CMOS 8-Bit Microcontroller

TMP88PS38BNG/FG

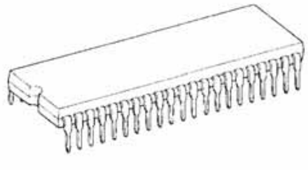
The TMP88PS38B is the high-speed and high performance 8-bit signal chip microcomputers which built in a program storage area (64 Kbytes), an OSD font storage area (24 Kbytes) and the one-time PROM of vector table storage area (256 bytes). The TMP88PS38B is pin compatible with the TMP88CS38B. The operation possible with the TMP88PS38B can be performed by writing programs to PROM. The TMP88PS38B can write and verify in the same way as the TC571000D an EPROM programmer.

Product No.	OTP	RAM	Package	Adaptor Socket
TMP88PS38BNG	64 Kbytes (256 bytes) 24 Kbytes	2 Kbytes	SDIP42-P-600-1.78	BM11174A
TMP88PS38BFG			P-QFP44-1414-0.80K	BM11175A

Pin Assignments

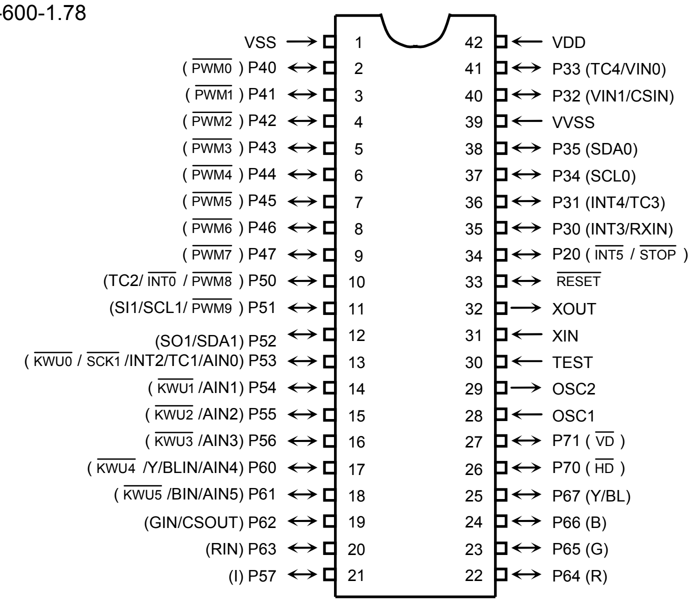
Package

SDIP42-P-600-1.78



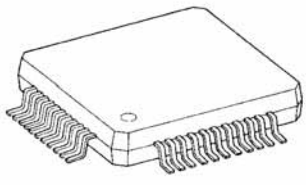
TMP88PS38BNG

SDIP42-P-600-1.78



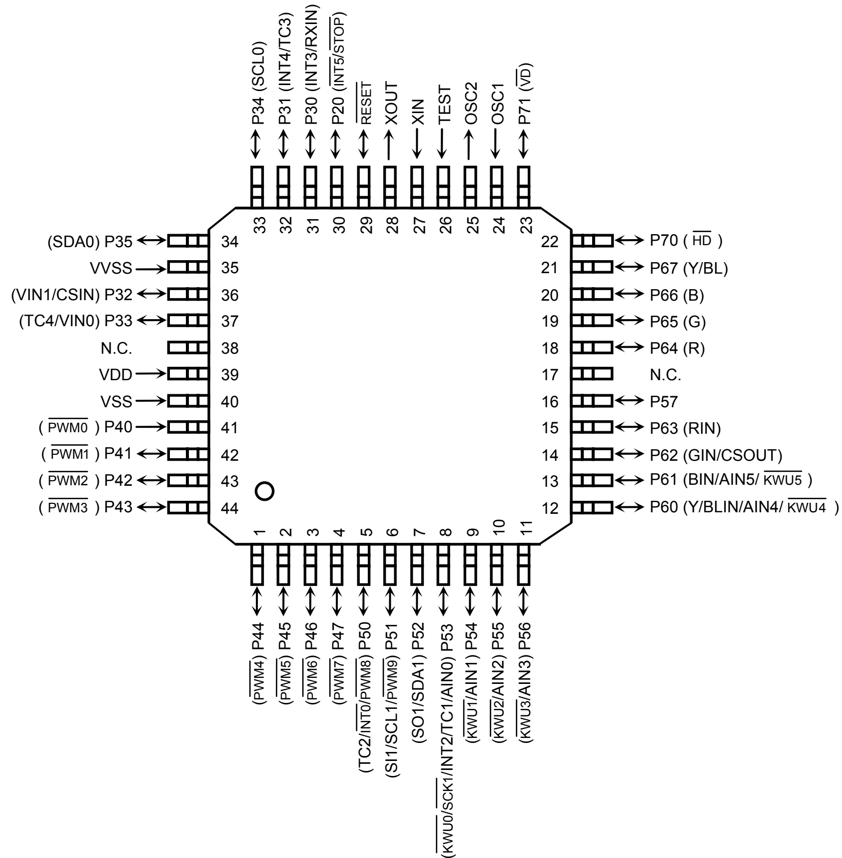
Package

P-QFP44-1414-0.80K



TMP88PS38BFG

P-QFP44-1414-0.80K



Operational Description

The configuration and function of the TMP88PS38B are the same as those of the TMP88CS38B, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. Operation Mode

The TMP88PS38B has two mode: MCU and PROM.

1.1 MCU Mode

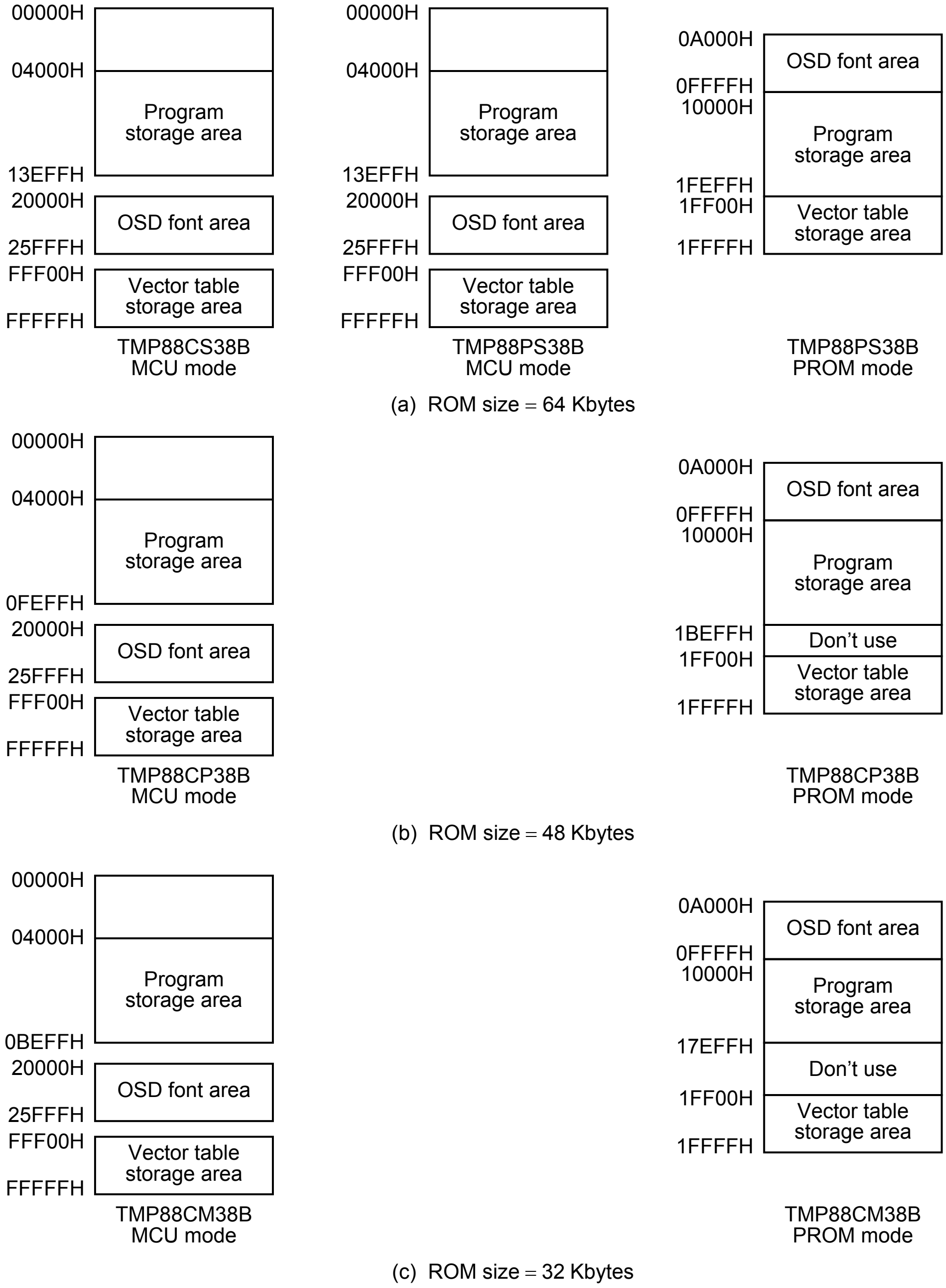
The MCU mode is activated by fixing the TEST/VPP pin at low level.
In the MCU mode, operation is the same as with the TMP88CS38B.

1.1.1 Program Memory

The TMP88PS38B has a 64 Kbytes (Addresses 04000H to 13EFFH in the MCU mode, addresses 10000H to 1FEFFH in the PROM mode) of program storage area, 24 Kbytes (Addresses 20000H to 25FFFH in the MCU mode, addresses 0A000H to 0FFFFH in the PROM mode) and 256 bytes (Addresses FFF00H to FFFFFH in the MCU mode, addresses 1FF00H to 1FFFFH in the PROM mode) one-time PROM of vector table storage area.

1.1.2 Data Memory

The TMP88PS38B has an on-chip 2-Kbyte data memory (Static RAM).



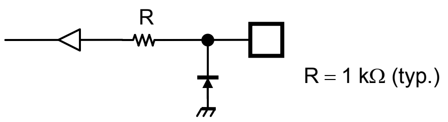
Note: Data in the unused area should be FFH. Or else, general-purpose PROM should be set to permit access to the program storage area only.

Figure 1.1 Program Storage Area

1.1.3 Input/Output Circuit for Pins

(1) Control pins

The TMP88PS38B is identical to the TMP88CS38B and TMP88CM38B/CP38B except that it has a TEST pin without a pull-down resistor.



Note: A pull-down resistor is not included.

Figure 1.2 TEST Pin

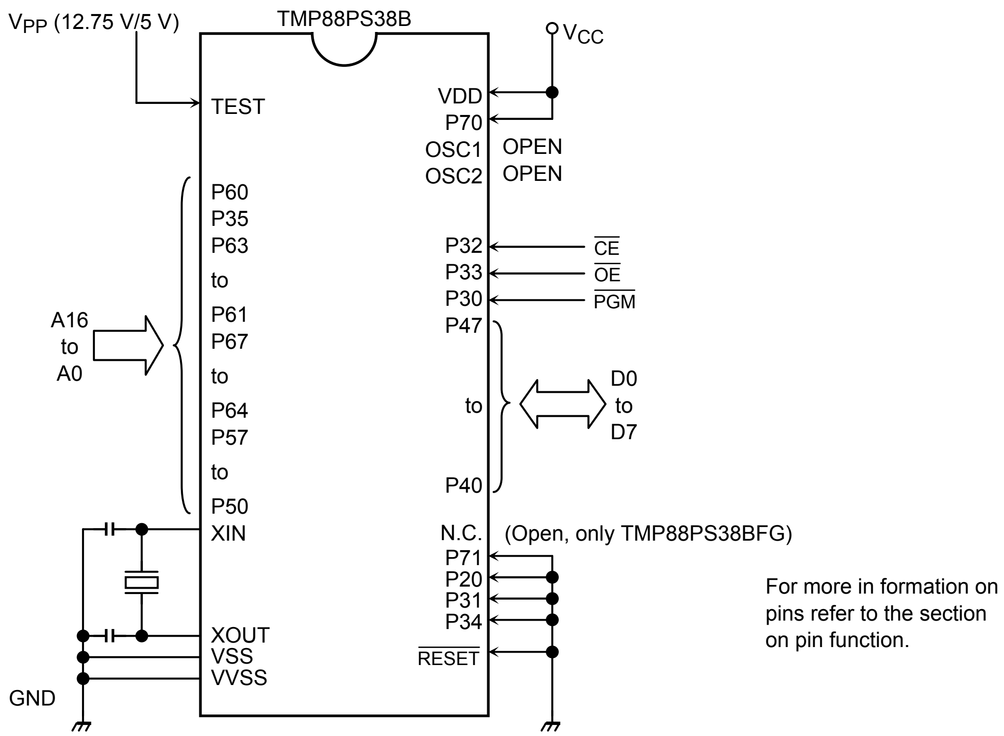
(2) I/O ports

The input/output circuit for the TMP88PS38B I/O port is the same as that for the TMP88CS38B and TMP88CM38B/CP38B.

1.2 PROM Mode

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 TMP88PS38B is not supported an electric signature mode, so the ROM type must be set to TC571000D.



PROM programmer connection adaptor socket: BM11174A for TMP88PS38BNG
BM11175A for TMP88PS38BFG

Figure 1.2.1 Setting for PROM Mode

Pin Name (EPROM mode)	Input/Output	Function	Pin Name (MCU mode)
A16	Input	PROM address inputs	P60
A15 to A8			P35, P63 to P61, P67 to P64
A7 to A0			P57 to P50
D7 to D0	I/O	PROM data inputs/outputs	P47 to p40
$\overline{\text{CE}}$	Input	Chip enable signal input (Active low)	P32
$\overline{\text{OE}}$		Output enable signal input (Active low)	P33
$\overline{\text{PGM}}$		Program mode signal input	P30
VPP	Power supply	+12.75 V/5 V (Program supply voltage)	TEST
VCC		+6.25 V/5 V	VDD
GND		0 V	VSS, VVSS
P70	Input	PROM mode setting pin. Be fixed at high level.	
P71, P20, P31, P34		PROM mode setting pin. Be fixed at low level.	
$\overline{\text{RESET}}$		PROM mode setting pin. Be fixed at low level.	
XIN	Input	Connect an 8 MHz oscillator to stabilize the state.	
XOUT	Output		
OSC1, OSC2	I/O	Open	
N.C.	Open	Open	

PROM programmer connection adaptor socket: BM11174A for TMP88PS38BNG
BM11175A for TMP88PS38BFG

1.3 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 Vcc = 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 $\overline{\text{PGM}}$ 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 Vcc = Vpp = 5 V.

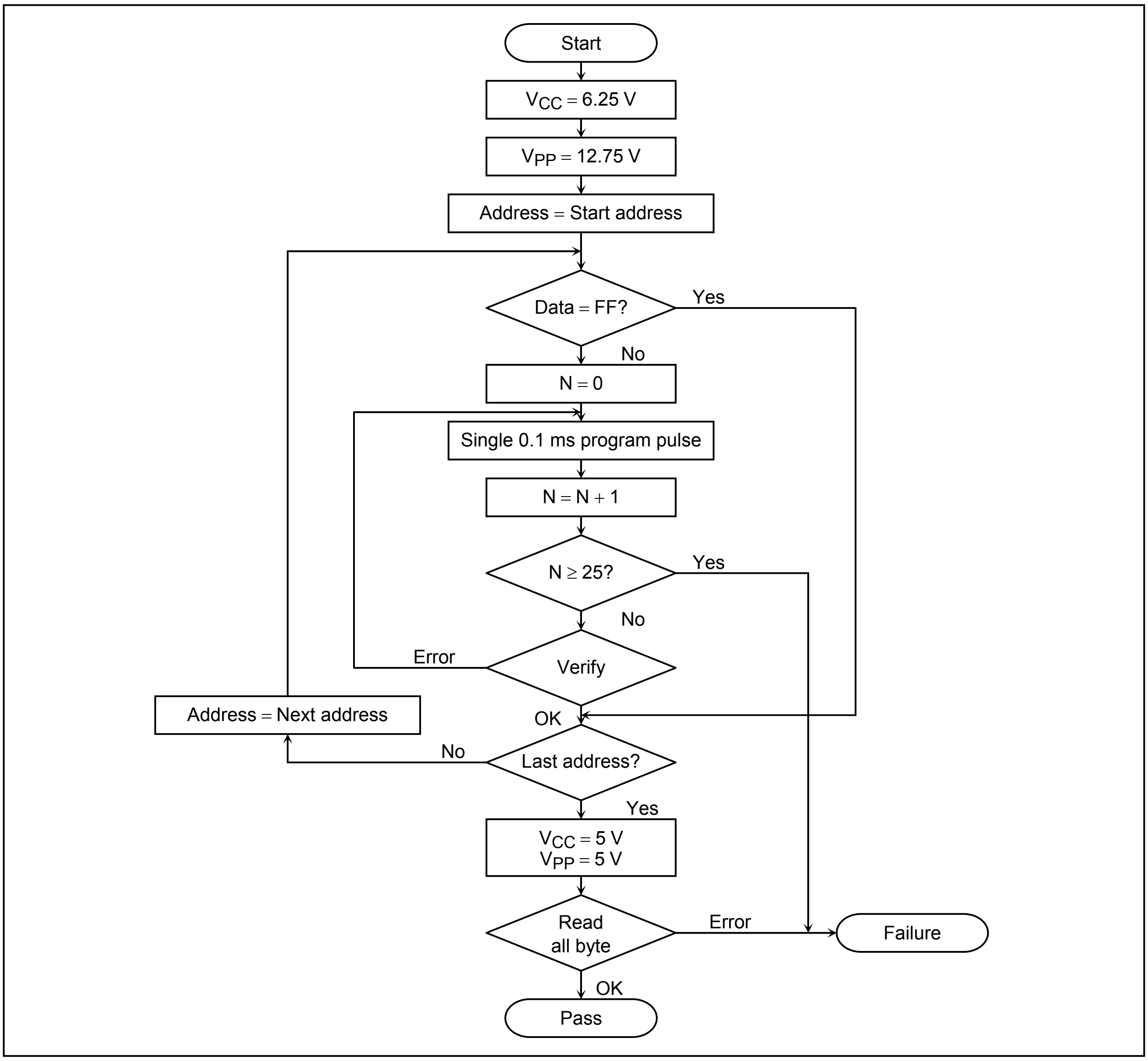


Figure 1.3.1 Flow Chart of High-speed Programming

1.4 Writing Method for General-purpose PROM Program

(1) Adapters

BM11174A: TMP88PS38BNG

BM11175A: TMP88PS38BFG

(2) PROM programmer specifying

i) PROM type is specified to TC571000D. (Note 1)

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

ii) Data transfer (copy) (Note 1)

In the TMP88PS38B, EPROM is within the addresses 10000H to 1FEFFH (Program storage area) and 0A000H to 0FFFFH (OSD font area) and 1FF00H to 1FFFFH (Vector table storage area). 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:0A000H

End address: 1FFFFH

(3) Writing

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

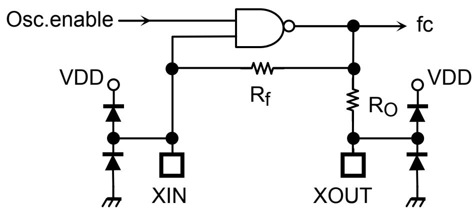
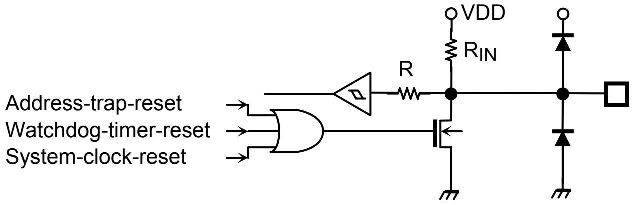
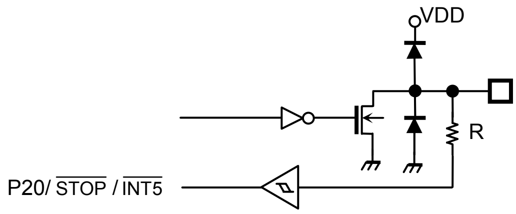
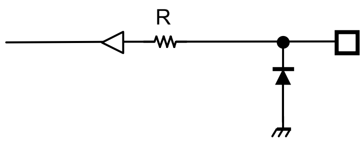
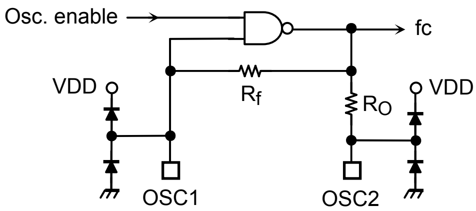
Note 1: The specifying method is referred to the PROM programmer description. Either write the data FFH to the unused area or set the PROM programmer to access only the program storage area.

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.

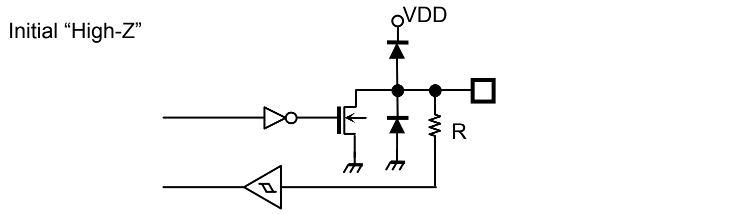
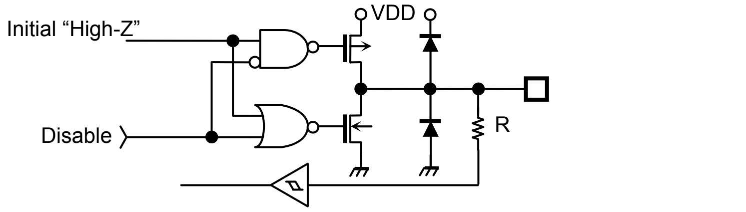
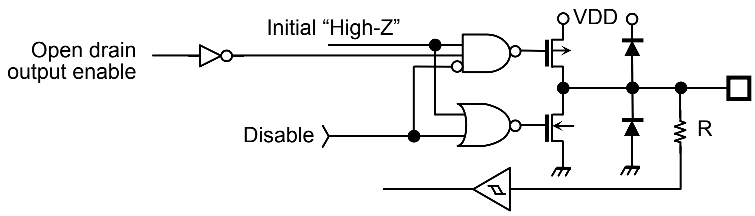
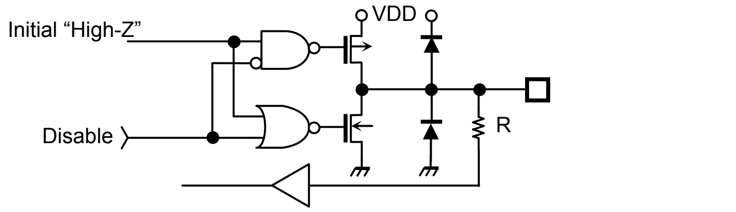
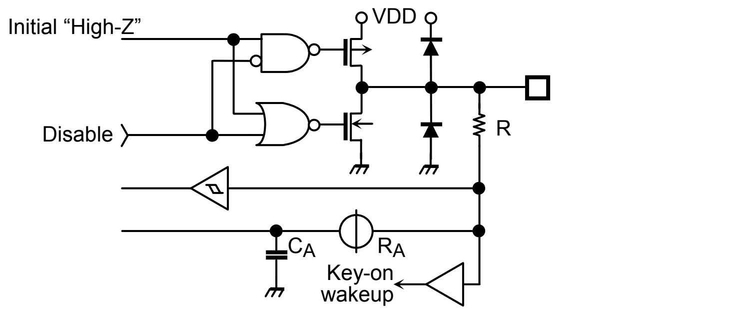
Input/Output Circuit

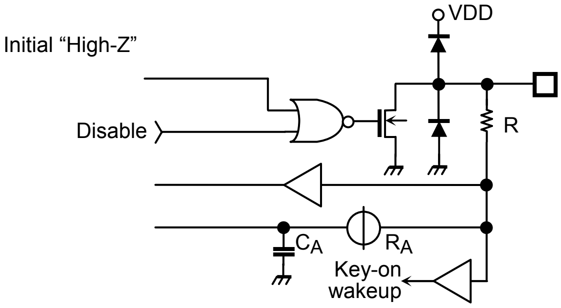
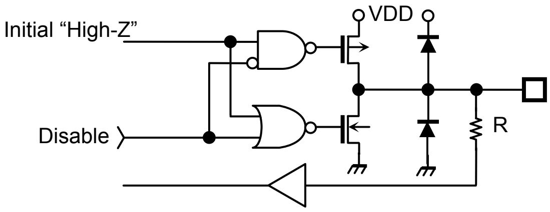
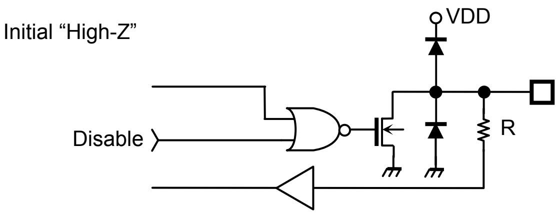
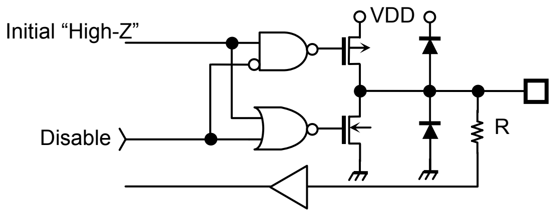
(1) Control pins

The input/output circuitries of the TMP88PS38B control pins are shown below.

Control Pin	I/O	Input/Output Circuitry	Remarks
XIN XOUT	I/O		Resonator connection pins (High frequency) R_f = 1.2 MΩ (typ.) R_O = 0.5 kΩ (typ.)
$\overline{\text{RESET}}$	I/O		Sink open-drain output Hysteresis input Pull-up resistor R_{IN} = 220 kΩ (typ.) R = 1 kΩ (typ.)
$\overline{\text{STOP}}$ / $\overline{\text{INT5}}$ (P20)	Input		Hysteresis input R = 1 kΩ (typ.)
TEST	Input		R = 1 kΩ (typ.)
OSC1 OSC2	I/O		Pin for connecting a resonator for on-screen display R_f = 1.2 MΩ (typ.) R_O = 0.5 kΩ (typ.)

(2) Input/output ports

Port	I/O	Input/Output Circuitry	Remarks
P20	I/O		Sink open-drain output Hysteresis input R = 1 kΩ (typ.)
P30 to P33 P50, P57 P70, P71	I/O		Tri-state I/O Hysteresis input R = 1 kΩ (typ.)
P34, P35, P51, P52	I/O		Tri-state I/O or open-drain output programmable Hysteresis input R = 1 kΩ (typ.)
P40 to P47	I/O		Tri-state I/O R = 1 kΩ (typ.)
P53 to P56	I/O		Tri-state I/O Hysteresis input Key-on wakeup input ($V_{IL4} = 0.65 \times V_{DD}$) R = 1 kΩ (typ.) R_A = 5 kΩ (typ.) C_A = 22 pF (typ.)

Port	I/O	Input/Output Circuitry	Remarks
P60, P61	I/O		Sink open-drain output High current output I_{OL} = 20 mA (typ.) R = 1 kΩ (typ.) R_A = 5 kΩ (typ.) C_A = 22 pF (typ.) Key-on wakeup input (V_{IL4} = 0.65 × V_{DD})
P62 (at CSOUT)	I/O		Tri-state I/O High current output I_{OL} = 20 mA (typ.) R = 1 kΩ (typ.)
P62, P63	I/O		Sink open-drain output High current output I_{OL} = 20 mA (typ.) R = 1 kΩ (typ.)
P64 to P67	I/O		Tri-state I/O R = 1 kΩ (typ.)

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply voltage	V_{DD}	–	–0.3 to 6.5	V
Programmable voltage	V_{PP}	TEST/V_{PP} 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	mA
Output current (Total)	$\Sigma\ I_{OUT1}$	Ports P2, P3, P4, P5, P64 to P67, P7	120	mA
	$\Sigma\ I_{OUT2}$	Ports P60 to P63	120	mA
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}	–	fc = 16 MHz	NORMAL mode	4.5	5.5	V
			fc = 16 MHz	IDLE mode			
			–	STOP mode			
Input high voltage	V_{IH1}	Except hysteresis input	V_{DD} = 4.5 to 5.5V		V_{DD} × 0.70	V_{DD}	V
	V_{IH2}	Hysteresis input			V_{DD} × 0.75		
Input low voltage	V_{IL1}	Except hysteresis input	V_{DD} = 4.5 to 5.5V		0	V_{DD} × 0.30	V
	V_{IL2}	Hysteresis input				V_{DD} × 0.25	
	V_{IL4}	Key-on wakeup input	V_{DD} = 4.5 to 5.5V			V_{DD} × 0.65	
Clock frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 5.5V		8.0	16.0	MHz
	f_{OSC}	OSC1, OSC2	V_{DD} = 4.5 to 5.5V	fc = 8 MHz	8.0	12.0	MHz
				fc = 16 MHz	16.0	24.0	MHz

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 fc: Supply voltage range is specified in NORMAL mode and IDLE mode.

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

DC Characteristics

(V_{SS} = 0 V, Topr = –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}	$\overline{\text{RESET}}$, $\overline{\text{STOP}}$	V_{DD} = 5.5 V, V_{IN} = 5.5 V/0 V	–	–	±2	
Input resistance	R_{IN2}	$\overline{\text{RESET}}$	V_{DD} = 5.5 V, V_{IN} = 0 V	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	
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 fc = 16 MHz (Note 3) V_{IN} = 5.3 V/0.2 V	–	25	30	
Supply current in IDLE mode				–	20	25	
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 Topr = 25°C, VDD = 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.

AD Conversion Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 V to 5.5 V, Topr = –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		V_{DD} = 5.0 V	–	–	±1	LSB
Zero point error			–	–	±2	
Full scale error			–	–	±2	
Total error			–	–	±3	

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

AC Characteristics

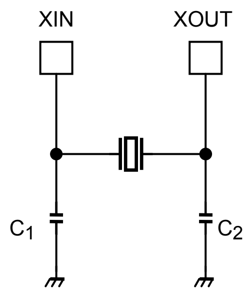
(V_{SS} = 0 V, V_{DD} = 4.5 V to 5.5 V, Topr = –30 to 70°C)

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	31.25	–	–	ns
Low level clock pulse width	T_{WCL}	(XIN input), fc = 16 MHz				

Recommended Oscillating Conditions

(V_{SS} = 0 V, V_{DD} = 4.5 V 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	Murata CSA 8.00MTZ	30 pF	30 pF
		16 MHz	Murata CSA 16.00MXZ040	5 pF	5 pF



High-frequency oscillation

Note 1: 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).

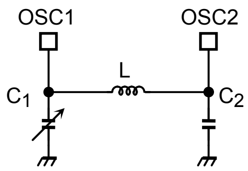
Note 2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL:

http://www.murata.co.jp/search/index.html

Recommended Oscillating Conditions

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

Item	Resonator	Oscillation Frequency	Recommended Parameter Value		
			L (μH)	C_1 (pF)	C_2 (pF)
Oscillation for OSD	LC resonator	8 MHz	33	5 to 30	10
		12 MHz	15	5 to 30	10
		16 MHz	10	5 to 30	10
		20 MHz	6.8	5 to 25	10
		24 MHz	4.7	5 to 25	10



Oscillation for OSD

The frequency generated in LC oscillation can be obtained using the following equations.

$$f = \frac{1}{2\pi\sqrt{LC}},\ C = \frac{C_1 \cdot C_2}{C_1 + C_2}$$

C_1 is not fixed at a constant value. It can be changed to tune into the desired frequency.

Note 1: Toshiba's OSD circuit determines a horizontal display start position by counting clock pulses generated in LC oscillation. For this reason, the OSD circuit may fail to detect clock pulses normally, resulting in the horizontal start position becoming unstable, at the beginning of oscillation, if the oscillation amplitude is low.

Changing L and C_2 from the values recommended for a specific frequency may hamper a stable OSD display.

If the LC oscillation frequency is the same as a high-frequency clock value, the oscillation of the high-frequency oscillator may cause the LC oscillation frequency to fluctuate, thus making OSD displays flicker.

When determining these parameters, please check the oscillation frequency and the stability of oscillation on your TV sets.

Also check the determined parameters on your final products, because the optimum parameter values may vary from one product to another.

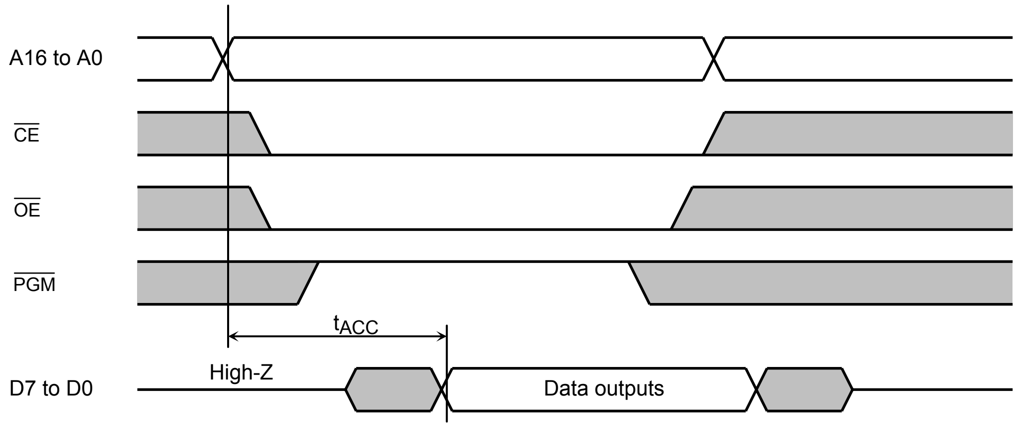
Note 2: When using the LSI package in a strong electric field, such as near a CRT, electrically shield the package so that its normal operation can be maintained.

DC/AC Characteristics (PROM mode)   (V_{SS} = 0 V)

(1) Read operation (V_{DD} = 5.0 ± 0.25 V, Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input high voltage (A0 to A16, $\overline{CE}$, $\overline{OE}$, $\overline{PGM}$)	V_{IH4}		V_{DD} × 0.7	–	VDD	V
Input low voltage (A0 to A16, $\overline{CE}$, $\overline{OE}$, $\overline{PGM}$)	V_{IL4}		0	–	0.8	V
Program power supply voltage	V_{PP}		4.75	5.0	5.25	V
Address access time	t_{ACC}		–	1.5tcyc + 300	–	ns

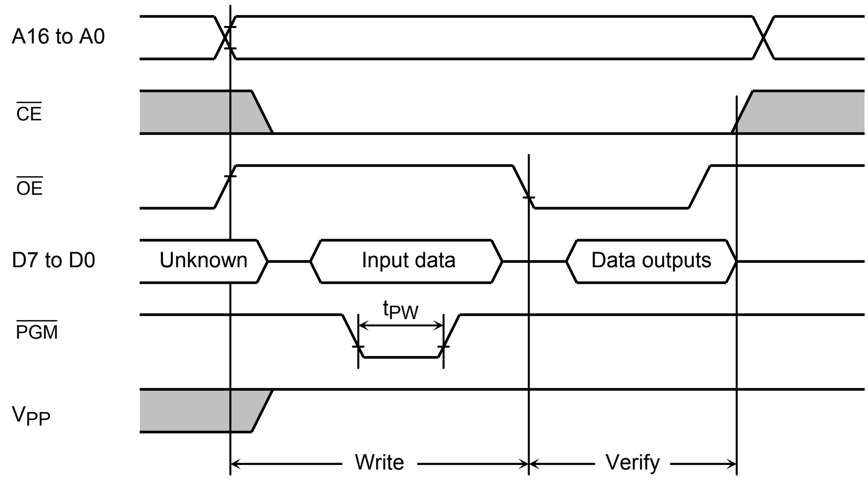
Note: tcyc = 400 ns at 10 MHz



(2) High-speed programming operation (Topr = 25 ± 5°C, V_{DD} = 6.25 ± 0.25 V)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input high voltage (D0 to D7, A0 to A16, $\overline{CE}$, $\overline{OE}$, $\overline{PGM}$)	V_{IH4}		V_{DD} × 0.7	–	V_{DD}	V
Input low voltage (D0 to D7, A0 to A16, $\overline{CE}$, $\overline{OE}$, $\overline{PGM}$)	V_{IL4}		0	–	0.8	V
Program power supply voltage	V_{PP}		12.5	12.75	13.0	V
Initial program pulse width	t_{PW}	V_{DD} = 6.0 V	0.095	0.1	0.105	ms

High-speed Programming Timing



Note 1: When Vcc power supply is turned on or after, Vpp must be increased.

When Vcc power supply is turned off or before, Vpp must be increased.

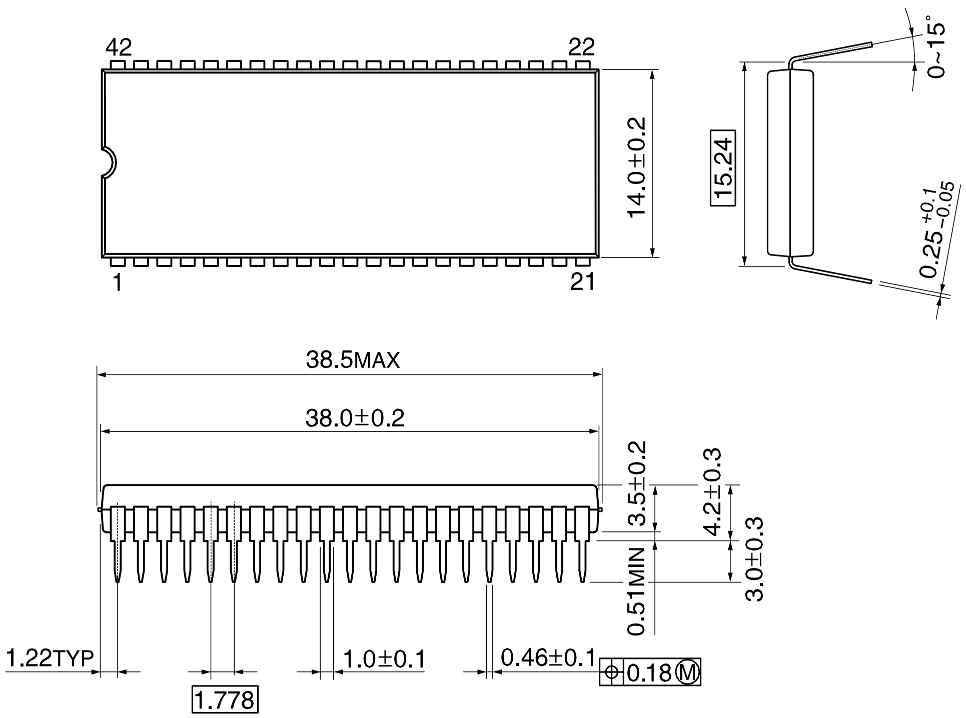
Note 2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75 V ± 0.25 V) to the Vpp pin as the device is damaged.

Note 3: Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

Package

P-SDIP42-600-1.78

Unit: mm



P-QFP44-1414-0.80K

Unit: mm