MX29LV320T/B

32M-BIT [4M x 8 / 2M x 16] SINGLE VOLTAGE 3V ONLY FLASH MEMORY

FEATURES

GENERAL FEATURES

- 4,194,304 x 8 / 2,097,152 x 16 switchable
- Sector Structure
  - 8K-Byte x 8 and 64K-Byte x 63
- Extra 64K-Byte sector for security
  - Features factory locked and identifiable, and customer lockable
- Twenty-Four Sector Groups
  - Provides sector group protect function to prevent program or erase operation in the protected sector group
  - Provides chip unprotect function to allow code changing
  - Provides temporary sector group unprotect function for code changing in previously protected sector groups
- Single Power Supply Operation
  - 2.7 to 3.6 volt for read, erase, and program operations
- Latch-up protected to 250mA from -1V to Vcc + 1V
- Low Vcc write inhibit is equal to or less than 1.4V
- Compatible with JEDEC standard
  - Pinout and software compatible to single power supply Flash

PERFORMANCE

- High Performance
  - Fast access time: 70/90/120ns
  - Fast program time: 7us/word typical utilizing accelerate function
  - Fast erase time: 1.6s/sector, 112s/chip (typical)
- Low Power Consumption
  - Low active read current: 10mA (typical) at 5MHz
  - Low standby current: 200nA (typical)
- Minimum 100,000 erase/program cycle
- 10-year data retention

SOFTWARE FEATURES

- Erase Suspend/ Erase Resume
  - Suspends sector erase operation to read data from or program data to another sector which is not being erased
- Status Reply
  - Data polling & Toggle bits provide detection of program and erase operation completion
- Support Common Flash Interface (CFI)

HARDWARE FEATURES

- Ready/Busy (RY/BY) Output
  - Provides a hardware method of detecting program and erase operation completion
- Hardware Reset (RESET) Input
  - Provides a hardware method to reset the internal state machine to read mode
- WP/ACC input pin
  - Provides accelerated program capability

PACKAGE

- 48-Pin TSOP
- 48-Ball CSP

GENERAL DESCRIPTION

The MX29LV320T/B is a 32-mega bit Flash memory organized as 4M bytes of 8 bits and 2M words of 16 bits. MXIC's Flash memories offer the most cost-effective and reliable read/write non-volatile random access memory. The MX29LV320T/B is packaged in 48-pin TSOP and 48-ball CSP. It is designed to be reprogrammed and erased in system or in standard EPROM programmers.

The standard MX29LV320T/B offers access time as fast as 70ns, allowing operation of high-speed microprocessors without wait states. To eliminate bus contention, the MX29LV320T/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 MX29LV320T/B uses a command register to manage this functionality.

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 program mechanisms. In addition, the combination of advanced tunnel oxide processing and low internal electric fields for erase and programming operations produces reliable cycling.

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The MX29LV320T/B uses a 2.7V to 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.

AUTOMATIC PROGRAMMING

The MX29LV320T/B is byte/word 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. The typical chip programming time at room temperature of the MX29LV320T/B is less than 36 seconds.

AUTOMATIC PROGRAMMING ALGORITHM

MXIC's Automatic Programming algorithm require 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.

AUTOMATIC CHIP ERASE

The entire chip is bulk erased using 50 ms erase pulses according to MXIC's Automatic Chip Erase algorithm. Typical erasure at room temperature is accomplished in less than 50 seconds. 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 MX29LV320T/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 controlled internally within the 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 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 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 .

MXIC's Flash technology combines years of EPROM experience to produce the highest levels of quality, reliability, and cost effectiveness. The MX29LV320T/B electrically erases all bits simultaneously using Fowler-Nordheim tunneling. The bytes/words 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 completed, 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.

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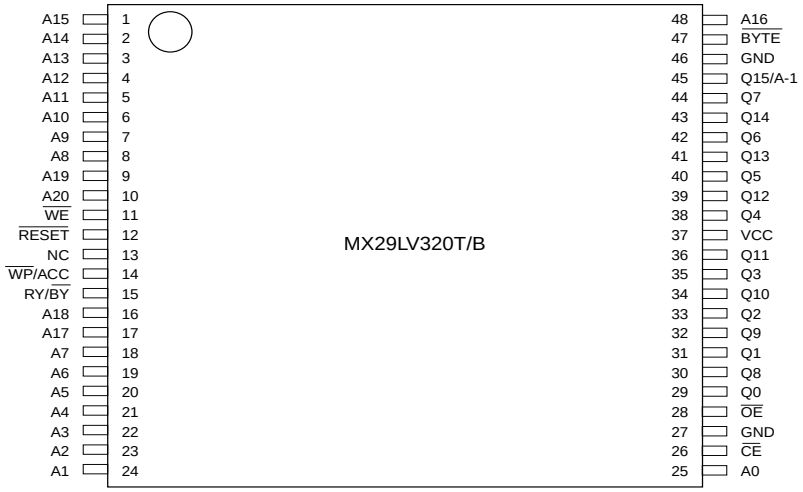
PIN CONFIGURATION

48 TSOP



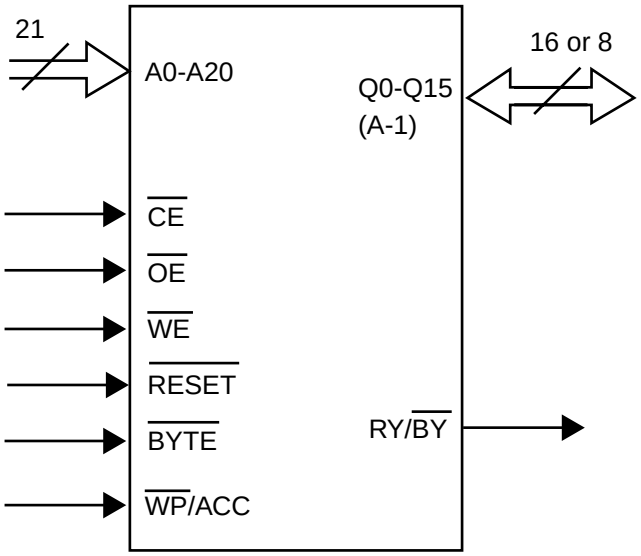
48-Ball CSP 8mm x 9mm (Ball Pitch = 0.8 mm), Top View, Balls Facing Down

	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	WP/ACC	A18	A20	Q2	Q10	Q11	Q3
2	A7	A17	A6	A5	Q0	Q8	Q9	Q1
1	A3	A4	A2	A1	A0	CE	OE	GND

PIN DESCRIPTION

SYMBOL	PIN NAME
A0~A20	Address Input
Q0~Q14	15 Data Inputs/Outputs
Q15/A-1	Q15(Data Input/Output, word mode) A-1(LSB Address Input, byte mode)
CE	Chip Enable Input
WE	Write Enable Input
OE	Output Enable Input
BYTE	Word/Byte Selection Input
RESET	Hardware Reset Pin, Active Low
RY/BY	Read/Busy Output
VCC	3.0 volt-only single power supply
WP/ACC	Hardware Write Protect/Acceleration Pin
GND	Device Ground
NC	Pin Not Connected Internally

LOGIC SYMBOL



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BLOCK DIAGRAM

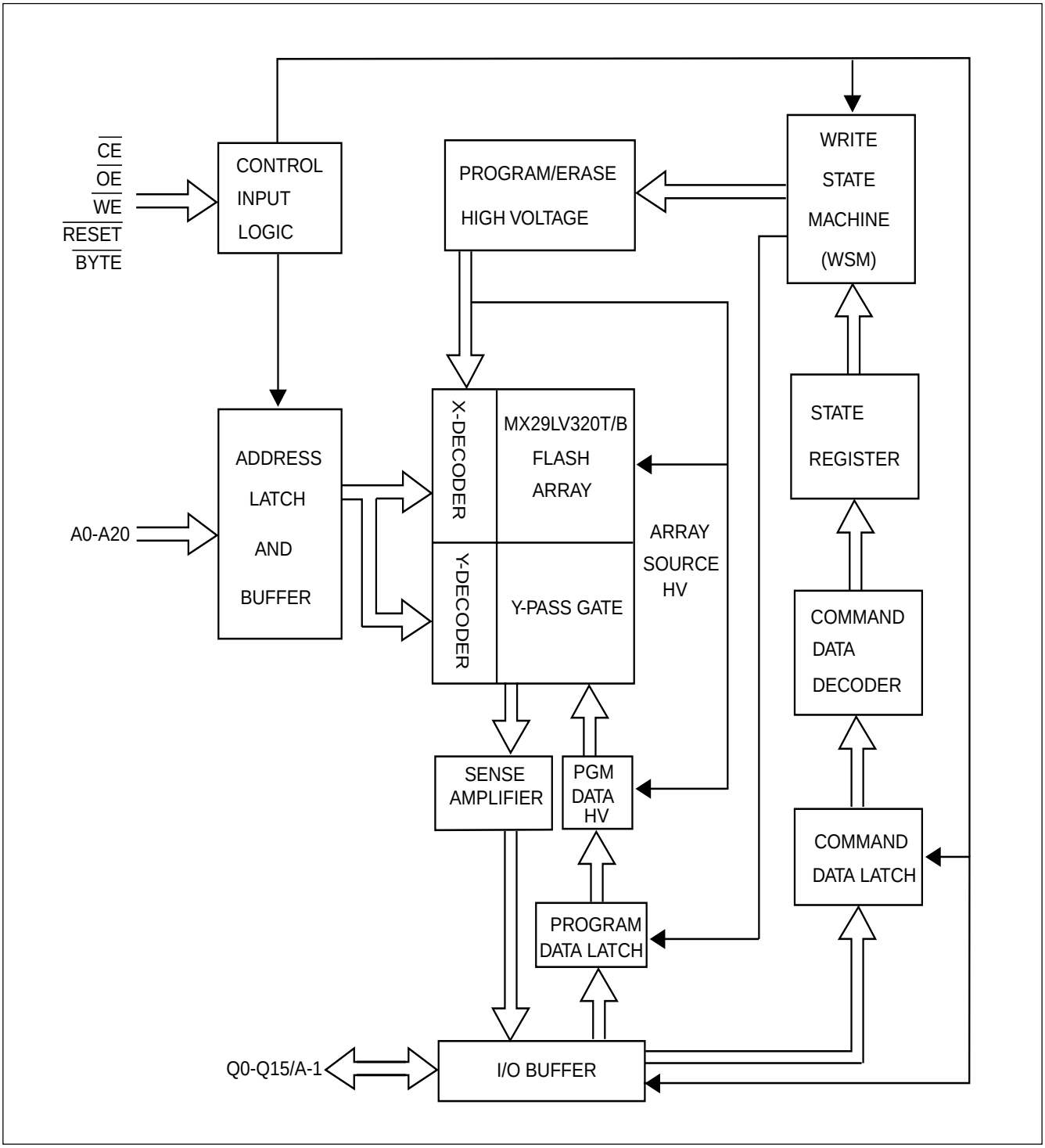

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Table 1.a: MX29LV320T SECTOR GROUP ARCHITECTURE

Sector Group	Sector	Sector Address A20-A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
1	SA0	000000xxx	64/32	000000h-00FFFFh	000000h-07FFFh
1	SA1	000001xxx	64/32	010000h-01FFFFh	008000h-0FFFFh
1	SA2	000010xxx	64/32	020000h-02FFFFh	010000h-17FFFh
1	SA3	000011xxx	64/32	030000h-03FFFFh	018000h-01FFFFh
2	SA4	000100xxx	64/32	040000h-04FFFFh	020000h-027FFFh
2	SA5	000101xxx	64/32	050000h-05FFFFh	028000h-02FFFFh
2	SA6	000110xxx	64/32	060000h-06FFFFh	030000h-037FFFh
2	SA7	000111xxx	64/32	070000h-07FFFFh	038000h-03FFFFh
3	SA8	001000xxx	64/32	080000h-08FFFFh	040000h-047FFFh
3	SA9	001001xxx	64/32	090000h-09FFFFh	048000h-04FFFFh
3	SA10	001010xxx	64/32	0A0000h-0AFFFFh	050000h-057FFFh
3	SA11	001011xxx	64/32	0B0000h-0BFFFFh	058000h-05FFFFh
4	SA12	001100xxx	64/32	0C0000h-0CFFFFh	060000h-067FFFh
4	SA13	001101xxx	64/32	0D0000h-0DFFFFh	068000h-06FFFFh
4	SA14	001110xxx	64/32	0E0000h-0EFFFFh	070000h-077FFFh
4	SA15	001111xxx	64/32	0F0000h-0FFFFFh	078000h-07FFFFh
5	SA16	010000xxx	64/32	100000h-10FFFFh	080000h-087FFFh
5	SA17	010001xxx	64/32	110000h-11FFFFh	088000h-08FFFFh
5	SA18	010010xxx	64/32	120000h-12FFFFh	090000h-097FFFh
5	SA19	010011xxx	64/32	130000h-13FFFFh	098000h-09FFFFh
6	SA20	010100xxx	64/32	140000h-14FFFFh	0A0000h-0A7FFFh
6	SA21	010101xxx	64/32	150000h-15FFFFh	0A8000h-0AFFFFh
6	SA22	010110xxx	64/32	160000h-16FFFFh	0B0000h-0B7FFFh
6	SA23	010111xxx	64/32	170000h-17FFFFh	0B8000h-0BFFFFh
7	SA24	011000xxx	64/32	180000h-18FFFFh	0C0000h-0C7FFFh
7	SA25	011001xxx	64/32	190000h-19FFFFh	0C8000h-0CFFFFh
7	SA26	011010xxx	64/32	1A0000h-1AFFFFh	0D0000h-0D7FFFh
7	SA27	011011xxx	64/32	1B0000h-1BFFFFh	0D8000h-0DFFFFh
8	SA28	011100xxx	64/32	1C0000h-1CFFFFh	0E0000h-0E7FFFh
8	SA29	011101xxx	64/32	1D0000h-1DFFFFh	0E8000h-0EFFFFh
8	SA30	011110xxx	64/32	1E0000h-1EFFFFh	0F0000h-0F7FFFh
8	SA31	011111xxx	64/32	1F0000h-1FFFFFh	0F8000h-0FFFFFh
9	SA32	100000xxx	64/32	200000h-20FFFFh	100000h-107FFFh
9	SA33	100001xxx	64/32	210000h-21FFFFh	108000h-10FFFFh
9	SA34	100010xxx	64/32	220000h-22FFFFh	110000h-117FFFh
9	SA35	100011xxx	64/32	230000h-23FFFFh	118000h-11FFFFh
10	SA36	100100xxx	64/32	240000h-24FFFFh	120000h-127FFFh
10	SA37	100101xxx	64/32	250000h-25FFFFh	128000h-12FFFFh
10	SA38	100110xxx	64/32	260000h-26FFFFh	130000h-137FFFh
10	SA39	100111xxx	64/32	270000h-27FFFFh	138000h-13FFFFh

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Sector Group	Sector	Sector Address A20-A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
11	SA40	101000xxx	64/32	280000h-28FFFFh	140000h-147FFFh
11	SA41	101001xxx	64/32	290000h-29FFFFh	148000h-14FFFFh
11	SA42	101010xxx	64/32	2A0000h-2AFFFFh	150000h-157FFFh
11	SA43	101011xxx	64/32	2B0000h-2BFFFFh	158000h-15FFFFh
12	SA44	101100xxx	64/32	2C0000h-2CFFFFh	160000h-147FFFh
12	SA45	101101xxx	64/32	2D0000h-2DFFFFh	168000h-14FFFFh
12	SA46	101110xxx	64/32	2E0000h-2EFFFFh	170000h-177FFFh
12	SA47	101111xxx	64/32	2F0000h-2FFFFFh	178000h-17FFFFh
13	SA48	110000xxx	64/32	300000h-30FFFFh	180000h-187FFFh
13	SA49	110001xxx	64/32	310000h-31FFFFh	188000h-18FFFFh
13	SA50	110010xxx	64/32	320000h-32FFFFh	190000h-197FFFh
13	SA51	110011xxx	64/32	330000h-33FFFFh	198000h-19FFFFh
14	SA52	110100xxx	64/32	340000h-34FFFFh	1A0000h-1A7FFFh
14	SA53	110101xxx	64/32	350000h-35FFFFh	1A8000h-1AFFFFh
14	SA54	110110xxx	64/32	360000h-36FFFFh	1B0000h-1B7FFFh
14	SA55	110111xxx	64/32	370000h-37FFFFh	1B8000h-1BFFFFh
15	SA56	111000xxx	64/32	380000h-38FFFFh	1C0000h-1C7FFFh
15	SA57	111001xxx	64/32	390000h-39FFFFh	1C8000h-1CFFFFh
15	SA58	111010xxx	64/32	3A0000h-3AFFFFh	1D0000h-1D7FFFh
15	SA59	111011xxx	64/32	3B0000h-3BFFFFh	1D8000h-1DFFFFh
16	SA60	111100xxx	64/32	3C0000h-3CFFFFh	1E0000h-1E7FFFh
16	SA61	111101xxx	64/32	3D0000h-3DFFFFh	1E8000h-1EFFFFh
16	SA62	111110xxx	64/32	3E0000h-3EFFFFh	1F0000h-1F7FFFh
17	SA63	111111000	8/4	3F0000h-3F1FFFh	1F8000h-1F8FFFh
18	SA64	111111001	8/4	3F2000h-3F3FFFh	1F9000h-1F9FFFh
19	SA65	111111010	8/4	3F4000h-3F5FFFh	1FA000h-1FAFFFh
20	SA66	111111011	8/4	3F6000h-3F7FFFh	1FB000h-1FBFFFh
21	SA67	111111100	8/4	3F8000h-3F9FFFh	1FC000h-1FCFFFh
22	SA68	111111101	8/4	3FA000h-3FBFFFh	1FD000h-1FDFFFh
23	SA69	111111110	8/4	3FC000h-3FDFFFh	1FE000h-1FEFFFh
24	SA70	111111111	8/4	3FE000h-3FFFFFh	1FF000h-1FFFFFh

Note:The address range is A20:A-1 in byte mode ($\overline{BYTE}$=VIL) or A20:A0 in word mode ($\overline{BYTE}$=VIH)

Top Boot Security Sector Addresses

Sector Address A20~A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
111111xxx	64/32	3F0000h-3FFFFFh	1F8000h-1FFFFFh

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Table 1.b: MX29LV320B SECTOR GROUP ARCHITECTURE

Sector Group	Sector	Sector Address A20-A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
1	SA0	000000000	8/4	000000h-001FFFh	000000h-000FFFh
2	SA1	000000001	8/4	002000h-003FFFh	001000h-001FFFh
3	SA2	000000010	8/4	004000h-005FFFh	002000h-002FFFh
4	SA3	000000011	8/4	006000h-007FFFh	003000h-003FFFh
5	SA4	000000100	8/4	008000h-009FFFh	004000h-004FFFh
6	SA5	000000101	8/4	00A000h-00BFFFh	005000h-005FFFh
7	SA6	000000110	8/4	00C000h-00DFFFh	006000h-006FFFh
8	SA7	000000111	8/4	00E000h-00FFFFh	007000h-007FFFh
9	SA8	000001xxx	64/32	010000h-01FFFFh	008000h-00FFFFh
9	SA9	000010xxx	64/32	020000h-02FFFFh	010000h-017FFFh
9	SA10	000011xxx	64/32	030000h-03FFFFh	018000h-01FFFFh
10	SA11	000100xxx	64/32	040000h-04FFFFh	020000h-027FFFh
10	SA12	000101xxx	64/32	050000h-05FFFFh	028000h-02FFFFh
10	SA13	000110xxx	64/32	060000h-06FFFFh	030000h-037FFFh
10	SA14	000111xxx	64/32	070000h-07FFFFh	038000h-03FFFFh
11	SA15	001000xxx	64/32	080000h-08FFFFh	040000h-047FFFh
11	SA16	001001xxx	64/32	090000h-09FFFFh	048000h-04FFFFh
11	SA17	001010xxx	64/32	0A0000h-0AFFFFh	050000h-057FFFh
11	SA18	001011xxx	64/32	0B0000h-0BFFFFh	058000h-05FFFFh
12	SA19	001100xxx	64/32	0C0000h-0CFFFFh	060000h-067FFFh
12	SA20	001101xxx	64/32	0D0000h-0DFFFFh	068000h-06FFFFh
12	SA21	001110xxx	64/32	0E0000h-0EFFFFh	070000h-077FFFh
12	SA22	001111xxx	64/32	0F0000h-0FFFFFh	078000h-07FFFFh
13	SA23	010000xxx	64/32	100000h-10FFFFh	080000h-087FFFh
13	SA24	010001xxx	64/32	110000h-11FFFFh	088000h-08FFFFh
13	SA25	010010xxx	64/32	120000h-12FFFFh	090000h-097FFFh
13	SA26	010011xxx	64/32	130000h-13FFFFh	098000h-09FFFFh
14	SA27	010100xxx	64/32	140000h-14FFFFh	0A0000h-0A7FFFh
14	SA28	010101xxx	64/32	150000h-15FFFFh	0A8000h-0AFFFFh
14	SA29	010110xxx	64/32	160000h-16FFFFh	0B0000h-0B7FFFh
14	SA30	010111xxx	64/32	170000h-17FFFFh	0B8000h-0BFFFFh
15	SA31	011000xxx	64/32	180000h-18FFFFh	0C0000h-0C7FFFh
15	SA32	011001xxx	64/32	190000h-19FFFFh	0C8000h-0CFFFFh
15	SA33	011010xxx	64/32	1A0000h-1AFFFFh	0D0000h-0D7FFFh
15	SA34	011011xxx	64/32	1B0000h-1BFFFFh	0D8000h-0DFFFFh
16	SA35	011100xxx	64/32	1C0000h-1CFFFFh	0E0000h-0E7FFFh
16	SA36	011101xxx	64/32	1D0000h-1DFFFFh	0E8000h-0EFFFFh
16	SA37	011110xxx	64/32	1E0000h-1EFFFFh	0F0000h-0F7FFFh
16	SA38	011111xxx	64/32	1F0000h-1FFFFFh	0F8000h-0FFFFFh

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Sector Group	Sector	Sector Address A20-A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
17	SA39	100000xxx	64/32	200000h-20FFFFh	100000h-107FFFh
17	SA40	100001xxx	64/32	210000h-21FFFFh	108000h-10FFFFh
17	SA41	100010xxx	64/32	220000h-22FFFFh	110000h-117FFFh
17	SA42	100011xxx	64/32	230000h-23FFFFh	118000h-11FFFFh
18	SA43	100100xxx	64/32	240000h-24FFFFh	120000h-127FFFh
18	SA44	100101xxx	64/32	250000h-25FFFFh	128000h-12FFFFh
18	SA45	100110xxx	64/32	260000h-26FFFFh	130000h-137FFFh
18	SA46	100111xxx	64/32	270000h-27FFFFh	138000h-13FFFFh
19	SA47	101000xxx	64/32	280000h-28FFFFh	140000h-147FFFh
19	SA48	101001xxx	64/32	290000h-29FFFFh	148000h-14FFFFh
19	SA49	101010xxx	64/32	2A0000h-2AFFFFh	150000h-157FFFh
19	SA50	101011xxx	64/32	2B0000h-2BFFFFh	158000h-15FFFFh
20	SA51	101100xxx	64/32	2C0000h-2CFFFFh	160000h-167FFFh
20	SA52	101101xxx	64/32	2D0000h-2DFFFFh	168000h-16FFFFh
20	SA53	101110xxx	64/32	2E0000h-2EFFFFh	170000h-177FFFh
20	SA54	101111xxx	64/32	2F0000h-2FFFFFh	178000h-17FFFFh
21	SA55	110000xxx	64/32	300000h-30FFFFh	180000h-187FFFh
21	SA56	110001xxx	64/32	310000h-31FFFFh	188000h-18FFFFh
21	SA57	110010xxx	64/32	320000h-32FFFFh	190000h-197FFFh
21	SA58	110011xxx	64/32	330000h-33FFFFh	198000h-19FFFFh
22	SA59	110100xxx	64/32	340000h-34FFFFh	1A0000h-1A7FFFh
22	SA60	110101xxx	64/32	350000h-35FFFFh	1A8000h-1AFFFFh
22	SA61	110110xxx	64/32	360000h-36FFFFh	1B0000h-1B7FFFh
22	SA62	110111xxx	64/32	370000h-37FFFFh	1B8000h-1BFFFFh
23	SA63	111000xxx	64/32	380000h-38FFFFh	1C0000h-1C7FFFh
23	SA64	111001xxx	64/32	390000h-39FFFFh	1C8000h-1CFFFFh
23	SA65	111010xxx	64/32	3A0000h-3AFFFFh	1D0000h-1D7FFFh
23	SA66	111011xxx	64/32	3B0000h-3BFFFFh	1D8000h-1DFFFFh
24	SA67	111100xxx	64/32	3C0000h-3CFFFFh	1E0000h-1E7FFFh
24	SA68	111101xxx	64/32	3D0000h-3DFFFFh	1E8000h-1EFFFFh
24	SA69	111110xxx	64/32	3E0000h-3EFFFFh	1F0000h-1F7FFFh
24	SA70	111111xxx	64/32	3F0000h-3FFFFFh	1F8000h-1FFFFFh

Note:The address range is A20:A-1 in byte mode ($\overline{BYTE}$=VIL) or A20:A0 in word mode ($\overline{BYTE}$=VIH)

Bottom Boot Security Sector Addresses

Sector Address A20~A12	Sector Size (Kbytes/Kwords)	(x8) Address Range	(x16) Address Range
111111xxx	64/32	000000h-00FFFFh	00000h-07FFFh

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Table 2. BUS OPERATION--1

Operation	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	$\overline{RESET}$	$\overline{WP}$/ACC	Addresses (Note 2)	Q0~Q7	Q8 ~ Q15	
								$\overline{Byte}$=VIH	$\overline{Byte}$=VIL
Read	L	L	H	H	L/H	A_{IN}	D_{OUT}	D_{OUT}	Q8-A14 =High-Z Q15=A-1
Write (Note 1)	L	H	L	H	Note 3	A_{IN}	D_{IN}	D_{IN}	
Accelerate Program	L	H	L	H	V_{HH}	A_{IN}	D_{IN}	D_{IN}	
Standby	VCC ± 0.3V	X	X	VCC ± 0.3V	H	X	High-Z	High-Z	High-Z
Output Disable	L	H	H	H	L/H	X	High-Z	High-Z	High-Z
Reset	X	X	X	L	L/H	X	High-Z	High-Z	High-Z
Sector Group Protect (Note 2)	L	H	L	V_{ID}	L/H	Sector Addresses, A6=L, A1=H, A0=L	D_{IN}, D_{OUT}	X	X
Chip Unprotect (Note 2)	L	H	L	V_{ID}	Note 3	Sector Addresses, A6=H, A1=H, A0=L	D_{IN}, D_{OUT}	X	X
Temporary Sector Group Unprotect	X	X	X	V_{ID}	Note 3	A_{IN}	D_{IN}	D_{IN}	High-Z

Legend:
L=Logic LOW=V_{IL}, H=Logic High=V_{IH}, V_{ID}=12.0±0.5V, V_{HH}=11.5-12.5V, X=Don't Care, A_{IN}=Address IN, D_{IN}=Data IN, D_{OUT}=Data OUT

Notes:
1. When the $\overline{WP}$/ACC pin is at V_{HH}, the device enters the accelerated program mode. See "Accelerated Program Operations" for more information.
2. The sector group protect and chip unprotect functions may also be implemented via programming equipment. See the "Sector Group Protection and Chip Unprotection" section.
3. If $\overline{WP}$/ACC=V_{IL}, the two outermost boot sectors remain protected. If $\overline{WP}$/ACC=V_{IH}, the two outermost boot sector protection depends on whether they were last protected or unprotected using the method described in "Sector/ Sector Block Protection and Unprotection". If $\overline{WP}$/ACC=V_{HH}, all sectors will be unprotected.
4. DIN or Dout as required by command sequence, data polling, or sector protection algorithm.
5. Address are A20:A0 in word mode ($\overline{BYTE}$=V_{IH}), A20:A-1 in byte mode ($\overline{BYTE}$=V_{IL}).

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BUS OPERATION--2

Operation	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	A20 to A12	A11 to A10	A9	A8 to A7	A6	A5 to A2	A1	A0	Q0-Q7	Q8-Q15
Read Silicon ID Manufacturer Code	L	L	H	X	X	V_{ID}	X	L	X	L	L	C2H	X
Read Silicon ID MX29LV320T	L	L	H	X	X	V_{ID}	X	L	X	L	H	A7H	22h(word)
													X (byte)
Read Silicon ID MX29LV320B	L	L	H	X	X	V_{ID}	X	L	X	L	H	A8H	22h(word)
													X (byte)
Sector Group Protect	L	V_{ID}	L	SA	X	V_{ID}	X	L	X	X	X	X	X
Chip Unprotect	L	V_{ID}	L	X	X	V_{ID}	X	H	X	X	X	X	X
Sector Protect Verification	L	L	H	SA	X	V_{ID}	X	L	X	H	L	01h(1), or 00h	X
Security Sector Indicater Bit (Q7)	L	L	H	X	X	V_{ID}	X	L	X	H	H	99h(2), or 19h	X

Notes:
1.Code=00h means unprotected, or code=01h protected.
2.Code=99 means factory locked, or code=19h not facory locked.

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REQUIREMENTS FOR READING ARRAY DATA

To read array data from the outputs, the system must drive the $\overline{CE}$ and $\overline{OE}$ pins to VIL. $\overline{CE}$ is the power control and selects the device. $\overline{OE}$ is the output control and gates array data to the output pins. $\overline{WE}$ 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 $\overline{WE}$ and $\overline{CE}$ to VIL, and $\overline{OE}$ to VIH.

An erase operation can erase one sector, multiple sectors , or the entire device. Table 1 indicates the address space that each sector occupies. A "sector address" consists of the address bits required to uniquely select a sector. Writing specific address and data commands or sequences into the command register initiates device operations. Table 3 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, or suspending/resuming the erase operation.

After the system writes the Automatic Select command sequence, the device enters the Automatic Select mode. The system can then read Automatic Select 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 Automatic Select Mode and Automatic Select 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.

ACCELERATED PROGRAM OPERATION

The device offers accelerated program operations through the $\overline{WP}$/ACC function. If the system asserts V_{HH} on ACC pin, the device will provide the fast programming time to user. This function is primarily intended to allow faster manufacturing throughput during production. Removing V_{HH} from the $\overline{WP}$/ACC pin returns the device to normal operation. Note that the $\overline{WP}$/ACC pin must not be at V_{HH} for operations other than accelerated programming, or device damage may result.

STANDBY MODE

MX29LV320T/B can be set into Standby mode with two different approaches. One is using both $\overline{CE}$ and $\overline{RESET}$ pins and the other one is using $\overline{RESET}$ pin only.

When using both pins of $\overline{CE}$ and $\overline{RESET}$, a CMOS Standby mode is achieved with both pins held at Vcc ± 0.3V. Under this condition, the current consumed is less than 0.2uA (typ.). If both of the $\overline{CE}$ and $\overline{RESET}$ 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 $\overline{CE}$ = "H" until the operation is completed. The device can be read with standard access time (tCE) from either of these standby modes.

When using only $\overline{RESET}$, a CMOS standby mode is achieved with $\overline{RESET}$ input held at Vss ± 0.3V, Under this condition the current is consumed less than 1uA (typ.). Once the $\overline{RESET}$ pin is taken high,the device is back to active without recovery delay.

In the standby mode the outputs are in the high impedance state, independent of the $\overline{OE}$ input.

MX29LV320T/B is capable to provide the Automatic Standby Mode to restrain power consumption during readout of data. This mode can be used effectively with an application requested low power consumption such as handy terminals.

To active this mode, MX29LV320T/B automatically switch themselves to low power mode when MX29LV320T/B addresses remain stable during access time of tACC+30ns. It is not necessary to control $\overline{CE}$, $\overline{WE}$, and $\overline{OE}$ on the mode. Under the mode, the current consumed is typically 0.2uA (CMOS level).

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OUTPUT DISABLE

With the $\overline{OE}$ 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.

$\overline{RESET}$ OPERATION

The $\overline{RESET}$ pin provides a hardware method of resetting the device to reading array data. When the $\overline{RESET}$ 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 $\overline{RESET}$ 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 $\overline{RESET}$ pulse. When $\overline{RESET}$ is held at VSS±0.3V, the device draws CMOS standby current (ICC4). If $\overline{RESET}$ is held at VIL but not within VSS±0.3V, the standby current will be greater.

The $\overline{RESET}$ pin may be tied to system reset circuitry. A system reset would that also reset the Flash memory, enabling the system to read the boot-up firm-ware from the Flash memory.

If $\overline{RESET}$ is asserted during a program or erase operation, the RY/$\overline{BY}$ pin remains a "0" (busy) until the internal reset operation is complete, which requires a time of tREADY (during Embedded Algorithms). The system can thus monitor RY/$\overline{BY}$ to determine whether the reset operation is complete. If $\overline{RESET}$ is asserted when a program or erase operation is not executing (RY/$\overline{BY}$ pin is "1"), the reset operation is completed within a time of tREADY (not during Embedded Algorithms). The system can read data tRH after the $\overline{RESET}$ pin returns to VIH.

Refer to the AC Characteristics tables for $\overline{RESET}$ parameters and to Figure 14 for the timing diagram.

SECTOR GROUP PROTECT OPERATION

The MX29LV320T/B features hardware sector group protection. This feature will disable both program and erase operations for these sector group protected. To activate this mode, the programming equipment must force V_{ID} on address pin A9 and control pin $\overline{OE}$, (suggest V_{ID} = 12V) A6 = VIL and $\overline{CE}$ = VIL.(see Table 2) Programming of the protection circuitry begins on the falling edge of the $\overline{WE}$ pulse and is terminated on the rising edge. Please refer to sector group protect algorithm and waveform.

MX29LV320T/B also provides another method which requires V_{ID} on the $\overline{RESET}$ only. This method can be implemented either in-system or via programming equipment. This method uses standard microprocessor bus cycle timing.

To verify programming of the protection circuitry, the programming equipment must force V_{ID} on address pin A9 (with $\overline{CE}$ and $\overline{OE}$ at VIL and $\overline{WE}$ at VIH). When A1=1, 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 group 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.

CHIP UNPROTECT OPERATION

The MX29LV320T/B 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 V_{ID} on control pin $\overline{OE}$ and address pin A9. The $\overline{CE}$ pins must be set at VIL. Pins A6 must be set to VIH.(see Table 2) Refer to chip unprotect algorithm and waveform for the chip unprotect algorithm. The unprotection mechanism begins on the falling edge of the $\overline{WE}$ pulse and is terminated on the rising edge.

MX29LV320T/B also provides another method which requires V_{ID} on the $\overline{RESET}$ only. This method can be implemented either in-system or via programming equipment. This method uses standard microprocessor bus cycle timing.

It is also possible to determine if the chip is unprotected in the system by writing the Read Silicon ID command.

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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.

TEMPORARY SECTOR GROUP UNPROTECT OPERATION

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 V_{ID}(11.5V-12.5V). During this mode, formerly protected sectors can be programmed or erased as un-protected sector. Once V_{ID} is remove from the RESET pin, all the previously protected sectors are protected again.

WRITE PROTECT ($\overline{WP}$)

The write protect function provides a hardware method to protect boot sectors without using V_{ID}.

If the system asserts VIL on the $\overline{WP}$/ACC pin, the device disables program and erase functions in the two "outermost" 8 Kbyte boot sectors independently of whether those sectors were protected or unprotected using the method described in Sector/Sector Group Protection and Chip Unprotection". The two outermost 8 Kbyte boot sectors are the two sectors containing the lowest addresses in a bottom-boot-configured device, or the two sectors containing the highest addresses in a top-boot-configured device.

If the system asserts VIH on the $\overline{WP}$/ACC pin, the device reverts to whether the two outermost 8K Byte boot sectors were last set to be protected or unprotected. That is, sector protection or unprotection for these two sectors depends on whether they were last protected or unprotected using the method described in "Sector/Sector Group Protection and Chip Unprotection".

Note that the $\overline{WP}$/ACC pin must not be left floating or unconnected; inconsistent behavior of the device may result.

AUTOMATIC SELECT OPERATION

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.

MX29LV320T/B provides hardware method to access the Automatic Select operation. This method requires V_{ID} on A9 pin, VIL on $\overline{CE}$, $\overline{OE}$, A6, and A1 pins. When applying VIL on A0 pin, the device will output MXIC's manufacture code of C2H. When applying VIH on A0 pin, the device will output MX29LV320T/B device code of 22A7h and 22A8h.

VERIFY SECTOR GROUP PROTECT STATUS OPERATION

MX29LV320T/B provides hardware method for sector group protect status verify. This method requires V_{ID} on A9 pin, VIH on $\overline{WE}$ and A1 pins, VIL on $\overline{CE}$, $\overline{OE}$, A6, and A0 pins, and sector address on A12 to A20 pins. When the identified sector is protected, the device will output 01H. When the identified sector is not protect, the device will output 00H.

SECURITY SECTOR FLASH MEMORY REGION

The Security Sector (Security Sector) feature provides a Flash memory region that enables permanent part identification through an Electronic Serial Number (ESN). The Security Sector is 64 Kbytes (32 Kwords) in length, and uses a Security Sector Indicator Bit (Q7) to indicate whether or not the Security Sector is locked when shipped from the factory. This bit is per-manently set at the factory and cannot be changed, which prevents cloning of a factory locked part. This ensures the security of the ESN once the product is shipped to the field.

MXIC offers the device with the Security Sector either factory locked or customer lockable. The factory-locked version is always protected when shipped from the factory, and has the Security on Silicon Sector (Security Sector) Indicator Bit permanently set to a "1". The customer-lockable version is shipped with the unprotected, allowing customers to utilize the that sector in any manner they choose. The customer-lockable version has the Security on Silicon Sector (Security Sector) Indicator Bit permanently set to a "0". Thus, the Security Sector Indicator Bit prevents customer-lockable devices from be-

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ing used to replace devices that are factory locked.

The system accesses the Security Sector through a command sequence (see "Enter Security Sector/Exit Security Sector Command Sequence"). After the system has written the Enter Security Sector command sequence, it may read the Security Sector by using the addresses normally occupied by the boot sectors. This mode of operation continues until the system issues the Exit Security Sector command sequence, or until power is removed from the device. On power-up, or following a hardware reset, the device reverts to sending commands to the boot sectors.

Factory Locked: Security Sector Programmed and Protected at the Factory

In a factory locked device, the Security Sector is protected when the device is shipped from the factory. The Security Sector cannot be modified in any way. The device is available preprogrammed with one of the following:

A random, secure ESN only.
Customer code through the Express Flash service.
Both a random, secure ESN and customer code through the Express Flash service.

In devices that have an ESN, a Bottom Boot device will have the 16-byte (8-word) ESN in the lowest addressable memory area starting at 00000h and ending at 0000Fh (00007h). In the Top Boot device the starting address of the ESN will be at the bottom of the lowest 8 Kbyte (4 Kword) boot sector starting at 3F0000h (1F8000h) and ending at 3F000Fh (1F8007h).

Customer Lockable: Security Sector NOT Programmed or Protected at the Factory

If the security feature is not required, the Security Sector can be treated as an additional Flash memory space, expanding the size of the available Flash array by 64 Kbytes (32 Kwords). The Security Sector can be read, programmed, and erased as often as required. The Security Sector area can be protected using one of the following procedures:

Write the three-cycle Enter Security Region command sequence, and then follow the in-system sector group protect algorithm as shown in Figure 17, except that $\overline{\text{RESET}}$ may be at either VIH or V_{ID}. This allows in-system protection of the without raising any device pin to a high voltage. Note that this method is only applicable to the Security Sector.

Write the three-cycle Enter Security Region command sequence, and then use the alternate method of sector protection described in the "Sector/Sector Block Protection and Unprotection section.

Once the Security Sector is locked and verified, the system must write the Exit Security Sector Region command sequence to return to reading and writing the remainder of the array.

The Security Sector protection must be used with caution since, once protected, there is no procedure available for unprotecting the Security Sector area and none of the bits in the Security Sector memory space can be modified in any way.

DATA PROTECTION

The MX29LV320T/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.

LOW VCC WRITE INHIBIT

When VCC is less than VLKO the device does not accept any write cycles. This protects data during VCC power-up and power-down. The command register and all internal program/erase circuits are disabled, and the device resets. Subsequent writes are ignored until VCC is greater than VLKO. The system must provide the proper signals to the control pins to prevent unintentional write when VCC is greater than VLKO.

WRITE PULSE "GLITCH" PROTECTION

Noise pulses of less than 5ns (typical) on $\overline{\text{OE}}$, $\overline{\text{CE}}$ or $\overline{\text{WE}}$ will not initiate a write cycle.

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LOGICAL INHIBIT

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

POWER-UP SEQUENCE

The MX29LV320T/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.

POWER-UP WRITE INHIBIT

If $\overline{WE}$=$\overline{CE}$=VIL and $\overline{OE}$=VIH during power up, the device does not accept commands on the rising edge of $\overline{WE}$. The internal state machine is automatically reset to the read mode on power-up.

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.

SOFTWARE 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 3 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).

All addresses are latched on the falling edge of $\overline{WE}$ or $\overline{CE}$, whichever happens later. All data are latched on rising edge of $\overline{WE}$ or $\overline{CE}$, whichever happens first.

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TABLE 3. MX29LV320T/B COMMAND DEFINITIONS

Command		Bus	First Bus Cycle		Second Bus Cycle		Third Bus Cycle		Fourth Bus Cycle		Fifth Bus Cycle		Sixth Bus Cycle	
		Cycles	Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data
Read(Note 5)		1	RA	RD										
Reset(Note 4)		1	XXX	F0										
Automatic Select(Note 5)														
Manufacturer ID	Word	4	555	AA	2AA	55	555	90	X00	C2H				
	Byte	4	AAA	AA	555	55	AAA	90	X00	C2H				
Device ID	Word	4	555	AA	2AA	55	555	90	X01	ID				
	Byte	4	AAA	AA	555	55	AAA	90	X02					
Security Sector Factory	Word	4	555	AA	2AA	55	555	90	X03	99/19				
Protect Verify (Note 6)	Byte	4	AAA	AA	555	55	AAA	90	X06					
Sector Protect Verify	Word	4	555	AA	2AA	55	555	90	(SA)X02	00/01				
(Note 7)	Byte	4	AAA	AA	555	55	AAA	90	(SA)X04					
Enter Security Sector	Word	3	555	AA	2AA	55	555	88						
Region	Byte	3	AAA	AA	555	55	AAA	88						
Exit Security Sector	Word	4	555	AA	2AA	55	555	90	XXX	00				
	Byte	4	AAA	AA	555	55	AAA	90	XXX	00				
Program	Word	4	555	AA	2AA	55	555	A0	PA	PD				
	Byte	4	AAA	AA	555	55	AAA	A0	PA	PD				
Chip Erase	Word	6	555	AA	2AA	55	555	80	555	AA	2AA	55	555	10
	Byte	6	AAA	AA	555	55	AAA	80	AAA	AA	555	55	AAA	10
Sector Erase	Word	6	555	AA	2AA	55	555	80	555	AA	2AA	55	SA	30
	Byte	6	AAA	AA	555	55	AAA	80	AAA	AA	555	55	SA	30
CFI Query (Note 8)	Word	1	55	98										
	Byte	1	AA	98										
Erase Suspend(Note 9)		1	SA	B0										
Erase Resume(Note 10)		1	SA	30										

Legend:

X=Don't care
RA=Address of the memory location to be read.
RD=Data read from location RA during read operation.
PA=Address of the memory location to be programmed. Addresses are latched on the falling edge of the $\overline{WE}$ or $\overline{CE}$ pulse.
PD=Data to be programmed at location PA. Data is latched on the rising edge of $\overline{WE}$ or $\overline{CE}$ pulse.
SA=Address of the sector to be erased or verified. Address bits A20-A12 uniquely select any sector.
ID=22A7h(Top), 22A8h(Bottom)

Notes:

1. See Table 1 for descriptions of bus operations.
2. All values are in hexadecimal.
3. Except when reading array or Automatic Select data, all bus cycles are write operation.
4. The Reset command is required to return to the read mode when the device is in the Automatic Select mode or if Q5 goes high.
5. The fourth cycle of the Automatic Select command sequence is a read cycle.
6. The data is 99h for factory locked and 19h for not factory locked.
7. The data is 00h for an unprotected sector/sector block and 01h for a protected sector/sector block. In the third cycle of the command sequence, address bit A20=0 to verify sectors 0~31, A20=1 to verify sectors 32~70 for Top Boot device.
8. Command is valid when device is ready to read array data or when device is in Automatic Select mode.
9. The system may read and program functions in non-erasing sectors, or enter the Automatic Select mode, when in the erase Suspend mode. The Erase Suspend command is valid only during a sector erase operation.
10. The Erase Resume command is valid only during the Erase Suspend mode.

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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.

After the device accepts an Erase Suspend command, the device enters the Erase Suspend mode. The system can read array data using the standard read timings, except that if it reads at an address within erase-suspended sectors, the device outputs status data. After completing a programming operation in the Erase Suspend mode, the system may once again read array data with the same exception. See Erase Suspend/Erase Resume Commands" for more information on this mode. The system must issue the reset command to re-enable the device for reading array data if Q5 goes high during an active program or erase operation, or while in the Automatic Select 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 (also applies to programming in Erase Suspend mode). 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 Automatic Select command sequence. Once in the Automatic Select mode, the reset command must be written to return to reading array data (also applies to Automatic Select during Erase Suspend).

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

AUTOMATIC SELECT COMMAND SEQUENCE

The Automatic Select command sequence allows the host system to access the manufacturer and device codes, and determine whether or not a sector is protected. Table 2 shows the address and data requirements. This method is an alternative to that shown in Table 3, which is intended for EPROM programmers and requires V_{ID} on address bit A9.

The Automatic Select command sequence is initiated by writ-ing two unlock cycles, followed by the Automatic Select command. The device then enters the Automatic Select mode, and the system may read at any address any number of times, without initiating another command sequence. A read cycle at address XX00h retrieves the manufacturer code. A read cycle at address XX01h in word mode (or xx02h in byte mode) returns the device code. A read cycle containing a sector address (SA) and the address 02h on A7-A0 in word mode (or the address 04h on A6-A-1 in byte mode) returns 01h if that sector is protected, or 00h if it is unprotected. Refer to Table 1 for valid sector addresses.

The system must write the reset command to exit the Automatic Select mode and return to reading array data.

ENTER SECURITY SECTOR & EXIT SECURITY SECTOR COMMAND SEQUENCE

The Security Sector provides a secured area which contains a random, sixteen-byte electronic serial number.(ESN)

The system can access the Security Sector area by issuing the three-cycle "Enter Security Sector command sequence. The device continues to access the security section area until the system issues the four-cycle Exit Security Sector command sequence. The Exit Security Sector command sequence returns the device to normal operation.

BYTE/WORD PROGRAM COMMAND SEQUENCE

The device programs one byte/word 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

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verifies the programmed cell margin. Table 3 shows the address and data requirements for the byte/word 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 Byte/Word 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 cause the device to 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".

SETUP AUTOMATIC CHIP/SECTOR ERASE

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 the sector erase command 30H.

The MX29LV320T/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. A read cycle with A1=VIL, A0=VIH returns the device code of A7H/A8H for MX29LV320T/B.

TABLE 4. SILICON ID CODE

Pins	A0	A1	Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0	Code (Hex)
Manufacture code	VIL	VIL	1	1	0	0	0	0	1	0	C2H
Device code for MX29LV320T	VIH	VIL	1	0	1	0	0	1	1	1	22A7H
Device code for MX29LV320B	VIH	VIL	1	0	1	0	1	0	0	0	22A8H

AUTOMATIC CHIP/SECTOR ERASE COMMAND

The device does not require the system to preprogram prior to erase. The Automatic Erase algorithm automatically preprograms and verifies the entire memory for an all zero data pattern prior to electrical erase. The system is not required to provide any controls or timings during these operations. Table 3 shows the address and data requirements for the chip erase command sequence.

Any commands written to the chip during the Automatic Erase algorithm are ignored. Note that a hard-ware reset during the chip erase operation immediately terminates the operation. The Chip Erase command sequence should be reinitiated once the device has returned to reading array data, to ensure data integrity.

The system can determine the status of the erase operation by using Q7, Q6, Q2, or RY/BY. See "Write Operation Status" for information on these status bits. When the Automatic Erase algorithm is complete, the device returns to reading array data and addresses are no longer latched.

Figure 5 illustrates the algorithm for the erase operation.See the Erase/Program Operations tables in "AC Characteristics" for parameters, and to Figure 4 for timing diagrams.

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SECTOR ERASE COMMANDS

The device does not require the system to entirely pre-program 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 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 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 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 $\overline{WE}$ or $\overline{CE}$, whichever happens later , while the command(data) is latched on the rising edge of $\overline{WE}$ or $\overline{CE}$, whichever happens first. Sector addresses selected are loaded into internal register on the sixth falling edge of $\overline{WE}$ or $\overline{CE}$, whichever happens later. Each successive sector load cycle started by the falling edge of $\overline{WE}$ or $\overline{CE}$, whichever happens later must begin within 50us from the rising edge of the preceding $\overline{WE}$ or $\overline{CE}$, 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) or Erase Suspend(B0H) during the time-out period resets the device to read mode.

ERASE SUSPEND

This command only has meaning while the state machine is executing Automatic Sector Erase operation, and therefore will only be responded during Automatic Sector Erase operation. When the Erase Suspend command is issued during the sector erase operation, the device requires a maximum 20us to suspend the sector erase operation. However, When the Erase Suspend command is written during the sector erase time-out, the device 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 Erase Resume, program data to, or read data from any sector not selected for erasure. The system can use Q7, or Q6 and Q2 together, to determine if a sector is actively erasing or is erase-suspended.

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 blocks.

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.

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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 5 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.

Table 5. Write Operation Status

	Status		Q7 Note1	Q6	Q5 Note2	Q3	Q2	RY/BY
In Progress	Byte/Word 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/Word 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. Performing successive read operations from the erase-suspended sector will cause Q2 to toggle.
2. Performing successive read operations from any address will cause Q6 to toggle.
3. Reading the byte/word address being programmed while in the erase-suspend program mode will indicate logic "1" at the Q2 bit.
   However, successive reads from the erase-suspended sector will cause Q2 to toggle.

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Q7: Data Polling

The Data Polling bit, Q7, indicates to the host system whether an Automatic Algorithm is in progress or completed, or whether the device is in Erase Suspend. 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. This Q7 status also applies to programming during Erase Suspend. 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. If a program address falls within a protected sector, Data Polling on Q7 is active for approximately 1 us, then the device returns to reading array data.

During the Automatic Erase algorithm, Data Polling produces a "0" on Q7. When the Automatic Erase algorithm is complete, or if the device enters the Erase Suspend mode, 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.

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 or CE, whichever happens first 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 for 100us 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 2us 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 5 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 II is valid after the rising edge of the final WE or CE, whichever happens first 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

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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 5 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:Program/Erase Timing

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 byte/word programming operation, it specifies that the entire sector containing that byte/word is bad and this sector maynot 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.

The Q5 failure condition may appear if the system tries to program a "1" to a location that is previously programmed to "0". Only an erase operation can change a "0" back to a "1"." Under this condition, the device halts the operation, and when the operation has exceeded the timing limits, Q5 produces a "1".

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

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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.

If the time between additional erase commands from the system can be less than 50us, the system need not to monitor Q3.

RY/BY:READY/BUSY OUTPUT

The RY/BY is a dedicated, open-drain output pin that indicates whether an Embedded 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 (includ-ing during the Erase Suspend mode), or is in the standby mode.

QUERY COMMAND AND COMMON FLASH

INTERFACE (CFI) MODE

MX29LV320T/B 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 3.

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

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

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Table 6-1. CFI mode: Identification Data Values
(All values in these tables are in hexadecimal)

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

Table 6-2. CFI Mode: System Interface Data Values

Description	Address (h) (Word Mode)	Address (h) (Byte Mode)	Data (h)
VCC supply, minimum (2.7V)	1B	36	0027
VCC supply, maximum (3.6V)	1C	38	0036
VPP supply, minimum (none)	1D	3A	0000
VPP supply, maximum (none)	1E	3C	0000
Typical timeout for single word/byte write (2^N us)	1F	3E	0004
Typical timeout for maximum size buffer write (2^N us) (not supported)	20	40	0000
Typical timeout for individual sector erase (2^N ms)	21	42	000A
Typical timeout for full chip erase (2^N ms)	22	44	0000
Maximum timeout for single word/byte write times (2^N X Typ)	23	46	0005
Maximum timeout for maximum size buffer write times (2^N X Typ)	24	48	0000
Maximum timeout for individual sector erase times (2^N X Typ)	25	4A	0004
Maximum timeout for full chip erase times (not supported)	26	4C	0000

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Table 6-3. CFI Mode: Device Geometry Data Values

Description	Address (h) (Word Mode)	Address (h) (Byte Mode)	Data (h)
Device size (2^N bytes)	27	4E	0016
Flash device interface code (02=asynchronous x8/x16)	28	50	0002
	29	52	0000
Maximum number of bytes in multi-byte write (not supported)	2A	54	0000
	2B	56	0000
Number of erase sector regions	2C	58	0002
Erase Sector Region 1 Information	2D	5A	0007
[2E,2D] = # of same-size sectors in region 1-1	2E	5C	0000
[30, 2F] = sector size in multiples of 256-bytes	2F	5E	0020
	30	60	0000
Erase Sector Region 2 Information	31	62	003E
	32	64	0000
	33	66	0000
	34	68	0001
Erase Sector Region 3 Information	35	6A	0000
	36	6C	0000
	37	6E	0000
	38	70	0000
Erase Sector Region 4 Information	39	72	0000
	3A	74	0000
	3B	76	0000
	3C	78	0000

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Table 6-4. CFI Mode: Primary Vendor-Specific Extended Query Data Values

Description	Address (h) (Word Mode)	Address (h) (Byte Mode)	Data (h)
Query-unique ASCII string "PRI"	40	80	0050
	41	82	0052
	42	84	0049
Major version number, ASCII	43	86	0031
Minor version number, ASCII	44	88	0031
Address sensitive unlock (0=required, 1= not required)	45	8A	0000
Erase suspend (2= to read and write)	46	8C	0002
Sector protect (N= # of sectors/group)	47	8E	0004
Temporary sector unprotect (1=supported)	48	90	0001
Sector protect/Chip unprotect scheme	49	92	0004
Simultaneous R/W operation (0=not supported)	4A	94	0000
Burst mode type (0=not supported)	4B	96	0000
Page mode type (0=not supported)	4C	98	0000
ACC (Acceleration) Supply Minimum (0=not supported, D7-D4:Volt, D3-D0:100mV	4D	9A	00B5
ACC (Acceleration) Supply Maximum (0=not supported, D7-D4:Volt, D3-D0:100mV	4E	9C	00C5
Top/Bottom Boot Sector Flag 02h=Bottom Boot Device, 03h=Top Boot Device	4F	9E	000X

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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, $\overline{OE}$, and

$\overline{RESET}$ (Note 2) . . . .-0.5 V to +12.5 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 20ns. 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, $\overline{OE}$, and $\overline{RESET}$ is -0.5 V. During voltage transitions, A9, $\overline{OE}$, and $\overline{RESET}$ may overshoot VSS to -2.0 V for periods of up to 20 ns. Maximum DC input voltage on pin A9 is +12.5 V which may overshoot to 14.0 V 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

Industrial (I) Devices

Ambient Temperature (T_A). . . . . -40°C to +85°C

V_{CC} Supply Voltages

V_{CC} for full voltage range. . . . . +2.7 V to 3.6 V

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

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DC CHARACTERISTICS VCC=2.7V~3.6V

Para-meter	Description	Test Conditions		TA=0℃ to 70℃			TA=-40℃ to 85℃			Unit
				Min	Typ	Max	Min	Typ	Max	
ILI	Input Load Current (Note 1)	VIN = VSS to VCC, VCC = VCC max				±1.0			±1.0	uA
ILIT	A9 Input Load Current	VCC = VCC max, A9=12.5V				35			45	uA
ILO	Output Leakage Current	VOUT = VSS to VCC , VCC = VCC max				±1.0			±1.0	uA
ICC1	VCC Active Read Current (Notes 2, 3)	$\overline{CE}$= VIL, $\overline{OE}$ = VIH	5 MHz		10	16		10	16	mA
			1 MHz		2	4		2	4	mA
ICC2	VCC Active Write Current (Notes 2, 4, 6)	$\overline{CE}$= VIL , $\overline{OE}$ = VIH, $\overline{WE}$=VIL			15	30		15	30	mA
ICC3	VCC Standby Current (Note 2)	$\overline{CE}$, $\overline{RESET}$, $\overline{WP}$/ACC = VCC±0.3V			0.2	15		0.2	15	uA
ICC4	VCC Reset Current (Note 2)	$\overline{RESET}$ = VSS ± 0.3V, $\overline{WP}$/ACC= VCC ± 0.3V			0.2	15		0.2	15	uA
ICC5	Automatic Sleep Mode (Notes 2,5)	VIH = VCC ± 0.3V; VIL = VSS ± 0.3V, $\overline{WP}$/ACC=VCC±0.3V			0.2	15		0.2	15	uA
IACC	WP/ACC Accelerated Program Current, Word or Byte	$\overline{CE}$=VIL,	$\overline{WP}$/ACC pin		5	10		5	10	mA
		$\overline{OE}$=VIH	VCC pin		15	30		15	30	mA
VIL	Input Low Voltage			-0.5		0.8	-0.5		0.8	V
VIH	Input High Voltage			0.7xVcc		Vcc+0.3	0.7xVcc		Vcc+0.3	V
VHH	Voltage for $\overline{WP}$/ACC Sector Protect/Unprotect and Program Acceleration	VCC = 3.0 V ± 10%		11.5		12.5	11.5		12.5	V
VID	Voltage for Automatic Select and Temporary Sector Unprotect	VCC = 3.0 V ± 10%		11.5		12.5	11.5		12.5	V
VOL	Output Low Voltage	IOL=4.0mA, VCC=VCC min				0.45			0.45	V
VOH1	Output High Voltage	IOH=-2.0mA, VCC=VCC min		0.85Vcc			0.85Vcc			V
VOH2		IOH=-100uA, VCC = VCC min		Vcc-0.4			Vcc-0.4			V
VLKO	Low VCC Lock-Out Voltage (Note 6)			1.4		2.1	1.4		2.1	V

Notes:
1. On the $\overline{WP}$/ACC pin only, the maximum input load current when $\overline{WP}$/ACC = VIL is ± 5.0uA / VIH is ± 3.0uA.
2. Maximum ICC specifications are tested with VCC = VCC max.
3. The ICC current listed is typically is less than 2 mA/MHz, with $\overline{OE}$ at VIH. Typical specifications are for VCC = 3.0V.
4. ICC active while Embedded Erase or Embedded Program is in progress.
5. Automatic sleep mode enables the low power mode when addresses remain stable for tACC + 30 ns. Typical sleep mode current is 200 nA.
6. Not 100% tested.

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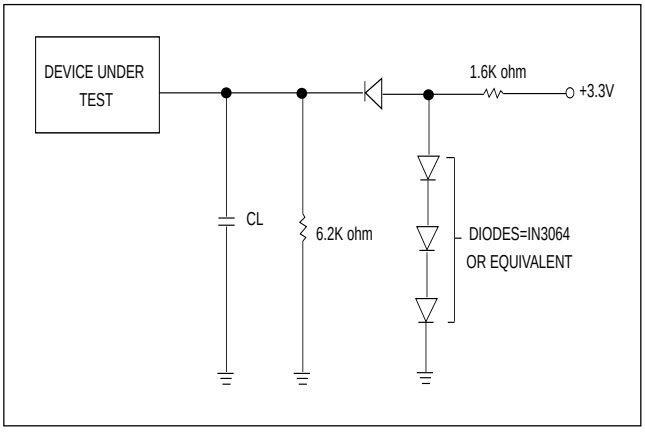
SWITCHING TEST CIRCUITS



TEST SPECIFICATIONS

Test Condition	70	90	120	Unit
Output Load	1 TTL gate			
Output Load Capacitance,CL (including jig capacitance)	30	30	100	pF
Input Rise and Fall Times	5			ns
Input Pulse Levels	0.0-3.0			V
Input timing measurement reference levels	1.5			V
Output timing measurement reference levels	1.5			V

KEY TO SWITCHING WAVEFORMS

WAVEFROM	INPUTS	OUTPUTS
	Steady	
	Changing from H to L	
	Changing from L to H	
	Don't Care, Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High Impedance State(High Z)

SWITCHING TEST WAVEFORMS

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AC CHARACTERISTICS TA=-40℃ to 85℃, VCC=2.7V~3.6V

Symbol	DESCRIPTION		CONDITION		70	90	120	Unit
tACC	Address to output delay		$\overline{CE}$=VIL $\overline{OE}$=VIL	MAX	70	90	120	ns
tCE	Chip enable to output delay		$\overline{OE}$=VIL	MAX	70	90	120	ns
tOE	Output enable to output delay			MAX	40	40	50	ns
tDF	$\overline{OE}$ High to output float(Note1)			MAX	30	30	30	ns
tOH	Output hold time of from the rising edge of Address, $\overline{CE}$, or $\overline{OE}$, whichever happens first			MIN	0	0	0	ns
tRC	Read cycle time (Note 1)			MIN	70	90	120	ns
tWC	Write cycle time (Note 1)			MIN	70	90	120	ns
tCWC	Command write cycle time(Note 1)			MIN	70	90	120	ns
tAS	Address setup time			MIN	0	0	0	ns
tAH	Address hold time			MIN	45	45	50	ns
tDS	Data setup time			MIN	45	45	50	ns
tDH	Data hold time			MIN	0	0	0	ns
tVCS	Vcc setup time(Note 1)			MIN	50	50	50	ns
tCS	Chip enable setup time			MIN	0	0	0	ns
tCH	Chip enable hold time			MIN	0	0	0	ns
tOES	Output enable setup time (Note 1)			MIN	0	0	0	ns
tOEH	Output enable hold time (Note 1)	Read		MIN	0	0	0	ns
		Toggle & $\overline{Data}$ Polling		MIN	10	10	10	ns
tWES	$\overline{WE}$ setup time			MIN	0	0	0	ns
tWEH	$\overline{WE}$ hold time			MIN	0	0	0	ns
tCEP	$\overline{CE}$ pulse width			MIN	45	45	50	ns
tCEPH	$\overline{CE}$ pulse width high			MIN	30	30	30	ns
tWP	$\overline{WE}$ pulse width			MIN	45	45	50	ns
tWPH	$\overline{WE}$ pulse width high			MIN	30	30	30	ns
tBUSY	Program/Erase valid to RY/$\overline{BY}$ delay			MAX	90	90	90	ns
tGHWL	Read recovery time before write			MIN	0	0	0	ns
tGHEL	Read recovery time before write			MIN	0	0	0	ns
tWHWH1	Programming operation	BYTE		TYP	9	9	9	us
		WORD		TYP	11	11	11	us
	Accelerated programming operation word or byte			TYP	7	7	7	us
tWHWH2	Sector erase operation			TYP	0.9	0.9	0.9	sec
tBAL	Sector address hold time			MAX	50	50	50	us

Note: 1.Not 100% Tested
2.t_r = t_f = 5ns

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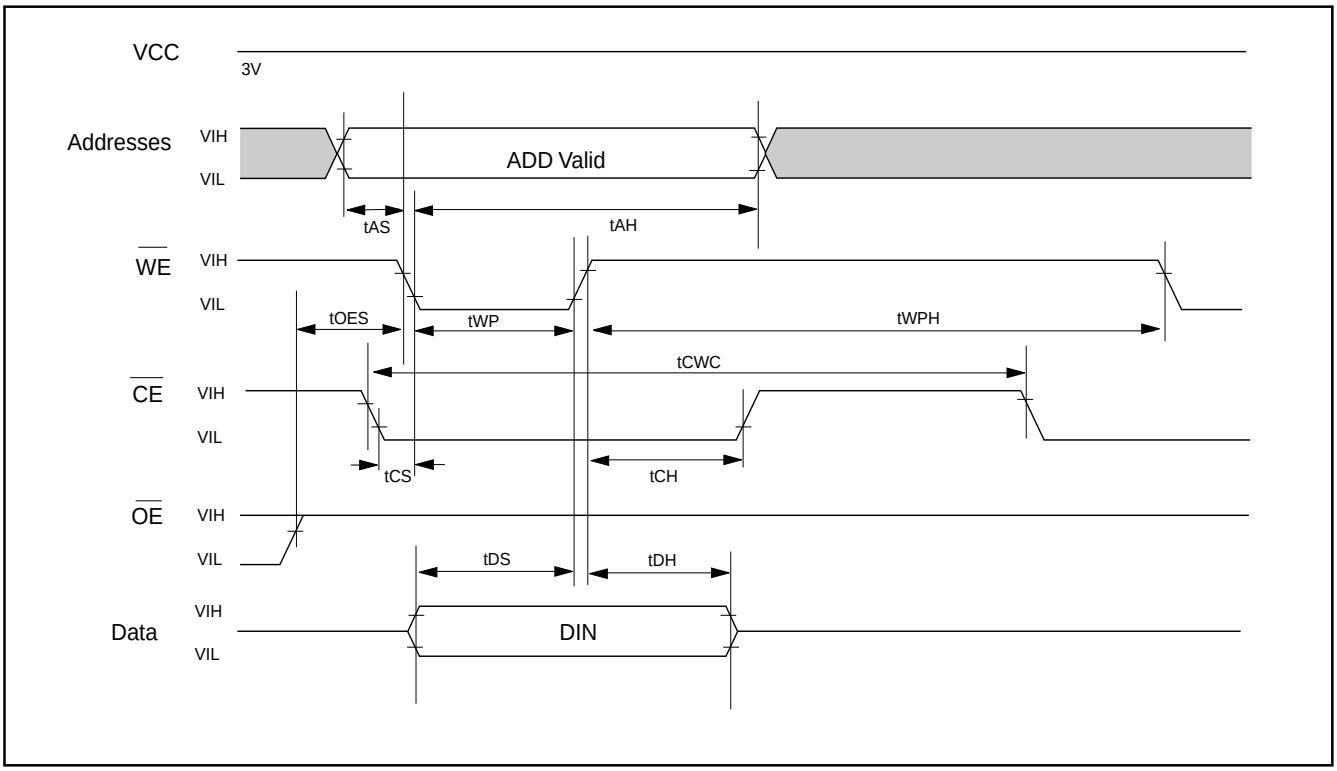
Fig 1. COMMAND WRITE OPERATION



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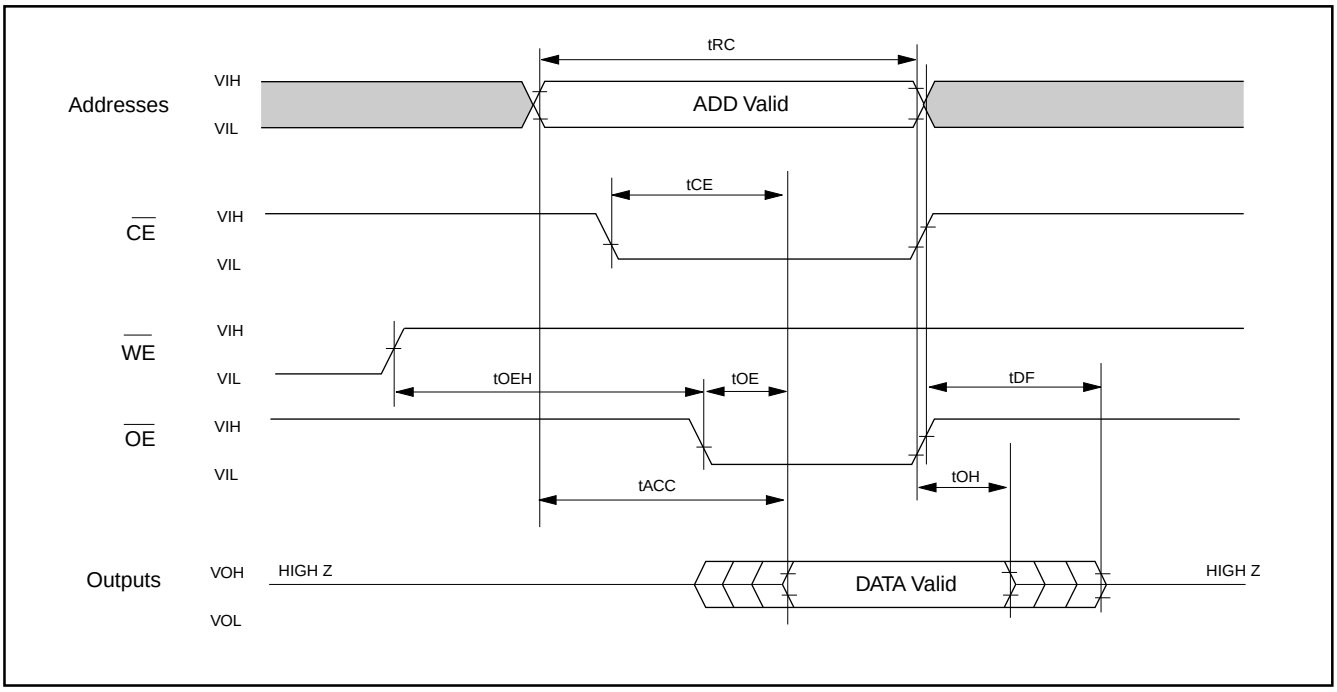
READ/RESET OPERATION

Fig 2. READ TIMING WAVEFORMS



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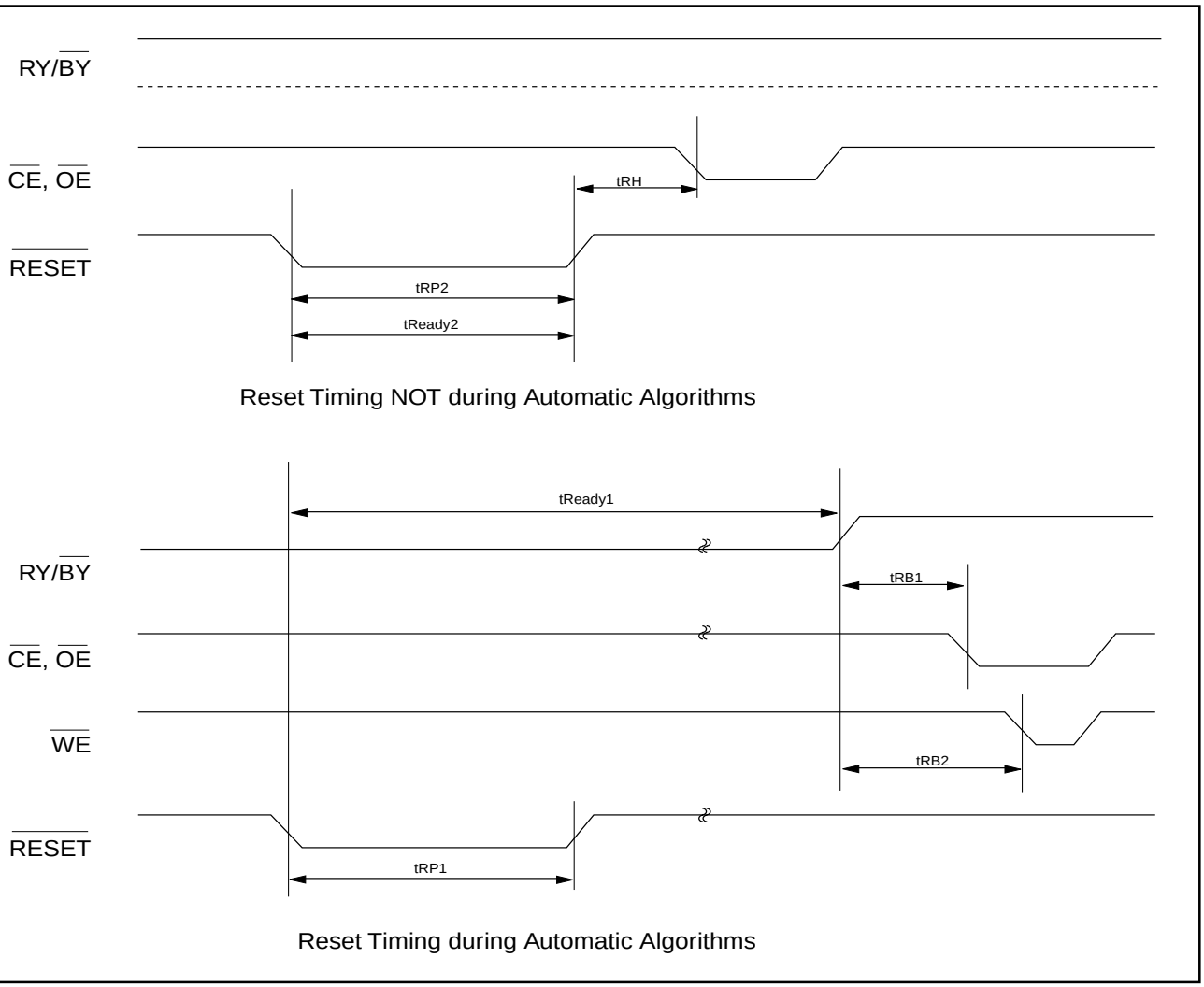
AC CHARACTERISTICS

Parameter	Description	Test Setup	All Speed Options	Unit
tREADY1	$\overline{\text{RESET}}$ PIN Low (During Automatic Algorithms) to Read or Write (See Note)	MAX	20	us
tREADY2	$\overline{\text{RESET}}$ PIN Low (NOT During Automatic Algorithms) to Read or Write (See Note)	MAX	500	ns
tRP1	$\overline{\text{RESET}}$ Pulse Width (During Automatic Algorithms)	MIN	10	us
tRP2	$\overline{\text{RESET}}$ Pulse Width (NOT During Automatic Algorithms)	MIN	500	ns
tRH	$\overline{\text{RESET}}$ High Time Before Read(See Note)	MIN	70	ns
tRB1	RY/$\overline{\text{BY}}$ Recovery Time(to $\overline{\text{CE}}$, $\overline{\text{OE}}$ go low)	MIN	0	ns
tRB2	RY/$\overline{\text{BY}}$ Recovery Time(to $\overline{\text{WE}}$ go low)	MIN	50	ns

Note:Not 100% tested

Fig 3. $\overline{\text{RESET}}$ TIMING WAVEFORM



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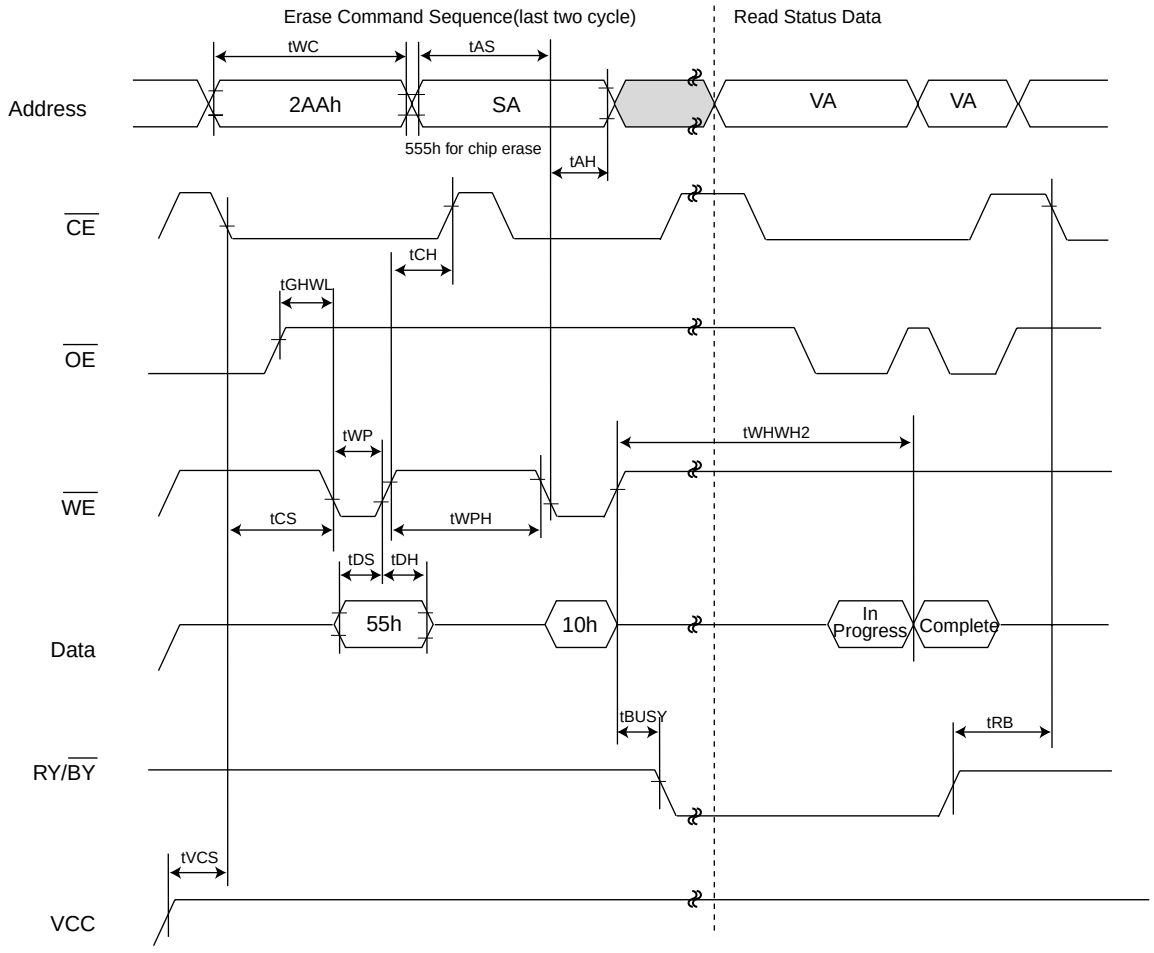
ERASE/PROGRAM OPERATION

Fig 4. AUTOMATIC CHIP ERASE TIMING WAVEFORM



NOTES:
SA=sector address(for Sector Erase), VA=Valid Address for reading status data(see "Write Operation Status").

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Fig 5. AUTOMATIC CHIP ERASE ALGORITHM FLOWCHART

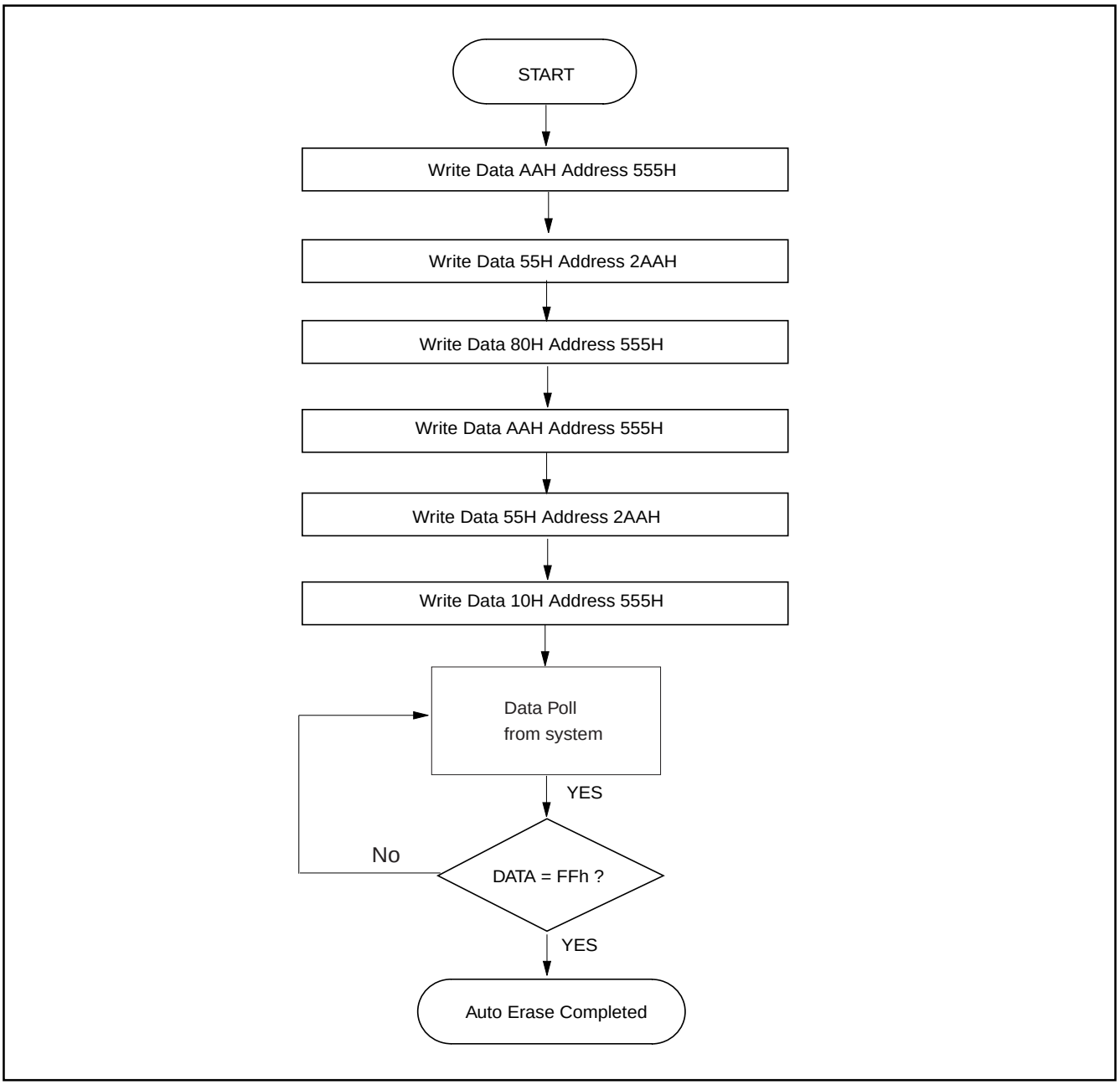

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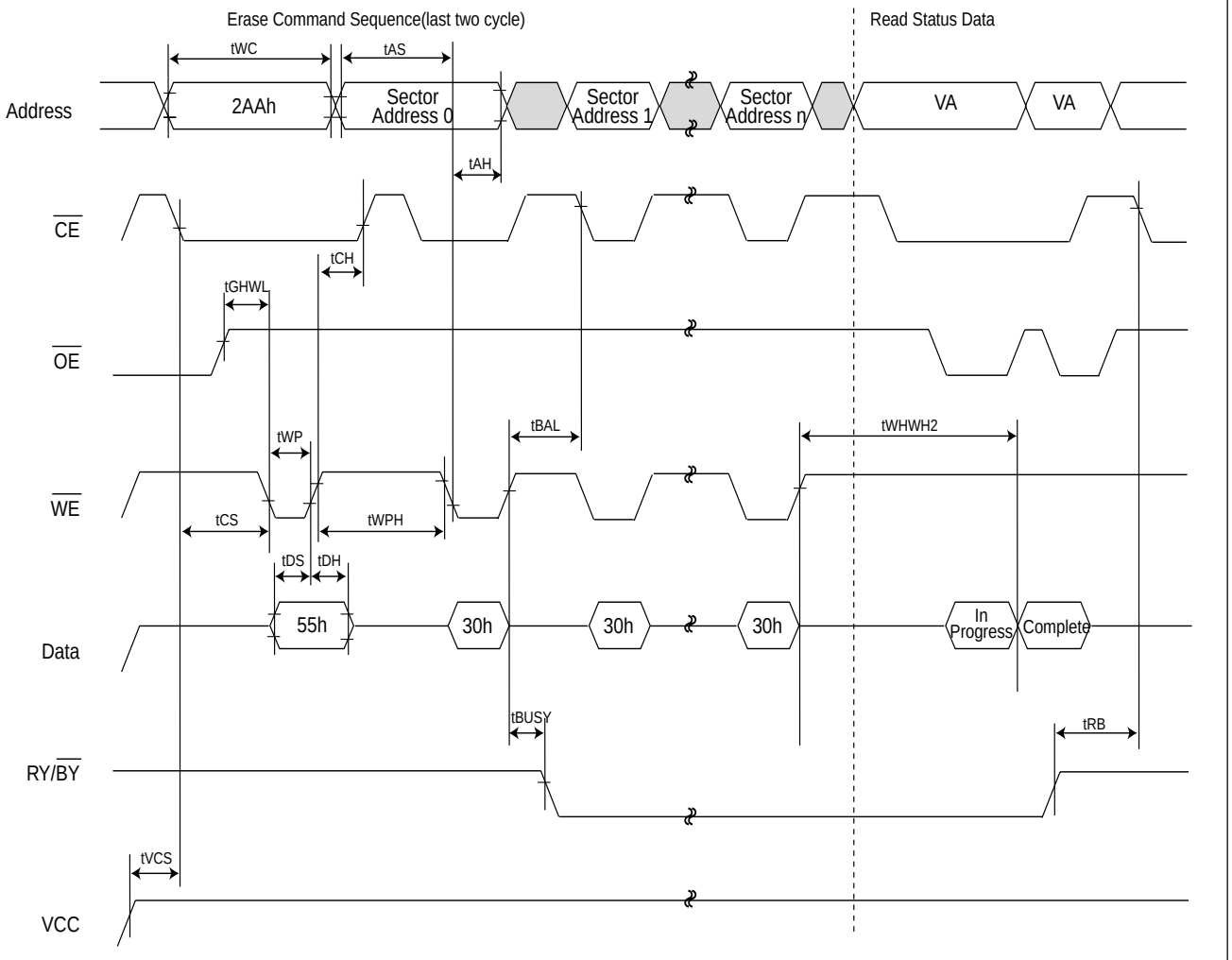
Fig 6. AUTOMATIC SECTOR ERASE TIMING WAVEFORM



NOTES:
SA=sector address(for Sector Erase), VA=Valid Address for reading status data(see "Write Operation Status").

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Fig 7. AUTOMATIC SECTOR ERASE ALGORITHM FLOWCHART

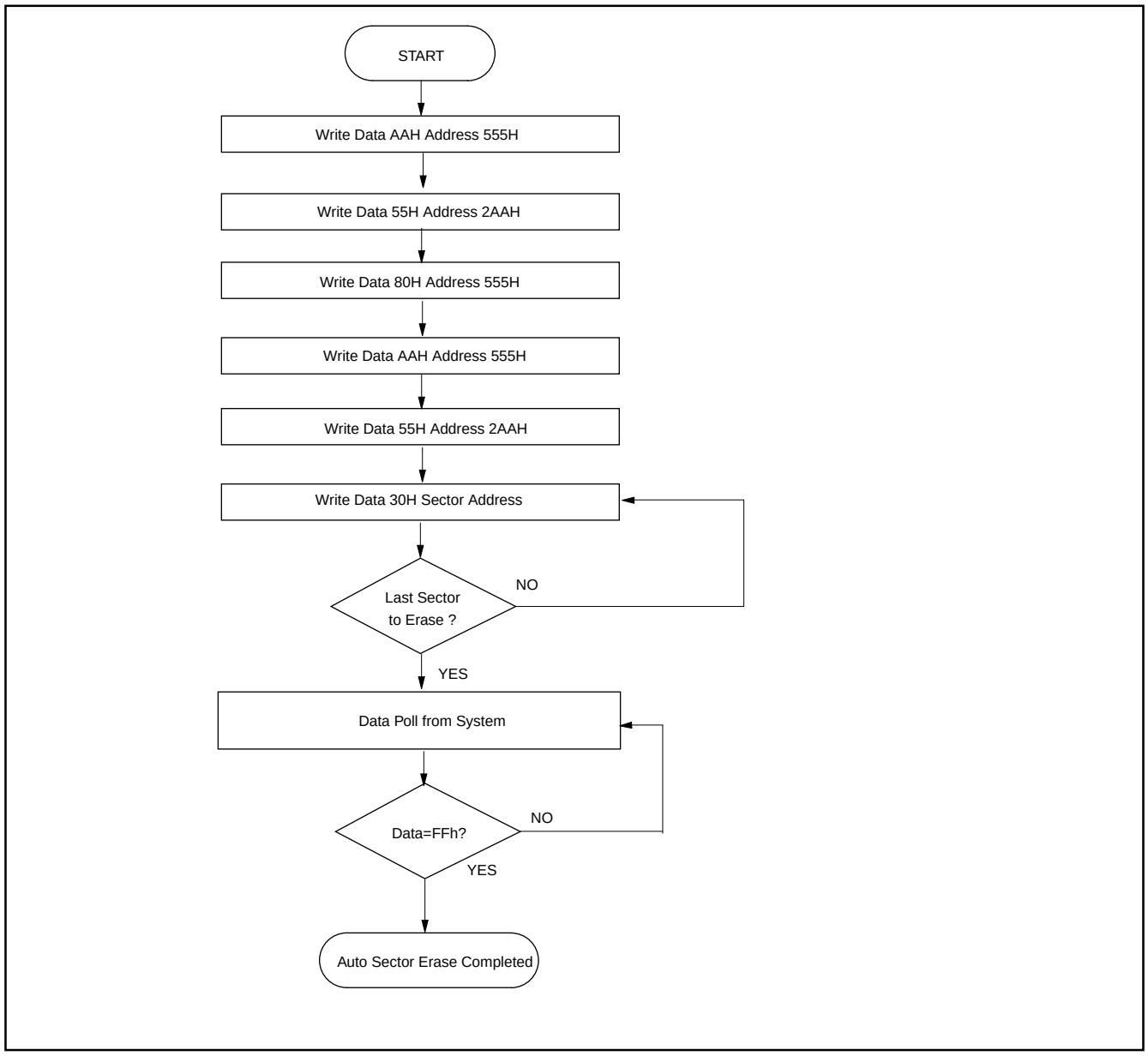

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Fig 8. ERASE SUSPEND/RESUME FLOWCHART

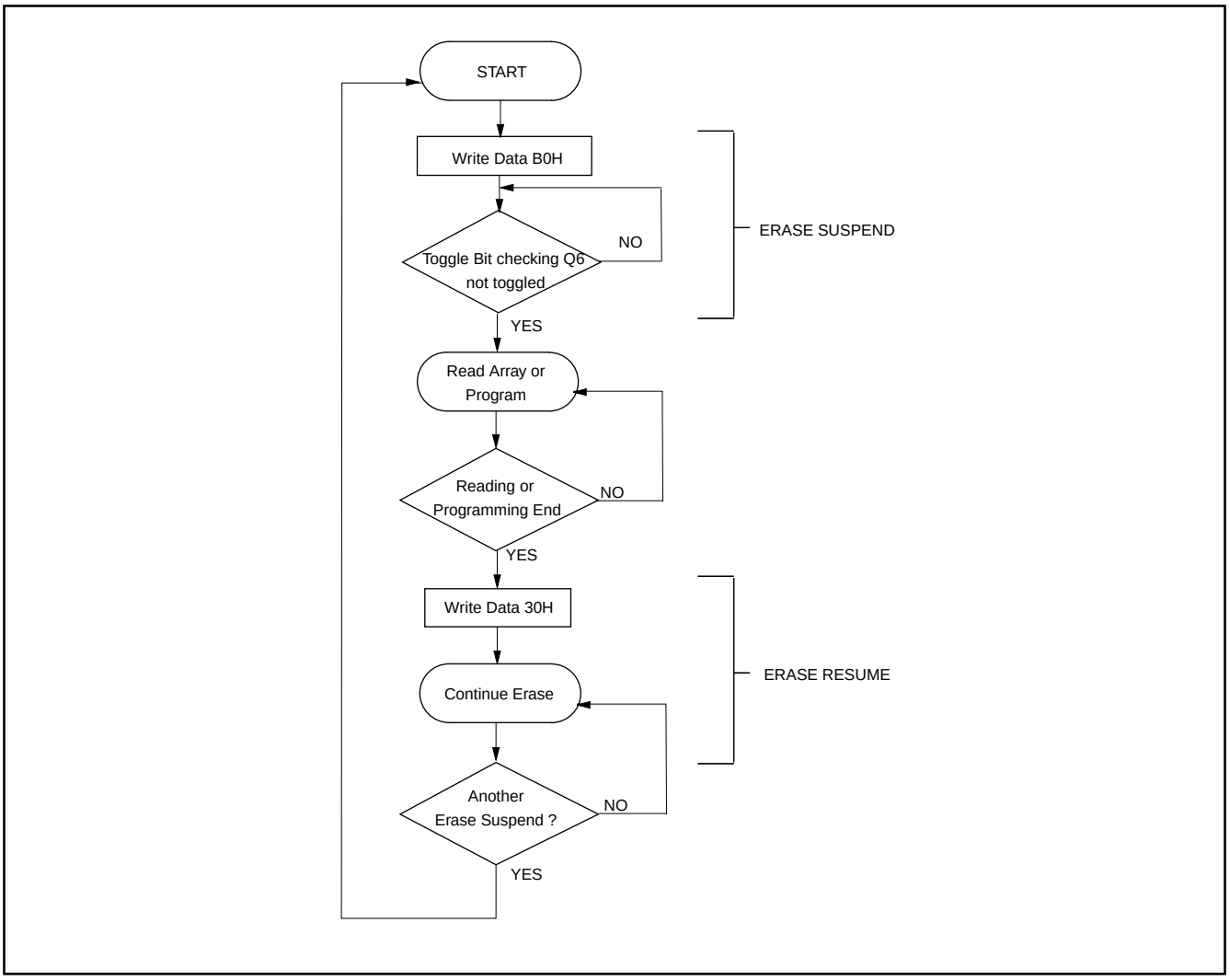

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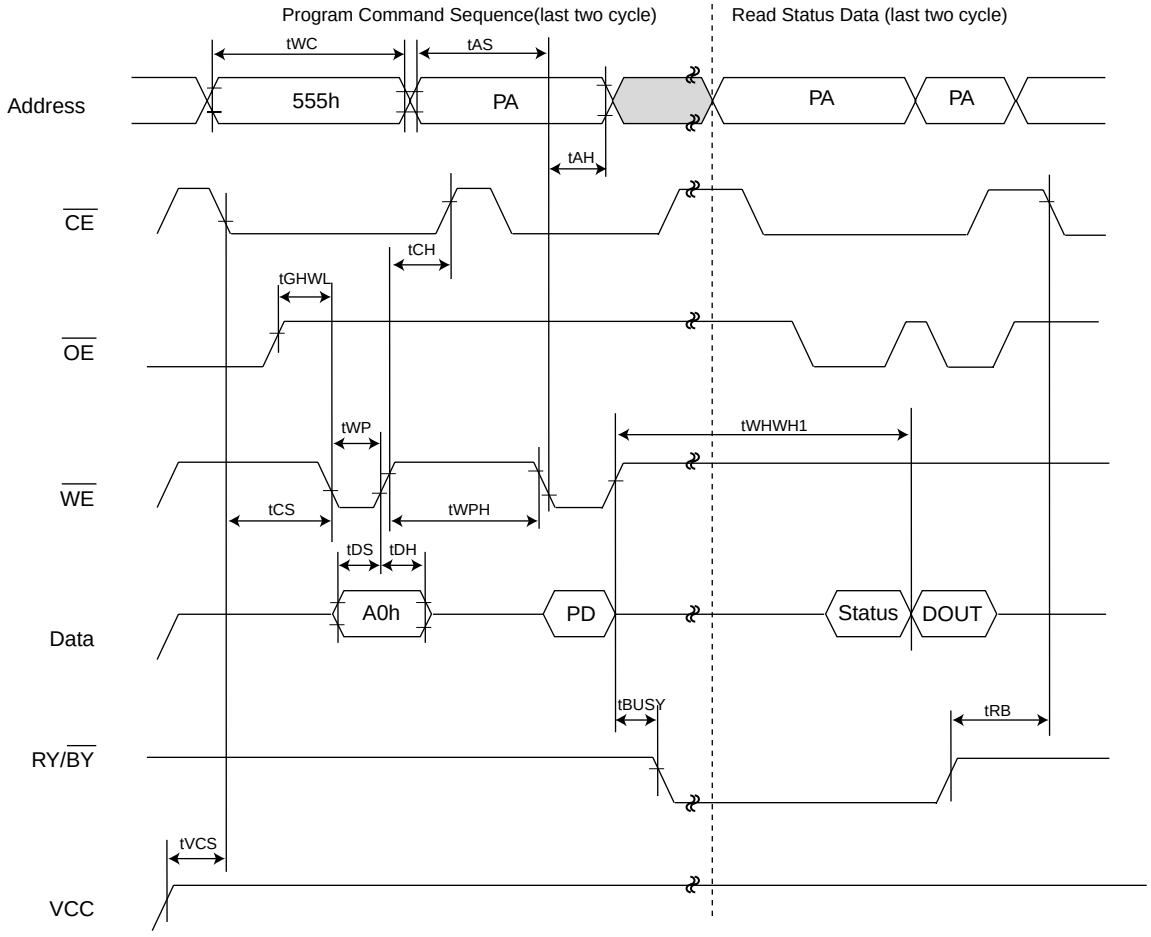
Fig 9. AUTOMATIC PROGRAM TIMING WAVEFORMS



NOTES:
1.PA=Program Address, PD=Program Data, DOUT is the true data the program address

Fig 10. Accelerated Program Timing Diagram

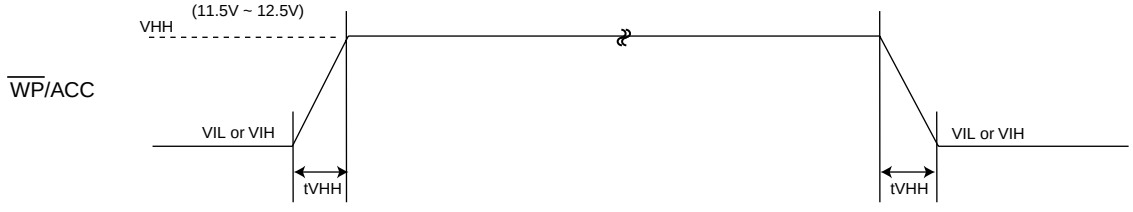


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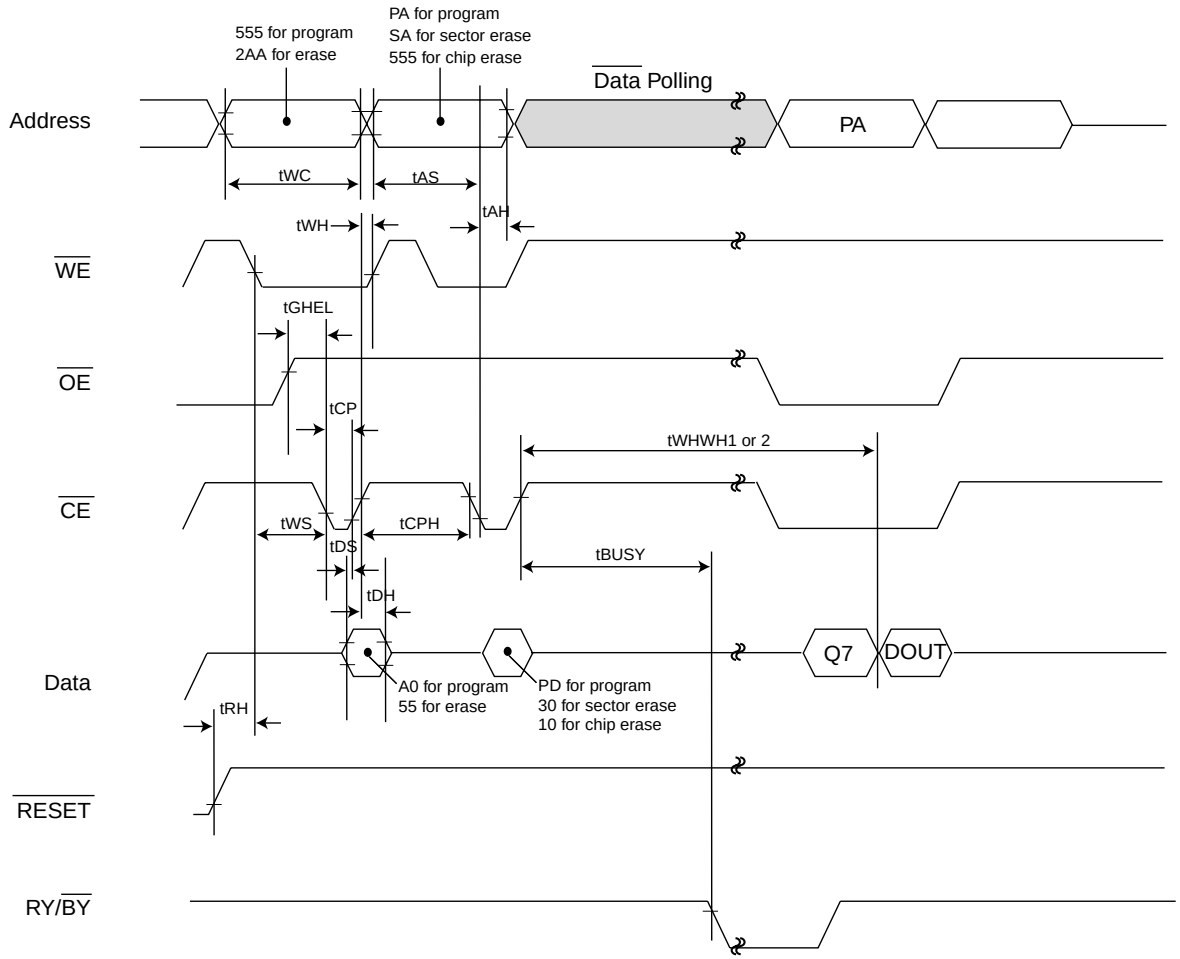
Fig 11. $\overline{CE}$ CONTROLLED WRITE TIMING WAVEFORM



NOTES:

1. PA=Program Address, PD=Program Data, DOUT=Data Out, Q7=complement of data written to device.
2. Figure indicates the last two bus cycles of the command sequence.

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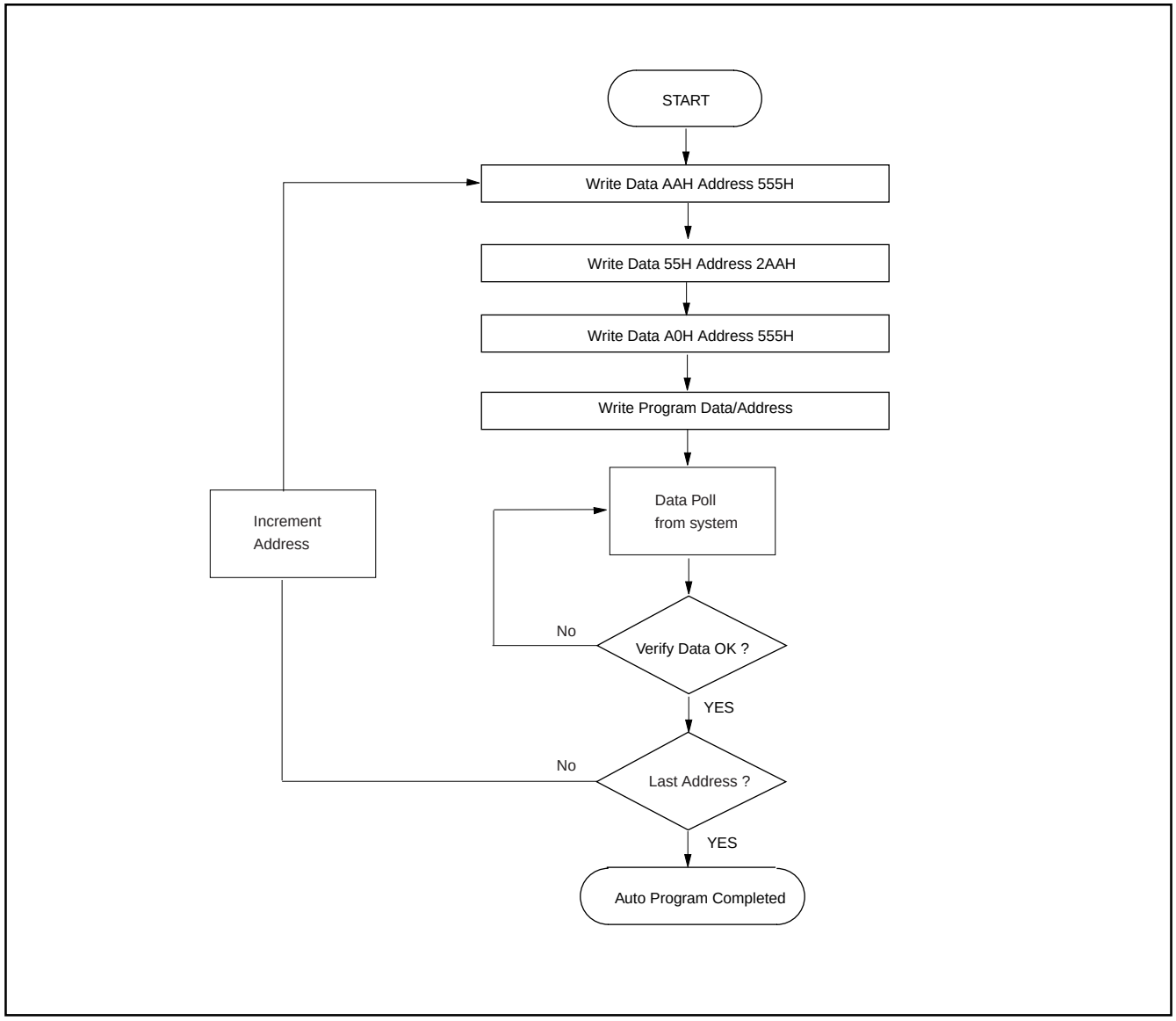
Fig 12. AUTOMATIC PROGRAMMING ALGORITHM FLOWCHART



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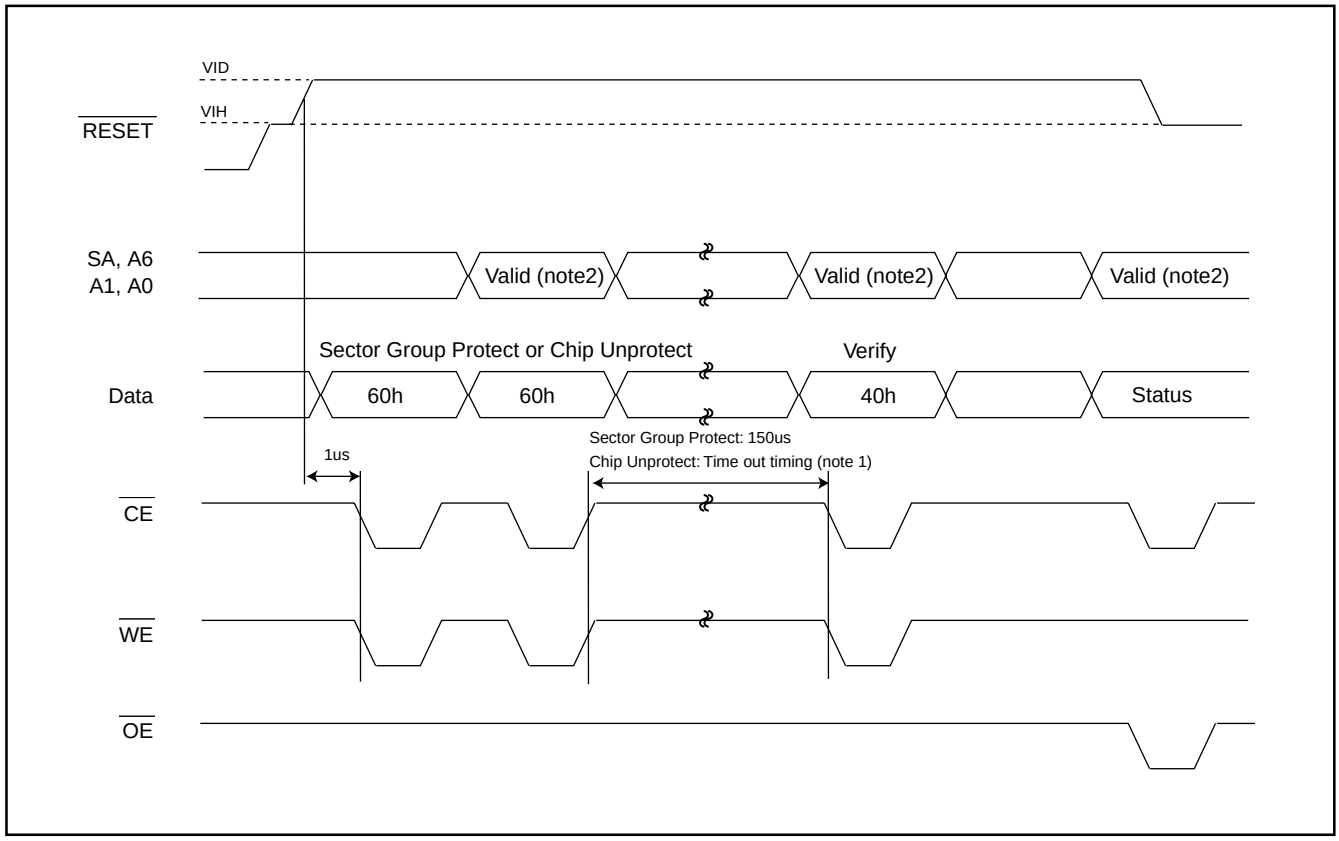
SECTOR GROUP PROTECT/CHIP UNPROTECT

Fig 13. Sector Group Protect/Chip Unprotect Waveform ($\overline{\text{RESET}}$ Control)



Note:
1. If TA range during 0℃ to 70℃, the time out timing is 15ms.
   If TA range during -40℃ to 85℃, the time out timing is 18ms.
2. For sector group protect A6=0, A1=1, A0=0 ; for chip unprotect A6=1, A1=1, A0=0

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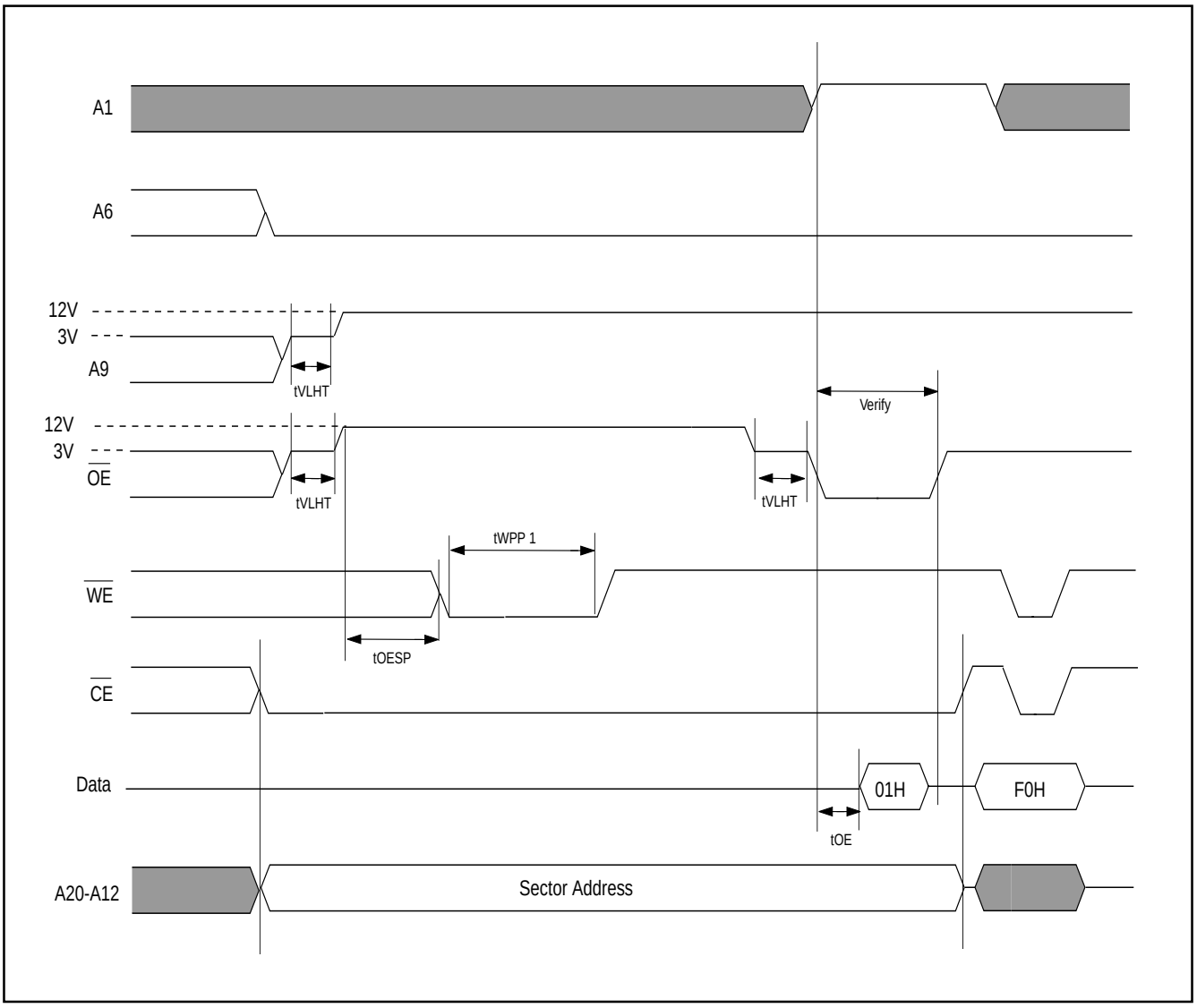
Fig 14. SECTOR GROUP PROTECT TIMING WAVEFORM (A9, $\overline{OE}$ Control)



Notes: tVLHT (Voltage transition time)=4us min.
tWPP1 (Write pulse width for sector group protect)=100ns min.
tOESP ($\overline{OE}$ setup time to $\overline{WE}$ active)=4us min.

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Fig 15. SECTOR GROUP PROTECTION ALGORITHM (A9, $\overline{OE}$ Control)

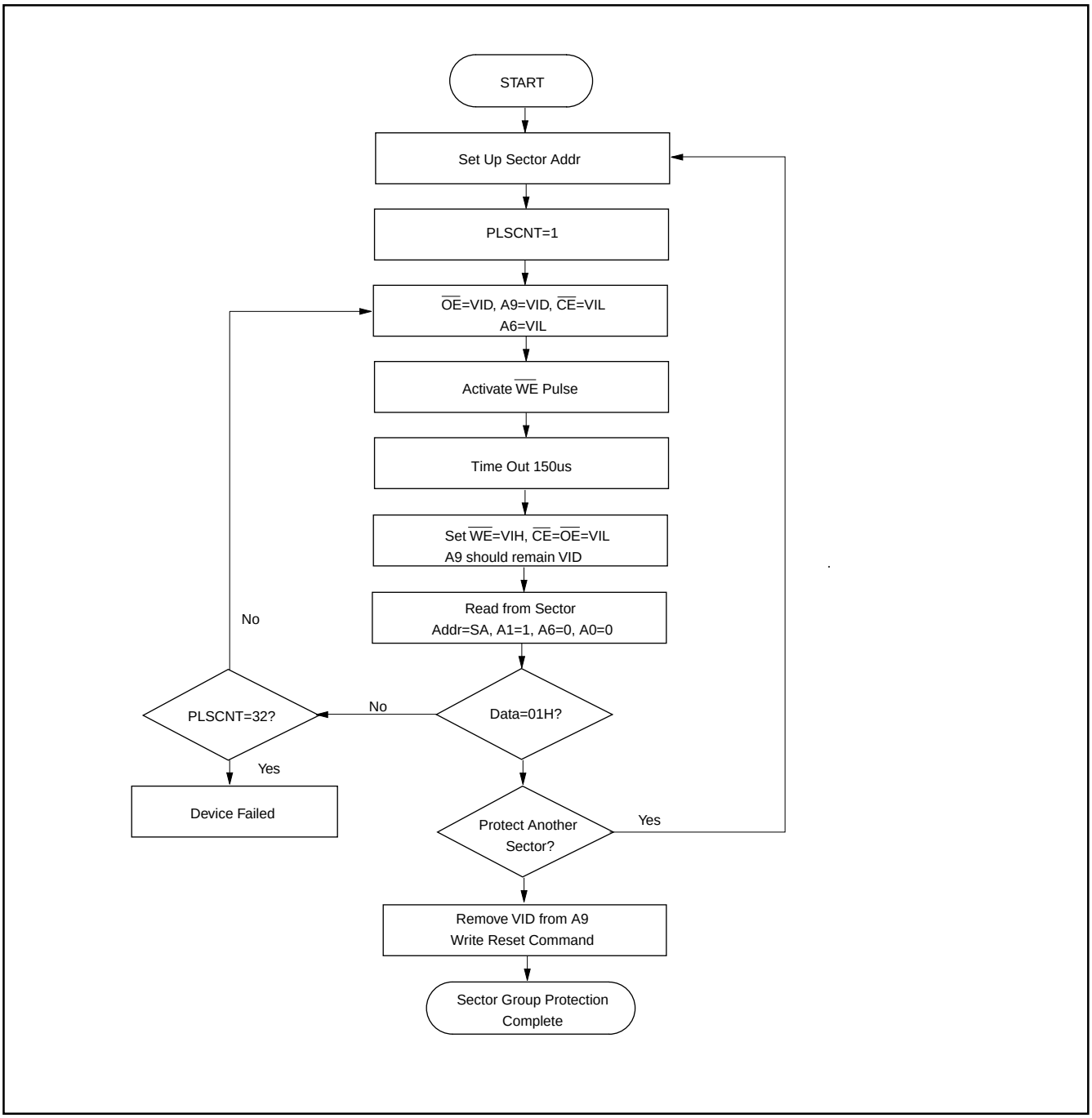

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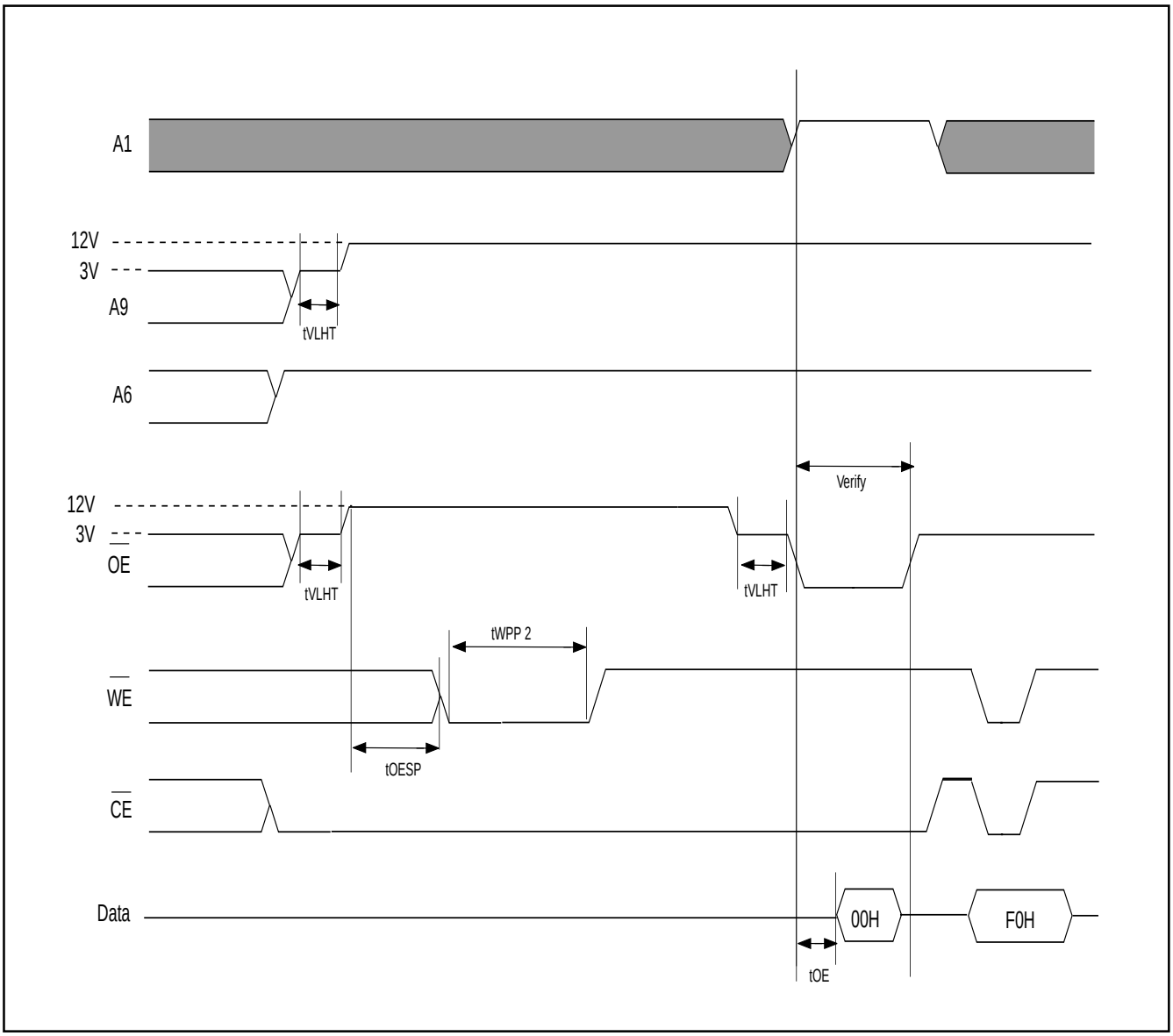
Fig 16. CHIP UNPROTECT TIMING WAVEFORM (A9, $\overline{OE}$ Control)



Notes: tVLHT (Voltage transition time)=4us min.
tWPP2 (Write pulse width for chip unprotect)=100ns min.
tOESP ($\overline{OE}$ setup time to $\overline{WE}$ active)=4us min.

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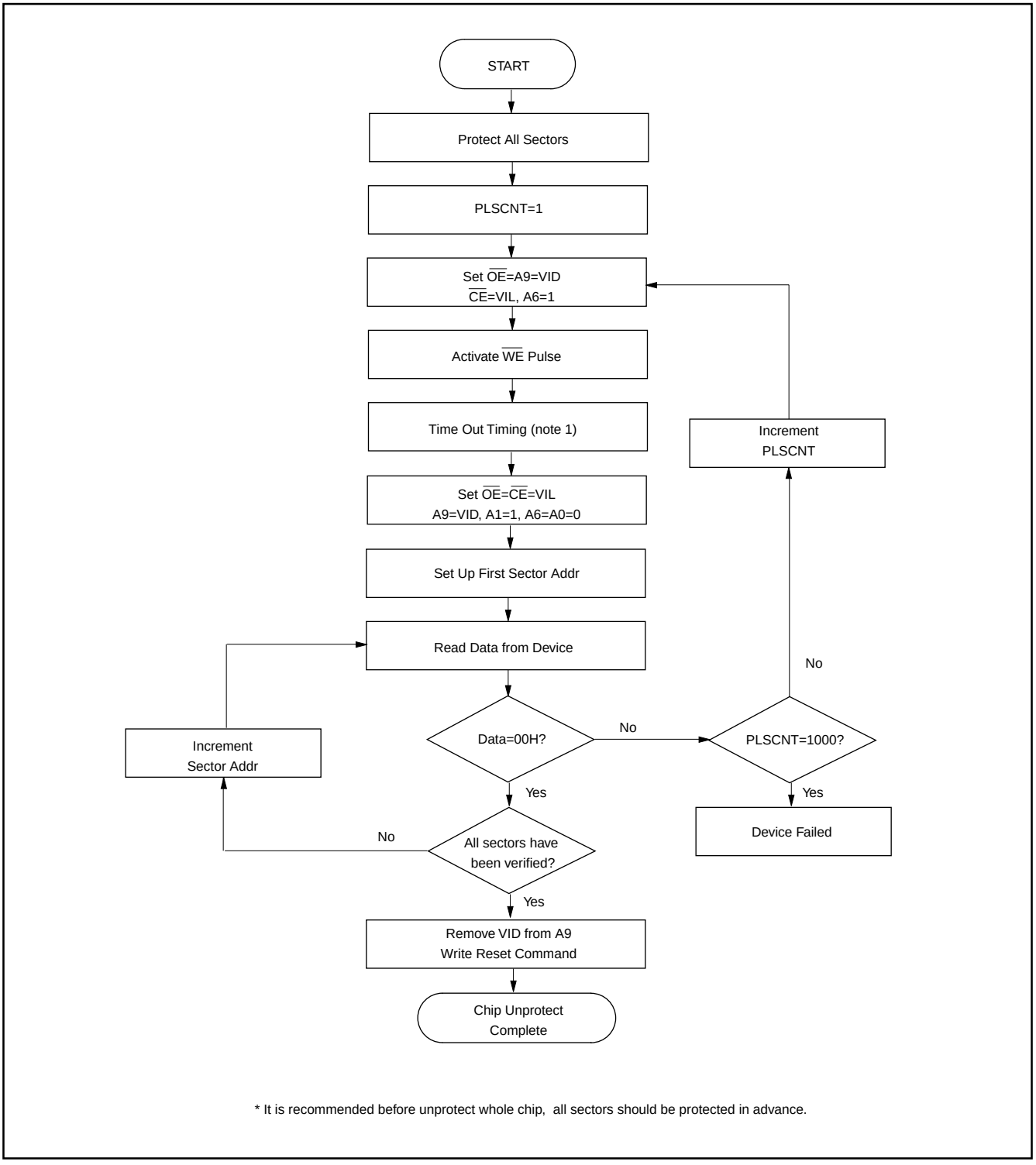
Fig 17. CHIP UNPROTECT FLOWCHART(A9, $\overline{OE}$ Control)



Note:

1. If TA range during 0℃ to 70℃, the time out timing is 15ms.
   If TA range during -40℃ to 85℃, the time out timing is 18ms.

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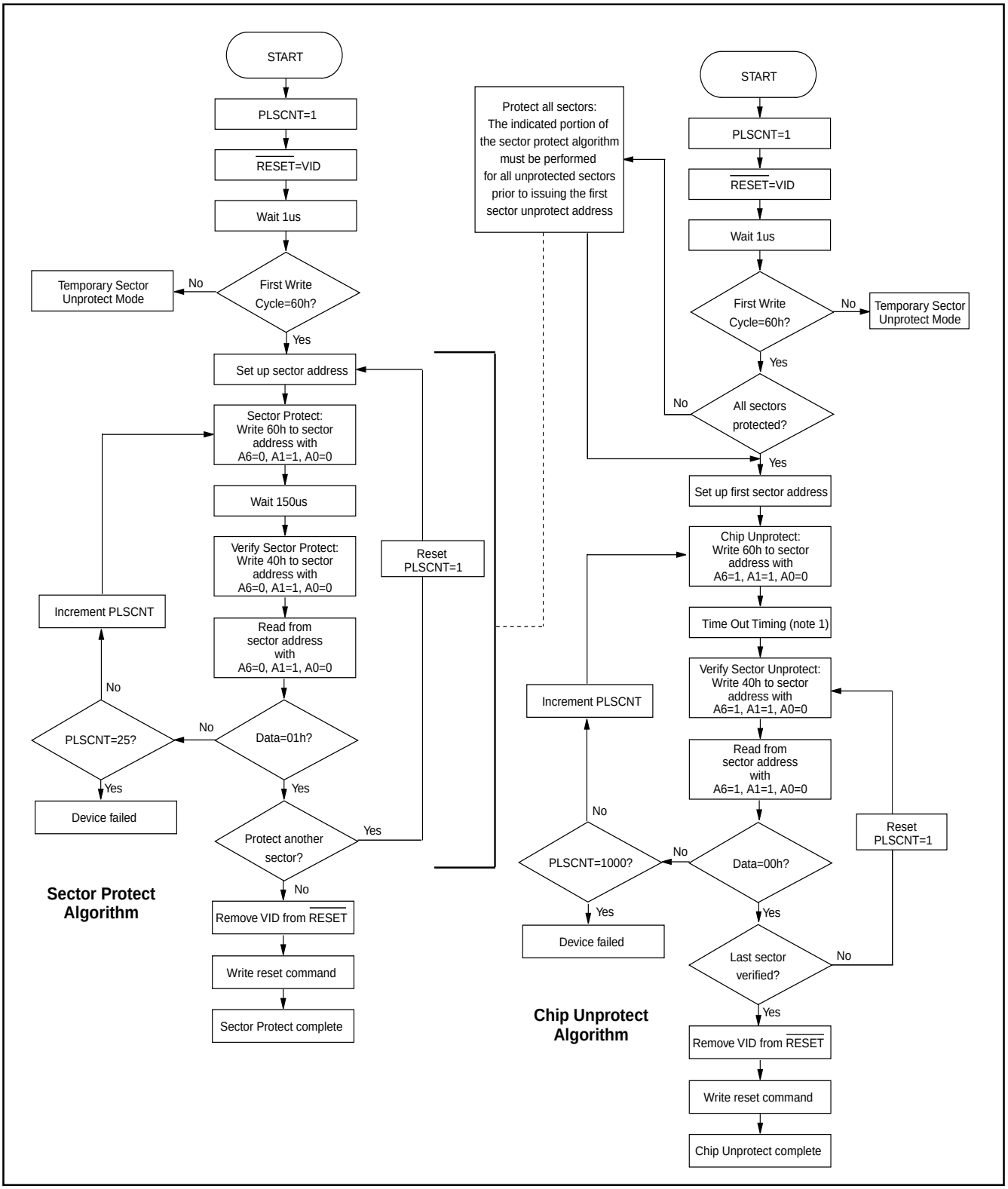
Fig 18. IN-SYSTEM SECTOR GROUP PROTECT/CHIP UNPROTECT ALGORITHMS WITH $\overline{\text{RESET}}$=VID



Note:

1. If TA range during 0℃ to 70℃, the time out timing is 15ms.
   If TA range during -40℃ to 85℃, the time out timing is 18ms.

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Table 7. TEMPORARY SECTOR GROUP UNPROTECT

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

Note:
Not 100% tested

Fig 19. TEMPORARY SECTOR GROUP UNPROTECT WAVEFORMS

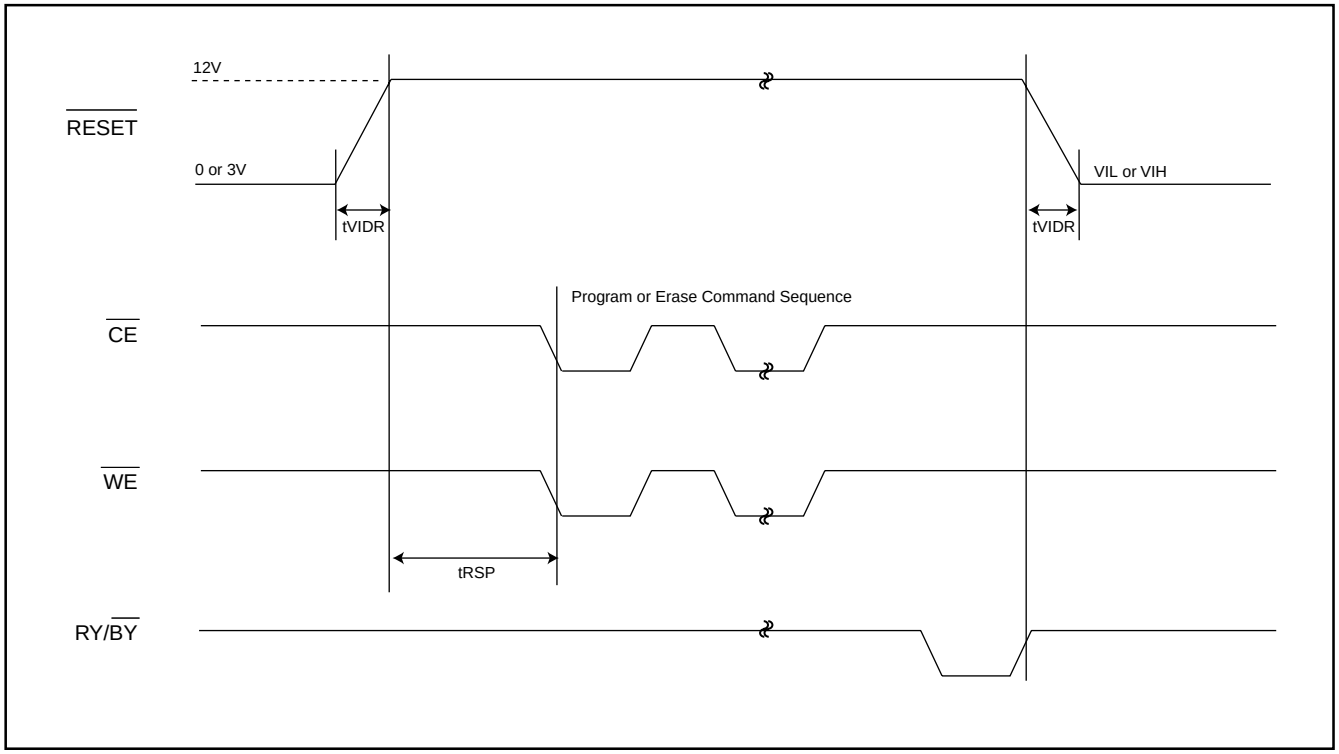

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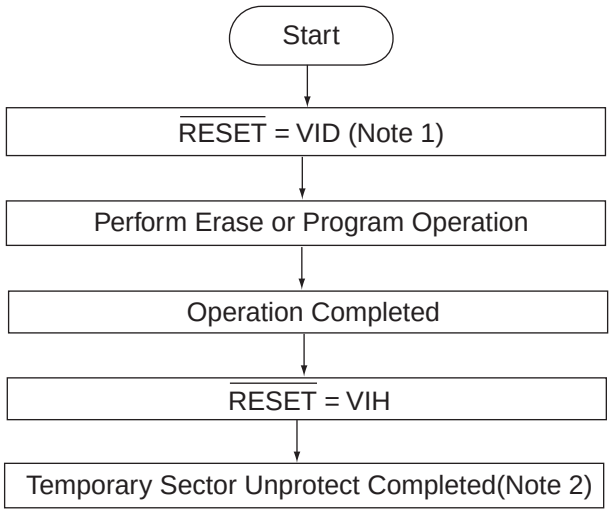
Fig 20. TEMPORARY SECTOR GROUP UNPROTECT FLOWCHART



Note : 1. All protected sectors are temporary unprotected. VID=11.5V~12.5V.
(if WP/ACC=VIL, outermost boot sectors will remain protected)

2. All previously protected sectors are protected again.

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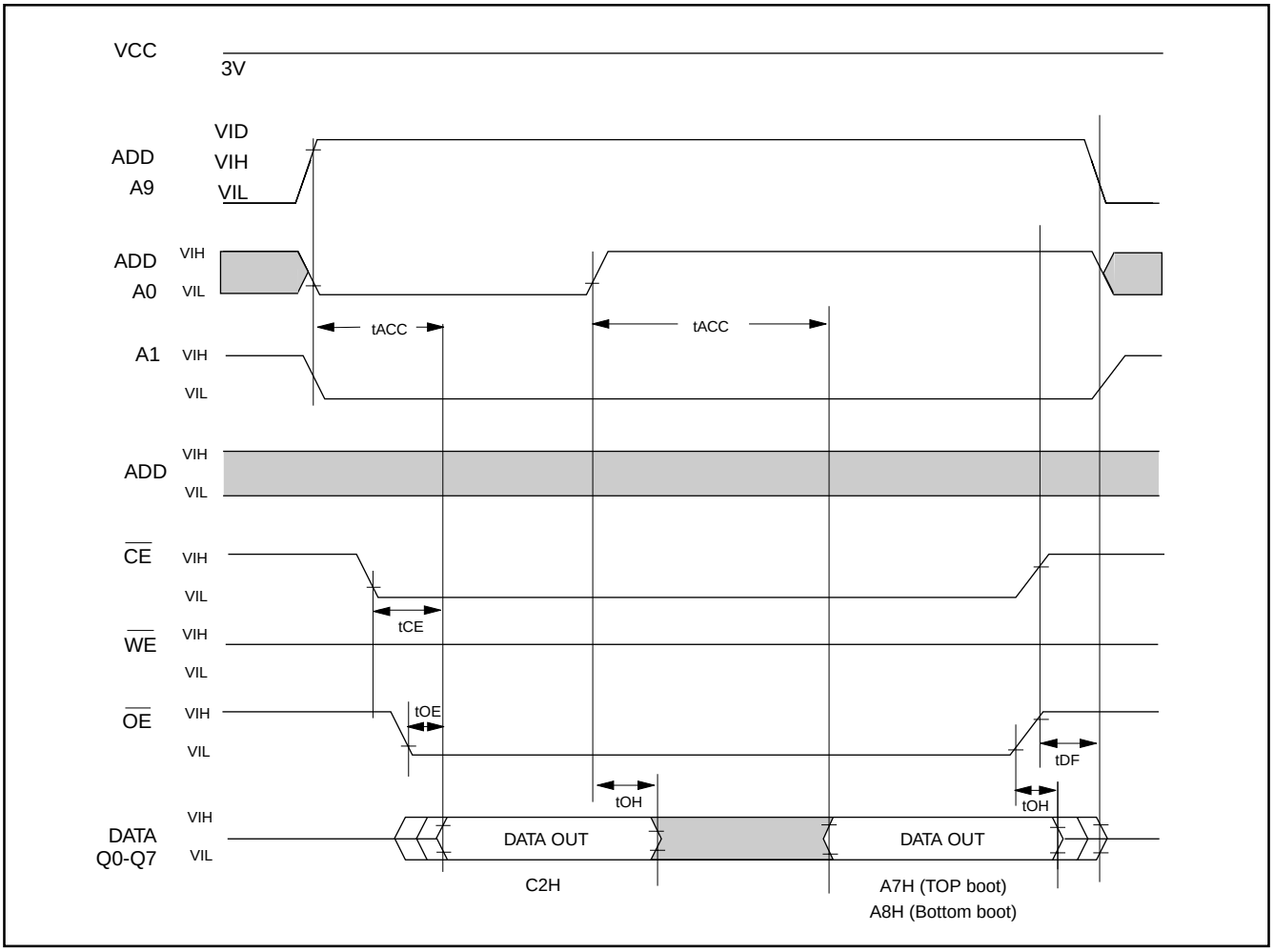
Fig 21. SILICON ID READ TIMING WAVEFORM



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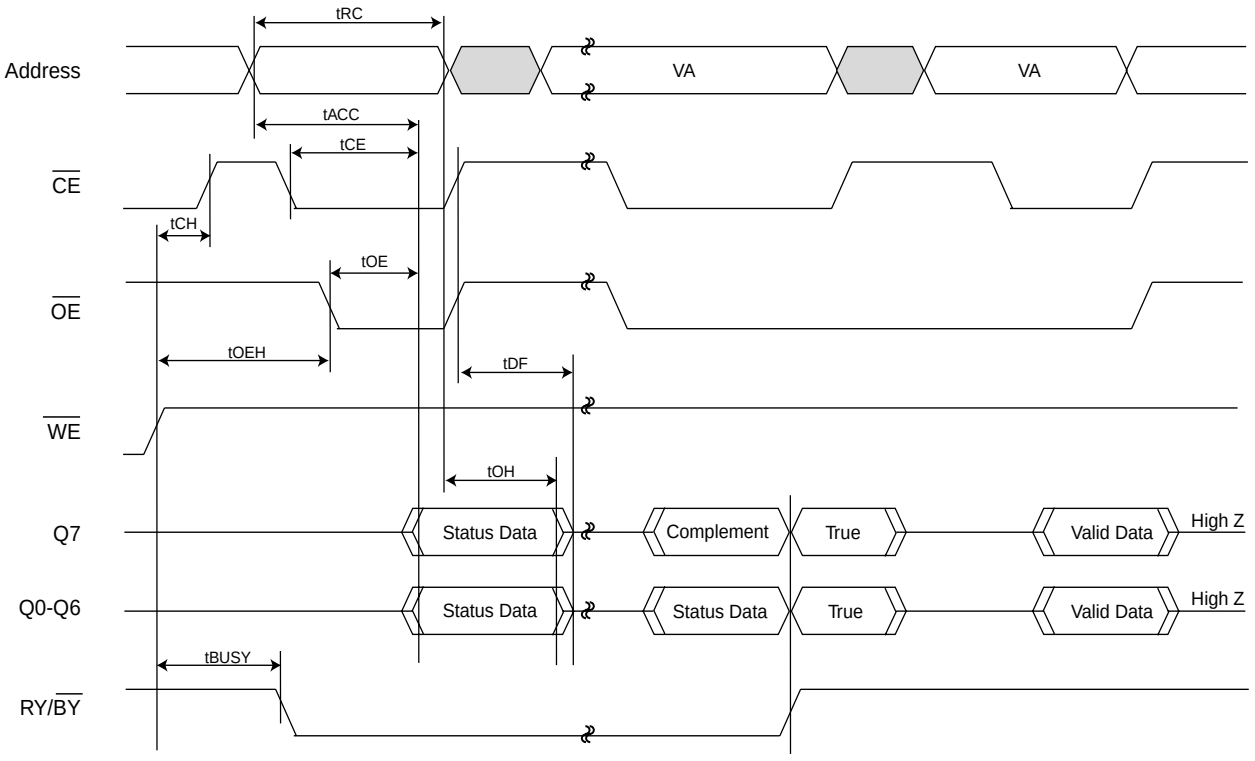
WRITE OPERATION STATUS

Fig 22. $\overline{\text{DATA}}$ POLLING TIMING WAVEFORMS (DURING AUTOMATIC ALGORITHMS)



NOTES:

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

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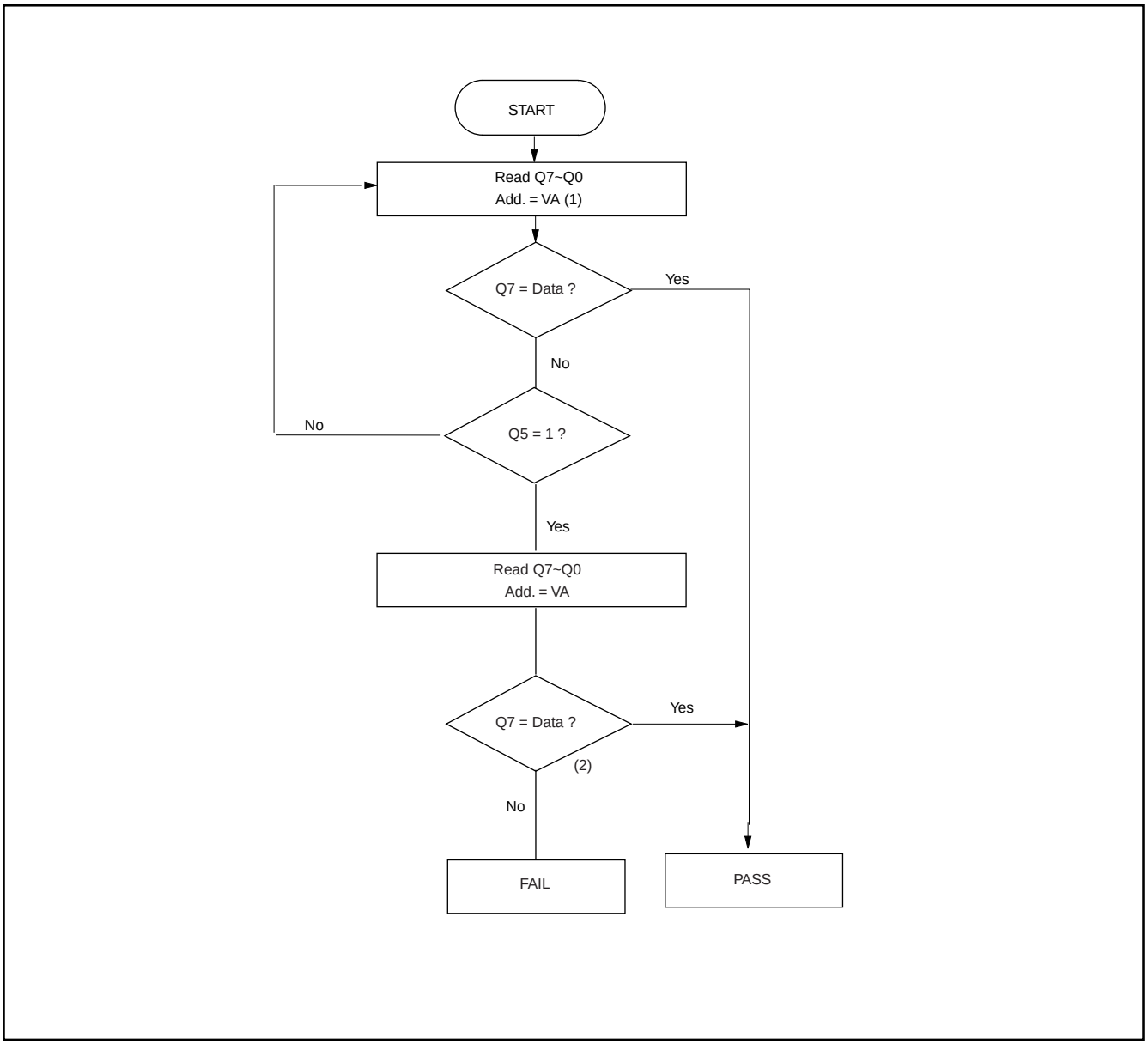
Fig 23. Data Polling Algorithm



Notes:
1. VA=valid address for programming or erasure.
2. Q7 should be rechecked even Q5="1"because Q7 may change simultaneously with Q5.

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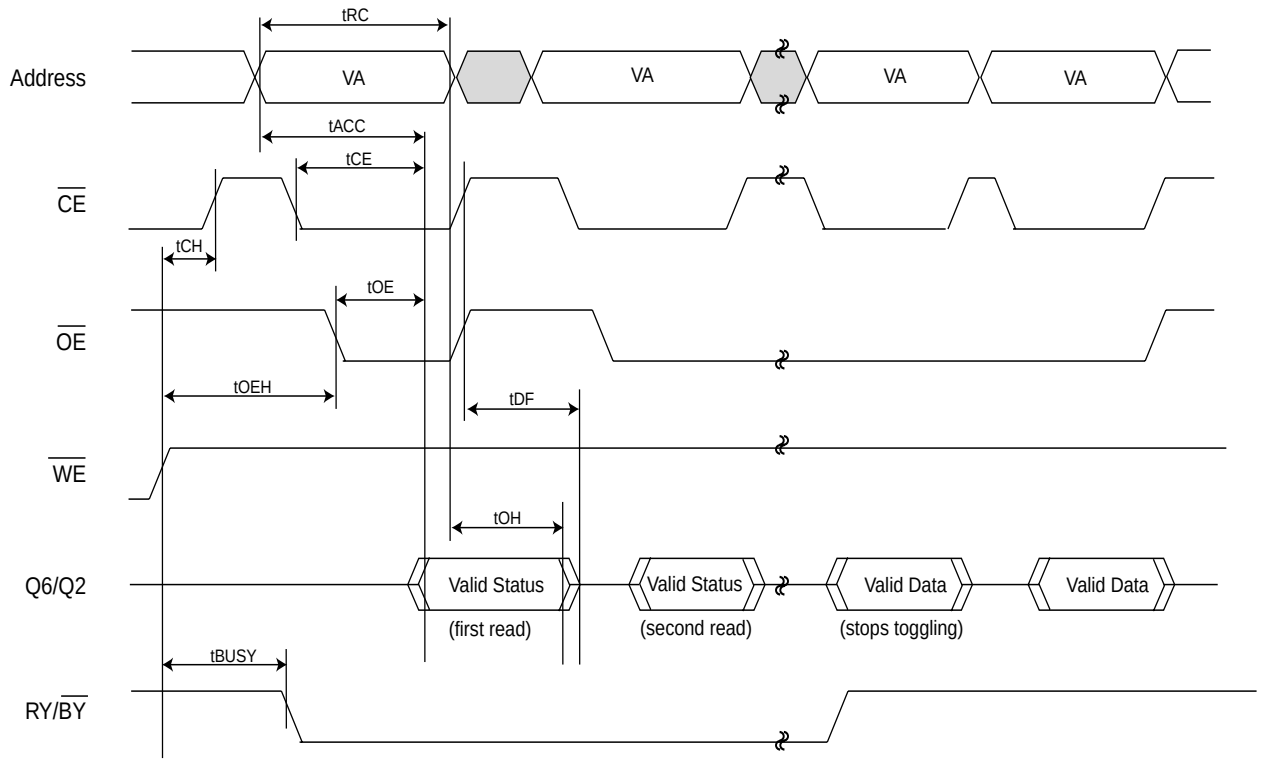
Fig 24. TOGGLE BIT TIMING WAVEFORMS (DURING AUTOMATIC ALGORITHMS)



NOTES:

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.

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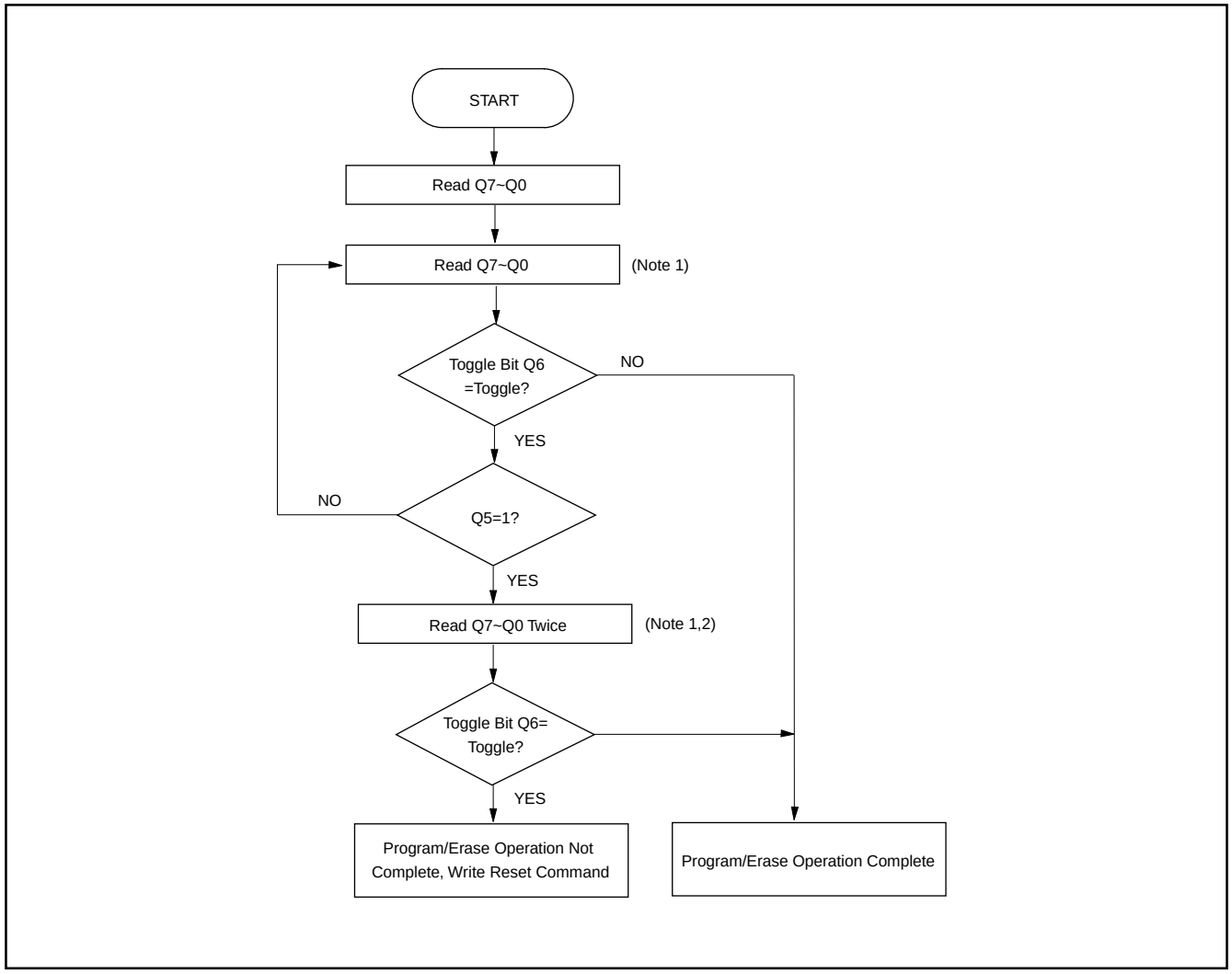
Fig 25. Toggle Bit Algorithm



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 changes to "1".

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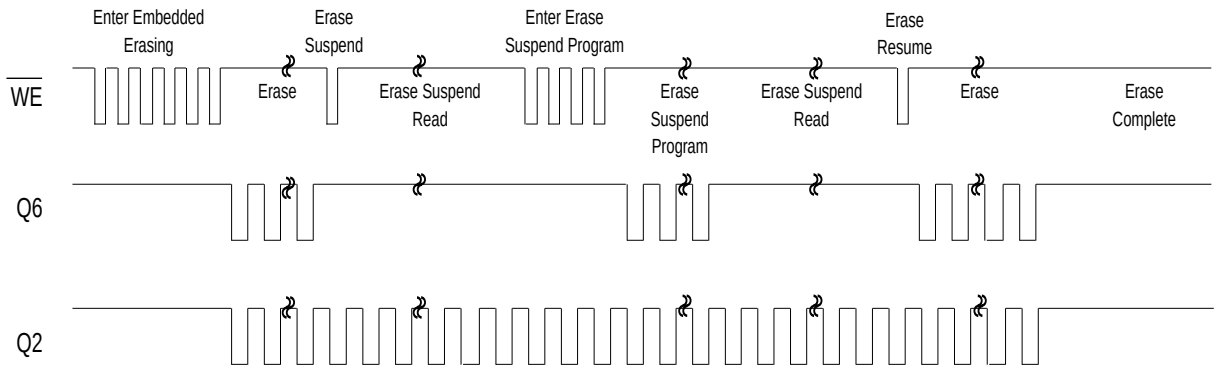
Fig 26. Q6 versus Q2



NOTES:

The system can use $\overline{OE}$ or $\overline{CE}$ to toggle Q2/Q6, Q2 toggles only when read at an address within an erase-suspended

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ERASE AND PROGRAMMING PERFORMANCE(1)

PARAMETER		LIMITS MIN.	TYP.(2)	MAX.	UNITS
Sector Erase Time			0.9	15	sec
Chip Erase Time			35	50	sec
Byte Programming Time			9	300	us
Word Program Time			11	360	us
Chip Programming Time	Byte Mode		36	108	sec
	Word Mode		24	72	sec
Accelerated Byte/Word Program Time			7	210	us
Erase/Program Cycles		100,000			Cycles

Note: 1.Not 100% Tested, Excludes external system level over head.
2.Typical values measured at 25℃,3.3V.

LATCH-UP CHARACTERISTICS

	MIN.	MAX.
Input Voltage with respect to GND on all pins except I/O pins	-1.0V	12.5V
Input Voltage with respect to GND on all I/O pins	-1.0V	Vcc + 1.0V
VCC Current	-100mA	+100mA
Includes all pins except Vcc. Test conditions: Vcc = 3.0V, one pin at a time.		

TSOP PIN CAPACITANCE

Parameter Symbol	Parameter Description	Test Set	TYP	MAX	UNIT
CIN	Input Capacitance	VIN=0	6	7.5	pF
COUT	Output Capacitance	VOUT=0	8.5	12	pF
CIN2	Control Pin Capacitance	VIN=0	7.5	9	pF

Notes:
1. Sampled, not 100% tested.
2. Test conditions TA=25℃, f=1.0MHz

DATA RETENTION

Parameter	Test Conditions	Min	Unit
Minimum Pattern Data Retention Time	150℃	10	Years
	125℃	20	Years

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ORDERING INFORMATION

PLASTIC PACKAGE

PART NO.	ACCESS TIME (ns)	Ball Pitch/ Ball Size	PACKAGE	Remark
MX29LV320TTC-70	70	-	48 Pin TSOP	
MX29LV320BTC-70	70	-	48 Pin TSOP	
MX29LV320TTI-70	70	-	48 Pin TSOP	
MX29LV320BTI-70	70	-	48 Pin TSOP	
MX29LV320TTC-90	90	-	48 Pin TSOP	
MX29LV320BTC-90	90	-	48 Pin TSOP	
MX29LV320TTI-90	90	-	48 Pin TSOP	
MX29LV320BTI-90	90	-	48 Pin TSOP	
MX29LV320TTI-12	120	-	48 Pin TSOP	
MX29LV320BTI-12	120	-	48 Pin TSOP	
MX29LV320TXBC-70	70	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBC-70	70	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEC-70	70	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEC-70	70	0.8mm/0.4mm	48-Ball CSP	
MX29LV320TXBI-70	70	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBI-70	70	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEI-70	70	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEI-70	70	0.8mm/0.4mm	48-Ball CSP	
MX29LV320TXBC-90	90	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBC-90	90	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEC-90	90	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEC-90	90	0.8mm/0.4mm	48-Ball CSP	
MX29LV320TXBI-90	90	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBI-90	90	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEI-90	90	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEI-90	90	0.8mm/0.4mm	48-Ball CSP	
MX29LV320TXBC-12	120	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBC-12	120	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEC-12	120	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEC-12	120	0.8mm/0.4mm	48-Ball CSP	
MX29LV320TXBI-12	120	0.8mm/0.3mm	48-Ball CSP	
MX29LV320BXBI-12	120	0.8mm/0.3mm	48-Ball CSP	
MX29LV320TXEI-12	120	0.8mm/0.4mm	48-Ball CSP	
MX29LV320BXEI-12	120	0.8mm/0.4mm	48-Ball CSP	

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PART NO.	ACCESS TIME (ns)	Ball Pitch/ Ball Size	PACKAGE	Remark
MX29LV320TTC-70G	70	-	48 Pin TSOP	PB free
MX29LV320BTC-70G	70	-	48 Pin TSOP	PB free
MX29LV320TTI-70G	70	-	48 Pin TSOP	PB free
MX29LV320BTI-70G	70	-	48 Pin TSOP	PB free
MX29LV320TTC-90G	90	-	48 Pin TSOP	PB free
MX29LV320BTC-90G	90	-	48 Pin TSOP	PB free
MX29LV320TTI-90G	90	-	48 Pin TSOP	PB free
MX29LV320BTI-90G	90	-	48 Pin TSOP	PB free
MX29LV320TTI-12G	120	-	48 Pin TSOP	PB free
MX29LV320BTI-12G	120	-	48 Pin TSOP	PB free
MX29LV320TXBC-70G	70	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBC-70G	70	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEC-70G	70	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEC-70G	70	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320TXBI-70G	70	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBI-70G	70	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEI-70G	70	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEI-70G	70	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320TXBC-90G	90	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBC-90G	90	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEC-90G	90	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEC-90G	90	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320TXBI-90G	90	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBI-90G	90	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEI-90G	90	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEI-90G	90	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320TXBC-12G	120	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBC-12G	120	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEC-12G	120	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEC-12G	120	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320TXBI-12G	120	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320BXBI-12G	120	0.8mm/0.3mm	48-Ball CSP	PB free
MX29LV320TXEI-12G	120	0.8mm/0.4mm	48-Ball CSP	PB free
MX29LV320BXEI-12G	120	0.8mm/0.4mm	48-Ball CSP	PB free

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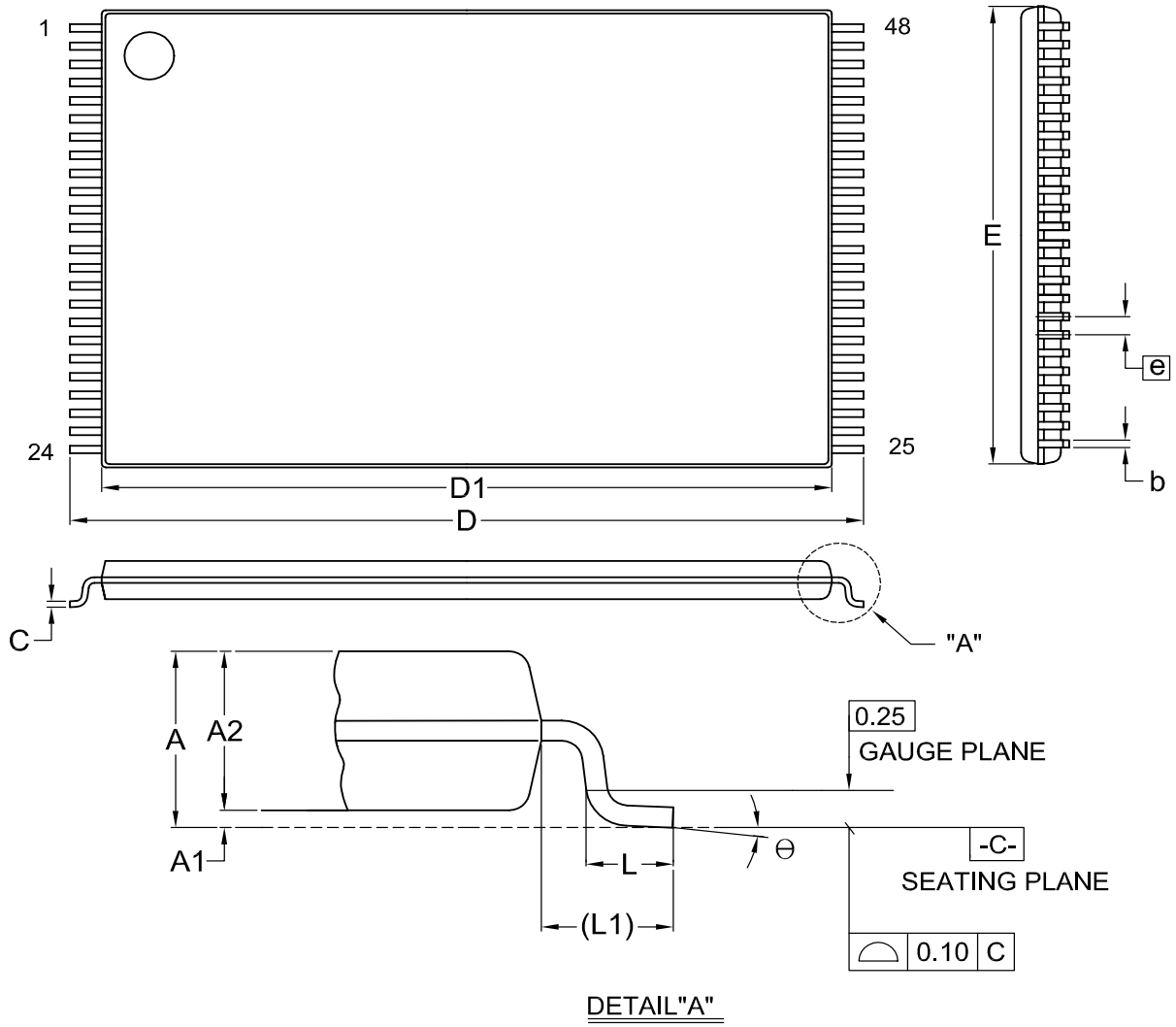
PACKAGE INFORMATION

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	6	MO-142			09-24-'02

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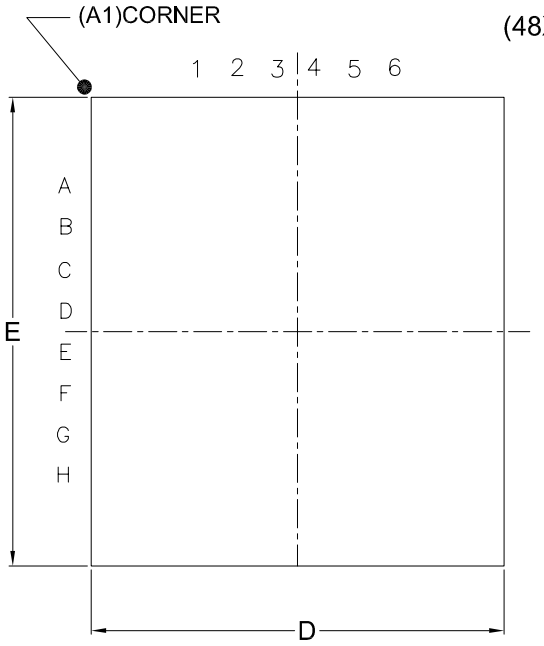
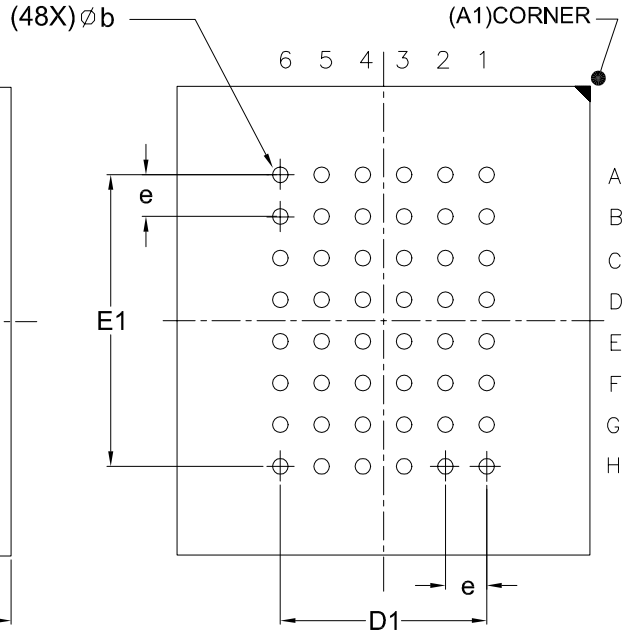
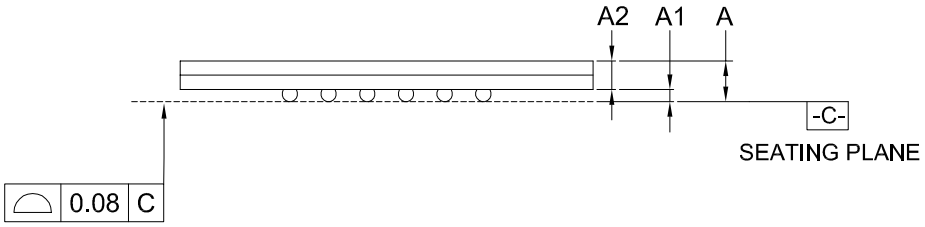
Title: **Package Outline for CSP 48BALL(8X9X1.2MM,BALL PITCH 0.8MM,BALL DIAMETER 0.3MM)**

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.	—	0.18	0.65	0.27	7.90		8.90		
	Nom.	—	0.23	---	0.30	8.00	4.00	9.00	5.60	0.80
	Max.	1.20	0.28	---	0.37	8.10		9.10		
Inch	Min.	---	0.007	0.026	0.011	0.311		0.350		
	Nom.	---	0.009	—	0.012	0.315	0.157	0.354	0.220	0.031
	Max.	0.047	0.011	—	0.015	0.319		0.358		

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-4210	5	MO-210			11-08-'02

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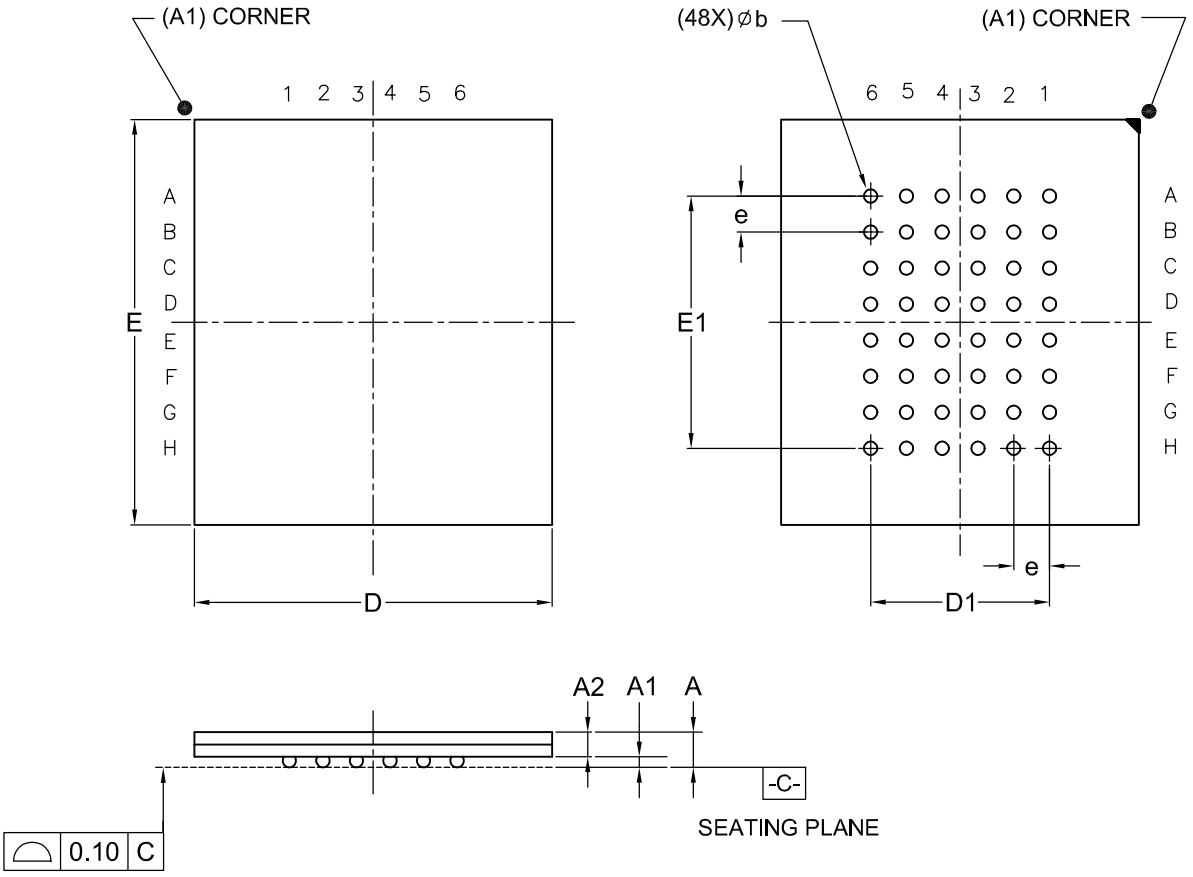
Title: **Package Outline for CSP 48BALL(8X9X1.3MM,BALL PITCH 0.8MM,BALL DIAMETER 0.4MM)**

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	7.90		8.90		
	Nom.	---	0.30	---	0.40	8.00	4.00	9.00	5.60	0.80
	Max.	1.30	0.35	---	0.45	8.10		9.10		
Inch	Min.	—	0.010	0.026	0.014	0.311		0.350		
	Nom.	—	0.012	—	0.016	0.315	0.157	0.354	0.220	0.031
	Max.	0.051	0.014	—	0.018	0.319		0.358		

DWG.NO.	REVISION	REFERENCE			ISSUE DATE
		JEDEC	EIAJ		
6110-4212	3	MO-219			09-24-'02

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REVISION HISTORY

Revision No.	Description	Page	Date
1.0	1. To removed "Advanced Information"	P1	NOV/21/2002
	2. To modify Package Information	P57~59	
	3. To modify sector erasy timing wavefrom and added tBAL timing in the AC Characteristics table	P30,36	
1.1	1. To modify the chip erase time from typ. 112sec to typ. 35sec/max.50sec	P2,56	FEB/10/2003
	2. To modify the sector erase time from typ. 1.6sec to typ. 0.9sec	P30,56	
1.2	1. To modify ILIT parameter value from 35uA to 45uA during TA=-40℃ to 85℃ in DC Characteristics	P28	MAR/26/2003
	2. To modify the chip unprotection time out timing during TA=-40℃ to 85℃ range from 15ms to 18ms	P42,46,47	
	3. Remove 70/90R information	P27~30, 57	
1.3	1. To added PB-free part no. in ordering information	P58	APR/23/2003
1.4	1. To corrected the fast program timing from normal program speed to ACC program speed	P1	JUL/04/2003

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