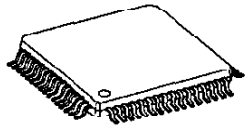
CMOS 8-Bit Microcontroller

TMP86PM29U/F

The 86PM29 is a OTP type MCU which includes 32 Kbyte One-time PROM. It is a pin compatible with a mask ROM product of the 86C420/820/829/H29/M29. Writing the program to built-in PROM, the 86PM29 operates as the same way as the 86C420/820/829/H29/M29. About elaboration, please refer to later "Difference between TMP86Cx20 and TMP86Cx29". Using the Adapter socket, you can write and verify the data for the 86PM29 with a general-purpose PROM programmer same as TC57100D/AD.

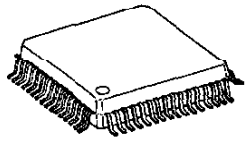
Part No.	OTP	RAM	Package	Adapter Socket
TMP86PM29U	32 K×8 bit	1.5 K×8 bit	P-LQFP64-1010-0.50	BM11162
TMP86PM29F			P-QFP64-1414-0.80A	BM11163

P-LQFP64-1010-0.50



TMP86PM29U

P-QFP64-1414-0.80A



TMP86PM29F

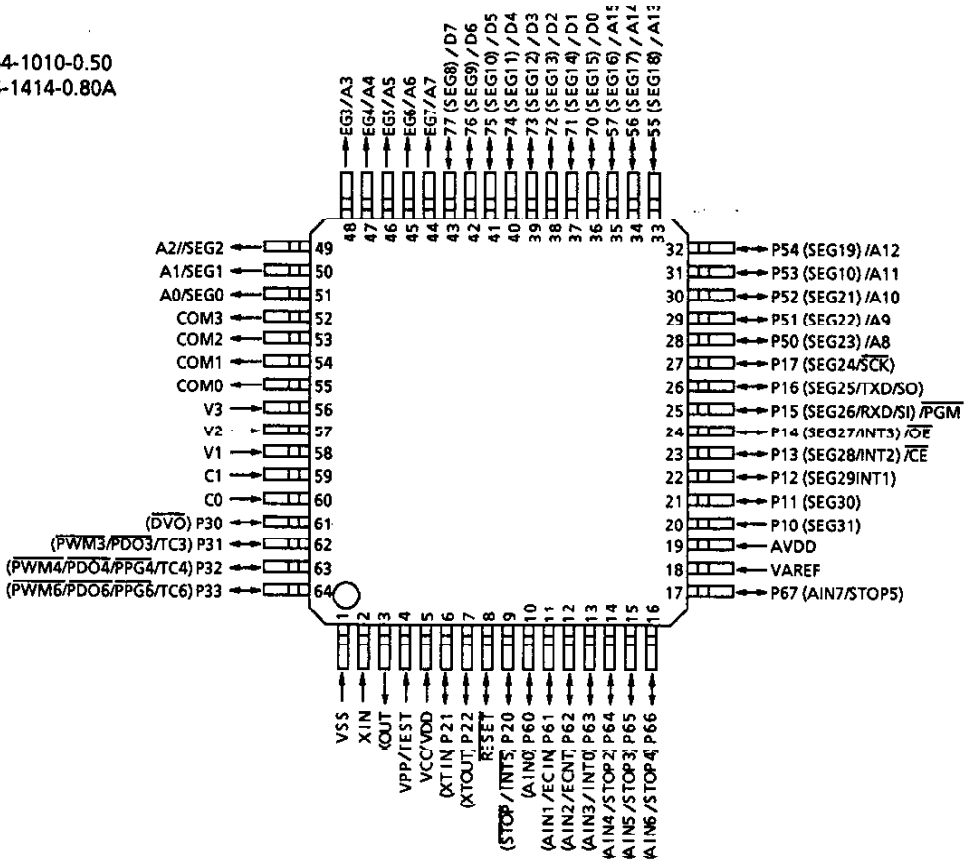
Difference Between TMP86Cx20 and TMP86Cx29

	TMP86Cx29U/F			TMP86Cx20U/F	
	TMP86C829U/F	TMP86CH29U/F	TMP86CM29U/F	TMP86C420U/F	TMP86C820U/F
ROM (byte)	8K	16K	32K	4K	8K
RAM (byte)	512	1.5K	1.5K	256	256
I/O	39			39	
Package (Body size)	LQFP64 (10 × 10 mm), QFP64 (14 × 14 mm)			LOFP64 (10 × 10 mm), QFP64 (14 × 14 mm)	
Min Instruction	0.25 μs (at 16 MHz) 122 μs (at 32.768 kHz)			0.25 μs (at 16 MHz) 122 μs (at 32.768 kHz)	
Supply Voltage	1.8 to 5.5 V at 4.2 MHz / 32.768 kHz 2.7 to 5.5 V at 8.0 MHz / 32.768 kHz 4.5 to 5.5 V at 16 MHz / 32.768 kHz			1.8 to 5.5 V at 4.2 MHz / 32.768 kHz 2.7 to 5.5 V at 8.0 MHz / 32.768 kHz 4.5 to 5.5 V at 16 MHz / 32.768 kHz	
18 bit timer counter	1 ch			1 ch	
8 bit timer counter	4 ch			2 ch	
Time base timer	1 ch			1 ch	
Watch dog timer	1 ch			1 ch	
A/D	10 bit × 8 ch			8 bit × 8 ch	
Serial I/O	1 ch (UART software selectable)			1 ch (Synchronous only)	
Operation Temp.	– 40 to 85 degree C			– 40 to 85 degree C	
LCD Driver	32 seg × 4 com			32 seg × 4 com	
OTP MCU	TMP86PM29U/F			TMP86PM29U/F	

is difference point between TMP86Cx20 and TMP86Cx29.

Pin Assignments (Top View)

P-LQFP64-1010-0.50
P-QFP64-1414-0.80A



Pin Function

The 86PM29 has MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the 86PM29 is a pin compatible with the 86C420/820/829/H29/M29 (Make sure to fix the TEST pin to low level).

(2) PROM mode

Pin Name	Input / Output	Functions	Pin Name (MCU mode)
A15 to A8	Input	Input of Memory address for program	P57 to P50
A7 to A0			SEG7 to SEG0
D7 to D0	I/O	Input/Output of Memory data for program	P77 to P70
$\overline{CE}$	Input	Chip enable	P13
$\overline{OE}$		Output enable	P14
$\overline{PGM}$		Program control	P15
VPP	Power supply	+ 12.75 V / 5 V (Power supply of program)	TEST
VCC, AVDD		+ 6.25 V / 5 V	VDD, AVDD
GND, VAREF		0 V	VSS, VAREF
P11, P21	I/O	PROM mode setting pin. Fix to high.	
P10, P22, P20		PROM mode setting pin. Fix to low.	
$\overline{RESET}$			
P64, P65, P67	Output	Output pin for PROM operation test. Open or release.	
P17, P16, P12	I/O	Open	
P66, P63 to P60			
P33 to P30			
COM3 to COM0			
V3 to V1			
C1, C0			
XIN	Input	Self oscillation with resonator (8 MHz).	
XOUT	Output		

Note: No pin is applied to A16 input.

Operation

This section describes the functions and basic operational blocks of 86PM29.
The 86PM29 has PROM in place of the mask ROM which is included in the 86C420/820/829/H29/M29. The configuration and function are the same as the 86C420/820/829/H29/M29. For the functions of 86PM29 in details, see the section of 86C420/820/829/H29/M29.
In addition, 86PM29 operates as the single clock mode when releasing reset.
When using the dual clock mode, oscillate a low-frequency clock by SET. XTEN command at the beginning of program.

1. Operating Mode

The 86PM29 has MCU mode and PROM mode.

1.1 MCU Mode

The MCU mode is set by fixing the TEST/VPP pin to the low level.
In the MCU mode, the operation is the same as the 86C420/820/829/H29/M29 (TEST/VPP pin cannot be used open because it has no built-in pull-down resister).

1.1.1 Program Memory

The 86PM29 has a 32 Kbyte built-in one time PROM (addresses 8000 to $FFFF_H$ in the MCU mode, addresses 0000 to $7FFF_H$ in the PROM mode).
When using 86PM29 for evaluation of 86C420/820/829/H29/M29, the program is written in the program storing area shown in Fig. 1-1.

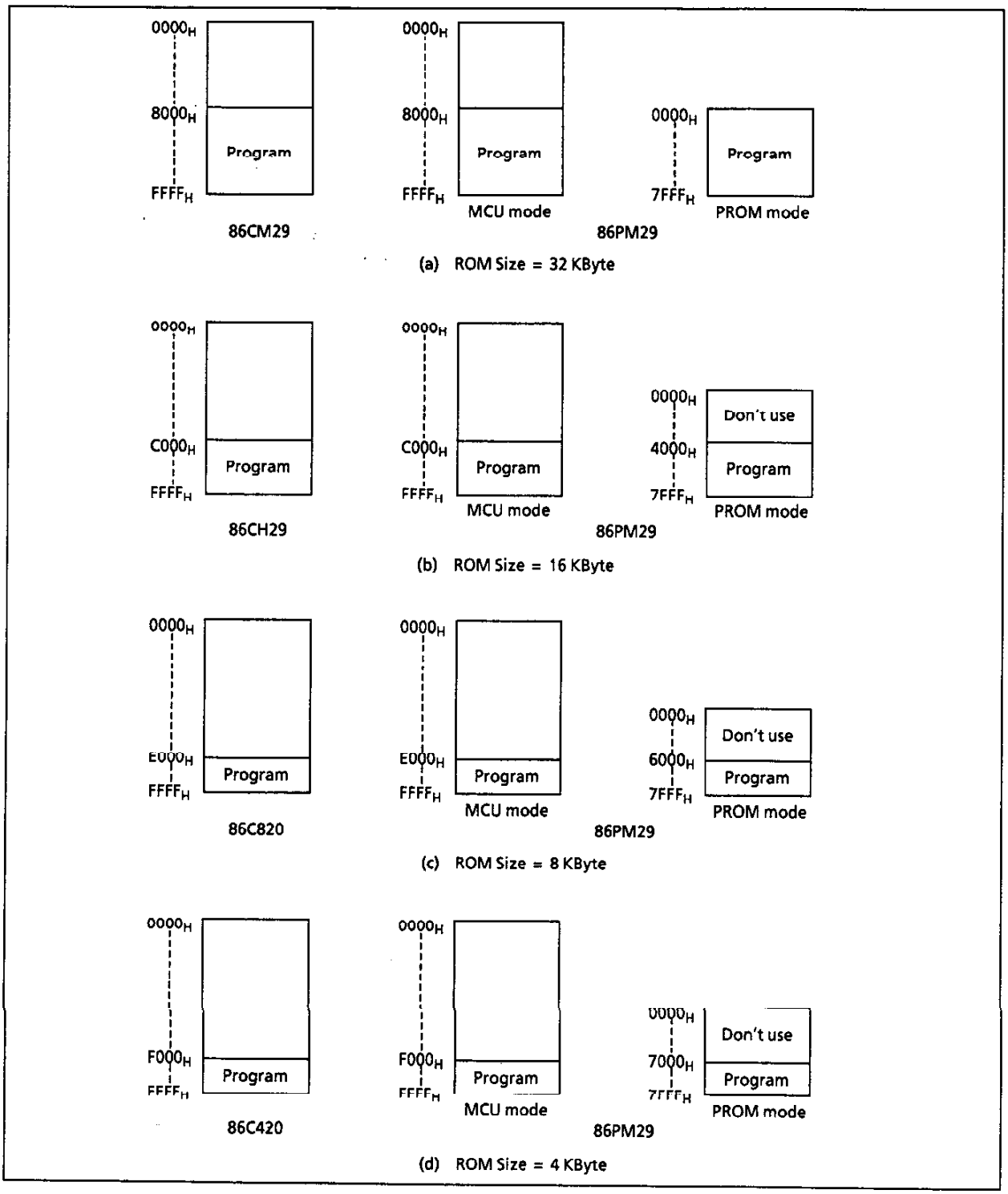


Figure 1-1. Program Memory Area

Note: The area that is not in use should be set data to FFH, or a general-purpose PROM programmer should be set only in the program memory area to access.

1.1.2 Data Memory

86PM29 has a built-in 1.5 Kyte Data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 86PM29 are the same as those of the 86C420/820/829/H29/M29 except that the TEST pin does not have a built-in pull-down resister.

(2) I/O ports

The I/O circuitries of 86PM29 I/O ports are the same as the those of 86C420/820/829/H29/M29.

1.2 PROM Mode

The PROM mode is set by setting the $\overline{\text{RESET}}$ pin, the ports P17 to P10, P22 to P20 and $\overline{\text{TEST}}$ as shown in Figure 1-2. The programming and verification for the internal PROM is achieved by using a general-purpose PROM programmer with the adapter socket.

Note: The high-speed program mode can be used. The setting is different according to the type of PROM programmer to use, refer to each description of PROM programmer.
The 86PM29 does not support the electric signature mode, apply the ROM type of PROM programmer to TC571000D/AD.

Always set the switch of Adapter socket to the N side when using TOSHIBA's Adapter socket.

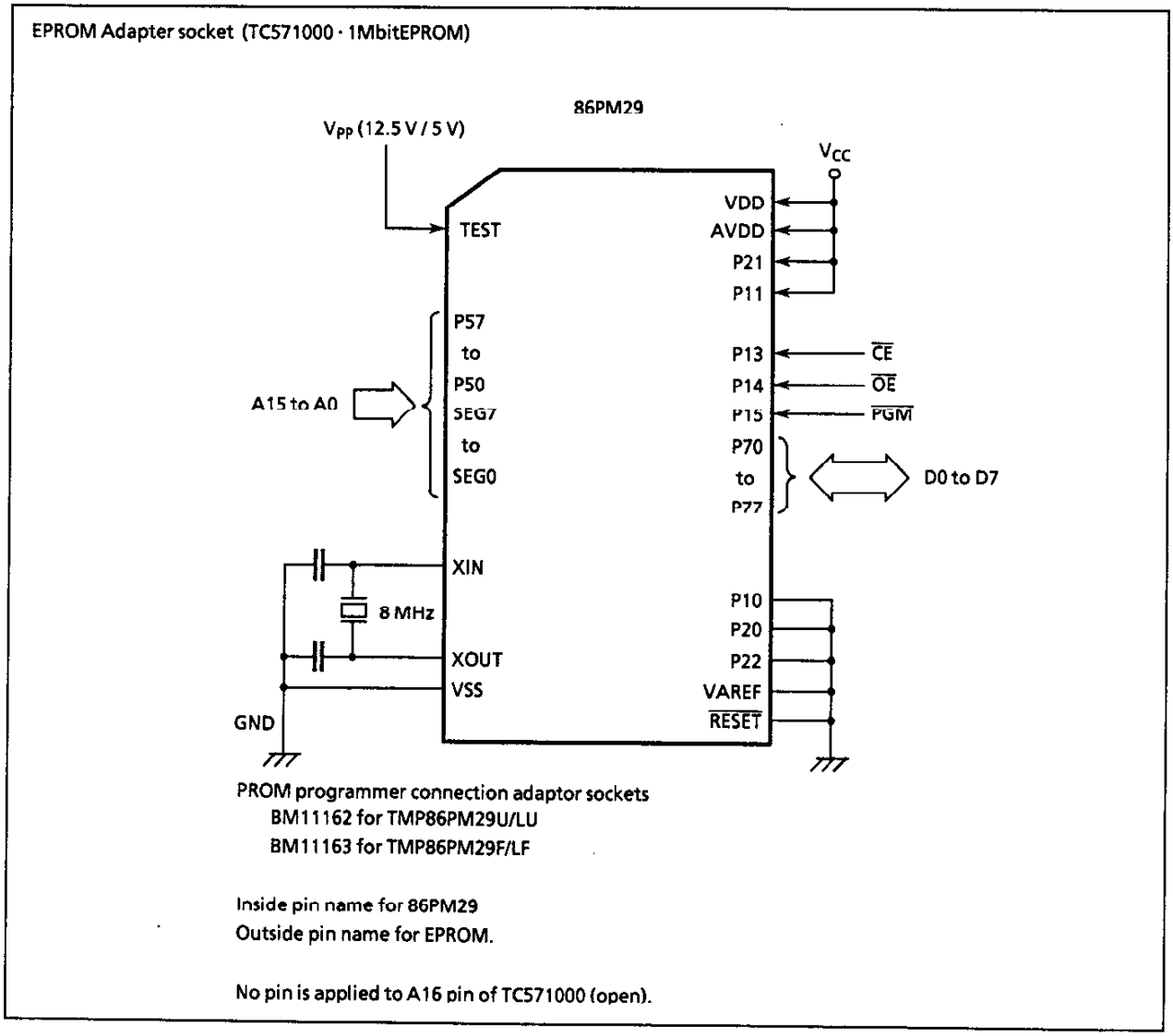


Figure 1-2. PROM Mode Setting

1.2.1 Programming Flowchart (High-speed Program Writing)

The high-speed programming mode is set by applying 12.75 V (programming voltage) to the V_{PP} pin when the V_{CC} is 6.25 V. After the address and data are fixed, the data in the address is written by applying 0.1ms of low level program pulse to $\overline{PGM}$ pin. Then verify if the data is written.
If the programmed data is incorrect, another 0.1 ms pulse is applied to $\overline{PGM}$ pin.
This programming procedure is repeated until correct data is read from the address (maximum of 25 times).
Subsequently, all data are programmed in all addresses.
When all data were written, verify all address under the condition of $V_{CC} = V_{PP} = 5$ V.

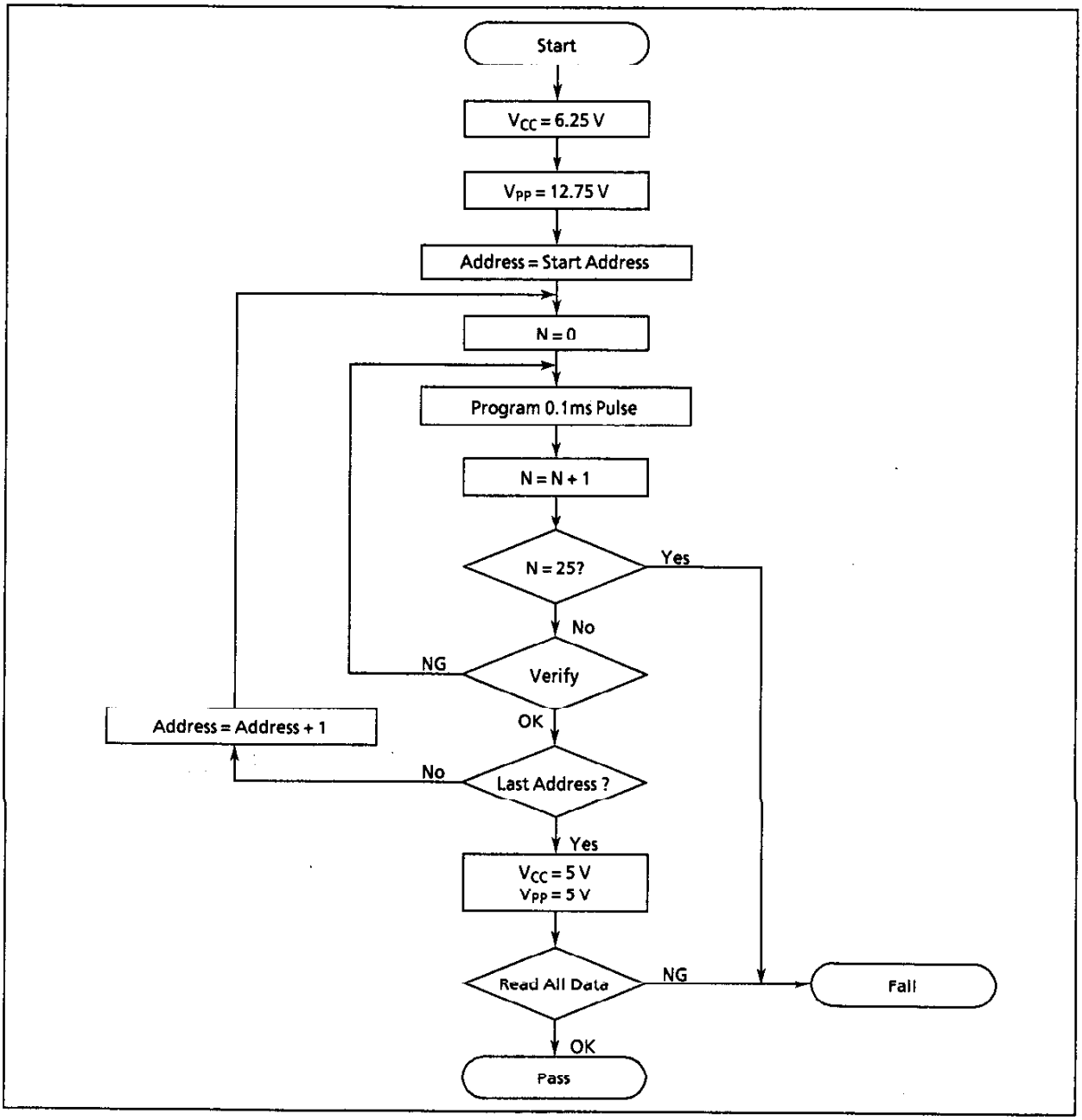


Figure 1-3. Programming Flow Chart

1.2.2 Program Writing using a general-purpose PROM programmer

(1) Recommended OTP Adapter

BM11162: for 86PM29U
BM11163: for 86PM29F

(2) Setting of OTP Adapter

Set the switch (SW1) to N side.

(3) Setting of PROM programmer

i) Set PROM type to TC571000D/AD.
VPP: 12.75 V (high-speed program writing)

ii) Data transmission (Note 1)

The PROM of 86PM29 is located on different addresses; it depends on operating modes: MCU mode and PROM mode. When you write the data of ROM for 86C420/820/829/H29/M29, the data should be transferred from the address for MCU mode to that for PROM mode before writing operation is executed. For the applicable program areas of MCU mode and PROM mode are different, refer to Figure 1-1 Program Memory Area.

Ex. In the block transfer (copy) mode, executed as below.
ROM capacity of 32 KB: Transferred address 8000_H to $FFFF_H$ to addresses 0000_H to $7FFF_H$
ROM capacity of 16 KB: Transferred address $C000_H$ to $FFFF_H$ to addresses 4000_H to $7FFF_H$
ROM capacity of 8 KB: Transferred address $E000_H$ to $FFFF_H$ to addresses 6000_H to $7FFF_H$
ROM capacity of 4 KB: Transferred address $F000_H$ to $FFFF_H$ to addresses 7000_H to $7FFF_H$

iii) Setting of the program address (Note 1)

Start address: 00000_H (When ROM capacity of 16 KB, start address is 4000_H. When ROM capacity of 8 KB, start address is 6000_H.)
End address: $07FFF_H$

(4) Writing program

Write and verify according to the above mentioned "Setting of PROM programmer."

Note 1: For the setting method, refer to each description of PROM programmer.
Make sure to set the data of address area that is not in used to FF_H.
Note 2: When setting MCU to the adapter or when setting the adapter to the PROM programmer, set the first pin of the adapter and that of PROM programmer socket matched. If the first pin is conversely set, MCU or adapter or programmer would be damaged.
Note 3: The 86PM29 does not support the electric signature mode.
If PROM programmer uses the signature, the device would be damaged because of applying voltage of 12 ± 0.5 V to pin 9 (A9) of the address.
Do not use the signature.

Electrical Characteristics

Absolute Maximum Ratings (V_{SS} = 0 V)

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		− 0.3 to 6.5	V
Program Voltage	V_{PP}	TEST/V_{PP}	− 0.3 to 13.0	
Input Voltage	V_{IN}		− 0.3 to V_{DD} + 0.3	
Output Voltage	V_{OUT1}	P21, P22, / RESET, Tri-state Port	− 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	P3, P6 Port	− 1.8	mA
	I_{OUT2}	P1, P2, P5, P6, P7 Port	3.2	
	I_{OUT3}	P3 Port	30	
Output Current (Total)	ΣI_{OUT1}	P1, P2, P5, P6, P7 Port	60	
	ΣI_{OUT2}	P3 Port	80	
Power Dissipation [T_{opr} = 85°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 μ)	°C
Storage Temperature	Tstg		− 55 to 125	
Operating Temperature	Topr		− 40 to 85	

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 Condition (V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Condition		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 16 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE0, 1, 2 mode			
			fc = 8 MHz	NORMAL1, 2 mode	2.7		
				IDLE0, 1, 2 mode			
			fc = 4.2 MHz	NORMAL1, 2 mode	1.8		
				IDLE0, 1, 2 mode			
			fs = 32.768 kHz	SLOW1, 2 mode			
				SLEEP0, 1, 2 mode			
				STOP mode			
Input high Level	V_{IH1}	Except Hysteresis input	$V_{DD} \geq 4.5$ V		V_{DD} × 0.70	V_{DD}	V
	V_{IH2}	Hysteresis input			V_{DD} × 0.75		
	V_{IH3}		$V_{DD} < 4.5$ V		V_{DD} × 0.90		
Input low Level	V_{IL1}	Except Hysteresis input	$V_{DD} \geq 4.5$ V		0	V_{DD} × 0.30	V
	V_{IL2}	Hysteresis input				V_{DD} × 0.25	
	V_{IL3}		$V_{DD} < 4.5$ V			V_{DD} × 0.10	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 1.8 to 5.5 V		1.0	4.2	MHz
			V_{DD} = 2.7 to 5.5 V			8.0	
			V_{DD} = 4.5 to 5.5 V			16.0	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note: 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.

D.C. Characteristics

(V_{SS} = 0 V, Topr = −40 to 85°C)

Parameter	Symbol	Pins	Condition	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis input		–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5 V, V_{IN} = 5.5 V / 0 V	–	–	±2	μA
	I_{IN2}	Sink Open Drain, Tri-state					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$ Pull-Up		100	220	450	kΩ
Output Leakage Current	I_{LO}	Sink Open Drain, Tri-state	V_{DD} = 5.5 V, V_{OUT} = 5.5 V / 0 V	–	–	±2	μA
Output High Voltage	V_{OH1}	Push-pull Port	V_{DD} = 4.5 V, I_{OH} = −200μA	2.4	–	–	V
	V_{OH2}	Tri-st Port	V_{DD} = 4.5 V, I_{OH} = −0.7 mA	4.1	–	–	
Output Low Voltage	V_{OL}	Except XOUT and P3 Port	V_{DD} = 4.5 V, I_{OL} = 1.6mA		–	0.4	V
Output Low Current	I_{OL}	High Current Port (P3 Port)	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	mA
Supply Current in NORMAL 1, 2 mode	V_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3 / 0.2 V fc = 16 MHz fs = 32.768 kHz	–	7.5	9	mA
Supply Current in IDLE 0, 1, 2 mode				–	5.5	6.5	
Supply Current in SLOW 1 mode			V_{DD} = 3.0 V V_{IN} = 2.8 V / 0.2 V fs = 32.768 kHz LCD driver is not enable.	–	18	42	μA
Supply Current in SLEEP 1 mode				–	16	25	
Supply Current in SLEEP 0 mode				–	12	20	
Supply Current in STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V / 0.2 V	–	0.5	10	

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

Note 2: Input current (I_{IN1}, I_{IN2}); The current through pull-up or pull-down resistor is not included.

Note 3: I_{DD} does not include I_{REF} current.

Note 4: The supply currents of SLOW 2 and SLEEP 2 modes are equivalent to IDLE 0, 1, 2.

A/D Conversion Characteristics

(V_{SS} = 0.0 V, V_{DD} = 4.5 to 5.5 V, Topr = − 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		V_{DD}-1.5	−	V_{DD}	V
Power Supply Voltage of Analog Control Circuit	A_{VDD}			V_{DD}		V
Analog Reference Voltage Range	$\triangle V_{AREF}$		2.5	−	−	V
Analog Input Voltage	V_{AIN}		V_{SS}	−	V_{AREF}	V
Power Supply Current of Analog Reference Voltage	I_{REF}	V_{DD} = A_{VDD} = V_{AREF} = 5.5 V V_{SS} = 0.0 V	−	0.6	1.0	mA
Non linearity Error		V_{DD} = 4.5 to 5.5 V, V_{SS} = 0.0 V A_{VDD} = V_{AREF} = 5.0 V	−	−	±4	LSB
Zero Point Error			−	−	±4	
Full Scale Error			−	−	±4	
Total Error			−	−	±8	

(V_{SS} = 0.0 V, V_{DD} = 2.7 to 4.5 V, Topr = − 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		V_{DD}-1.5	−	V_{DD}	V
Power Supply Voltage of Analog Control Circuit	A_{VDD}			V_{DD}		V
Analog Reference Voltage Range	$\triangle V_{AREF}$		2.5	−	−	V
Analog Input Voltage	V_{AIN}		V_{SS}	−	V_{AREF}	V
Power Supply Current of Analog Reference Voltage	I_{REF}	V_{DD} − A_{VDD} = V_{AREF} = 4.5 V V_{SS} = 0.0 V	−	0.5	0.8	mA
Non linearity Error		V_{DD} = 2.7 to 4.5 V, V_{SS} = 0.0 V A_{VDD} = V_{AREF} = 2.7 V	−	−	±4	LSB
Zero Point Error			−	−	±4	
Full Scale Error			−	−	±4	
Total Error			−	−	±8	

(V_{SS} = 0.0 V, V_{DD} = 1.8 to 2.7 V, Topr = − 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		V_{DD}-0.9	−	V_{DD}	V
Power Supply Voltage of Analog Control Circuit	A_{VDD}			V_{DD}		V
Analog Reference Voltage Range	$\triangle V_{AREF}$		1.8	−	−	V
Analog Input Voltage	V_{AIN}		V_{SS}	−	V_{AREF}	V
Power Supply Current of Analog Reference Voltage	I_{REF}	V_{DD} = A_{VDD} = V_{AREF} = 2.7 V V_{SS} = 0.0 V	−	0.3	0.5	mA
Non linearity Error		V_{DD} = 1.8 to 2.7 V, V_{SS} = 0.0 V A_{VDD} = V_{AREF} = 1.8 V	−	−	±4	LSB
Zero Point Error			−	−	±4	
Full Scale Error			−	−	±4	
Total Error			−	−	±8	

Note 1: Total errors includes all errors, except quantization error.
Note 2: Conversion time is different in recommended value by power supply voltage.
About conversion time, please refer to "2.10.2 Register Framing".
Note 3: Please use input voltage to AIN input Pin in limit of V_{AREF} - V_{SS}.
When voltage of range outside is input, conversion value becomes unsettled and gives affect to other channel conversion value.

A.C. Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = −40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.25	–	4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 16 MHz	–	31.25	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

(V_{SS} = 0 V, V_{DD} = 2.7 to 4.5 V, Topr = −40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.5	–	4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 8 MHz	–	62.5	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

(V_{SS} = 0 V, V_{DD} = 1.8 to 2.7 V, Topr = −40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.95		4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 4.2 MHz	–	119.05	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

Timer Counter 1 input (ECIN) Characteristics

(V_{SS} = 0 V, Topr = −40 to 85°C)

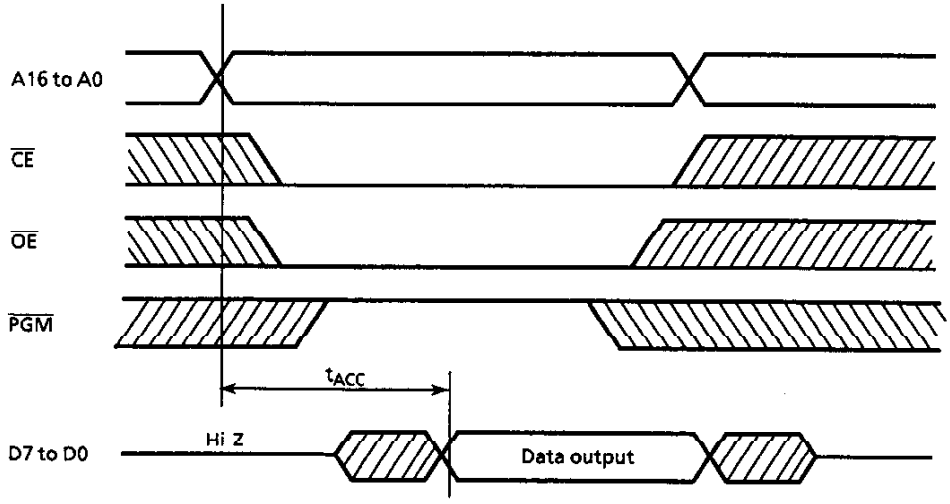
Parameter	Symbol	Condition		Min	Typ.	Max	Unit
TC1 input (ECIN input)	t_{TC1}	Frequency measurement mode V_{DD} = 4.5 to 5.5 V	Single edge count	–	–	16	MHz
			Both edge count	–	–		
		Frequency measurement mode V_{DD} = 2.7 to 4.0 V	Single edge count	–	–	8	
			Both edge count	–	–		
		Frequency measurement mode V_{DD} = 1.8 to 2.7 V	Single edge count	–	–	4.2	
			Both edge count	–	–		

DC Characteristics, AC Characteristics (PROM Mode) (V_{SS} = 0 V, Topr = – 40 to 85°C)

(1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	V
Power supply	V_{CC}		4.75	5.0	5.25	V
Power supply of program	V_{PP}					
Address access time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5tcyc + 300	–	ns

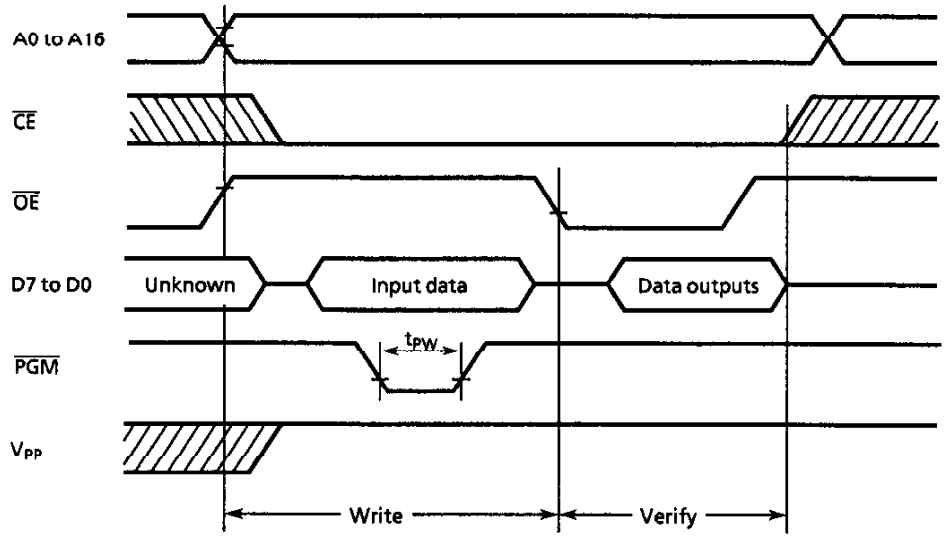
Note: tcyc = 500 ns at 8 MHz



(2) Program operation (High-speed) (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	V
Power supply	V_{CC}		6.0	6.25	6.5	V
Power supply of program	V_{PP}		12.5	12.75	13.0	V
Pulse width of initializing program	t_{PW}	V_{CC} = 6.0 V	0.095	0.1	0.105	ms

High-speed program writing

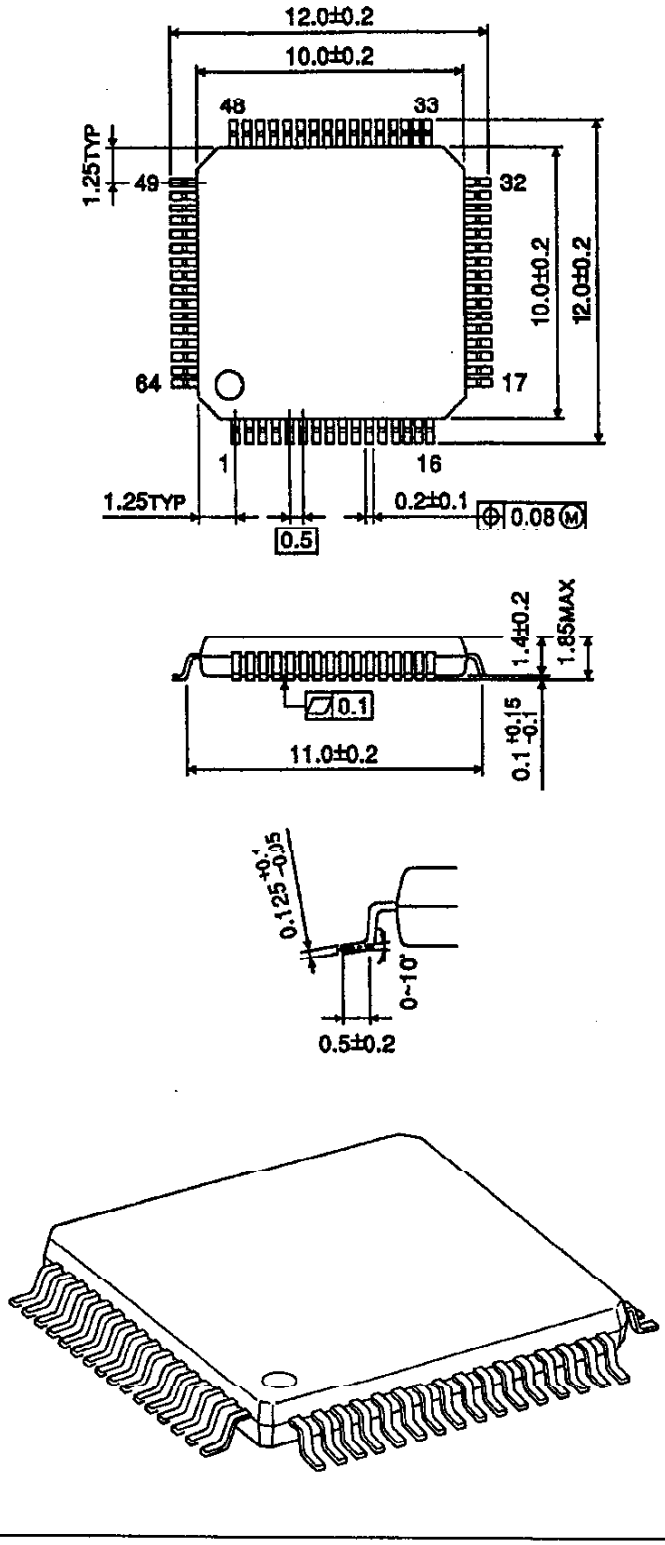


Note 1: The power supply of V_{PP} (12.75 V) must be set power-on at the same time or the later time for a power supply of V_{CC} and must be clear power-on at the same time or early time for a power supply of V_{CC}.

Note2 : The pulling up/down device on the condition of V_{PP} = 12.75 V ± 0.25 V causes a damage for the device. Do not pull up/down at programming.

Note3 : Use the recommended adapter (see 1.2.2 (1)) and mode (see 1.2.2 (3) i).
Using other than the above condition may cause the trouble of the writting.

P-LQFP64-1010-0.50 Unit: mm



P-QFP64-1414-0.80A Unit: mm