



MX29F200C T/B

2M-BIT [256Kx8/128Kx16] CMOS FLASH MEMORY

FEATURES

- 5.0V±10% for read, erase and write operation
- 131072x16/262144x8 switchable
- Fast access time: 55/70/90ns
- **Compatible with MX29F200T/B device**
- Low power consumption
 - 40mA maximum active current@5MHz
 - 1uA typical standby current
- Command register architecture
 - Byte/Word Programming (9us/11us typical)
 - Sector Erase (16K-Bytex1, 8K-Bytex2, 32K-Bytex1, and 64K-Byte x3)
- Auto Erase (chip & sector) and Auto Program
 - Automatically erase any combination of sectors or the whole chip with Erase Suspend capability.
 - Automatically program and verify data at specified address
- Status Reply
 - Data# Polling & Toggle bit for detection of program and erase cycle completion.
- Ready/Busy# pin (RY/BY#)
 - Provides a hardware method of detecting program or erase cycle completion
- Compatibility with JEDEC standard
 - Pinout and software compatible with single-power supply Flash
- Superior inadvertent write protection
- 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
- Sector protect/chip unprotect for 5V only system
- 100,000 minimum erase/program cycles
- Latch-up protected to 100mA from -1V to VCC+1V
- Boot Code Sector Architecture
 - T = Top Boot Sector
 - B = Bottom Boot Sector
- Low VCC write inhibit is equal to or less than 3.2V
- Erase suspend/ Erase Resume
 - Suspends an erase operation to read data from, or program data to a sector that is not being erased, then resume the erase operation.
- Hardware reset pin
 - Resets internal state machine to the read mode
- 20 years data retention
- Package type:
 - 44-pin SOP
 - 48-pin TSOP
- **All Pb-free devices are RoHS Compliant**

GENERAL DESCRIPTION

The MX29F200C T/B is a 2-mega bit, single 5 Volt Flash memory organized as 1M word x16 or 2M bytex8 MXIC's Flash memories offer the most cost-effective and reliable read/write non-volatile random access memory. The MX29F200C T/B is packaged in 44-pin SOP and 48-pin TSOP. It is designed to be reprogrammed and erased in-system or in-standard EPROM programmers.

The standard MX29F200C T/B offers access time as fast as 55ns, allowing operation of high-speed microprocessors without wait states. To eliminate bus contention, the MX29F200C T/B has separate chip enable (CE#) and output enable (OE#) controls.

MXIC's Flash memories augment EPROM functionality with in-circuit electrical erasure and programming. The MX29F200C T/B uses a command register to manage this functionality. The command register allows for 100%

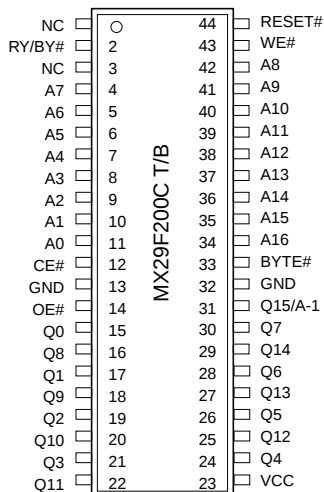
TTL level control inputs and fixed power supply levels during erase and programming, while maintaining maximum EPROM compatibility.

MXIC Flash technology reliably stores memory contents even after 100,000 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 programming operations produces reliable cycling. The MX29F200C T/B uses a 5.0V ±10% 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 milliamps on address and data pin from -1V to VCC + 1V.

PIN CONFIGURATIONS

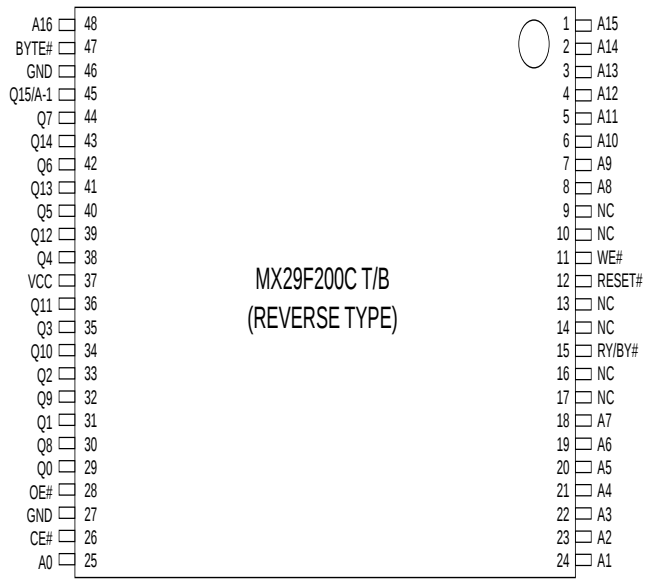
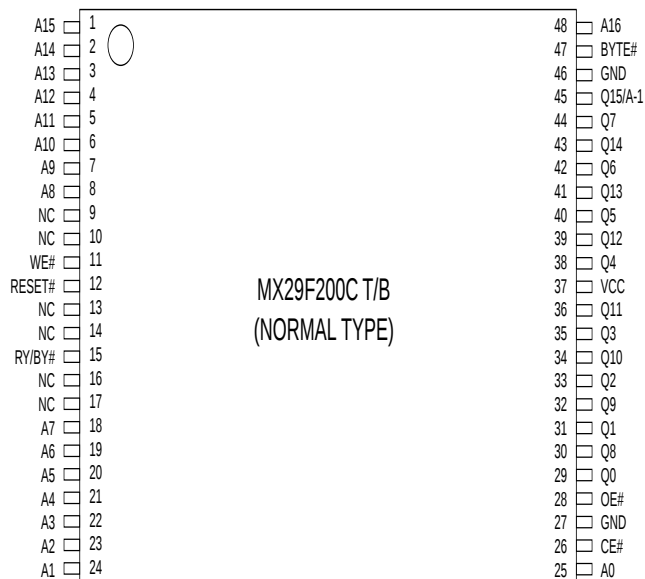
44 SOP(500mil)



PIN DESCRIPTION

SYMBOL	PIN NAME
A0-A16	Address Input
Q0-Q14	Data Input/Output
Q15/A-1	Q15(Word mode)/LSB addr.(Byte mode)
CE#	Chip Enable Input
OE#	Output Enable Input
RESET#	Hardware Reset Pin, Active low
WE#	Write Enable Input
RY/BY#	Read/Busy Output
BYTE#	Word/Byte Selection Input
VCC	Power Supply Pin (+5V)
GND	Ground Pin
NC	Pin Not Connected Internally

48 TSOP(TYPE I) (12mm x 20mm)



SECTOR STRUCTURE

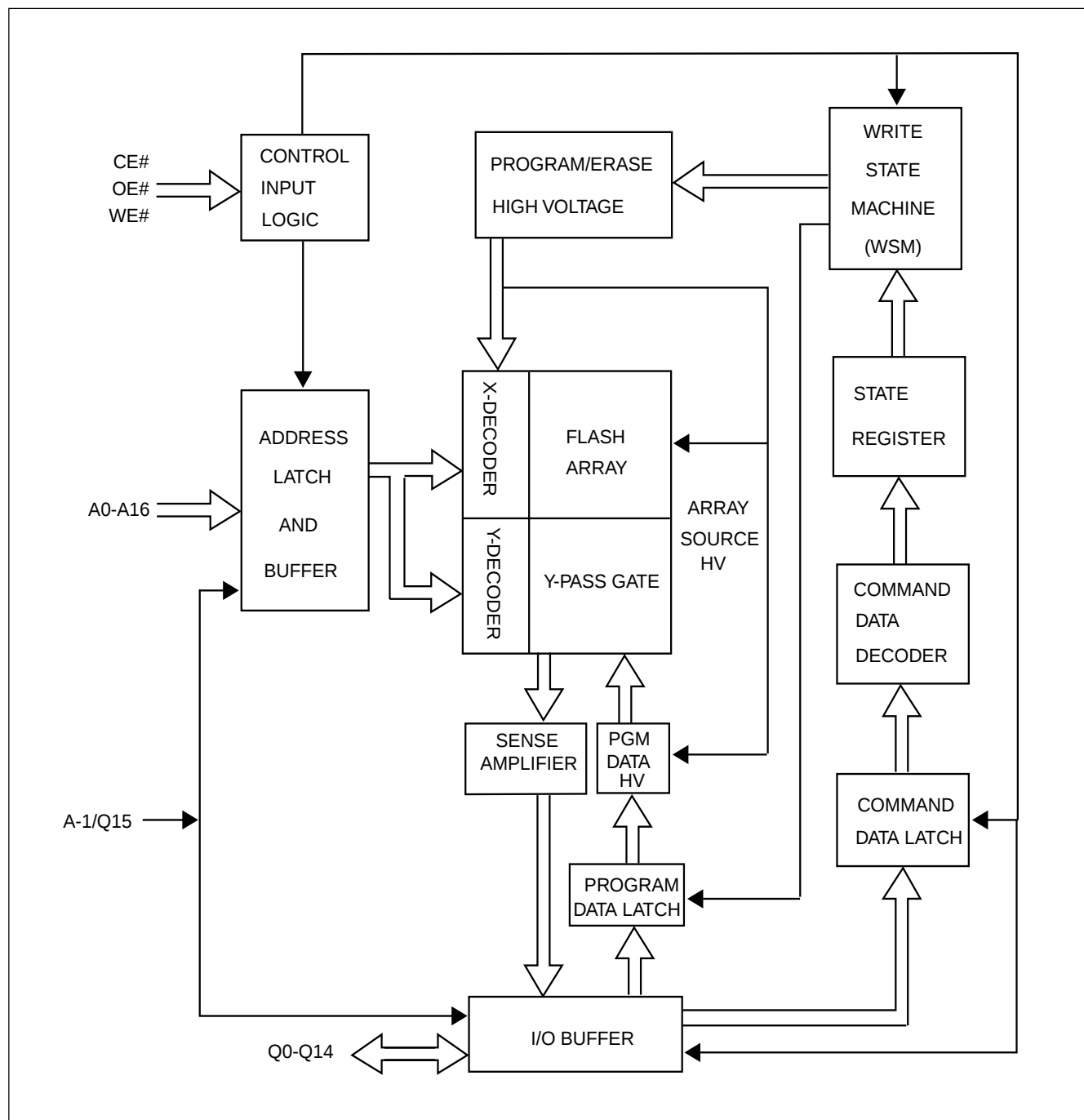
MX29F200CT Top Boot Sector Addresses Tables

	A16	A15	A14	A13	A12	Sector Size (Kbytes/ Kwords)	Address Range (in hexadecimal)	
							(x8)Address Range	(x16) Address Range
SA0	0	0	X	X	X	64/32	00000h-0FFFFh	00000h-07FFFh
SA1	0	1	X	X	X	64/32	10000h-1FFFFh	08000h-0FFFFh
SA2	1	0	X	X	X	64/32	20000h-2FFFFh	10000h-17FFFh
SA3	1	1	0	X	X	32/16	30000h-37FFFh	18000h-1BFFFh
SA4	1	1	1	0	0	8/4	38000h-39FFFh	1C000h-1CFFFh
SA5	1	1	1	0	1	8/4	3A000h-3BFFFh	1D000h-1DFFFh
SA6	1	1	1	1	X	16/8	3C000h-3FFFFh	1E000h-1FFFFh

MX29F200CB Bottom Boot Sector Addresses Tables

	A16	A15	A14	A13	A12	Sector Size (Kbytes/ Kwords)	Address Range (in hexadecimal)	
							(x8)Address Range	(x16) Address Range
SA0	0	0	0	0	X	16/8	00000h-03FFFh	00000h-01FFFh
SA1	0	0	0	1	0	8/4	04000h-05FFFh	02000h-02FFFh
SA2	0	0	0	1	1	8/4	06000h-07FFFh	03000h-03FFFh
SA3	0	0	1	X	X	32/16	08000h-0FFFFh	04000h-07FFFh
SA4	0	1	X	X	X	64/32	10000h-1FFFFh	08000h-0FFFFh
SA5	1	0	X	X	X	64/32	20000h-2FFFFh	10000h-17FFFh
SA6	1	1	X	X	X	64/32	30000h-3FFFFh	18000h-1FFFFh

BLOCK DIAGRAM



AUTOMATIC PROGRAMMING

The MX29F200C T/B is byte programmable using the Automatic Programming algorithm. The Automatic Programming algorithm does not require the system to time out sequence or verify the data programmed. The typical chip programming time of the MX29F200C T/B at room temperature is less than 4.5 seconds.

AUTOMATIC CHIP ERASE

The entire chip is bulk erased using 10 ms erase pulses according to MXIC's Automatic Chip Erase algorithm. Typical erasure at room temperature is accomplished in less than two second. The Automatic Erase algorithm automatically programs the entire array prior to electrical erase. The timing and verification of electrical erase are internally controlled by the device.

AUTOMATIC SECTOR ERASE

The MX29F200C T/B is sector(s) erasable using MXIC's Auto Sector Erase algorithm. Sector erase modes allow sectors of the array to be erased in one erase cycle. The Automatic Sector Erase algorithm automatically programs the specified sector(s) prior to electrical erase. The timing and verification of electrical erase are internally controlled by the device.

AUTOMATIC PROGRAMMING ALGORITHM

MXIC's Automatic Programming algorithm requires the user to only write program set-up commands (include 2 unlock write cycle and A0H) and a program command (program data and address). The device automatically times the programming pulse width, verifies the program, and counts the number of sequences. A status bit similar to Data# Polling and a status bit toggling between consecutive read cycles, provides feedback to the user as to the status of the programming operation.

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, verifies the erase 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 programming 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 addresses 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#.

MXIC's Flash technology combines years of EPROM experience to produce the highest levels of quality, reliability, and cost effectiveness. The MX29F200C T/B 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. During a Sector Erase cycle, the command register will only respond to Erase Suspend command. After Erase Suspend is complete, the device stays in read mode. After the state machine has completed its task, it will allow the command register to respond to its full command set.

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 1 defines the valid register

command sequences. Note that the Erase Suspend (B0H) and Erase Resume (30H) commands are valid only while the Sector Erase operation is in progress. Either of the two reset command sequences will reset the device(when applicable).

TABLE 1. SOFTWARE 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	00 01				
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
Sector Erase Suspend		1	XXXH	B0H										
Sector Erase Resume		1	XXXH	30H										
Unlock for sector protect/unprotect		6	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	555H	20H

NOTES:

- ADI = Address of Device identifier; A1=0, A0 =0 for manufacture code, A1=0, A0 =1 for device code.(Refer to Table 3)
DDI = Data of Device identifier : C2H for manufacture code,51H/57H(x8) and 2251H/2257H(x16) 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.
- PA = Address of memory location to be programmed.
PD = Data to be programmed at location PA.
SA = Address to the sector to be erased.
- The system should generate the following address patterns: 555H or 2AAH to Address A0~A10.
Address bit A11~A16=X=Don't care for all address commands except for Program Address (PA) and Sector Address (SA).
Write Sequence may be initiated with A11~A16 in either state.
- For Sector Protection 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.

TABLE 2. MX29F200C T/B BUS OPERATIONS

Mode	Pins	CE#	OE#	WE#	A0	A1	A6	A9	Q0 ~ Q15
Read Silicon ID Manufacturer Code(1)		L	L	H	L	L	X	V _{ID} (2)	C2H(Byte mode) 00C2H(Word mode)
Read Silicon ID Device Code(1)		L	L	H	H	L	X	V _{ID} (2)	51H/57H(Byte mode) 2251H/2257H(Word mode)
Read		L	L	H	A0	A1	A6	A9	D _{OUT}
Standby		H	X	X	X	X	X	X	HIGH Z
Output Disable		L	H	H	X	X	X	X	HIGH Z
Write		L	H	L	A0	A1	A6	A9	D _{IN} (3)
Sector Protect without 12V system (6)		L	H	L	X	X	L	H	X
Chip Unprotect without 12V system (6)		L	H	L	X	X	H	H	X
Verify Sector Protect/ Unprotect without 12V system (7)		L	L	H	X	H	X	H	Code(5)
Reset		X	X	X	X	X	X	X	HIGH Z

NOTES:

1. Manufacturer and device codes may also be accessed via a command register write sequence. Refer to Table 1.
2. VID is the Silicon-ID-Read high voltage, 11.5V to 12.5V.
3. Refer to Table 1 for valid Data-In during a write operation.
4. X can be VIL or VIH.
5. Code=00H/0000H means unprotected.
Code=01H/0001H means protected.
A16~A12=Sector address for sector protect.
6. Refer to sector protect/unprotect algorithm and waveform.
Must issue "unlock for sector protect/unprotect" command before "sector protect/unprotect without 12V system" command.
7. The "verify sector protect/unprotect without 12V system" is only following "Sector protect/unprotect without 12V system" command.

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

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. However, multiplexing high voltage onto address lines is not generally desired system design practice.

The MX29F200C T/B contains a Silicon-ID-Read operation to supplement traditional PROM programming methodology. The operation is initiated by writing the read silicon ID command sequence into the command register. Following the command write, a read cycle with A1=VIL, A0=VIL retrieves the manufacturer code of C2H/00C2H. A read cycle with A1=VIL, A0=VIH returns the device code of 51H/2251H for MX29F200CT, 57H/2257H for MX29F200CB.

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.

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 does not require 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-verified command is required).

If the Erase operation was unsuccessful, the data on Q5 is "1" (see Table 4), indicating an erase operation exceed internal timing limit.

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

TABLE 3. EXPANDED SILICON ID CODE

Pins		A0	A1	Q15~Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0	Code(Hex)
Code													
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 for MX29F200CT	Word	VIH	VIL	22H	0	1	0	1	0	0	0	1	2251H
	Byte	VIH	VIL	X	0	1	0	1	0	0	0	1	51H
Device code for MX29F200CB	Word	VIH	VIL	22H	0	1	0	1	0	1	1	1	2257H
	Byte	VIH	VIL	X	0	1	0	1	0	1	1	1	57H
Sector Portection Verification		X	VIH	X	0	0	0	0	0	0	0	1	01H(Protected)
		X	VIH	X	0	0	0	0	0	0	0	0	00H(Unprotected)

SECTOR ERASE COMMANDS

The Automatic Sector Erase does not require the device to be entirely pre-programmed prior to executing the Automatic Set-up Sector Erase 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 does not require 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 verification begin. The erase and verification operations are complete when the data on Q7 is "1" and the data on Q6 stops toggling for two consecutive read cycles, at which time the device returns to the Read mode. The system does not require 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-verified 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#, while the command(data) is latched on the rising edge of WE#. Sector addresses selected are loaded into internal register on the sixth falling edge of WE#. Each successive sector load cycle started by the falling edge of WE# must begin within 30us from the rising edge of the preceding WE#. 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) or Erase Suspend (B0H) during the time-out period resets the device to read mode.

ERASE SUSPEND

This command is only valid while the state machine is executing Automatic Sector Erase operation, and therefore will only be responded to period during Automatic Sector Erase operation. Writing the Erase Suspend command during the Sector Erase time-out immediately terminates the time-out period and suspends the erase operation. After this command has been executed, the command register will initiate erase suspend mode. The state machine will return to read mode automatically after suspend is ready. At this time, state machine only allows the command register to respond to the Read Memory Array, Erase Resume and Program commands.

The system can determine the status of the program operation using the Q7 or Q6 status bits, just as in the standard program operation. After an erase-suspend program operation is complete, the system can once again read array data within non-suspended sectors.

Table 4. Write Operation Status

	Status		Q7 Note1	Q6	Q5 Note2	Q3	Q2	RY/BY#
In Progress	Byte Program in Auto Program Algorithm		Q7#	Toggle	0	N/A	No Toggle	0
	Auto Erase Algorithm		0	Toggle	0	1	Toggle	0
	Erase Suspended Mode	Erase Suspend Read (Erase Suspended Sector)	1	No Toggle	0	N/A	Toggle	1
		Erase Suspend Read (Non-Erase Suspended Sector)	Data	Data	Data	Data	Data	1
		Erase Suspend Program	Q7#	Toggle	0	N/A	N/A	0
Exceeded Time Limits	Byte Program in Auto Program Algorithm		Q7#	Toggle	1	N/A	No Toggle	0
	Auto Erase Algorithm		0	Toggle	1	1	Toggle	0
	Erase Suspend Program		Q7#	Toggle	1	N/A	N/A	0

Notes:

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.

ERASE RESUME

This command will cause the command register to clear the suspend state and return back to Sector Erase mode but only if an Erase Suspend command was previously issued. Erase Resume will not have any effect in all other conditions. Another Erase Suspend command can be written after the chip has resumed erasing. However, a time delay must be required after the erase resume command, if the system implements an endless erase suspend/resume loop, or the number of erase suspend/resume is exceeded 1024 times. The erase times will be expended if the erase behavior always be suspended.

SET-UP AUTOMATIC PROGRAM COMMANDS

To initiate Automatic Program mode, A three-cycle command sequence is required. There are two "unlock" write cycles. These are followed by writing the Automatic Program command A0H.

Once the Automatic Program command is initiated, the next WE# pulse causes a transition to an active programming operation. Addresses are latched on the falling edge, and data are internally latched on the rising edge of the WE# pulse. The rising edge of WE# also begins the programming operation. The system does not require to provide further controls or timings. The device will automatically provide an adequate internally generated program pulse and verify margin.

If the program operation was unsuccessful, the data on Q5 is "1" (see Table 4), indicating the program operation exceed internal timing limit. The automatic programming operation is completed when the data read on Q6 stops toggling for two consecutive read cycles and the data on Q7 and Q6 are equivalent to data written to these two bits, at which time the device returns to the Read mode (no program verify command is required).

DATA# POLLING-Q7

The MX29F200C T/B also features Data# Polling as a method to indicate to the host system that the Automatic Program or Erase algorithms are either in progress or completed.

While the Automatic Programming algorithm is in operation, an attempt to read the device will produce the

complement data of the data last written to Q7. Upon completion of the Automatic Program Algorithm an attempt to read the device will produce the true data last written to Q7. The Data# Polling feature is valid after the rising edge of the fourth WE# pulse of the four write pulse sequences for automatic program.

While the Automatic Erase algorithm is in operation, Q7 will read "0" until the erase operation is completed. Upon completion of the erase operation, the data on Q7 will read "1". The Data# Polling feature is valid after the rising edge of the sixth WE# pulse of six write pulse sequences for automatic chip/sector erase.

The Data# Polling feature is active during Automatic Program/Erase algorithm or sector erase time-out. (see section Q3 Sector Erase Timer)

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# pulse 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. (This includes programming in the Erase Suspend mode.) If the output is high (Ready), the device is ready to read array data (including during the Erase Suspend mode), or is in the standby mode.

Q6: Toggle BIT I

Toggle Bit I on Q6 indicates whether an Automatic Program or Erase algorithm is in progress or complete, or whether the device has entered the Erase Suspend mode. Toggle Bit I may be read at any address, and is valid after the rising edge of the final WE# pulse 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.

After an erase command sequence is written, if all sectors selected for erasing are protected, Q6 toggles and 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.

The system can use Q6 and Q2 together to determine whether a sector is actively erasing or is erase suspended. When the device is actively erasing (that is, the Automatic Erase algorithm is in progress), Q6 toggling. When the device enters the Erase Suspend mode, Q6 stops toggling. However, the system must also use Q2 to determine which sectors are erasing or erase-suspended. Alternatively, the system can use Q7.

If a program address falls within a protected sector, Q6 toggles for approximately 2 μ s after the program command sequence is written, then returns to reading array data.

Q6 also toggles during the erase-suspend-program mode, and stops toggling once the Automatic Program algorithm is complete.

Table 4 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), or whether that sector is erase-suspended. Toggle Bit I is valid after the rising edge of the final WE# pulse 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 whether the sector is actively erasing or is erase-suspended. Q6, by comparison, indicates whether the device is actively erasing, or is in Erase Suspend, but cannot distinguish which sectors are selected for erasure. Thus, both status bits are required for sectors and mode information. Refer to Table 4 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 which 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 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 may also appear if a user tries to program a non blank location without erasing. In this case the device locks out and never completes the Automatic Algorithm operation. Hence, the system never reads a valid data on Q7 bit and Q6 never stops toggling. Once the Device has exceeded timing limits, the Q5 bit will indicate a "1". Please note that this is not a device failure condition since the device was incorrectly used.

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 MX29F200C T/B 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.

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.

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.

SECTOR PROTECTION WITHOUT 12V SYSTEM

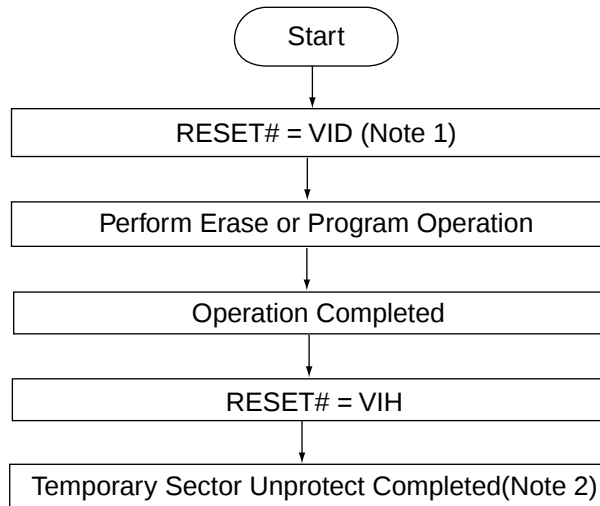
The MX29F200C T/B also feature a hardware sector protection method in a system without 12V power supply. The programming equipment do not need to supply 12 volts to protect sectors. The details are shown in sector protect algorithm and waveform.

CHIP UNPROTECT WITHOUT 12V SYSTEM

The MX29F200C T/B also feature a hardware chip unprotection method in a system without 12V power supply. The programming equipment do not need to supply 12 volts to unprotect all sectors. The details are shown in chip unprotect algorithm and waveform.

POWER-UP SEQUENCE

The MX29F200C T/B 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 OPERATION

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

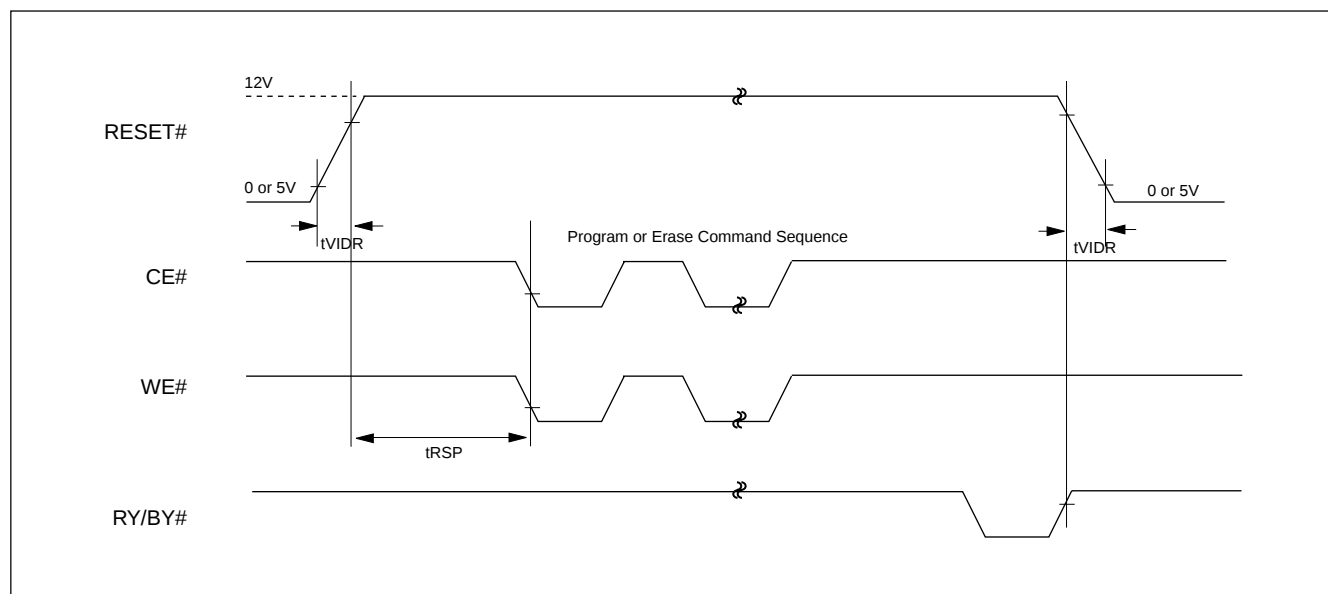
2. All previously protected sectors are protected again.

TEMPORARY SECTOR UNPROTECT

Parameter Std.	Description	Test Setup	AllSpeed 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:

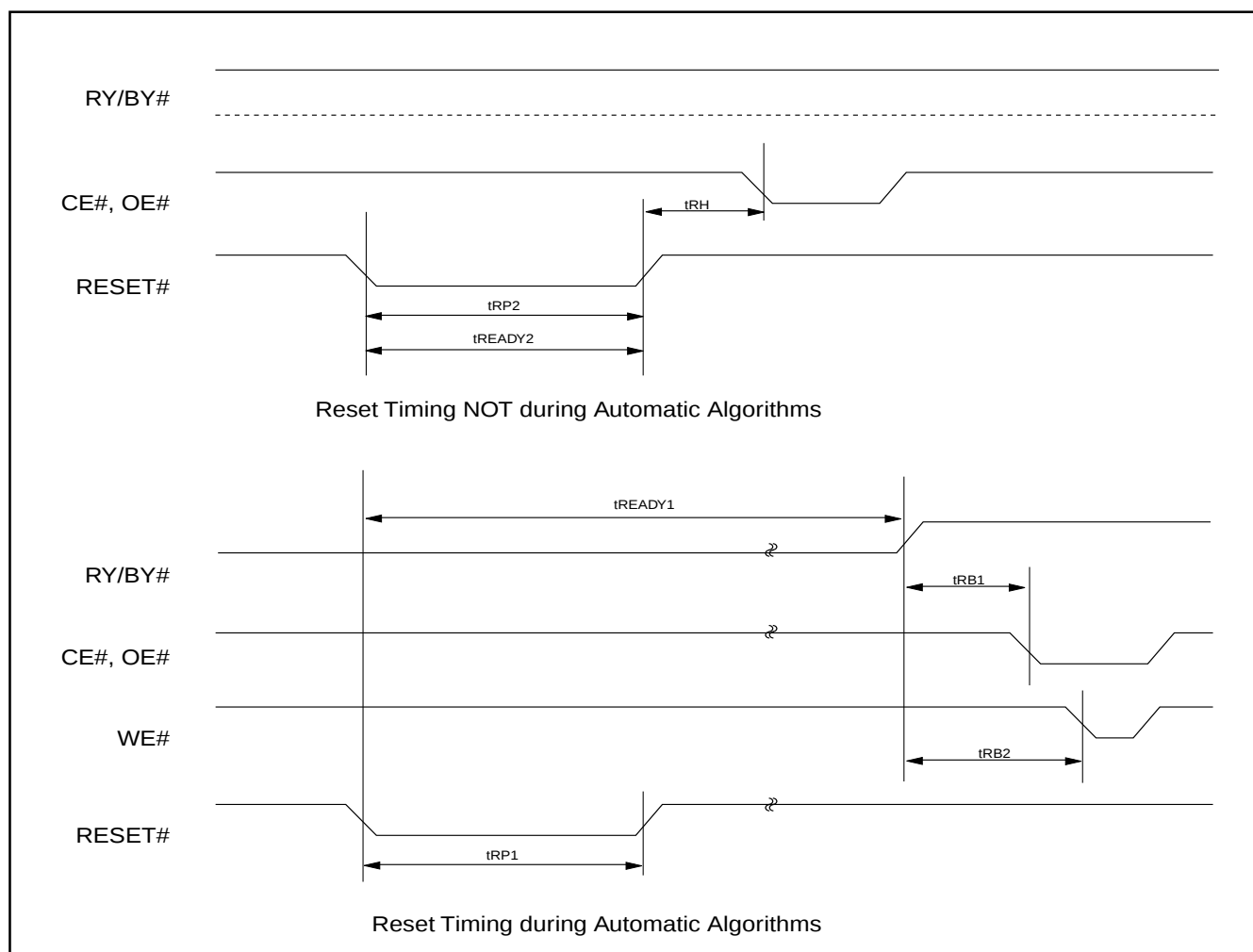
Not 100% tested

TEMPORARY SECTOR UNPROTECT TIMING DIAGRAM


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
tRP1	RESET# Pulse Width (During Automatic Algorithms)	MIN	10	us
tRP2	RESET# Pulse Width (NOT During Automatic Algorithms)	MIN	500	ns
tRH	RESET# High Time Before Read(See Note)	MIN	0	ns
tRB1	RY/BY# Recovery Time(to CE#, OE# go low)	MIN	0	ns
tRB2	RY/BY# Recovery Time(to WE# go low)	MIN	50	ns

Note:Not 100% tested

RESET# TIMING WAVEFORM



ABSOLUTE MAXIMUM RATINGS

RATING	VALUE
Ambient Operating Temperature	-40°C to 85°C
Ambient Temperature with Power Applied	-55°C to 125°C
Storage Temperature	-65°C to 125°C
Applied Input Voltage	-0.5V to 7.0V
Applied Output Voltage	-0.5V to 7.0V
VCC to Ground Potential	-0.5V to 7.0V
A9	-0.5V to 13.5V

NOTICE:

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.

NOTICE:

Specifications contained within the following tables are subject to change.

DC/AC Operating Conditions

		MX29F200C T/B		
		-55	-70	-90
Operating Temperature	Industrial	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C
VCC Power Supply		5V ± 10%	5V ± 10%	5V ± 10%

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

READ OPERATION

DC CHARACTERISTICS

Symbol	PARAMETER	MIN.	TYP	MAX.	UNIT	CONDITIONS
ILI	Input Leakage Current			1	uA	VIN = GND to VCC
ILO	Output Leakage Current			10	uA	VOUT = GND to VCC
ISB1	Standby VCC current			1	mA	CE# = VIH
ISB2			1	5	uA	CE# = VCC + 0.3V
ICC1	Operating VCC current			40	mA	IOUT = 0mA, f=5MHz
ICC2				50	mA	IOUT = 0mA, f=10MHz
VIL	Input Low Voltage	-0.3(Note1)		0.8	V	
VIH	Input High Voltage	0.7xVCC		VCC+0.3	V	
VOL	Output Low Voltage			0.45	V	IOL = 2.1mA, VCC=VCC MIN
VOH1	Output High Voltage(TTL)	2.4			V	IOH = -2mA, VCC=VCC MIN
VOH2	Output High Voltage(CMOS)	VCC-0.4			V	IOH = -100uA, VCC=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.

AC CHARACTERISTICS

SYMBOL	PARAMETER	<u>29F200C-55</u>		<u>29F200C-70</u>		<u>29F200C-90</u>		UNIT	CONDITIONS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
tACC	Address to Output Delay		55		70		90	ns	CE#=OE#=VIL
tCE	CE# to Output Delay		55		70		90	ns	OE#=VIL
tOE	OE# to Output Delay		30		30		35	ns	CE#=VIL
tDF	OE# High to Output Float (Note1)	0	20	0	20	0	20	ns	CE#=VIL
tOH	Address to Output hold	0		0		0		ns	CE#=OE#=VIL

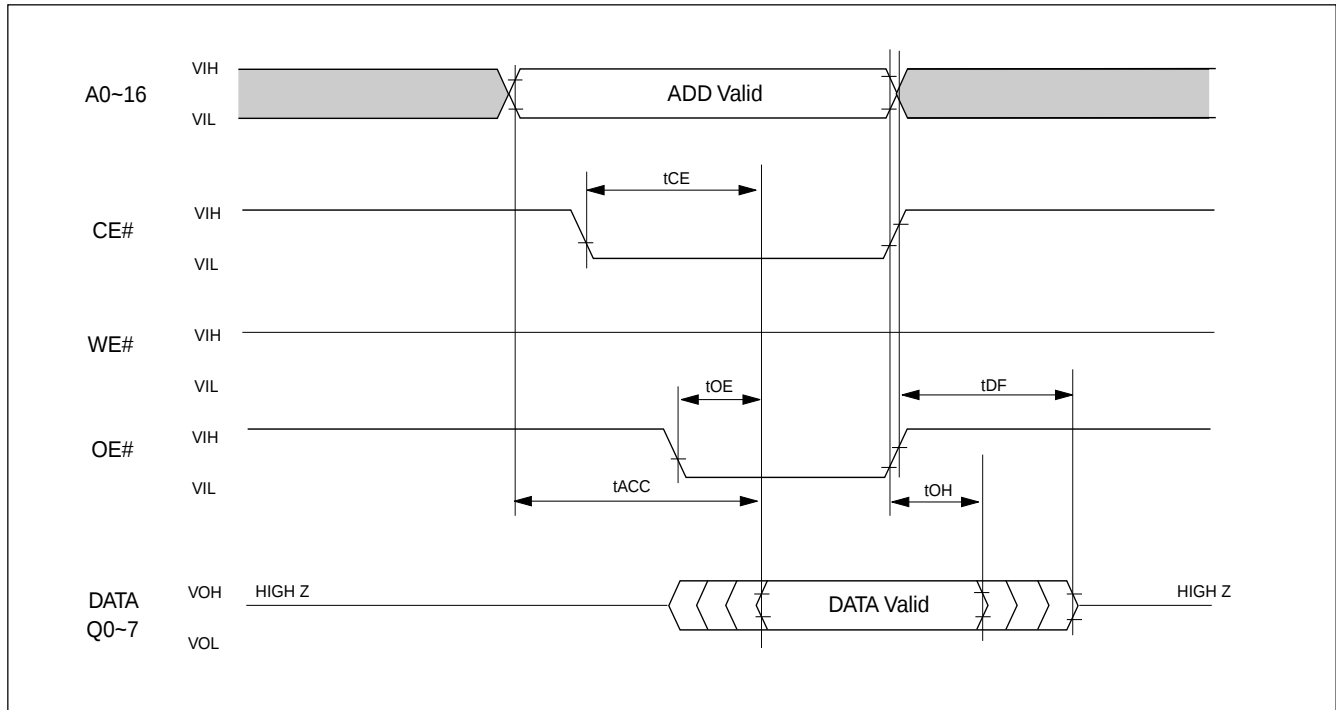
TEST CONDITIONS:

- Input pulse levels: 0.45V/0.7xVCC for 70ns & 90ns, 0V/3V for 55ns
- Input rise and fall times: is equal to or less than 10ns for 70ns & 90ns, 5ns for 55ns
- Output load: 1 TTL gate + 100pF (Including scope and jig) for 70ns & 90ns, 1TTLgate+30pF for 55ns max.
- Reference levels for measuring timing: 0.8V, 2.0V for 70ns & 90ns, 1.5V for 55ns

NOTE:

1. tDF is defined as the time at which the output achieves the open circuit condition and data is no longer driven.

READ TIMING WAVEFORMS



DC CHARACTERISTICS

SYMBOL	PARAMETER	MIN.	TYP	MAX.	UNIT	CONDITIONS
ICC1 (Read)	Operating VCC Current			40	mA	IOUT=0mA, f=5MHz
ICC2				50	mA	IOUT=0mA, F=10MHz
ICC3 (Program)				50	mA	In Programming
ICC4 (Erase)				50	mA	In Erase
ICCES	VCC Erase Suspend Current		2		mA	CE#=VIH, Erase Suspended

NOTES:

1. VIL min. = -0.6V for pulse width is equal to or less than 20ns.
2. If VIH is over the specified maximum value, programming operation cannot be guaranteed.
3. ICCES is specified with the device de-selected. If the device is read during erase suspend mode, current draw is the sum of ICCES and ICC1 or ICC2.
4. All current are in RMS unless otherwise noted.

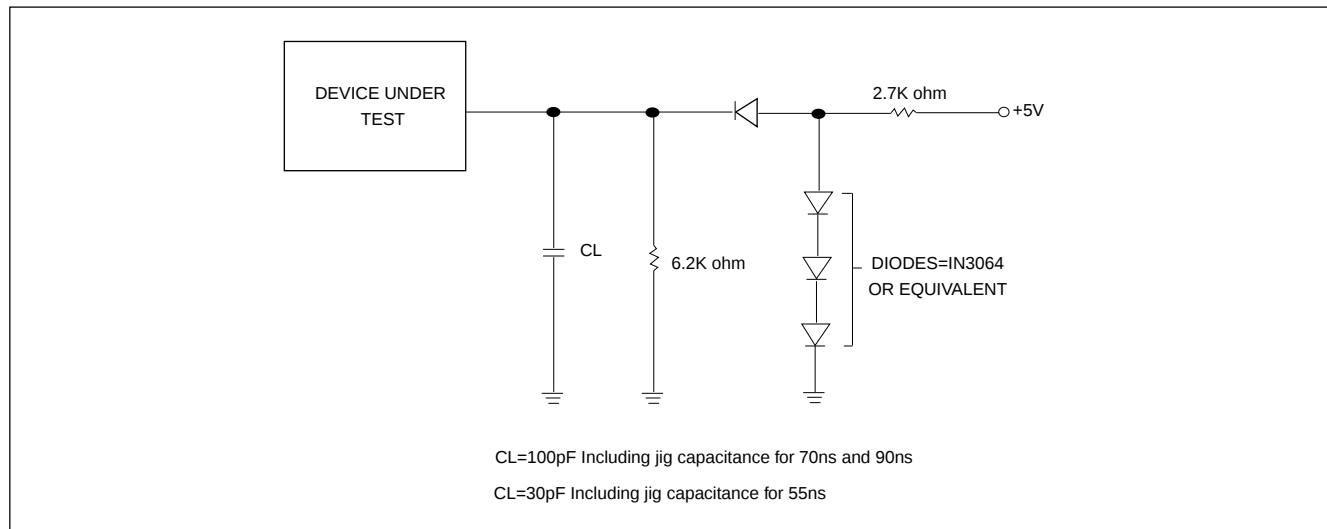
AC CHARACTERISTICS $T_A = -40^{\circ}\text{C to } 85^{\circ}\text{C}$, $V_{CC} = 5\text{V} \pm 10\%$

SYMBOL	PARAMETER	MIN.	Speed Option			UNIT
			55(Note 2)	70	90	
tOES	OE# setup time	MIN.	0	0	0	ns
tCWC	Command programming cycle	MIN.	55	70	90	ns
tCEP	WE# programming pulse width	MIN.	35	35	45	ns
tCEPH	WE# programming pulse width High	MIN.	20	20	20	ns
tAS	Address setup time	MIN.	0	0	0	ns
tAH	Address hold time	MIN.	45	45	45	ns
tDS	Data setup time	MIN.	35	35	35	ns
tDH	Data hold time	MIN.	0	0	0	ns
tCESC	CE# setup time before command write	MIN.	0	0	0	ns
tDF	Output disable time (Note 1)	MAX.	20	20	20	ns
tAETC	Erase time in auto chip erase	TYP.	4	4	4	s
		MAX.	32	32	32	s
tAETB	Erase time in auto sector erase	TYP.	0.7	0.7	0.7	s
		MAX.	15	15	15	s
tAVT	Programming time in auto verify (Byte/Word program time)	TYP.	9/11	9/11	9/11	us
		MAX.	300/360	300/360	300/360	us
tBAL	Sector address load time	MIN.	50	50	50	us
tCH	CE# Hold Time	MIN.	0	0	0	ns
tCS	CE# setup to WE# going low	MIN.	0	0	0	ns

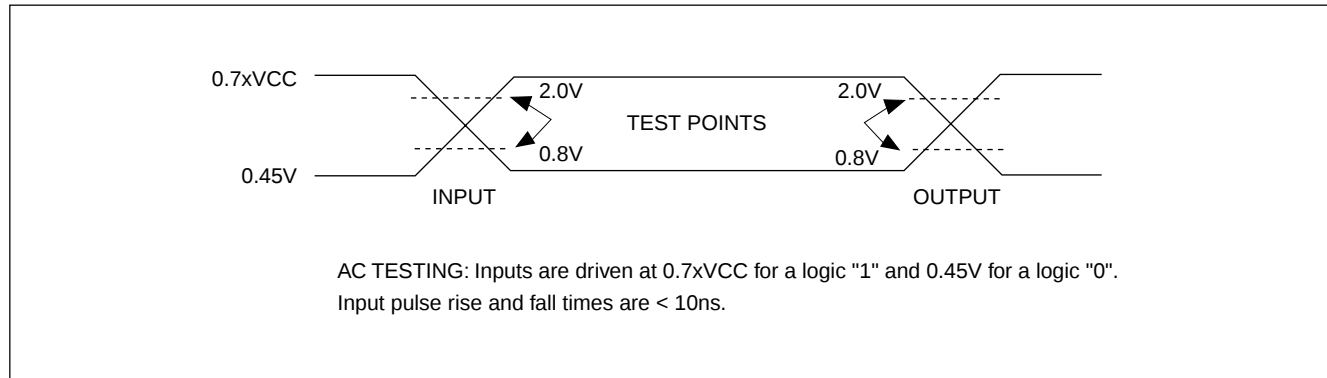
NOTES:

1. tDF defined as the time at which the output achieves the open circuit condition and data is no longer driven.
2. Under condition of $V_{CC} = 5\text{V} \pm 10\%$, $C_L = 30\text{pF}$, $V_{IH}/V_{IL} = 3.0\text{V}/0\text{V}$, $V_{OH}/V_{OL} = 1.5\text{V}/1.5\text{V}$, $I_{OL} = 2\text{mA}$, $I_{OH} = 2\text{mA}$.

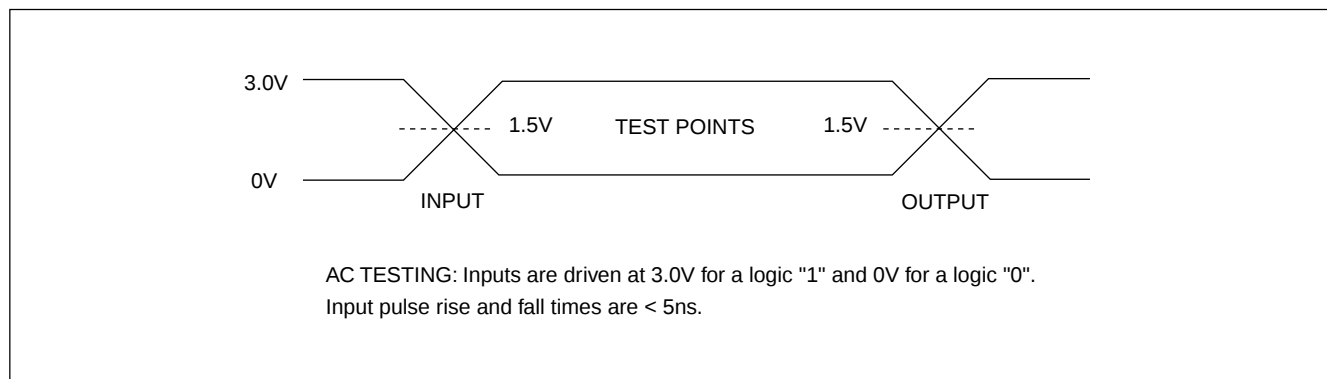
SWITCHING TEST CIRCUITS

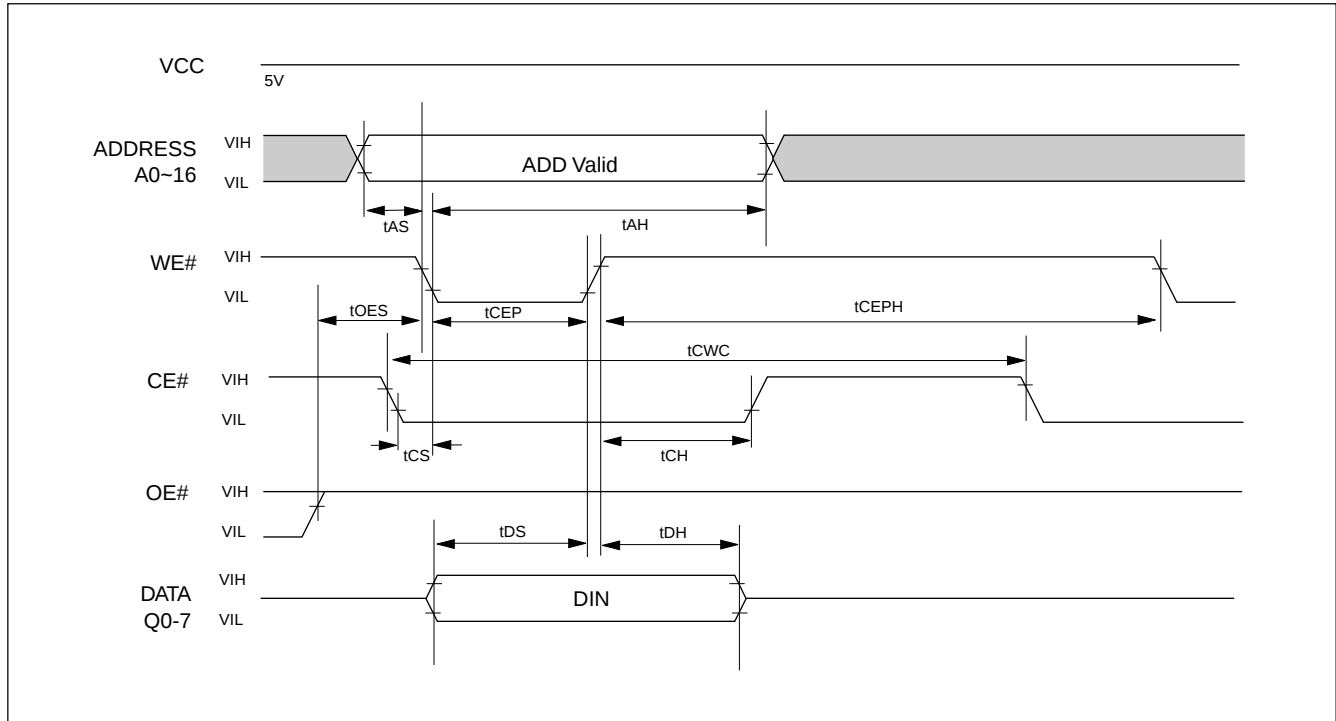


SWITCHING TEST WAVEFORMS for 29F200C T/B-70 and 29F200C T/B-90



SWITCHING TEST WAVEFORMS for 29F200C T/B-55



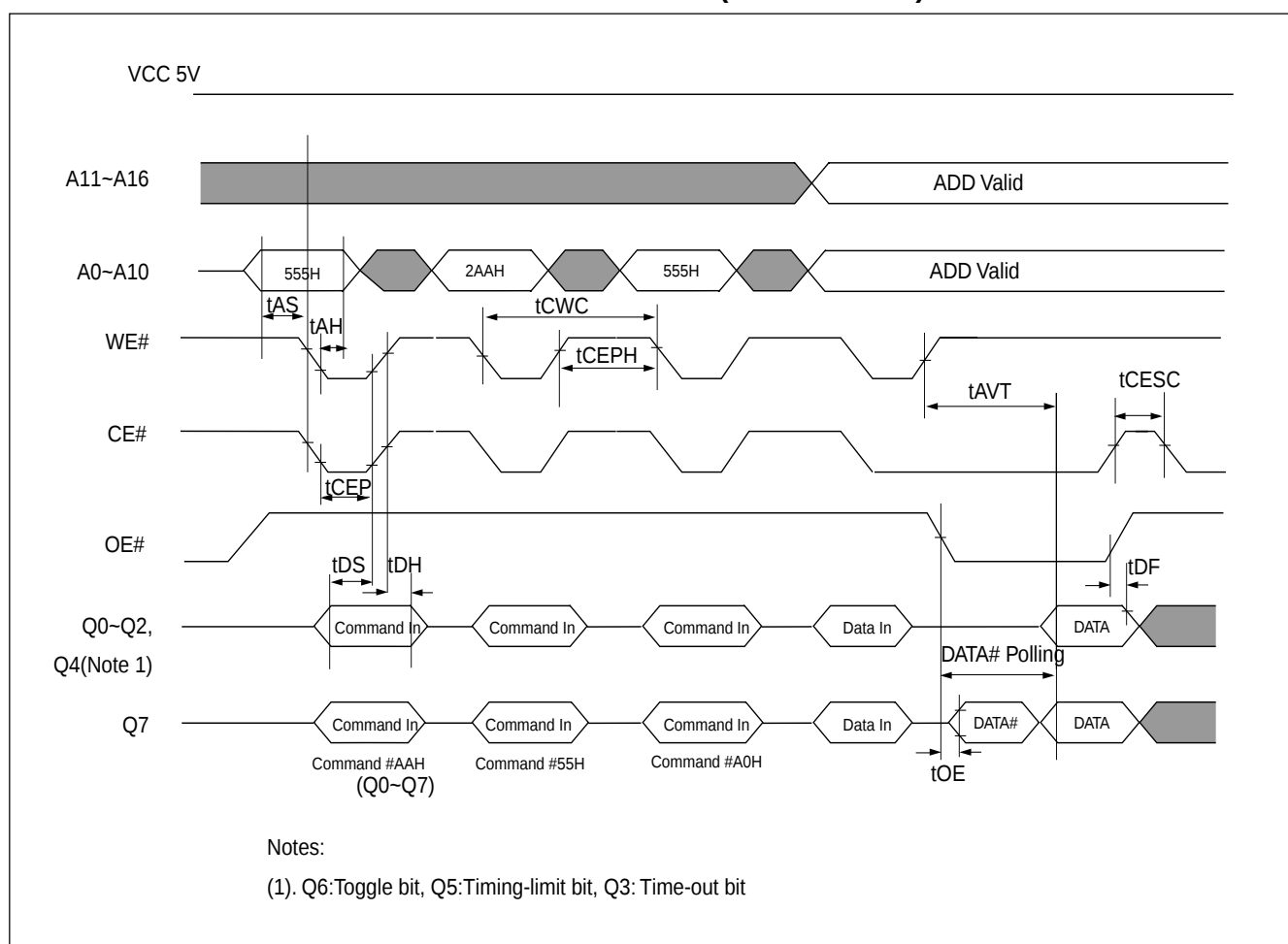
COMMAND WRITE TIMING WAVEFORM


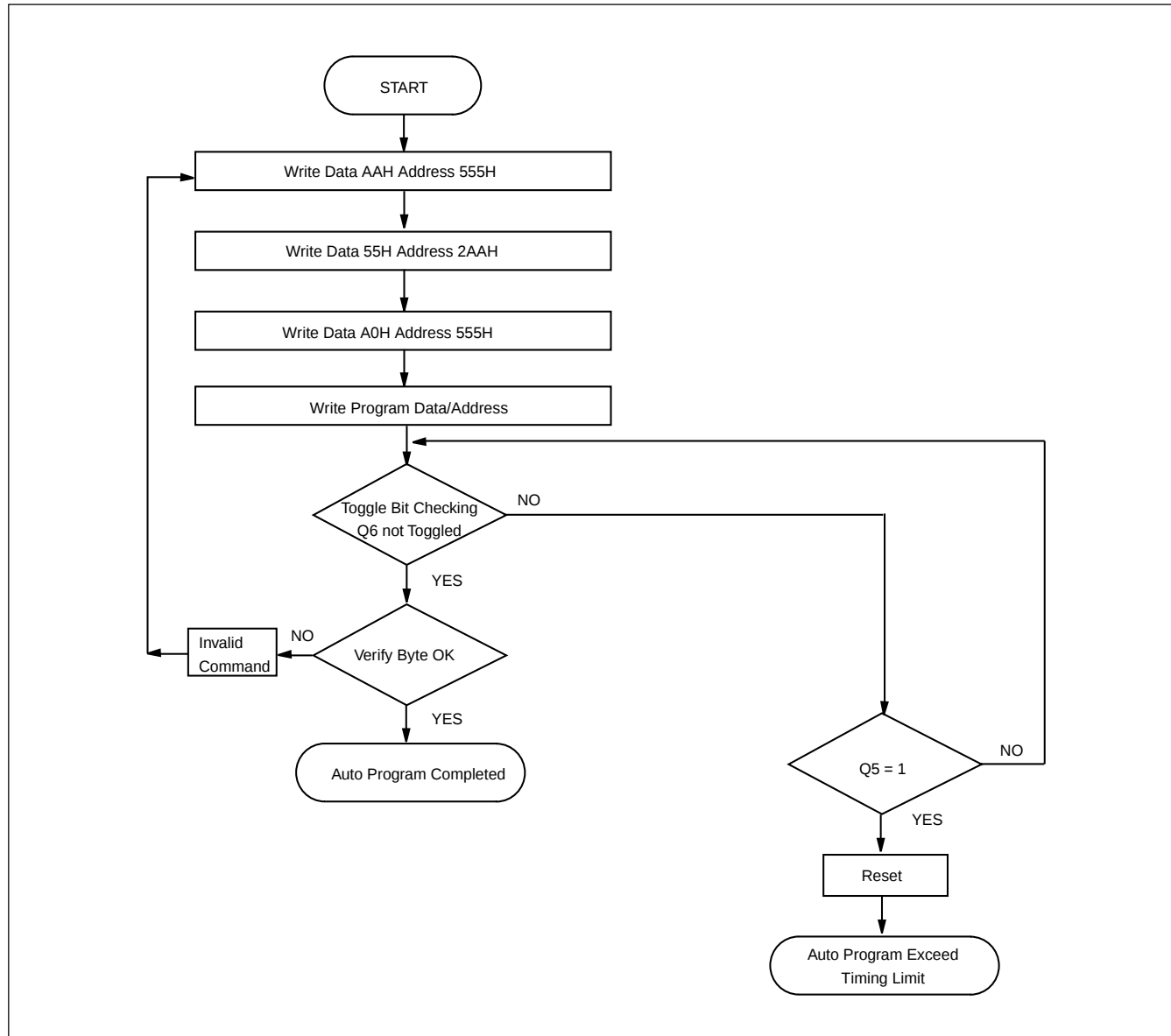
AUTOMATIC PROGRAMMING TIMING WAVEFORM

One byte data is programmed. Verify in fast algorithm and additional programming 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

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

AUTOMATIC PROGRAMMING TIMING WAVEFORM (WORD MODE)



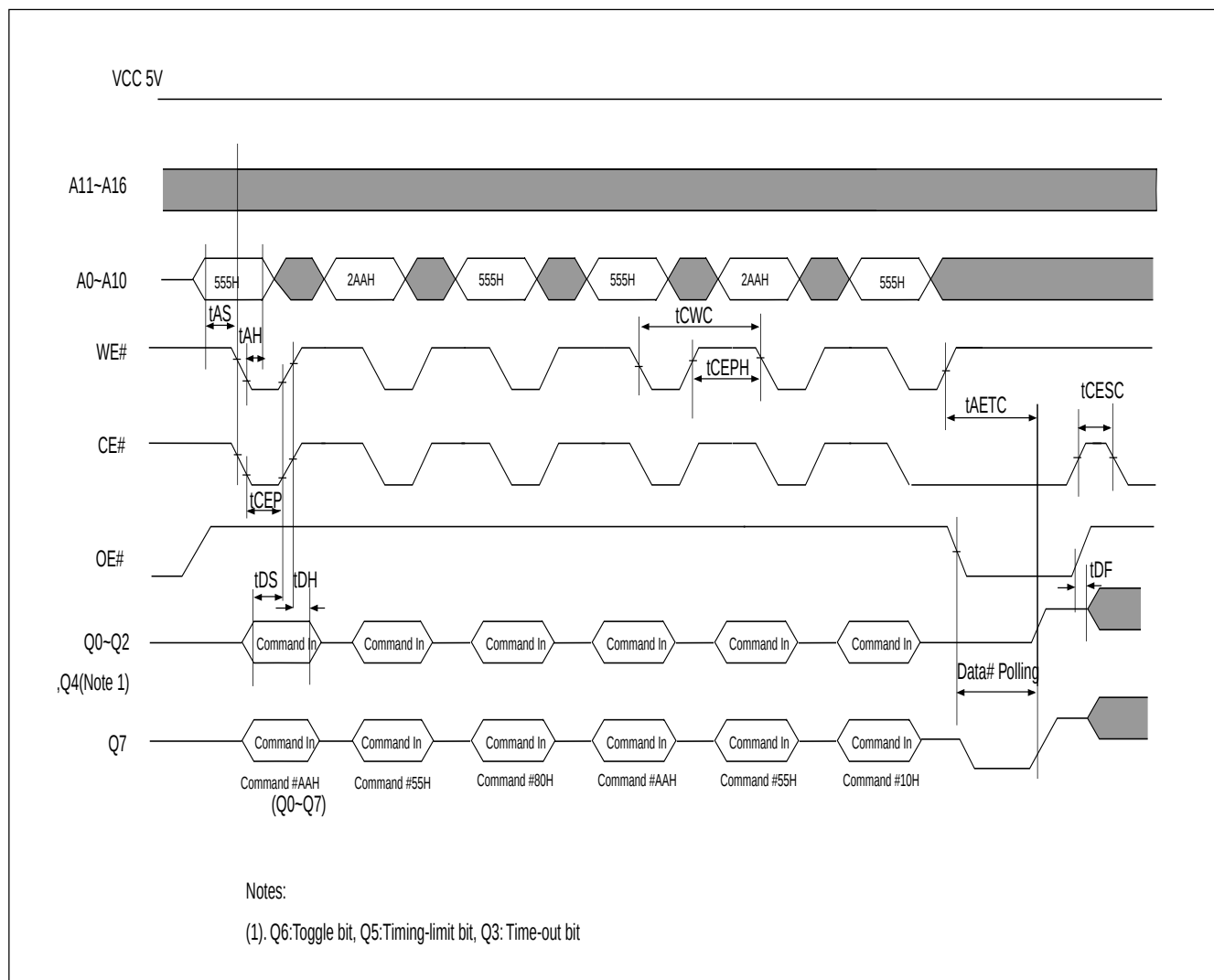
AUTOMATIC PROGRAMMING ALGORITHM FLOWCHART (WORD MODE)


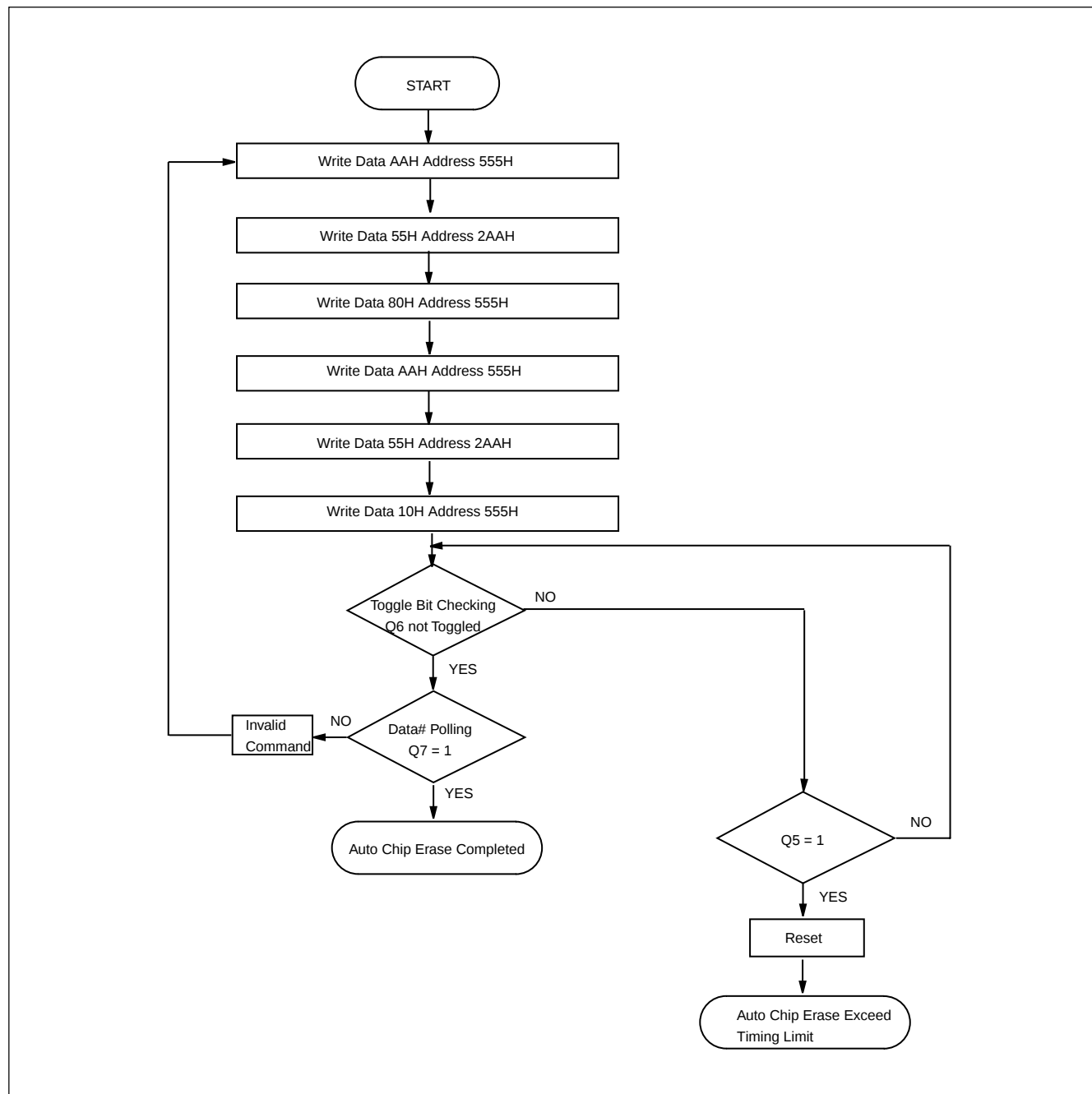
AUTOMATIC CHIP ERASE TIMING WAVEFORM

All data in chip are erased. External erase verification is not required because data is erased 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 0n Q7. (Q6 is for toggle bit; see toggle bit, Data# Polling, timing waveform)

AUTOMATIC CHIP ERASE TIMING WAVEFORM (WORD MODE)



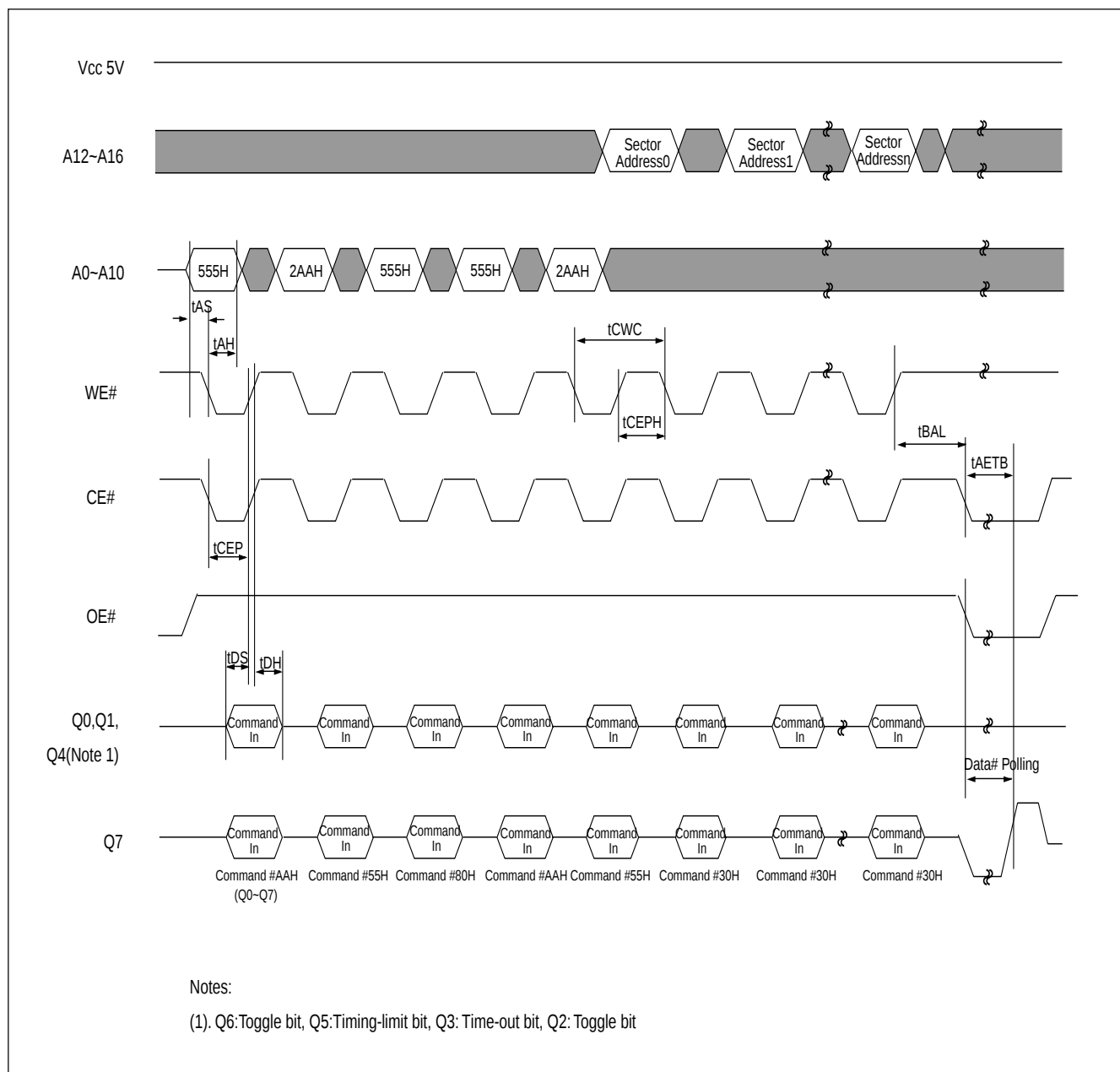
AUTOMATIC CHIP ERASE ALGORITHM FLOWCHART (WORD MODE)


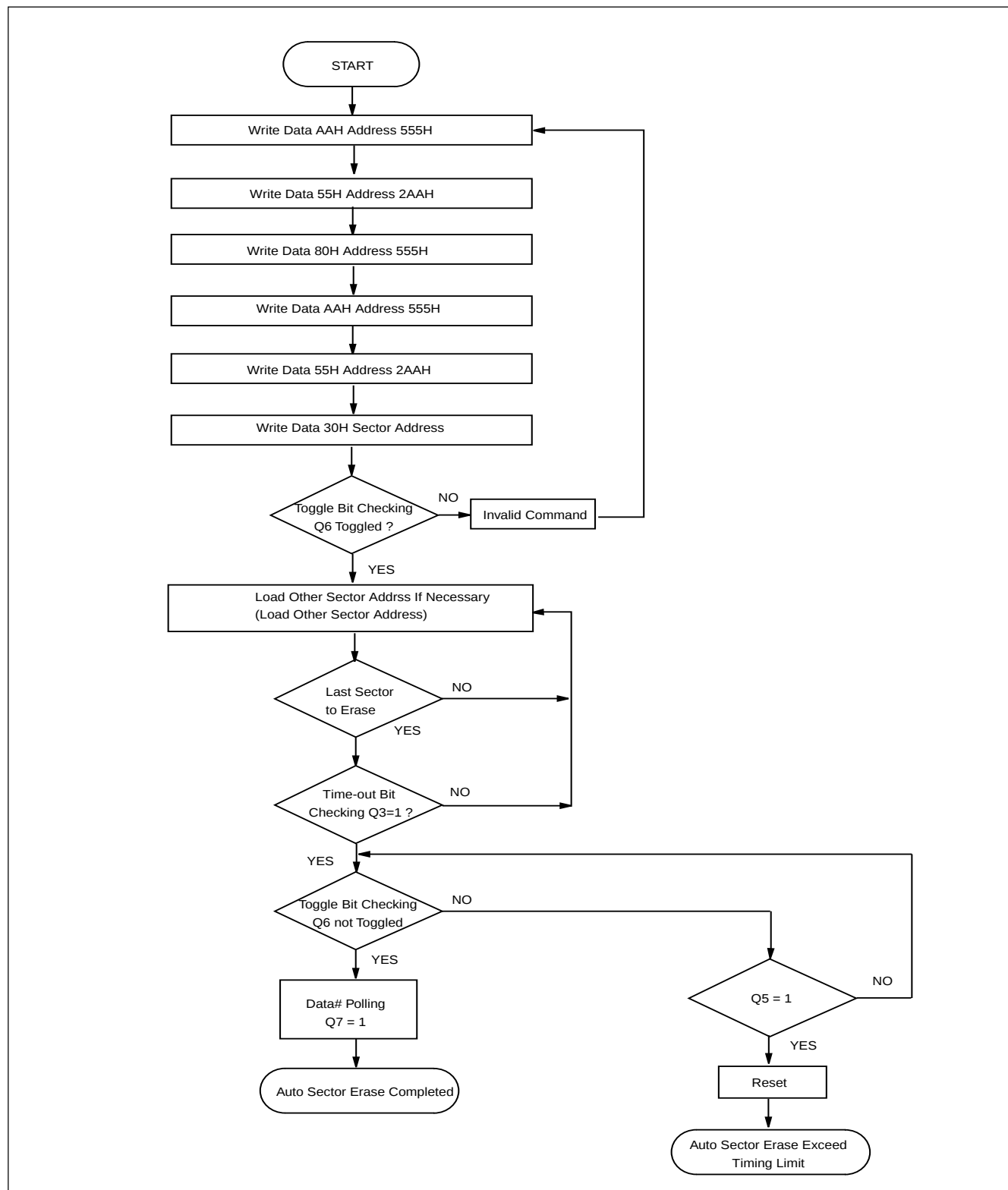
AUTOMATIC SECTOR ERASE TIMING WAVEFORM

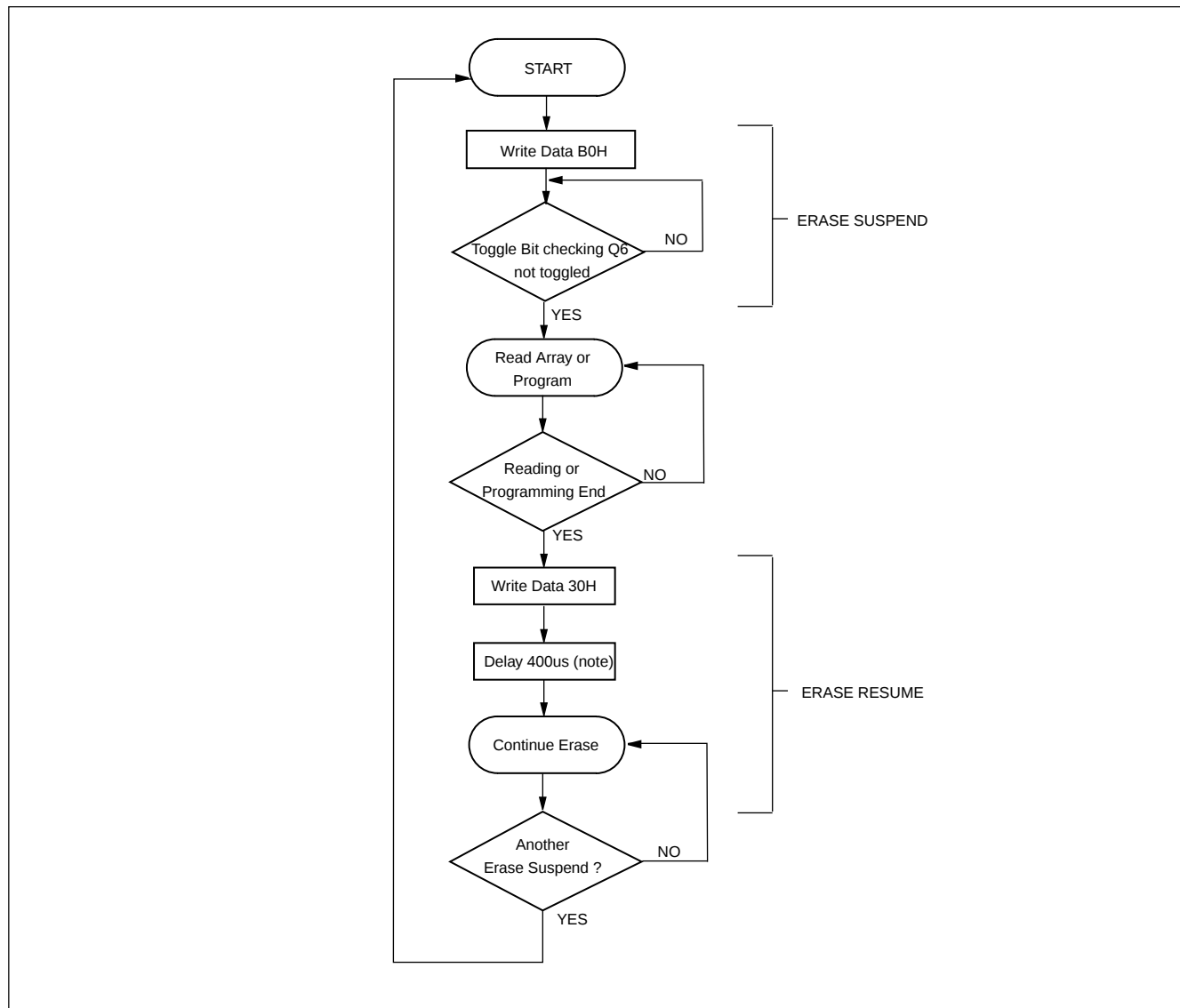
Sector data indicated by A12 to A16 are erased. External erase verification is not required because data are erased automatically by internal control circuit. Erasure completion can be verified by Data# Polling and toggle bit

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)

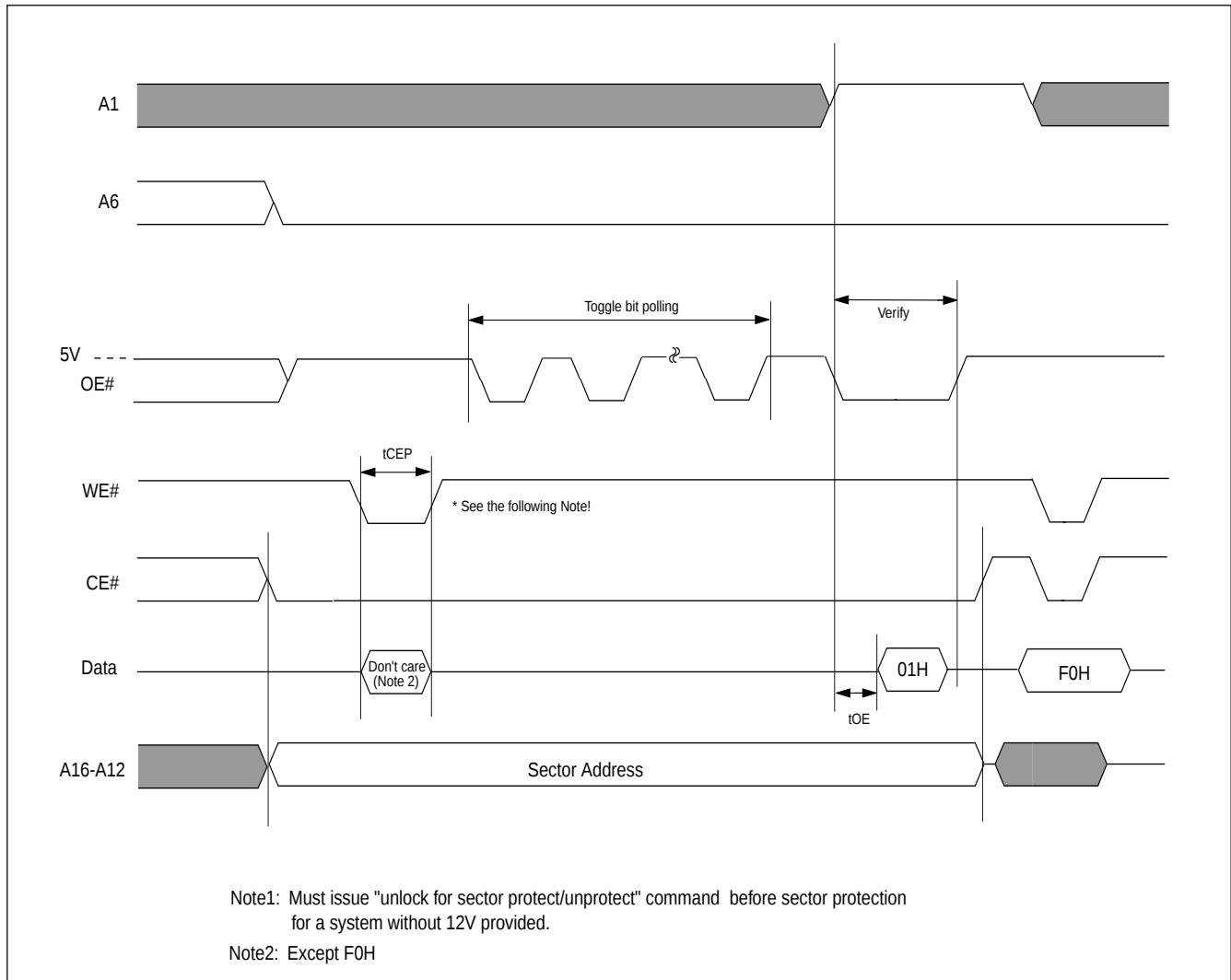
AUTOMATIC SECTOR ERASE TIMING WAVEFORM (WORD MODE)



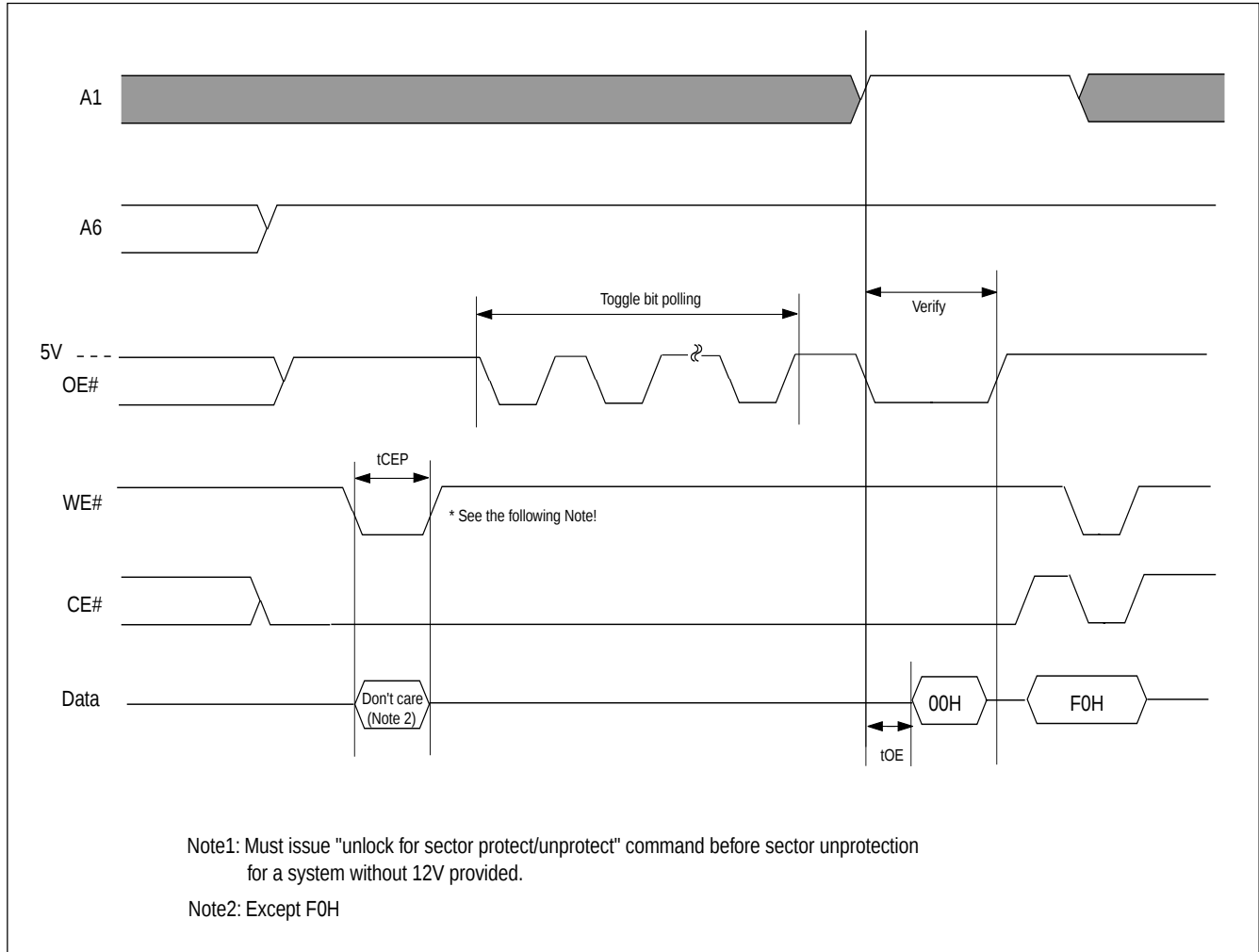
AUTOMATIC SECTOR ERASE ALGORITHM FLOWCHART


ERASE SUSPEND/ERASE RESUME FLOWCHART


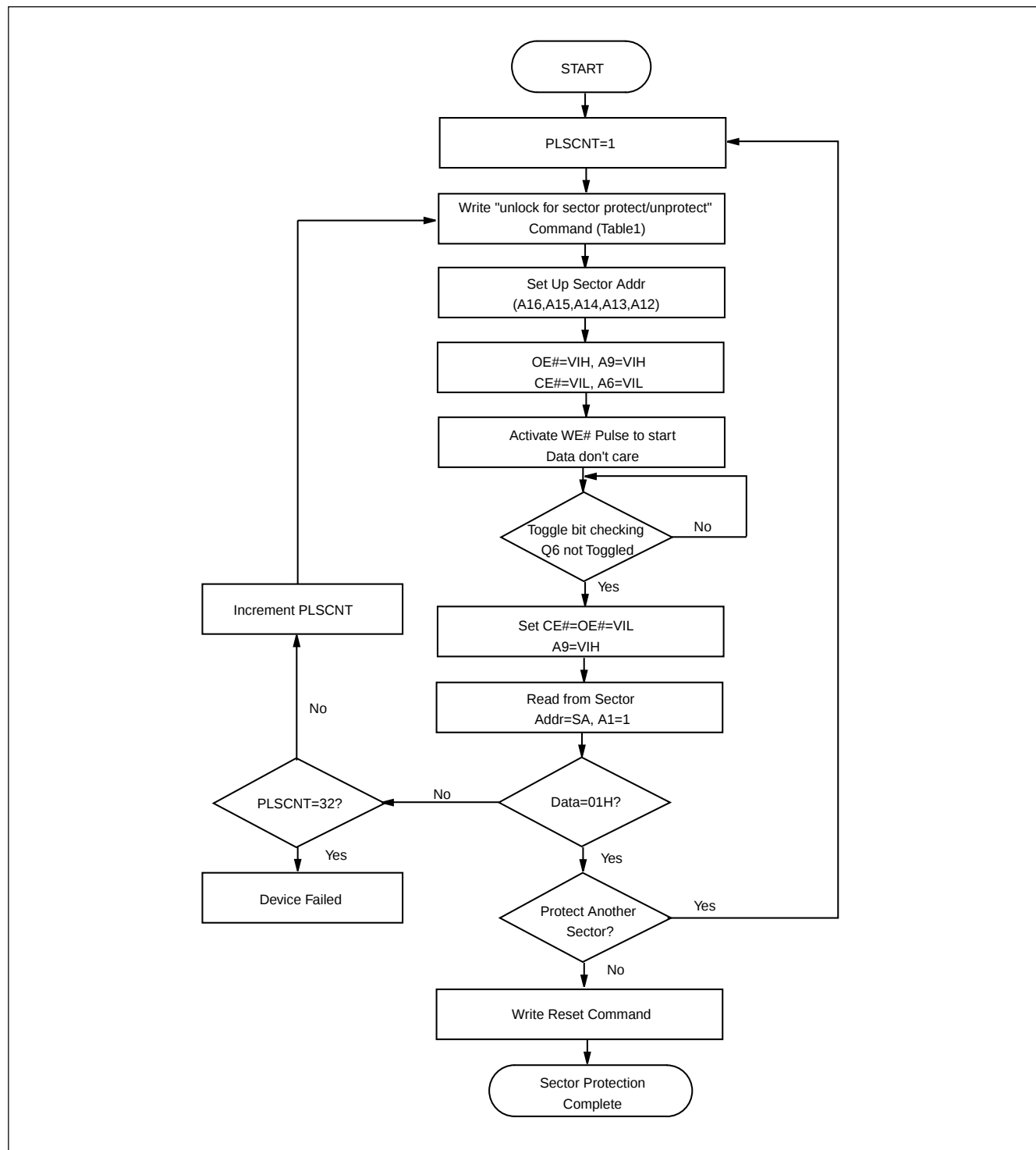
Note: If the system implements an endless erase suspend/resume loop, or the number of erase suspend/resume is exceeded 1024 times, then the 400us time delay must be put into consideration.

TIMING WAVEFORM FOR SECTOR PROTECTION FOR SYSTEM WITHOUT 12V


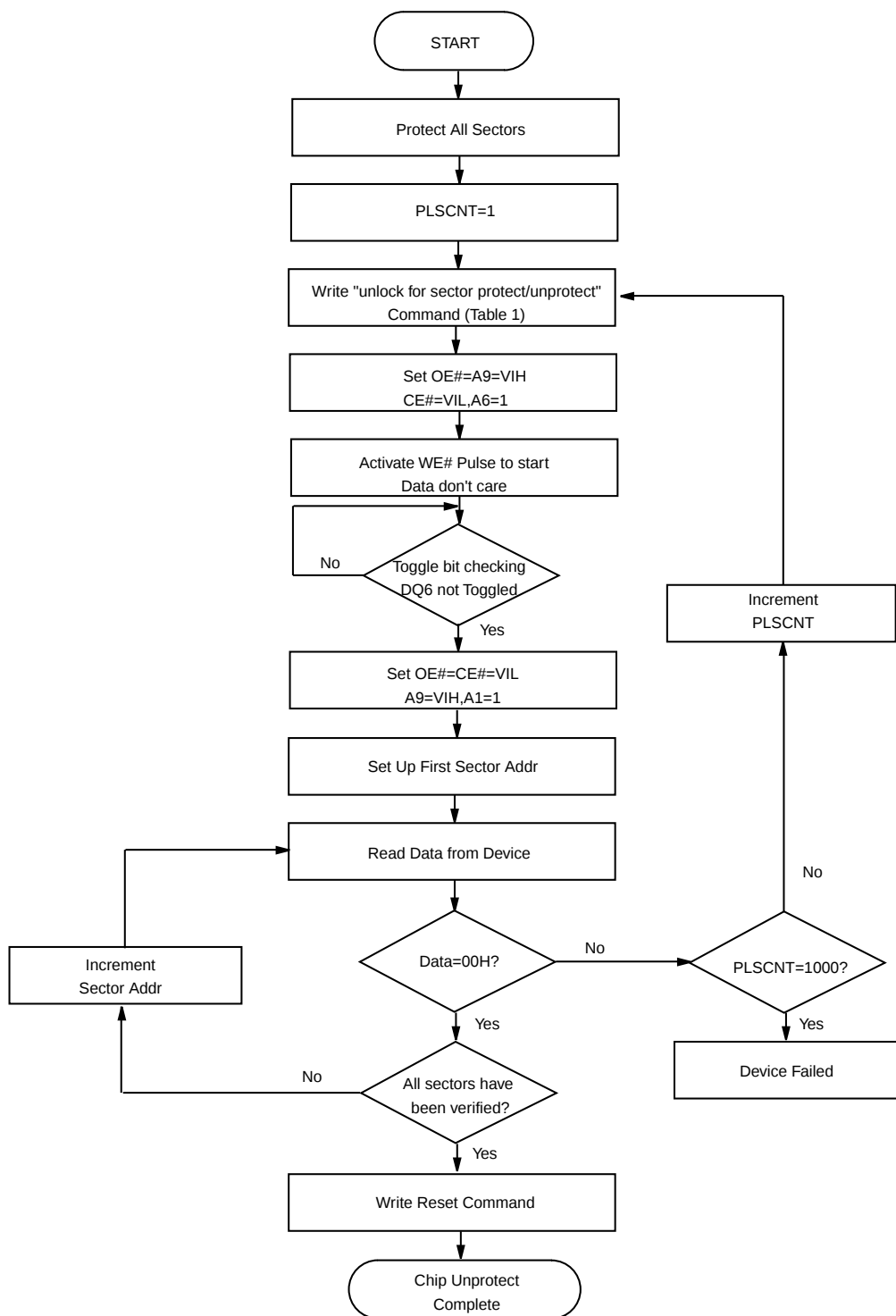
TIMING WAVEFORM FOR CHIP UNPROTECTION FOR SYSTEM WITHOUT 12V



SECTOR PROTECTION ALGORITHM FOR SYSTEM WITHOUT 12V

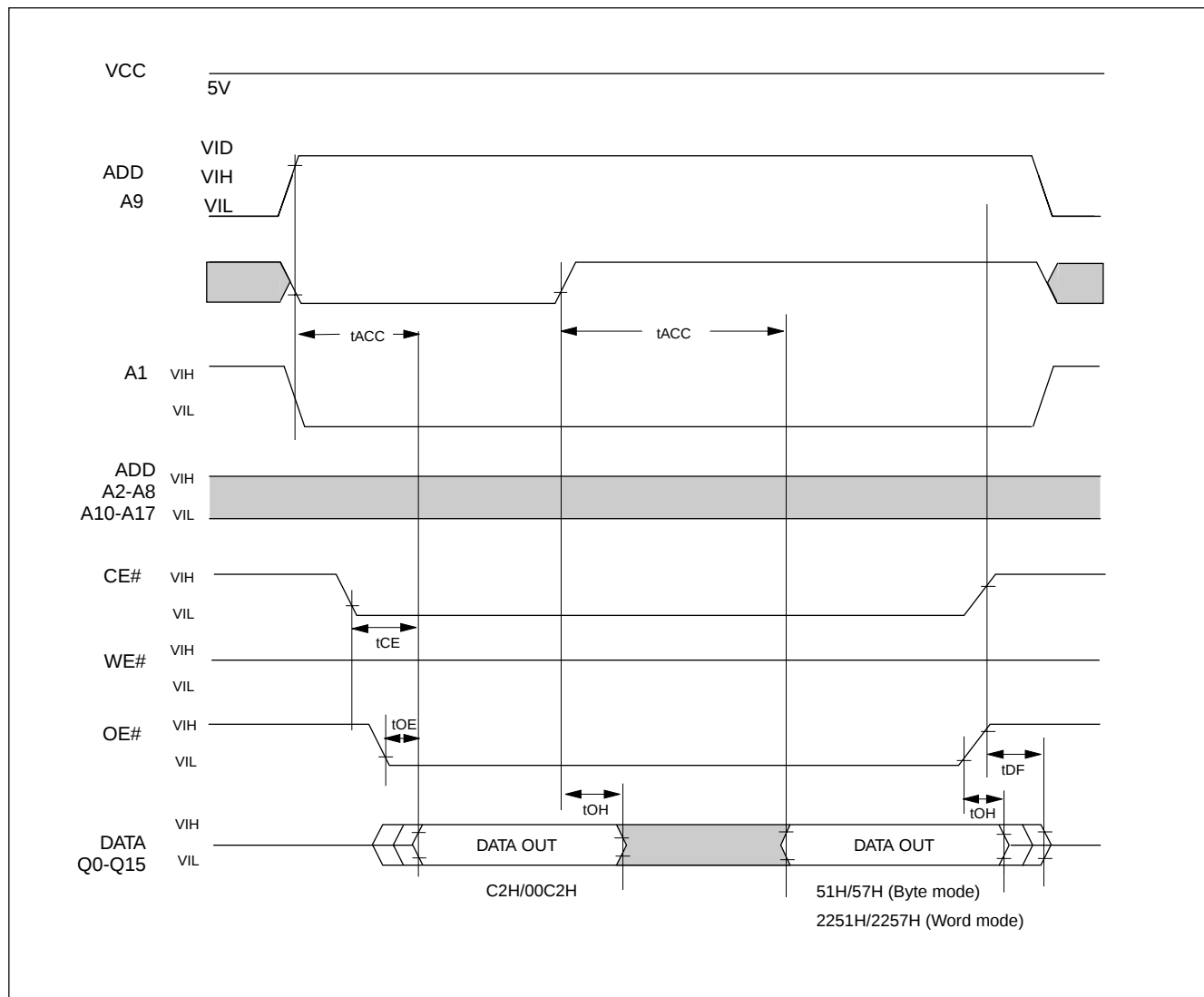


SECTOR UNPROTECTION ALGORITHM FOR SYSTEM WITHOUT 12V



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

ID CODE READ TIMING WAVEFORM



RECOMMENDED OPERATING CONDITIONS

At Device Power-Up

AC timing illustrated in Figure A is recommended for the supply voltages and the control signals at device power-up. If the timing in the figure is ignored, the device may not operate correctly.

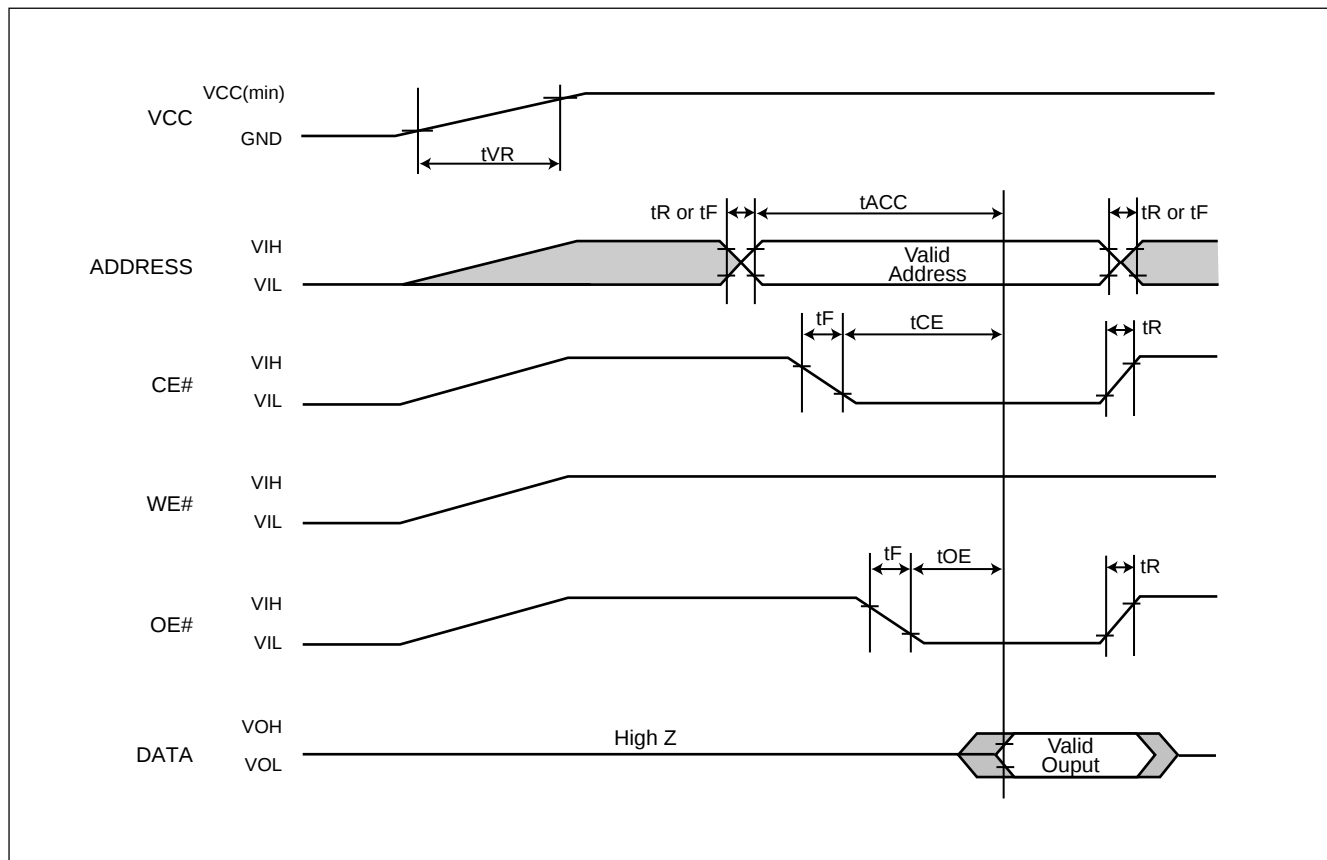


Figure A. AC Timing at Device Power-Up

Symbol	Parameter	Notes	Min.	Max.	Unit
tVR	VCC Rise Time	1	20	500000	us/V
tR	Input Signal Rise Time	1,2		20	us/V
tF	Input Signal Fall Time	1,2		20	us/V

Notes :

1. Sampled, not 100% tested.
2. This specification is applied for not only the device power-up but also the normal operations.

ERASE AND PROGRAMMING PERFORMANCE(1)

PARAMETER		LIMITS			UNITS
		MIN.	TYP.(2)	MAX.(3)	
Sector Erase Time			0.7	15	sec
Chip Erase Time			4	32	sec
Byte Programming Time			9	300	us
Word Programming Time			11	360	us
Chip Programming Time	Byte Mode		2.3	6.8	sec
	Word Mode		1.5	4.5	sec
Erase/Program Cycles		100,000			Cycles

Note: 1. Not 100% Tested, Excludes external system level over head.
2. Typical values measured at 25° C, 5V.
3. Maximum values measured at worst condition: 90° C, 4.5V, 100K cycles.

LATCH-UP CHARACTERISTICS

	MIN.	MAX.
Input Voltage with respect to GND on all pins except I/O pins	-1.0V	13.5V
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 = 5.0V, one pin at a time.		

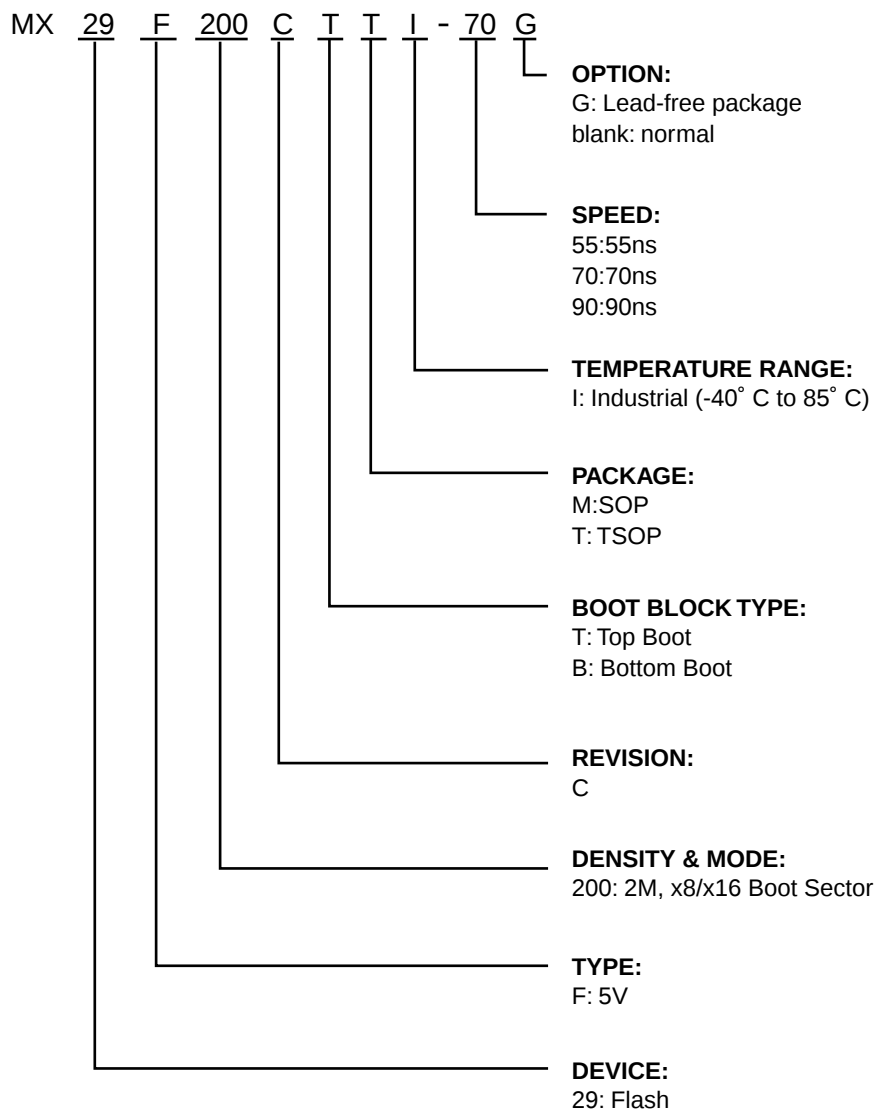
DATA RETENTION

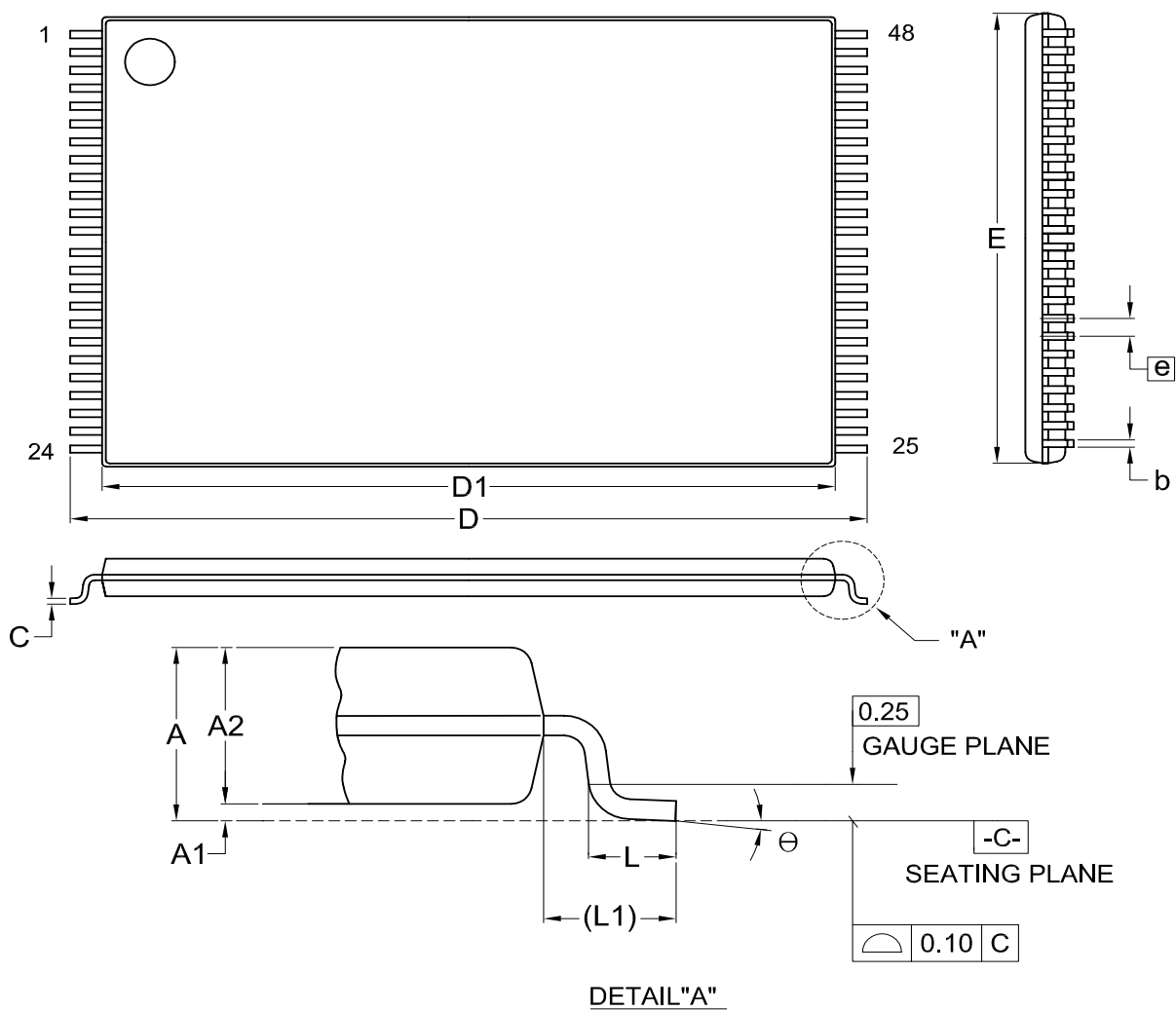
PARAMETER	MIN.	UNIT
Data Retention Time	20	Years

ORDERING INFORMATION

PART NO.	ACCESS	OPERATING	STANDBY	PACKAGE	Remark
	TIME (ns)	Current MAX. (mA)	Current MAX. (uA)		
MX29F200CTMI-55	55	40	5	44 Pin SOP	
MX29F200CTMI-70	70	40	5	44 Pin SOP	
MX29F200CTMI-90	90	40	5	44 Pin SOP	
MX29F200CTTI-55	55	40	5	48 Pin TSOP (Normal Type)	
MX29F200CTTI-70	70	40	5	48 Pin TSOP (Normal Type)	
MX29F200CTTI-90	90	40	5	48 Pin TSOP (Normal Type)	
MX29F200CBMI-55	55	40	5	44 Pin SOP	
MX29F200CBMI-70	70	40	5	44 Pin SOP	
MX29F200CBMI-90	90	40	5	44 Pin SOP	
MX29F200CBTI-55	55	40	5	48 Pin TSOP (Normal Type)	
MX29F200CBTI-70	70	40	5	48 Pin TSOP (Normal Type)	
MX29F200CBTI-90	90	40	5	48 Pin TSOP (Normal Type)	
MX29F200CTMI-55G	55	40	5	44 Pin SOP	Pb-free
MX29F200CTMI-70G	70	40	5	44 Pin SOP	Pb-free
MX29F200CTMI-90G	90	40	5	44 Pin SOP	Pb-free
MX29F200CTTI-55G	55	40	5	48 Pin TSOP (Normal Type)	Pb-free
MX29F200CTTI-70G	70	40	5	48 Pin TSOP (Normal Type)	Pb-free
MX29F200CTTI-90G	90	40	5	48 Pin TSOP (Normal Type)	Pb-free
MX29F200CBMI-55G	55	40	5	44 Pin SOP	Pb-free
MX29F200CBMI-70G	70	40	5	44 Pin SOP	Pb-free
MX29F200CBMI-90G	90	40	5	44 Pin SOP	Pb-free
MX29F200CBTI-55G	55	40	5	48 Pin TSOP (Normal Type)	Pb-free
MX29F200CBTI-70G	70	40	5	48 Pin TSOP (Normal Type)	Pb-free
MX29F200CBTI-90G	90	40	5	48 Pin TSOP (Normal Type)	Pb-free

PART NAME DESCRIPTION



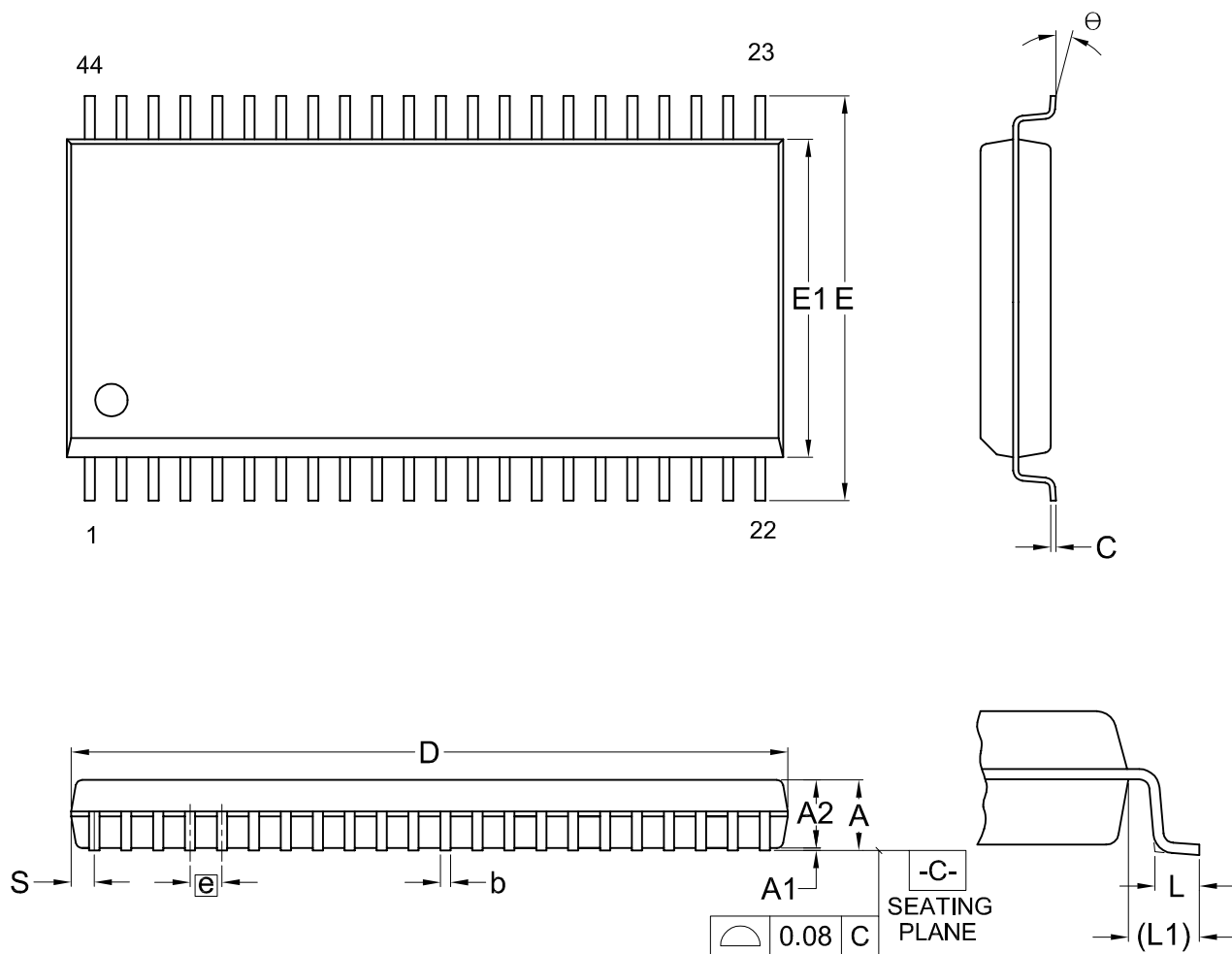
PACKAGE INFORMATION
Title: Package Outline for TSOP(I) 48L (12X20mm)NORMAL FORM


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

Title: Package Outline for SOP 44L (500MIL)



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

SYMBOL UNIT		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



REVISION HISTORY

Revision No.	Description	Page	Date
1.0	1. Removed "Preliminary" title	P1	DEC/14/2005
	2. Removed commercial grade	All	
	3. Added access time: 55ns	All	



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