MITSUBISHI LSIs
M6MGB/T162S2BVP
16,777,216-BIT (1,048,576 -WORD BY 16-BIT) CMOS
3.3V-ONLY FLASH MEMORY &
2,097,152-BIT (262,144-WORD BY 8-BIT) CMOS SRAM
Stacked-MCP (Multi Chip Package)

DESCRIPTION

The MITSUBISHI M6MGB/T162S2BVP is a Stacked Multi Chip Package (S-MCP) that contents 16M-bits flash memory and 2M-bits Static RAM in a 48-pin TSOP (TYPE-I).

16M-bits Flash memory is a 1048576 words, 3.3V-only, and high performance non-volatile memory fabricated by CMOS technology for the peripheral circuit and DINOR(DIvided bit-line NOR) architecture for the memory cell.
2M-bits SRAM is a 262144bytes unsynchronous SRAM fabricated by silicon-gate CMOS technology.

M6MGB/T162S2BVP is suitable for the application of the mobile-communication-system to reduce both the mount space and weight .
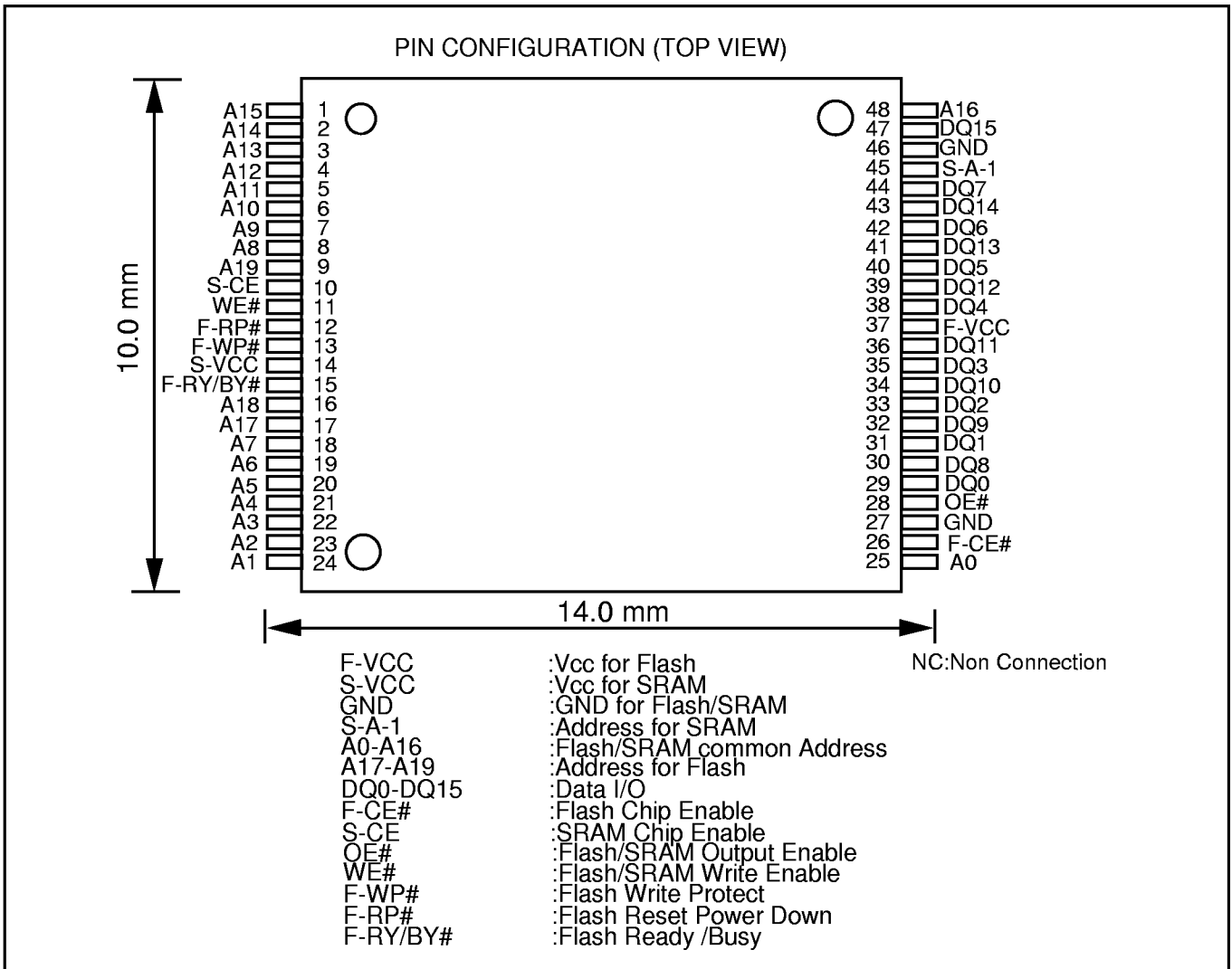
FEATURES

• Access time

Flash Memory	90ns (Max.)
SRAM	85ns (Max.)

• Supply voltage   Vcc=2.7 ~ 3.6V
• Ambient temperature
     W version   Ta=-20 ~ 85°C
• Package : 48-pin TSOP (Type-I) , 0.4mm lead pitch

APPLICATION

Mobile communication products

PIN CONFIGURATION (TOP VIEW)

Left pins		Right pins	
A15	1	48	A16
A14	2	47	DQ15
A13	3	46	GND
A12	4	45	S-A-1
A11	5	44	DQ7
A10	6	43	DQ14
A9	7	42	DQ6
A8	8	41	DQ13
A19	9	40	DQ5
S-CE	10	39	DQ12
WE#	11	38	DQ4
F-RP#	12	37	F-VCC
F-WP#	13	36	DQ11
S-VCC	14	35	DQ3
F-RY/BY#	15	34	DQ10
A18	16	33	DQ2
A17	17	32	DQ9
A7	18	31	DQ1
A6	19	30	DQ8
A5	20	29	DQ0
A4	21	28	OE#
A3	22	27	GND
A2	23	26	F-CE#
A1	24	25	A0

10.0 mm

14.0 mm

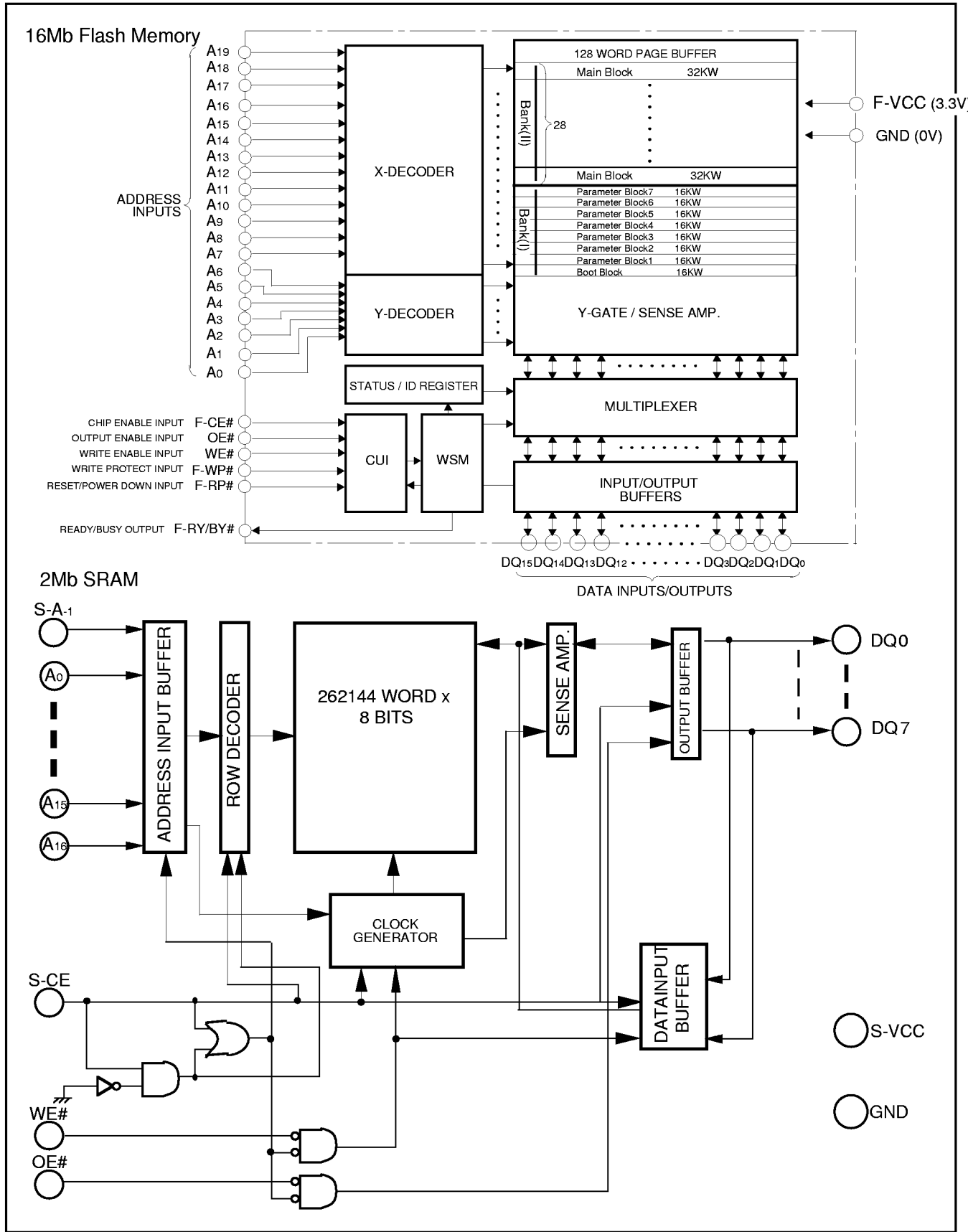|	
F-VCC	:Vcc for Flash
S-VCC	:Vcc for SRAM
GND	:GND for Flash/SRAM
S-A-1	:Address for SRAM
A0-A16	:Flash/SRAM common Address
A17-A19	:Address for Flash
DQ0-DQ15	:Data I/O
F-CE#	:Flash Chip Enable
S-CE	:SRAM Chip Enable
OE#	:Flash/SRAM Output Enable
WE#	:Flash/SRAM Write Enable
F-WP#	:Flash Write Protect
F-RP#	:Flash Reset Power Down
F-RY/BY#	:Flash Ready /Busy

NC:Non Connection

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BLOCK DIAGRAM

16Mb Flash Memory

ADDRESS INPUTS

A_{19}, A_{18}, A_{17}, A_{16}, A_{15}, A_{14}, A_{13}, A_{12}, A_{11}, A_{10}, A_9, A_8, A_7, A_6, A_5, A_4, A_3, A_2, A_1, A_0

X-DECODER

Y-DECODER

128 WORD PAGE BUFFER

Bank(II)

Main Block 32KW
28
Main Block 32KW

Bank(I)

Parameter Block7 16KW
Parameter Block6 16KW
Parameter Block5 16KW
Parameter Block4 16KW
Parameter Block3 16KW
Parameter Block2 16KW
Parameter Block1 16KW
Boot Block 16KW

Y-GATE / SENSE AMP.

F-VCC (3.3V)
GND (0V)

STATUS / ID REGISTER

MULTIPLEXER

CHIP ENABLE INPUT F-CE#
OUTPUT ENABLE INPUT OE#
WRITE ENABLE INPUT WE#
WRITE PROTECT INPUT F-WP#
RESET/POWER DOWN INPUT F-RP#

CUI WSM

INPUT/OUTPUT BUFFERS

READY/BUSY OUTPUT F-RY/BY#

$DQ_{15}DQ_{14}DQ_{13}DQ_{12}$ • • • • • • • $DQ_3DQ_2DQ_1DQ_0$

DATA INPUTS/OUTPUTS

2Mb SRAM

S-A_{-1}
A_0
A_{15}
A_{16}

ADDRESS INPUT BUFFER

ROW DECODER

262144 WORD x 8 BITS

SENSE AMP.

OUTPUT BUFFER

DQ0
DQ7

CLOCK GENERATOR

DATA INPUT BUFFER

S-CE

WE#

OE#

S-VCC

GND

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1. Flash Memory

DESCRIPTION

The Flash Memory of M6MGB/T162S2BVP is 3.3V-only high speed 16,777,216-bit CMOS boot block Flash Memories with alternating BGO (Back Ground Operation) feature. The BGO feature of the device allows Program or Erase operations to be performed in one bank while the device simultaneously allows Read operations to be performed on the other bank. This BGO feature is suitable for mobile and personal computing, and communication products. The Flash Memory of M6MGB/T162S2BVP is fabricated by CMOS technology for the peripheral circuits and DINOR(Divided bit line NOR) architecture for the memory cells.

FEATURES

- Organization ....1048,576 word x 16bit

- Supply voltage ···························· V_{CC} = 2.7~3.6V

- Access time ···························· 90ns (Max)

- Power Dissipation
    Read ································· 54 mW (Max. at 5MHz)
    (After Automatic Power saving) ········· 0.33μW (typ.)
    Program/Erase ····························126 mW (Max.)
    Standby ··························· 0.33μW (typ.)
    Deep power down mode ···················· 0.33μW (typ.)
- Auto program for Bank(I)
    Program Time ······················4ms (typ.)
    Program Unit
        (Byte Program) ······················1word
        (Page Program) ······················128word
- Auto program for Bank(II)
    Program Time ····················4ms (typ.)
    Program Unit ···················· 128word
- Auto Erase
    Erase time ···················· 40 ms (typ.)
    Erase Unit
        Bank(I)   Boot Block ····················16Kword x 1
                   Parameter Block ············ 16Kword x 7
        Bank(II) Main Block ····················32Kword x 28

- Program/Erase cycles ································100Kcycles

- Boot Block
    M6MGB162S2BVP ························ Bottom Boot
    M6MGT162S2BVP ························ Top Boot

- Other Functions
    Soft Ware Command Control
    Selective Block Lock
    Erase Suspend/Resume
    Program Suspend/Resume
    Status Register Read
    Alternating Back Ground Program/Erase Operation
        Between Bank(I) and Bank(II)

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FUNCTION

The Flash Memory of M6MGB/T162S2BVP includes on-chip program/erase control circuitry. The Write State Machine (WSM) controls block erase and byte/page program operations. Operational modes are selected by the commands written to the Command User Interface (CUI). The Status Register indicates the status of the WSM and when the WSM successfully completes the desired program or block erase operation.
A Deep Powerdown mode is enabled when the F-RP# pin is at GND, minimizing power consumption.

Read

The Flash Memory of M6MGB/T162S2BVP has three read modes, which accesses to the memory array, the Device Identifier and the Status Register. The appropriate read command are required to be written to the CUI. Upon initial device powerup or after exit from deep powerdown, the Flash Memory automatically resets to read array mode. In the read array mode, low level input to F-CE# and OE#, high level input to WE# and F-RP#, and address signals to the address inputs (A19-A0) output the data of the addressed location to the data input/output (D15-D0).

Write

Writes to the CUI enables reading of memory array data, device identifiers and reading and clearing of the Status Register. They also enable block erase and program. The CUI is written by bringing WE# to low level, while F-CE# is at low level and OE# is at high level. Address and data are latched on the earlier rising edge of WE# and F-CE#. Standard micro-processor write timings are used.

Alternating Background Operation (BGO)

The Flash Memory of M6MGB/T162S2BVP allows to read array from one bank while the other bank operates in software command write cycling or the erasing / programming operation in the background. Read array operation with the other bank in BGO is performed by changing the bank address without any additional command. When the bank address points the bank in software command write cycling or the erasing / programming operation, the data is read out from the status register. The access time with BGO is the same as the normal read operation.

Output Disable

When OE# is at VIH, output from the devices is disabled. Data input/output are in a high-impedance(High-Z) state.

Standby

When F-CE# is at VIH, the device is in the standby mode and its power consumption is reduced. Data input/output are in a high-impedance(High-Z) state. If the memory is deselected during block erase or program, the internal control circuits remain active and the device consume normal active power until the operation completes.

Deep Power-Down

When F-RP# is at VIL, the device is in the deep powerdown mode and its power consumption is substantially low. During read modes, the memory is deselected and the data input/output are in a high-impedance(High-Z) state. After return from powerdown, the CUI is reset to Read Array , and the Status Register is cleared to value 80H.
During block erase or program modes, F-RP# low will abort either operation. Memory array data of the block being altered become invalid.

Automatic Power-Saving (APS)

The Automatic Power-Saving minimizes the power consumption during read mode. The device automatically turns to this mode when any addresses or F-CE# isn't changed more than 200ns after the last alternation. The power consumption becomes the same as the stand-by mode. While in this mode, the output data is latched and can be read out. New data is read out correctly when addresses are changed.

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SOFTWARE COMMAND DEFINITIONS
The device operations are selected by writing specific software command into the Command User Interface.

Read Array Command (FFH)
The device is in Read Array mode on initial device power up and after exit from deep powerdown, or by writing FFH to the Command User Interface. After starting the internal operation the device is set to the read status register mode automatically.

Read Device Identifier Command (90H)
It can normally read device identifier codes when Read Device Identifier Code Command(90H) is written to the command latch. Following the command write, the manufacturer code and the device code can be read from address 0000H and 0001H, respectively.

Read Status Register Command (70H)
The Status Register is read after writing the Read Status Register command of 70H to the Command User Interface. Also, after starting the internal operation the device is set to the Read Status Register mode automatically.
The contents of Status Register are latched on the later falling edge of OE# or F-CE#. So F-CE# or OE# must be toggled every status read.

Clear Status Register Command (50H)
The Erase Status, Program Status and Block Status bits are set to "1"s by the Write State Machine and can only be reset by the Clear Status Register command of 50H. These bits indicates various failure conditions.

Block Erase / Confirm Command (20H/D0H)
Automated block erase is initiated by writing the Block Erase command of 20H followed by the Confirm command of D0H. An address within the block to be erased is required. The WSM executes iterative erase pulse application and erase verify operation.

Program Commands

A)Word/Byte Program (40H)
Word/Byte program is executed by a two-command sequence. The Word/Byte Program Setup command of 40H is written to the Command Interface, followed by a second write specifying the address and data to be written. The WSM controls the program pulse application and verify operation. The Word/Byte Program Command is Valid for only Bank(I).

B)Page Program for Data Blocks (41H)
Page Program for Bank(I) and Bank(II) allows fast programming of 128words/256bytes of data. Writing of 41H initiates the page program operation for the Data area. From 2nd cycle to 129th cycle, write data must be serially inputted. Address A6-A0 have to be incremented from 00H to 7FH. After completion of data loading, the WSM controls the program pulse application and verify operation.

C)Single Data Load to Page Buffer (74H) / Page Buffer to Flash (0EH/D0H)
Single data load to the page buffer is performed by writing 74H followed by a second write specifying the column address and data. Distinct data up to 128word can be loaded to the page buffer by this two-command sequence. On the other hand, all of the loaded data to the page buffer is programed simultaneously by writing Page Buffer to Flash command of 0EH followed by the confirm command of D0H. After completion of programing the data on the page buffer is cleared automatically.
This command is valid for only Bank(I) alike Word Program.

Clear Page Buffer Command (55H)
Loaded data to the page buffer is cleared by writing the Clear Page Buffer command of 55H followed by the Confirm command of D0H. This command is valid for clearing data loaded by Single Data Load to Page Buffer command.

Suspend/Resume Command (B0H/D0H)
Writing the Suspend command of B0H during block erase operation interrupts the block erase operation and allows read out from another block of memory. Writing the Suspend command of B0H during program operation interrupts the program operation and allows read out from another block of memory. The Bank address is required when writing the Suspend/Resume Command. The device continues to output Status Register data when read, after the Suspend command is written to it. Polling the WSM Status and Suspend Status bits will determine when the erase operation or program operation has been suspended. At this point, writing of the Read Array command to the CUI enables reading data from blocks other than that which is suspended. When the Resume command of D0H is written to the CUI, the WSM will continue with the erase or program processes.

DATA PROTECTION

The Flash Memory of M6MGB/T162S2BVP provides selectable block locking of memory blocks. Each block has an associated nonvolatile lock-bit which determines the lock status of the block. In addition, the Flash Memory has a master Write Protect pin (F-WP#) which prevents any modifications to memory blocks whose lock-bits are set to "0", when F-WP# is low. When F-WP# is high, all blocks can be programmed or erased regardless of the state of the lock-bits, and the lock-bits are cleared to "1" by erase. See the BLOCK LOCKING table on P.9 for details.

Power Supply Voltage
When the power supply voltage (F-VCC) is less than V$_{LKO}$, Low Vcc Lock-Out voltage, the device is set to the Read-only mode. Regarding DC electrical characteristics of V$_{LKO}$, see P.10.
A delay time of 2 us is required before any device operation is initiated. The delay time is measured from the time F-Vcc reaches F-Vccmin (2.7V).
During power up, F-RP#=GND is recommended. Falling in Busy status is not recommended for possibility of damaging the device.

MEMORY ORGANIZATION
The Flash Memory of M6MGB/T162S2BVP has one 16Kword boot block, seven 16Kword parameter blocks, for Bank(I) and twenty-eight 32Kword main blocks for Bank(II). A block is erased independently of other blocks in the array.

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MEMORY ORGANIZATION

Address	Block	Bank
F8000H-FFFFFH	32Kword MAIN BLOCK 35	
F0000H-F7FFFH	32Kword MAIN BLOCK 34	
E8000H-EFFFFH	32Kword MAIN BLOCK 33	
E0000H-E7FFFH	32Kword MAIN BLOCK 32	
D8000H-DFFFFH	32Kword MAIN BLOCK 31	
D0000H-D7FFFH	32Kword MAIN BLOCK 30	
C8000H-CFFFFH	32Kword MAIN BLOCK 29	
C0000H-C7FFFH	32Kword MAIN BLOCK 28	
B8000H-BFFFFH	32Kword MAIN BLOCK 27	
B0000H-B7FFFH	32Kword MAIN BLOCK 26	
A8000H-AFFFFH	32Kword MAIN BLOCK 25	
A0000H-A7FFFH	32Kword MAIN BLOCK 24	
98000H-9FFFFH	32Kword MAIN BLOCK 23	
90000H-97FFFH	32Kword MAIN BLOCK 22	BANK(II)
88000H-8FFFFH	32Kword MAIN BLOCK 21	
80000H-87FFFH	32Kword MAIN BLOCK 20	
78000H-7FFFFH	32Kword MAIN BLOCK 19	
70000H-77FFFH	32Kword MAIN BLOCK 18	
68000H-6FFFFH	32Kword MAIN BLOCK 17	
60000H-67FFFH	32Kword MAIN BLOCK 16	
58000H-5FFFFH	32Kword MAIN BLOCK 15	
50000H-57FFFH	32Kword MAIN BLOCK 14	
48000H-4FFFFH	32Kword MAIN BLOCK 13	
40000H-47FFFH	32Kword MAIN BLOCK 12	
38000H-3FFFFH	32Kword MAIN BLOCK 11	
30000H-37FFFH	32Kword MAIN BLOCK 10	
28000H-2FFFFH	32Kword MAIN BLOCK 9	
20000H-27FFFH	32Kword MAIN BLOCK 8	
1C000H-1FFFFH	16Kword PARAMETER BLOCK 7	
18000H-1BFFFH	16Kword PARAMETER BLOCK 6	
14000H-17FFFH	16Kword PARAMETER BLOCK 5	
10000H-13FFFH	16Kword PARAMETER BLOCK 4	BANK(I)
0C000H-0FFFFH	16Kword PARAMETER BLOCK 3	
08000H-0BFFFH	16Kword PARAMETER BLOCK 2	
04000H-07FFFH	16Kword PARAMETER BLOCK 1	
00000H-03FFFH	16Kword BOOT BLOCK 0	

$A_{19}-A_0$

**Flash Memory of M6MGB162S2BVP
Memory Map**

Address	Block	Bank
FC000H-FFFFFH	16Kword BOOT BLOCK 35	
F8000H-FBFFFH	16Kword PARAMETER BLOCK 34	
F4000H-F7FFFH	16Kword PARAMETER BLOCK 33	
F0000H-F3FFFH	16Kword PARAMETER BLOCK 32	BANK(II)
EC000H-EFFFFH	16Kword PARAMETER BLOCK 31	
E8000H-EBFFFH	16Kword PARAMETER BLOCK 30	
E4000H-E7FFFH	16Kword PARAMETER BLOCK 29	
E0000H-E3FFFH	16Kword PARAMETER BLOCK 28	
D8000H-DFFFFH	32Kword MAIN BLOCK 27	
D0000H-D7FFFH	32Kword MAIN BLOCK 26	
C8000H-CFFFFH	32Kword MAIN BLOCK 25	
C0000H-C7FFFH	32Kword MAIN BLOCK 24	
B8000H-BFFFFH	32Kword MAIN BLOCK 23	
B0000H-B7FFFH	32Kword MAIN BLOCK 22	
A8000H-AFFFFH	32Kword MAIN BLOCK 21	
A0000H-A7FFFH	32Kword MAIN BLOCK 20	
98000H-9FFFFH	32Kword MAIN BLOCK 19	
90000H-97FFFH	32Kword MAIN BLOCK 18	
88000H-8FFFFH	32Kword MAIN BLOCK 17	
80000H-87FFFH	32Kword MAIN BLOCK 16	
78000H-7FFFFH	32Kword MAIN BLOCK 15	
70000H-77FFFH	32Kword MAIN BLOCK 14	BANK(I)
68000H-6FFFFH	32Kword MAIN BLOCK 13	
60000H-67FFFH	32Kword MAIN BLOCK 12	
58000H-5FFFFH	32Kword MAIN BLOCK 11	
50000H-57FFFH	32Kword MAIN BLOCK 10	
48000H-4FFFFH	32Kword MAIN BLOCK 9	
40000H-47FFFH	32Kword MAIN BLOCK 8	
38000H-3FFFFH	32Kword MAIN BLOCK 7	
30000H-37FFFH	32Kword MAIN BLOCK 6	
28000H-2FFFFH	32Kword MAIN BLOCK 5	
20000H-27FFFH	32Kword MAIN BLOCK 4	
18000H-1FFFFH	32Kword MAIN BLOCK 3	
10000H-17FFFH	32Kword MAIN BLOCK 2	
08000H-0FFFFH	32Kword MAIN BLOCK 1	
00000H-07FFFH	32Kword MAIN BLOCK 0	

$A_{19}-A_0$

**Flash Memory of M6MGT162S2BVP
Memory Map**

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BUS OPERATIONS

Bus Operations for Word-Wide Mode

Mode	Pins	F-CE#	OE#	WE#	F-RP#	DQ$_{0-15}$	F-RY/BY#
Read	Array	V$_{IL}$	V$_{IL}$	V$_{IH}$	V$_{IH}$	Data out	V$_{OH}$ (Hi-Z)
Read	Status Register	V$_{IL}$	V$_{IL}$	V$_{IH}$	V$_{IH}$	Status Register Data	X [1]
Read	Lock Bit Status	V$_{IL}$	V$_{IL}$	V$_{IH}$	V$_{IH}$	Lock Bit Data (DQ6)	X
Read	Identifier Code	V$_{IL}$	V$_{IL}$	V$_{IH}$	V$_{IH}$	Identifier Code	V$_{OH}$ (Hi-Z)
Output disable		V$_{IL}$	V$_{IH}$	V$_{IH}$	V$_{IH}$	Hi-Z	X
Stand by		V$_{IH}$	X [2]	X	V$_{IH}$	Hi-Z	X
Write	Program	V$_{IL}$	V$_{IH}$	V$_{IL}$	V$_{IH}$	Command/Data in	X
Write	Erase	V$_{IL}$	V$_{IH}$	V$_{IL}$	V$_{IH}$	Command	X
Write	Others	V$_{IL}$	V$_{IH}$	V$_{IL}$	V$_{IH}$	Command	X
Deep Power Down		X	X	X	V$_{IL}$	Hi-Z	V$_{OH}$ (Hi-Z)

1) X at F-RY/BY# is V$_{OL}$ or V$_{OH}$(Hi-Z).
*The F-RY/BY# is an open drain output pin and indicates status of the internal WSM. When low,it indicates that the WSM is Busy performing an operation.
 A pull-up resistor of 10K-100K Ohms is required to allow the F-RY/BY# signal to transition high indicating a Ready WSM condition.
2) X can be V$_{IH}$ or V$_{IL}$ for control pins.

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SOFTWARE COMMAND DEFINITION

Command List

Command	1st bus cycle			2nd bus cycle			3rd ~129th bus cycles (Word Mode)		
	Mode	Address	Data (DQ15-0)	Mode	Address	Data (DQ15-0)	Mode	Address	Data (DQ15-0)
Read Array	Write	X	FFH						
Device Identifier	Write	X	90H	Read	IA [2]	ID [2]			
Read Status Register	Write	Bank[3]	70H	Read	Bank	SRD[4]			
Clear Status Register	Write	X	50H						
Clear Page Buffer	Write	X	55H	Write	X	D0H [1]			
Word Program [5]	Write	Bank(I) [5]	40H	Write	WA [6]	WD [6]			
Page Program [7]	Write	Bank	41H	Write	WA0 [7]	WD0 [7]	Write	WAn [7]	WDn [7]
Single Data Load to Page Buffer [5]	Write	Bank(I) [5]	74H	Write	WA	WD			
Page Buffer to Flash [5]	Write	Bank(I) [5]	0EH	Write	WA [8]	D0H [1]			
Block Erase / Confirm	Write	Bank	20H	Write	BA [9]	D0H [1]			
Suspend	Write	Bank	B0H						
Resume	Write	Bank	D0H						
Read Lock Bit Status	Write	X	71H	Read	BA	DQ6 [10]			
Lock Bit Program / Confirm	Write	Bank	77H	Write	BA	D0H [1]			
Erase All Unlocked Blocks	Write	X	A7H	Write	X	D0H [1]			

1) In the word-wide version, upper byte data (DQ8-DQ15) is ignored.
2) IA=ID Code Address : A0=VIL (Manufacturer's Code) : A0=VIH (Device Code), ID=ID Code
3) Bank = Bank Address (Bank(I) or Bank(II)) : A19-A17.
4) SRD = Status Register Data
5) Word Program, Single Data Load and Page Buffer to Flash Command is valid for only Bank(I).
6) WA = Write Address,WD = Write Data
7) WA0,WAn=Write Address, WD0,WDn=Write Data.
   Word Mode : Write Address and Write Data must be provided sequentially from 00H to 7FH for A6-A0. Page size is 128word (128word x 16bit).
            and also A19-A7(Block Address, Page Address) must be valid.
8) WA = Write Address : Upper page address, A19-A7(Block Address, Page Address) must be valid.
9) BA = Block Address : BA = Block Address : A19-A14(Bank1) A19-A15(Bank2)
10) DQ6 provides Block Lock Status, DQ6 = 1 : Block Unlock, DQ6 = 0 : Block Locked.

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BLOCK LOCKING

F-RP#	F-WP#	Lock Bit (Internally)	Write Protection Provided BANK(I) Boot	Write Protection Provided BANK(I) Parameter	Write Protection Provided BANK(II) Data	Lock Bit	Note
V_{IL}	X	X	Locked	Locked	Locked	Locked	Deep Power Down Mode
V_{IH}	V_{IL}	0	Locked	Locked	Locked	Locked	
V_{IH}	V_{IL}	1	Locked	Unlocked	Unlocked	Locked	
	V_{IH}	X	Unlocked	Unlocked	Unlocked	Unlocked	All Blocks Unlocked

1) DQ_6 provides Lock Status of each block after writing the Read Lock Status command (71H).
F-WP# pins must not be switched during performing Erase / Write operations or WSM Busy (WSMS = 0).
2) Erase/Write command for locked blocks is aborted. At this time read mode is not array read mode but status read mode and
00B0H is read. Please issue Clear Status Register command plus Read Array command to change the mode from status read mode
to array read mode.

STATUS REGISTER

Symbol	Status	Definition "1"	Definition "0"
SR.7 (DQ_7)	Write State Machine Status	Ready	Busy
SR.6 (DQ_6)	Suspend Status	Suspended	Operation in Progress / Completed
SR.5 (DQ_5)	Erase Status	Error	Successful
SR.4 (DQ_4)	Program Status	Error	Successful
SR.3 (DQ_3)	Block Status after Program	Error	Successful
SR.2 (DQ_2)	*Reserved*	-	-
SR.1 (DQ_1)	*Reserved*	-	-
SR.0 (DQ_0)	*Reserved*	-	-

*The F-RY/BY# is an open drain output pin and indicates status of the internal WSM. When low,it indicates that the WSM is Busy performing an operation.
 A pull-up resistor of 10K-100K Ohms is required to allow the F-RY/BY# signal to transition high indicating a Ready WSM condition.
*DQ_3 indicates the block status after the page programming, word programming and page buffer to flash. When DQ_3 is "1", the page has the over-programed
cell . If over-program occurs, the device is block fail. However if DQ_3 is "1", please try the block erase to the block. The block may revive.

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Stacked-MCP (Multi Chip Package)

DEVICE IDENTIFIER CODE

Code \ Pins	A_0	DQ_7	DQ_6	DQ_5	DQ_4	DQ_3	DQ_2	DQ_1	DQ_0	Hex. Data
Manufacturer Code	V_{IL}	0	0	0	1	1	1	0	0	1CH
Device Code (-T162S2BVP)	V_{IH}	1	0	1	0	0	0	0	0	A0H
Device Code (-B162S2BVP)	V_{IH}	1	0	1	0	0	0	0	1	A1H

The upper data(D_{15-8}) is "0".

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Min	Max	Unit
F-V_{CC}	Flash V_{CC} voltage	With respect to Ground	-0.2	4.6	V
V_{I1}	All input or output voltage 1)		-0.6	4.6	V
T_a	Ambient temperature		-20	85	°C
T_{bs}	Temperature under bias		-50	95	°C
T_{stg}	Storage temperature		-65	125	°C
I_{OUT}	Output short circuit current			100	mA

1) Minimum DC voltage is -0.5V on input/output pins. During transitions, this level may undershoot to -2.0V for periods <20ns. Maximum DC voltage on input/output pins is F-Vcc+0.5V which, during transitions, may overshoot to F-Vcc+1.5V for periods <20ns.

CAPACITANCE

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
C_{IN}	Input capacitance (Address, Control Pins)	Ta = 25°C, f = 1MHz, $V_{in} = V_{out} = 0V$			8	pF
C_{OUT}	Output capacitance				12	pF

Note: The value of common pins to Flash Memory is the sum of Flash Memory and SRAM.

DC ELECTRICAL CHARACTERISTICS (Ta = -20~ 85°C, F-Vcc = 2.7V ~ 3.6V, unless otherwise noted)

Symbol	Parameter	Test conditions		Min	Typ1)	Max	Unit
I_{LI}	Input leakage current	$0V≤V_{IN}≤F-V_{CC}$				±2.0	μA
I_{LO}	Output leakage current	$0V≤V_{OUT}≤F-V_{CC}$				±11	μA
I_{SB1}	F-V_{CC} standby current	F-VCC = 3.6V, VIN=VIL/VIH, F-CE# = F-RP# =F-WP# = VIH			50	200	μA
I_{SB2}		F-Vcc = 3.6V, VIN=GND or F-Vcc, F-CE# = F-RP# = F-WP# = F-Vcc±0.3V			0.1	5	μA
I_{SB3}	F-V_{CC} deep powerdown current	F-Vcc = 3.6V, VIN=VIL/VIH, F-RP# = VIL			5	15	μA
I_{SB4}		F-VCC = 3.6V, VIN=GND or VCC, F-RP# =GND±0.3V			0.1	5	μA
I_{CC1}	F-V_{CC} read current for Word or Byte	F-Vcc = 3.6V, VIN=VIL/VIH, F-CE# = VIL, F-RP#=OE#=VIH, IOUT = 0mA	5MHz		8	15	mA
			1MHz		2	4	
I_{CC2}	F-V_{CC} Write current for Word or Byte	F-Vcc = 3.6V,VIN=VIL/VIH, F-CE# =WE#= VIL, F-RP#=OE#=VIH				15	mA
I_{CC3}	F-V_{CC} program current	F-VCC = 3.6V, VIN=VIL/VIH, F-CE# = F-RP# =F-WP# = VIH				35	mA
I_{CC4}	F-V_{CC} erase current	F-VCC = 3.6V, VIN=VIL/VIH, F-CE# = F-RP# =F-WP# = VIH				35	mA
I_{CC5}	F-V_{CC} suspend current	F-VCC = 3.6V, VIN=VIL/VIH, F-CE# = F-RP# =F-WP# = VIH				200	μA
V_{IL}	Input low voltage			− 0.5		0.8	V
V_{IH}	Input high voltage			2.0		F-Vcc+0.5	V
V_{OL}	Output low voltage	IOL = 4.0mA				0.45	V
V_{OH1}	Output high voltage	IOH = −2.0mA		0.85(F-Vcc)			V
V_{OH2}		IOH = −100μA		F-Vcc−0.4			V
V_{LKO}	Low V_{CC} Lock-Out voltage 2)			1.5		2.2	V

All currents are in RMS unless otherwise noted.
1) Typical values at F-Vcc=3.3V, Ta=25°C
2) To protect against initiation of write cycle during Vcc power-up/ down, a write cycle is locked out for Vcc less than VLKO.
   If Vcc is less than VLKO, Write State Machine is reset to read mode. When the Write State Machine is in Busy state, if Vcc is less than VLKO, the alteration of memory contents may occur.

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Stacked-MCP (Multi Chip Package)

AC ELECTRICAL CHARACTERISTICS (Ta = -20 ~85°C, F-Vcc = 2.7V ~3.6V)
Read-Only Mode

Symbol		Parameter	Limits			Unit
			F-Vcc=2.7-3.6V			
			90ns			
			Min	Typ	Max	
tRC	tAVAV	Read cycle time	90			ns
ta (AD)	tAVQV	Address access time			90	ns
ta (CE)	tELQV	Chip enable access time			90	ns
ta (OE)	tGLQV	Output enable access time			30	ns
tCLZ	tELQX	Chip enable to output in low-Z	0			ns
tDF(CE)	tEHQZ	Chip enable high to output in high Z			25	ns
tOLZ	tGLQX	Output enable to output in low-Z	0			ns
tDF(OE)	tGHQZ	Output enable high to output in high Z			25	ns
tPHZ	tPLQZ	F-RP# low to output high-Z			150	ns
tOH	tOH	Output hold from F-CE#, OE#, addresses	0			ns
tPS	tPHEL	F-RP# recovery to F-CE# low	150			ns

Timing measurements are made under AC waveforms for read operations.

AC ELECTRICAL CHARACTERISTICS (Ta = -20 ~85°C, F-Vcc = 2.7V ~3.6V)
Write Mode (F-WE# control)

Symbol		Parameter	Limits			Unit
			F-Vcc=2.7-3.6V			
			90ns			
			Min	Typ	Max	
tWC	tAVAV	Write cycle time	90			ns
tAS	tAVWH	Address set-up time	50			ns
tAH	tWHAX	Address hold time	0			ns
tDS	tDVWH	Data set-up time	50			ns
tDH	tWHDX	Data hold time	0			ns
tOEH	tWHGL	OE# hold from WE# high	10			ns
tRE	-	Latency between Read and Write FFH or 71H	30			ns
tCS	tELWL	Chip enable set-up time	0			ns
tCH	tWHEH	Chip enable hold time	0			ns
tWP	tWLWH	Write pulse width	60			ns
tWPH	tWHWL	Write pulse width high	30			ns
tGHWL	tGHWL	OE# hold to WE# Low	0			ns
tBLS	tPHHWH	Block Lock set-up to write enable high	90			ns
tBLH	tQVPH	Block Lockhold from valid SRD	0			ns
tDAP	tWHRH1	Duration of auto-program operation		4	80	ms
tDAE	tWHRH2	Duration of auto-block erase operation		40	600	ms
tWHRL	tWHRL	Write enable high to F-RY/BY# low			90	ns
tPS	tPHWL	F-RP# high recovery to write enable low	150			ns

Read timing parameters during command write operations mode are the same as during read-only operations mode.
Typical values at F-Vcc=3.3V, Ta=25°C

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AC ELECTRICAL CHARACTERISTICS (Ta = -20 ~ 85°C, F-Vcc = 2.7V ~ 3.6V)

Write Mode (F-CE# control)

Symbol		Parameter	Limits			Unit
			F-Vcc=2.7-3.6V			
			90ns			
			Min	Typ	Max	
tWC	tAVAV	Write cycle time	90			ns
tAS	tAVWH	Address set-up time	50			ns
tAH	tEHAX	Address hold time	0			ns
tDS	tDVWH	Data set-up time	50			ns
tDH	tEHDX	Data hold time	0			ns
tOEH	tEHGL	OE# hold from F-CE# high	10			ns
tRE	-	Latency between Read and Write FFH or 71H	30			ns
tWS	tWLEL	Write enable set-up time	0			ns
tWH	tEHWH	Write enable hold time	0			ns
tCEP	tELEH	F-CE# pulse width	60			ns
tCEPH	tEHEL	F-CE# pulse width high	30			ns
tGHEL	tGHEL	OE# hold to F-CE# Low	90			ns
tBLS	tPHHEH	Block Lock set-up to write enable high	90			ns
tBLH	tQVPH	Block Lockhold from valid SRD	0			ns
tDAP	tEHRH1	Duration of auto-program operation		4	80	ms
tDAE	tEHRH2	Duration of auto-block erase operation		40	600	ms
tEHRL	tEHRL	F-CE# high to F-RY/BY# low			90	ns
tPS	tPHWL	F-RP# high recovery to write enable low	150			ns

Read timing parameters during command write operation mode are the same as during read-only operation mode.
Typical values at F-Vcc=3.3V, Ta=25°C

Erase and Program Performance

Parameter	Min	Typ	Max	Unit
Block Erase Time		40	600	ms
Main Block Write Time (Page Mode)		1.0	1.8	sec
Page Write Time		4	80	ms

Program Suspend Latency / Erase Suspend Time

Parameter	Min	Typ	Max	Unit
Program Suspend Latency			15	µs
Erase Suspend Time			15	µs

Vcc Power Up / Down Timing

| Symbol	Parameter	Min	Typ	Max	Unit
tVCS	F-RP# =VIH set-up time from Vccmin	2			µs

During power up/down, by the noise pulses on control pins, the device has possibility of accidental erasure or programming.
The device must be protected against initiation of write cycle for memory contents during power up/down.
The delay time of min.2µsec is always required before read operation or write operation is initiated from the time F-Vcc reaches F-Vccmin during power up/down.
By holding F-RP# VIL, the contents of memory is protected during F-Vcc power up/down.
During power up, F-RP# must be held VIL for min.2µs from the time F-Vcc reaches F-Vccmin.
During power down, F-RP# must be held VIL until Vcc reaches GND.
F-RP# doesn't have latch mode ,therefore F-RP# must be held VIH during read operation or erase/program operation.

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Vcc POWER UP / DOWN TIMING
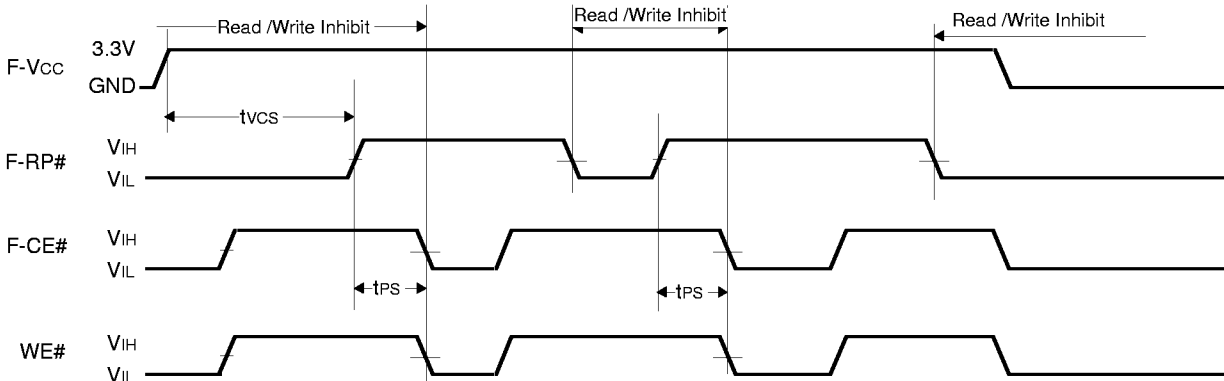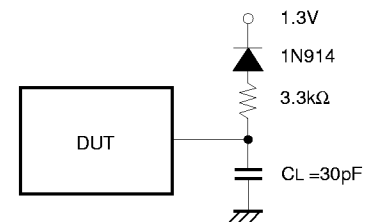

AC WAVEFORMS FOR READ OPERATION AND TEST CONDITIONS
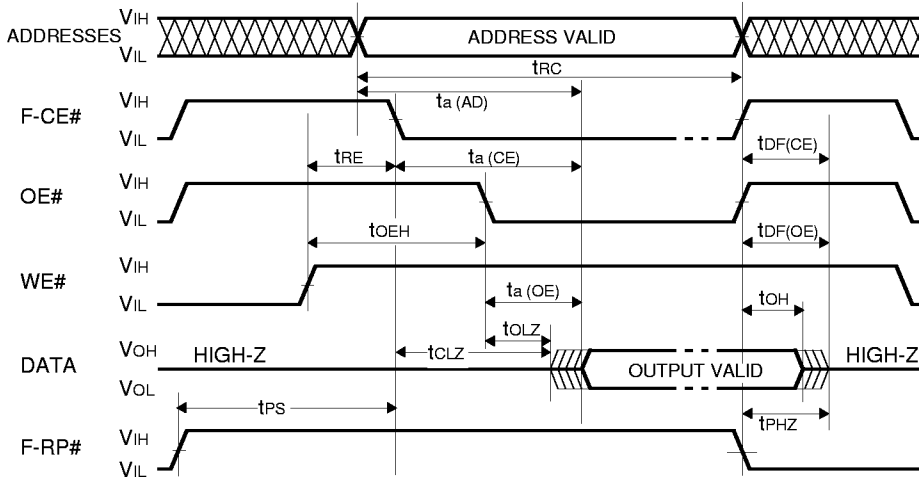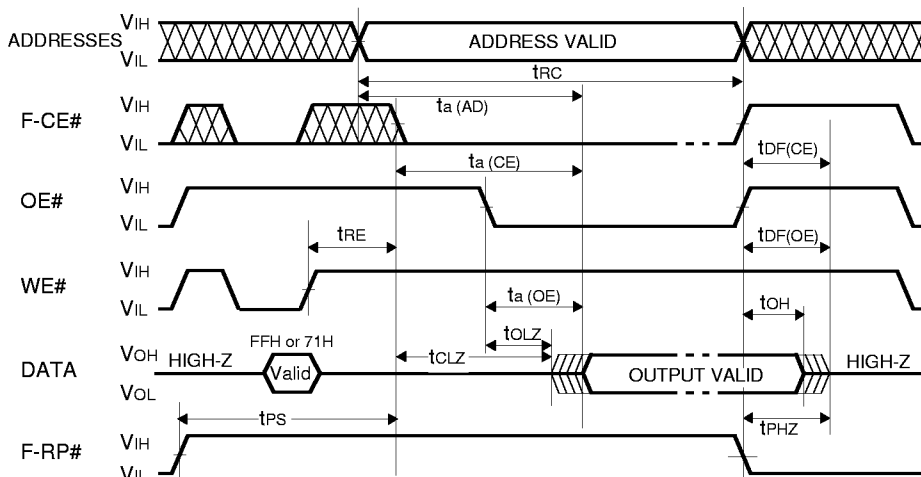

TEST CONDITIONS
FOR AC CHARACTERISTICS

Input voltage : V_{IL} = 0V, V_{IH} = 3.0V
Input rise and fall times : ≤5ns
Reference voltage
at timing measurement : 1.5V

Output load : 1 TTL gate +
CL(30pF)
or

1.3V
1N914
3.3kΩ
DUT
CL =30pF

AC WAVEFORMS FOR WRITE FFH or 71H AND READ OPERATION

In the case of use F-CE# is Low fixed, it is allowed to define a timming specification of tRE
from rising edge of WE# to falling edge of OE#, and valid data is read after spec of tRE+ta(CE).
(This is only for FFH,71H program and read)

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AC WAVEFORMS FOR PAGE PROGRAM OPERATION (WE# control)
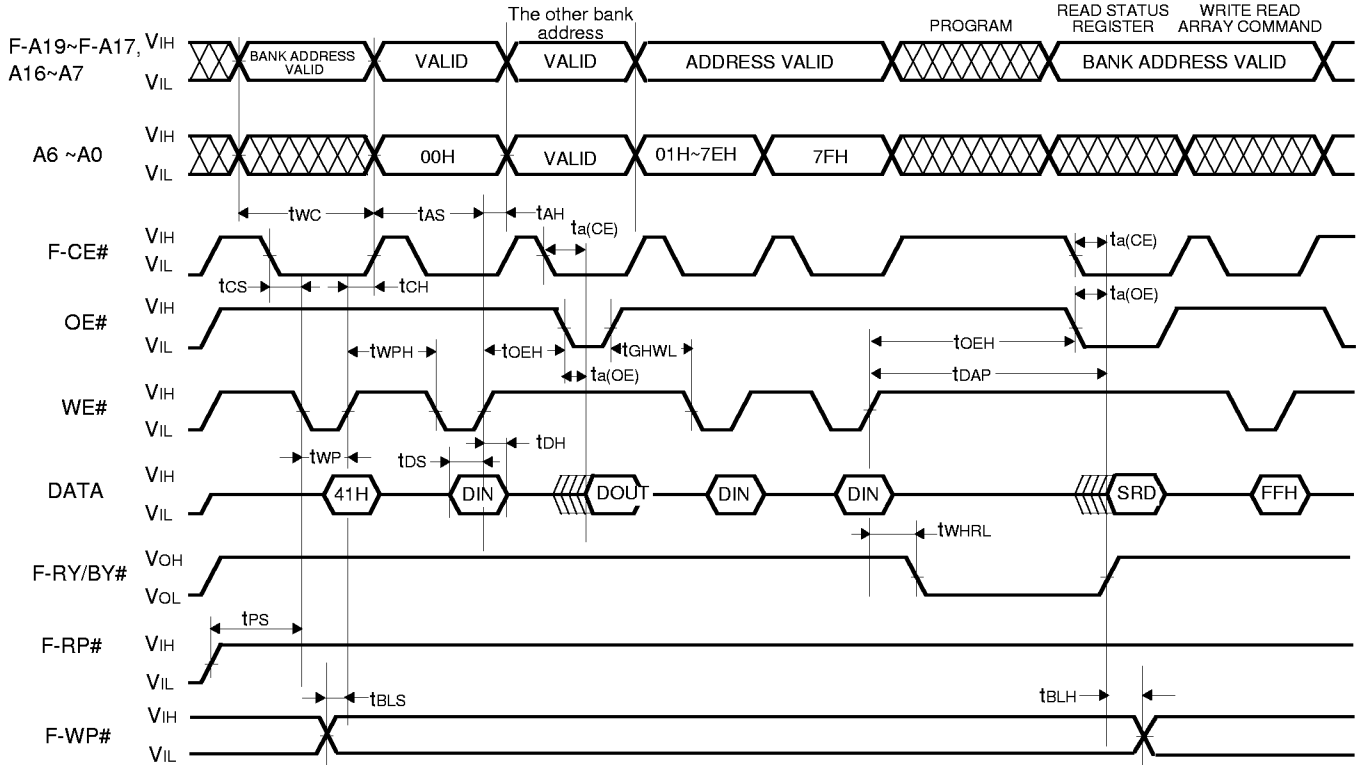
AC WAVEFORMS FOR PAGE PROGRAM OPERATION (F-CE# control)
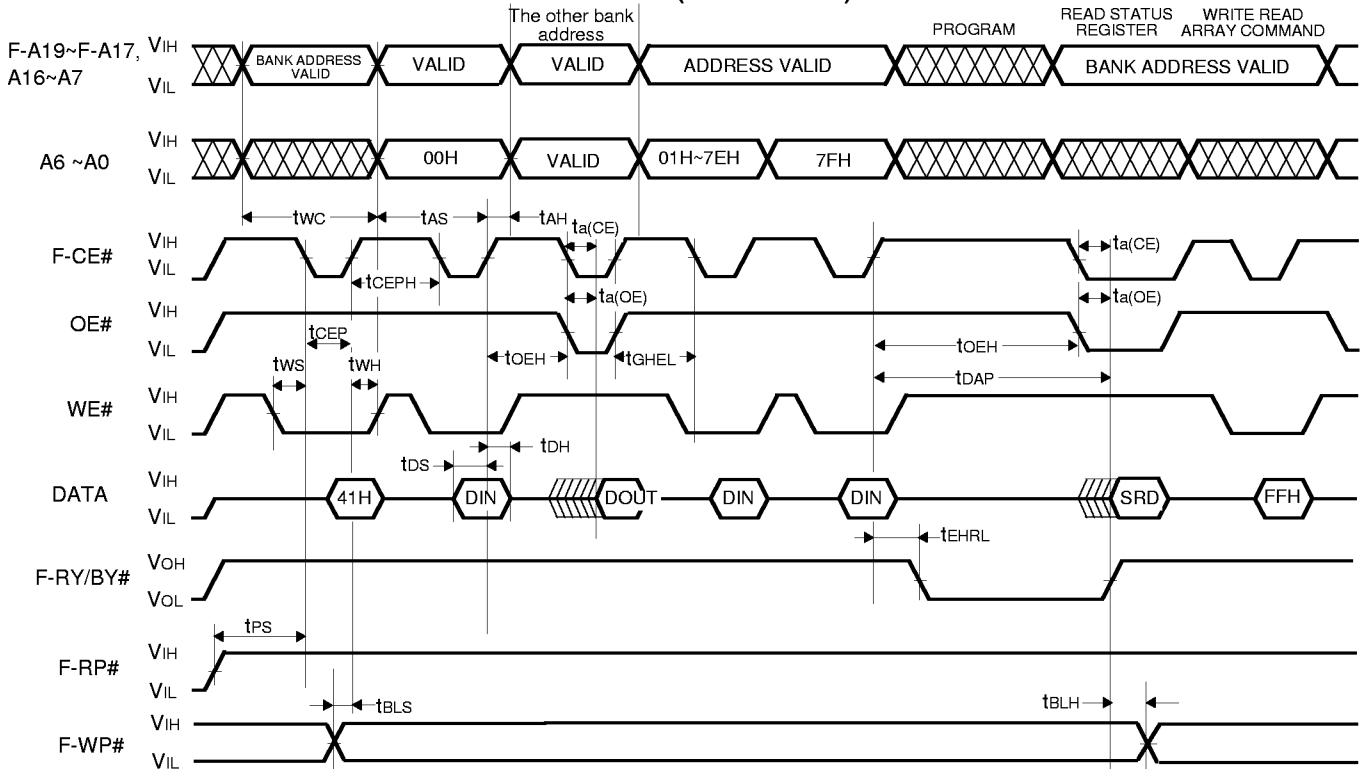
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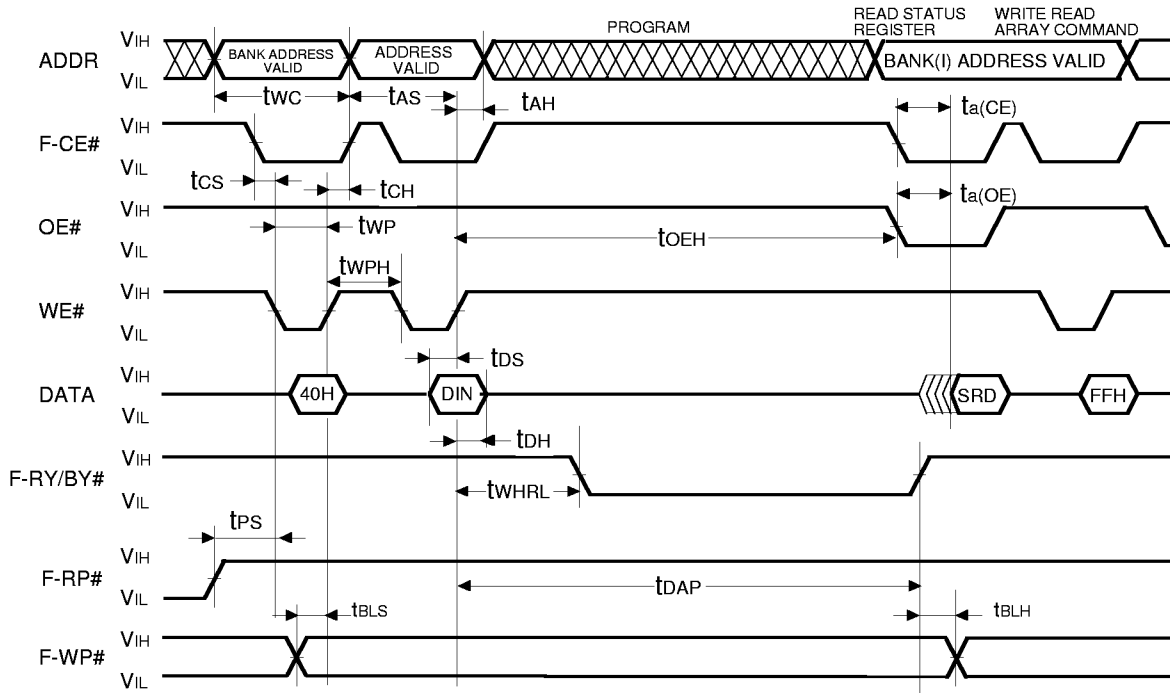## AC WAVEFORMS FOR WORD PROGRAM OPERATION (WE# control) (to only BANK(I))

AC WAVEFORMS FOR WORD PROGRAM OPERATION (F-CE# control) (to only BANK(I))

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AC WAVEFORMS FOR ERASE OPERATIONS (WE# control)

AC WAVEFORMS FOR ERASE OPERATIONS (F-CE# control)
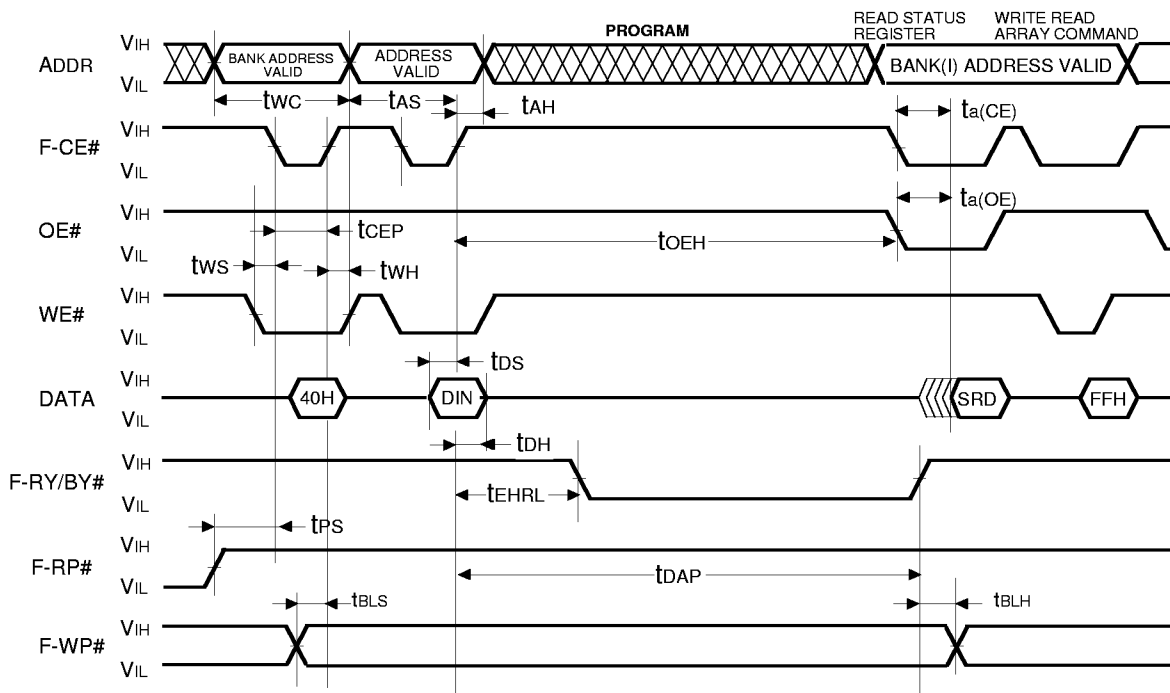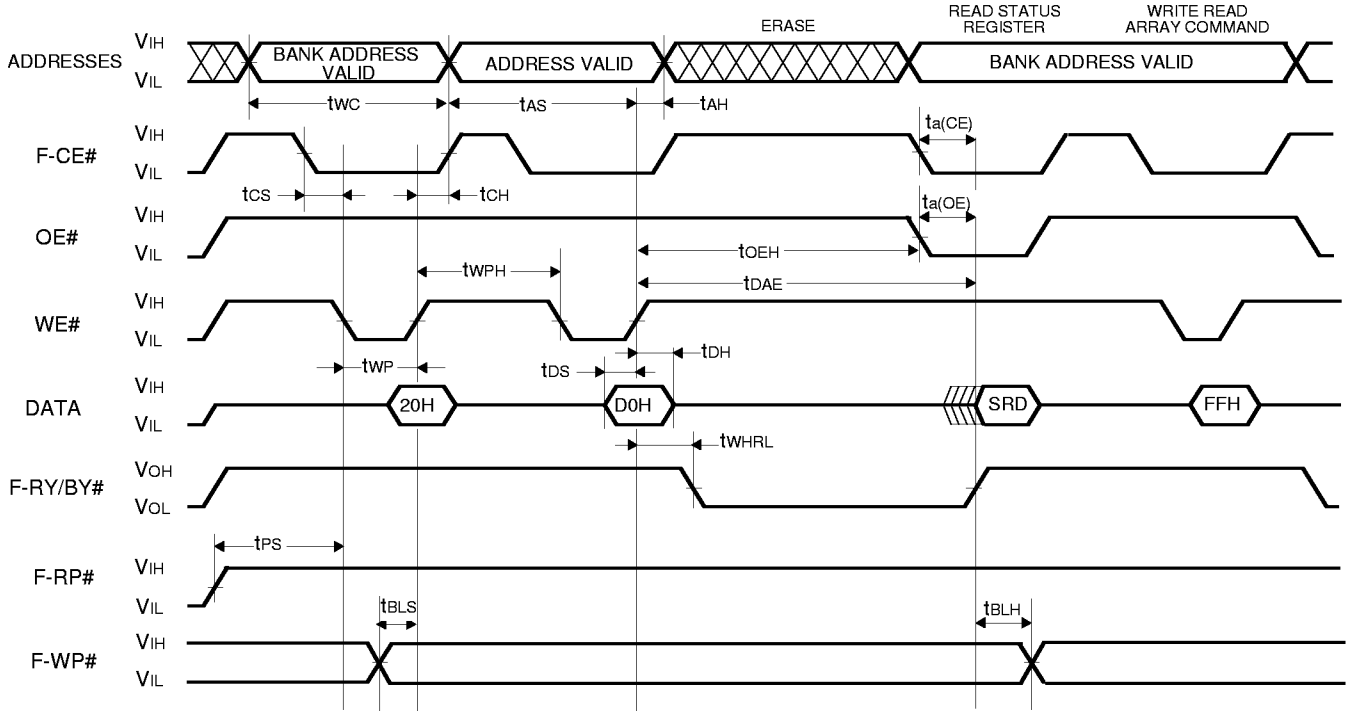
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AC WAVEFORMS FOR PAGE PROGRAM OPERATION WITH BGO (WE# control)

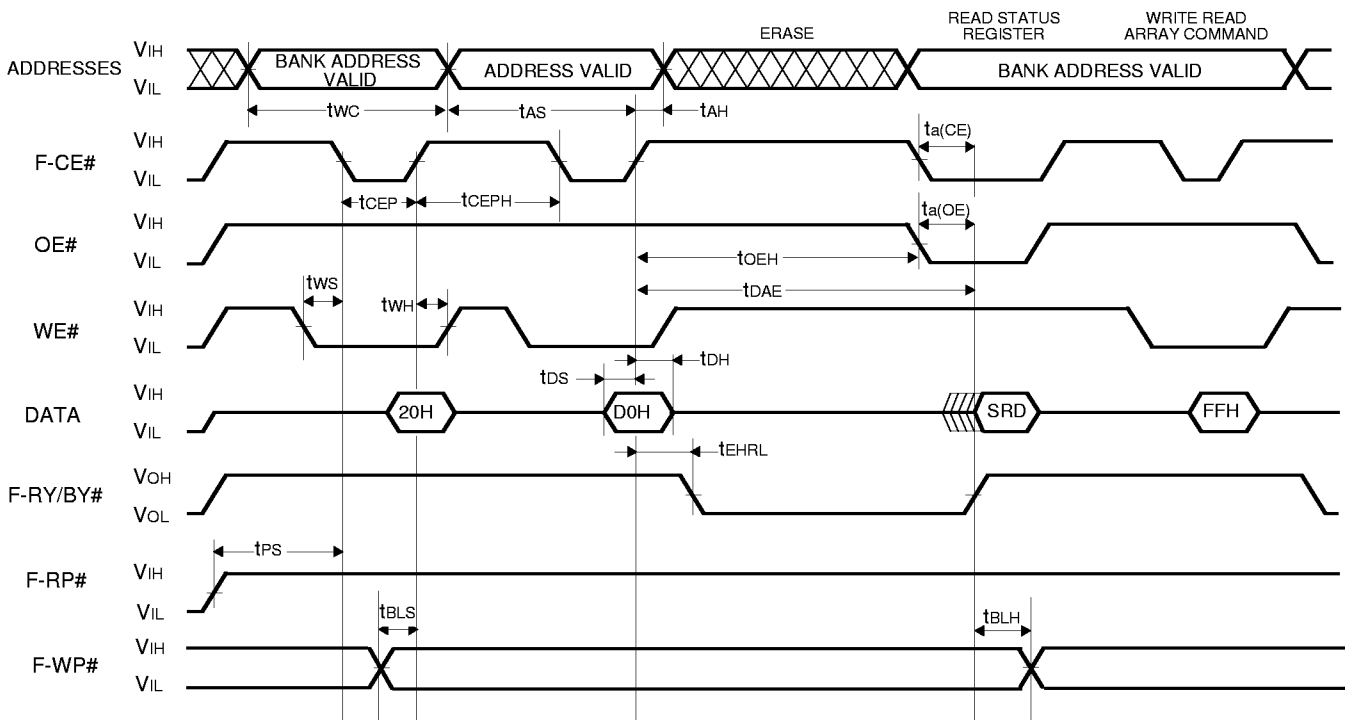## AC WAVEFORMS FOR PAGE PROGRAM OPERATION WITH BGO (F-CE# control)

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AC WAVEFORMS FOR WORD PROGRAM OPERATION WITH BGO (WE# control)

Change Bank Address

PROGRAM DATA TO BANK(I) READ STATUS REGISTER ARRAY READ FROM BANK(II) WITH BGO

A19~A7 VIH / VIL BANK ADDRESS VALID ADDRESS VALID VALID VALID

A6 ~A0 VIH / VIL VALID VALID VALID

twc tAS tAH ta(CE)

F-CE# VIH / VIL

tCS tCH ta(OE)

OE# VIH / VIL

twP tOEH

twPH

WE# VIH / VIL

tDS

DATA VIH / VIL 40H DIN SRD DOUT DOUT

tDH

F-RY/BY# VIH / VIL

twHRL

AC WAVEFORMS FOR WORD PROGRAM OPERATION WITH BGO (F-CE# control)

Change Bank Address

PROGRAM DATA TO BANK(I) READ STATUS REGISTER ARRAY READ FROM BANK(II) WITH BGO

A19~A7 VIH / VIL BANK ADDRESS VALID ADDRESS VALID VALID VALID

A6 ~A0 VIH / VIL VALID VALID VALID

twc tAS ta(CE)

F-CE# VIH / VIL

tCEPH ta(OE)

OE# VIH / VIL

tCEP

tws tCH

toEH

WE# VIH / VIL

tDS

DATA VIH / VIL 40H DIN SRD DOUT DOUT

tDH

F-RY/BY# VIH / VIL

tEHRL

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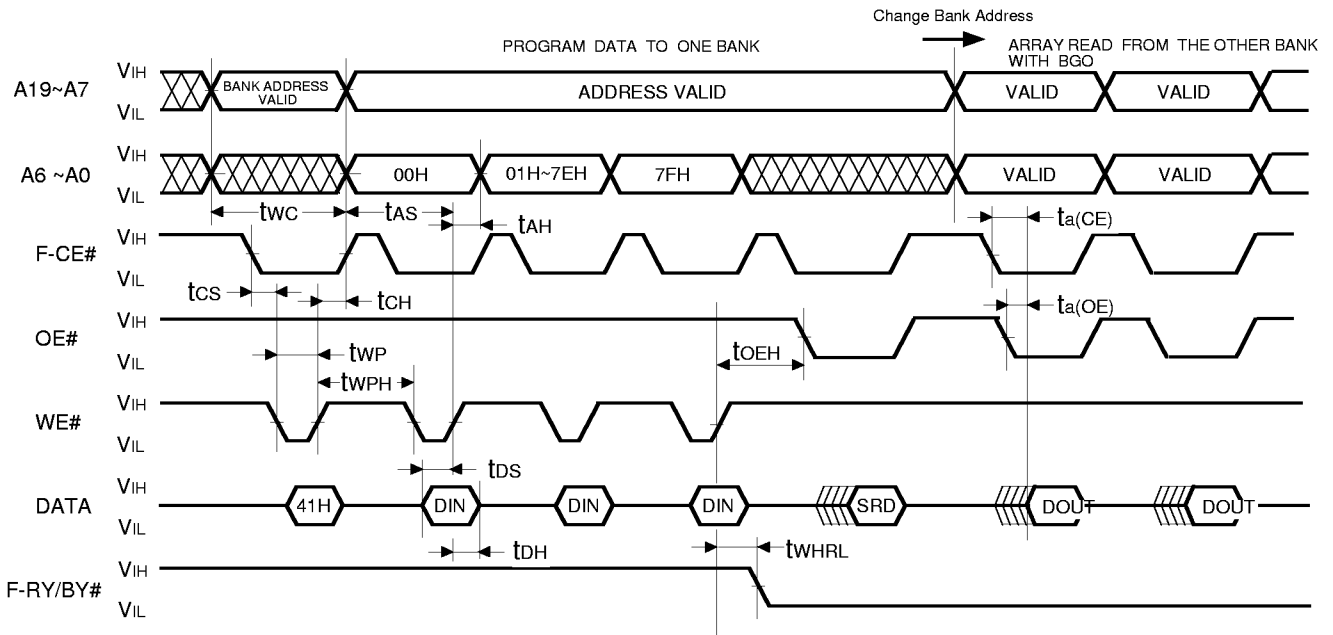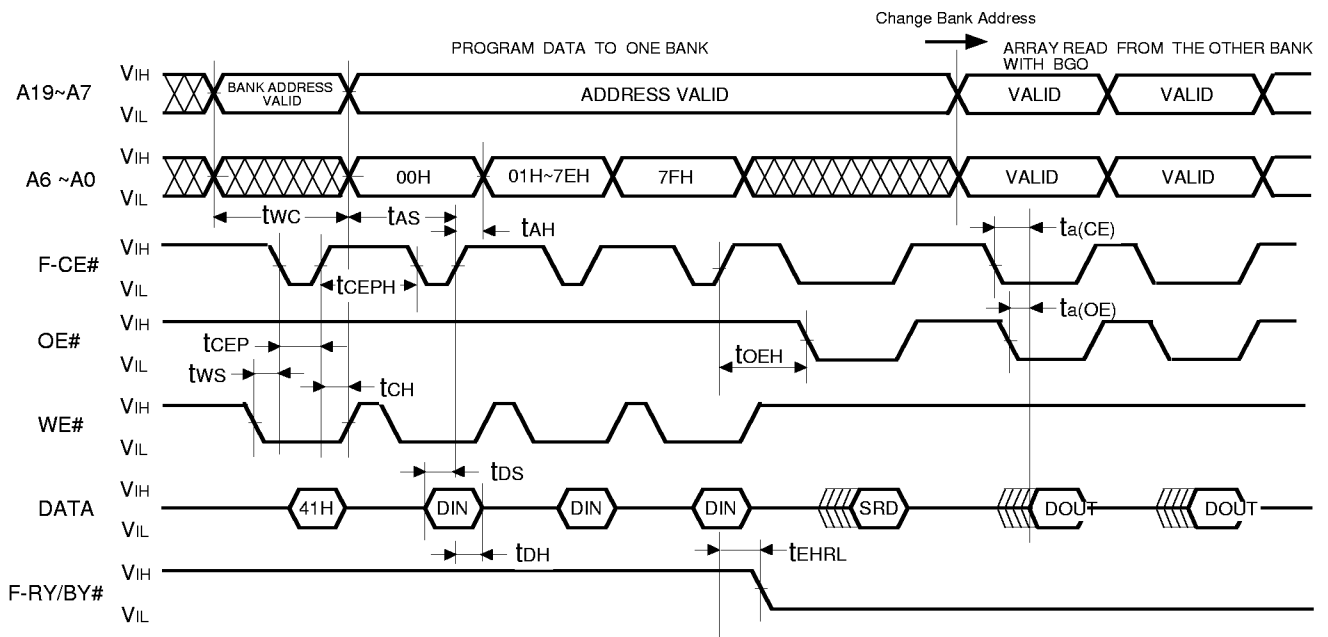
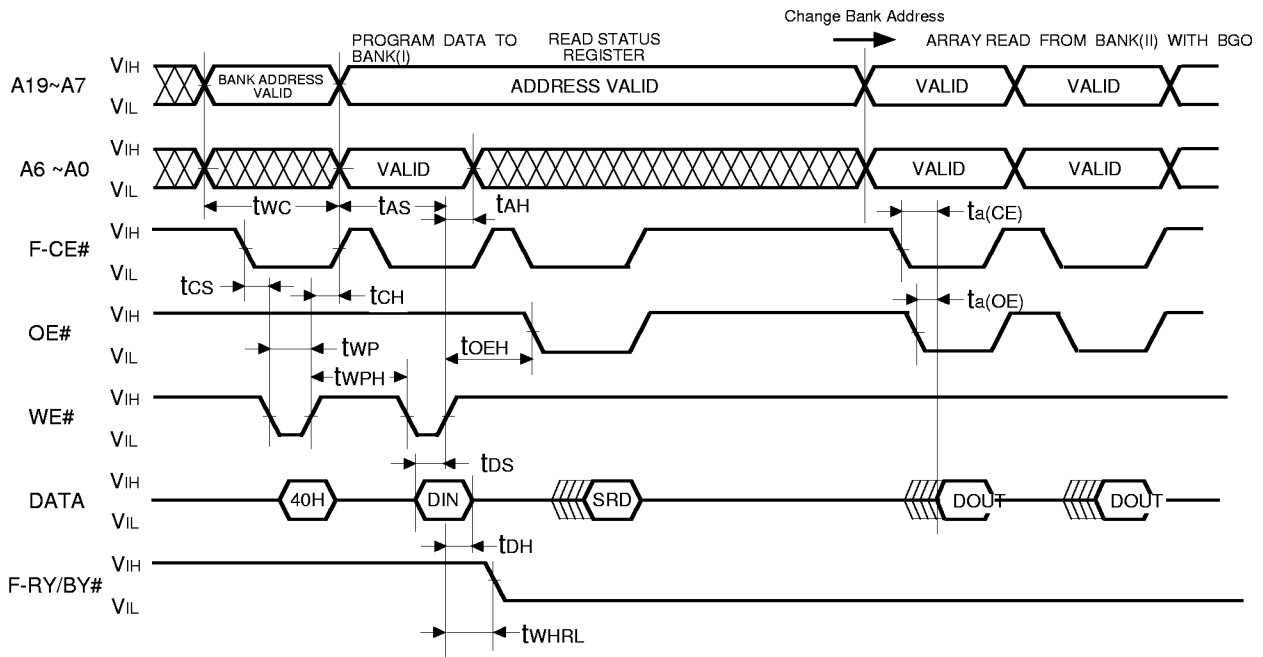## AC WAVEFORMS FOR BLOCK ERASE OPERATION WITH BGO (WE# control)

AC WAVEFORMS FOR BLOCK ERASE OPERATION WITH BGO (F-CE# control)

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AC WAVEFORMS FOR SUSPEND OPERATION (WE# control)

AC WAVEFORMS FOR SUSPEND OPERATION (F-CE# control)
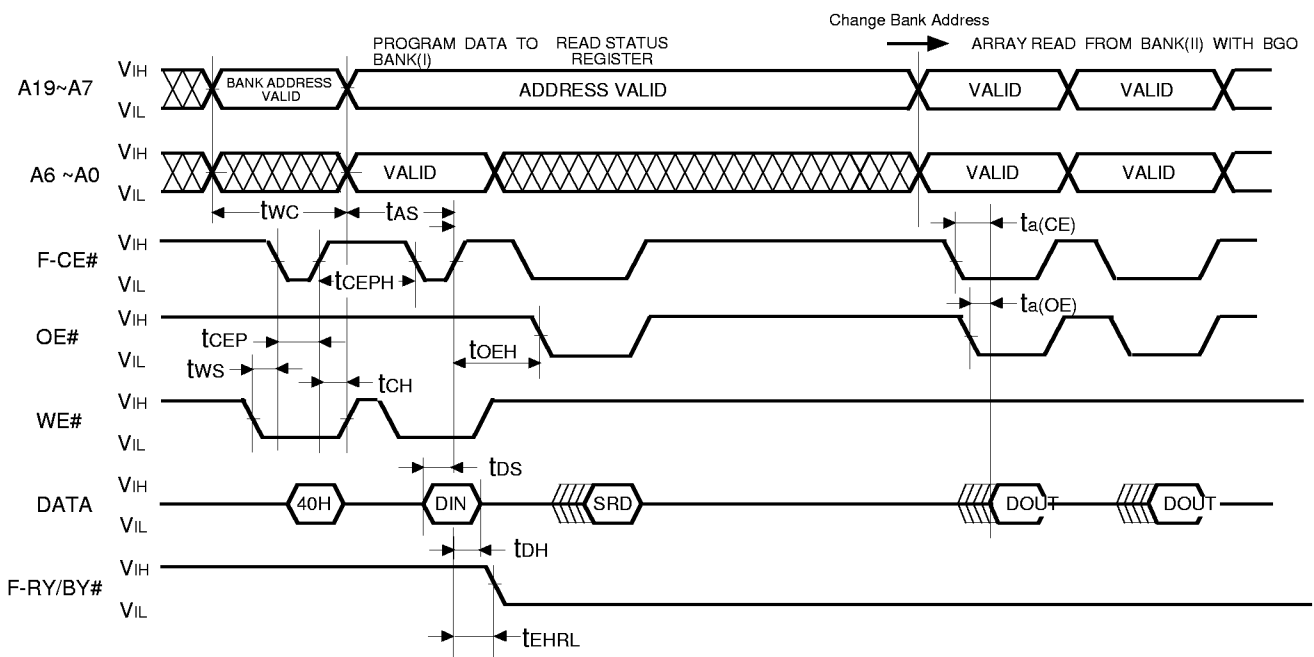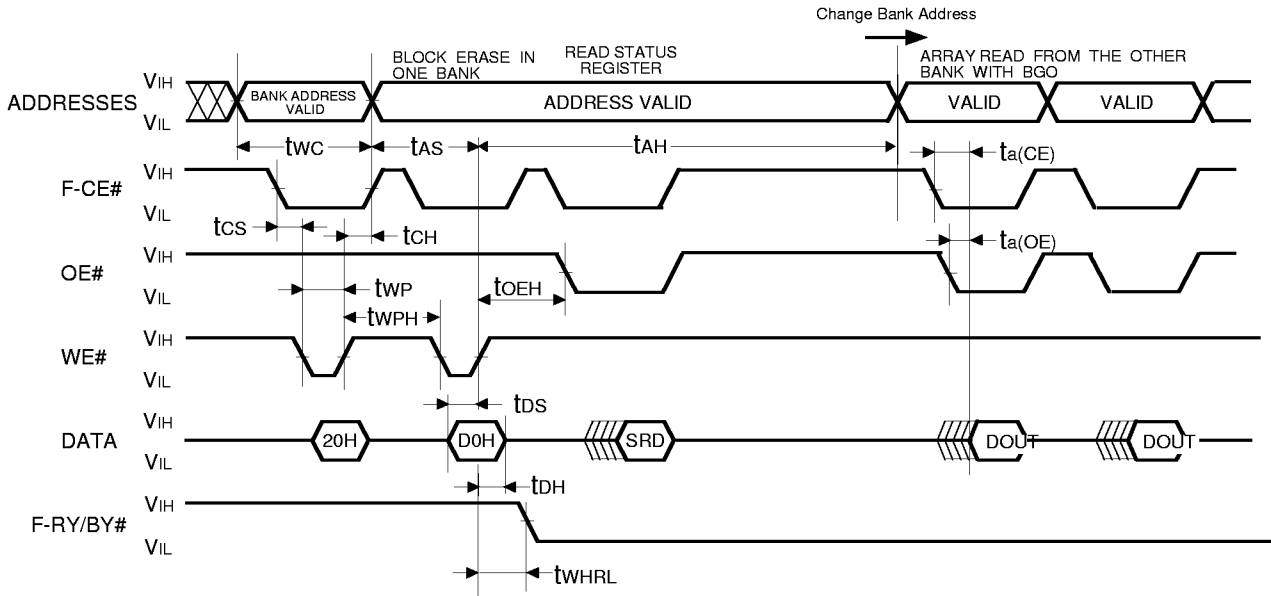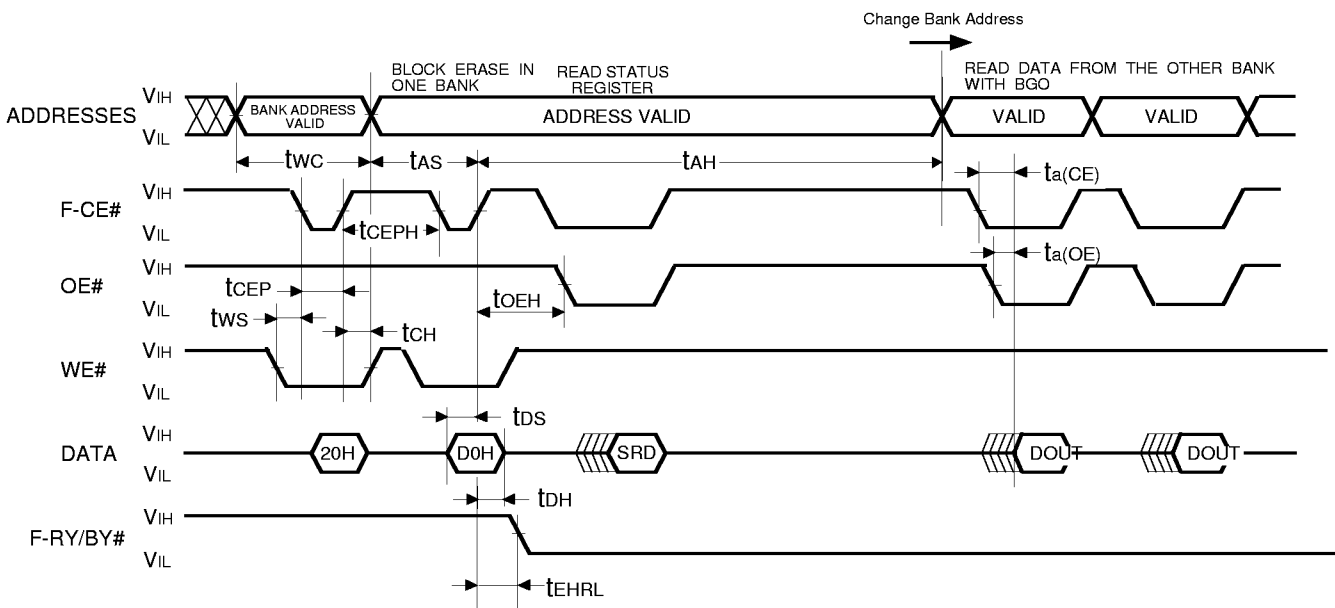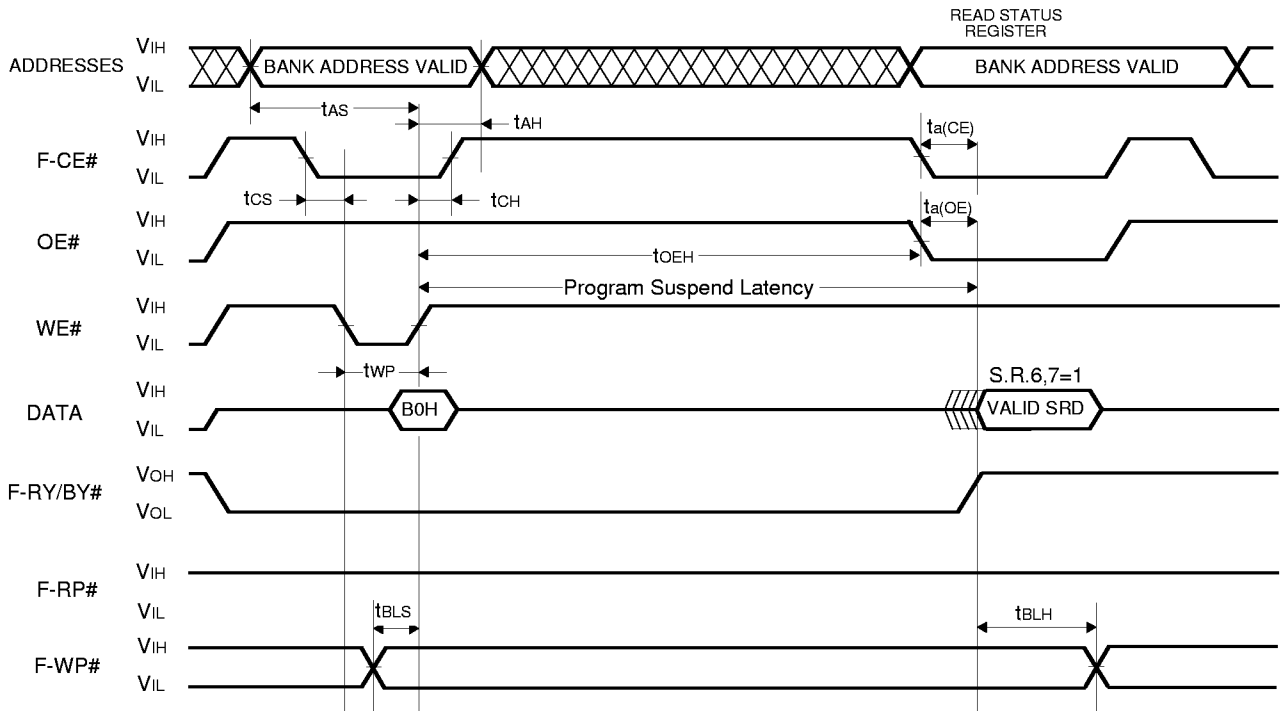
MITSUBISHI LSIs

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FULL STATUS CHECK PROCEDURE

STATUS REGISTER READ

SR.4 =1 and SR.5 =1 ? — YES → COMMAND SEQUENCE ERROR

NO

SR.5 = 0 ? — NO → BLOCK ERASE ERROR

YES

SR.4 = 0 ? — NO → PROGRAM ERROR (PAGE, LOCK BIT)

YES

SR.3 = 0 ? — NO → PROGRAM ERROR (BLOCK)

YES

SUCCESSFUL (BLOCK ERASE, PROGRAM)

LOCK BIT PROGRAM FLOW CHART

START

WRITE 77H

WRITE D0H BLOCK ADDRESS

SR.7 = 1 ? — NO

YES

SR.4 = 0 ? — NO → LOCK BIT PROGRAM FAILED

YES

LOCK BIT PROGRAM SUCCESSFUL

BYTE PROGRAM FLOW CHART

START

WRITE 40H

WRITE ADDRESS , DATA

STATUS REGISTER READ

SR.7 = 1 ? — NO → WRITE B0H ? — NO

YES   YES

FULL STATUS CHECK IF DESIRED   SUSPEND LOOP [WRITE D0H]

PAGE PROGRAM COMPLETED   YES
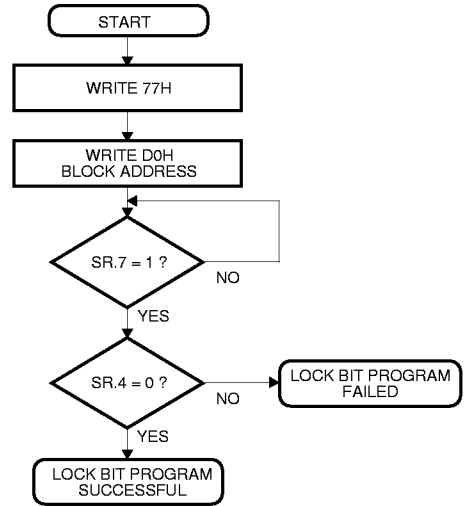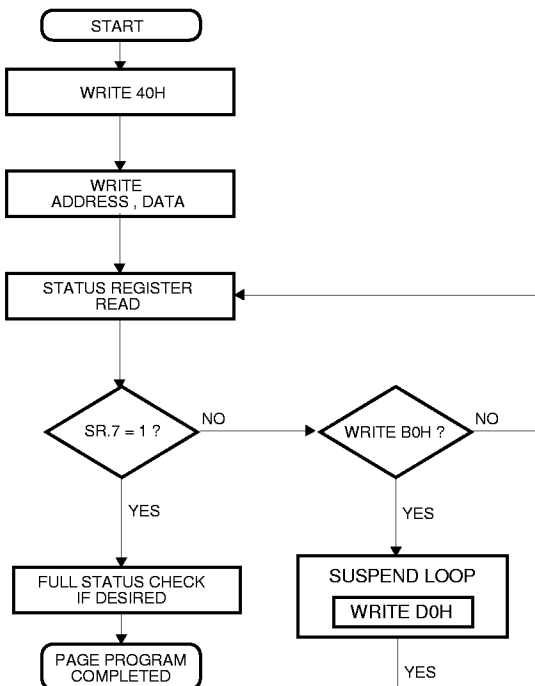
* Word program is admitted to only BANK(I).

PAGE PROGRAM FLOW CHART
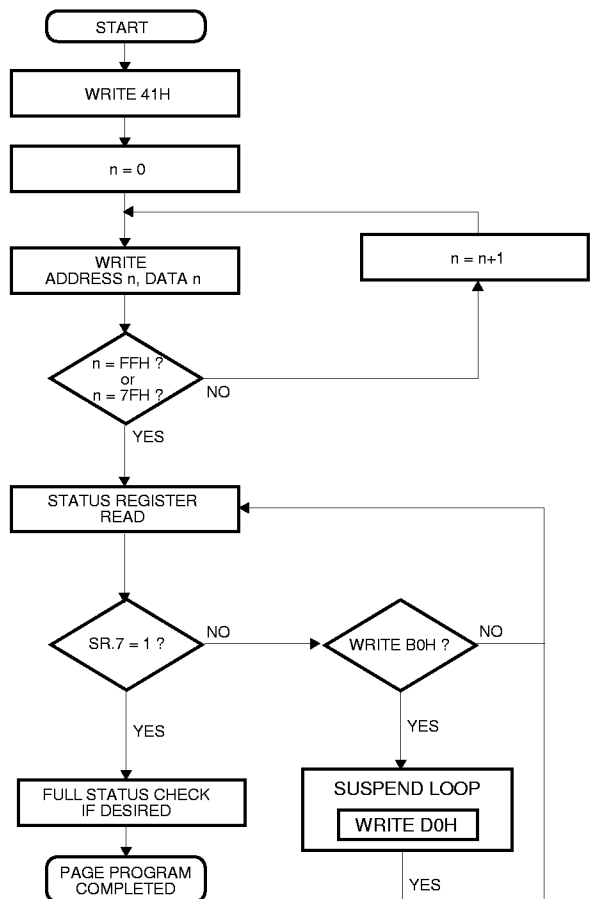
START

WRITE 41H

n = 0

WRITE ADDRESS n, DATA n

n = FFH ? or n = 7FH ? — NO → n = n+1

YES

STATUS REGISTER READ

SR.7 = 1 ? — NO → WRITE B0H ? — NO

YES   YES

FULL STATUS CHECK IF DESIRED   SUSPEND LOOP [WRITE D0H]

PAGE PROGRAM COMPLETED   YES

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CLEAR PAGE BUFFER

```
        START
          │
          ▼
      WRITE 55H
          │
          ▼
      WRITE D0H
          │
          ▼
  PAGE BUFFER CLEAR
     COMPLETED
```

SINGLE DATA LOAD TO PAGE BUFFER

```
        START
          │
          ▼ ◄─────────┐
      WRITE 74H        │
          │            │
          ▼            │
       WRITE           │
   ADDRESS , DATA      │
          │            │
          ▼            │
        DONE    NO     │
      LOADING? ────────┘
          │
        YES
          ▼
  SINGLE DATA LOAD
   TO PAGE BUFFER
     COMPLETED
```

PAGE BUFFER TO FLASH

```
        START
          │
          ▼
      WRITE 0EH
          │
          ▼
      WRITE D0H
     PAGE ADDRESS
          │
          ▼
  STATUS REGISTER ◄───────────────────┐
       READ                           │
          │                           │
          ▼                  NO       │
      SR.7 = 1 ? ──NO──► WRITE B0H ? ──┘
          │                   │
        YES                  YES
          ▼                   ▼
  FULL STATUS CHECK      SUSPEND LOOP
    IF DESIRED          ┌──────────┐
          │             │ WRITE D0H │
          ▼             └──────────┘
  PAGE BUFFER TO FLASH        │
     COMPLETED               YES
```
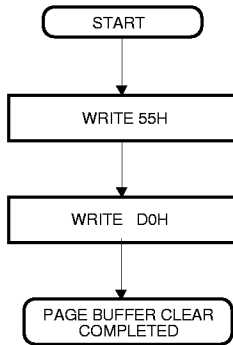
SUSPEND / RESUME FLOW CHART

```
        START
          │
          ▼
      WRITE B0H        SUSPEND
          │
          ▼
  STATUS REGISTER ◄────┐
       READ            │
          │            │
          ▼      NO     │
      SR.7 = 1? ────────┘
          │
        YES
          ▼                  PROGRAM / ERASE
      SR.6 =1? ──NO──────►    COMPLETED
          │
        YES
          ▼
      WRITE FFH
          │
          ▼
  READ ARRAY DATA ◄────┐
          │            │
          ▼      NO     │
        DONE    ────────┘
      READING ?
          │
        YES
          ▼
      WRITE D0H         RESUME
          │
          ▼
     OPERATION
      RESUMED
```

* The bank address is required when writing this command. Also, there is no need to suspend the erase or program operation when reading data from the other bank. Please use BGO function.

BLOCK ERASE FLOW CHART

```
        START
          │
          ▼
      WRITE 20H
          │
          ▼
      WRITE D0H
     BLOCK ADDRESS
          │
          ▼
  STATUS REGISTER ◄────────────────────────┐
       READ                                │
          │                                │
          ▼           NO              NO    │
      SR.7 = 1 ? ──────► WRITE B0H ? ───────┘
          │                  │
        YES                 YES
          ▼                  ▼
  FULL STATUS CHECK      SUSPEND LOOP
    IF DESIRED          ┌──────────┐
          │             │ WRITE D0H │
          ▼             └──────────┘
   BLOCK ERASE                │
    COMPLETED                YES
```

MITSUBISHI LSIs
M6MGB/T162S2BVP
16,777,216-BIT (1,048,576 -WORD BY 16-BIT) CMOS
3.3V-ONLY FLASH MEMORY &
2,097,152-BIT (262,144-WORD BY 8-BIT) CMOS SRAM
Stacked-MCP (Multi Chip Package)
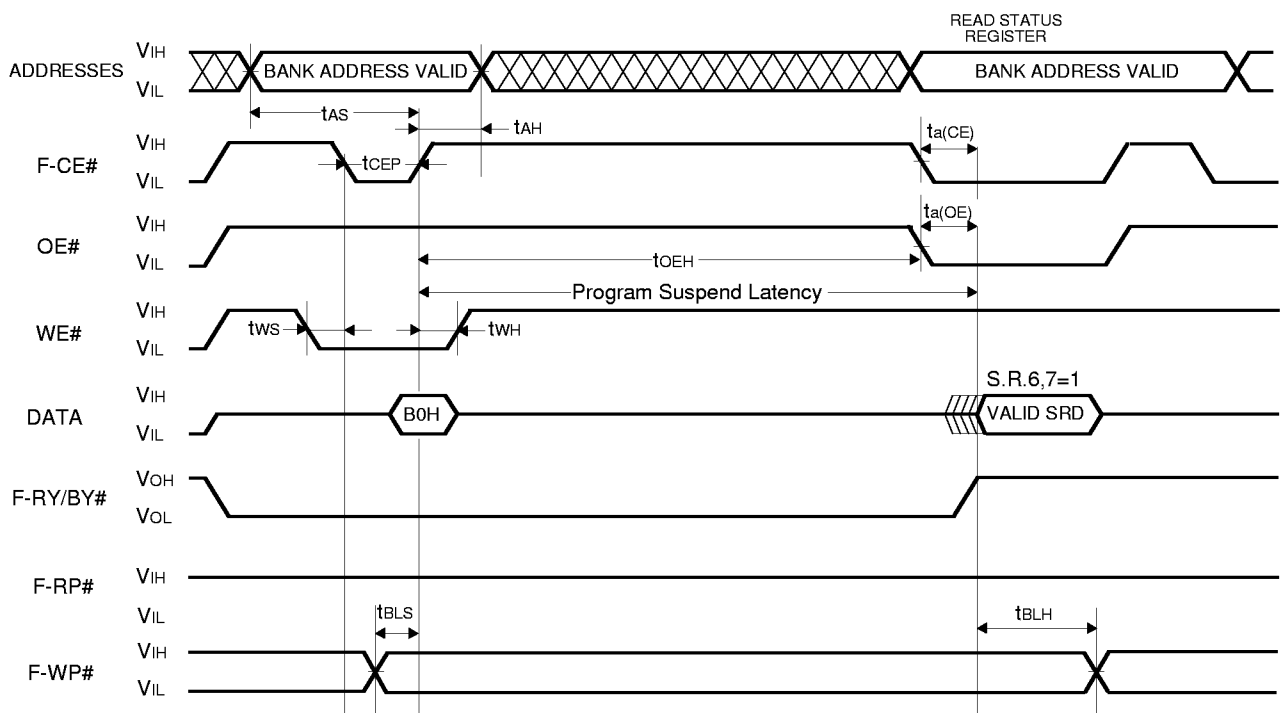
OPERATION STATUS and EFFECTIVE COMMAND

MITSUBISHI LSIs
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16,777,216-BIT (1,048,576 -WORD BY 16-BIT) CMOS
3.3V-ONLY FLASH MEMORY &
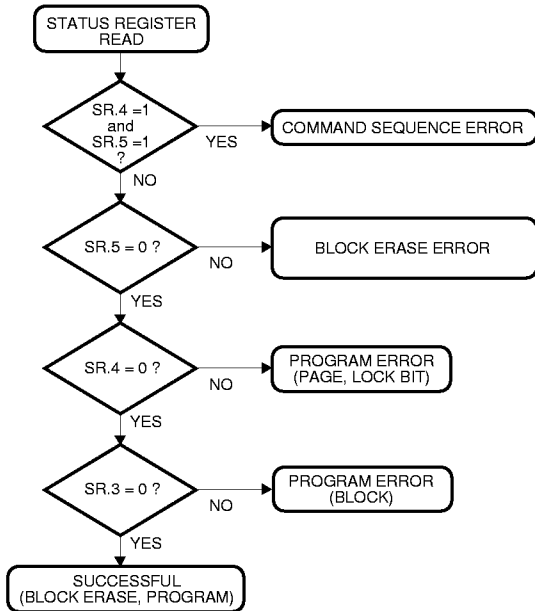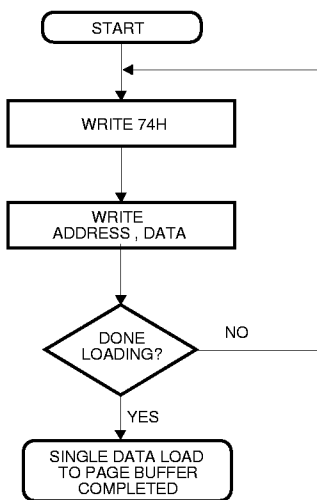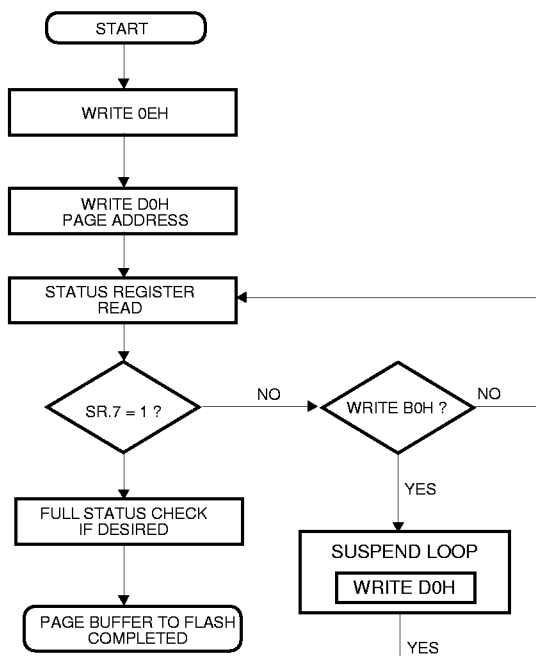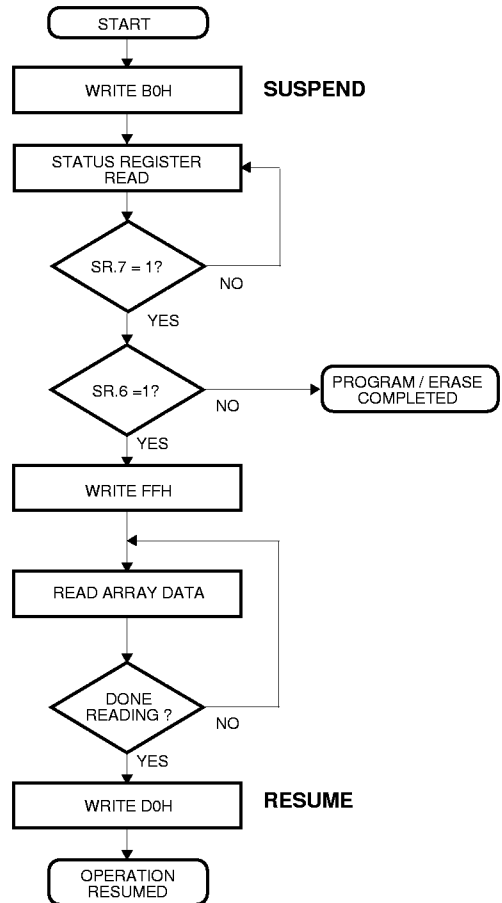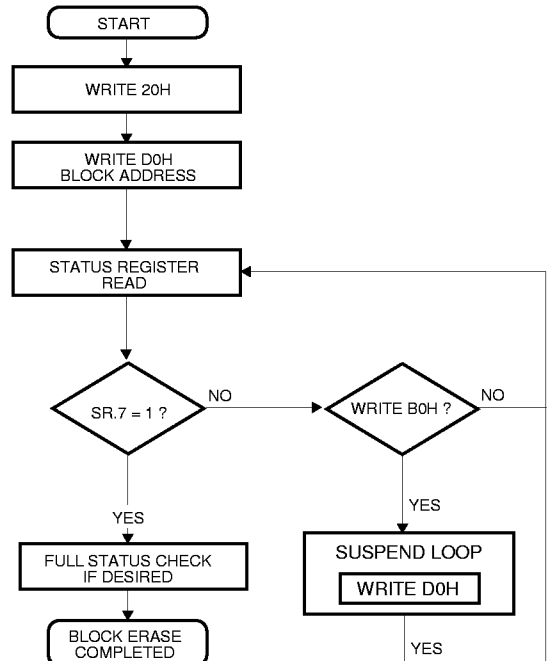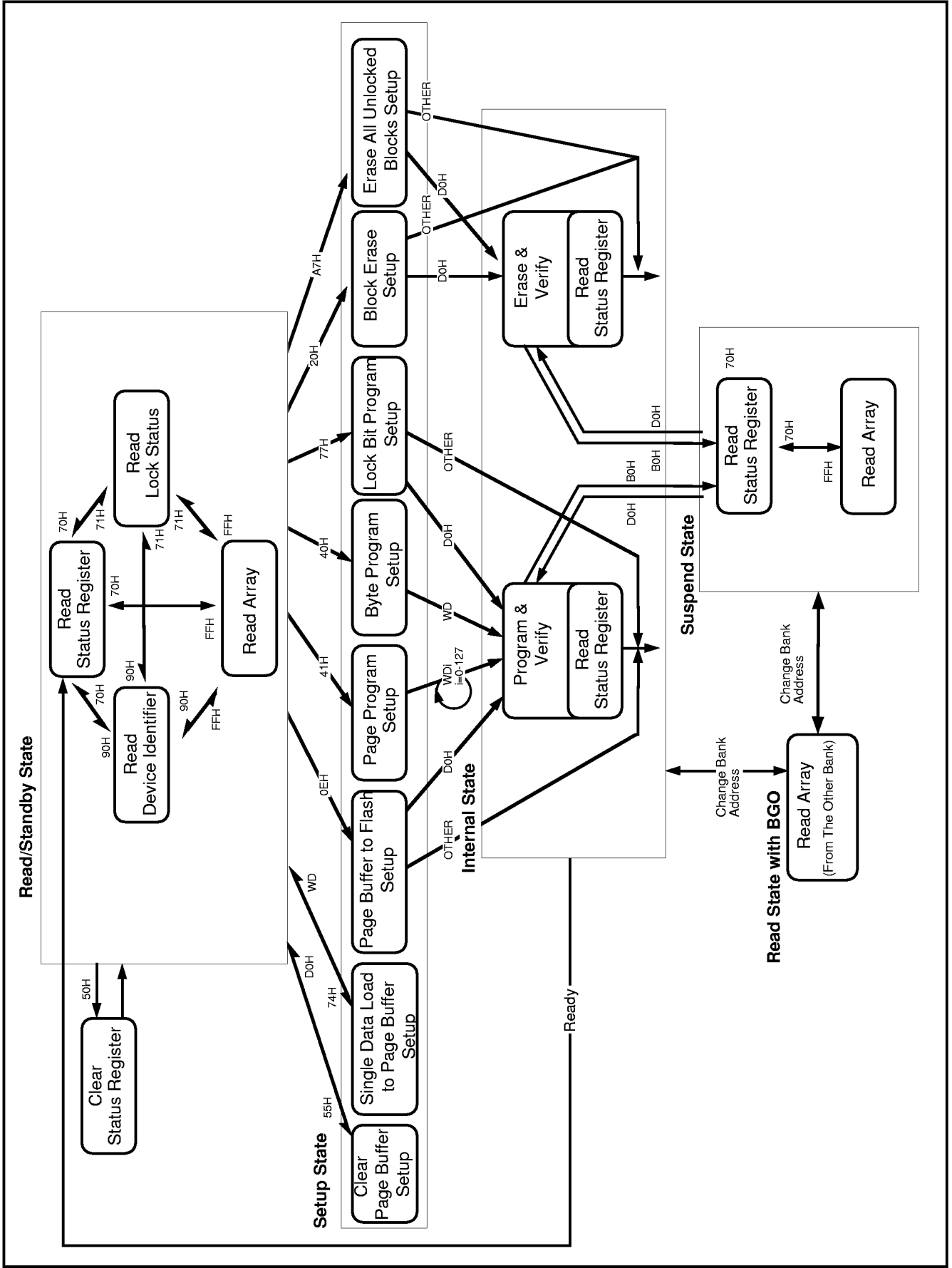2,097,152-BIT (262,144-WORD BY 8-BIT) CMOS SRAM
Stacked-MCP (Multi Chip Package)

2. SRAM

The SRAM of M6MGB/T162S2BVP is organized as 262,144-word by 8-bit. These devices operate on a single +2.7~3.6V powersupply, and are directly TTL compatible to both input and output. Its fully static circuit needs no clocks and no refresh, and makes it useful.

The operation mode are determined by a combination of the device control inputs , S-CE , WE# and OE#. Each mode is summarized in the function table.

A write operation is executed whenever the low level WE# overlaps with the high level S-CE. The address (S-A$_{-1}$~A16:byte mode) must be set up before the write cycle and must be stable during the entire cycle.

A read operation is executed by setting WE# at a high level and OE# at a low level while S-CE are in an active state(S-CE=H).

When setting S-CE at a low level,the chips are in a non-selectable mode in which both reading and writing are disabled. In this mode, the output stage is in ahigh-impedance state, allowing OR-tie with other chips and memory expansion by S-CE.

The power supply current is reduced as low as 0.3µA(25 °C,typical), and the memory data can be held at +2V powersupply, enabling battery back-up operation during power failure or power-down operation in the non-selected mode.

FUNCTION TABLE

S-CE	WE#	OE#	Mode	DQ0~7	Icc
L	X	X	Non selection	High-Z	Standby
H	L	X	Write	Din	Active
H	H	L	Read	Dout	Active
H	H	H	————	High-Z	Active

MITSUBISHI LSIs

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ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Units
S-V$_{CC}$	Supply voltage	With respect to GND	-0.5* ~ +4.6	V
V$_I$	Input voltage	With respect to GND	-0.5* ~ S-Vcc + 0.5	
V$_O$	Output voltage	With respect to GND	0 ~ S-Vcc	
P$_d$	Power dissipation	Ta=25°C	700	mW
T$_a$	Operating temperature	W-version	- 20 ~ +85	°C
T$_{stg}$	Storage temperature		- 65 ~ +150	°C

* -3.0V in case of AC (Pulse width≦ 30ns)

DC ELECTRICAL CHARACTERISTICS

(S-Vcc=2.7 ~ 3.6V, unless otherwise noted)

Symbol	Parameter	Conditions			Limits			Units
					Min	Typ	Max	
V$_{IH}$	High-level input voltage				2.0		S-Vcc+0.3V	V
V$_{IL}$	Low-level input voltage				-0.3 *		0.6	
V$_{OH1}$	High-level output voltage 1	I$_{OH}$= -0.5mA			2.4			
V$_{OH2}$	High-level output voltage 2	I$_{OH}$= -0.05mA			S-Vcc-0.5V			
V$_{OL}$	Low-level output voltage	I$_{OL}$=2mA					0.4	
I$_I$	Input leakage current	V$_I$ =0 ~ S-Vcc					±1	μA
I$_O$	Output leakage current	S-CE=V$_{IL}$ or OE#=V$_{IH}$, V$_{I/O}$=0 ~ S-Vcc					±1	
I$_{CC1}$	Active supply current (AC,MOS level)	S-CE ≧S-Vcc-0.2V other inputs ≦ 0.2V or ≧ S-Vcc-0.2V Output - open (duty 100%)	f= 10MHz		-	45	60	mA
			f= 1MHz		-	5	15	
I$_{CC2}$	Active supply current (AC,TTL level)	S-CE=V$_{IH}$ other pins =V$_{IH}$ or V$_{IL}$ Output - open (duty 100%)	f= 10MHz		-	45	60	
			f= 1MHz		-	5	15	
I$_{CC3}$	Stand by supply current (AC,MOS level)	S-CE ≦ 0.2V Other inputs=0~S-Vcc	-W	+70 ~ +85°C	-	-	30	μA
				+40 ~ +70°C	-	-	10	
				+25 ~ +40°C	-	1	5	
				- 20 ~ +25°C	-	0.3	2	
I$_{CC4}$	Stand by supply current (AC,TTL level)	S-CE=V$_{IL}$ Other inputs= 0 ~ S-Vcc			-	-	0.5	mA

Note 1: Direction for current flowing into IC is indicated as positive (no mark)
Note 2: Typical value is for S-Vcc=3.0V and Ta=25 °C

* -3.0V in case of AC (Pulse width≦ 30ns)

CAPACITANCE

(S-Vcc=2.7 ~ 3.6V, unless otherwise noted)

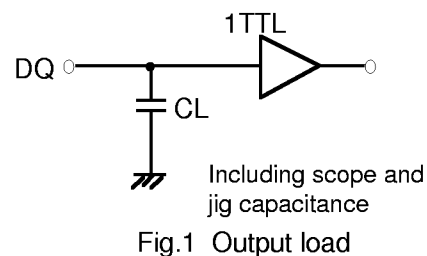| Symbol	Parameter	Conditions	Limits			Units
			Min	Typ	Max	
C$_I$	Input capacitance	V$_I$=GND, V$_I$=25mVrms, f=1MHz			8	pF
C$_O$	Output capacitance	V$_O$=GND,V$_O$=25mVrms, f=1MHz			10	

Note: The value of common pins to SRAM is the sum of Flash Memory and SRAM.

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AC ELECTRICAL CHARACTERISTICS (S-Vcc=2.7 ~ 3.6V, unless otherwise noted)

(1) TEST CONDITIONS

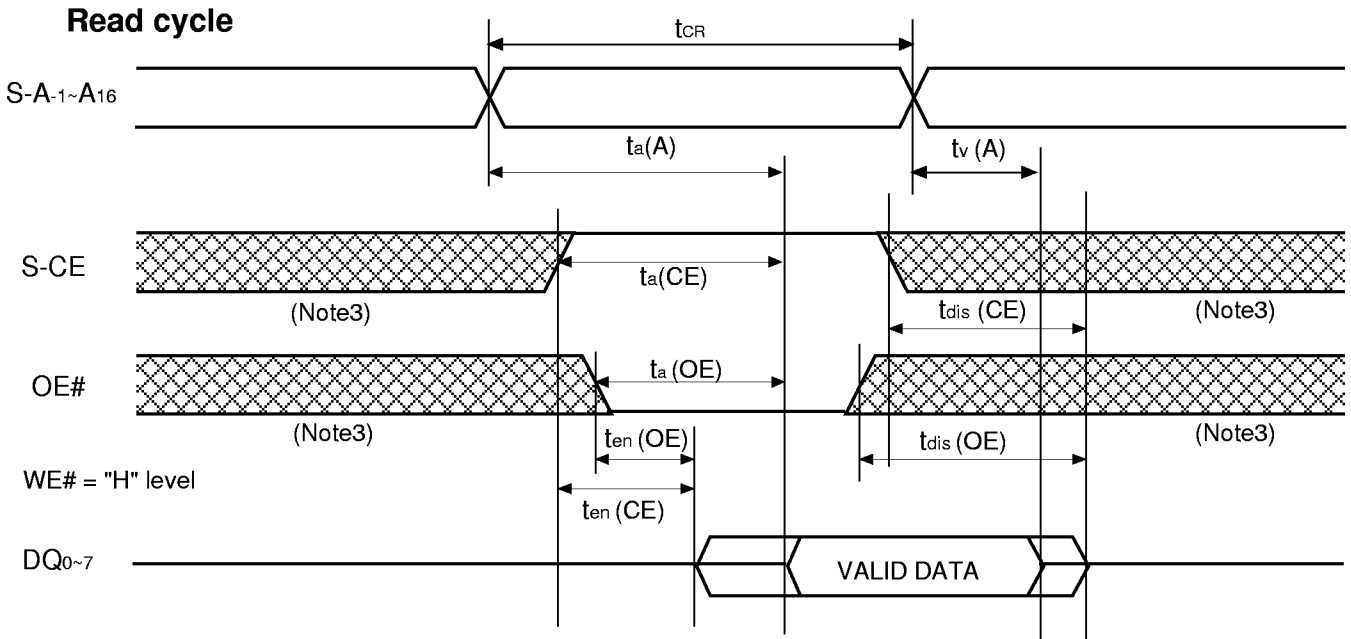| Supply voltage	2.7V~3.6V
Input pulse	V_{IH}=2.2V,V_{IL}=0.4V
Input rise time and fall time	5ns
Reference level	V_{OH}=V_{OL}=1.5V Transition is measured ±500mV from steady state voltage.(for t_{en},t_{dis})
Output loads	Fig.1,CL=30pF CL=5pF (for ten,tdis)

1TTL

DQ ○———

CL

Including scope and
jig capacitance

Fig.1 Output load

(2) READ CYCLE

Symbol	Parameter	Limits SRAM		Units
		Min	Max	
t_{CR}	Read cycle time	85		ns
$t_a(A)$	Address access time		85	ns
$t_a(CE)$	Chip select access time		85	ns
$t_a(OE)$	Output enable access time		45	ns
$t_{dis}(CE)$	Output disable time after S-CE low		30	ns
$t_{dis}(OE)$	Output disable time after OE# high		30	ns
$t_{en}(CE)$	Output enable time after S-CE high	10		ns
$t_{en}(OE)$	Output enable time after OE# low	5		ns
$t_v(A)$	Data valid time after address	10		ns

(3) WRITE CYCLE

Symbol	Parameter	Limits SRAM		Units
		Min	Max	
t_{CW}	Write cycle time	85		ns
$t_w(W)$	Write pulse width	60		ns
$t_{su}(A)$	Address setup time	0		ns
$t_{su}(A-WH)$	Address setup time with respect to WE#	70		ns
$t_{su}(CE)$	Chip select setup time	70		ns
$t_{su}(D)$	Data setup time	35		ns
$t_h(D)$	Data hold time	0		ns
$t_{rec}(W)$	Write recovery time	0		ns
$t_{dis}(W)$	Output disable time from WE# low		30	ns
$t_{dis}(OE)$	Output disable time from OE# high		30	ns
$t_{en}(W)$	Output enable time from WE# high	5		ns
$t_{en}(OE)$	Output enable time from OE# low	5		ns

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(4)TIMING DIAGRAMS

Read cycle

WE# = "H" level

Write cycle (WE# control mode)

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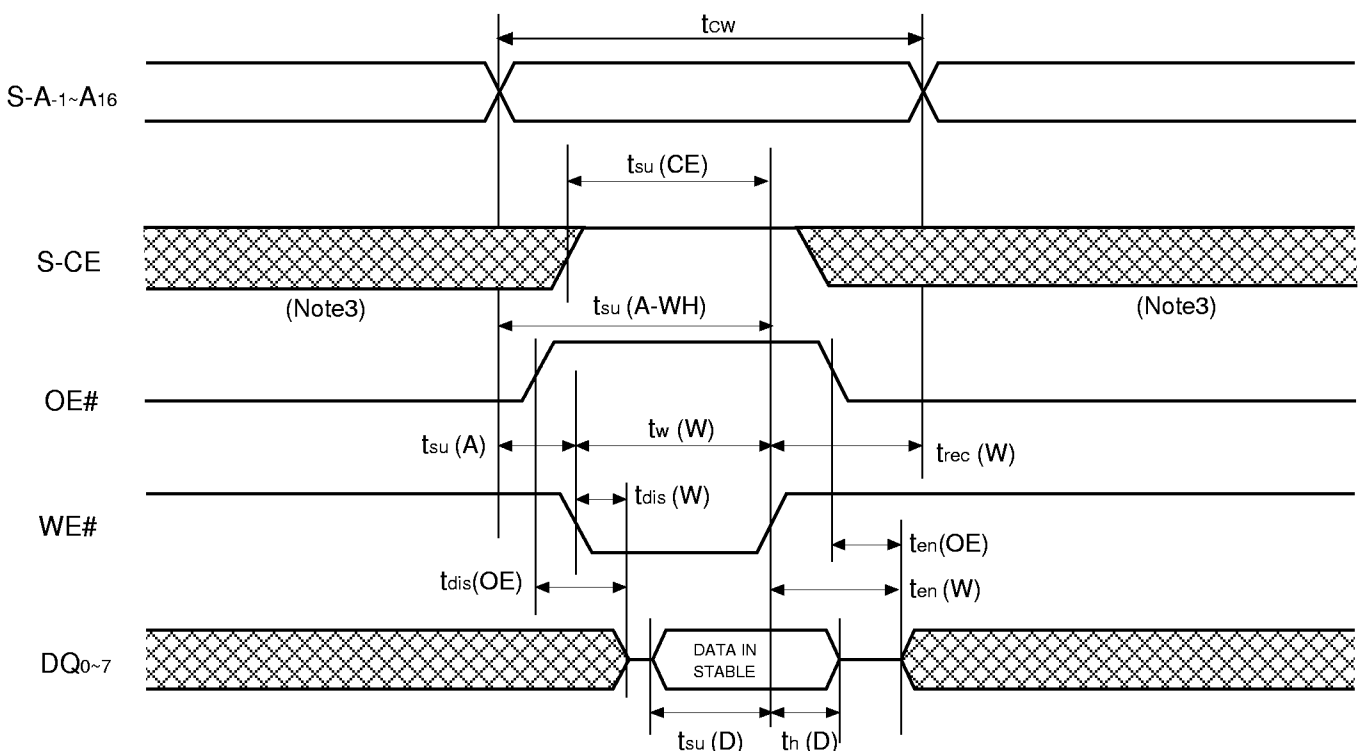
Write cycle (S-CE control mode)
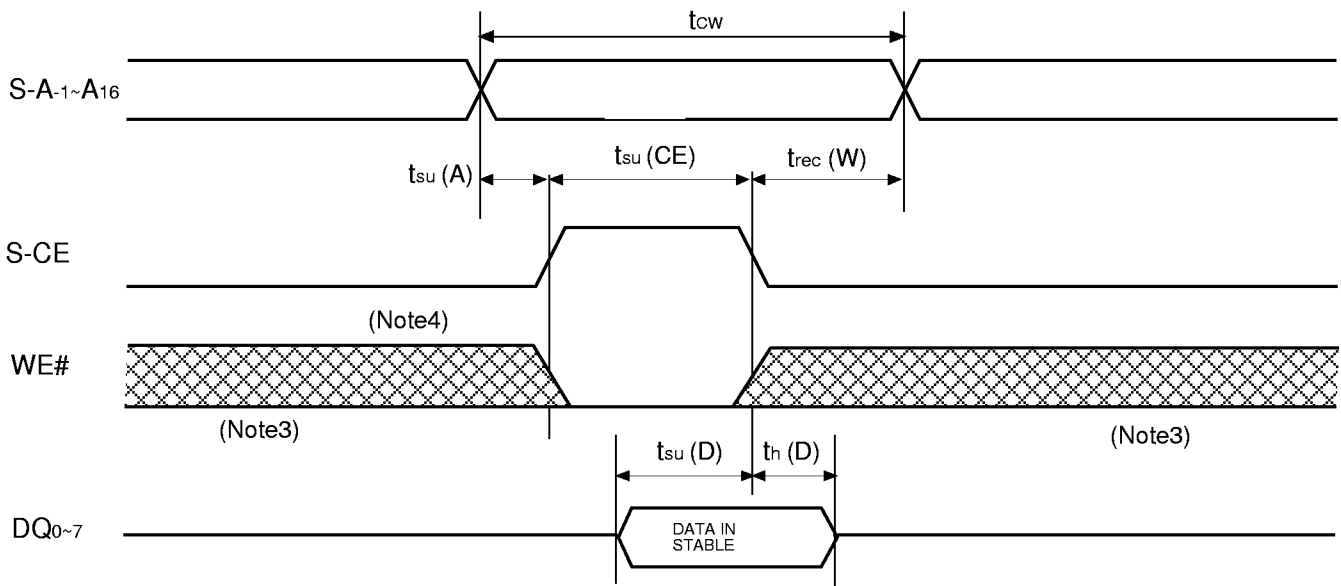
Note 3: Hatching indicates the state is "don't care".

Note 4: When the falling edge of WE# is simultaneously or priorto the rising edge of S-CE,
the outputs are maintained in the high impedance state.

Note 5: Don't apply inverted phase signal externally when DQ pin is in output mode.

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POWER DOWN CHARACTERISTICS

(1) ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test conditions			Limits			Units
					Min	Typ	Max	
S-Vcc (PD)	Power down supply voltage				2.0			V
VI (S-CE)	Chip select input S-CE						0.2	V
Icc (PD)	Power down supply current	S-Vcc=3.0V S-CE≦0.2V other inputs=0~3V	-W	+70 ~ +85°C	-	-	24	μA
				+40 ~ +70°C	-	-	8	μA
				+25 ~ +40°C	-	1	3	μA
				-20 ~ +25°C	-	0.3	1	μA

Typical value is for Ta=25°C

(2) TIMING REQUIREMINTS

Symbol	Parameter	Test conditions	Limits			Units
			Min	Typ	Max	
tsu (PD)	Power down set up time		0			ns
trec (PD)	Power down recovery time		5			ms

(3) TIMING DIAGRAM
S-CE control mode