFFFF	1	1	0	0	1	X	X	X
SA29	64Kbytes	32Kwords	1A0000-1AFFFF	D0000-D7FFF	1	1	0	1	0	X	X	X
SA30	64Kbytes	32Kwords	1B0000-1BFFFF	D8000-DFFFF	1	1	0	1	1	X	X	X
SA31	64Kbytes	32Kwords	1C0000-1CFFFF	E0000-E7FFF	1	1	1	0	0	X	X	X
SA32	64Kbytes	32Kwords	1D0000-1DFFFF	E8000-EFFFF	1	1	1	0	1	X	X	X
SA33	64Kbytes	32Kwords	1E0000-1EFFFF	F0000-F7FFF	1	1	1	1	0	X	X	X
SA34	64Kbytes	32Kwords	1F0000-1FFFFF	F8000-FFFFF	1	1	1	1	1	X	X	X

Note: Byte mode:address range A19:A-1, word mode:address range A19:A0.

BLOCK DIAGRAM

CE#
OE#
WE#
RESET#

CONTROL
INPUT
LOGIC

PROGRAM/ERASE
HIGH VOLTAGE

WRITE
STATE
MACHINE
(WSM)

ADDRESS
LATCH
AND
BUFFER

A0-A19

X-DECODER

Y-DECODER

FLASH
ARRAY

Y-PASS GATE

ARRAY
SOURCE
HV

STATE
REGISTER

COMMAND
DATA
DECODER

SENSE
AMPLIFIER

PGM
DATA
HV

PROGRAM
DATA LATCH

COMMAND
DATA LATCH

Q0-Q15/A-1

I/O BUFFER
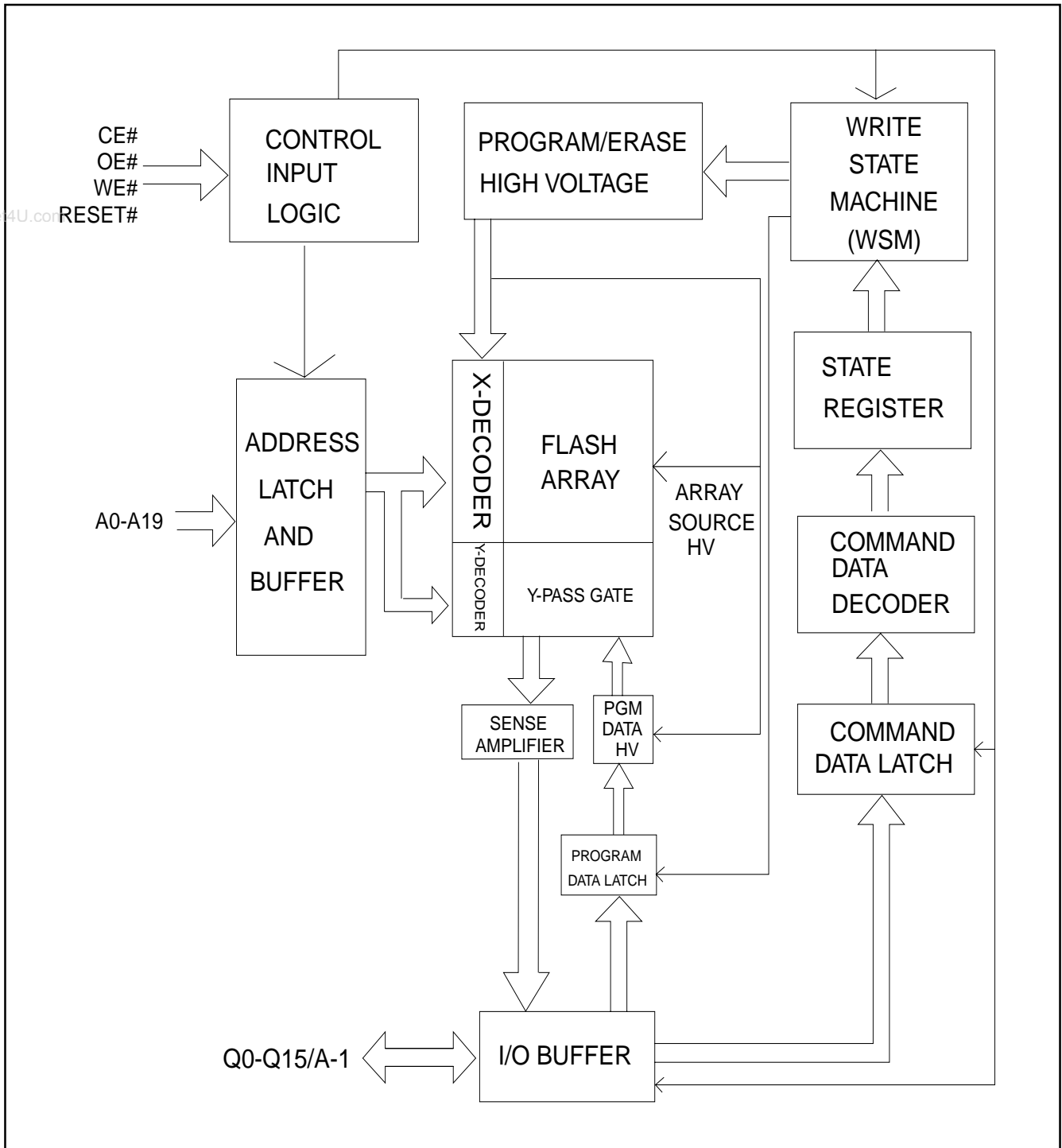
AUTOMATIC PROGRAMMING

The MX26LV160AT/AB is word/byte programmable using the Automatic Programming algorithm. The Automatic Programming algorithm makes the external system do not need to have time out sequence nor to verify the data programmed.

AUTOMATIC PROGRAMMING ALGORITHM

MXIC's Automatic Programming algorithm requires the user to only write program set-up commands (including 2 unlock write cycle and A0H) and a program command (program data and address). The device automatically times the programming pulse width, provides the program verification, and counts the number of sequences. A status bit similar to DATA# polling and a status bit toggling between consecutive read cycles, provide feedback to the user as to the status of the programming operation. Refer to write operation status, table 7, for more information on these status bits.

AUTOMATIC CHIP ERASE

The entire chip is bulk erased using 10 ms erase pulses according to MXIC's Automatic Chip Erase algorithm. The Automatic Erase algorithm automatically programs the entire array prior to electrical erase. The timing and verification of electrical erase are controlled internally within the device.

AUTOMATIC SECTOR ERASE

The MX26LV160AT/AB is sector(s) erasable using MXIC's Auto Sector Erase algorithm. The Automatic Sector Erase algorithm automatically programs the specified sector(s) prior to electrical erase. The timing and verification of electrical erase are controlled internally within the device. An erase operation can erase one sector, multiple sectors, or the entire device.

AUTOMATIC ERASE ALGORITHM

MXIC's Automatic Erase algorithm requires the user to write commands to the command register using standard microprocessor write timings. The device will automatically pre-program and verify the entire array. Then the device automatically times the erase pulse width,

provides the erase verification, and counts the number of sequences. A status bit toggling between consecutive read cycles provides feedback to the user as to the status of the erasing operation.

Register contents serve as inputs to an internal state-machine which controls the erase and programming circuitry. During write cycles, the command register internally latches address and data needed for the programming and erase operations. During a system write cycle, addresses are latched on the falling edge, and data are latched on the rising edge of WE# or CE#, whichever happens first.

MXIC's high speed Flash technology combines years of EPROM experience to produce the highest levels of quality, reliability, and cost effectiveness. The MX26LV160AT/AB electrically erases all bits simultaneously using Fowler-Nordheim tunneling. The bytes are programmed by using the EPROM programming mechanism of hot electron injection.

During a program cycle, the state-machine will control the program sequences and command register will not respond to any command set. After the state machine has completed its task, it will allow the command register to respond to its full command set.

AUTOMATIC SELECT

The auto select mode provides manufacturer and device identification, protection verification, through identifier codes output on Q7~Q0. This mode is mainly adapted for programming equipment on the device to be programmed with its programming algorithm. When programming by high voltage method, automatic select mode requires VID (11V to 12V) on address pin A9 and other address pin A6, A1 and A0 as referring to Table 3. In addition, to access the automatic select codes in-system, the host can issue the automatic select command through the command register without requiring VID, as shown in table 4.

To verify whether or not sector being protected, the sector address must appear on the appropriate highest order address bit (see Table 1 and Table 2). The rest of address bits, as shown in Table 3, are don't care. Once all necessary bits have been set as required, the programming equipment may read the corresponding identifier code on Q7~Q0.

TABLE 3. MX26LV160AT/AB AUTO SELECT MODE OPERATION

Description		Mode	CE#	OE#	WE#	A19 | A12	A11 | A10	A9	A8 | A7	A6	A5 | A2	A1	A0	Q15~Q0
Read Silicon ID	Manufacturer Code		L	L	H	X	X	VID	X	L	X	L	L	C2H
	Device ID (Top Boot Block)	Word	L	L	H	X	X	VID	X	L	X	L	H	22C4H
		Byte	L	L	H	X	X	VID	X	L	X	L	H	XXC4H
	Device ID (Bottom Boot Block)	Word	L	L	H	X	X	VID	X	L	X	L	H	2249H
		Byte	L	L	H	X	X	VID	X	L	X	L	H	XX49H
Sector Protection Verification			L	L	H	SA	X	VID	X	L	X	H	L	XX01H (protected) XX00H (unprotected)

NOTE:SA=Sector Address, X=Don't Care, L=Logic Low, H=Logic High

COMMAND DEFINITIONS

Device operations are selected by writing specific address and data sequences into the command register. Writing incorrect address and data values or writing them in the improper sequence will reset the device to the read mode. Table 5 defines the valid register command sequences.

TABLE 4. MX26LV160AT/AB COMMAND DEFINITIONS

Command		Bus Cycle	First Bus Cycle		Second Bus Cycle		Third Bus Cycle		Fourth Bus Cycle		Fifth Bus Cycle		Sixth Bus Cycle	
			Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data
Reset		1	XXXH	F0H										
Read		1	RA	RD										
Read Silicon ID	Word	4	555H	AAH	2AAH	55H	555H	90H	ADI	DDI				
	Byte	4	AAAH	AAH	555H	55H	AAAH	90H	ADI	DDI				
Sector Protect Verify	Word	4	555H	AAH	2AAH	55H	555H	90H	(SA) x02H	XX00H XX01H				
	Byte	4	AAAH	AAH	555H	55H	AAAH	90H	(SA) x04H	00H 01H				
Program	Word	4	555H	AAH	2AAH	55H	555H	A0H	PA	PD				
	Byte	4	AAAH	AAH	555H	55H	AAAH	A0H	PA	PD				
Chip Erase	Word	6	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	555H	10H
	Byte	6	AAAH	AAH	555H	55H	AAAH	80H	AAAH	AAH	555H	55H	AAAH	10H
Sector Erase	Word	6	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	SA	30H
	Byte	6	AAAH	AAH	555H	55H	AAAH	80H	AAAH	AAH	555H	55H	SA	30H
CFI Query	Word	1	555H	98										
	Byte		AAAH	98										

Note:
1. ADI = Address of Device identifier; A1=0, A0 = 0 for manufacturer code, A1=0, A0 = 1 for device code. A2-A19=do not care. (Refer to table 3)
   DDI = Data of Device identifier : C2H for manufacture code, 22DA/DA(Top), and 225B/5B(Bottom) for device code.
   X = X can be VIL or VIH
   RA=Address of memory location to be read.
   RD=Data to be read at location RA.
2. PA = Address of memory location to be programmed.
   PD = Data to be programmed at location PA.
   SA = Address of the sector.
3. The system should generate the following address patterns: 555H or 2AAH to Address A10~A0 in word mode/AAAH or 555H to Address A10~A-1 in byte mode.
   Address bit A11~A19=X=Don't care for all address commands except for Program Address (PA) and Sector Address (SA). Write Sequence may be initiated with A11~A19 in either state.
4. For Sector Protect Verify operation: If read out data is 01H, it means the sector has been protected. If read out data is 00H, it means the sector is still not being protected.
5. Any number of CFI data read cycles are permitted.

COMMAND DEFINITIONS

Device operations are selected by writing specific address and data sequences into the command register. Writing incorrect address and data values or writing them in the improper sequence will reset the device to the read mode. Table 5 defines the valid register command sequences.

TABLE 5. MX26LV160AT/AB BUS OPERATION

DESCRIPTION	CE#	OE#	WE#	RE-SET#	A19 — A12	A11 — A10	A9	A8 — A7	A6	A5 — A2	A1	A0	Q0~Q7	Q8~Q15 BYTE =VIH	Q8~Q15 BYTE =VIL
Read	L	L	H	H	AIN								Dout	Dout	Q8~Q14 =High Z Q15=A-1
Write	L	H	L	H	AIN								DIN(3)	DIN	
Reset	X	X	X	L	X								High Z	High Z	High Z
Output Disable	L	H	H	H	X								High Z	High Z	High Z
Standby	Vcc± 0.3V	X	X	Vcc± 0.3V	X								High Z	High Z	High Z
Sector Protect	L	H	L	VID	SA	X	X	X	L	X	H	L	DIN	X	X
Chip Unprotect	L	H	L	VID	X	X	X	X	H	X	H	L	DIN	X	X
Sector Protection Verify	L	L	H	H	SA	X	VID	X	L	X	H	L	CODE(5)	X	X

NOTES:
1. Manufacturer and device codes may also be accessed via a command register write sequence. Refer to Table 4.
2. VID is the Silicon-ID-Read high voltage, 11V to 12V.
3. Refer to Table 5 for valid Data-In during a write operation.
4. X can be VIL or VIH.
5. Code=00H/XX00H means unprotected.
   Code=01H/XX01H means protected.
6. A19~A12=Sector address for sector protect.
7. The sector protect and chip unprotect functions may also be implemented via programming equipment.

REQUIREMENTS FOR READING ARRAY DATA

To read array data from the outputs, the system must drive the CE# and OE# pins to VIL. CE# is the power control and selects the device. OE# is the output control and gates array data to the output pins. WE# should remain at VIH.

The internal state machine is set for reading array data upon device power-up, or after a hardware reset. This ensures that no spurious alteration of the memory content occurs during the power transition. No command is necessary in this mode to obtain array data. Standard microprocessor read cycles that assert valid address on the device address inputs produce valid data on the device data outputs. The device remains enabled for read access until the command register contents are altered.

WRITE COMMANDS/COMMAND SEQUENCES

To program data to the device or erase sectors of memory , the system must drive WE# and CE# to VIL, and OE# to VIH.

The "Word/byte Program Command Sequence" section has details on programming data to the device.

An erase operation can erase one sector, multiple sectors , or the entire device. Table indicates the address space that each sector occupies. A "sector address" consists of the address bits required to uniquely select a sector. The "Writing specific address and data commands or sequences into the command register initiates device operations. Table 1 defines the valid register command sequences. Writing incorrect address and data values or writing them in the improper sequence resets the device to reading array data. Section has details on erasing a sector or the entire chip.

After the system writes the autoselect command sequence, the device enters the autoselect mode. The system can then read autoselect codes from the internal register (which is separate from the memory array) on Q7-Q0. Standard read cycle timings apply in this mode. Refer to the Autoselect Mode and Autoselect Command Sequence section for more information.

ICC2 in the DC Characteristics table represents the active current specification for the write mode. The "AC Characteristics" section contains timing specification table and timing diagrams for write operations.

STANDBY MODE

When using both pins of CE# and RESET#, the device enter CMOS Standby with both pins held at VCC ±0.3V. If CE# and RESET# are held at VIH, but not within the range of VCC ±0.3V, the device will still be in the standby mode, but the standby current will be larger. During Auto Algorithm operation, Vcc active current (Icc2) is required even CE# = "H" until the operation is completed. The device can be read with standard access time (tCE) from either of these standby modes, before it is ready to read data.

OUTPUT DISABLE

With the OE# input at a logic high level (VIH), output from the devices are disabled. This will cause the output pins to be in a high impedance state.

RESET# OPERATION

The RESET# pin provides a hardware method of resetting the device to reading array data. When the RESET# pin is driven low for at least a period of tRP, the device immediately terminates any operation in progress, tristates all output pins, and ignores all read/write commands for the duration of the RESET# pulse. The device also resets the internal state machine to reading array data. The operation that was interrupted should be reinitiated once the device is ready to accept another command sequence, to ensure data integrity

Current is reduced for the duration of the RESET# pulse. When RESET# is held at VSS±0.3V, the device draws CMOS standby current (ICC4). If RESET# is held at VIL but not within VSS±0.3V, the standby current will be greater.

The RESET# pin may be tied to system reset circuitry. A system reset would that also reset the high speed Flash, enabling the system to read the boot-up firmware from the high speed Flash.

If RESET# is asserted during a program or erase operation, the RY/BY# pin remains a "0" (busy) until the inter-

nal reset operation is complete, which requires a time of tREADY (during Embedded Algorithms). The system can thus monitor RY/BY# to determine whether the reset operation is complete. If RESET# is asserted when a program or erase operation is completed within a time of tREADY (not during Embedded Algorithms). The system can read data tRH after the RESET# pin returns to VIH.

Refer to the AC Characteristics tables for RESET# parameters and to Figure 21 for the timing diagram.

READ/RESET COMMAND

The read or reset operation is initiated by writing the read/reset command sequence into the command register. Microprocessor read cycles retrieve array data. The device remains enabled for reads until the command register contents are altered.

If program-fail or erase-fail happen, the write of F0H will reset the device to abort the operation. A valid command must then be written to place the device in the desired state.

SILICON-ID READ COMMAND

High speed Flash memories are intended for use in applications where the local CPU alters memory contents. As such, manufacturer and device codes must be accessible while the device resides in the target system. PROM programmers typically access signature codes by raising A9 to a high voltage (VID). However, multiplexing high voltage onto address lines is not generally desired system design practice.

The MX26LV160AT/AB contains a Silicon-ID-Read operation to supple traditional PROM programming methodology. The operation is initiated by writing the read silicon ID command sequence into the command register.

SET-UP AUTOMATIC CHIP/SECTOR ERASE COMMANDS

Chip erase is a six-bus cycle operation. There are two "unlock" write cycles. These are followed by writing the "set-up" command 80H. Two more "unlock" write cycles are then followed by the chip erase command 10H or sector erase command 30H.

The Automatic Chip Erase does not require the device to be entirely pre-programmed prior to executing the Automatic Chip Erase. Upon executing the Automatic Chip Erase, the device will automatically program and verify the entire memory for an all-zero data pattern. When the device is automatically verified to contain an all-zero pattern, a self-timed chip erase and verify begin. The erase and verify operations are completed when the data on Q7 is "1" at which time the device returns to the Read mode. The system is not required to provide any control or timing during these operations.

When using the Automatic Chip Erase algorithm, note that the erase automatically terminates when adequate erase margin has been achieved for the memory array (no erase verification command is required).

If the Erase operation was unsuccessful, the data on Q5 is "1" (see Table 7), indicating the erase operation exceed internal timing limit.

The automatic erase begins on the rising edge of the last WE# or CE# pulse, whichever happens first in the command sequence and terminates when the data on Q7 is "1" at which time the device returns to the Read mode, or the data on Q6 stops toggling for two consecutive read cycles at which time the device returns to the Read mode.

TABLE 6. SILICON ID CODE

Pins		A0	A1	Q15~Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0	Code (Hex)
Manufacture code	Word	VIL	VIL	00H	1	1	0	0	0	0	1	0	00C2H
	Byte	VIL	VIL	X	1	1	0	0	0	0	1	0	C2H
Device code	Word	VIH	VIL	22H	1	1	0	0	0	1	0	0	22C4H
for MX26LV160AT	Byte	VIH	VIL	X	1	1	0	0	0	1	0	0	C4H
Device code	Word	VIH	VIL	22H	0	1	0	0	1	0	0	1	2249H
for MX26LV160AB	Byte	VIH	VIL	X	0	1	0	0	1	0	0	1	49H
Sector Protection	Word	X	VIH	X	0	0	0	0	0	0	0	1	01H (Protected)
Verification	Byte	X	VIH	X	0	0	0	0	0	0	0	0	00H (Unprotected)

READING ARRAY DATA

The device is automatically set to reading array data after device power-up. No commands are required to retrieve data. The device is also ready to read array data after completing an Automatic Program or Automatic Erase algorithm.

The system must issue the reset command to re-enable the device for reading array data if Q5 goes high, or while in the "read silicon-ID" and "sector protect verify" mode. See the "Reset Command" section, next.

RESET COMMAND

Writing the reset command to the device resets the device to reading array data. Address bits are don't care for this command.

The reset command may be written between the sequence cycles in an erase command sequence before erasing begins. This resets the device to reading array data. Once erasure begins, however, the device ignores reset commands until the operation is complete.

The reset command may be written between the sequence cycles in a program command sequence before programming begins. This resets the device to reading array data Once programming begins, however, the device ignores reset commands until the operation is complete.

The reset command may be written between the sequence cycles in an SILICON ID READ command sequence. Once in the SILICON ID READ mode, the reset command must be written to return to reading array data.

If Q5 goes high during a program or erase operation, writing the reset command returns the device to read-ing array data.

SECTOR ERASE COMMANDS

The Automatic Sector Erase does not require the device to be entirely pre-programmed prior to executing the Automatic Sector Erase Set-up command and Automatic Sector Erase command. Upon executing the Automatic Sector Erase command, the device will automatically program and verify the sector(s) memory for an all-zero data pattern. The system is not required to provide any control or timing during these operations.

When the sector(s) is automatically verified to contain an all-zero pattern, a self-timed sector erase and verify begin. The erase and verify operations are complete when either the data on Q7 is "1" at which time the device returns to the Read mode, or the data on Q6 stops toggling for two consecutive read cycles at which time the device returns to the Read mode. The system is not required to provide any control or timing during these operations.

When using the Automatic sector Erase algorithm, note that the erase automatically terminates when adequate erase margin has been achieved for the memory array (no erase verification command is required). Sector erase is a six-bus cycle operation. There are two "unlock" write cycles. These are followed by writing the set-up command 80H. Two more "unlock" write cycles are then followed by the sector erase command 30H. The sector address is latched on the falling edge of WE# or CE#, whichever happens later, while the command (data) is latched on the rising edge of WE# or CE#, whichever happens first. Sector addresses selected are loaded into internal register on the sixth falling edge of WE# or CE#, whichever happens later. Each successive sector load cycle started by the falling edge of WE# or CE#, whichever happens later must begin within 50us from the rising edge of the preceding WE# or CE#, whichever happens first. Otherwise, the loading period ends and internal auto sector erase cycle starts. (Monitor Q3 to determine if the sector erase timer window is still open, see section Q3, Sector Erase Timer.) Any command other than Sector Erase (30H) during the time-out period resets the device to read mode.

WORD/BYTE PROGRAM COMMAND SEQUENCE

The device programs one byte of data for each program operation. The command sequence requires four bus cycles, and is initiated by writing two unlock write cycles, followed by the program set-up command. The program address and data are written next, which in turn initiate the Embedded Program algorithm. The system is not required to provide further controls or timings. The device automatically generates the program pulses and verifies the programmed cell margin. Table 1 shows the address and data requirements for the word/byte program command sequence.

When the Embedded Program algorithm is complete, the device then returns to reading array data and addresses are no longer latched. The system can determine the status of the program operation by using Q7, Q6, or RY/BY#. See "Write Operation Status" for information on these status bits.

Any commands written to the device during the Embedded Program Algorithm are ignored. Note that a hardware reset immediately terminates the programming operation. The word/byte Program command sequence should be reinitiated once the device has reset to reading array data, to ensure data integrity.

Programming is allowed in any sequence and across sector boundaries. A bit cannot be programmed from a "0" back to a "1". Attempting to do so may halt the operation and set Q5 to "1", or cause the Data# Polling algorithm to indicate the operation was successful. However, a succeeding read will show that the data is still "0". Only erase operations can convert a "0" to a "1".

WRITE OPERATION STATUS

The device provides several bits to determine the status of a write operation: Q2, Q3, Q5, Q6, Q7, and RY/BY#. Table 7 and the following subsections describe the functions of these bits. Q7, RY/BY#, and Q6 each offer a method for determining whether a program or erase operation is complete or in progress. These three bits are discussed first.

Q7: Data# Polling

The Data# Polling bit, Q7, indicates to the host system whether an Automatic Algorithm is in progress or completed. Data# Polling is valid after the rising edge of the final WE# pulse in the program or erase command sequence.

During the Automatic Program algorithm, the device outputs on Q7 the complement of the datum programmed to

Q7. When the Automatic Program algorithm is complete, the device outputs the datum programmed to Q7. The system must provide the program address to read valid status information on Q7.

During the Automatic Erase algorithm, Data# Polling produces a "0" on Q7. When the Automatic Erase algorithm is complete, Data# Polling produces a "1" on Q7. This is analogous to the complement/true datum out-put described for the Automatic Program algorithm: the erase function changes all the bits in a sector to "1" prior to this, the device outputs the "complement," or "0". The system must provide an address within any of the sectors selected for erasure to read valid status information on Q7.

After an erase command sequence is written, if all sectors selected for erasing are protected, Data# Polling on Q7 is active for approximately 100 us, then the device returns to reading array data. If not all selected sectors are protected, the Automatic Erase algorithm erases the unprotected sectors, and ignores the selected sectors that are protected.

When the system detects Q7 has changed from the complement to true data, it can read valid data at Q7-Q0 on the following read cycles. This is because Q7 may change asynchronously with Q0-Q6 while Output Enable (OE#) is asserted low.

RY/BY# : Ready/Busy

The RY/BY# is a dedicated, open-drain output pin that indicates whether an Automatic Erase/Program algorithm is in progress or complete. The RY/BY# status is valid after the rising edge of the final WE# or CE#, whichever happens first, in the command sequence. Since RY/BY# is an open-drain output, several RY/BY# pins can be tied together in parallel with a pull-up resistor to VCC.

If the output is low (Busy), the device is actively erasing or programming. If the output is high (Ready), the device is ready to read array data, or is in the standby mode.

Table 7 shows the outputs for RY/BY# during write operation.

Q6:Toggle BIT I

Toggle Bit I on Q6 indicates whether an Automatic Pro-

gram or Erase algorithm is in progress or complete. Toggle Bit I may be read at any address, and is valid after the rising edge of the final WE# or CE#, whichever happens first, in the command sequence (prior to the program or erase operation), and during the sector time-out.

During an Automatic Program or Erase algorithm operation, successive read cycles to any address cause Q6 to toggle. The system may use either OE# or CE# to control the read cycles. When the operation is complete, Q6 stops toggling.

When the device is actively erasing (that is, the Automatic Erase algorithm is in progress), Q6 toggling. However, the system must also use Q2 to determine which sectors are erasing. Alternatively, the system can use Q7.

Q6 stops toggling once the Automatic Program algorithm is complete.

Table 7 shows the outputs for Toggle Bit I on Q6.

Q2:Toggle Bit II

The "Toggle Bit II" on Q2, when used with Q6, indicates whether a particular sector is actively erasing (that is, the Automatic Erase algorithm is in process). Toggle Bit II is valid after the rising edge of the final WE# or CE#, whichever happens first, in the command sequence.

Q2 toggles when the system reads at addresses within those sectors that have been selected for erasure. (The system may use either OE# or CE# to control the read cycles.) But Q2 cannot distinguish when the sector is actively erasing or is in Erase Suspend. Q6, by comparison, indicates when the device is actively erasing but cannot distinguish which sectors are selected for erasure. Thus, both status bits are required for sectors and mode information. Refer to Table 7 to compare outputs for Q2 and Q6.

Reading Toggle Bits Q6/ Q2

Whenever the system initially begins reading toggle bit status, it must read Q7-Q0 at least twice in a row to determine whether a toggle bit is toggling. Typically, the system would note and store the value of the toggle bit after the first read. After the second read, the system would compare the new value of the toggle bit with the

first. If the toggle bit is not toggling, the device has completed the program or erase operation. The system can read array data on Q7-Q0 on the following read cycle.

However, if after the initial two read cycles, the system determines that the toggle bit is still toggling, the system also should note whether the value of Q5 is high (see the section on Q5). If it is, the system should then determine again whether the toggle bit is toggling, since the toggle bit may have stopped toggling just as Q5 went high. If the toggle bit is no longer toggling, the device has successfully completed the program or erase operation. If it is still toggling, the device did not complete the operation successfully, and the system must write the reset command to return to reading array data.

The remaining scenario is that system initially determines that the toggle bit is toggling and Q5 has not gone high. The system may continue to monitor the toggle bit and Q5 through successive read cycles, determining the status as described in the previous paragraph. Alternatively, it may choose to perform other system tasks. In this case, the system must start at the beginning of the algorithm when it returns to determine the status of the operation.

Q5
Exceeded Timing Limits

Q5 will indicate if the program or erase time has exceeded the specified limits (internal pulse count). Under these conditions Q5 will produce a "1". This time-out condition indicates that the program or erase cycle was not successfully completed. Data# Polling and Toggle Bit are the only operating functions of the device under this condition.

If this time-out condition occurs during sector erase operation, it specifies that a particular sector is bad and it may not be reused. However, other sectors are still functional and may be used for the program or erase operation. The device must be reset to use other sectors. Write the Reset command sequence to the device, and then execute program or erase command sequence. This allows the system to continue to use the other active sectors in the device.

If this time-out condition occurs during the chip erase operation, it specifies that the entire chip is bad or combination of sectors are bad.

If this time-out condition occurs during the word/byte programming operation, it specifies that the entire sector containing that byte is bad and this sector may not be reused, (other sectors are still functional and can be reused).

The time-out condition will not appear if a user tries to program a non blank location without erasing. Please note that this is not a device failure condition since the device was incorrectly used.

TABLE 7. WRITE OPERATION STATUS

	Status	Q7 (Note1)	Q6	Q5 (Note2)	Q3	Q2	RY/BY#
In Progress	Word/Byte Program in Auto Program Algorithm	Q7#	Toggle	0	N/A	No Toggle	0
	Auto Erase Algorithm	0	Toggle	0	1	Toggle	0
Exceeded Time	Word/Byte Program in Auto Program Algorithm	Q7#	Toggle	1	N/A	No Toggle	0
Limits	Auto Erase Algorithm	0	Toggle	1	1	Toggle	0

Note:
1. Q7 and Q2 require a valid address when reading status information. Refer to the appropriate subsection for further details.
2. Q5 switches to '1' when an Auto Program or Auto Erase operation has exceeded the maximum timing limits. See "Q5 : Exceeded Timing Limits" for more information.

Q3
Sector Erase Timer

After the completion of the initial sector erase command sequence, the sector erase time-out will begin. Q3 will remain low until the time-out is complete. Data# Polling and Toggle Bit are valid after the initial sector erase command sequence.

If Data# Polling or the Toggle Bit indicates the device has been written with a valid erase command, Q3 may be used to determine if the sector erase timer window is still open. If Q3 is high ("1") the internally controlled erase cycle has begun; attempts to write subsequent commands to the device will be ignored until the erase operation is completed as indicated by Data# Polling or Toggle Bit. If Q3 is low ("0"), the device will accept additional sector erase commands. To insure the command has been accepted, the system software should check the status of Q3 prior to and following each subsequent sector erase command. If Q3 were high on the second status check, the command may not have been accepted.

DATA PROTECTION

The MX26LV160AT/AB is designed to offer protection against accidental erasure or programming caused by spurious system level signals that may exist during power transition. During power up the device automatically resets the state machine in the Read mode. In addition, with its control register architecture, alteration of the memory contents only occurs after successful completion of specific command sequences. The device also incorporates several features to prevent inadvertent write cycles resulting from VCC power-up and power-down transition or system noise.

WRITE PULSE "GLITCH" PROTECTION

Noise pulses of less than 5ns(typical) on CE# or WE# will not initiate a write cycle.

LOGICAL INHIBIT

Writing is inhibited by holding any one of OE# = VIL, CE# = VIH or WE# = VIH. To initiate a write cycle CE# and WE# must be a logical zero while OE# is a logical one.

POWER SUPPLY DECOUPLING

In order to reduce power switching effect, each device should have a 0.1uF ceramic capacitor connected between its VCC and GND.

POWER-UP SEQUENCE

The MX26LV160AT/AB powers up in the Read only mode. In addition, the memory contents may only be altered after successful completion of the predefined command sequences.

TEMPORARY SECTOR UNPROTECT

This feature allows temporary unprotection of previously protected sector to change data in-system. The Temporary Sector Unprotect mode is activated by setting the RESET# pin to VID (11.5V-12.5V). During this mode, formerly protected sectors can be programmed or erased as un-protected sector. Once VID is remove from the RESET# pin. All the previously protected sectors are protected again.

SECTOR PROTECTION

The MX29LV160AT/AB features hardware sector protection. This feature will disable both program and erase operations for these sectors protected. To activate this mode, the programming equipment must force VID on address pin A9 and OE# (suggest VID = 12V). Programming of the protection circuitry begins on the falling edge of the WE# pulse and is terminated on the rising edge. Please refer to sector protect algorithm and waveform.

To verify programming of the protection circuitry, the programming equipment must force VID on address pin A9 (with CE# and OE# at VIL and WE# at VIH). When A1=VIH, A0=VIL, A6=VIL, it will produce a logical "1" code at device output Q0 for a protected sector. Otherwise the device will produce 00H for the unprotected sector. In this mode, the addresses, except for A1, are don't care. Address locations with A1 = VIL are reserved to read manufacturer and device codes. (Read Silicon ID)

It is also possible to determine if the sector is protected in the system by writing a Read Silicon ID command. Performing a read operation with A1=VIH, it will produce a logical "1" at Q0 for the protected sector.

The system must write the reset command to exit the "Silicon-ID Read Command" code.

CHIP UNPROTECT

The MX29LV160AT/AB also features the chip unprotect mode, so that all sectors are unprotected after chip unprotect is completed to incorporate any changes in the code. It is recommended to protect all sectors before activating chip unprotect mode.

To activate this mode, the programming equipment must force VID on control pin OE# and address pin A9. The CE# pins must be set at VIL. Pins A6 must be set to VIH. Refer to chip unprotect algorithm and waveform for the chip unprotect algorithm. The unprotection mechanism begins on the falling edge of the WE# pulse and is terminated on the rising edge.

It is also possible to determine if the chip is unprotected in the system by writing the Read Silicon ID command. Performing a read operation with A1=VIH, it will produce 00H at data outputs(Q0-Q7) for an unprotected sector.

It is noted that all sectors are unprotected after the chip unprotect algorithm is completed.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature

Plastic Packages . . . . -65°C to +150°C

Ambient Temperature

with Power Applied. . . . . -65°C to +125°C

Voltage with Respect to Ground

   VCC (Note 1) . . . . -0.5 V to +4.0 V

   A9, OE#, and

   RESET# (Note 2) . . . . -0.5 V to +12 V

   All other pins (Note 1) . . . . -0.5 V to VCC +0.5 V

Output Short Circuit Current (Note 3) . . . . . . 200 mA

Notes:

1. Minimum DC voltage on input or I/O pins is -0.5 V. During voltage transitions, input or I/O pins may overshoot VSS to -2.0 V for periods of up to 20 ns. Maximum DC voltage on input or I/O pins is VCC +0.5 V. During voltage transitions, input or I/O pins may overshoot to VCC +2.0 V for periods up to 20 ns.

2. Minimum DC input voltage on pins A9, OE#, and RESET# is -0.5 V. During voltage transitions, A9, OE#, and RESET# may overshoot VSS to -2.0 V for periods of up to 20 ns. Maximum DC input voltage on pin A9 is +12 V which may overshoot to 13.5V for periods up to 20 ns.

3. No more than one output may be shorted to ground at a time. Duration of the short circuit should not be greater than one second.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational sections of this data sheet is not implied. Exposure of the device to absolute maximum rating conditions for extended periods may affect device reliability.

OPERATING RATINGS

Commercial (C) Devices

Ambient Temperature (T$_A$). . . . . 0° C to +70° C

V$_{CC}$ Supply Voltages

V$_{CC}$ for full voltage range. . . . . +3.0 V to 3.6 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

CAPACITANCE   TA = 25°C, f = 1.0 MHz

SYMBOL	PARAMETER	MIN.	TYP	MAX.	UNIT	CONDITIONS
CIN1	Input Capacitance			8	pF	VIN = 0V
CIN2	Control Pin Capacitance			12	pF	VIN = 0V
COUT	Output Capacitance			12	pF	VOUT = 0V

TABLE 8. DC CHARACTERISTICS   TA = 0°C to 70°C, VCC = 3.0V~3.6V

Symbol	PARAMETER	MX26LV160AT/AB			UNIT	CONDITIONS	
		MIN.	TYP	MAX.			
ILI	Input Leakage Current		±1	±3	uA	VIN = VSS to VCC	
ILIT	A9 Input Leakage Current		35	200	uA	VCC=VCC max; A9=12V	
ILO	Output Leakage Current			±1	uA	VOUT = VSS to VCC, VCC=VCC max	
ICC1	VCC Active Read Current		20	30	mA	CE#=VIL, OE#=VIH	@5MHz
			8	14	mA		@1MHz
ICC2	VCC Active write Current		26	30	mA	CE#=VIL, OE#=VIH	
ICC3	VCC Standby Current		30	100	uA	CE#; RESET#=VCC ±0.3V	
ICC4	VCC Standby Current During Reset		30	100	uA	RESET#=VSS ± 0.3V	
VIL	Input Low Voltage (Note 1)	-0.5		0.8	V		
VIH	Input High Voltage	0.7xVCC		VCC+0.3	V		
VID	Voltage for Automatic Select and Temporary Sector Unprotect	11		12	V	VCC=3.3V	
VOL	Output Low Voltage			0.45	V	IOL = 4.0mA, VCC= VCC min	
VOH1	Output High Voltage (TTL)	0.85xVCC				IOH = -2mA, VCC=VCC min	
VOH2	Output High Voltage (CMOS)	VCC-0.4				IOH = -100uA, VCC min	

NOTES:
1. VIL min. = -1.0V for pulse width is equal to or less than 50 ns.
   VIL min. = -2.0V for pulse width is equal to or less than 20 ns.
2. VIH max. = VCC + 1.5V for pulse width is equal to or less than 20 ns
   If VIH is over the specified maximum value, read operation cannot be guaranteed.
3. Automatic sleep mode enable the low power mode when addresses remain stable for tACC +30ns.

AC CHARACTERISTICS TA = 0°C to 70°C, VCC = 3.0V~3.6V

TABLE 9. READ OPERATIONS

SYMBOL	PARAMETER		26LV160AT/AB-55		26LV160AT/AB-70		UNIT	CONDITIONS
			MIN.	MAX.	MIN.	MAX.		
tRC	Read Cycle Time (Note 1)		55		70		ns	
tACC	Address to Output Delay			55		70	ns	CE#=OE#=VIL
tCE	CE# to Output Delay			55		70	ns	OE#=VIL
tOE	OE# to Output Delay			25		30	ns	CE#=VIL
tDF	OE# High to Output Float (Note1)		0	25	0	25	ns	CE#=VIL
tOEH	Output Enable Hold Time	Read	0		0		ns	
		Toggle and Data# Polling	10		10		ns	
tOH	Address to Output hold		0		0		ns	CE#=OE#=VIL

TEST CONDITIONS:

- Input pulse levels: 0V/3.0V.
- Input rise and fall times is equal to or less than 5ns.
- Output load: 1 TTL gate + 100pF (Including scope and jig), for 26LV160AT/AB-70. 1 TTL gate + 30pF (Including scope and jig) for 26LV160AT/AB-55.
- Reference levels for measuring timing: 1.5V.

NOTE:
1. Not 100% tested.
2. tDF is defined as the time at which the output achieves the open circuit condition and data is no longer driven.

SWITCHING TEST CIRCUITS

DEVICE UNDER TEST

2.7K ohm

+3.3V

CL

6.2K ohm

DIODES=IN3064
OR EQUIVALENT

CL= 100pF Including jig capacitance for MX26LV160T/B-70
    (30pF for MX26LV160T/B-55)
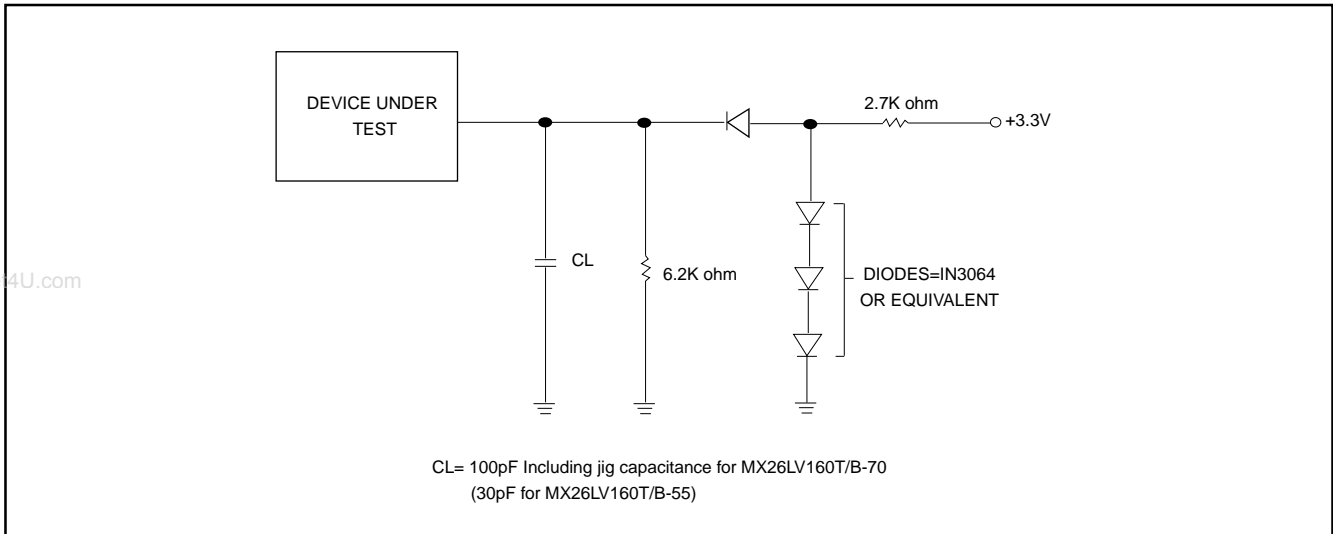
SWITCHING TEST WAVEFORMS

3.0V

TEST POINTS

0V

INPUT

OUTPUT

AC TESTING: Inputs are driven at 3.0V for a logic "1" and 0V for a logic "0".
Input pulse rise and fall times are < 5ns.

FIGURE 1. READ TIMING WAVEFORMS
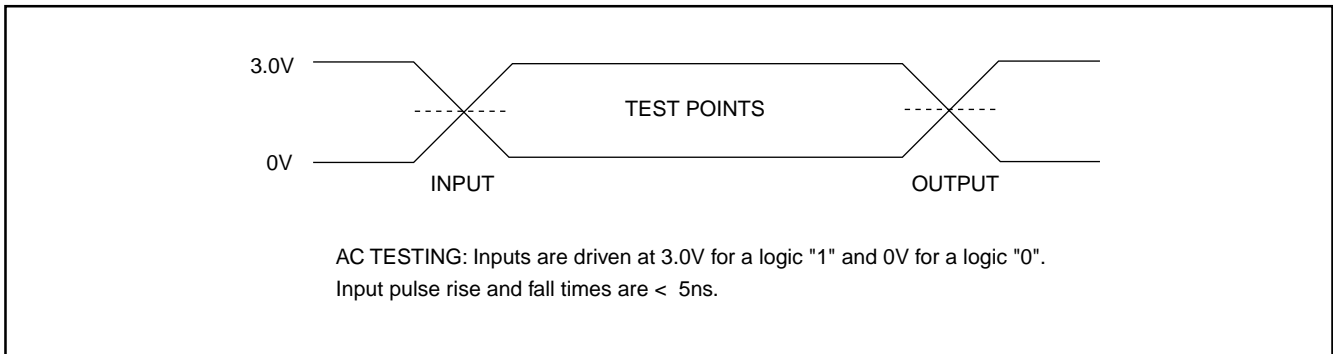
AC CHARACTERISTICS TA = 0ºC to 70ºC, VCC = 3.0V~3.6V

TABLE 10. Erase/Program Operations

SYMBOL	PARAMETER	26LV160AT/AB-55		26LV160AT/AB-70		UNIT
		MIN.	MAX.	MIN.	MAX.	
tWC	Write Cycle Time (Note 1)	55		70		ns
tAS	Address Setup Time	0		0		ns
tAH	Address Hold Time	45		45		ns
tDS	Data Setup Time	35		35		ns
tDH	Data Hold Time	0		0		ns
tOES	Output Enable Setup Time	0		0		ns
tGHWL	Read Recovery Time Before Write (OE# High to WE# Low)	0		0		ns
tCS	CE# Setup Time	0		0		ns
tCH	CE# Hold Time	0		0		ns
tWP	Write Pulse Width	35		35		ns
tWPH	Write Pulse Width High	30		30		ns
tWHWH1	Programming Operation (Note 2) (Byte/Word program time)	55/70(TYP.)		55/70(TYP.)		us
tWHWH2	Sector Erase Operation (Note 2)	2.4(TYP.)		2.4(TYP.)		sec
tVCS	VCC Setup Time (Note 1)	50		50		us
tRB	Recovery Time from RY/BY#	0		0		ns
tBUSY	Program/Erase Valid to RY/BY# Delay		90		90	ns
tWPP1	Write pulse width for sector protect (A9, OE# Control)	100ns	10us(typ.)	100ns	10us(typ.)	
tWPP2	Write pulse width for sector unprotect (A9, OE# Control)	100ns	12ms(typ.)	100ns	12ms(typ.)	
tVLHT	Voltage transition time	4		4		us
tOESP	OE# setup time to WE# active	4		4		us
tBAL	Sector Address Load Time		50		50	us

NOTES:

1. Not 100% tested.
2. See the "Erase and Programming Performance" section for more information.

AC CHARACTERISTICS TA = 0ºC to 70ºC, VCC = 3.0V~3.6V

TABLE 11. Alternate CE# Controlled Erase/Program Operations

SYMBOL	PARAMETER		26LV160AT/AB-55 MIN.	MAX.	26LV160AT/AB-70 MIN.	MAX.	UNIT
tWC	Write Cycle Time (Note 1)		55		70		ns
tAS	Address Setup Time		0		0		ns
tAH	Address Hold Time		45		45		ns
tDS	Data Setup Time		35		35		ns
tDH	Data Hold Time		0		0		ns
tOES	Output Enable Setup Time		0		0		ns
tGHEL	Read Recovery Time Before Write		0		0		ns
tWS	WE# Setup Time		0		0		ns
tWH	WE# Hold Time		0		0		ns
tCP	CE# Pulse Width		35		35		ns
tCPH	CE# Pulse Width High		30		30		ns
tWHWH1	Programming	Byte	55(Typ.)		55(Typ.)		us
	Operation(note2)	Word	70(Typ.)		70(Typ.)		us
tWHWH2	Sector Erase Operation (note2)		2.4(Typ.)		2.4(Typ.)		sec

NOTE:
1. Not 100% tested.
2. See the "Erase and Programming Performance" section for more information.

FIGURE 2. COMMAND WRITE TIMING WAVEFORM
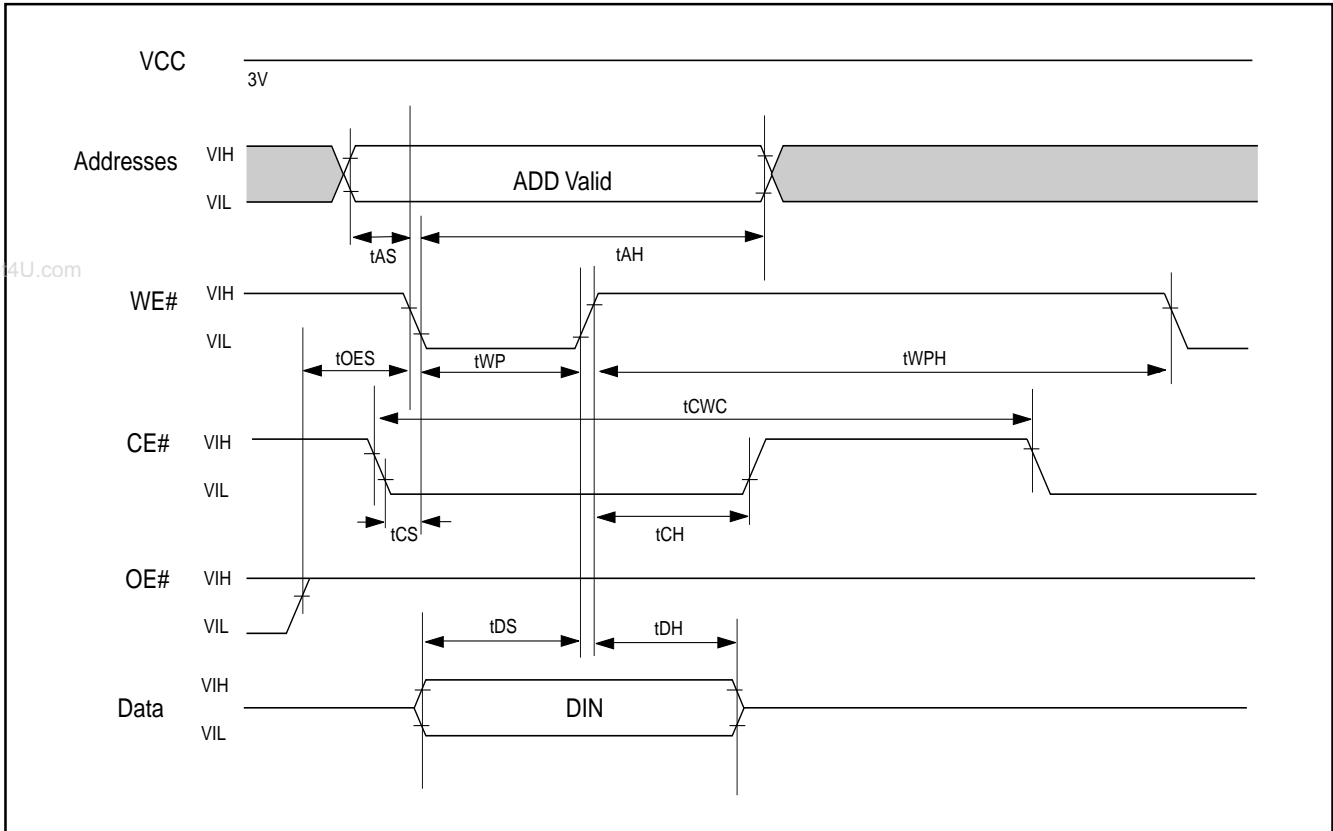
AUTOMATIC PROGRAMMING TIMING WAVEFORM

One byte data is programmed. Verify in fast algorithm and additional verification by external control are not required because these operations are executed automatically by internal control circuit. Programming completion can be verified by DATA# polling and toggle bit check-

ing after automatic programming starts. Device outputs DATA# during programming and DATA# after programming on Q7. (Q6 is for toggle bit; see toggle bit, DATA# polling, timing waveform)

FIGURE 3. AUTOMATIC PROGRAMMING TIMING WAVEFORM

NOTES:
 1.PA=Program Address, PD=Program Data, DOUT is the true data the program address
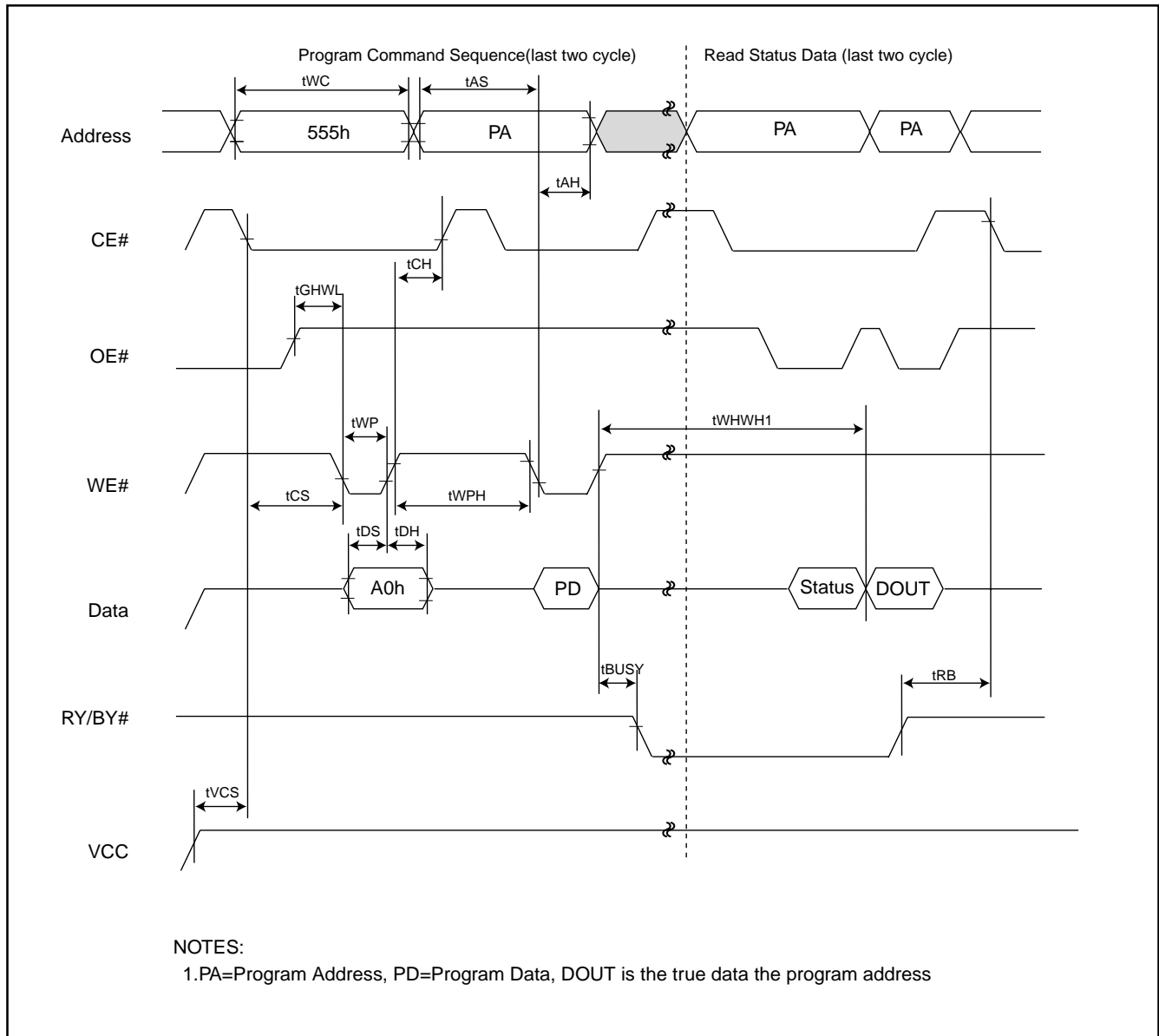
FIGURE 4. AUTOMATIC PROGRAMMING ALGORITHM FLOWCHART

28
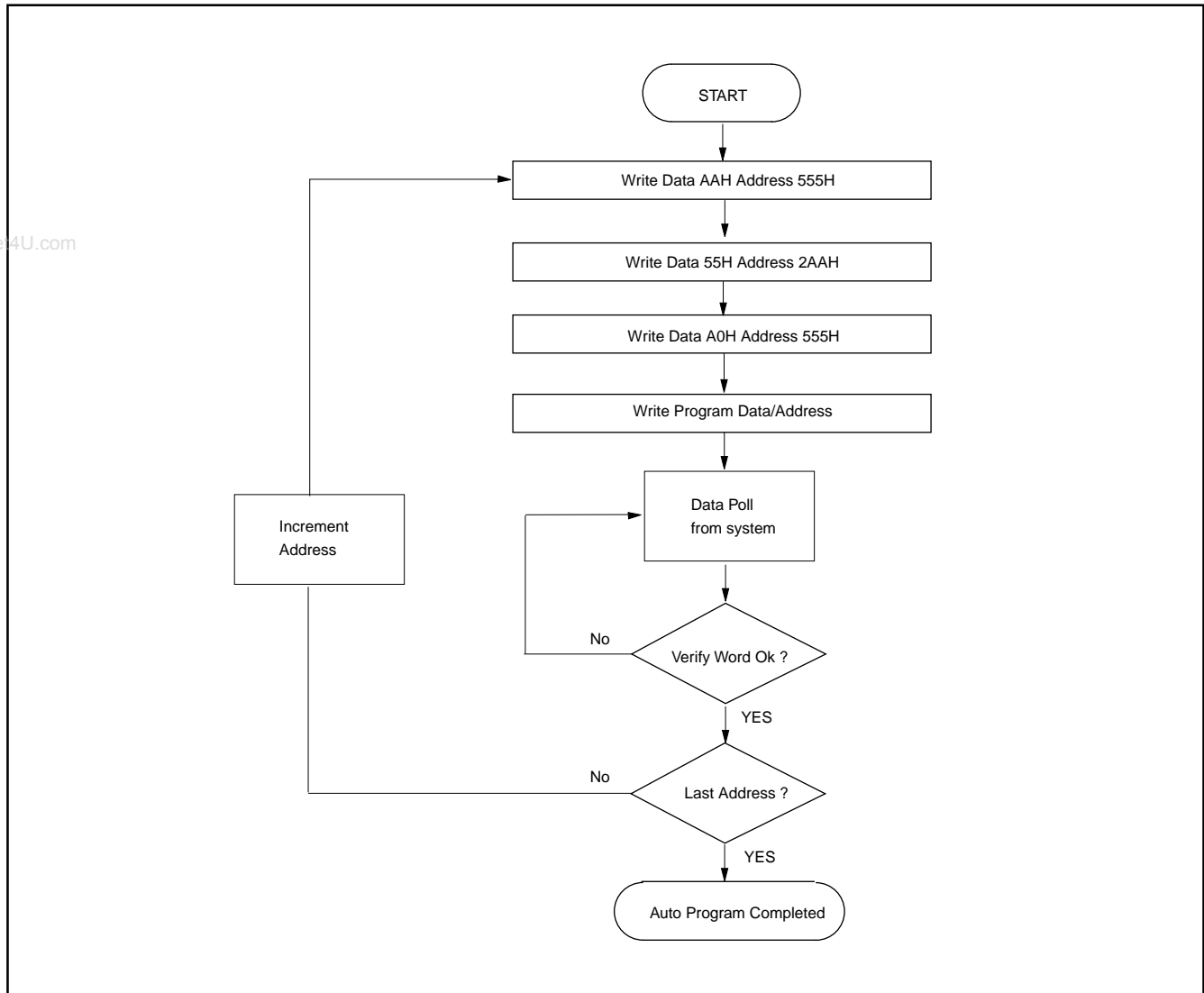
FIGURE 5. CE# CONTROLLED PROGRAM TIMING WAVEFORM

NOTES:

1.PA=Program Address, PD=Program Data, DOUT=Data Out, DQ7=complement of data written to device.
2.Figure indicates the last two bus cycles of the command sequence.
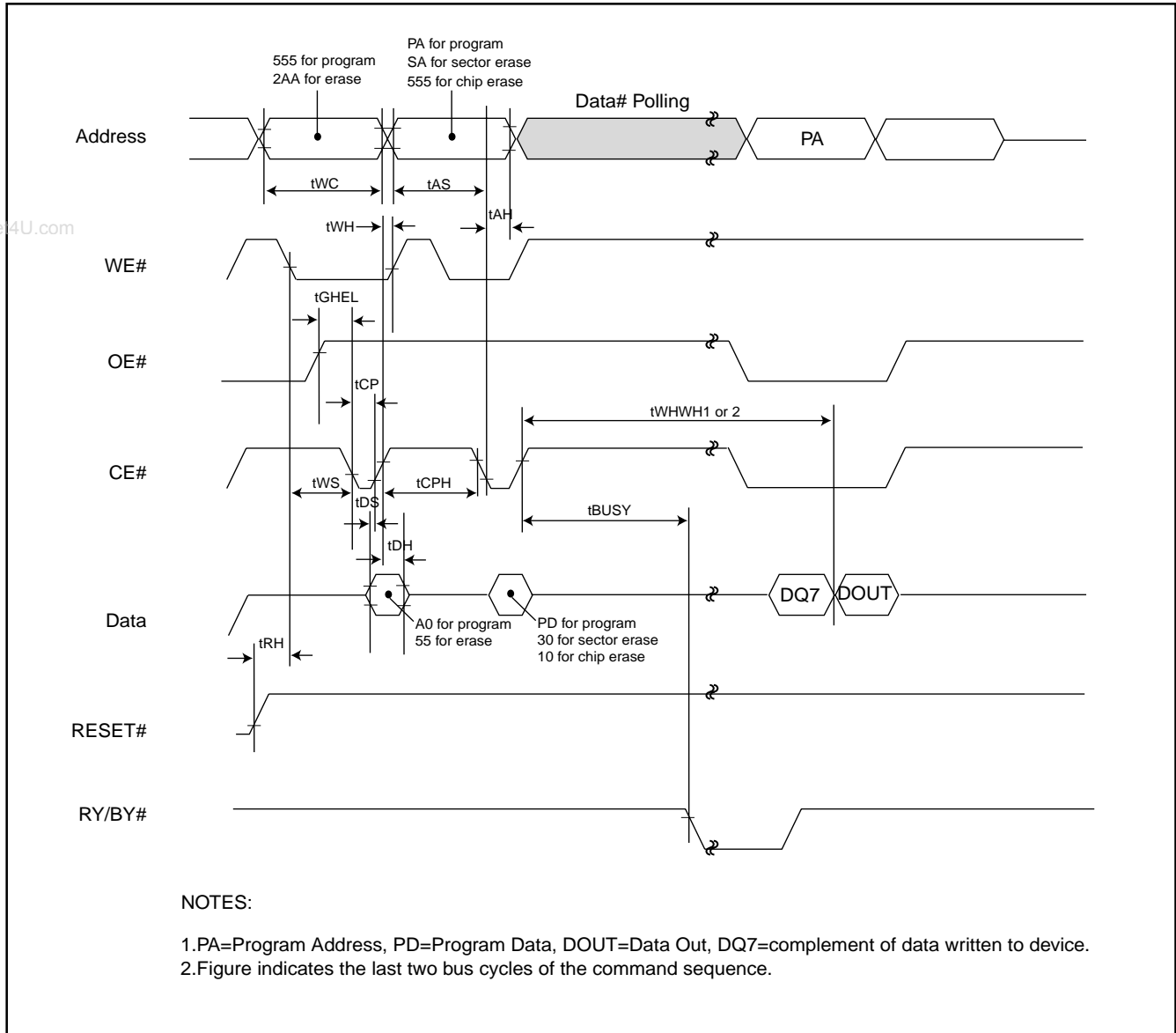
AUTOMATIC CHIP ERASE TIMING WAVEFORM

All data in chip are erased. External erase verification is not required because data is verified automatically by internal control circuit. Erasure completion can be verified by DATA# polling and toggle bit checking after auto-

matic erase starts. Device outputs 0 during erasure and 1 after erasure on Q7. (Q6 is for toggle bit; see toggle bit, DATA# polling, timing waveform)

FIGURE 6. AUTOMATIC CHIP ERASE TIMING WAVEFORM

NOTES:
SA=sector address(for Sector Erase), VA=Valid Address for reading status data(see "Write Operation Status").
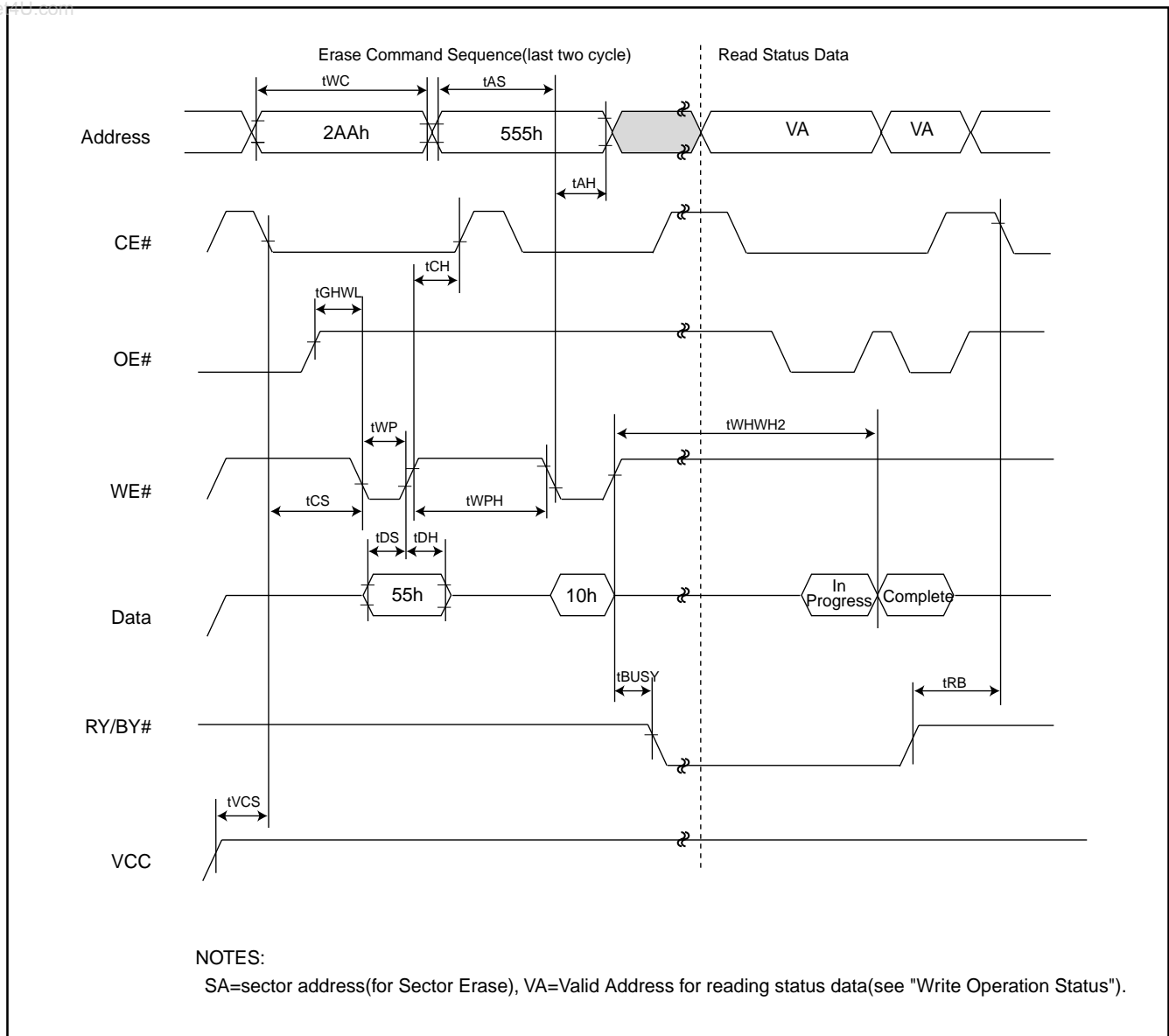
FIGURE 7. AUTOMATIC CHIP ERASE ALGORITHM FLOWCHART
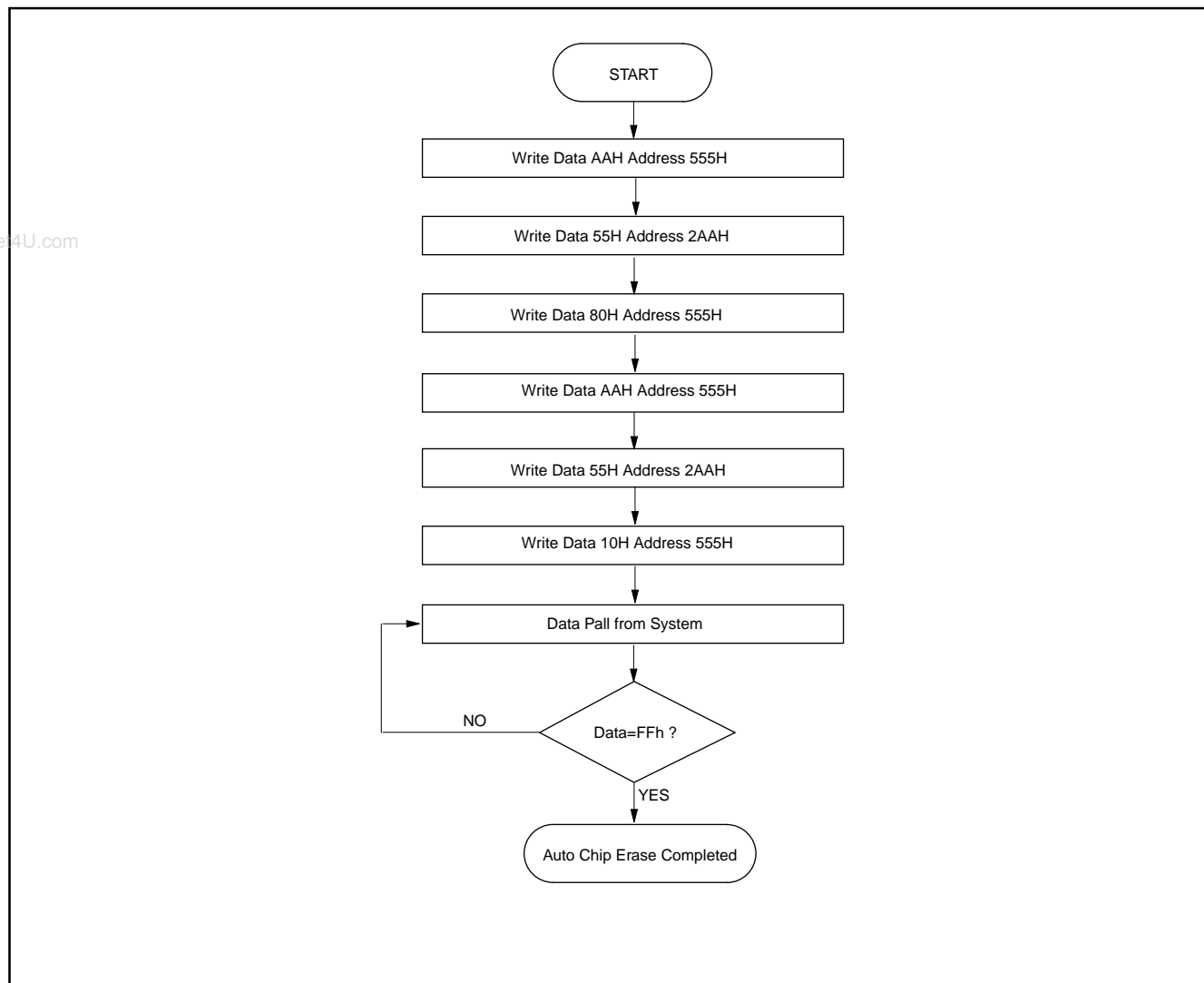
AUTOMATIC SECTOR ERASE TIMING WAVEFORM

Sector indicated by A12 to A19 are erased. External erase verify is not required because data are verified automatically by internal control circuit. Erasure completion can be verified by DATA# polling and toggle bit checking after automatic erase starts. Device outputs 0 during erasure and 1 after erasure on Q7. (Q6 is for toggle bit; see toggle bit, DATA# polling, timing waveform)

FIGURE 8. AUTOMATIC SECTOR ERASE TIMING WAVEFORM

NOTES:
  SA=sector address(for Sector Erase), VA=Valid Address for reading status data(see "Write Operation Status").
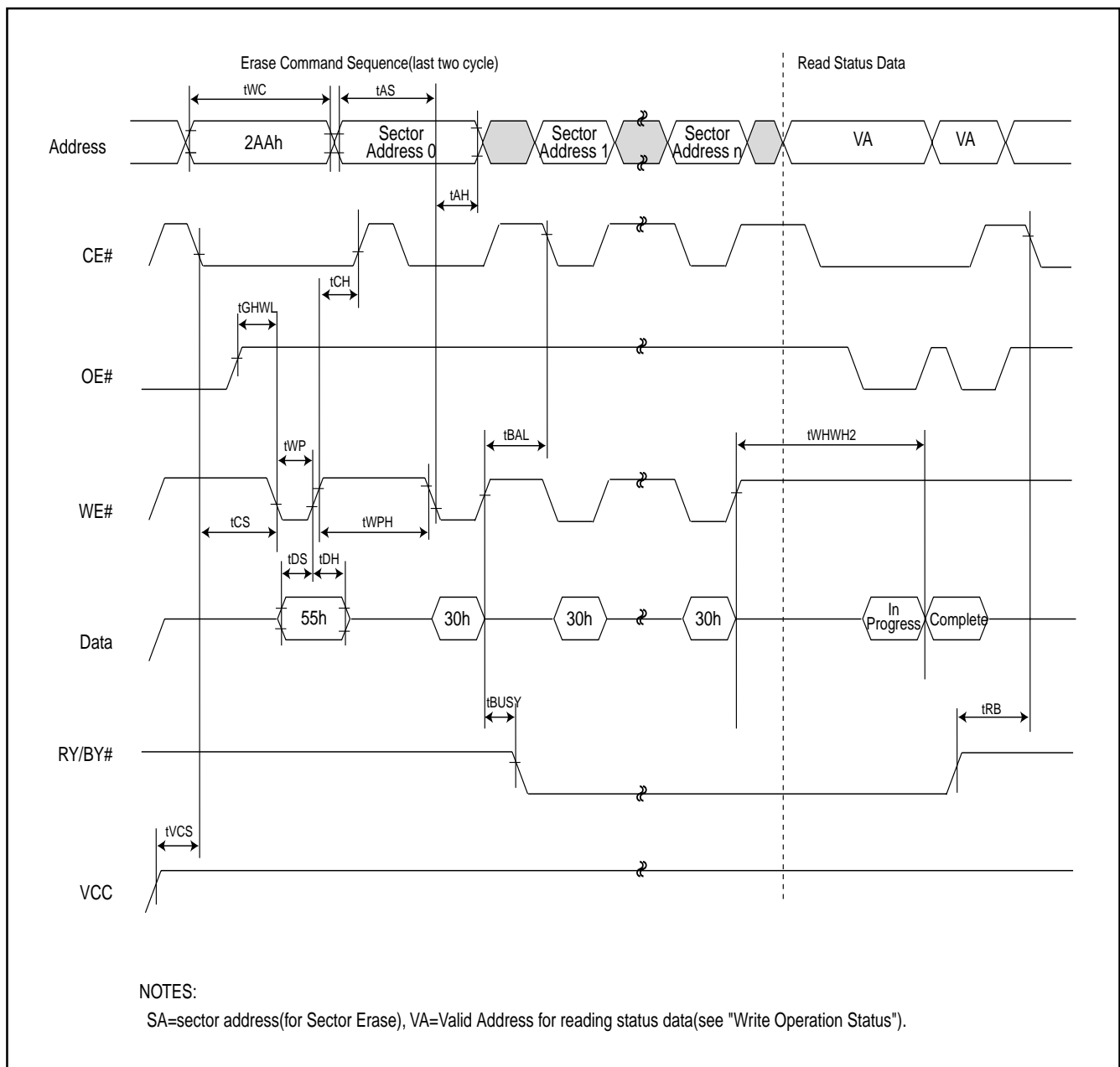
FIGURE 9. AUTOMATIC SECTOR ERASE ALGORITHM FLOWCHART

```
                    ┌─────────┐
                    │  START  │
                    └─────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data AAH Address 555H      │
         └───────────────────────────────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data 55H Address 2AAH      │
         └───────────────────────────────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data 80H Address 555H      │
         └───────────────────────────────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data AAH Address 555H      │
         └───────────────────────────────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data 55H Address 2AAH      │
         └───────────────────────────────────┘
                         │
         ┌───────────────────────────────────┐
         │  Write Data 30H Sector Address    │◄──────┐
         └───────────────────────────────────┘       │
                         │                            │
                    ╱────────────╲                    │
                   ╱  Last Sector  ╲    NO            │
                   ╲   to Erase    ╱───────────────────┘
                    ╲────────────╱
                         │ YES
         ┌───────────────────────────────────┐
         │  Data Poll from System            │◄──────┐
         └───────────────────────────────────┘       │
                         │                            │
                    ╱────────────╲                    │
                   ╱  Data=FFh     ╲    NO            │
                   ╲               ╱───────────────────┘
                    ╲────────────╱
                         │ YES
                 ┌───────────────────┐
                 │ Auto Sector Erase │
                 │    Completed      │
                 └───────────────────┘
```
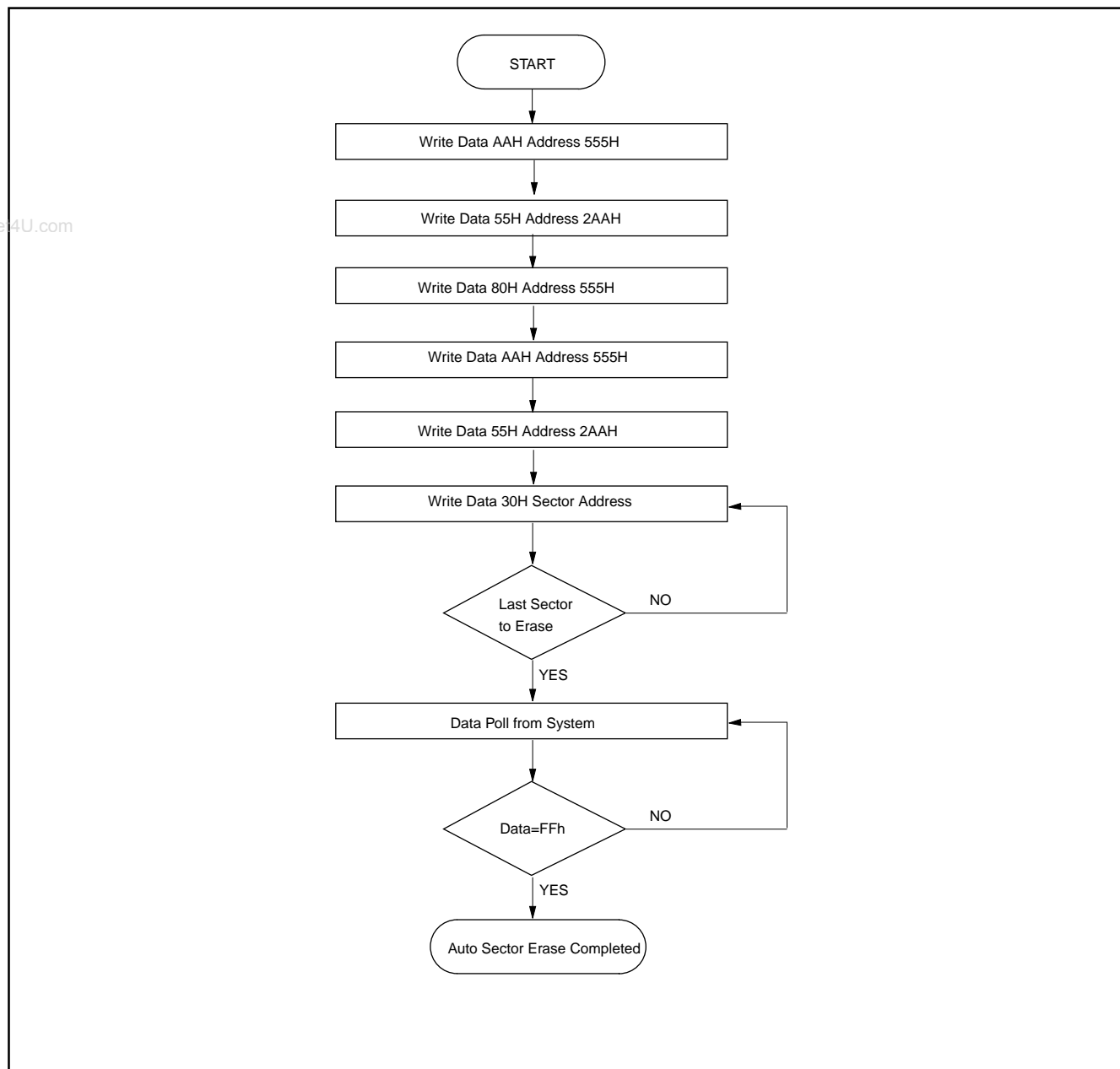
Figure 10. IN-SYSTEM SECTOR PROTECT/CHIP UNPROTECT TIMING WAVEFORM (RESET# Control)

Note: When sector protect, A6=0, A1=1, A0=0. When chip unprotect, A6=1, A1=1, A0=0.

Figure 11. SECTOR PROTECT TIMING WAVEFORM (A9, $\overline{OE}$# Control)

Notes: tVLHT (Voltage transition time)=4us min.
tOESP (OE# setup time to WE# active)=4us min.

Figure 12. SECTOR PROTECTION ALGORITHM (A9, OE# Control)

Figure 13. IN-SYSTEM SECTOR PROTECTION ALGORITHM WITH RESET#=VID

```
                          ┌─────────────┐
                          │    START    │
                          └──────┬──────┘
                                 │
                          ┌──────▼──────┐
                          │  PLSCNT=1   │
                          └──────┬──────┘
                                 │
                          ┌──────▼──────┐
                          │  RESET#=VID │
                          └──────┬──────┘
                                 │
                          ┌──────▼──────┐
                          │  Wait 1us   │
                          └──────┬──────┘
                                 │
                          ╱──────▼──────╲        No    ┌──────────────────┐
                         ╱ First Write   ╲────────────▶│ Temporary Sector │
                         ╲ Cycle=60H     ╱             │ Unprotect Mode   │
                          ╲──────┬──────╱              └──────────────────┘
                              Yes│
                          ┌──────▼──────────┐
                          │ Set up sector   │◀──────────────┐
                          │ address         │               │
                          └──────┬──────────┘               │
                                 │                          │
                          ┌──────▼──────────────┐           │
              ┌──────────▶│ Write 60H to sector │           │
              │           │ address with A6=0,  │           │
              │           │ A1=1, A0=0          │           │
              │           └──────┬──────────────┘           │
              │                  │                          │
              │           ┌──────▼──────┐                   │
              │           │  Wait 150us │                   │
              │           └──────┬──────┘                   │
              │                  │                          │
     ┌────────┴────────┐  ┌──────▼──────────────┐   ┌───────┴────────┐
     │ Increment PLSCNT│  │ Verify sector protect│   │ Reset PLSCNT=1 │
     └────────┬────────┘  │ write 90H with A6=0, │   └────────────────┘
              ▲           │ A1=1, A0=0           │
              │           └──────┬──────────────┘
              │                  │
              │           ┌──────▼──────────┐
              │           │ Read from sector│
              │           │ address         │
              │           └──────┬──────────┘
           No │                  │
      ╱───────┴──────╲     No  ╱─▼────────╲
     ╱  PLSCNT=25?    ╲◀──────╱ Data=01H ? ╲
     ╲                ╱       ╲            ╱
      ╲──────┬───────╱         ╲──────┬───╱
          Yes│                    Yes │
     ┌────────▼────────┐       ╱───────▼──────╲      Yes
     │  Device failed  │      ╱ Protect another╲──────────┘
     └─────────────────┘      ╲   sector?      ╱
                               ╲──────┬───────╱
                                   No │
                          ┌───────────▼───────────┐
                          │ Remove VID from RESET# │
                          └───────────┬───────────┘
                                      │
                          ┌───────────▼───────────┐
                          │  Write reset command  │
                          └───────────┬───────────┘
                                      │
                          ┌───────────▼───────────┐
                          │ Sector protect complete│
                          └───────────────────────┘
```
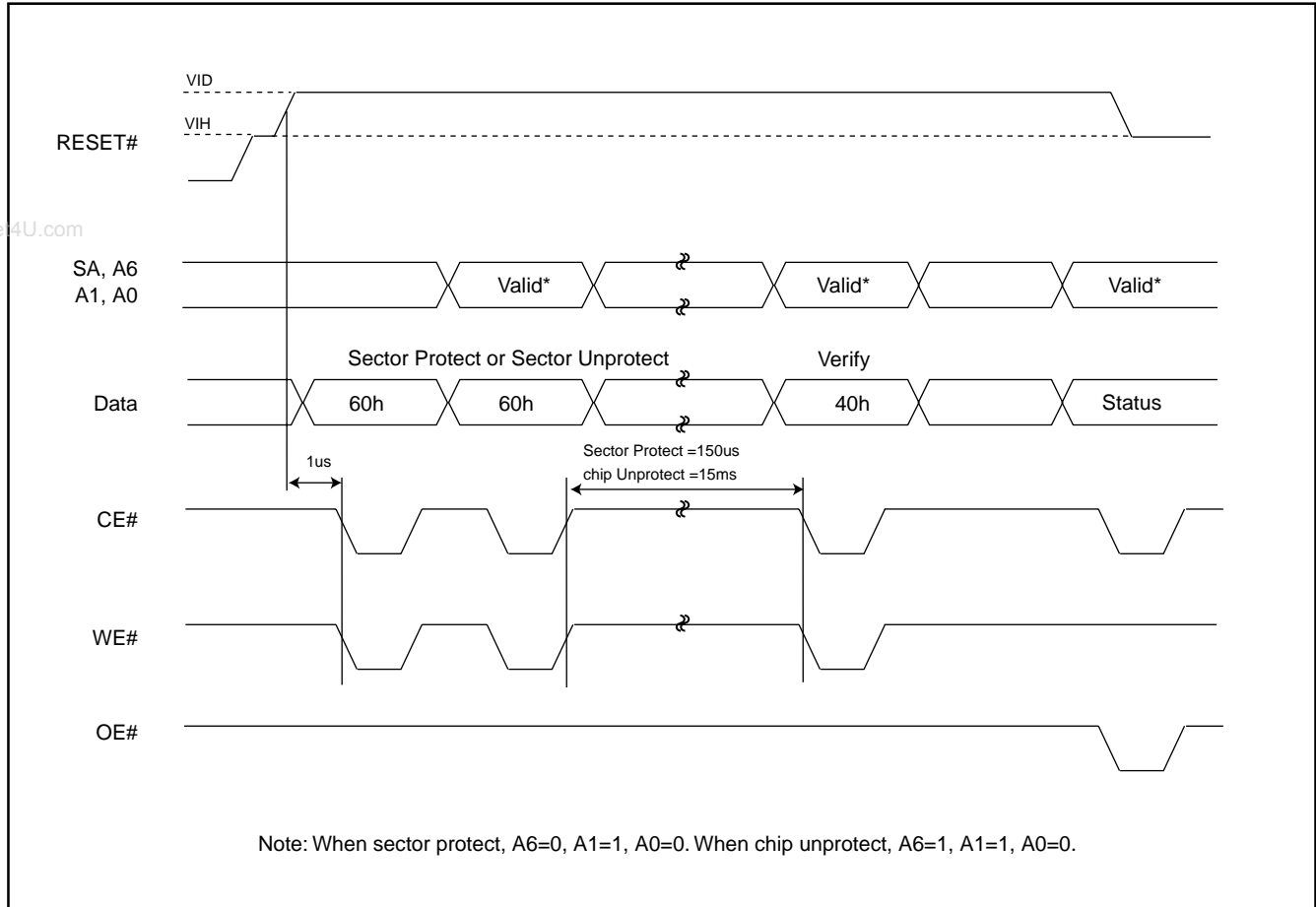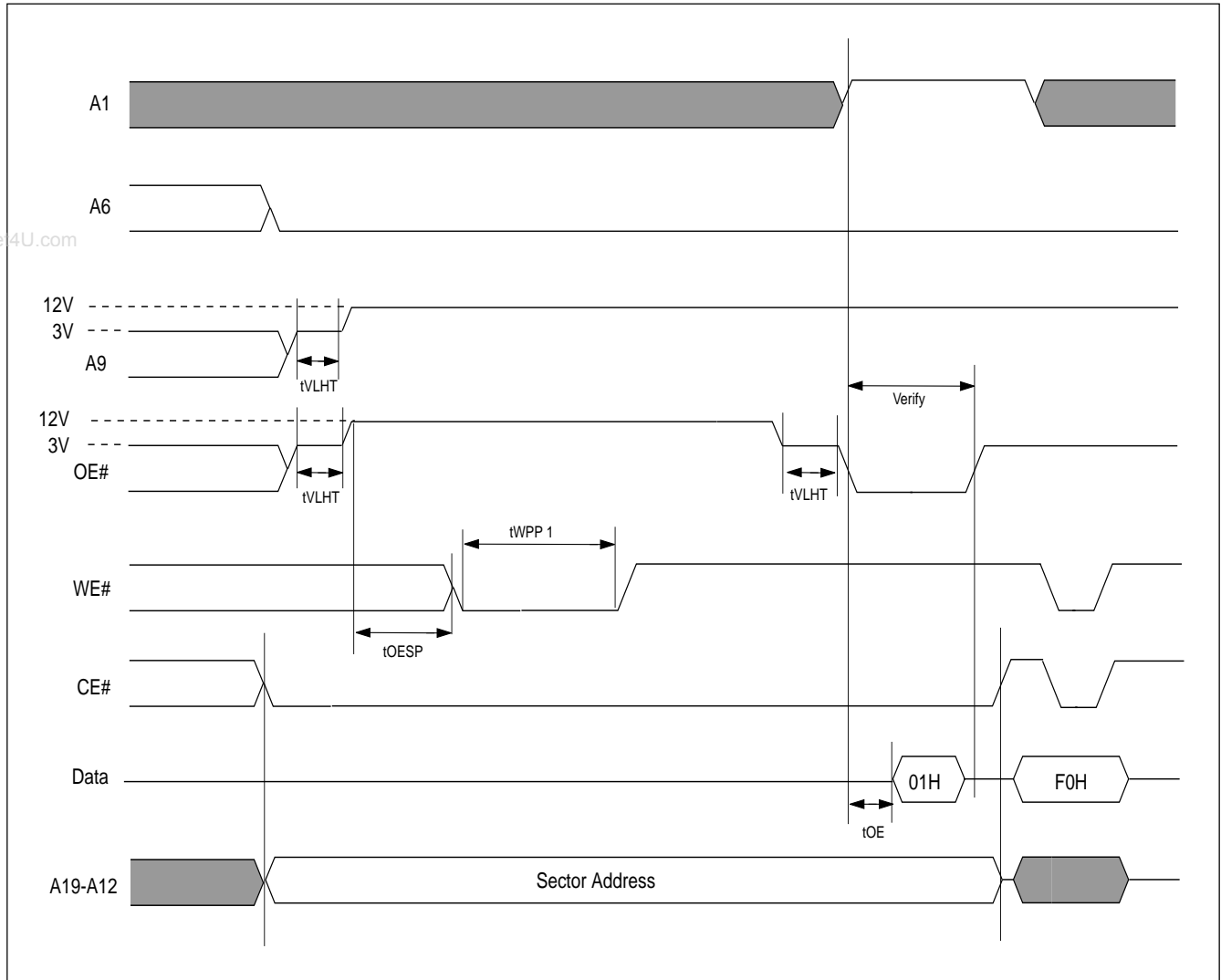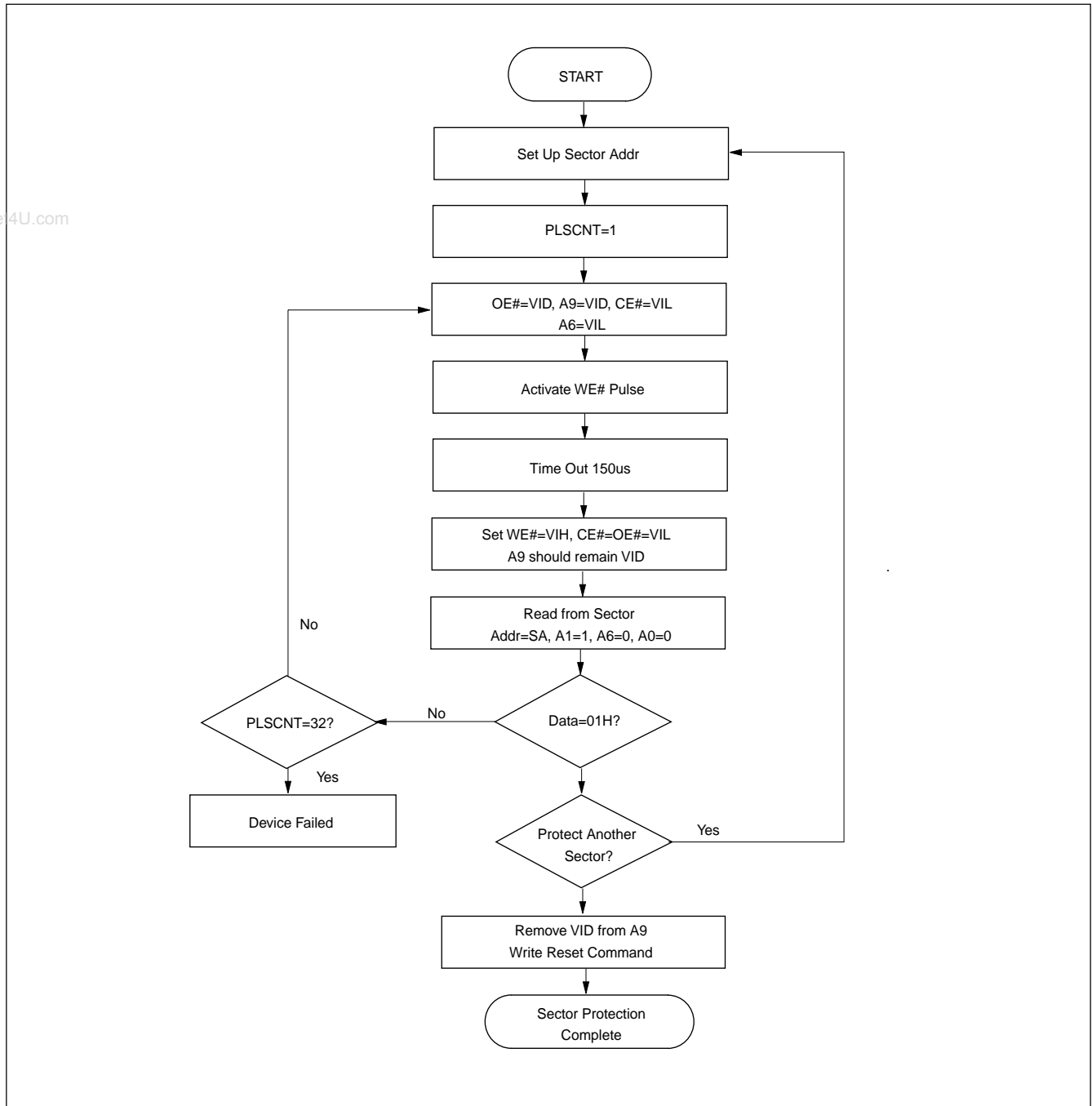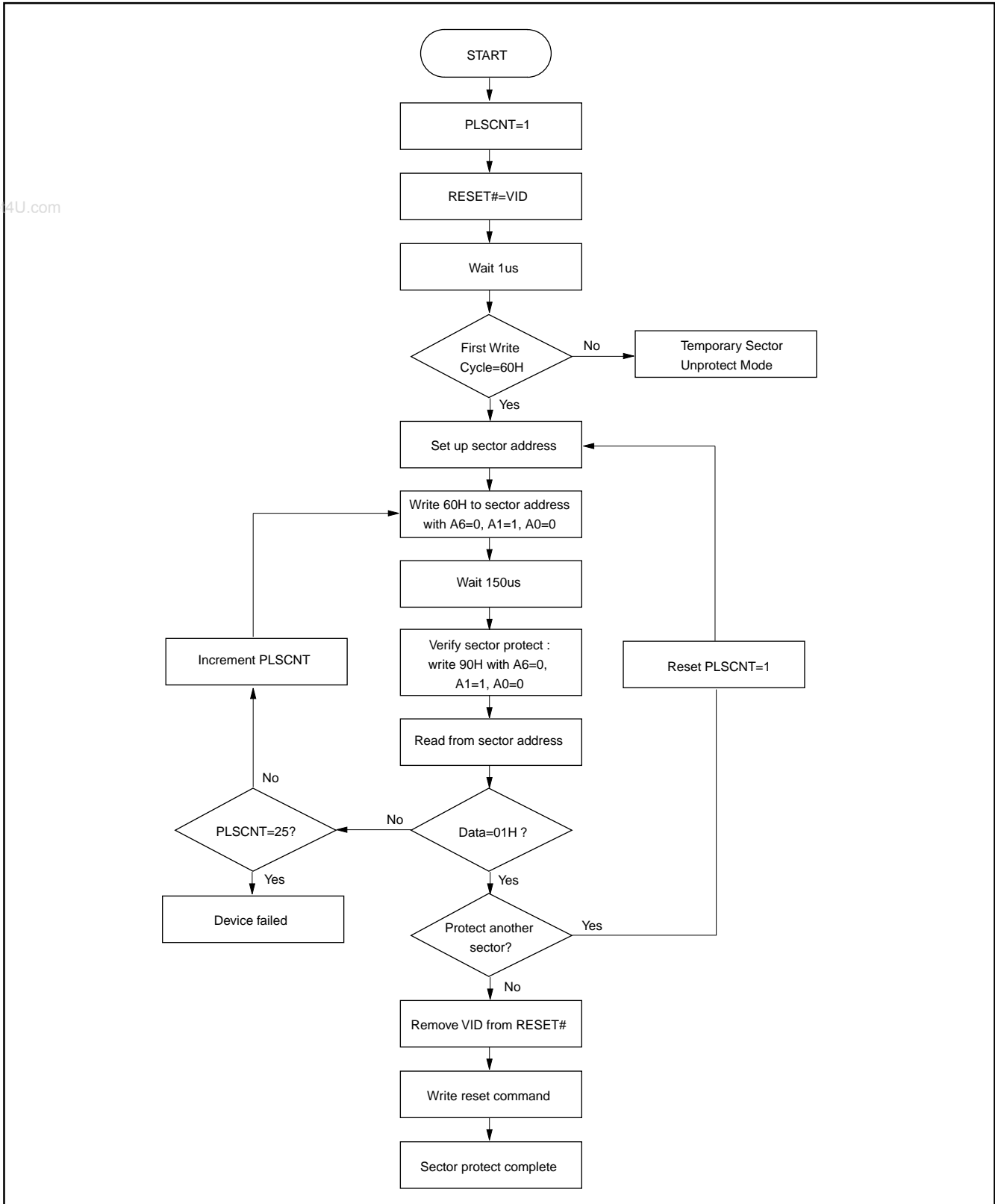
Figure 14. IN-SYSTEM CHIP UNPROTECTION ALGORITHM WITH RESET#=VID

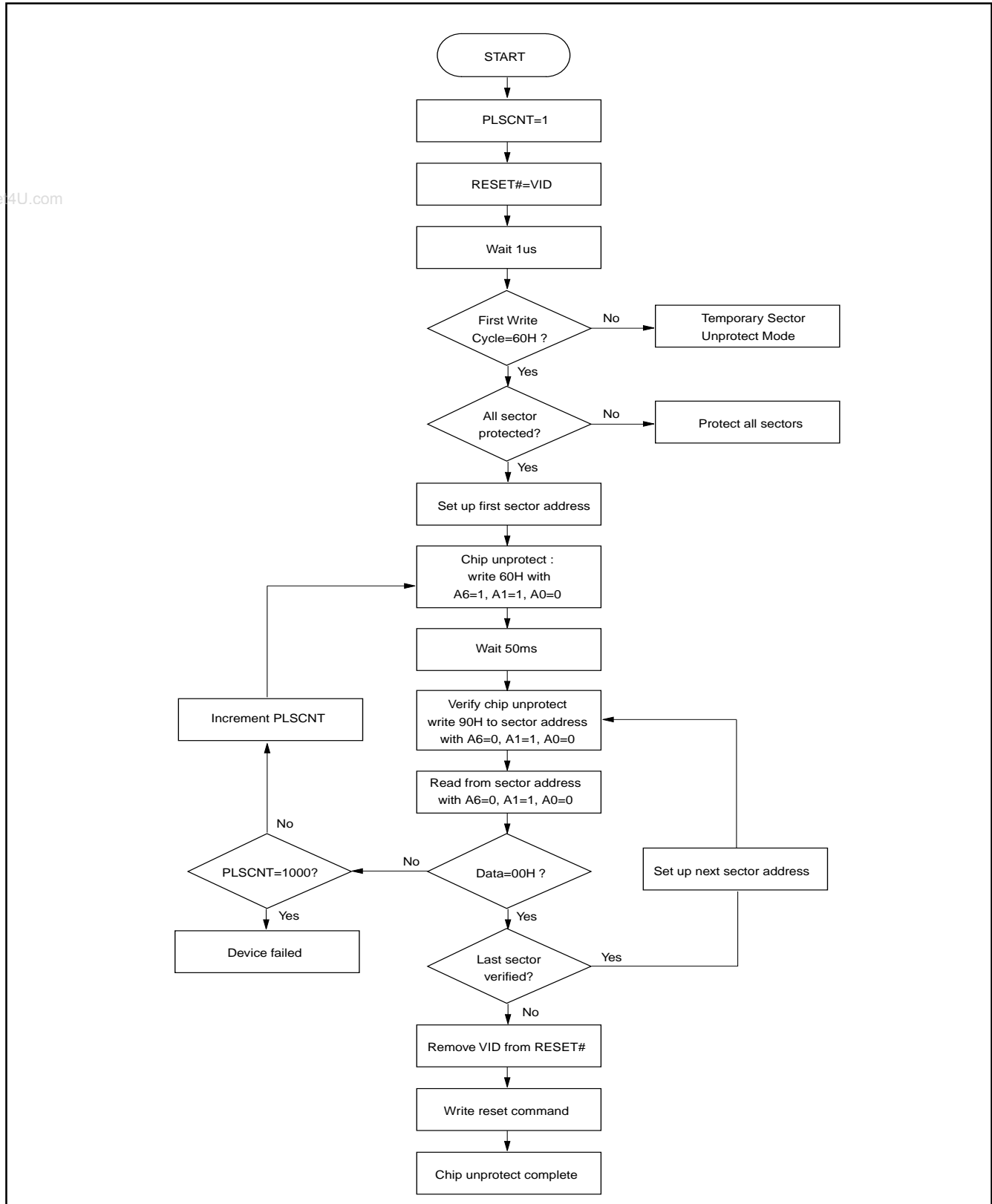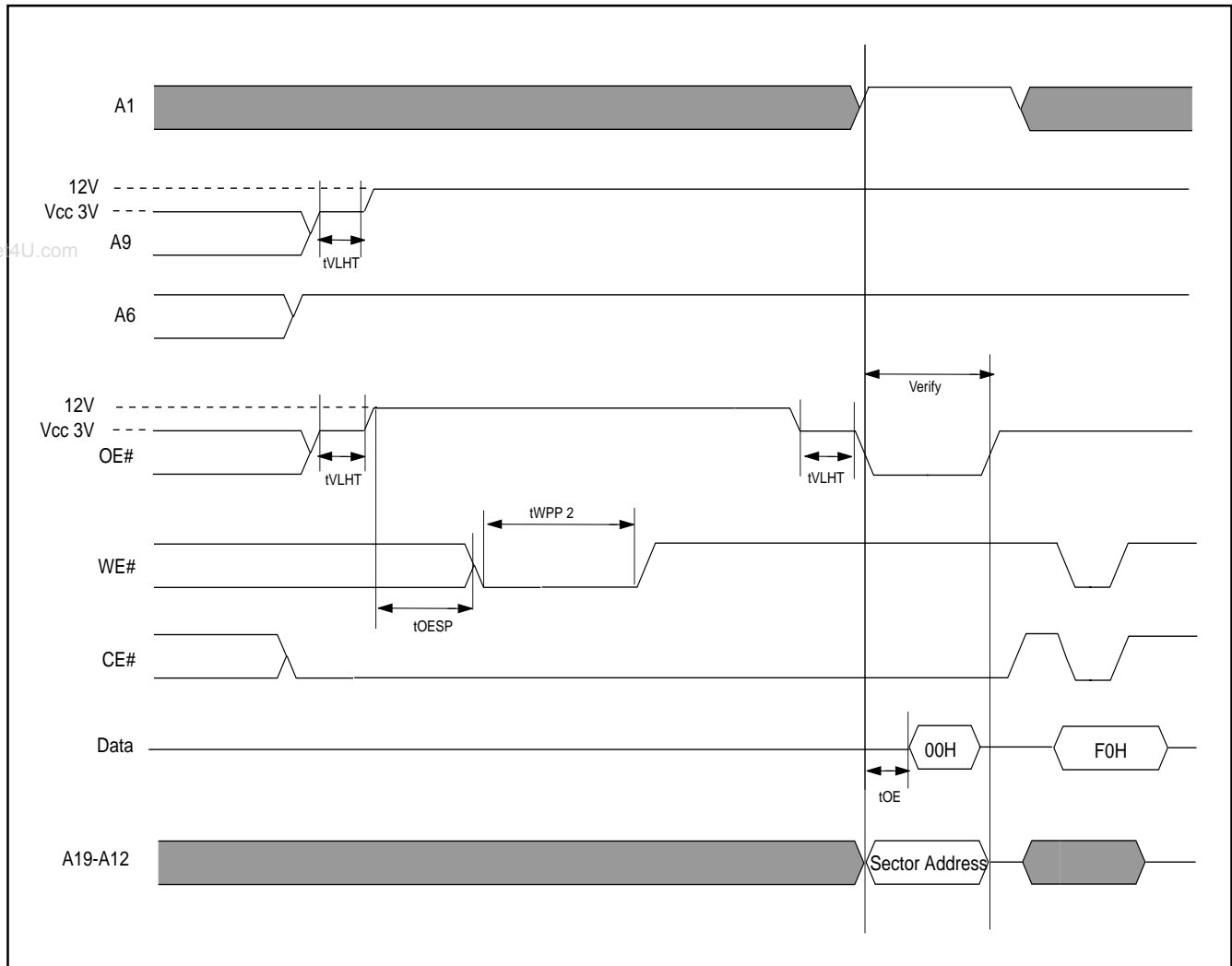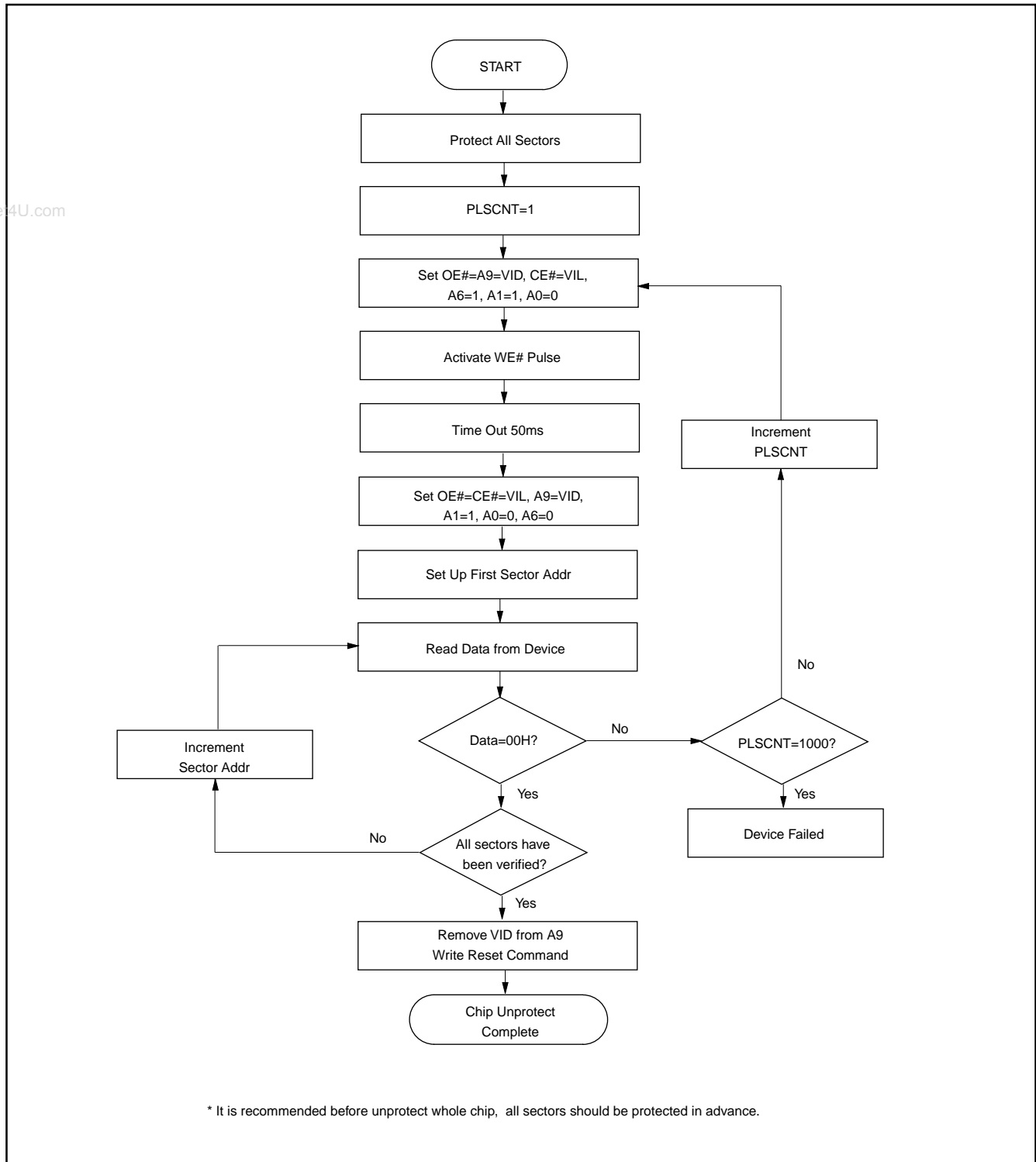**Figure 15. TIMING WAVEFORM FOR CHIP UNPROTECTION (A9, OE# Control)**

Figure 16. CHIP UNPROTECTION ALGORITHM (A9, OE# Control)


```
                        START

                   Protect All Sectors

                      PLSCNT=1

              Set OE#=A9=VID, CE#=VIL,
                  A6=1, A1=1, A0=0

                  Activate WE# Pulse

                   Time Out 50ms            Increment
                                             PLSCNT

              Set OE#=CE#=VIL, A9=VID,
                  A1=1, A0=0, A6=0

                Set Up First Sector Addr

               Read Data from Device                   No

                      Data=00H?    No      PLSCNT=1000?

  Increment                Yes              Yes
  Sector Addr
                   All sectors have       Device Failed
            No     been verified?

                       Yes
              Remove VID from A9
              Write Reset Command

                  Chip Unprotect
                    Complete
```

* It is recommended before unprotect whole chip, all sectors should be protected in advance.

WRITE OPERATION STATUS

FIGURE 17. DATA# POLLING ALGORITHM

NOTE : 1.VA=Valid address for programming
2.Q7 should be re-checked even Q5="1" because Q7 may change simultaneously with Q5.
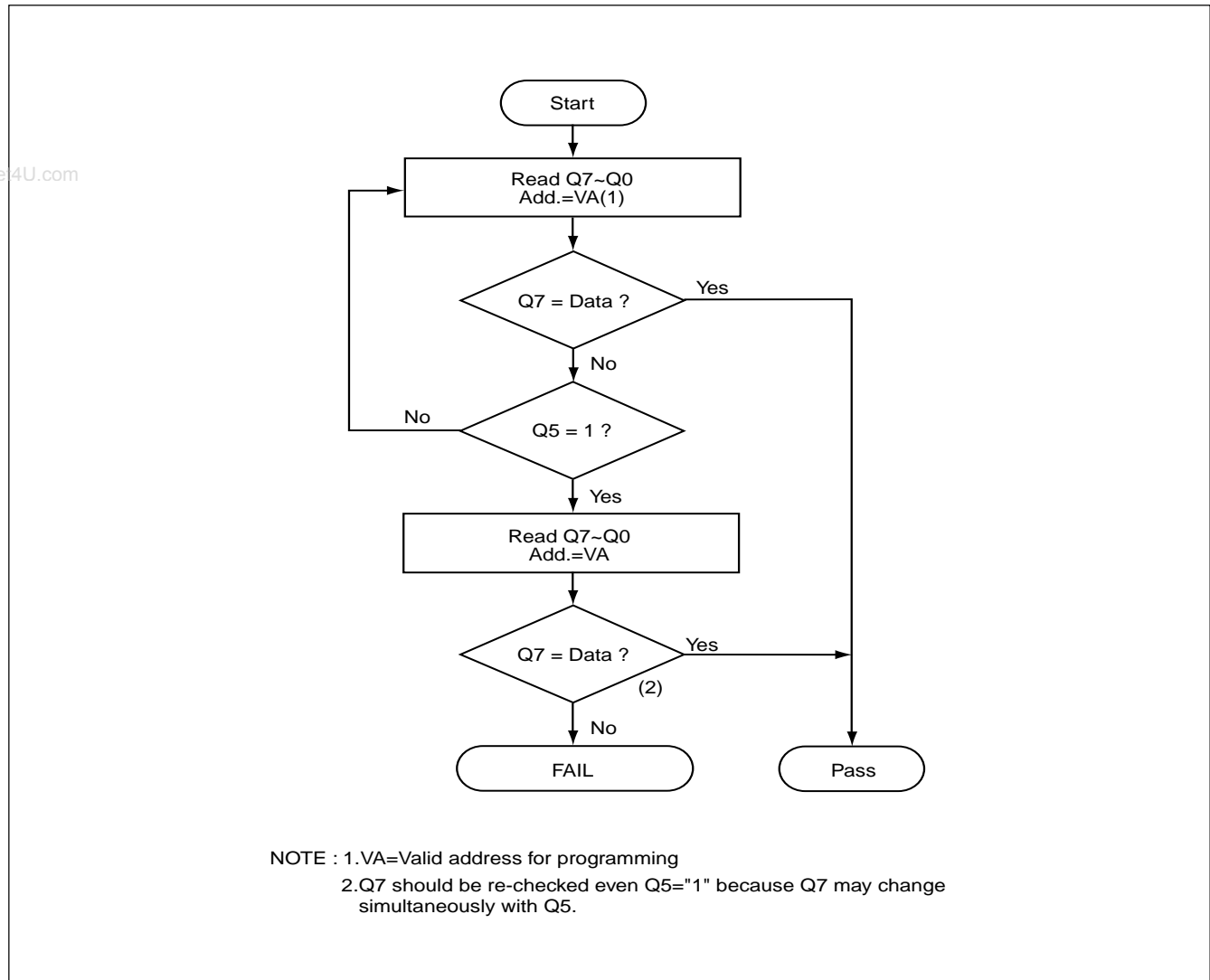
FIGURE 18. TOGGLE BIT ALGORITHM

Note:1.Read toggle bit twice to determine whether or not it is toggling.
2. Recheck toggle bit because it may stop toggling as Q5 change to "1".
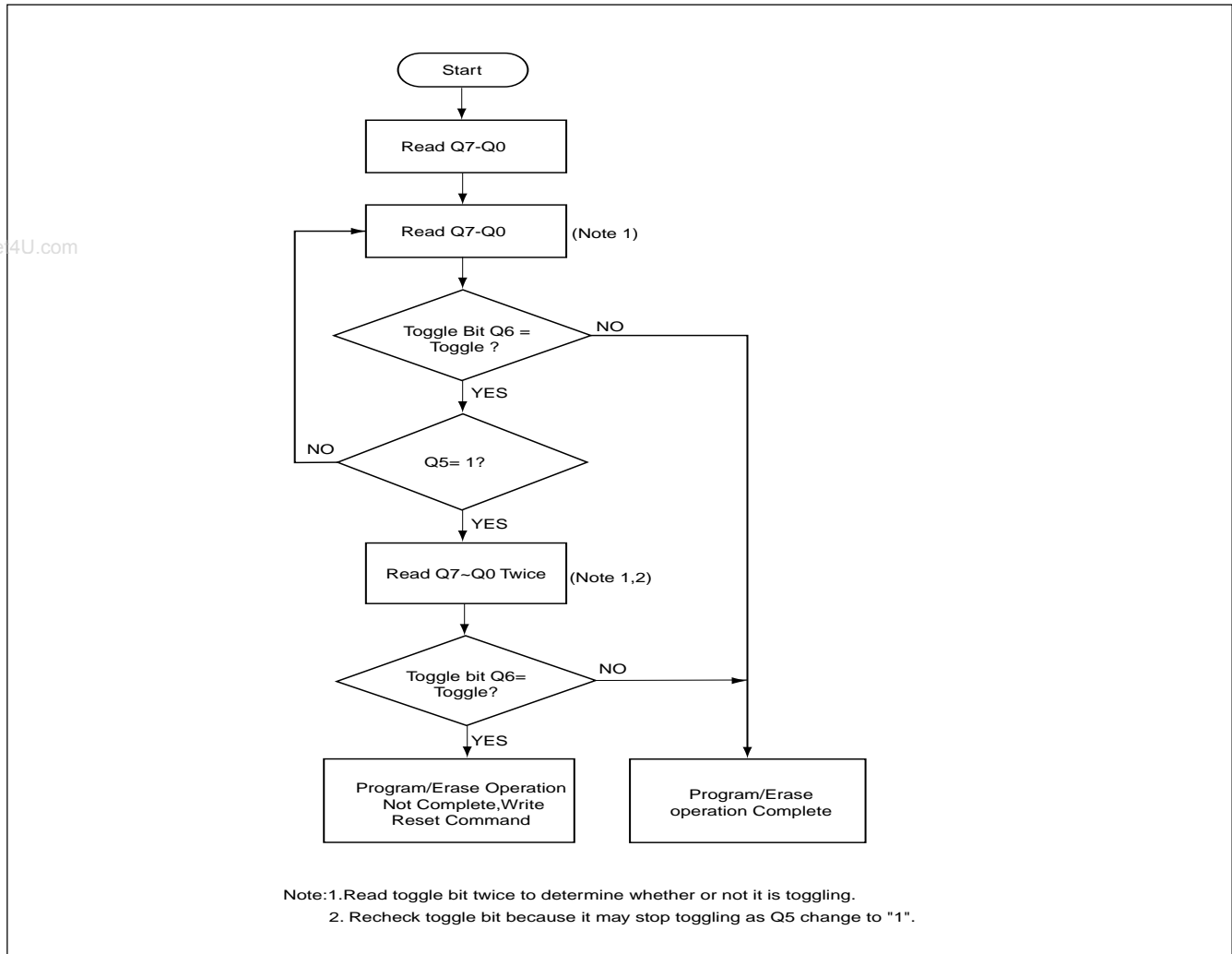
FIGURE 19. Data# Polling Timings (During Automatic Algorithms)
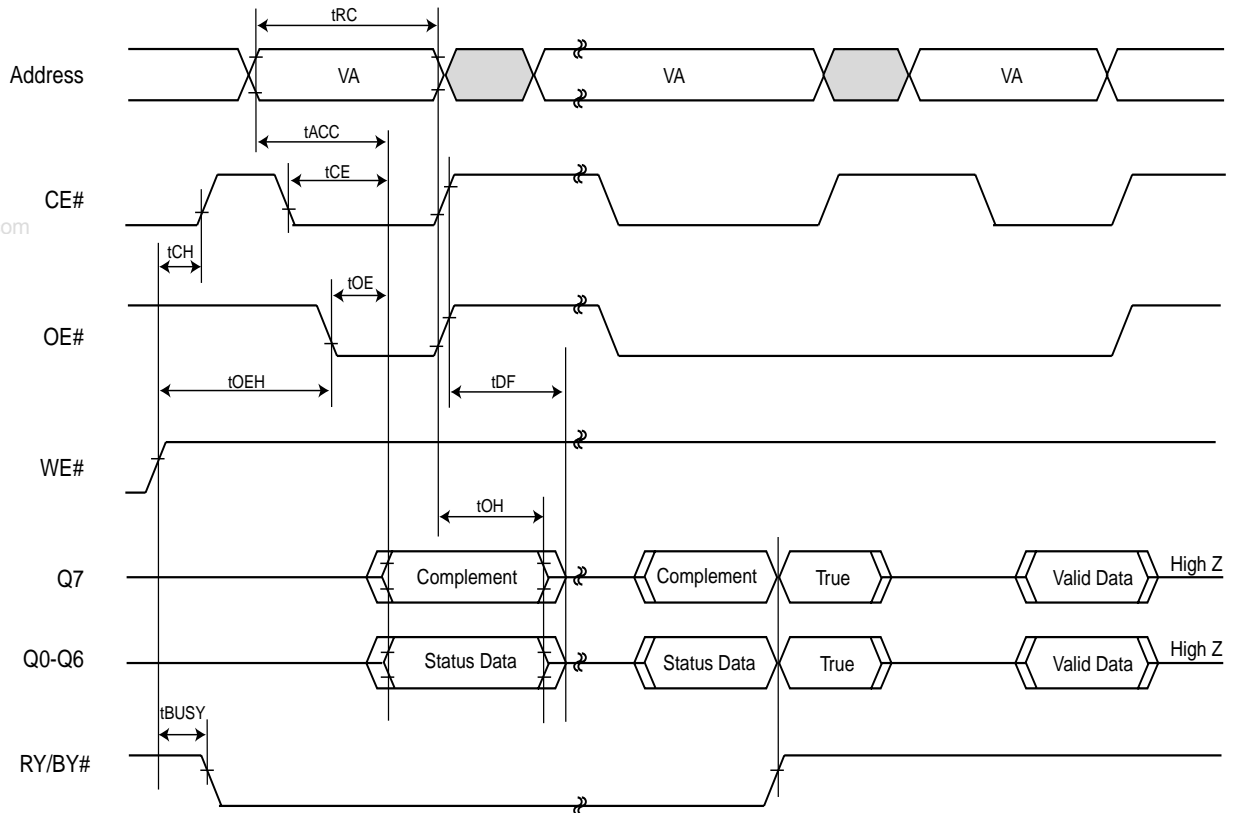
NOTES:

1. VA=Valid address. Figure shows are first status cycle after command sequence, last status read cycle, and array data read cycle.

2. CE# must be toggled when DATA# polling.
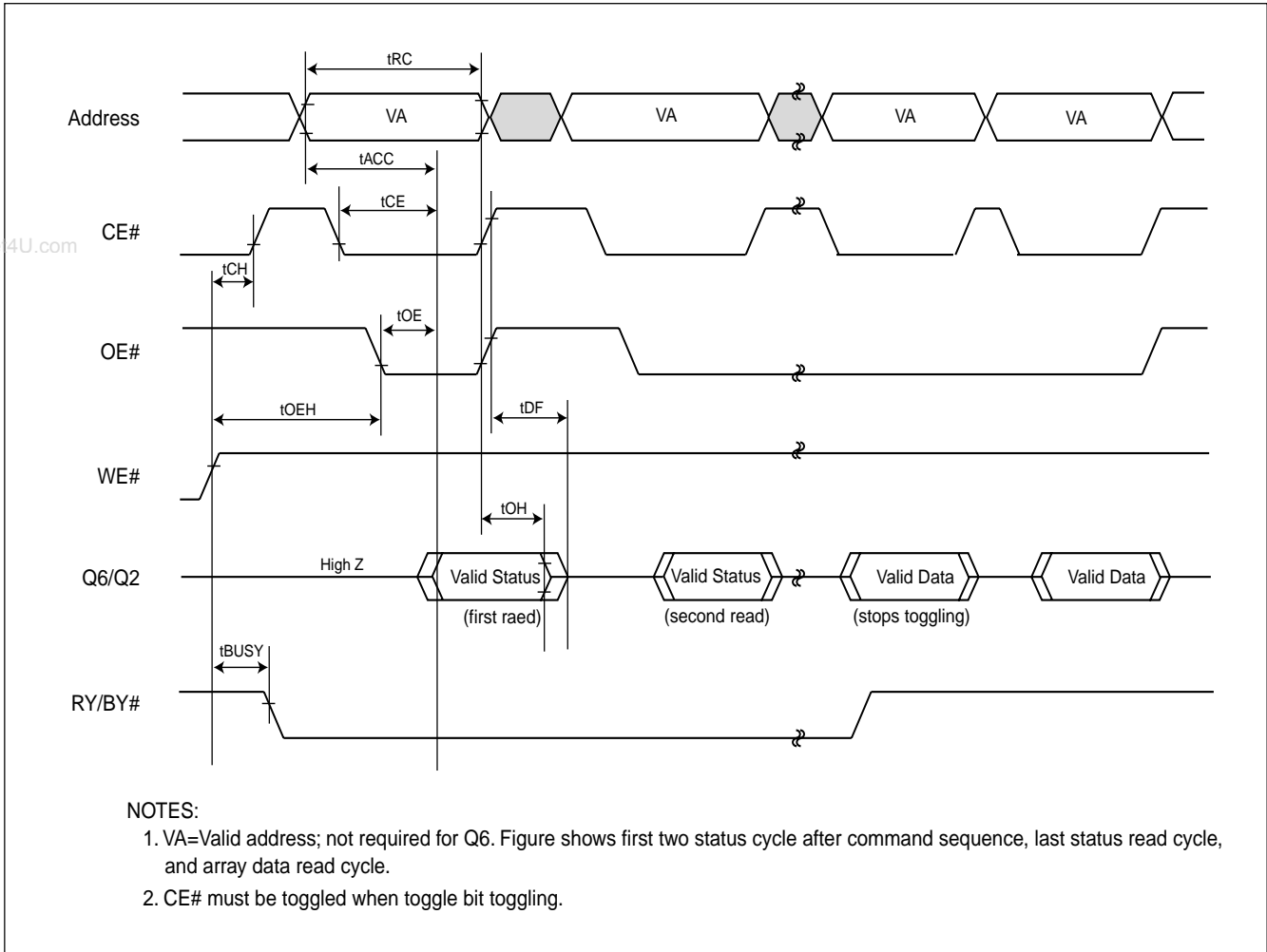
**FIGURE 20. Toggle Bit Timings (During Automatic Algorithms)**

NOTES:
  1. VA=Valid address; not required for Q6. Figure shows first two status cycle after command sequence, last status read cycle, and array data read cycle.
  2. CE# must be toggled when toggle bit toggling.

TABLE 12. AC CHARACTERISTICS

Parameter Std	Description	Test Setup	All Speed Options	Unit
tREADY1	RESET# PIN Low (During Automatic Algorithms) to Read or Write (See Note)	MAX	20	us
tREADY2	RESET# PIN Low (NOT During Automatic Algorithms) to Read or Write (See Note)	MAX	500	ns
tRP	RESET# Pulse Width (During Automatic Algorithms)	MIN	500	ns
tRH	RESET# High Time Before Read (See Note)	MIN	50	ns
tRB	RY/BY# Recovery Time (to CE#, OE# go low)	MIN	0	ns

Note: Not 100% tested

FIGURE 21. RESET# TIMING WAVEFORM

Reset Timing NOT during Automatic Algorithms

Reset Timing during Automatic Algorithms
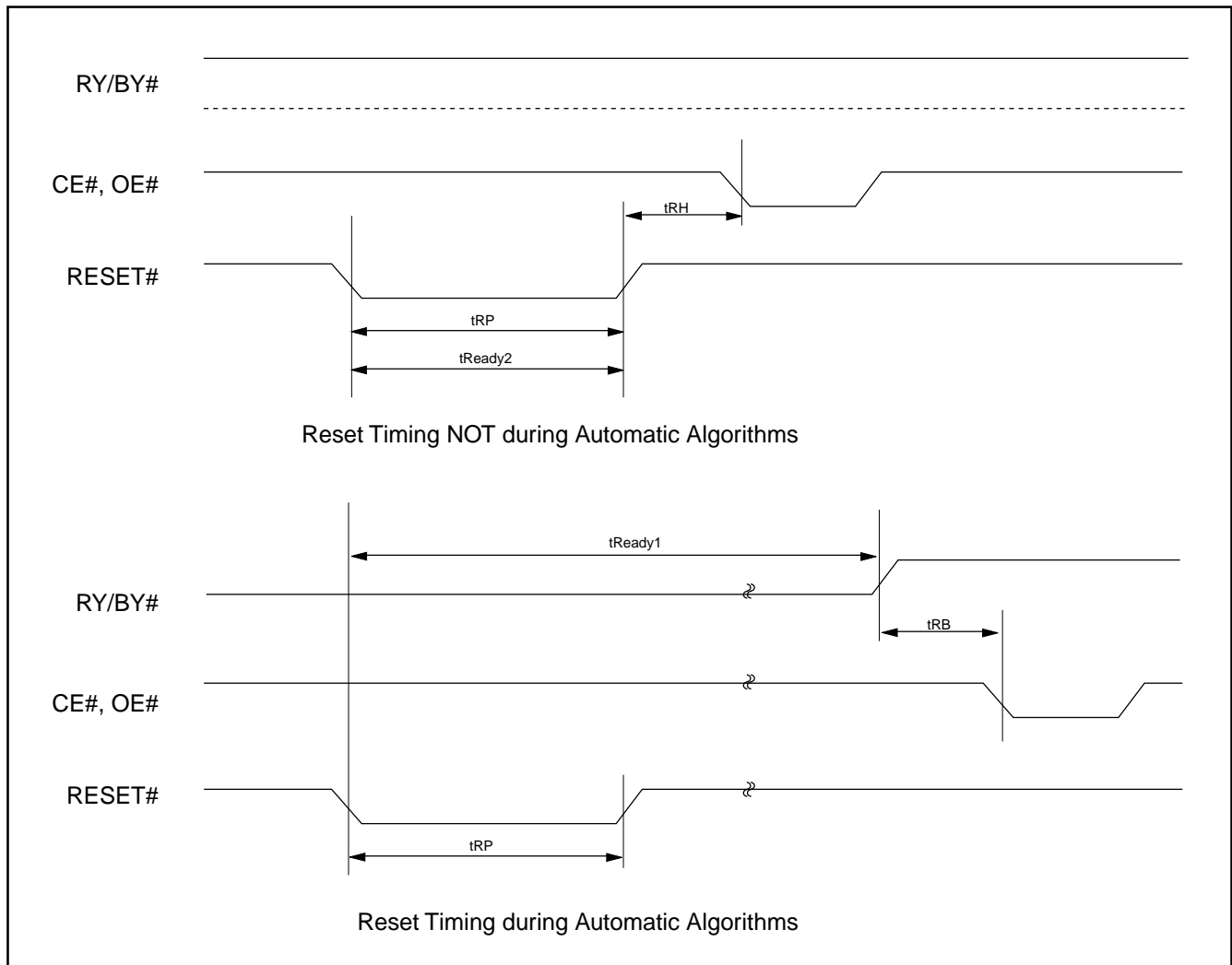
AC CHARACTERISTICS

TABLE 13. WORD/BYTE CONFIGURATION (BYTE#)

Parameter		Description		Speed Options		Unit
JEDEC	Std			-55	-70	
	tELFL/tELFH	CE# to BYTE# Switching Low or High	Max	5		ns
	tFLQZ	BYTE# Switching Low to Output HIGH Z	Max	25	25	ns
	tFHQV	BYTE# Switching High to Output Active	Min	55	70	ns

FIGURE 22.   BYTE# TIMING WAVEFORM FOR READ OPERATIONS (BYTE# switching from byte mode to word mode)
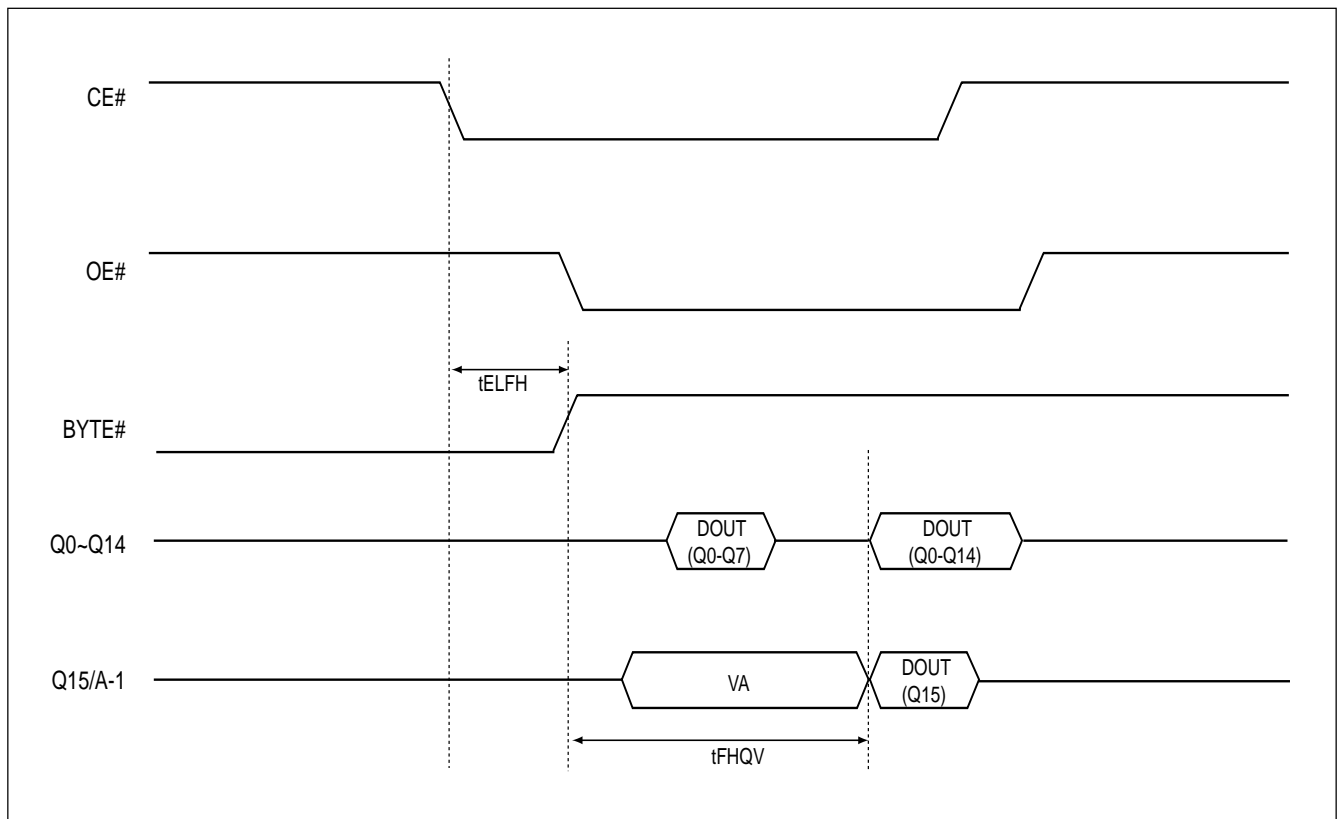
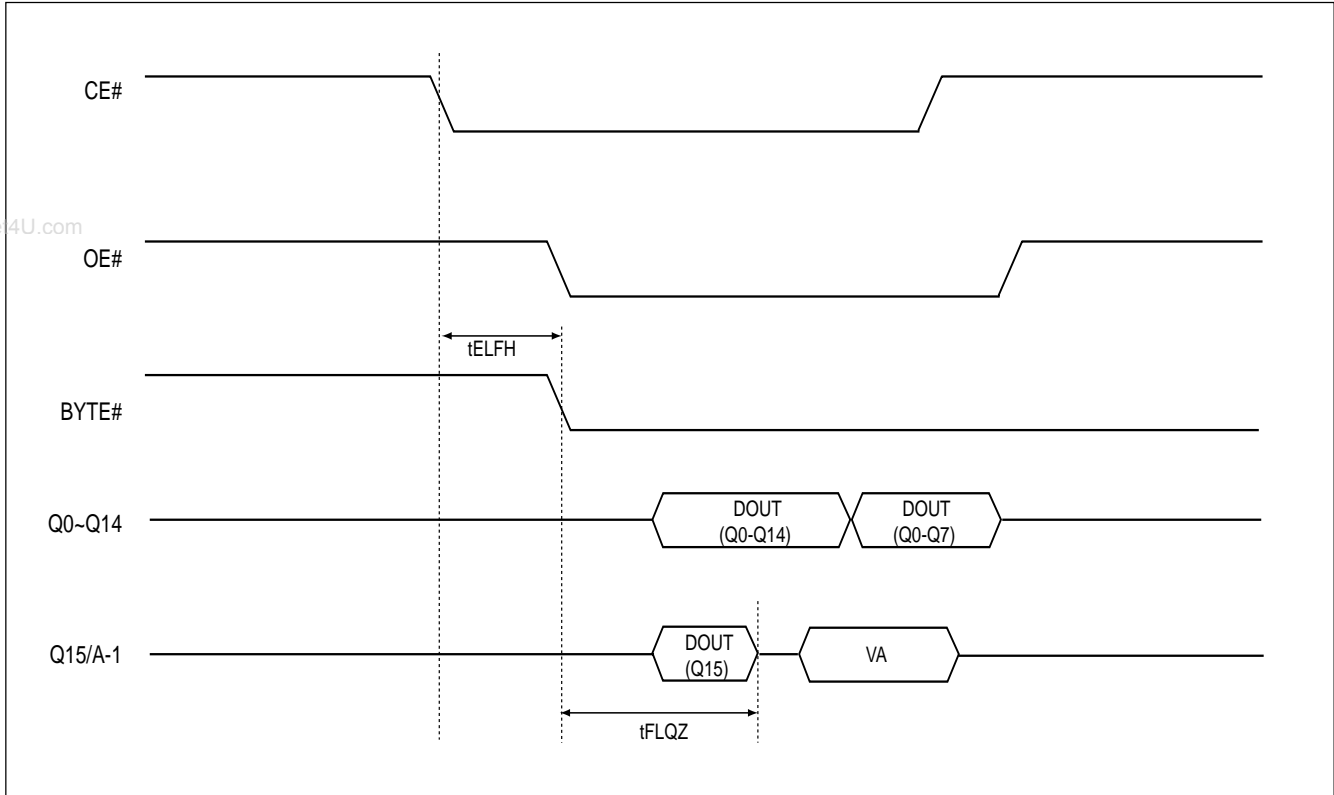## FIGURE 23. BYTE# TIMING WAVEFORM FOR READ OPERATIONS (BYTE# switching from word mode to byte mode)

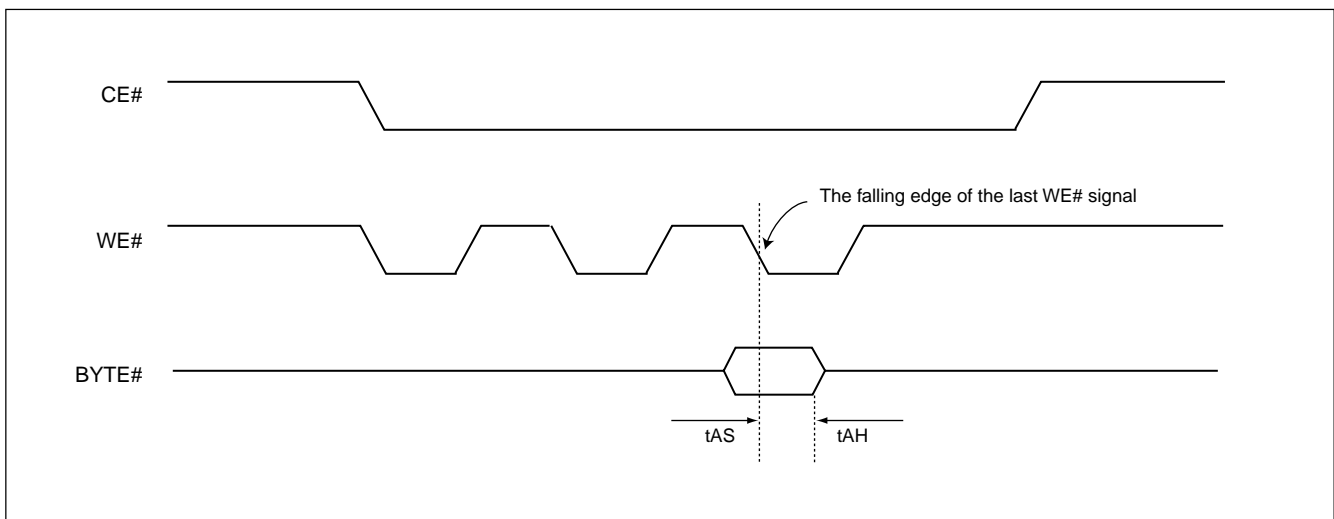## FIGURE 24. BYTE# TIMING WAVEFORM FOR PROGRAM OPERATIONS

Table 14. TEMPORARY SECTOR UNPROTECT

Parameter Std.	Description	Test Setup	All Speed Options	Unit
tVIDR	VID Rise and Fall Time (See Note)	Min	500	ns
tRSP	RESET# Setup Time for Temporary Sector Unprotect	Min	4	us

Note:
Not 100% tested
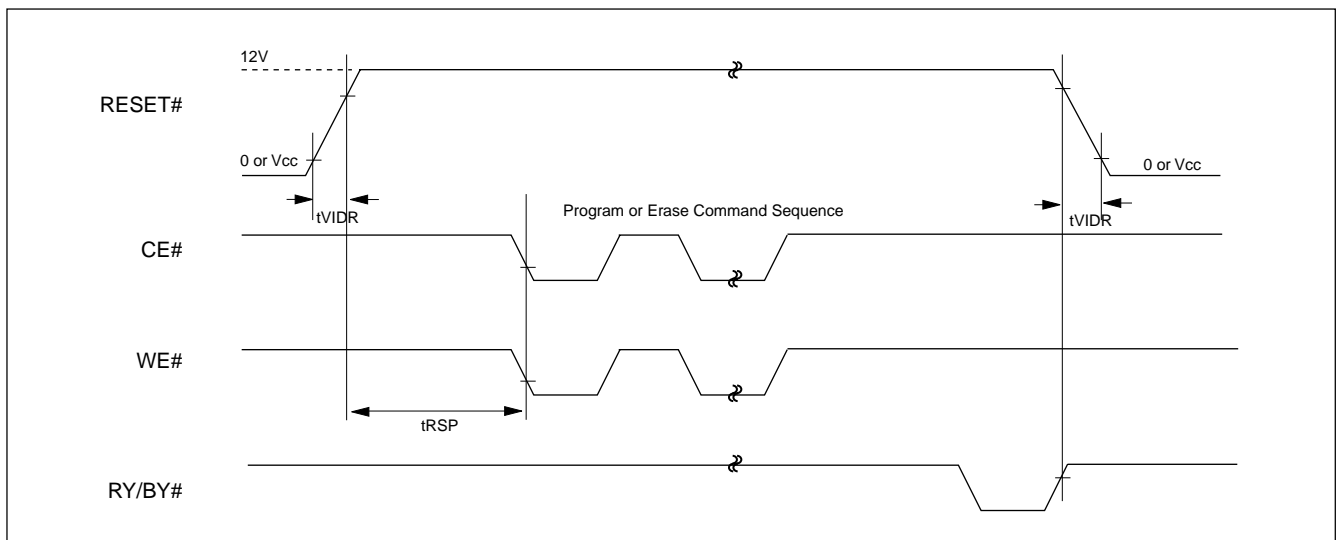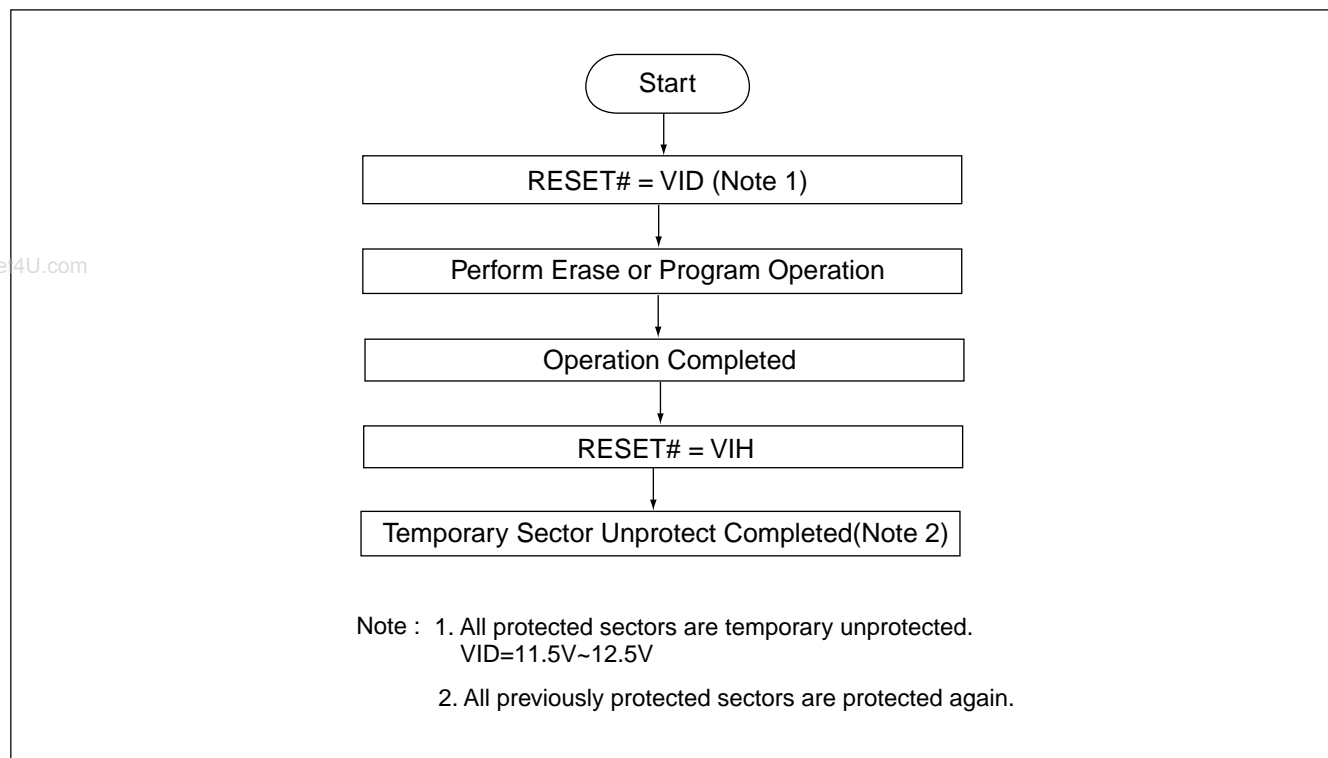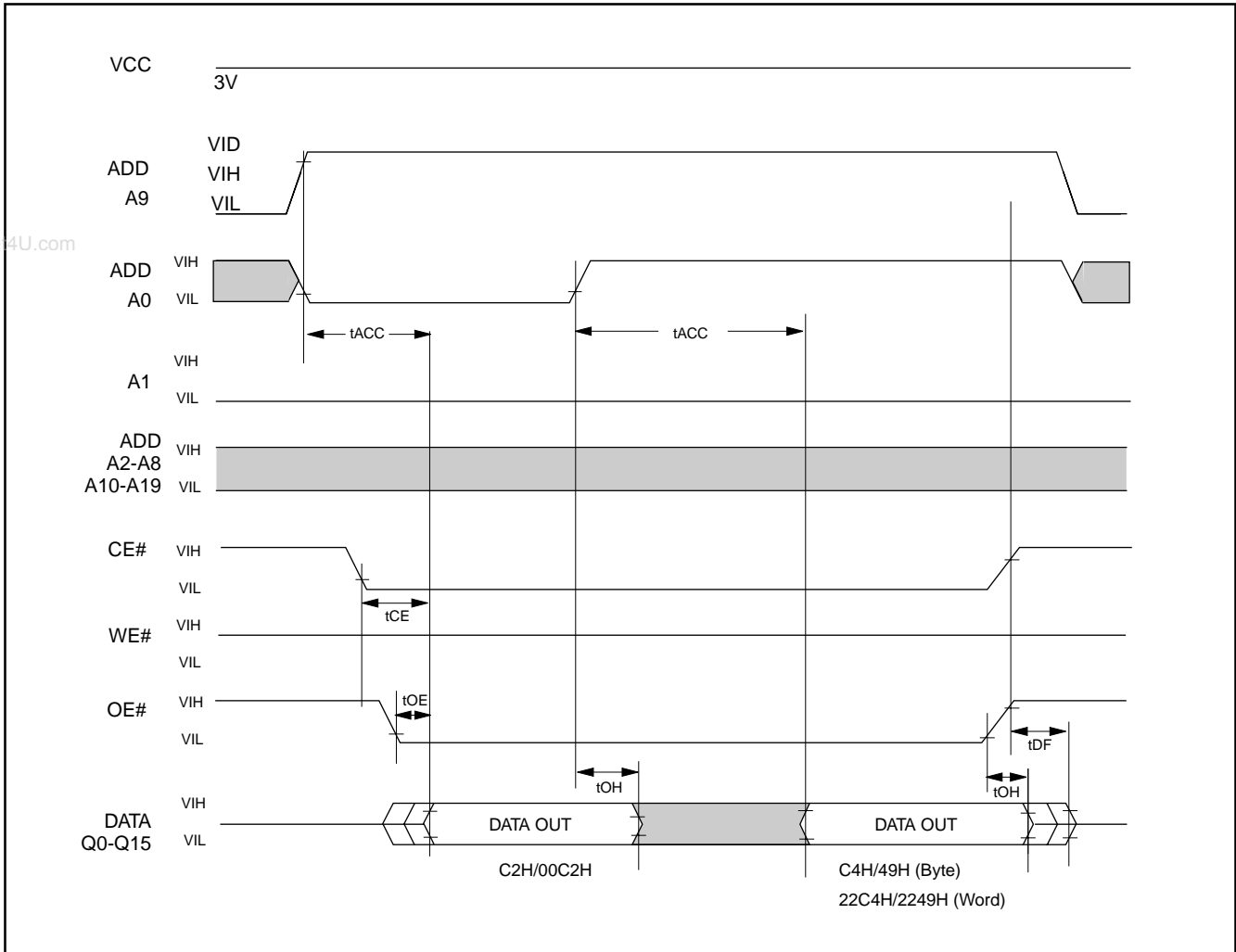
Figure 25. TEMPORARY SECTOR UNPROTECT TIMING DIAGRAM

Figure 26. TEMPORARY SECTOR UNPROTECT ALGORITHM

```
                        ┌──────────────┐
                        │    Start     │
                        └──────┬───────┘
                               │
              ┌────────────────▼────────────────┐
              │      RESET# = VID (Note 1)       │
              └────────────────┬────────────────┘
                               │
              ┌────────────────▼────────────────┐
              │  Perform Erase or Program Operation │
              └────────────────┬────────────────┘
                               │
              ┌────────────────▼────────────────┐
              │      Operation Completed         │
              └────────────────┬────────────────┘
                               │
              ┌────────────────▼────────────────┐
              │         RESET# = VIH             │
              └────────────────┬────────────────┘
                               │
              ┌────────────────▼────────────────┐
              │ Temporary Sector Unprotect Completed(Note 2) │
              └─────────────────────────────────┘
```

Note : 1. All protected sectors are temporary unprotected.
           VID=11.5V~12.5V

        2. All previously protected sectors are protected again.

FIGURE 27. ID CODE READ TIMING WAVEFORM

QUERY COMMAND AND COMMON FLASH

INTERFACE (CFI) MODE

MX26LV160AT/AB is capable of operating in the CFI mode. This mode all the host system to determine the manufacturer of the device such as operating parameters and configuration. Two commands are required in CFI mode. Query command of CFI mode is placed first, then the Reset command exits CFI mode. These are described in Table 15.

The single cycle Query command is valid only when the device is in the Read mode, Standby mode, and Automatic Select mode; however, it is ignored otherwise.

The Reset command exits from the CFI mode to the Read mode, or Automatic Select mode. The command is valid only when the device is in the CFI mode.

Table 15-1. CFI mode: Identification Data Values
(All values in these tables are in hexadecimal)

Description	Address (Byte Mode)	Address (Word Mode)	Data
Query-unique ASCII string "QRY"	20	10	0051
	22	11	0052
	24	12	0059
Primary vendor command set and control interface ID code	26	13	0002
	28	14	0000
Address for primary algorithm extended query table	2A	15	0040
	2C	16	0000
Alternate vendor command set and control interface ID code (none)	2E	17	0000
	30	18	0000
Address for secondary algorithm extended query table (none)	32	19	0000
	34	1A	0000

Table 15-2. CFI Mode: System Interface Data Values
(All values in these tables are in hexadecimal)

Description	Address (Byte Mode)	Address (Word Mode)	Data
VCC supply, minimum (3.0V)	36	1B	0030
VCC supply, maximum (3.6V)	38	1C	0036
VPP supply, minimum (none)	3A	1D	0000
VPP supply, maximum (none)	3C	1E	0000
Typical timeout for single word/byte write (2^N us)	3E	1F	0004
Typical timeout for Minimum size buffer write (2^N us) (not supported)	40	20	0000
Typical timeout for individual sector erase (2^N ms)	42	21	000A
Typical timeout for full chip erase (2^N ms)	44	22	0000
Maximum timeout for single word/byte write times (2^N X Typ)	46	23	0005
Maximum timeout for buffer write times (2^N X Typ)	48	24	0000
Maximum timeout for individual sector erase times (2^N X Typ)	4A	25	0004
Maximum timeout for full chip erase times (not supported)	4C	26	0000

Table 15-3. CFI Mode: Device Geometry Data Values
(All values in these tables are in hexadecimal)

Description	Address (Byte Mode)	Address (Word Mode)	Data
Device size (2^N bytes)	4E	27	0015
Flash device interface code (x8/x16 async.)	50	28	0002
	52	29	0000
Maximum number of bytes in multi-byte write (not supported)	54	2A	0000
	56	2B	0000
Number of erase sector regions	58	2C	0004
Erase sector region 1 information (refer to the CFI publication 100)	5A	2D	0000
	5C	2E	0000
	5E	2F	0040
	60	30	0000
Erase sector region 2 information	62	31	0001
	64	32	0000
	66	33	0020
	68	34	0000
Erase sector region 3 information	6A	35	0000
	6C	36	0000
	6E	37	0080
	70	38	0000
Erase sector region 4 information	72	39	001E
	74	3A	0000
	76	3B	0000
	78	3C	0001

Table 15-4. CFI Mode: Primary Vendor-Specific Extended Query Data Values
(All values in these tables are in hexadecimal)

Description	Address (Byte Mode)	Address (Word Mode)	Data
Query-unique ASCII string "PRI"	80	40	0050
	82	41	0052
	84	42	0049
Major version number, ASCII	86	43	0031
Minor version number, ASCII	88	44	0030
Address sensitive unlock (0=required, 1= not required)	8A	45	0000
Erase suspend (0=not supported)	8C	46	0000
Sector protect (0=not supported)	8E	47	0000
Temporary sector unprotect (0=not supported)	90	48	0000
Sector protect/chip unprotect scheme (0=not supported)	92	49	0004
Simultaneous R/W operation (0=not supported)	94	4A	0000
Burst mode type (0=not supported)	96	4B	0000
Page mode type (0=not supported)	98	4C	0000

TABLE 16. ERASE AND PROGRAMMING PERFORMANCE (1)

PARAMETER	LIMITS			UNITS
	MIN.	TYP. (2)	MAX. (3)	
Sector Erase Time		2.4	15	sec
Chip Erase Time		80	320	sec
Byte Programming Time		55	220	us
Word Programming Time		70	280	us
Chip Programming Time (Word/Byte Mode)		70	140	sec
Erase/Program Cycles	2K (6)			Cycles

Note:
1. Not 100% tested.
2. Typical program and erase times assume the following conditions : 25° C, 3.3V VCC. Programming spec. assume that all bits are programmed to checkerboard pattern.
3. Maximum values are measured at VCC=3.0V, worst case temperature. Maximum values are up to including 2K program/erase cycles.
4. System-level overhead is the time required to execute the command sequences for the all program command.
5. Excludes 00H programming prior to erasure. (In the pre-programming step of the embedded erase algorithm, all bits are programmed to 00H before erasure)
6. Min. erase/program cycles is under : 3.3V VCC, 25° C, checkerboard pattern conditions, and without baking process.

TABLE 17. LATCH-UP CHARACTERISTICS

	MIN.	MAX.
Input Voltage with respect to GND on ACC, OE#, RESET#, A9	-1.0V	12V
Input Voltage with respect to GND on all power pins, Address pins, CE# and WE#	-1.0V	VCC + 1.0V
Input Voltage with respect to GND on all I/O pins	-1.0V	VCC + 1.0V
Current	-100mA	+100mA
Includes all pins except VCC. Test conditions: VCC = 3.0V, one pin at a time.		

ORDERING INFORMATION

PART NO.	ACCESS TIME (ns)	OPERATING Current MAX. (mA)	STANDBY Current MAX. (uA)	PACKAGE	Remark
MX26LV160ATMC-55	55	30	100	44 Pin SOP	
MX26LV160ATMC-70	70	30	100	44 Pin SOP	
MX26LV160ABMC-55	55	30	100	44 Pin SOP	
MX26LV160ABMC-70	70	30	100	44 Pin SOP	
MX26LV160ATTC-55	55	30	100	48 Pin TSOP (Normal Type)	
MX26LV160ABTC-55	55	30	100	48 Pin TSOP (Normal Type)	
MX26LV160ATTC-70	70	30	100	48 Pin TSOP (Normal Type)	
MX26LV160ABTC-70	70	30	100	48 Pin TSOP (Normal Type)	
MX26LV160ATXBC-55	55	30	100	48 Ball CSP (Ball size:0.3mm)	
MX26LV160ABXBC-55	55	30	100	48 Ball CSP (Ball size:0.3mm)	
MX26LV160ATXBC-70	70	30	100	48 Ball CSP (Ball size:0.3mm)	
MX26LV160ABXBC-70	70	30	100	48 Ball CSP (Ball size:0.3mm)	
MX26LV160ATXEC-55	55	30	100	48 Ball CSP (Ball size:0.4mm)	
MX26LV160ABXEC-55	55	30	100	48 Ball CSP (Ball size:0.4mm)	
MX26LV160ATXEC-70	70	30	100	48 Ball CSP (Ball size:0.4mm)	
MX26LV160ABXEC-70	70	30	100	48 Ball CSP (Ball size:0.4mm)	
MX26LV160ATMC-55G	55	30	100	44 Pin SOP	Pb-free
MX26LV160ATMC-70G	70	30	100	44 Pin SOP	Pb-free
MX26LV160ABMC-55G	55	30	100	44 Pin SOP	Pb-free
MX26LV160ABMC-70G	70	30	100	44 Pin SOP	Pb-free
MX26LV160ATTC-55G	55	30	100	48 Pin TSOP (Normal Type)	Pb-free
MX26LV160ABTC-55G	55	30	100	48 Pin TSOP (Normal Type)	Pb-free
MX26LV160ATTC-70G	70	30	100	48 Pin TSOP (Normal Type)	Pb-free
MX26LV160ABTC-70G	70	30	100	48 Pin TSOP (Normal Type)	Pb-free

PART NO.	ACCESS TIME (ns)	OPERATING Current MAX. (mA)	STANDBY Current MAX. (uA)	PACKAGE	Remark
MX26LV160ATXBC-55G	55	30	100	48 Ball CSP (Ball size:0.3mm)	Pb-free
MX26LV160ABXBC-55G	55	30	100	48 Ball CSP (Ball size:0.3mm)	Pb-free
MX26LV160ATXBC-70G	70	30	100	48 Ball CSP (Ball size:0.3mm)	Pb-free
MX26LV160ABXBC-70G	70	30	100	48 Ball CSP (Ball size:0.3mm)	Pb-free
MX26LV160ATXEC-55G	55	30	100	48 Ball CSP (Ball size:0.4mm)	Pb-free
MX26LV160ABXEC-55G	55	30	100	48 Ball CSP (Ball size:0.4mm)	Pb-free
MX26LV160ATXEC-70G	70	30	100	48 Ball CSP (Ball size:0.4mm)	Pb-free
MX26LV160ABXEC-70G	70	30	100	48 Ball CSP (Ball size:0.4mm)	Pb-free

PACKAGE INFORMATION

Title: Package Outline for SOP 44L (500MIL)
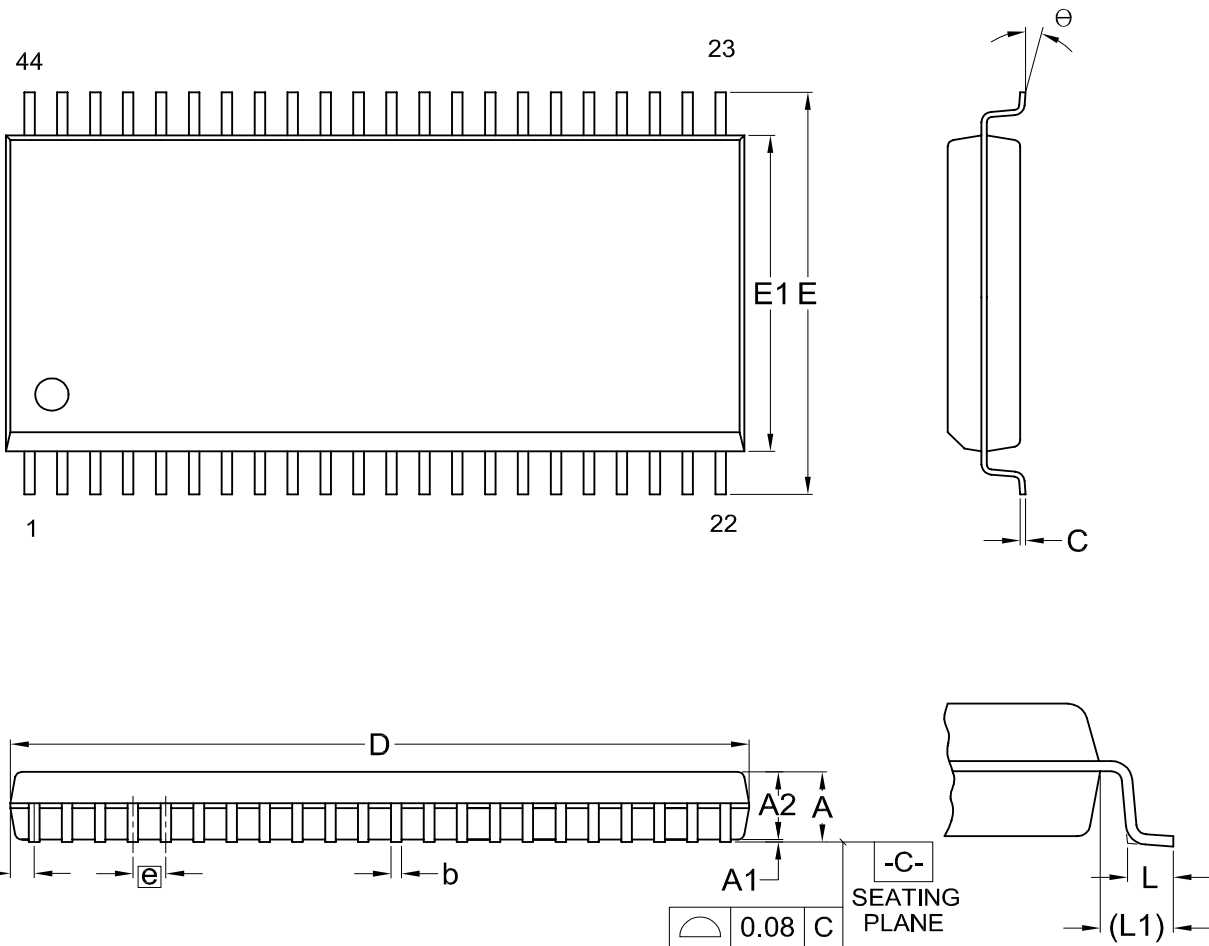
Dimensions (inch dimensions are derived from the original mm dimensions)

UNIT	SYMBOL	A	A1	A2	b	C	D	E	E1	e	L	L1	S	Θ
mm	Min.	---	0.10	2.59	0.36	0.15	28.37	15.83	12.47		0.56	1.51	0.78	0
	Nom.	---	0.15	2.69	0.41	0.20	28.50	16.03	12.60	1.27	0.76	1.71	0.91	5
	Max.	3.00	0.20	2.80	0.51	0.25	28.63	16.23	12.73		0.96	1.91	1.04	10
Inch	Min.	---	0.004	0.102	0.014	0.006	1.117	0.623	0.491		0.022	0.059	0.031	0
	Nom.	---	0.006	0.106	0.016	0.008	1.122	0.631	0.496	0.050	0.030	0.067	0.036	5
	Max.	0.118	0.008	0.110	0.020	0.010	1.127	0.639	0.501		0.038	0.075	0.041	10

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-1405	6	MO-175			11-26-'03

Title: Package Outline for TSOP(I) 48L (12X20mm)NORMAL FORM
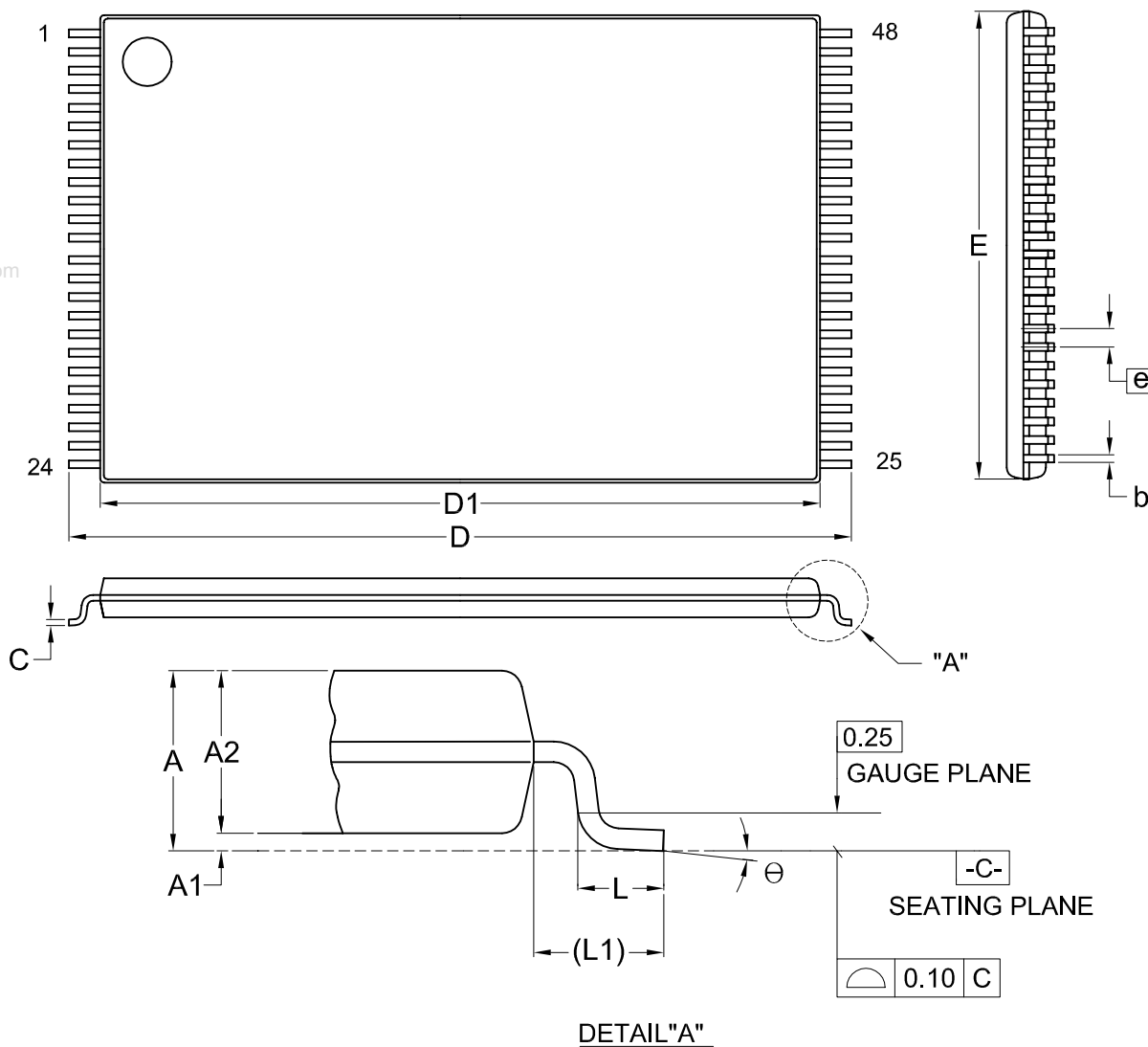
DETAIL"A"

Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL UNIT		A	A1	A2	b	C	D	D1	E	e	L	L1	Θ
mm	Min.	---	0.05	0.95	0.17	0.10	19.80	18.30	11.90		0.50	0.70	0
	Nom.	---	0.10	1.00	0.20	0.13	20.00	18.40	12.00	0.50	0.60	0.80	5
	Max.	1.20	0.15	1.05	0.27	0.21	20.20	18.50	12.10		0.70	0.90	8
Inch	Min.	---	0.002	0.037	0.007	0.004	0.780	0.720	0.469		0.020	0.028	0
	Nom.	---	0.004	0.039	0.008	0.005	0.787	0.724	0.472	0.020	0.024	0.031	5
	Max.	0.047	0.006	0.041	0.011	0.008	0.795	0.728	0.476		0.028	0.035	8

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-1607	7	MO-142			12-01-'03

48-Ball CSP (for MX26LV160ATXBC/ATXBI/ABXBC/ABXBI)

Title: Package Outline for CSP 48BALL(6X8X1.2MM,BALL PITCH 0.8MM,BALL DIAMETER 0.3MM)

TOP VIEW

BOTTOM VIEW
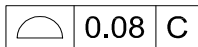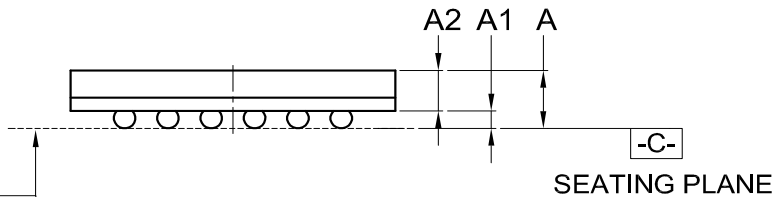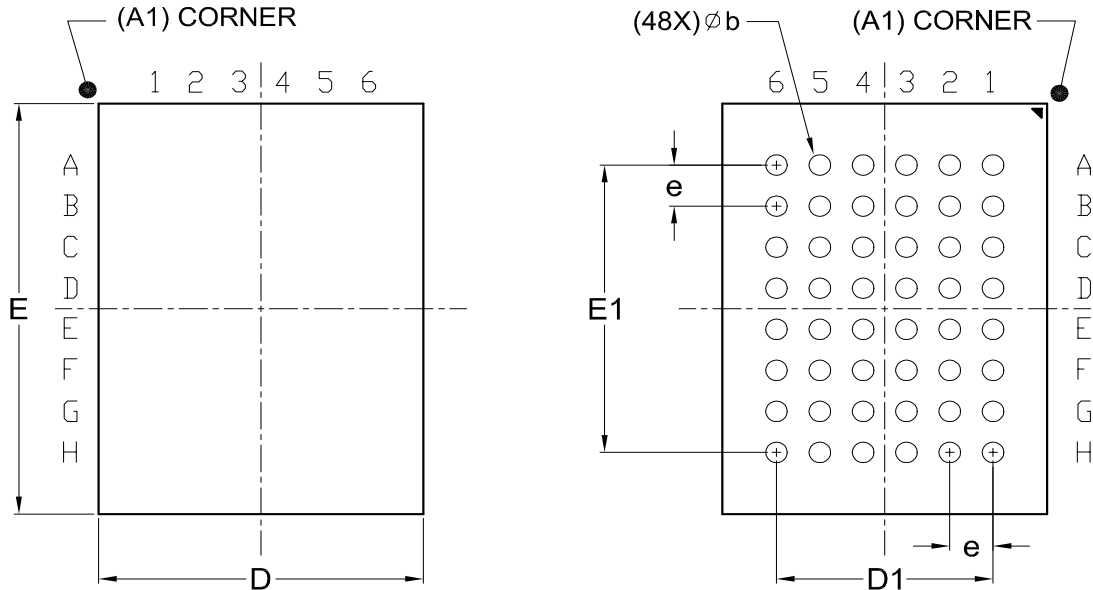
SEATING PLANE

Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL / UNIT		A	A1	A2	b	D	D1	E	E1	e
mm	Min.	---	0.18	0.65	0.27	5.90		7.90		
	Nom.	---	0.23	---	0.30	6.00	4.00	8.00	5.60	0.80
	Max.	1.20	0.28	---	0.37	6.10		8.10		
Inch	Min.	---	0.007	0.026	0.011	0.232		0.311		
	Nom.	---	0.009	---	0.012	0.236	0.157	0.315	0.220	0.031
	Max.	0.047	0.011	---	0.015	0.240		0.319		

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-4201	4	MO-210			12-12-'03

48-Ball CSP (for MX26LV160ATXEC/ATXEI/ABXEC/ABXEI)

Title: Package Outline for CSP 48BALL(6X8X1.3MM,BALL PITCH 0.8MM,BALL DIAMETER 0.4MM)

TOP VIEW   BOTTOM VIEW
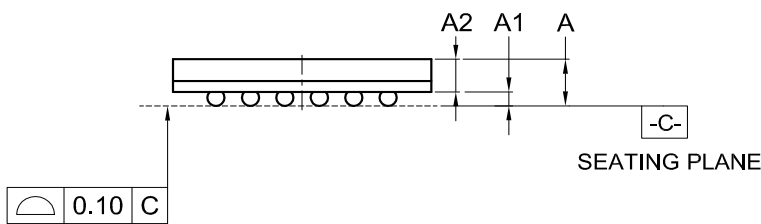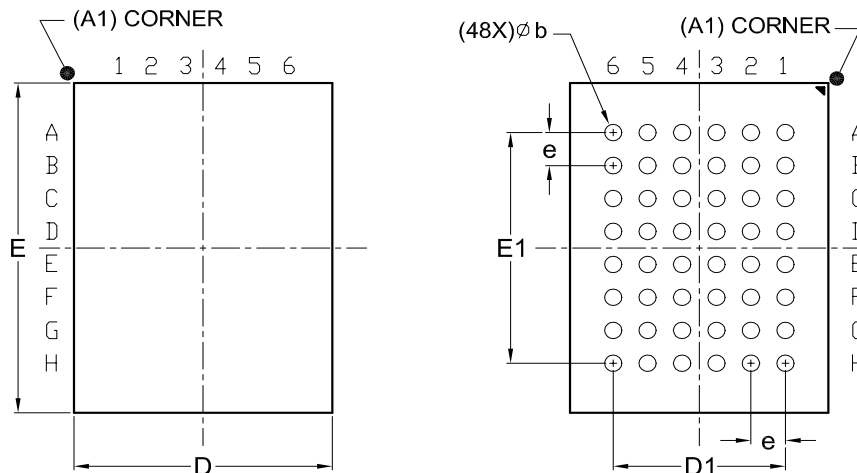
Dimensions (inch dimensions are derived from the original mm dimensions)

SYMBOL UNIT		A	A1	A2	b	D	D1	E	E1	e
mm	Min.	---	0.25	0.65	0.35	5.90		7.90		
	Nom.	---	0.30	---	0.40	6.00	4.00	8.00	5.60	0.80
	Max.	1.30	0.35	---	0.45	6.10		8.10		
Inch	Min.	—	0.010	0.026	0.014	0.232		0.311		
	Nom.	—	0.012	--	0.016	0.236	0.157	0.315	0.220	0.031
	Max.	0.051	0.014	--	0.018	0.240		0.319		

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-4202	4	MO-219			12-12-'03

REVISION HISTORY

Revision No.	Description	Page	Date
1.0	1. Removed "Preliminary"	P1	NOV/15/2004
	2. To added 44-SOP package information	All	
	3. To modified cycling time from 10K to 2K	P1,53	
1.1	1. To corrected protect/unprotect information in CFI table	P52	NOV/18/2004

MACRONIX INTERNATIONAL CO., LTD.

Headquarters:
TEL:+886-3-578-6688
FAX:+886-3-563-2888

Europe Office :
TEL:+32-2-456-8020
FAX:+32-2-456-8021

Hong Kong Office :
TEL:+86-755-834-335-79
FAX:+86-755-834-380-78

Japan Office :
Kawasaki Office :
TEL:+81-44-246-9100
FAX:+81-44-246-9105
Osaka Office :
TEL:+81-6-4807-5460
FAX:+81-6-4807-5461

Singapore Office :
TEL:+65-6346-5505
FAX:+65-6348-8096

Taipei Office :
TEL:+886-2-2509-3300
FAX:+886-2-2509-2200

MACRONIX AMERICA, INC.
TEL:+1-408-262-8887
FAX:+1-408-262-8810

http : //www.macronix.com