

CMOS 8-Bit Microcontroller

TMP87PS38N / F

The 87PS38 is a One-Time PROM microcontroller with low-power 541K bits (a 60 Kbytes program memory and a 256 characters OSD font memory) electrically programmable read only memory for the 87CM38/P38/S38 system evaluation. The 87PS38 is pin compatible with the 87CM38/P38/S38. The operations possible with the 87CM38/P38/S38 can be performed by writing programs and OSD font data to PROM (The TMP87PS38's functions are different from the TMP87CH38/K38's in a few functions. Refer to section 1.3 about details.). The 87PS38 can write and verify in the same way as the TC571000 using an adaptor socket (BM11112 or BM11136) and an EPROM programmer.

Part No.	OTP	RAM	Package	Adaptor Socket
TMP87PS38N	60 Kbytes + 14 × 18 × 256 bits	2 Kbytes	P-SDIP42-600-1.78	BM11112
TMP87PS38F			P-QFP44-1414-0.80D	BM11136

030619EBP1

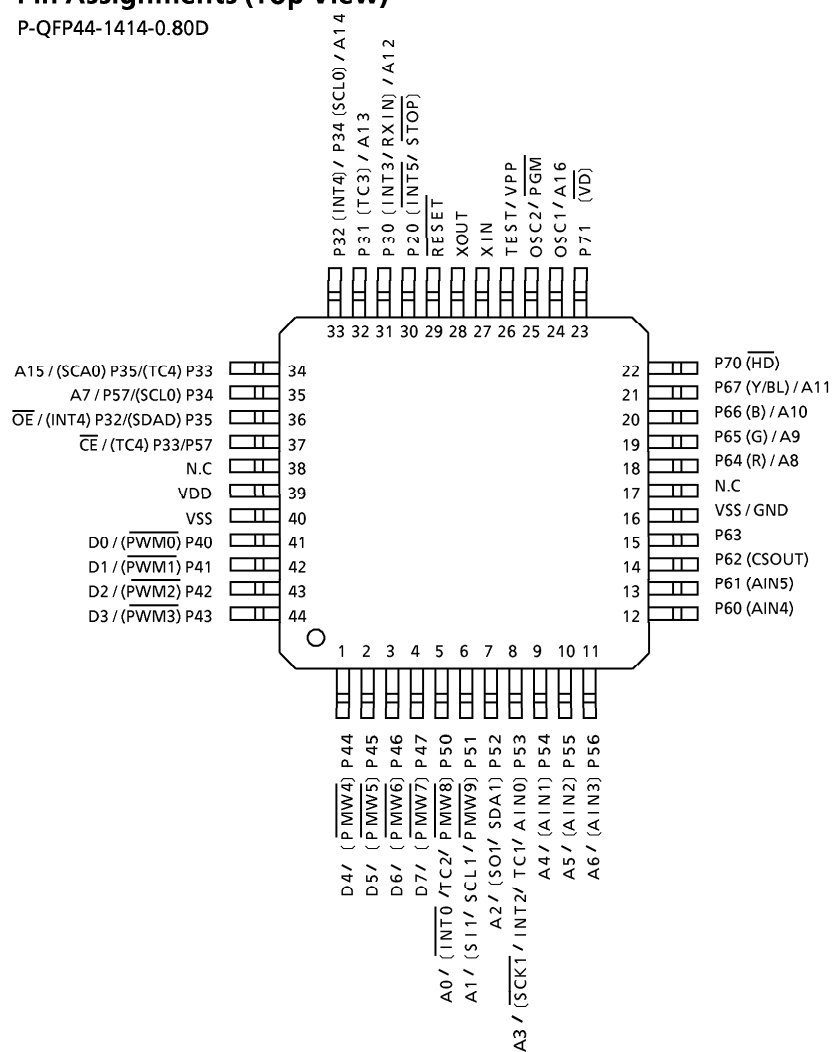
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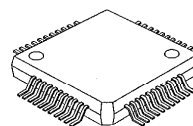
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Pin Assignments (Top View)

P-QFP44-1414-0.80D



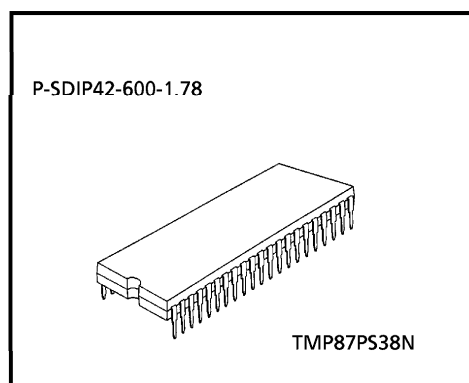
P-QFP44-1414-0.80D



TMP87PS38F

Pin Assignments (Top View)

P-SDIP42-600-1.78



[GND]	VSS	1	42	VDD	[VCC]
[D0]	(PWM0) P40	2	41	P57 / P33 (TC4)	[CE]
[D1]	(PWM1) P41	3	40	P35 (SDA0) / P32 (INT4)	[OE]
[D2]	(PWM2) P42	4	39	P34 (SCL0) / P57	[A7]
[D3]	(PWM3) P43	5	38	P33 (TC4) / P35 (SDA0)	[A15]
[D4]	(PWM4) P44	6	37	P32 (INT4) / P34 (SCL0)	[A14]
[D5]	(PWM5) P45	7	36	P31 (TC3)	[A13]
[D6]	(PWM6) P46	8	35	P30 (INT3 / RXIN)	[A12]
[D7]	(PWM7) P47	9	34	P20 (INT5 / STOP)	
[A0]	(INT0 / TC2 / PWM8) P50	10	33	RESET	
[A1]	(SI1 / SCL1 / PWM9) P51	11	32	XOUT	
[A2]	(SO1 / SDA1) P52	12	31	XIN	
[A3]	(SCK1 / INT2 / TC1 / AIN0) P53	13	30	TEST	[VPP]
[A4]	(AIN1) P54	14	29	OSC2	[PGM]
[A5]	(AIN2) P55	15	28	OSC1	[A16]
[A6]	(AIN3) P56	16	27	P71 (VD)	
	(AIN4) P60	17	26	P70 (HD)	
	(AIN5) P61	18	25	P67 (Y / BL)	[A11]
	(CSOUT) P62	19	24	P66 (B)	[A10]
	P63	20	23	P65 (G)	[A9]
[GND]	VSS	21	22	P64 (R)	[A8]

Pin Function

The 87PS38 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PS38 is pin compatible with the 87CM38/P38/S38 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A16	Input	PROM address inputs	OSC1
A15 to A12			P33 to P30
A11 to A8			P67 to P64
A7 to A0			P34, P56 to P50
D7 to D0	I/O	PROM data input/outputs	P47 to P40
$\overline{\text{CE}}$	Input	Chip enable signal input (active low)	P57
$\overline{\text{OE}}$		Output enable signal input (active low)	P35
$\overline{\text{PGM}}$	Input	Program mode signal input (active low)	OSC2
VPP	Power supply	+ 12.75 V / 5 V (Program supply voltage)	TEST
VCC		+ 6.25 V / 5 V	VDD
GND		0 V	VSS
P61	I/O	PROM mode setting pin. Be fixed at high level.	
P70			
P20		PROM mode setting pin. Be fixed at low level.	
P63, P62, P60			
P71			
$\overline{\text{RESET}}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		

Operational Description

The following explains the 87PS38 hardware configuration and operation. The configuration and functions of the 87PS38 are the same as those of the 87CM38/P38/S38, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. Operating Mode

The 87PS38 has two modes: MCU and PROM.

1.1 MCU Mode

The MCU mode is activated by fixing the TEST / VPP pin at low level.

In the MCU mode, operation is the same as with the 87CM38/P38/S38. (The TMP87PS38's functions are different from the TMP87CH38/K38's in a few functions. Refer to section 1.3 about details.)

Note: The TEST / VPP pin cannot be used open because it has no built-in pull-down resistance.

1.1.1 Program memory and OSD character font memory

The 87PS38 has a 60 Kbytes (addresses 1100_H to FFFF_H in the MCU mode, address 11100_H to 1FFFF_H in the PROM mode) of program memory and a 14 × 18 × 256 bits (addresses 4000_H to 7FFF_H in the PROM mode) of OSD character font memory.

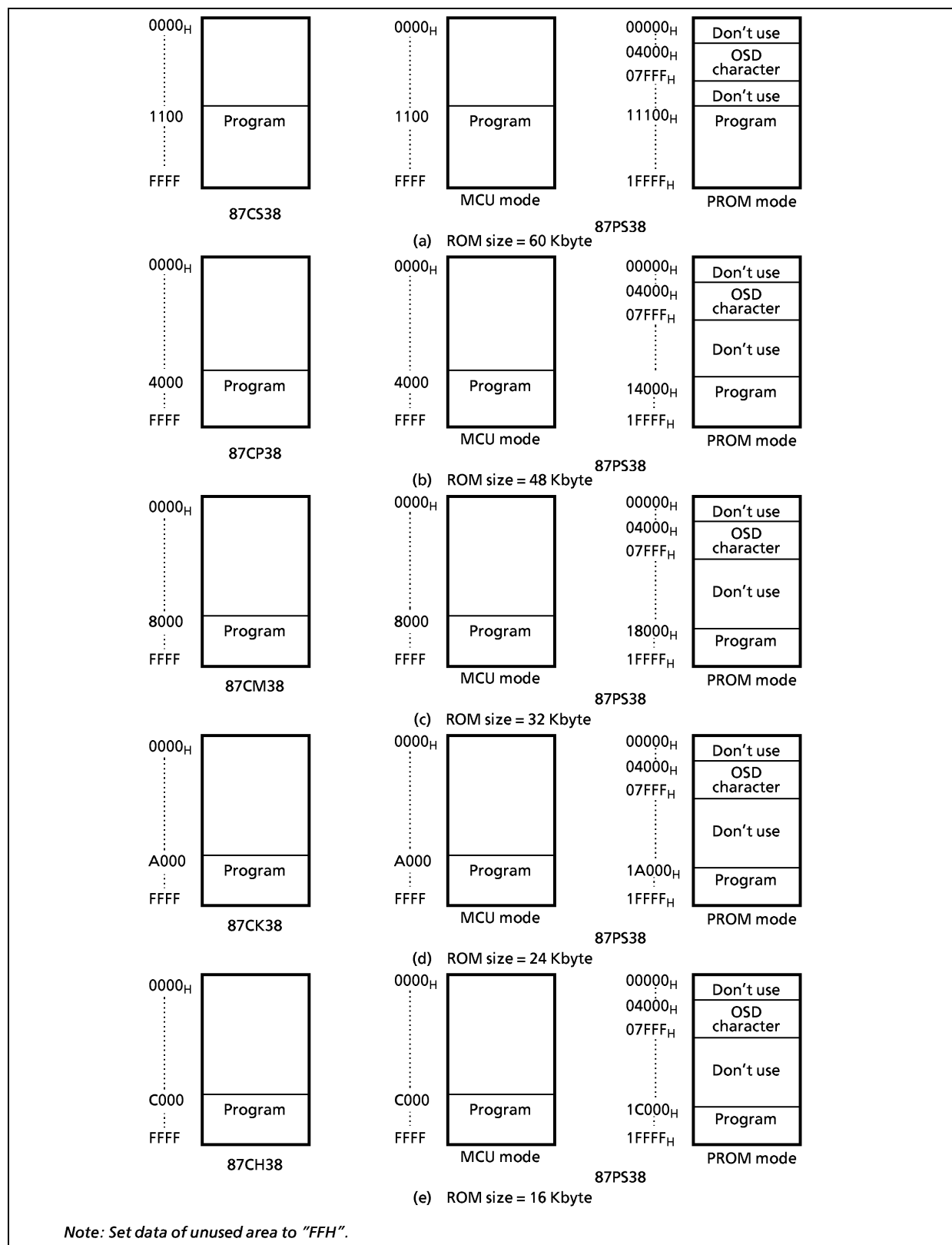


Figure 1-1. Program memory area

1.1.2 Data memory

The 87PS38 has an on-chip 2 Kbytes data memory (static RAM).

1.1.3 Input / output circuitry

(1) Control pins

The control pins of the 87PS38 are the same as those of the 87CS38 except that the TEST pin has no built-in pull-down resistance.

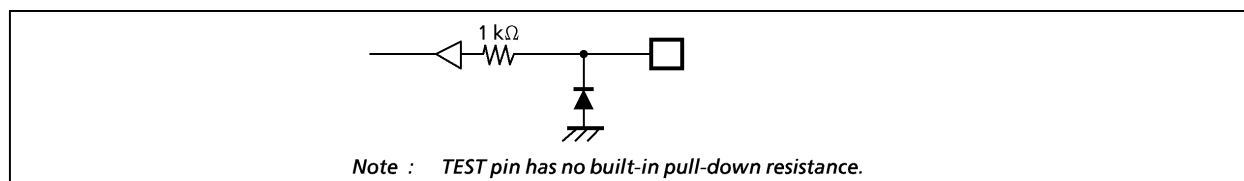


Figure 1-2. TEST pin

(2) I/O ports

The I/O circuitries of 87PS38 are the same as those of the 87CS38.

1.2 PROM Mode

The PROM mode is activated by setting the $\overline{\text{RESET}}$ pin and the ports P71 to P70, P63 to P60 and P20 as shown in Figure 1-2. The PROM mode is used to write and verify programs with a general-purpose PROM programmer. The high-speed programming mode can be used for program operation.

The 87PS38 is not supported an *electric signature mode*, so the ROM type must be set to TC571000.

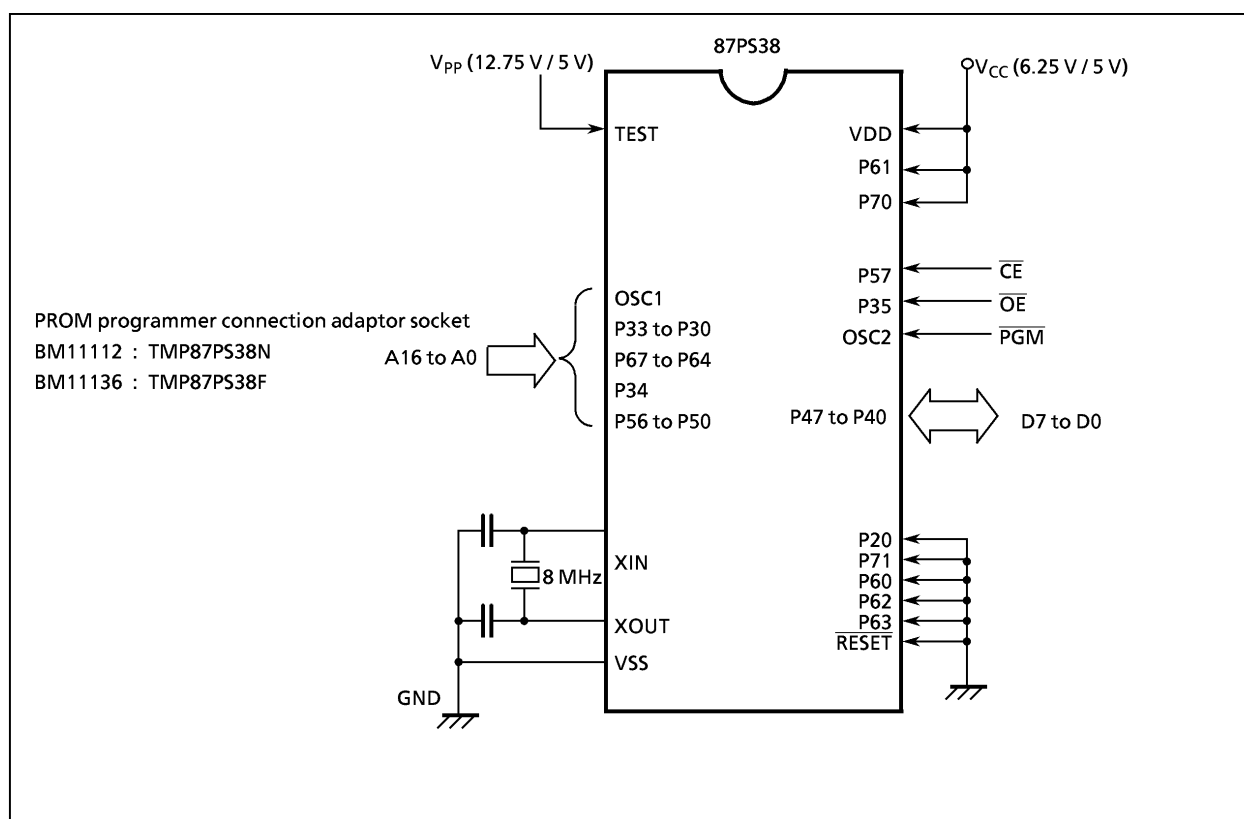


Figure 1-3. Setting for PROM mode

1.2.1 Programming flowchart (High-speed programming mode)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the VPP pin when $V_{CC} = 6.25$ V. After the address and input data are stable, the data is programmed by applying a single 0.1ms program pulse to the $\overline{PGM}$ input. The programmed data is verified. If incorrect, another 0.1ms program pulse is applied. This process should be repeated (up to 25 times) until the program operates correctly. After that, change the address and input data, and program as before. When programming has been completed, the data in all addresses should be verified with $V_{CC} = V_{PP} = 5$ V.

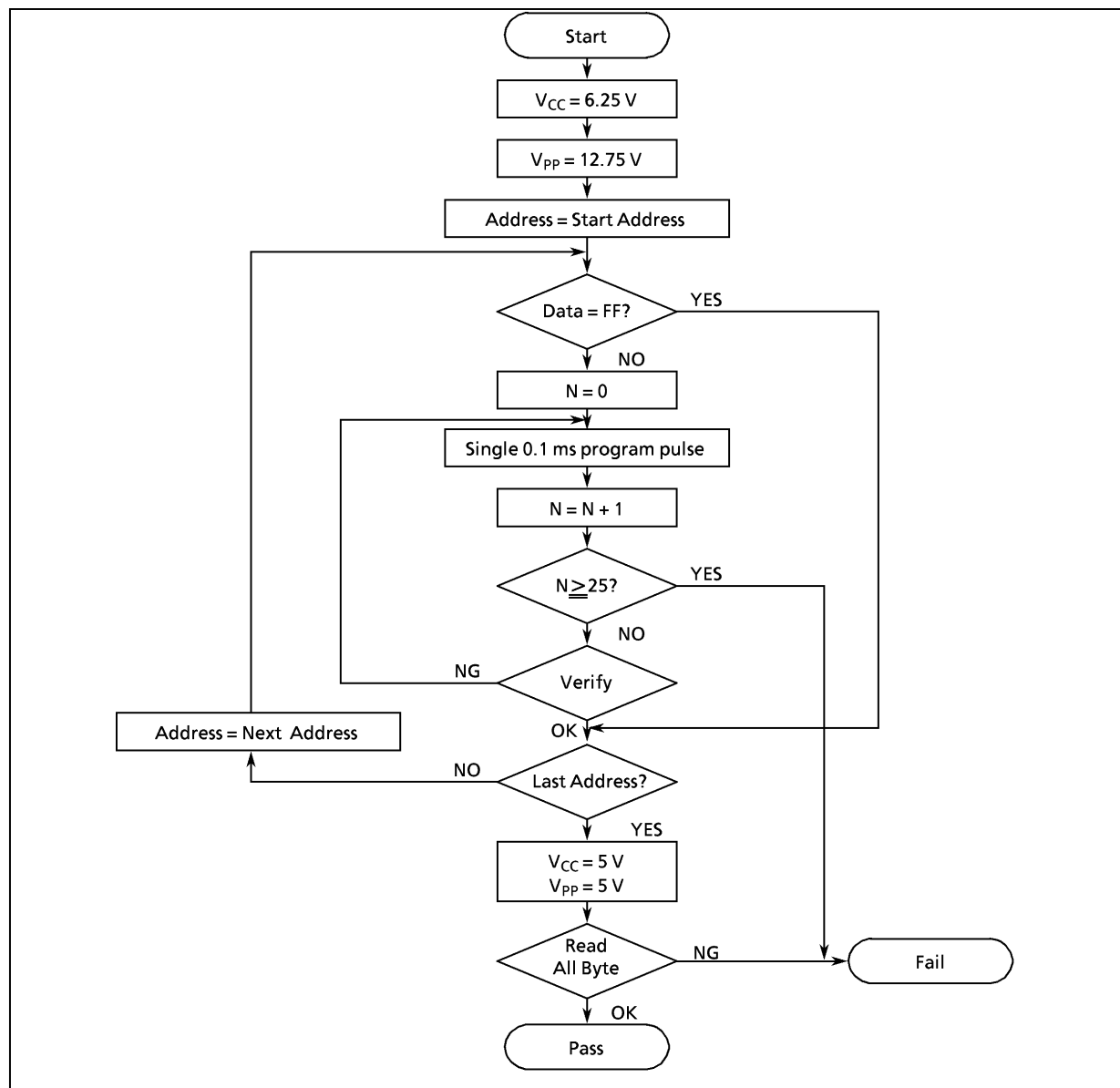


Figure 1-4. Flow chart of high-speed programming

1.2.2 Writing method for general-purpose PROM program

(1) Adapters

BM11112 : TMP87PS38N

BM11136 : TMP87PS38F (Under development)

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC571000D.

Writing voltage: 12.75 V (high-speed program mode)

ii) Data transfer (copy) (note 1)

In the TMP87PS38, EPROM is within the addresses 04000_H to 07FFF_H and 11100_H to 1FFFF_H. Data is required to be transferred (copied) to the addresses where it is possible to write. The program area in MCU mode and PROM mode is referred to "Program memory area" in Figure 1-1.

iii) Writing address is specified. (note 1)

Start address : 04000_H

End address : 1FFFF_H

(4) Writing

Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

Note 1 : The specifying method is referred to the PROM programmer description. Either write the data FF_H to the unused area or set the PROM programmer to access only the program storage area.

Note 2 : When MCU is set to an adapter or the adapter is set to PROM programmer, a position of pin 1 must be adjusted. If the setting is reversed, MCU, the adapter and PROM program is damaged.

Note 3 : The TMP87PS38 does not support the electric signature mode (hereinafter referred to as "signature"). If the signature is used in PROM program, a device is damaged due to applying 12 V $\pm$ 0.5 V to the address pin 9 (A9). The signature must not be used.

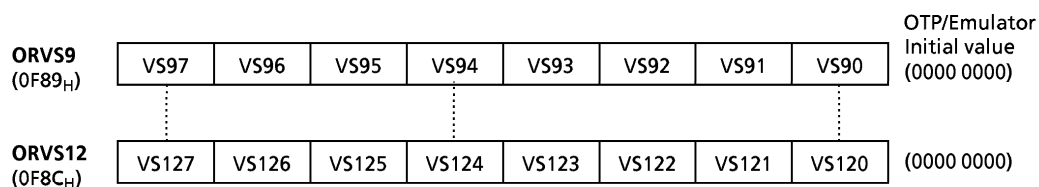
1.3 Notice When Developing a Program of TMP87CH38/K38

When developing a program of 87CH38/K38 by using an OTP (87PS38) and an emulator (BM87CS38N0A), it is necessary to take notice as follows for emulating the operation of 87CH38/K38 with them.

On-Screen-Display Circuit

- (1) Setting ORVFn (Vertical Display Start Position) of line 9 to line 12

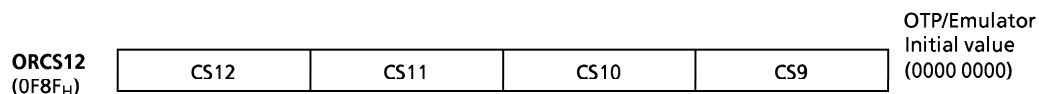
Set "FF_H" into ORVS9 to ORVF12. If these registers are set other value or have an initial value, cannot emulate the operation of 87CH38/K38 with an OTP and an emulator.



87CH38/K38 does not have ORVF9 to ORVF12. But the operation of OSD interrupt is similar with setting "FF_H" into ORVF9 to ORVF12.

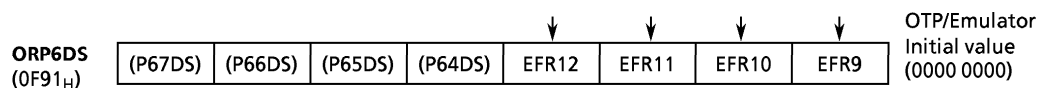
- (2) Setting CSn (Character size and display on/off) of line 9 to line 12

Set "00_H" (Initial value) into ORCS12. If these registers are set other value, cannot emulate the operation of 87CH38/K38 with an OTP and an emulator.



- (3) Setting EFRn (Fringing Specification) of line 9 to line 12

Set "0" (Initial value) into ORP6DS (EFR12 to EFR9). If these registers are set other value, cannot emulate the operation of 87CH38/K38 with an OTP and an emulator.



ROM Correction Circuit

RAM area which is used for ROM correction circuit in 87CH38/K38 can use address from 0140H to 023FH, but RAM area which is used for ROM correction circuit in OTP (87PS38) can use address from 0240H to 083FH. Therefore, when using ROM correction circuit in 87CH38/K38, load address for patch program codes and jump vector must be changed after debugging a program by OTP.

Note : Development tool does not have a ROM correction circuit.

Electrical Characteristics

Absolute maximum ratings

(V_{SS} = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V _{DD}		– 0.3 to 6.5	V
Programable Voltage	V _{PP}	TEST / VPP Pin	– 0.3 to 13.0	V
Input Voltage	V _{IN}		– 0.3 to V _{DD} + 0.3	V
Output Voltage	V _{OUT1}		– 0.3 to V _{DD} + 0.3	V
Output Current (Per 1 pin)	I _{OUT1}	Ports P2, P3, P4, P5, P64 to P67, P7	3.2	mA
	I _{OUT2}	Ports P60 to P63	30	
Output Current (Total)	Σ I _{OUT1}	Ports P2, P3, P4, P5, P64 to P67, P7	120	mA
	Σ I _{OUT2}	Ports P60 to P63	120	
Power Dissipation [Topr = 70°C]	PD		600	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

Note: The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

Recommended operating conditions

(V_{SS} = 0 V, Topr = –30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V _{DD}		NORMAL mode	4.5	5.5	V
			IDLE mode			
			STOP mode	2.0		
Input High Voltage	V _{IH1}	Except hysteresis input		V _{DD} × 0.70	V _{DD}	V
	V _{IH2}	Hysteresis input		V _{DD} × 0.75		
Input Low Voltage	V _{IL1}	Except hysteresis input		0	V _{DD} × 0.30	V
	V _{IL2}	Hysteresis input			V _{DD} × 0.25	
Clock Frequency	f _c	XIN, XOUT		4.0	8.0	MHz
	f _{OSC}	OSC1, OSC2	Normal frequency mode (FORS = 0, V _{DD} = 4.5 to 5.5 V)	4.0	f _{OSC} ≤ f _c × 1.2 ≤ 8.0	
			Double frequency mode (FORS = 1, V _{DD} = 4.5 to 5.5 V)	2.0	f _{OSC} ≤ f _c × 0.6 ≤ 4.0	

Note 1: The recommended operating conditions for a device are operating conditions under which it can be guaranteed that the device will operate as specified. If the device is used under operating conditions other than the recommended operating conditions (supply voltage, operating temperature range, specified AC/DC values etc.), malfunction may occur. Thus, when designing products which include this device, ensure that the recommended operating conditions for the device are always adhered to.

Note 2: Clock frequency f_c ; Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

Note 3: Smaller value is alternatively specified as the maximum value.

D.C. Characteristics

(V_{SS} = 0 V, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V _{HS}	Hysteresis inputs		–	0.9	–	V
Input Current	I _{IN1}	TEST	V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V	–	–	± 2	μA
	I _{IN2}	Open drain ports	V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V	–	–	± 2	
	I _{IN3}	Tri-state ports	V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V	–	–	± 2	
	I _{IN4}	RESET, STOP	V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V	–	–	± 2	
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ
Output Leakage Current	I _{LO1}	Sink open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	–	–	2	μA
	I _{LO2}	Tri-state ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V / 0 V	–	–	± 2	
Output High Voltage	V _{OH2}	Tri-state ports	V _{DD} = 4.5 V, I _{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V _{OL}	Except XOUT, OSC2 and ports P60 to P63	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	–	–	0.4	V
Output Low current	I _{OL3}	Port P60 to P63	V _{DD} = 4.5 V, V _{OL} = 1.0 V	–	20	–	mA
Supply Current in NORMAL mode	I _{DD}		V _{DD} = 5.5 V f _c = 8 MHz V _{IN} = 5.3 V / 0.2 V (Note3)	–	14	17	mA
Supply Current in IDLE mode				–	7	10	mA
Supply Current in STOP mode			V _{DD} = 5.5 V V _{IN} = 5.3 V / 0.2 V	–	0.5	10	μA

Note 1 : Typical values show those at T_{opr} = 25°C, V_{DD} = 5 V.

Note 2 : Input Current I_{IN3}; The current through resistor is not included.

Note 3 : Supply Current I_{DD}; The current (Typ. 0.5 mA) through ladder resistors of ADC is included in NORMAL mode and IDLE mode.

A/D Conversion Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 V to 5.5 V, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V _{AREF}	supplied from V _{DD} pin.	–	V _{DD}	–	V
	V _{ASS}	supplied from V _{SS} pin.	–	0	–	
Analog Reference Voltage Range	ΔV _{AREF}	= V _{DD} – V _{SS}	–	V _{DD}	–	
Analog Input Voltage	V _{AIN}		V _{SS}	–	V _{DD}	
Nonlinearity Error			–	–	± 1	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 3	

Note: The total error means all error except quanting error.

A.C. characteristics

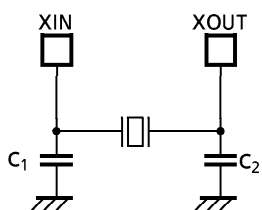
(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL mode	0.5	–	1.0	μs
		In IDLE mode				
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XIN input), f _c = 8 MHz	50	–	–	ns
Low Level Clock Pulse Width	t _{WCL}					

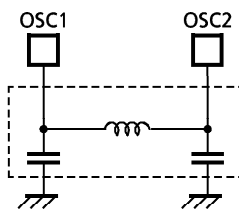
Recommended oscillating conditions

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 30 to 70°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				C ₁	C ₂
High-frequency Oscillation	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
		4 MHz	KYOCERA KBR4.0MS		
			MURATA CSA4.00MG		
	Crystal Oscillator	8 MHz	TOYOCOM 210B 8.0000	20 pF	20 pF
		4 MHz	TOYOCOM 204B 4.0000		
OSD	LC Resonator	8 MHz	TOKO A285TNIS-11695	–	–
		7 MHz	TOKO TBEKSES-30375FBY		



(1) High-frequency Oscillation



(2) LC Resonator for OSD

Note : On our OSD circuit, the horizontal display start position is determined by counting the clock from LC oscillator. So, the unstable start of oscillation after the rising edge of Horizontal Sync. Signal will be cause the OSD distortion.

Generally, smaller C and larger L make clearer wave form at the beginning of oscillation.

We recommend that the value of LC oscillator should be equal and bigger than 33μH.

Note: To keep reliable operation, shield the device electrically with the metal plate on its package mold surface against the high electric field, for example, by CRT (Cathode Ray Tube) .

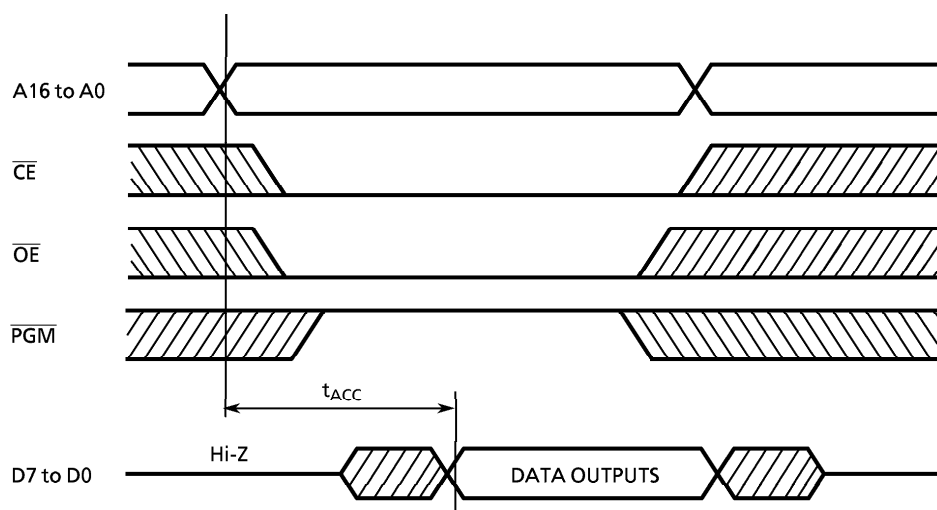
D.C./A.C. characteristics (PROM mode)

(V_{SS} = 0 V)

(1) Read operation

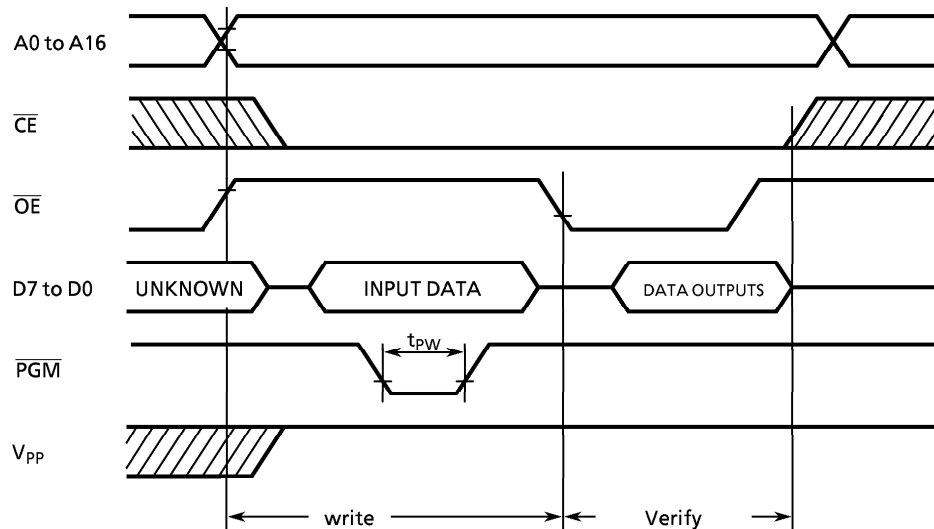
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V _{IH4}		V _{CC} × 0.7	—	V _{CC}	V
Input Low Voltage	V _{IL4}		0	—	V _{CC} × 0.12	V
Power Supply Voltage	V _{CC}		4.75	5.0	5.25	V
Program Power Supply Voltage	V _{PP}					
Address Access Time	t _{ACC}	V _{CC} = 5.0 ± 0.25 V	—	1.5tcyc + 300	—	ns

Note : tcyc = 500 ns at 8 MHz

(2) High-speed programming operation (T_{opr} = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V _{IH4}		V _{CC} × 0.7	—	V _{CC}	V
Input Low Voltage	V _{IL4}		0	—	V _{CC} × 0.12	V
Power Supply Voltage	V _{CC}		6.0	6.25	6.5	V
Program Power Supply Voltage	V _{PP}		12.5	12.75	13.0	V
Initial Program Pulse Width	t _{PW}	V _{CC} = 6.0 V	0.095	0.1	0.105	ms

High-Speed Programming Timing

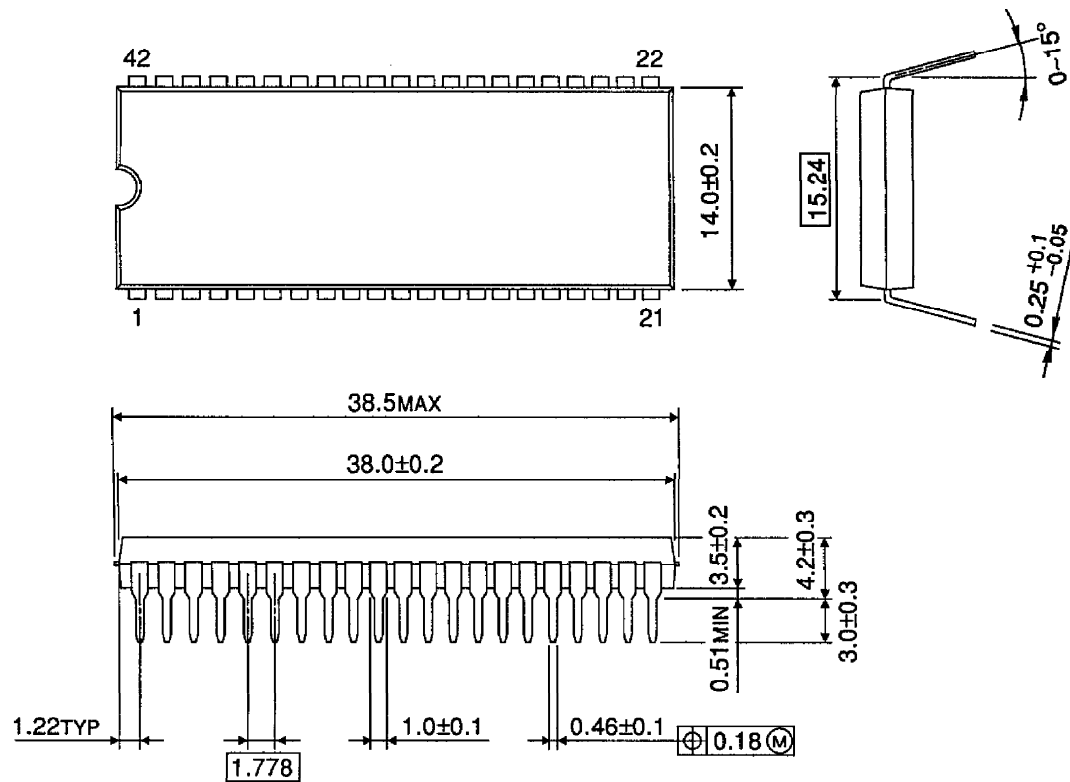


- Note1:** When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be increased.
- Note2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.75\text{ V} \pm 0.25\text{ V} = V$) to the V_{pp} pin as the device is damaged.
- Note3:** Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

Package Dimensions

P-SDIP42-600-1.78

Unit: mm



P-QFP44-1414-0.80D

Unit: mm

