4-BIT SINGLE CHIP MICROCONTROLLER

The μPD17P108 is a tiny microcontroller consisting of a 1K-byte ROM, 16-word RAM, and 16 input/output ports. It is a one-time PROM version of the μPD17108, whose internal mask ROM is replaced with a one-time PROM.

Two μPD17P108 models are available: μPD17P108CS and μPD17P108GS, which allow a program to be written only once. They are suitable for evaluation of μPD17108 and for small-scale production.

The 17K architecture of the CPU uses general registers so that data memory can be manipulated directly for effective programming. Every instruction is 1 word long, consisting of 16 bits.

FEATURES

- Compatible with the μPD17108
- Program memory (one-time PROM) : 1K bytes (512 words x 16 bits)
- Data memory (RAM) : 16 words x 4 bits
- Input/output ports : 16 ports (including four N-ch open-drain outputs)
- Instruction execution time : 128 μs (62.5 kHz) to 8 μs (1 MHz)
- Number of instructions : 24 (Each instruction is 1 word long.)
- Stack level : 1
- A standby function is supported (with the STOP and HALT instructions).
- Data memory can retain data on low voltage (2.0 V at minimum).
- An oscillator is included for the system clock. (Only resistors are mounted externally.)
- Operating supply voltage : 2.5 to 6.0 V (at 250 kHz)
  4.5 to 6.0 V (at 1 MHz)

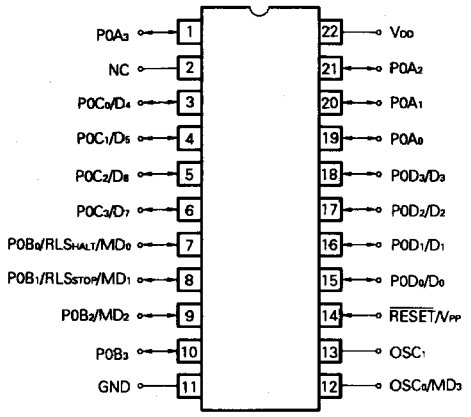
APPLICATIONS

- Controlling electric appliances or toys

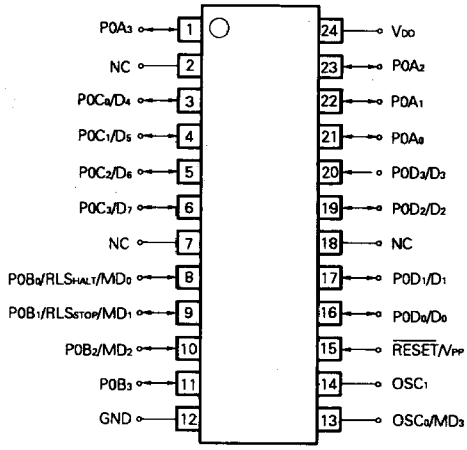
ORDERING INFORMATION

Order Code	Package
μPD17P108CS	22-pin plastic shrink DIP (300 mil)
μPD17P108GS	24-pin plastic SOP (300 mil)

PIN CONFIGURATION (Top View)

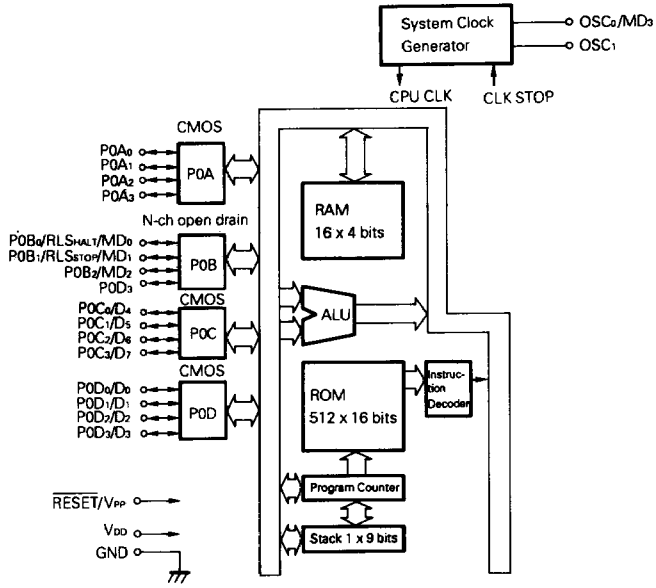


22-pin plastic shrink DIP



24-pin plastic SOP

BLOCK DIAGRAM



PIN FUNCTIONS

Pin Functions

- Port pins

Pin name	Input/ output	Dual function pin		Function		When writing to program memory or verifying its contents	When reset
$P0A_0$	Input/ output			CMOS (push-pull) 4-bit input/output port (port 0A)		Pull down	High impedance (input mode)
$P0A_1$							
$P0A_2$							
$P0A_3$							
$P0B_0$	Input/ output	RLS_{HALT}	MD_0	N-ch open-drain 4-bit input/output port (port 0B)	For the HALT mode releasing	Mode selection pin	High impedance (input mode)
$P0B_1$		RLS_{STOP}	MD_1		For the STOP mode releasing		
$P0B_2$		MD_2					
$P0B_3$						Pull down	
$P0C_0$	Input/ output	D_4		CMOS (push-pull) 4-bit input/output port (port 0C)		8-bit data input/ output pin (high-order 4 bits)	High impedance (input mode)
$P0C_1$		D_5					
$P0C_2$		D_6					
$P0C_3$		D_7					
$P0D_0$	Input/ output	D_0		CMOS (push-pull) 4-bit input/output port (port 0D)		8-bit data input/ output pin (low-order 4 bits)	High impedance (input mode)
$P0D_1$		D_1					
$P0D_2$		D_2					
$P0D_3$		D_3					

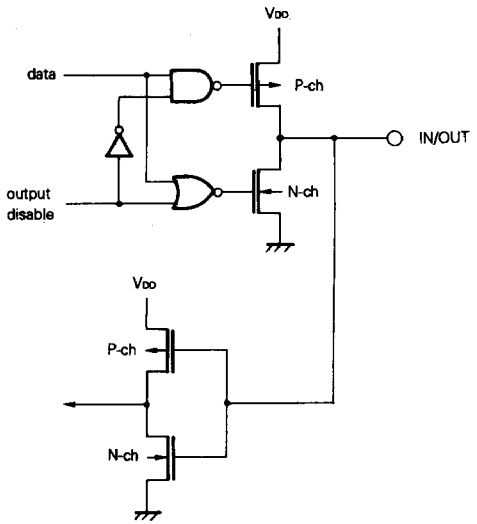
- Non-port pins

Pin name	Input/ output	Dual Function pin	Function	When writing to program memory or verifying its contents
$\overline{RESET}$	Input	V_{PP}	System reset input pin	Voltage is applied to this pin (+12.5 V)
V_{DD}			Positive power supply pin	Positive power supply pin (+6.0 V)
GND			GND pin	GND pin
OSC_1			Pins to be connected to the system clock resonator	Program memory address update
OSC_0		MD_3	Pins to be connected to the system clock resonator	
NC			NC pin is not connected internally.	Mode selection pin

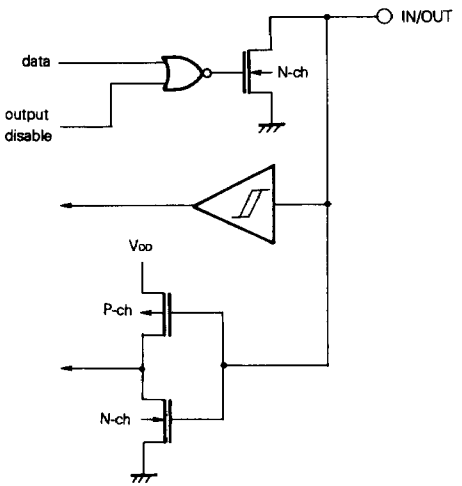
PIN INPUT/OUTPUT CIRCUITS

Following are schematics of the input/ouput circuits of the pins of the μPD17P108.

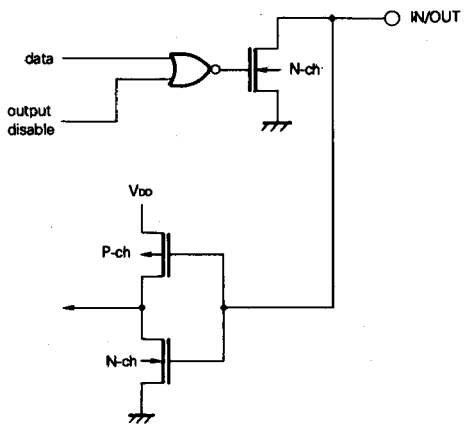
(1) P0A, P0C, and P0D



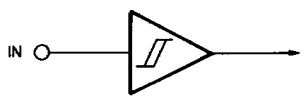
(2) $P0B_0$ and $P0B_1$



(3) $P0B_2$ and $P0B_3$



(4) $\overline{\text{RESET}}$



10. WRITING TO AND VERIFYING ONE-TIME PROM (PROGRAM MEMORY)

The μPD17P108's internal program memory consists of a 512 x 16 bit one-time PROM.

Writing to the one-time PROM or verifying the contents of the PROM is accomplished using the pins shown in the table below. Note that address inputs are not used; instead, the address is updated using the clock input from the OSC_1 pin.

Pin name	Function
V_{PP}	Voltage is applied to this pin when writing to program memory or verifying its contents.
OSC_1	Input pin for address update clock used when writing to program memory or verifying its contents
MD_0 to MD_3	Pins that turn to input pins and are used as operation mode selection pins when writing to program memory or verifying its contents
D_0 to D_7	Input/output pins for 8-bit data used when writing to program memory or verifying its contents

10.1 PROGRAM MEMORY WRITE/VERIFY MODES

If +6 V is applied to the V_{DD} pin and +12.5 V is applied to the V_{PP} pin after a certain duration of reset status (V_{DD} = 5 V, $\overline{RESET}$ = 0 V), the μPD17P108 enters program memory write/verify mode. A specific operating mode is then selected by setting the MD_0 through MD_3 pins as follows. Set the other unused pins to GND level by means of pull-down resistors.

Operating mode specification						Operating mode
V_{PP}	V_{DD}	MD_0	MD_1	MD_2	MD_3	
+12.5 V	+6 V	H	L	H	L	Program memory address clear mode
		L	H	H	H	Write mode
		L	L	H	H	Verify mode
		H	x	H	H	Program inhibit mode

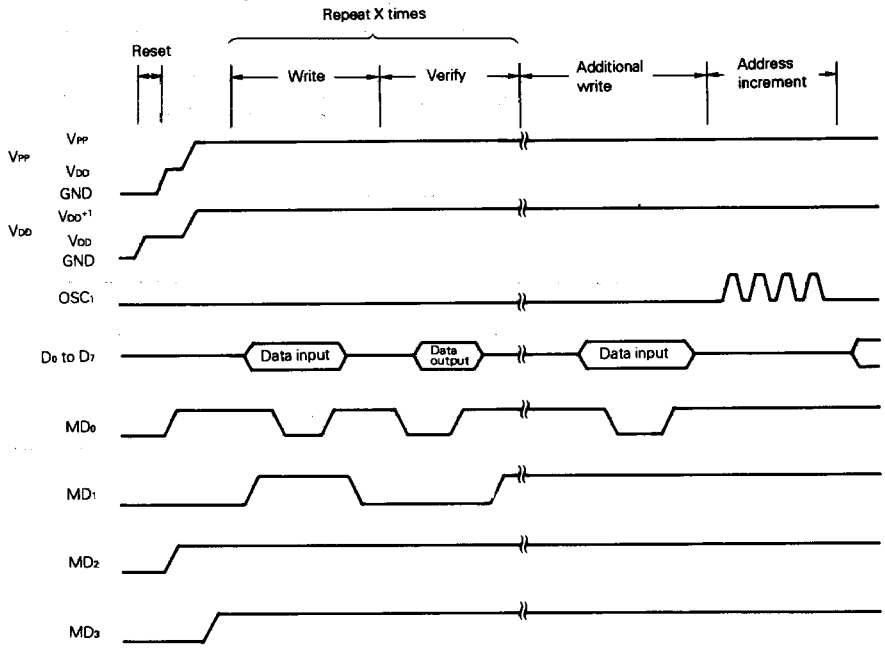
x : L (low) or H (high)

10.2 WRITING TO PROGRAM MEMORY

The procedure for writing to program memory is described below; high-speed write is possible.

(1) Pull low the levels on all unused pins to GND by means of resistors. Bring OSC_1 to low level.
(2) Apply 5 V to V_{DD} and bring V_{PP} to low level.
(3) Wait 10 μs. Then apply 5 V to V_{PP}
(4) Set the mode selection pins to program memory address clear mode.
(5) Apply 6 V to V_{DD} and 12.5 V to V_{PP}.
(6) Select program inhibit mode.
(7) Write data in 1 ms write mode.
(8) Select program inhibit mode.
(9) Select verify mode. If the write operation is found successful, proceed to step (10). If the operation is found unsuccessful, repeat steps (7) to (9).
(10) Perform additional write for (number of repetitions of steps (7) to (9) x 1 ms.
(11) Select program inhibit mode.
(12) Increment the program memory address by one on reception of four pulses on the OSC_1 pin.
(13) Repeat steps (7) to (12) until the last address is reached.
(14) Select program memory address clear mode.
(15) Apply 5 V to the V_{DD} and V_{PP} pins.
(16) Turn power off.

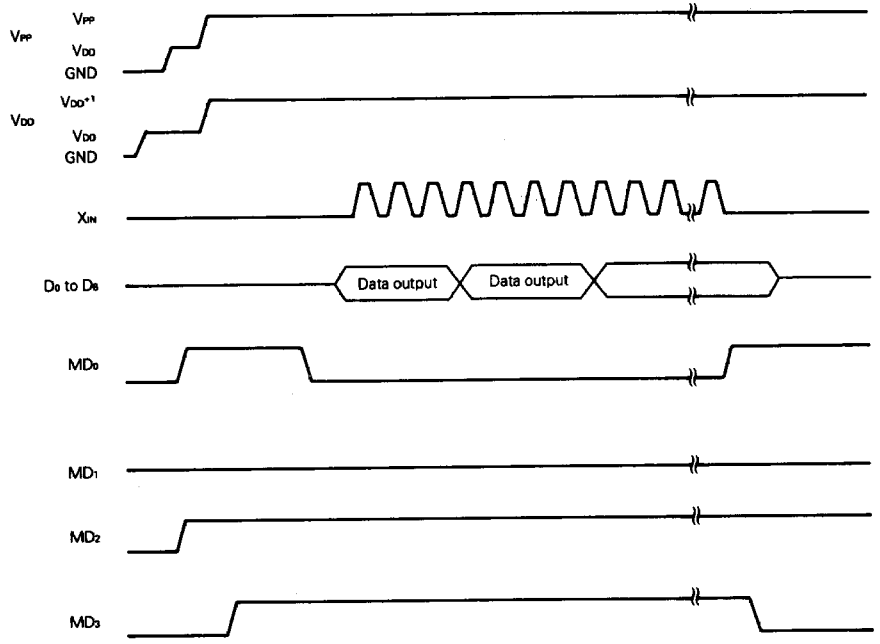
The timing for steps (2) to (12) is shown below.



10.3 READING PROGRAM MEMORY

(1) Pull low the levels of all unused pins to GND by means of resistors. Bring OSC_1 to low level.
(2) Apply 5 V to V_{DD} and bring V_{PP} to low level.
(3) Wait 10 μs. Then apply 5 V to V_{PP}
(4) Set the mode selection pins to program memory address clear mode.
(5) Apply 6 V to V_{DD} and 12.5 V to V_{PP}
(6) Select program inhibit mode.
(7) Select verify mode. Data is output sequentially one address at a time for each cycle of four clock pulses on the OSC_1 pin.
(8) Select program inhibit mode.
(9) Select program memory address clear mode.
(10) Apply 5 V to the V_{DD} and V_{PP} pins.
(11) Turn power off.

The timing for steps (2) to (9) is shown below.



11. ASSEMBLER RESERVED WORDS

Table 11-1 lists the reserved words defined in the μPD17P108 device file (AS17108).

Table 11-1 Reserved Words

Name	Attribute	Value	Read/write	Description
P0A0	FLG	0.70H.0	Read/write	Bit 0 of port 0A
P0A1	FLG	0.70H.1	Read/write	Bit 1 of port 0A
P0A2	FLG	0.70H.2	Read/write	Bit 2 of port 0A
P0A3	FLG	0.70H.3	Read/write	Bit 3 of port 0A
P0B0	FLG	0.71H.0	Read/write	Bit 0 of port 0B
P0B1	FLG	0.71H.1	Read/write	Bit 1 of port 0B
P0B2	FLG	0.71H.2	Read/write	Bit 2 of port 0B
P0B3	FLG	0.71H.3	Read/write	Bit 3 of port 0B
P0C0	FLG	0.72H.0	Read/write	Bit 0 of port 0C
P0C1	FLG	0.72H.1	Read/write	Bit 1 of port 0C
P0C2	FLG	0.72H.2	Read/write	Bit 2 of port 0C
P0C3	FLG	0.72H.3	Read/write	Bit 3 of port 0C
P0D0	FLG	0.73H.0	Read/write	Bit 0 of port 0D
P0D1	FLG	0.73H.1	Read/write	Bit 1 of port 0D
P0D2	FLG	0.73H.2	Read/write	Bit 2 of port 0D
P0D3	FLG	0.73H.3	Read/write	Bit 3 of port 0D
BCD	FLG	0.7EH.0	Read/write	BCD arithmetic flag
PSW	MEM	0.7FH	Read/write	Program status word
Z	FLG	0.7FH.1	Read/write	Zero flag
CY	FLG	0.7FH.2	Read/write	Carry flag
CMP	FLG	0.7FH.3	Read/write	Compare flag

12. INSTRUCTION SET

12.1 INSTRUCTION SET LIST

$b_{14}-b_{11}$ \ b_{15}		0	1
BIN	HEX		
0 0 0 0	0	ADD r, m	ADD m, #i
0 0 0 1	1	SUB r, m	SUB m, #i
0 0 1 0	2	ADDC r, m	ADDC m, #i
0 0 1 1	3	SUBC r, m	SUBC m, #i
0 1 0 0	4	AND r, m	AND m, #i
0 1 0 1	5	XOR r, m	XOR m, #i
0 1 1 0	6	OR r, m	OR m, #i
0 1 1 1	7	RET RETSK RORC r STOP s HALT h NOP	
1 0 0 0	8	LD r, m	ST m, r
1 0 0 1	9	SKE m, #i	SKGE m, #i
1 0 1 0	A		
1 0 1 1	B	SKNE m, #i	SKLT m, #i
1 1 0 0	C	BR addr	CALL addr
1 1 0 1	D		MOV m, #i
1 1 1 0	E		SKT m, #n
1 1 1 1	F		SKF m, #n

12.2 INSTRUCTIONS

Legend:

M	: One of data memory	n	: Bit position ; 4 bits
m	: Data memory address specified by [m_H, m_L] of each bank	addr	: One of program memory address ; 11 bits
m_H	: Data memory address high (row address) ; 3 bits	a_H	: Program memory address high ; 3 bits
m_L	: Data memory address low (column address) ; 4 bits	a_M	: Program memory address middle ; 4 bits
R	: One of general register specified by [(RP), r]	a_L	: Program memory address low ; 4 bits
r	: General register address low (column address) ; 4 bits	CY	: Carry flag
RP	: General register pointer	CMP	: Compare flag
PC	: Program counter	s	: Stop release condition
SP	: Stack pointer	h	: Halt release condition
STACK	: Stack specified by (SP)	[ ]	: Address of M, R
i	: Immediate data ; 4 bits	( )	: Contents of M, R

Type	Mnemonic	Operand	Function	Operation	Machine code			
					Op code	3 bits	4 bits	4 bits
Add	ADD	r, m	Add memory to register	R← (R) + (M)	00000	m_H	m_L	r
		m, #i	Add immediate data to memory	M← (M) + i	10000	m_H	m_L	i
	ADDC	r, m	Add memory to register with carry	R← (R) + (M) + (CY)	00010	m_H	m_L	r
		m, #i	Add immediate data to memory with carry	R← (M) + i + (CY)	10010	m_H	m_L	i
Subtract	SUB	r, m	Subtract memory from register	R← (R) − (M)	00001	m_H	m_L	r
		m, #i	Subtract immediate data from memory	M← (M) − i	10001	m_H	m_L	i
	SUBC	r, m	Subtract memory from register with borrow	R← (R) − (M) − (CY)	00011	m_H	m_L	r
		m, #i	Subtract immediate data from memory with borrow	M← (M) − i − (CY)	10011	m_H	m_L	i
Compare	SKE	m, #i	Skip if memory equal to immediate data	M−i, skip if zero	01001	m_H	m_L	i
	SKGE	m, #i	Skip if memory greater than or equal to immediate data	M−i, skip if not borrow	11001	m_H	m_L	i
	SKLT	m, #i	Skip if memory less than immediate data	M−i, skip if borrow	11011	m_H	m_L	i
	SKNE	m, #i	Skip if memory not equal to immediate data	M−i, skip if not zero	01011	m_H	m_L	i
Logical operation	AND	m, #i	Logical AND of memory and immediate data	M← (M) AND i	10100	m_H	m_L	i
		r, m	Logical AND of register and memory	R← (R) AND (M)	00100	m_H	m_L	r
	OR	m, #i	Logical OR of memory and immediate data	M← (M) OR i	10110	m_H	m_L	i
		r, m	Logical OR of register and memory	R← (R) OR (M)	00110	m_H	m_L	r
	XOR	m, #i	Logical XOR of memory and immediate data	M← (M) XOR i	10101	m_H	m_L	i
		r, m	Logical XOR of register and memory	R← (R) XOR (M)	00101	m_H	m_L	r
Transfer	LD	r, m	Load memory of register	R← (M)	01000	m_H	m_L	r
	ST	m, r	Store register to memory	(M)←R	11000	m_H	m_L	r
	MOV	m, #i	Move immediate data to memory	M←i	11101	m_H	m_L	i
Test	SKT	m, #n	Test memory bits, then skip if all bits specified are true	CMP←0 skip if M_n=all "1"	11110	m_H	m_L	n
	SKF	m, #n	Test memory bits, then skip if all bits specified are false	CMP←0 skip if M_n=all "0"	11111	m_H	m_L	n

Type	Mnemonie	Operahd	Function	Operation	Machine code			
					Op code	3 bits	4 bits	4 bits
Branch	BR	addr	Jump to the address	PC←ADDR	01100	a_H	a_M	a_L
Shift	RORC	r	Rotate register right with carry	(CY)→(R)→CY	00111	000	0111	r
Subroutine	CALL	addr	Call subroutine	SP←(SP) − 1 STACK←((PC) + 1), PC←ADDR	11100	a_H	a_M	a_L
	RET		Return to main routine from subroutine	PC←(STACK), SP←(SP) + 1	00111	000	1110	0000
	RETSK		Return to main routine from subroutine, then skip unconditionary	PC←(STACK), SP←(SP) + 1 and skip	00111	001	1110	0000
Miscell-aneous	STOP	s	Stop clock	STOP	00111	010	1111	s
	HALT	h	Halt the CPU, restart by condition h	HALT	00111	011	1111	h
	NOP		No operation	No Operation	00111	100	1111	0000

13. ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

Supply Voltage	V_{DD}			−0.3 to +7.0	V
Supply Voltage	V_{PP}			−0.3 to +13.5	V
Input Voltage	V_I	P0A, P0C, P0D		−0.3 to V_{DD}+0.3	V
		P0B		−0.3 to +11	V
Output Voltage	V_O	P0A, P0C, P0D		−0.3 to V_{DD}+0.3	V
		P0B		−0.3 to +11	V
High-Level output Current	I_{OH}	Each of P0A, P0B, P0C, P0D		−5	mA
		Total of all pins		−15	mA
Low-Level output Current	I_{OL}	Each of P0A, P0B, P0C, P0D		30	mA
		Total of all pins		100	mA
Operating Temperature	T_{opt}			−40 to +85	°C
Storage Temperature	T_{stg}			−65 to +150	°C
Power Consumption	P_d	T_a = 85 °C	22-pin shrink DIP	400	mW
			24-pin SOP	250	

CAPACITY (T_a = 25 °C, V_{DD} = 0 V)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Input Capacitance	C_{IN}			15	pF	f = 1 MHz
Input/Output Capacitance	C_{IO}			15	pF	0 V for pins other than pins to be measured

DC CHARACTERISTICS (T_a = −40 to +85 °C, V_{DD} = 2.5 to 6.0 V)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION	
High-Level Input Voltage	V_{IH1}	0.7 V_{DD}		V_{DD}	V	Other than the following pins and port	
	V_{IH2}	0.8 V_{DD}		V_{DD}	V	P0B and $\overline{RESET}$	
	V_{IH3}	0.8 V_{DD}		9	V	P0B	(*)
	V_{IH4}	V_{DD} − 0.5		V_{DD}	V	OSC_1	
Low-Level Input Voltage	V_{IL1}	0		0.3 V_{DD}	V	Other than the following pins and port	
	V_{IL2}	0		0.2 V_{DD}	V	P0B and $\overline{RESET}$	
	V_{IL3}	0		0.5	V	OSC_1	
High-Level Output Voltage on P0A, P0C, and P0D	V_{OH}	V_{DD} − 2.0			V	V_{DD} = 4.5 to 6.0 V, I_{OH} = −2 mA	
		V_{DD} − 1.0			V	I_{OH} = −200 μA	
Low-Level Output Voltage on P0A, P0B, P0C, and P0D	V_{OL}			2.0	V	V_{DD} = 4.5 to 6.0 V, I_{OL} = 15 mA	
				0.5	V	I_{OL} = 600 μA	
High-Level Input Leakage Current on P0A to P0D	I_{LIH1}			5	μA	V_{IN} = V_{DD}	
	I_{LIH2}			10	μA	V_{IN} = 9 V	(*)
Low-Level Input Leakage Current on P0A to P0D	I_{LIL}			−5	μA	V_{IN} = 0 V	
High-Level Output Leakage Current on P0A to P0D	I_{LOH1}			5	μA	V_{OUT} = V_{DD}	
	I_{LOH2}			10	μA	V_{OUT} = 9 V	(*)
Low-Level Output Leakage Current on P0A to P0D	I_{LOL}			−5	μA	V_{OUT} = 0 V	
Power Supply Current	I_{DD1}		0.4	1.2	mA	Operation mode	V_{DD} = 5 V ±10%, f_{CC} = 1.0 MHz ±20%
			50	150	μA		V_{DD} = 3 V ±10% f_{CC} = 250 kHz ±20%
	I_{DD2}		0.3	0.9	mA	HALT mode	V_{DD} = 5 V ±10%, f_{CC} = 1.0 MHz ±20%
			40	120	μA		V_{DD} = 3 V ±10% f_{CC} = 250 kHz ±20%
	I_{DD3}		0.1	10	μA	STOP mode	V_{DD} = 5 V ±10%
			0.1	5	μA		V_{DD} = 3 V ±10%

* When N-ch open-drain input/output is selected

CHARACTERISTICS OF DATA MEMORY FOR HOLDING DATA ON LOW SUPPLY VOLTAGE IN THE STOP MODE (T_a = −40 to +85 °C)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Data Hold Supply Voltage	V_{DDDR}	2.0		6.0	V	
Data Hold Supply Current	I_{DDDR}		0.1	5.0	μA	V_{DDDR} = 2.0 V
Release Signal Set Time	t_{SREL}	0			μs	

AC CHARACTERISTICS (T_a = -40 to +85 °C, V_{DD} = 2.5 to 6.0 V)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Internal Clock Cycle Time	T_{CY}	6.6		160	μs	V_{DD} = 4.5 to 6.0 V
		26.6		160	μs	
High/Low Level Width on $P0B_0$ and $P0B_1$	T_{PBH} T_{PBL}	10			μs	
High/Low Level Width on $\overline{RESET}$	T_{RSH} T_{RSL}	10			μs	

DC PROGRAMMING CHARACTERISTICS (T_a = 25 °C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.5 V)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Input Voltage High	V_{IH1}	0.7 V_{DD}		V_{DD}	V	Except OSC_1
	V_{IH2}	V_{DD} −0.5		V_{DD}	V	OSC_1
Input Voltage Low	V_{IL1}	0		0.3 V_{DD}	V	Except OSC_1
	V_{IL2}	0		0.4	V	OSC_1
Input Leakage Current	I_{LI}			10	μA	V_{IN} = V_{IL} or V_{IH}
Output Voltage High	V_{OH}	V_{DD} −1.0			V	I_{OH} = −1 mA
Output Voltage Low	V_{OL}			0.4	V	I_{OL} = 1.6 mA
V_{DD} Power Supply Current	I_{DD}			30	mA	
V_{PP} Power Supply Current	I_{PP}			30	mA	MD0 = V_{IL}, MD1 = V_{IH}

Notes 1. V_{PP} must be under +13.5 V including overshoot.
2. V_{DD} must be applied before V_{PP} on and must be off after V_{PP} off.

AC PROGRAMMING CHARACTERISTICS (T_a = 25 °C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.5 V)

CHARACTERISTICS	SYMBOL	(*1)	MIN.	TYP.	MAX.	UNIT	CONDITION
Address Set Up Time to MD0↓ (*2)	t_{AS}	t_{AS}	2			μs	
MD1 Setup Time to MD0↓	t_{M1S}	t_{OES}	2			μs	
Data Setup Time to MD0↓	t_{DS}	t_{DS}	2			μs	
Address Hold Time to MD0↑ (*2)	t_{AH}	t_{AH}	2			μs	
Data Hold Time to MD0↑	t_{DH}	t_{DH}	2			μs	
Data Output Float Delay Time from MD0↑→	t_{DF}	t_{DF}	0		130	ns	
V_{PP} Setup Time to MD3↑	t_{VPS}	t_{VPS}	2			μs	
V_{DD} Setup Time to MD3↑	t_{VDS}	t_{VCS}	2			μs	
Initial Program Pulse Width	t_{PW}	t_{PW}	0.95	1.0	1.05	ms	
Additional Program Pulse Width	t_{OPW}	t_{OPW}	0.95		21.0	ms	
MD0 Setup Time to MD1↑	t_{MOS}	t_{CES}	2			μs	
Data Output Delay Time from MD0↓→	t_{DV}	t_{DV}			1	μs	
MD1 Hold Time to MD0↑	t_{M1H}	t_{OEH}	2			μs	MD0 = MD1 = V_{IL}
MD1 Recovery Time to MD0↓	t_{M1R}	t_{OR}	2			μs	
Program Counter Reset Time	t_{PCR}	–	10			μs	$t_{M1H} = t_{M1R} \geq 50$ μs
OSC_1 Input High, Low Level Range	t_{XH}, t_{XL}	–	0.42			μs	
OSC_1 Input Frequency	f_{OSC}				1.2	MHz	
Initial Mode Set Time	t_I	–	2			μs	
MD3 Setup Time to MD1↑	t_{M3S}	–	2			μs	
MD3 Hold Time to MD1↓	t_{M3H}	–	2			μs	
MD3 Setup Time to MD0↓	t_{M3SR}	–	2			μs	Read program memory
Data Output Delay Time From Address (*2)	t_{DAD}	–	2			μs	Read program memory
Data Output Hold Time From Address (*2)	t_{HAD}	t_{ACC}	0		130	ns	Read program memory
MD3 Hold Time to MD0↑	t_{M3HR}	t_{OH}	2			μs	Read program memory
Data Output float Delay Time From MD3↓→	t_{DFR}	–	2			μs	Read program memory
Reset Setup Time	t_{RES}	–	10			μs	

*1 Symbols for corresponding μPD27C256.
*2 Internal address signal is incremented by one at the falling edge of the third OSC_1 input, and it is not connected to the pin.

Write program memory timing