PRELIMINARY

M37413E6HXXXFP
M37413E6HFS

PROM VERSION of M37413M6HXXXFP

DESCRIPTION

The M37413E6HFS, M37413E6HXXXFP are single-chip microcomputers designed with CMOS silicon gate technology. M37413E6HXXXFP is housed in a 80-pin shrink plastic molded QFP. M37413E6HFS is housed in a 80-pin ceramic QFP. The features of this chip are similar to those of the M37413M4HXXXFP except that this chip has a 12288 bytes PROM built in. This single-chip microcomputer is useful for home electrical appliances and consumer appliance controllers.

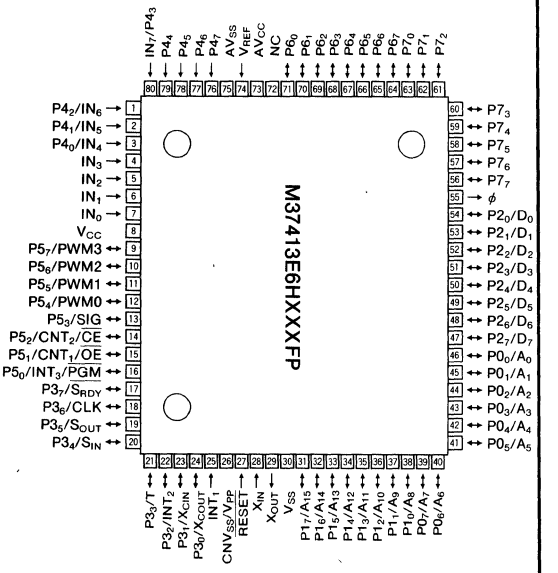
In addition to its simple instruction sets, the PROM, RAM, and I/O addresses are placed on the same memory map to enable easy programming. Since general purpose PROM writers can be used for the built-in PROM, this chip is suitable for small quantity production runs.

The M37413E6HFS is the window type. The differences between the M37413E6HXXXFP and the M37413E6HFS are the package outline and the power dissipation ability (absolute maximum ratings).

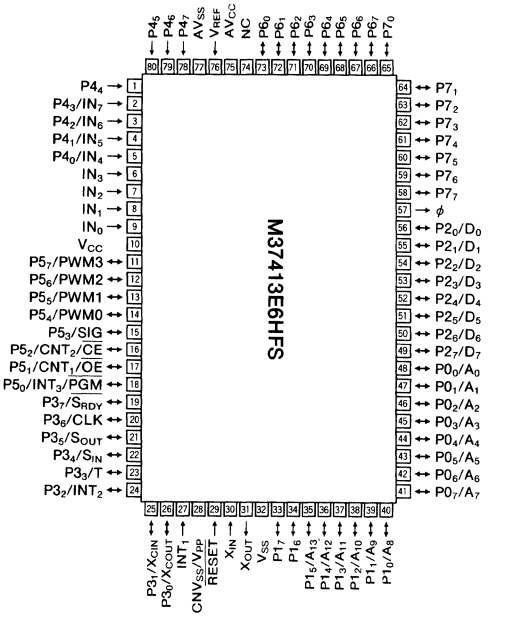
FEATURES

- Number of basic instructions 69
- Memory size PROM ..... 12288 bytes
  RAM ..... 256 bytes
- Instruction execution time
  (minimum instructions at 4MHz frequency)
  at high-speed mode 2μs
  at low-speed mode 8μs
- Single power supply
  M37413E6HXXXFP ..... 2.5~5.5V
  M37413E6HFS ..... 4.5~5.5V
- Power dissipation
  normal operation mode (at 4MHz frequency)
  ..... 15mW (V_{CC}=5V, Typ.)
  low-speed operation mode (at 32kHz frequency for clock function) ..... 54μW(V_{CC}=3V, Typ.)
- RAM retention voltage (stop mode)
  ..... 2.0V$\leqq V_{RAM} \leqq$5.5V
- Subroutine nesting ..... 96 levels (Max.)
- Interrupt ..... 10 types, 5 vectors
- 8-bit timer ..... 4 (3 when used as serial I/O)
- 16-bit timer 1
- Programmable I/O ports
  (Ports P0, P1, P2, P3, P5, P6, P7) 56
- Input port (Port P4) 8
- Serial I/O (8-bit) 1
- A-D converter 8-bit, 8-channel
  conversion speed (49.5μs)
- Two clock generating circuits
  (One is for main clock, the other is for clock function)
- PROM (equivalent to the M5L27128)
  program voltage 21V

PIN CONFIGURATION (TOP VIEW)



Outline 80P6S (OTP)



Outline 80S6 (Window)

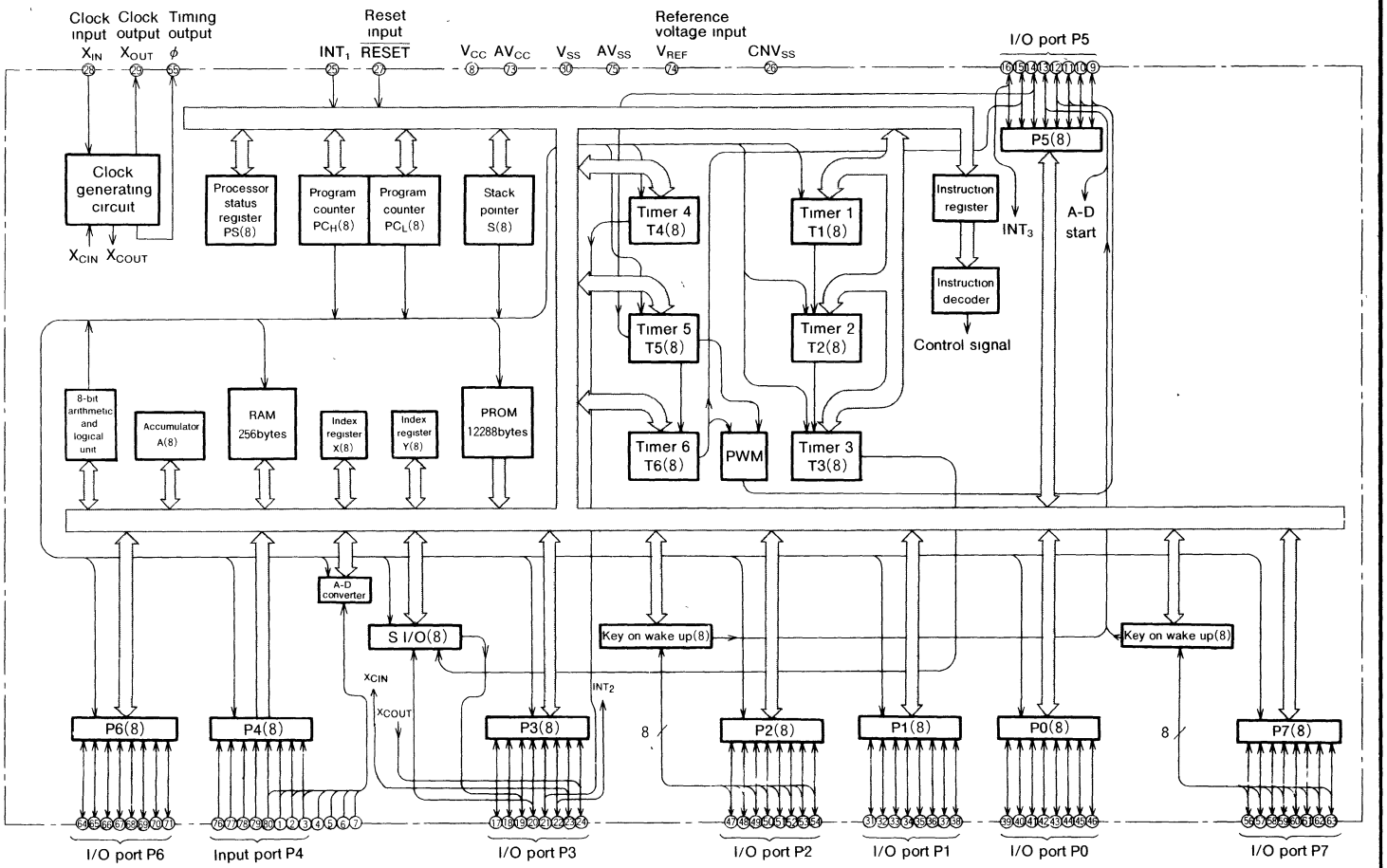
NC : No Connection

APPLICATION

Audio-visual equipment, VCR, Tuner,
Office automation equipment,
Camera

MITSUBISHI ELECTRIC

M37413E6HXXXFP BLOCK DIAGRAM



FUNCTIONS OF M37413E6HXXXFP

Parameters			Functions
Number of basic instructions			69
Instruction execution time			2μs (minimum instructions, at 4MHz of frequency)
Clock frequency			4MHz
Memory size	PROM		12288bytes
	RAM		256bytes
Input/Output port	P0, P2, P7	I/O	8-bit×3 (CMOS output)
	P1, P3, P5, P6	I/O	8-bit×4 (N-channel open drain output)
	P4	Input	8-bit×1
Serial I/O			8-bit×1
Timers			8-bit timer×4
			16-bit timer×1
Subrotine nesting			96(max)
Interrupt			Three external interrupts, three timer interrupts (or two timer, one serial I/O)
Clock generating circuit			Two built-in circuits (ceramic or quartz crystal oscillator)
Operating temperature range			−10∼70°C
Device structure			CMOS silicon gate
Package			80-pin plastic molded QFP

PIN DESCRIPTION

Pin	Mode	Name	Input/ Output	Functions
V_{CC}, V_{SS}	Single-chip /EPROM	Power supply		Supply 5V±5% to V_{CC} and 0V to V_{SS}
CNV_{SS}/ V_{PP}	Single-chip	CNV_{SS}		Connect to V_{SS}.
	EPROM	V_{PP} input	Input	Connect to V_{PP} when programming or verifing
$\overline{RESET}$	Single-chip	Reset input	Input	To reset, keep this input terminal low for more than 16μs (min) under normal V_{CC} conditions If more time is needed for the crystal oscillator to stabilize, this "L" condition should be maintained for the required time.
	EPROM			Connect to 0V.
X_{IN}	Single-chip /EPROM	Clock input	Input	These are I/O pins of internal clock generating circuit for main clock To control generating frequency, an external ceramic or a quartz crystal oscillator is connected between the X_{IN} and X_{OUT} pins If an external clock is used, the clock source should be connected the X_{IN} pin and the X_{OUT} pin should be left open
X_{OUT}		Clock output	Output	
INT_1	Single-chip	Interrupt input	Input	This is the highest order interrupt input pin
	EPROM			Connect to 0V
$P0_0$~$P0_7$	Single-chip	I/O port P0	I/O	Port P0 is an 8-bit I/O port with directional registers allowing each I/O bit to be individually programmed as input or output At reset, this port is set to input mode The output structure is CMOS output
	EPROM	Address input A_0~A_7	Input	P0 works as the lower 8 bit address input (A_0~A_7)
$P1_0$~$P1_7$	Single-chip	I/O port P1	I/O	Port P1 is an 8-bit I/O port and has basically the same functions as port P0 The output structure is N-channel open drain
	EPROM	Address input A_8~A_{13}	Input	$P1_0$~$P1_5$ works as the higher 6 bit address inputs (A_8~A_{13}) Connect $P1_6$~$P1_7$ to V_{SS}
$P2_0$~$P2_7$	Single-chip	I/O port P2	I/O	Port P2 is an 8-bit I/O port and has basically the same function as port P0 Also all bits are for key on wake up input pins.
	EPROM	Data input/ output D_0~D_7	I/O	Port P2 works as an 8 bit data bus (D_0~D_7)
$P3_0$~$P3_7$	Single-chip	I/O port P3	I/O	Port P3 is an 8-bit I/O port and has basically the same functions as port P0 When serial I/O is used, $P3_7$, $P3_6$, $P3_5$ and $P3_4$ work as $\overline{S_{RDY}}$, CLK, S_{OUT}, and S_{IN} pins, respectively Also $P3_3$, $P3_2$, $P3_1$, and $P3_0$ work as timer 4 overflow signal divided by 2 output pin (T), INT_2 pin, X_{CIN} and X_{COUT} pins, respectively
	EPROM	Input port P3	Input	Connect to 0V
$P4_0$~$P4_7$	Single-chip	Input port P4	Input	Port P4 is an 8-bit input port. $P4_0$~$P4_3$ work as analog input pin IN_4~IN_7
	EPROM			Connect to V_{SS}
IN_0~IN_7	Single-chip	Input port IN	Input	These are analog input pin
	EPROM			Connect to V_{SS}
$P5_0$~$P5_7$	Single-chip	I/O port P5	I/O	Port P5 is an 8-bit I/O port and has basically the same function as P1 $P5_0$, $P5_1$, $P5_2$ and $P5_3$ are in common with INT_3, timer3 input, timer5 input and A-D trigger input, respectively.
	EPROM	Select mode	Input	Connect to V_{SS}

PIN DESCRIPTION (Continued)

Pin	Mode	Name	Input/ Output	Functions
$P6_0 \sim P6_7$	Single-chip	I/O port P6	I/O	Port P6 is an 8-bit I/O port and has basically the same functions as port P1
	EPROM	Input port P6	Input	Connect to V_{SS}
$P7_0 \sim P7_7$	Single-chip	I/O port P7	I/O	Port P7 is an 8-bit I/O port and has basically the same functions as port P2
	EPROM	Input port P7	Input	Connect to V_{SS}
AV_{CC}	Single-chip	Analog voltage input	Input	Analog voltage input pin for A-D converter
	EPROM			Connect to V_{SS}.
AV_{SS}	Single-chip /EPROM	Analog voltage input	Input	Connect to V_{SS}.
V_{REF}	Single-chip	Reference voltage input	Input	Reference input pin for A-D converter.
	EPROM			Connect to V_{CC}.

EPROM MODE

The M37413E6HXXXFP, M37413E6HFS feature an EPROM mode in addition to its normal modes. When the $\overline{\text{RESET}}$ signal level is low ("L"), the chip automatically enters the EPROM mode. Table 1 list the correspondence between pins and Figure 1, Figure 2 give the pin connections in the EPROM mode. When in the EPROM mode, ports P0, P1, P2, $P5_0 \sim P5_2$, and CNV_{SS} are used for the PROM (equivalent to the M5L27128). When in this mode, the built-in PROM can be written to or read from using these pins in the same way as with the M5L27128. The oscillator should be connected to the X_{IN} and X_{OUT} pins, or external clock should be connected to the X_{IN} pin.

Table 1. Pin function in EPROM mode

	M37413E6HXXXFP, M37413E6HFS	M5L27128
V_{CC}	V_{CC}	V_{CC}
V_{PP}	CNV_{SS}/V_{PP}	V_{PP}
V_{SS}	V_{SS}	V_{SS}
Address input	Ports P0, $P1_0 \sim P1_5$	$A_0 \sim A_{13}$
Data I/O	Port P2	$D_0 \sim D_7$
$\overline{CE}$	$P5_2/\overline{CE}$	$\overline{CE}$
$\overline{OE}$	$P5_1/\overline{OE}$	$\overline{OE}$
$\overline{PGM}$	$P5_0/\overline{PGM}$	$\overline{PGM}$

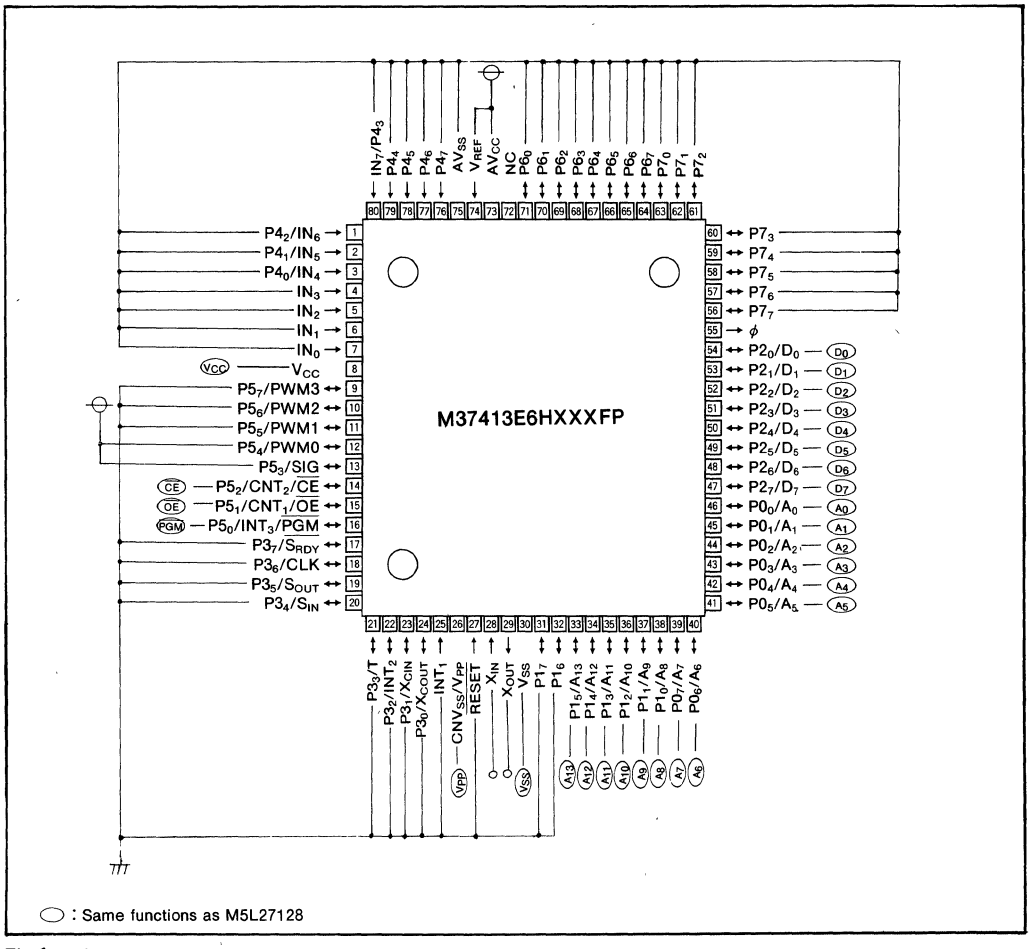


Fig.1 Pin connection in EPROM mode

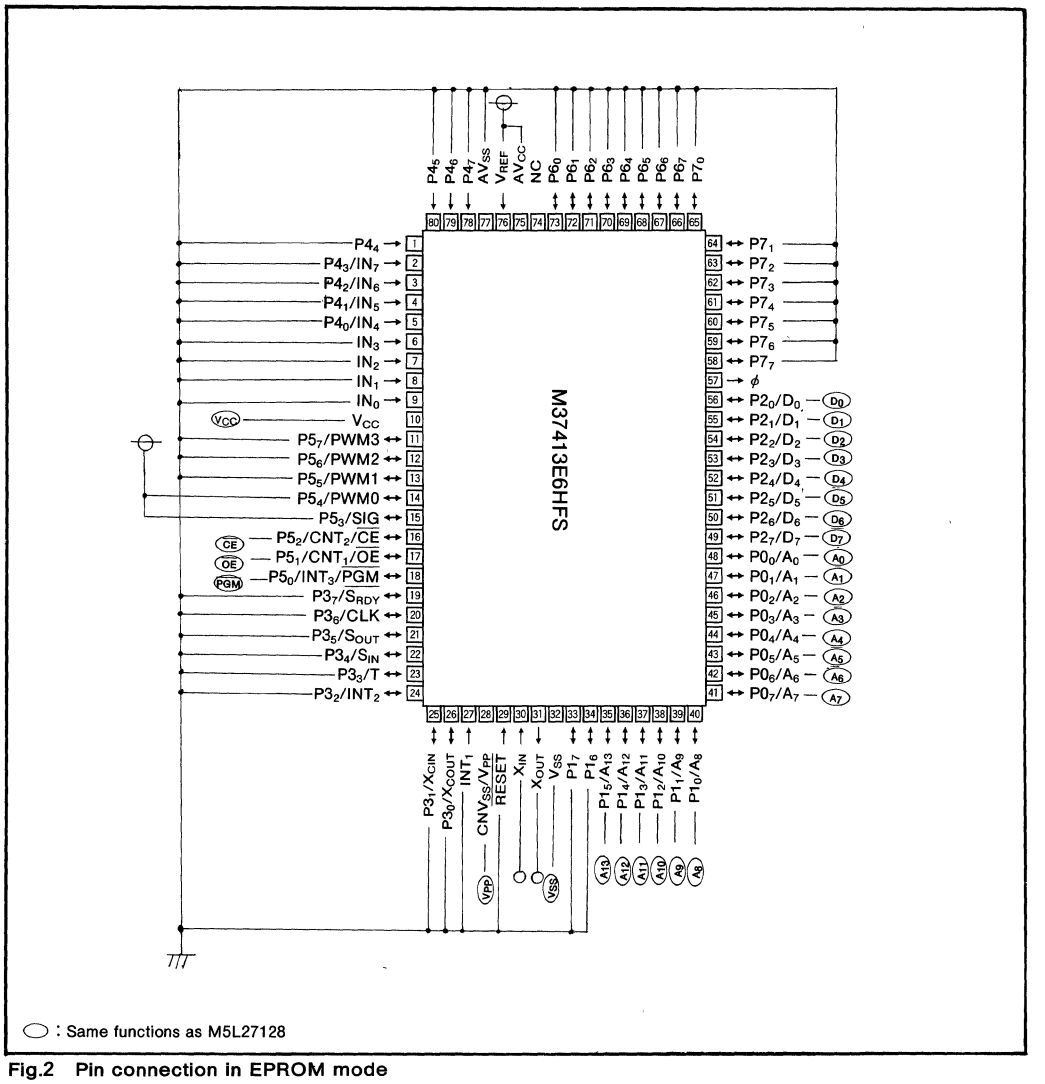


Fig.2 Pin connection in EPROM mode

MITSUBISHI ELECTRIC

PROM READING, WRITING AND ERASING

Reading

To read the PROM, set the $\overline{CE}$ and $\overline{OE}$ pins to a "L" level, and the $\overline{PGM}$ pin to a "H" level. Input the address of the data (A_0~A_{13}) to be read and the data will be output to the I/O pins D_0~D_7. The data I/O pins will be floating when either the $\overline{CE}$ or $\overline{OE}$ pins are in the "H" state.

Writing

To write to the PROM, set the $\overline{CE}$ pin to a "L" level and the $\overline{OE}$ pin to a "H" level. The CPU will enter the program mode when V_{PP} is applied to the V_{PP} pin. The address to be written to is selected with pins A_0~A_{13}, and the data to be written is input to pins D_0~D_7. Set the $\overline{PGM}$ pin to a "L" level to begin writing.

Erasing

Data can only erased on the M37413E6HFS ceramic package, which includes a window. To erase data on this chip, use an ultraviolet light source with a 2537 Angstrom wave length. The minimum radiation power necessary for erasing is 15W·s/cm^2.

Functional differences from M37413M4HXXXFP
(excluding characteristic differences).

	M37413M4HXXXFP	M37413E6HXXXFP
Port P0 pull-up resistor	Option	Not provided
Port P1 pull-up resistor	Option	Not provided
Port P2 pull-up resistor	Option	Not provided
Port P3 pull-up resistor	Option	Not provided
Port P4 pull-up resistor	Option	Not provided
Port P5 pull-up resistor	Option	Not provided
Port P6 pull-up resistor	Option	Not provided
Port P7 pull-up resistor	Option	Not provided
Port P2 key on wake up	Option	Provided (all bits)
Port P7 key on wake up	Option	Provided (all bits)

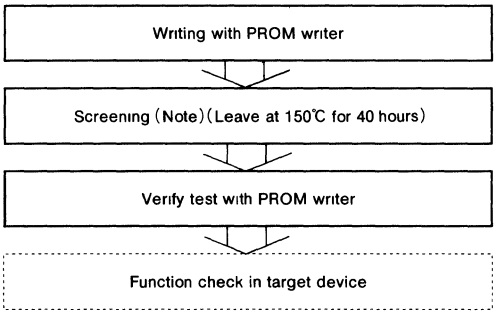
NOTES ON HANDLING

(1) Sunlight and fluorescent light contain wave lengths capable of erasing data. For ceramic package types, cover the transparent window with a seal (provided) when this chip is in use. However, this seal must not contact the lead pins.

(2) Before erasing, the glass should be cleaned and stains such as finger prints should be removed thoroughly. If these stains are not removed, complete erasure of the data could be prevented.

(3) Since a high voltage (21V) is used to write data, care should be taken when turning on the PROM writer's power.

(4) For the programmable microcomputer (shipped in blank or OTP type), Mitsubishi does not perform PROM write test and screening in the assembly process and following processes. To improve reliability after write, performing write and test according to the flow below before use is recommended.



Note : Since the screening temperature is higher than storage temperature, never expose to 150℃ exceeding 100 hours.

Table 2. I/O signal in each mode

Mode \ Pin	$\overline{CE}$(14)	$\overline{OE}$(15)	$\overline{PGM}$(16)	V_{PP}(26)	V_{CC}(8)	Data I/O (33~54)
Read-out	V_{IL}	V_{IL}	V_{IH}	V_{CC}	V_{CC}	Output
Programming	V_{IL}	V_{IH}	Pulse(V_{IH}→V_{IL})	V_{PP}	V_{CC}	Input
Programming verify	V_{IL}	V_{IL}	V_{IH}	V_{PP}	V_{CC}	Output
Program disable	V_{IH}	X	X	V_{PP}	V_{CC}	Floating

Note 1 : V_{IL} and V_{IH} indicate a "L" and "H" input voltage, respectively.
2 : An X indicates either V_{IL} or V_{IH}

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		−0.3∼7	V
AV_{CC}	Analog supply voltage	V_{CC}=AV_{CC}	−0.3∼7	V
V_I	Input voltage $P0_0$∼$P0_7$, $P2_0$∼$P2_7$, $P3_0$, $P3_1$, $P4_0$∼$P4_7$, $P7_0$∼$P7_7$, IN_0∼IN_7, V_{REF}, X_{IN}		−0.3∼V_{CC}+0.3	V
V_I	Input voltage CNV_{SS}, (Note 1)		−0.3∼7	V
V_I	Input voltage INT_1, $\overline{RESET}$, $P1_0$∼$P1_7$, $P3_2$∼$P3_7$, $P5_0$∼$P5_7$, $P6_0$∼$P6_7$		−0.3∼10	V
V_O	Output voltage $P0_0$∼$P0_7$, $P2_0$∼$P2_7$, $P3_0$, $P3_1$, $P7_0$∼$P7_7$, X_{OUT}		−0.3∼V_{CC}+0.3	V
V_O	Output voltage $P1_0$∼$P1_7$, $P3_2$∼$P3_7$, $P5_0$∼$P5_7$, $P6_0$∼$P6_7$		−0.3∼10	V
Pd	Power dissipation	T_a = 25℃	300	mW
Topr	Operating temperature		−10∼70	℃
Tstg	Storage temperature		−40∼125	℃

Note 1 : In PROM programming mode, CNV_{SS} is 21.0V

RECOMMENDED OPERATING CONDITIONS (V_{CC}= 5 V± 5 %, T_a=−10∼70℃, unless otherwise noted)

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ	Max	
V_{CC}	Supply voltage (Note 1)	f(X_{IN})=4MHz High-speed mode	4.5		5.5	V
		f(X_{IN})=4MHz Normal mode or f(X_{IN})=2MHz High-speed mode (Note 2)	2.5 (Note 3)		5.5	
V_{SS}	Supply voltage			0		V
V_{IH}	"H" input voltage $P0_0$∼$P0_7$, $P3_0$, $P3_1$, $P4_0$∼$P4_7$, X_{IN}, CNV_{SS} (Note 4)		0.7V_{CC}		V_{CC}	V
V_{IH}	"H" input voltage $P2_0$∼$P2_7$, $P7_0$∼$P7_7$		0.8V_{CC}		V_{CC}	V
V_{IH}	"H" input voltage $P1_0$∼$P1_7$, $P5_1$∼$P5_7$, $P6_0$∼$P6_7$, S_{IN}		0.7V_{CC}		10	V
V_{IH}	"H" input voltage $P5_0$, INT_1, INT_2, INT_3, $P3_2$∼$P3_7$, CNT_1, CNT_2, SIG, CLK		0.8V_{CC}		10	V
V_{IH}	"H" input voltage $\overline{RESET}$, X_{CIN}		0.85V_{CC}		10	V
V_{IL}	"L" input voltage $P0_0$∼$P0_7$, $P1_0$∼$P1_7$, $P3_0$∼$P3_7$, $P4_0$∼$P4_7$, $P5_1$∼$P5_7$, $P6_0$∼$P6_7$, S_{IN}		0		0.3V_{CC}	V
V_{IL}	"L" input voltage $P2_0$∼$P2_7$, $P5_0$, $P7_0$∼$P7_7$, INT_1, INT_2, INT_3, CNT_1, CNT_2, SIG, CLK		0		0.2V_{CC}	V
V_{IL}	"L" input voltage $\overline{RESET}$, X_{IN}, X_{CIN}		0		0.15V_{CC}	V
I_{OH}	"H" output current $P0_0$∼$P0_7$, $P2_0$∼$P2_7$, $P7_0$∼$P7_7$, X_{OUT} (Note 5)				−1	mA
I_{OL}	"L" output current $P0_0$∼$P0_7$, $P2_0$∼$P2_7$, $P3_0$∼$P3_7$, $P5_0$∼$P5_7$, $P6_0$∼$P6_7$, $P7_0$∼$P7_7$, X_{OUT}, PWM0∼PWM3, T, S_{OUT}, CLK, $\overline{S_{RDY}}$, SIG (Note 6)				1	mA
I_{OL}	"L" output current $P1_0$∼$P1_7$ (Note 7)	V_{CC}=5V			10	mA
f(X_{IN})	Clock oscillating frequency		0.2		4	MHz
f(X_{CIN})	Clock oscillating frequency for clock function		30		50	kHz

Note 1 : When only maintaining the RAM data, minimum value of V_{CC} is 2V
2 : We say the high-speed mode, when the system clock is chosen X_{IN}/4, and the normal mode, when the system clock is chosen X_{IN}/16
3 : In case M37413E6HFS, 4.5V
4 : When P3 is X_{CIN} mode, the limits of V_{IH} of $P3_1$ is $0.85V_{CC} \leqq V_{IH} \leqq V_{CC}$, $0 \leqq V_{IL} \leqq 0.15V_{CC}$
5 : Total of $I_{OH(peak)}$ of ports P0, P2, P7 and X_{OUT} is less than 35mA.
6 : Total of $I_{OL(peak)}$ of ports P0, P2, P3, P5, P6 and P7 is less than 32mA
7 : Total of $I_{OL(peak)}$ of port P1 is less than 80mA
Total of $I_{OL(avg)}$ of port P1 is less than 40mA.

ELECTRICAL CHARACTERISTICS (T_a=−10~70℃, V_{SS}=0V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{OH}	"H" output voltage $P0_0$~$P0_7$, $P2_0$~$P2_7$, $P7_0$~$P7_7$	V_{CC}=5V, I_{OH}=−0.5mA	4			V
V_{OH}	"H" output voltage X_{OUT}	V_{CC}=5V, I_{OH}=−0.3mA	4			V
V_{OL}	"L" output voltage $P0_0$~$P0_7$, $P2_0$~$P2_7$, $P3_0$~$P3_7$, $P5_0$~$P5_7$, $P6_0$~$P6_7$, $P7_0$~$P7_7$, T, S_{OUT}, CLK, $\overline{S_{RDY}}$, SIG, PWM0~PWM3	V_{CC}=5V, I_{OL}=1mA			1	V
V_{OL}	"L" output voltage $P1_0$~$P1_7$	V_{CC}=5V, I_{OL}=20mA			2	V
V_{OL}	"L" output voltage X_{OUT}	V_{CC}=5V, I_{OL}=0.3mA			1	V
$V_{T+}-V_{T-}$	Hysteresis INT_1, INT_2, INT_3, CLK, CNT_1, CNT_2, SIG, S_{IN}, $P2_0$~$P2_7$, $P7_0$~$P7_7$, X_{CIN}	V_{CC}=5V		0.7		V
$V_{T+}-V_{T-}$	Hysteresis $\overline{RESET}$	V_{CC}=5V		2		V
$V_{T+}-V_{T-}$	Hysteresis X_{IN}	V_{CC}=5V		0.5		V
I_{IL}	"L" input current {$P0_0$~$P0_7$, $P1_0$~$P1_7$, $P2_0$~$P2_7$, $P3_0$~$P3_7$, $P4_0$~$P4_3$, $P5_0$~$P5_7$, $P6_0$~$P6_7$, $P7_0$~$P7_7$} Without pull-up T_f (Note 1) IN_0~IN_7, INT_1, $\overline{RESET}$, X_{IN}	V_{CC}=5V, V_I=0V			−5	μA
I_{IH}	"H" input current $P0_0$~$P0_7$, $P2_0$~$P2_7$, $P3_0$, $P3_1$, $P4_0$~$P4_7$, $P7_0$~$P7_7$, IN_0~IN_7, X_{IN}, X_{CIN}, CNV_{SS}	V_{CC}=5V, V_I=5V			5	μA
I_{IH}	"H" input current {$P1_0$~$P1_7$, $P3_0$~$P3_7$, $P5_0$~$P5_7$, $P6_0$~$P6_7$} Without pull-up T_f INT_1, INT_2, INT_3, CNT_1, CNT_2, SIG, $\overline{RESET}$, S_{IN}, CLK	V_I=10V			10	μA
I_{CC}	Supply current — at operation	f(X_{IN})=4MHz High-speed mode V_{CC}=5V		3	8	mA
		f(X_{CIN})=32kHz, V_{CC}=3V		30	60	μA
	at wait state	f(X_{CIN})=32kHz, V_{CC}=5V		15	30	
	at stop state	V_{CC}=5V, all clock stop | T_a=25℃		0.1	1.0	
V_{RAM}	RAM retention voltage		2		5.5	V

Note 1 : Also the same as when each pin is used as INT_2, INT_3, CNT1, CNT2, SIG, S_{IN} and X_{IN}, respectively

A-D CONVERTER CHARACTERISTICS (V_{CC}=AV_{CC}=5V, V_{SS}=AV_{SS}=0V, T_a=25℃, f(X_{IN})=4MHz, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
——	Resolution				8	bits
——	Non-linearity error	V_{CC}=V_{REF}=5.12V			±2	LSB
——	Differential non-linearity	V_{CC}=V_{REF}=5.12V			±0.9	LSB
V_{OT}	Zero transition error	V_{CC}=V_{REF}=5.12V			2	LSB
V_{FST}	Full-scale transition error	V_{CC}=V_{REF}=5.12V			8	LSB
T_C	Conversion time	V_{CC}=5V High-speed mode		25		μs
I_{REF}	Reference input current	V_{REF}=5V		1.0	2.5	mA
I_{IN}	Analog port input current	V_{IN}=0~V_{CC}		1	10	μA
V_{IN}	Analog input voltage	V_{CC}=5V	AV_{SS}		V_{CC}	V
V_{REF}	Reference input voltage		2.5		V_{CC}	V