NEC

MOS INTEGRATED CIRCUIT

μPD61P24

4-BIT SINGLE-CHIP MICROCONTROLLER FOR REMOTE CONTROL TRANSMISSION

DESCRIPTION

The μPD61P24 is a 4-bit single-chip microcontroller for infrared remote controllers for TVs, VCRs, stereos, cassette decks, air conditioners, etc.

As the μPD61P24 is user-programmable, it is ideal for evaluation of programs running in a μPD6124A or 6600A, and for small-scale production of such systems.

The functions of the μPD61P24 are described in detail in the following User's Manual. Be sure to read this manual before designing your system.

μPD612X Series User's Manual: IEP-1083

FEATURES

- Transmitter for programmable infrared remote controller
- 19 types of instructions
- Instruction execution time: 17.6 μs (with 455-kHz ceramic resonator)
- On-chip one-time PROM: 1002 × 10 bits
- Data memory (RAM) capacity : 32 × 5 bits
- 9-bit programmable timer: 1 channel
- I/O pins ($K_{I/O}$): 8 pins
- Input pins (K_I): 4 pins
- Serial input pins (S-IN): 1 pin
- Transmission-in-progress indication pin (S-OUT): 1 pin
- Transmit carrier frequency (REM)
  $f_{OSC}/12$, $f_{OSC}/8$
- Standby operation (HALT/STOP mode)
- Low power consumption
- Current consumption in STOP mode (T_A = 25°C)
  1 μA MAX.
- Low-voltage operation: V_{DD} = 2.2 to 5.5 V

Caution To use the NEC transmission format, ask NEC to supply the custom code.

★ **Do no use R_0 when using a register as an operand of the branch instruction.**

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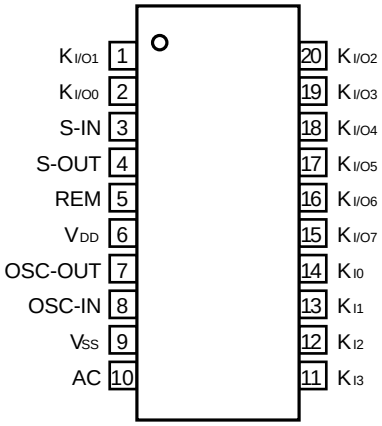
The mark ★ shows major revised points.

ORDERING INFORMATION

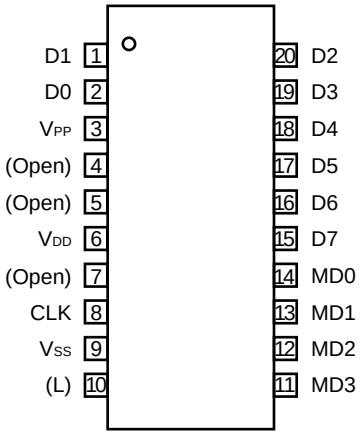
Part Number	Package
μPD61P24CS	20-pin plastic shrink DIP (300 mil)
μPD61P24GS	20-pin plastic SOP (300 mil)

PIN CONFIGURATION (Top View)

(1) Normal operating mode



(2) PROM programming mode

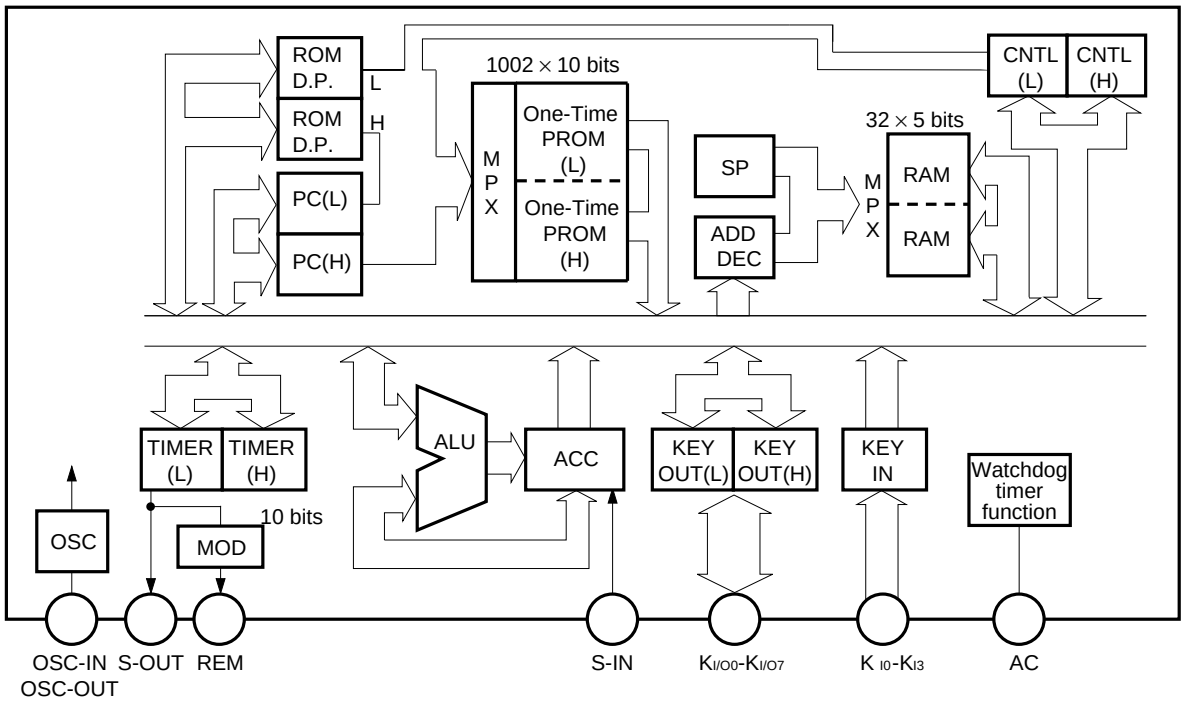


Caution Round brackets ( ) indicate the pins not used in the PROM programming mode.

L : Connect each of these pins to GND via a resistor (470 Ω).

Open: Leave these pins open.

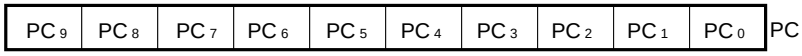
BLOCK DIAGRAM



1. PROGRAM COUNTER (PC) ……. 10 BITS

The program counter (PC) is a binary counter, which holds the address information for the program memory.

Figure 1-1. Program Counter Organization



Normally, the program counter contents are automatically incremented each time an instruction is executed, according to the number of instruction bytes.

When executing a jump instruction (JMP0, JC, JF), the program counter indicates the jump destination.

Immediate data or the data memory contents are loaded to all or some bits of the PC.

When executing the call instruction (CALL0), the PC contents are incremented (+1) and saved into the stack memory. Then, a value needed for each jump instruction will be loaded.

When executing the return instruction (RET), the stack memory contents are double incremented (+2) and loaded into the PC.

When “all clear” is input or on reset, the PC contents are cleared to “000H”.

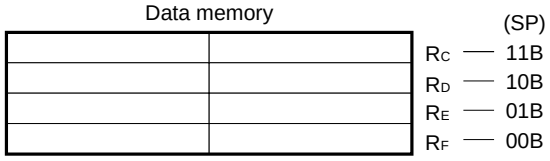
2. STACK POINTER (SP) ……. 2 BITS

This 2-bit register holds the start address information for the stack area. The stack area is shared with the data memory.

The SP contents are incremented, when the call instruction (CALL0) is executed. They are decremented, when the return instruction (RET) is executed.

The stack pointer is cleared to “00B” after reset or “all clear” is input, and indicates the highest address FH for the data memory as the stack area.

The figure below shows the relationship for the stack pointer and the data memory area.

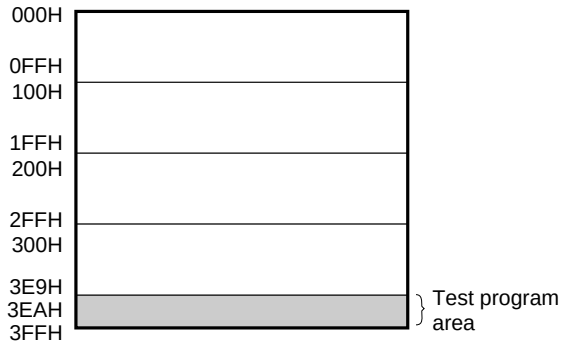


If the stack pointer overflows or underflows, it is determined that the CPU overflows, and the PC internal reset signal will be generated.

3. PROGRAM MEMORY (ROM) ..... 1002 STEPS × 10 BITS

The program memory (ROM) is configured in 10 bits steps. It is addressed by the program counter. Program and table data are stored in the program memory.

Figure 3-1. Program Memory Map

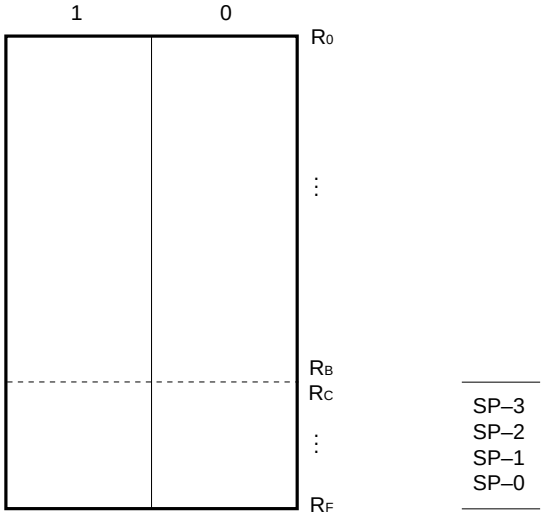


4. DATA MEMORY (RAM) ..... 32 WORDS × 5 BITS

The data memory is a RAM of 32 words × 5 bits. The data memory stores processing data. In some cases, the data memory is processed in 8-bit units. R_0 may be used as the data pointer for the ROM.

★ After power application, the RAM will be undefined. The RAM retains the previous data on reset.

Figure 4-1. Data Memory Organization



★ **Caution Avoid using the RAM areas R_D, R_E, and R_F in a CALL routine as much as possible because these areas are also used as stack memory areas (to prevent program hang-up in case the value of the SP is destroyed due to some reason such as noise).**
When using these RAM areas as general-purpose RAM areas, be sure to include stack pointer checking in the main routine.

5. DATA POINTER (R_0)

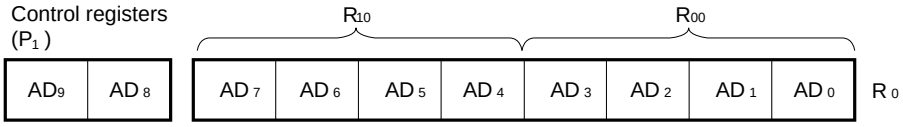
R_0 (R_{10}, R_{00}) for the data memory can serve as the data pointer for the ROM.

R_0 specifies the low-order 8 bits in the ROM address. The high-order 2 bits in the ROM address are specified by the control register.

Table referencing for ROM data can be easily executed by calling the ROM contents by setting the ROM address to the data pointer.

★ On reset or "all clear" is input, it becomes undefined.

Figure 5-1. Data Pointer Organization

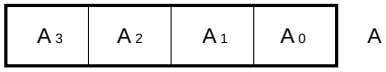


6. ACCUMULATOR (A) ……. 4 BITS

The accumulator (A) is a 4-bit register. The accumulator plays a major role in each operation.

★ On reset or "all clear" is input, it becomes undefined.

Figure 6-1. Accumulator Organization



7. ARITHMETIC LOGIC UNIT (ALU) ……. 4 BITS

The arithmetic logic unit (ALU) is a 4-bit operation circuit, and executes simple operations, such as arithmetic operations.

8. FLAGS

(1) Status flag

When the status for each pin is checked by the STTS instruction, if the condition coincides with the condition specified by the STTS instruction, the status flag (F) is set (to 1).

★ On reset or "all clear" is input, it becomes undefined.

(2) Carry flag

When the INC (increment) instruction or the RL (rotate left) instruction is executed, if a carry is generated from the MSB for the accumulator, the carry flag (C) is set (to 1).

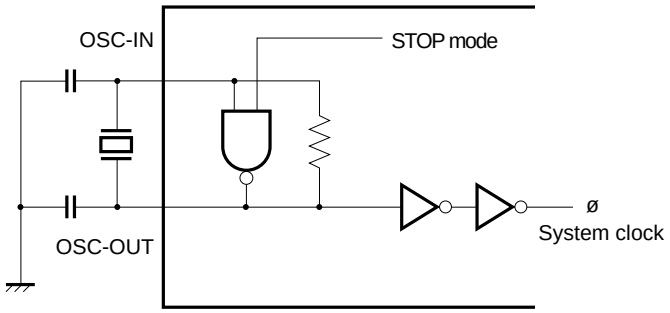
The carry flag (C) is also set (to 1), if the contents for the accumulator are "FH", when the SCAF instruction is executed.

★ On reset or "all clear" is input, it becomes undefined.

9. SYSTEM CLOCK GENERATOR

The system clock generator consists of a resonator, which uses a ceramic resonator (400kHz to 500kHz).

Figure 9-1. System Clock Generator



In the STOP mode (oscillation stop HALT instruction), the oscillator in the system clock generator stops its operation, and the system clock ø is stopped.

10. TIMER

The timer block determines the transmission output pattern. The timer consists of 10 bits, of which 9 bits serve as the 9-bit down counter and the remaining 1 bit serves as the 1-bit latch, which determines the carrier output validity.

The 9-bit down counter is decremented (–1) every 8/f_{OSC}(s) in synchronization with the machine cycle, after starting down count operation. Down counting stops after all of the 9 bits become 0. When down counting is stopped, the signal indicating that the timer operation has stopped, is output. If the CPU is at standby (HALT TIMER) for
★ the timer operation completion, the standby (HALT) condition is released and the next instruction will be executed. If the next instruction again sets the value of the down counter, down counting continues without any error (the carrier output of the REM pin is not affected).

Set the down count time according to the following calculation; (set value (HEX) + 1) × 8/f_{OSC}. Setting the value to the timer is done by the timer manipulation instruction.

When the down counter is operating, the remote control transmission carrier can be output to the REM pin. Whether or not to output the carrier can be selected by the MSB for the timer register block. Set "1", when outputting the carrier, or "0", when not outputting the carrier.

If all the down counter bits become "0", when outputting the carrier, the carrier output will be stopped. When not outputting the carrier, the REM pin output will become low level.

A signal in synchronization with the REM output is output to the S-OUT pin. However, the waveform for the S-OUT pin is low, when the carrier is being output to the REM pin, or it is high, when the carrier is not being output to the REM pin.

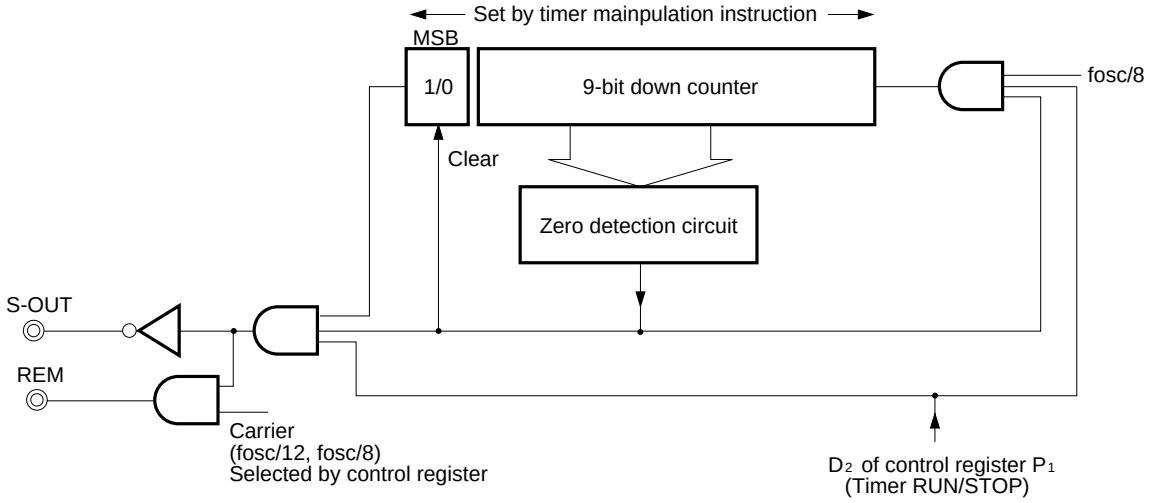
If the HALT instruction, which initiates the oscillation stop mode, is executed when the down counter is operating, the oscillation stop mode is initiated after down counting is stopped (after 0).

Timer operation STOP/RUN is controlled by the control register (P_1). (Refer to **13. CONTROL REGISTER (P_1)**.)

★ At reset (all clear) time, the REM pin goes low and S-OUT pin goes high. All 10 bits of the timer are cleared to 000H.

Caution Because the timer clock is not synchronized with the carrier output, the pulse width may be shortened at the beginning and end of the carrier output.

Figure 10-1. Timer Block Organization



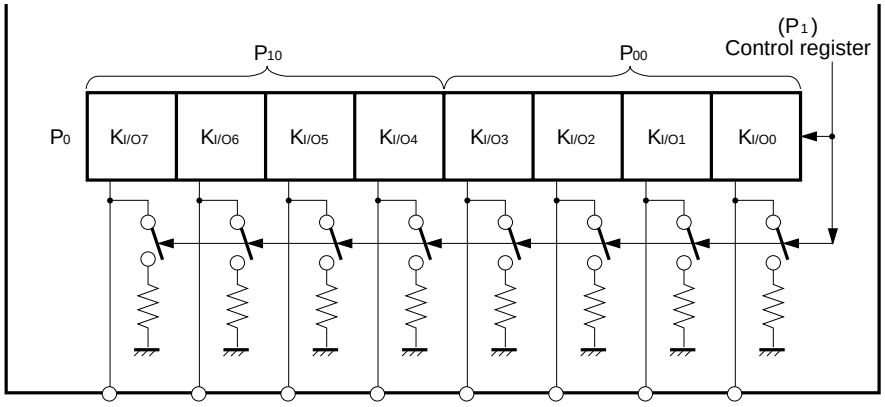
11. PIN FUNCTIONS

11.1 $K_{I/O}$ Pin (P_0)

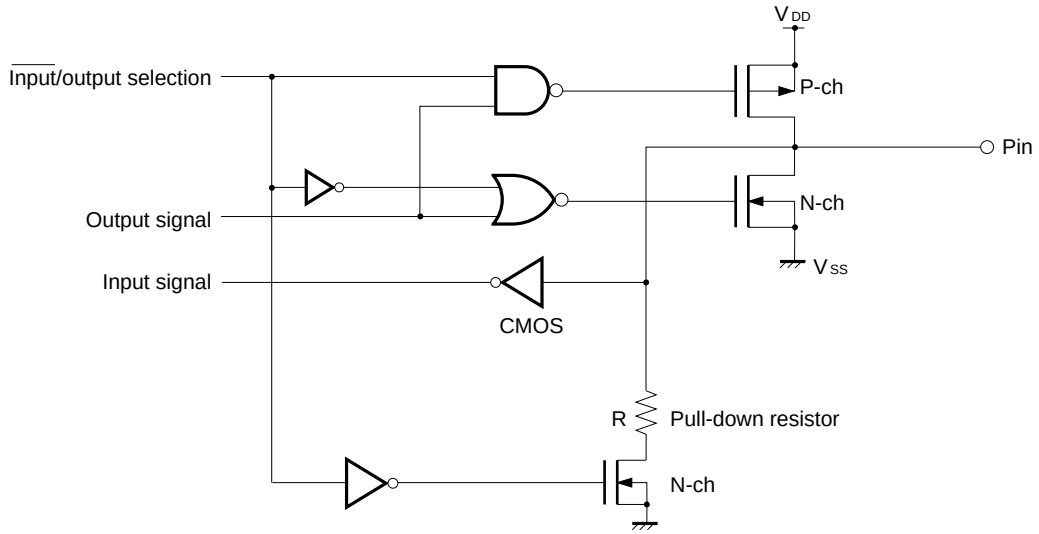
This is the 8-bit I/O pin for key-scan output. When the control register (P_1) is set for the input port, the port can be used as an 8-bit input pin. When the port is set for the input mode, all of these pins are pulled down to the V_{SS} level inside the LSI.

★ At reset (all cleared), the value of I/O mode and output latch becomes undefined.

Figure 11-1. $K_{I/O}$ Pin Organization



11.2 $K_{I/O}$ Pull-Down Resistor Configuration

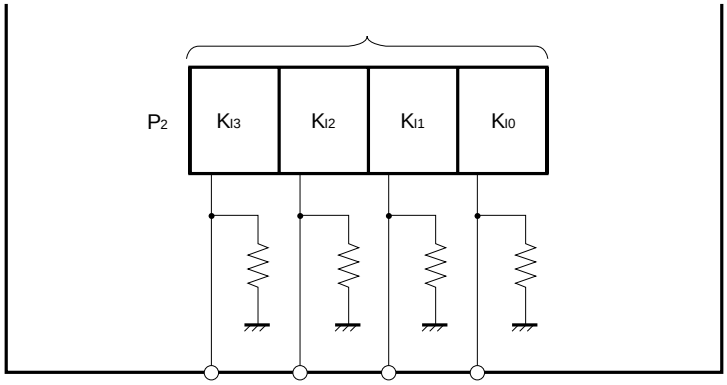


When $K_{I/O}$ is set to the input mode, pull-down resistor R is turned on.

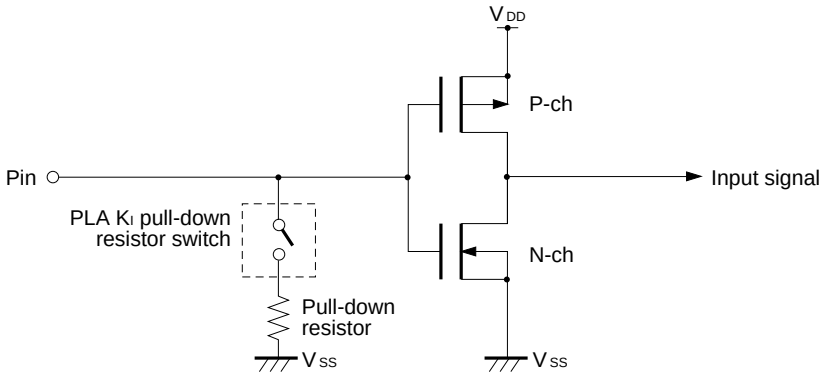
11.3 K_I Pin (P_{12})

This is the 4-bit pin for key input. All of these pins are pulled down to the V_{SS} level by PLA data.

Figure 11-2. K_I Pin Organization



11.4 K_I Pull-Down Resistor Configuration



When the pull-down resistor switch is turned on (set 1) by PLA data, pull-down resistor R is turned on.

11.5 S-OUT Pin

By going low whenever the carrier frequency is output from the REM pin, the S-OUT pin indicates that communication is in progress.

★ The S-OUT pin is CMOS output.

The S-OUT pin goes high on reset.

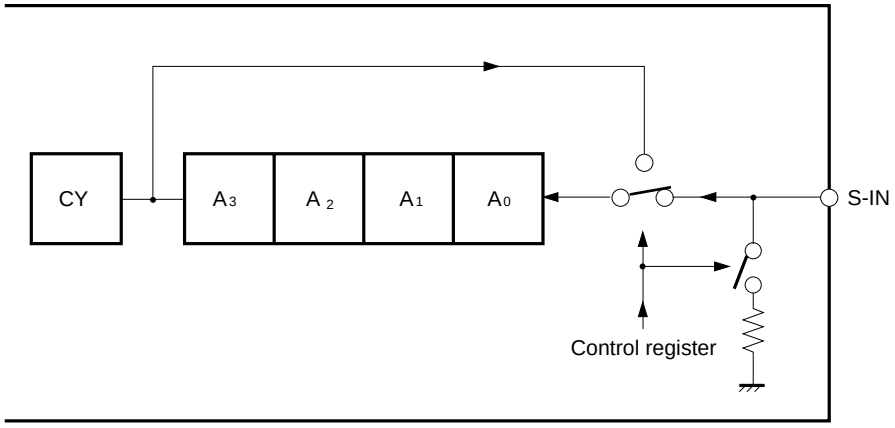
11.6 S-IN Pin (D_0 bit of P_1)

To input serial data, use the S-IN pin. When control register (P_1) is set to serial input mode, the S-IN pin is connected as an input to the LSB of the accumulator; the S-IN pin is pulled down to the V_{SS} level within the LSI. In this state, if the rotate-left accumulator instruction (RL A) is executed, the data on the S-IN pin is copied to the LSB of the accumulator.

If the control register is released from serial input mode, the S-IN pin goes into a high-impedance state, but no through current flows internally. When the RL A instruction is executed, the MSB is copied to the LSB.

★ At reset (all cleared), the S-IN pin goes into a high-impedance state.

★ **Figure 11-3. Configuration of the S-IN Pin**



★ 12. PORT REGISTER ($P_{\times}$)

$K_{I/O}$, K_I, and the control register are handled as port registers.
The table below shows the relations between the port registers and pins.

Table 12-1. Relations between Port Registers and Pins

Pin Name	Input Mode		Output Mode		On Reset
	Read	Write	Read	Write	
$K_{I/O}$	Pin status	Output latch	Pin status	Output latch	Undefined [input mode, output latch]
K_I	Pin status	–	–	–	Input mode
S-IN	Pin status is read by RL A instruction when D_0 of P_1 register = 1.				High impedance (D_0 of P_1 register = 0)

$P_{1\times}$ (H)	$P_{0\times}$ (L)	
$K_{I/O7-4}$ P_{10}	$K_{I/O3-0}$ P_{00}	P_0
Control register (H) P_{11}	Control register (L) P_{01}	P_1
K_{I3-0} P_{12}	— P_{02}	P_2

13. CONTROL REGISTER (P_1)

The control register contains of 10 bits. The controllable items are shown in Table 13-1.

Table 13-1. Control Register (P_1)

Bit		D_9	D_8	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
Name		Test mode		–	HALT	D.P. AD_9	D.P. AD_8	MOD	Timer	$K_{I/O}$	RL A_{CC} $A_0 \leftarrow$
Set Value	0	Be sure to set 0.			NOP	AD_9=0	AD_8=0	f_{OSC}/8	STOP	IN	A_3
	1				OSC STOP	AD_9=1	AD_8=1	f_{OSC}/12	RUN	OUT	S-IN

D_0 ..... Specifies data to be input to A_0 when the accumulator is shifted to the left.
0: A_3, 1:S-IN

D_1 ..... Specifies the status of $K_{I/O}$, as follows:
0: input mode, 1: output mode

D_2 ..... Specifies the status of the timer, as follows:
0: Count stop, 1: Count execution

D_3 ..... Specifies the carrier frequency output from the REM pin.
0: f_{OSC}/8, 1: f_{OSC}/12

D_4, D_5 ..... Specify the high-order 2 bits of the ROM data pointer.

D_6 ..... Determines what happen to the oscillation circuit when the HALT instruction is executed.
0: Oscillation does not stop
1: Oscillation stops (STOP mode)

D_7 ..... Be sure to set this bit to 0.

D_8, D_9 ..... These bits specify test modes. Be sure to set them to 0.

★ **Remark** $D_0 = D_8 = D_9 = 0$ on reset, and the other bits are undefined.

14. STANDBY FUNCTION (HALT INSTRUCTION)

The μPD6600A is provided with the standby mode (HALT instruction), in order to reduce the power consumption, when not executing the program. Clock oscillation can be stopped in the standby mode (STOP mode).

In the standby mode, the program execution stops. However, the contents of the internal registers and the data memory are all retained.

14.1 STOP Mode (Oscillation stop HALT instruction)

In the STOP mode, the operation of the system clock generator (ceramic resonator oscillation circuit) stops. Therefore, operations requiring the system clock will stop.

If the HALT instruction is executed during timer operation, the program counter stops. The oscillation stop mode will be initiated, after the timer count down operation is completed.

14.2 HALT Mode (Oscillation continue HALT instruction)

The CPU stops its operation, until the HALT release condition is satisfied.

The system clock operation continues in this mode.

14.3 Standby Release Conditions

(1) S-IN input
(2) $K_{I/O}$ input
(3) K_I input
(4) Timer count down operation completion

Remark Either high level or low level can be specified for setting a release condition by input.

Table 14-1. Standby Mode Releasing Condition

D_3	D_2	D_1	D_0	Releasing Condition	Remarks
0/1	0	0	0	S-IN	When RL ← A_3 is selected, the standby mode is always released.
	0	0	1	$K_{I/O}$	Valid only in the IN mode.
	0	1	0	K_I	
0	0	1	1	Timer	Released when 0.

Releasing condition: "0"···Low level detection
"1"···High level detection

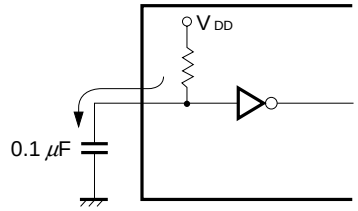
15. AC PIN (ALL CLEAR PIN)

Internal part of the CPU including the program counter can be reset by setting the AC pin to the low level.

Watchdog Timer Function

A power-on reset function and a CR watchdog timer function, that can be controlled by program, can be realized by connecting a 0.1 μF capacitor across the AC pin and the V_{SS}.

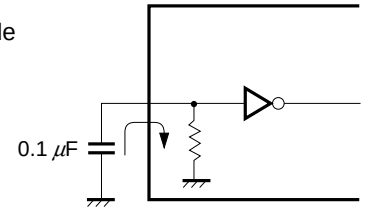
Charge mode



Charge start instruction

Execute HALT instruction immediately before NOP. (Charge for 0.4 ms or more)

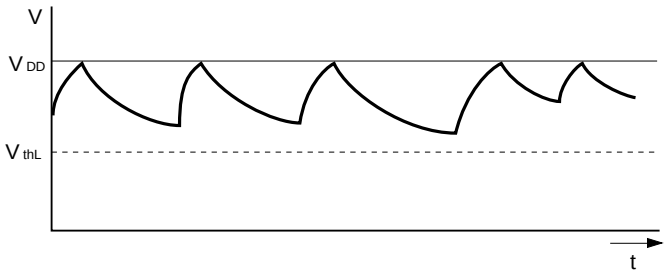
Discharge mode



Discharge start instruction

Discharge starts after the NOP instruction execution. (Discharge time is about 5 ms from V_{DD} to V_{thL})

Charge-discharge pattern



The pattern must be controlled by the program, in such a manner that the C charge level will not go below V_{thL}.

Caution When the watchdog timer function is not used, switch to charging mode by executing a NOP instruction immediately before a HALT instruction at the beginning of the program. (Be sure to connect the capacitor.)

16. MASK OPTIONS (PLA DATA)

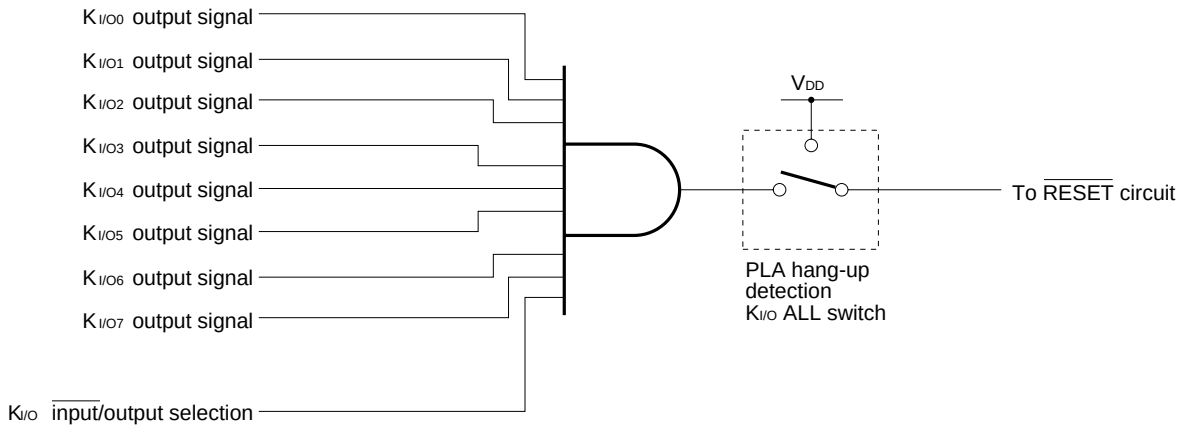
The following items are fixed by mask option:

- K_I, S-IN pin pull-down resistor provided
- Carrier duty selection (1/3) at $f_{OSC}/12$
- Hang-up detection provided

<1> $K_{I/O}$ ALL

The system is reset when the hang-up detection $K_{I/O}$ ALL switch is set to ON ("1") by PLA data and if the $K_{I/O}$ pins are in the input mode in the oscillation stop HALT mode or if even one of the $K_{I/O}$ pins is low. To use a pin as a key source of the switch, turn ON the switch with PLA data.

Figure 16-1. Hang-up Detection $K_{I/O}$ ALL Configuration Diagram



<2> HALT release condition specification (S-IN, $K_{I/O}$, K_I)

The system is reset if S-IN and $K_{I/O}$ are used in the HALT mode when S-IN and $K_{I/O}$ are specified by PLA data not to be used ("1"). K_I is used ("0").

BIT Assignment by Switch Selection

Address	Corresponding Portion	MSB 7	6	5	4	3	2	1	LSB 0
0	KI pull-down resistor[Note]	K_{I3}	K_{I2}	K_{I1}	K_{I0}	0			
		1 (Provided)	1 (Provided)	1 (Provided)	1 (Provided)				
1	Duty S-IN	0	0	0	Duty	0	0	S-IN pull-down resistor	0
					1 (1/3 duty)			1 (Provided)	
2	Hang-up detection	$K_{I/O}$ ALL	HALT S-IN	HALT $K_{I/O}$	HALT K_I	0			
		1 (Detection provided)	1 (Unused)	1 (Unused)	0 (Used)				

17. WRITING, READING, AND VERIFYING ONE-TIME PROM (PROGRAM MEMORY)

To write, read, or verify the PROM, set the PROM mode and use the pins shown in Table 17-1. No address input pin is used. To update the address, the clock signal input from the CLK pin is used.

Table 17-1. Pins Used to Write, Read, and Verify Program Memory

Symbol	Function
V_{PP}	Applies program voltage (12.5 V)
CLK	Inputs clock to update address
MD0-MD3	Selects operation mode
D0-D7	Inputs/outputs 8-bit data
V_{DD}	Applies supply voltage (6 V)

17.1 Operation Mode When Writing, Reading, and Verifying Program Memory

The μPD61P24 enters the program memory write, read, or verify mode if +6 V is applied to the V_{DD} pin and +12.5 V is applied to the V_{PP} pin after the reset status has been held a certain time (V_{DD} = 5 V, AC = low level).

In this mode, the operation modes listed in Table 17-2 can be selected by using the MD0 through MD3 pins.

Any input pins not used for writing, reading, or verifying the program memory must be open or connected to GND via a pull-down resistor (470 Ω).

Table 17-2. Operating Mode When Writing, Reading, and Verifying Program Memory

Specifies Operation Mode						Operation Mode
V_{PP}	V_{DD}	MD0	MD1	MD2	MD3	
+12.5 V	+6 V	H	L	H	L	Clears program memory address to 0
		L	H	H	H	Write mode
		L	L	H	H	Read and verify modes
		H	×	H	H	Program inhibit mode

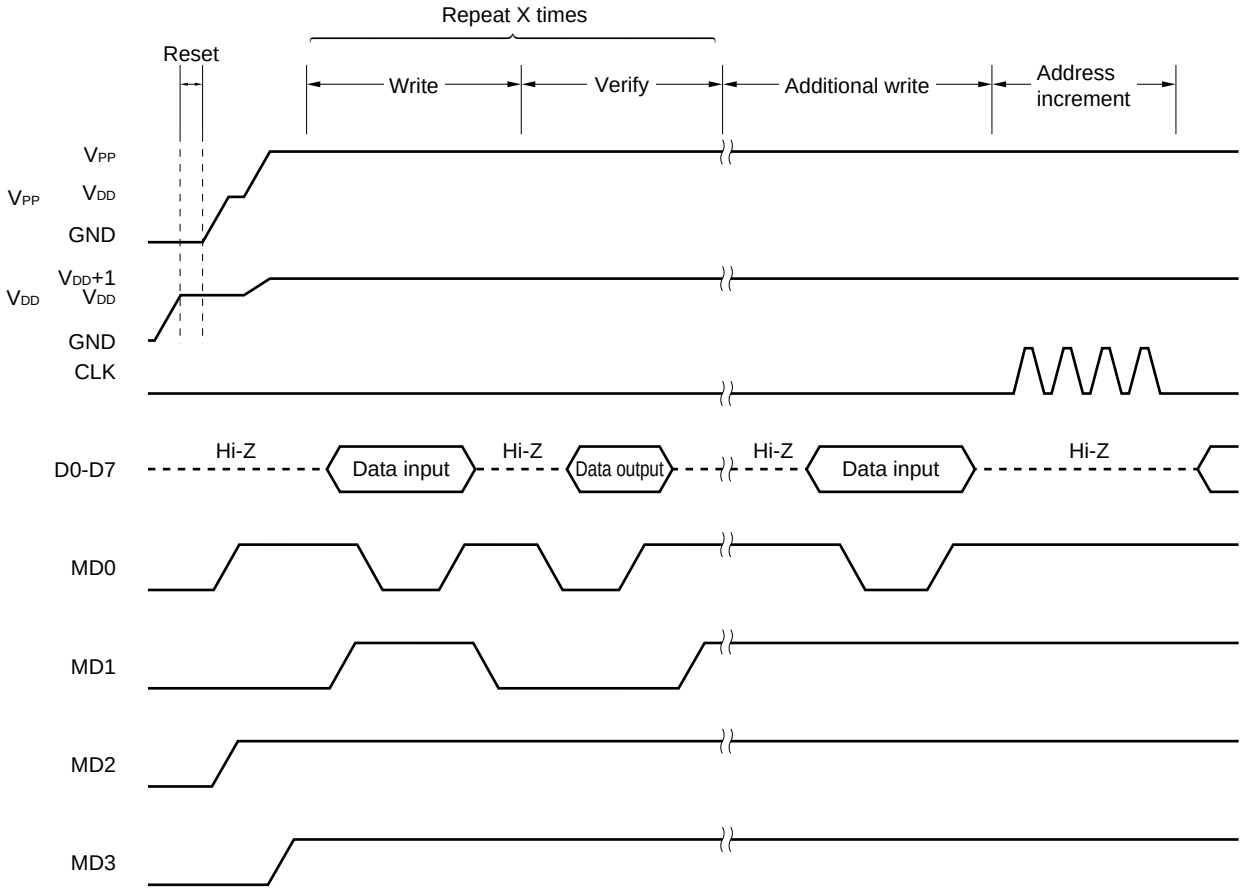
×: don't care (L or H)

17.2 Program Memory Writing Procedure

The program memory is written at high speed in the following procedure.

(1) Pull down the pins not used to GND via resistor. Keep the CLK pin low.
(2) Supply 5 V to the V_{DD} pin. Keep the V_{PP} pin low.
(3) Wait for 10 μs, and supply 5 V to the V_{PP} pin.
(4) Set the mode in which the program memory address is cleared to 0, by using the mode setting pins.
(5) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(6) Set the program inhibit mode.
(7) Write data in the 1-ms write mode.
(8) Set the program inhibit mode.
(9) Set the verify mode. If the data has been correctly written, proceed to (10). If not, repeat (7) through (9).
(10) Additional writing of (Number of times data has been written in (7) through (9): X) × 1 ms
(11) Set the program inhibit mode.
(12) Input a pulse four times to the CLK pin to update the program memory address (+1).
(13) Repeat (7) through (12) until the data is written to the last address.
(14) Set the mode in which the program memory address is cleared to 0.
(15) Change the voltage on the V_{DD} and V_{PP} pins to 5 V.
(16) Turn off power supply.

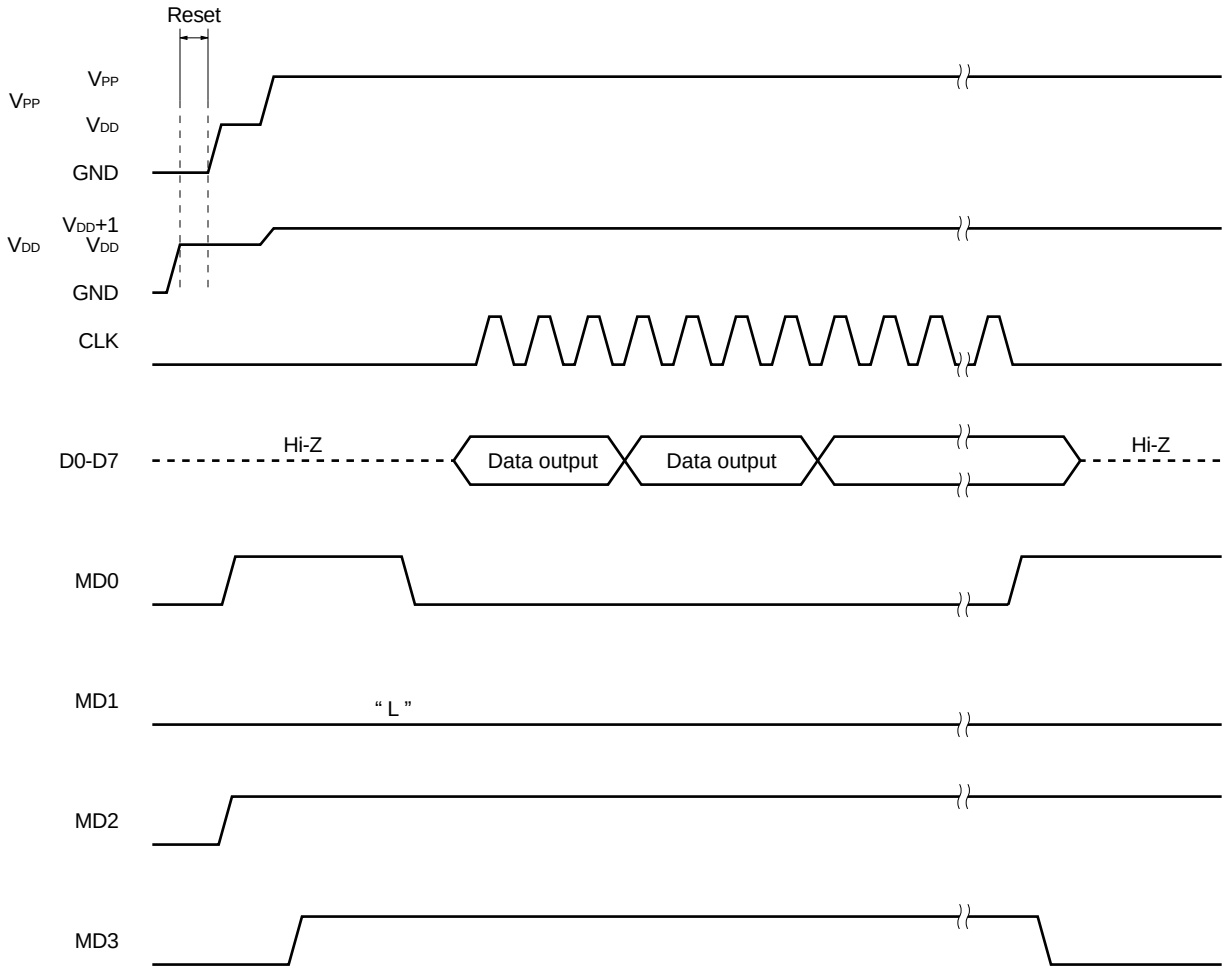
Program memory writing steps (2) through (12) are illustrated below.



17.3 Program Memory Reading Procedure

(1) Pull down the pins not used to GND via resistor. Keep the CLK pin low.
(2) Supply 5 V to the V_{DD} pin. Keep the V_{PP} pin low.
(3) Wait for 10 μs, and supply 5 V to the V_{PP} pin.
(4) Set the mode in which the program memory address is cleared to 0, by using the mode setting pins.
(5) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(6) Set the program inhibit mode.
(7) Set the verify mode. If a clock pulse is input to the CLK pin, the data of one address is output each time the pulse has been input to the CLK pin four times.
(8) Set the program inhibit mode.
(9) Set the mode in which the program memory address is cleared to 0.
(10) Change the voltage on the V_{DD} and V_{PP} pins to 5 V.
(11) Turn off power supply.

Program memory reading steps (2) through (9) are illustrated below.



18. INSTRUCTION SET

Accumulator Manipulation Instructions

	R_r	–	R_{10}	R_{11}	R_{12}		R_{1F}	R_{00}	R_{01}		R_{0F}
ANL	A, R_r		D00	D01	D02		D0F	D20	D21		D2F
ANL	A, @R_0H	D10									
ANL	A, @R_0L	D30									
ANL	A, #data	D31									
ORL	A, R_r		E00	E01	E02		E0F	E20	E21		E2F
ORL	A, @R_0H	E10									
ORL	A, @R_0L	E30									
ORL	A, #data	E31									
XRL	A, R_r		A00	A01	A02		A0F	A20	A21		A2F
XRL	A, @R_0H	A10									
XRL	A, @R_0L	A30									
XRL	A, #data	A31									
INC	A	A13									
RL	A	F13									

Input/Output Instructions

	P_P	P_{10}	P_{11}	P_{12}	P_{00}	P_{01}	P_{02}
IN	A, P_P	F18	F19	F1A	F38	F39	F3A
OUT	P_P, A	218	219	21A	238	239	23A
ANL	A, P_P	D18	D19	D1A	D38	D39	D3A
ORL	A, P_P	E18	E19	E1A	E38	E39	E3A
XRL	A, P_P	A18	A19	A1Z	A38	A39	A3A

	P_P	P_0	P_1	P_2
OUT	P_P #data	318	319	31A

P_{1P} and P_{0P} operate in pair format

Data Transfer Instructions

	R_r		R_{10}	R_{11}	R_{12}		R_{1F}	R_{00}	R_{01}		R_{0F}
MOV	A, R_r		F00	F01	F02		F0F	F20	F21		F2F
MOV	A, @R_0H	F10									
MOV	A, @R_0H	F30									
MOV	A, #data	F31									
MOV	R_r, A		200	201	202		20F	220	221		22F

	R_r		R_0	R_1	R_2		R_F
MOV	R_r, #data		300	301	302		30F
MOV	R_r, @R_0		320	321	322		32F

R_{1r} and R_{0r} operate in pair format

Branch Instructions

		R_r	–	R_0	R_1	R_2		R_F
	JMP0 addr	411						
★	JMP0 Rr^{Note}	–	–	401	402			40F
	JC addr	611						
	JC Rr^{Note}	–	–	601	602			60F
	JNC addr	631						
	JNC Rr^{Note}	–	–	621	622			62F
	JF addr	711						
	JF Rr^{Note}	–	–	701	702			70F
	JNF addr	731						
	JNF Rr^{Note}	–	–	721	722			72F

← Pair register

★ **Note** r = 1 through F
r = 0 canot be used.

Subroutine Instructions

CALL0 addr	312	411
RET	412	

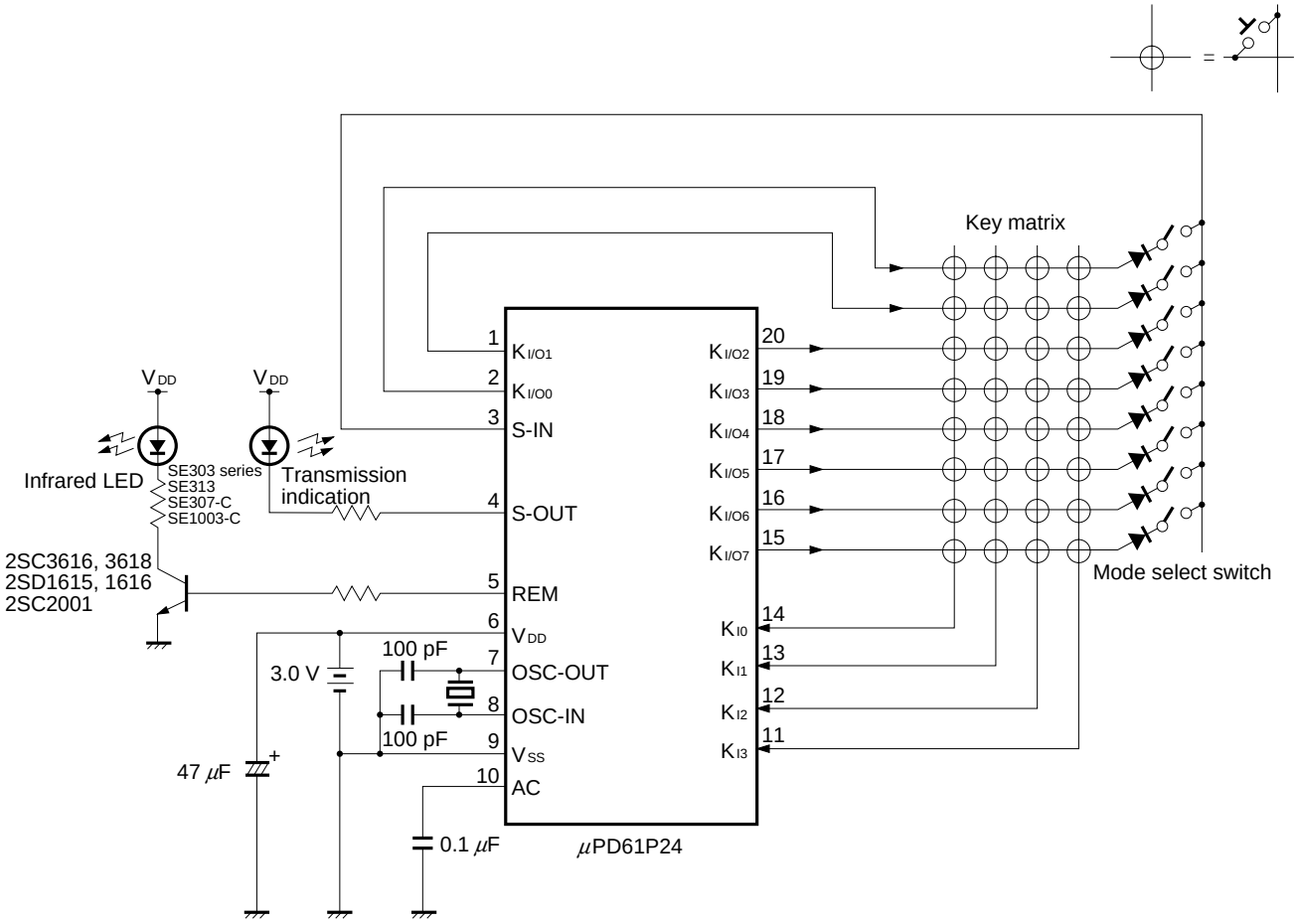
Timer/Counter Manipulation Instructions

	T_t	T_{0-1}	T_1	T_0
MOV A, T_t	–	F1F	F3F
MOV T_t, A		21F	23F
MOV T, #data	31F		
MOV T, @R_0	33F		

Other Instructions

		R_{00}	R_{01}	R_{02}		R_{0F}
HALT #data	111					
STTS R_{0r}		120	121	122		12F
STTS #data	131					
SCAF	D13					
NOP	000					

19. APPLICATION CIRCUIT EXAMPLE



Caution The ceramic resonator start up capacitor value must be determined, by taking the voltage level and the oscillation start up characteristics for the ceramic resonator into consideration.

20. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25 °C)

Parameter	Symbol	Ratings	Unit
Supply Voltage	V_{DD}	7.0	V
Input Voltage	V_{IN}	–0.3 to V_{DD} + 0.3	V
Operating Ambient Temperature	T_A	–20 to +75	°C
Storage Temperature	T_{stg}	–40 to +125	°C

Caution Even if one of the parameters exceeds its absolute maximum rating even momentarily, the quality of the product may be degraded. The absolute maximum rating therefore specifies the upper or lower limit of the value at which the product can be used without physical damages. Be sure to use the product(s) within the ratings.

Recommended Operating Range (T_A = 25 °C)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V_{DD}	2.2		5.5	V
Oscillation Frequency	f_{OSC}	400		500	kHz

DC Characteristics (V_{DD} = 3.0 V, f_{OSC} = 455 kHz, T_A = 25 °C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply Voltage	V_{DD}		2.2		5.5	V
Current Consumption 1	I_{DD1}	f_{OSC} = 455 kHz		0.3	1.5	mA
Current Consumption 2	I_{DD2}	f_{OSC} = STOP			1.0	μA
REM High Level Output Current	I_{OH1}	V_O = 1.0 V	–5	–8	–15	mA
REM Low Level Output Current	I_{OL1}	V_O = 0.3 V	0.5	1.5	2.5	mA
S-OUT High Level Output Current	I_{OH2}	V_O = 2.7 V	–0.3	–1.0	–2.0	mA
S-OUT Low Level Output Current	I_{OL2}	V_O = 0.3 V	1	1.5	2.5	mA
KI High Level Input Current	I_{IH1}	V_I = 3.0 V	10		30	μA
KI High Level Input Current	$I_{IH1'}$	V_I = 3.0 V, without pull-down resistor			0.2	μA
KI Low Level Input Current	I_{IL1}	V_I = 0 V			–0.2	μA
KI/O High Level Input Current	I_{IH2}	V_I = 3.0 V	10		30	μA
KI/O High Level Input Current	$I_{IH2'}$	V_I = 3.0 V, without pull-down resistor			0.2	μA
KI/O Low Level Input Current	I_{IL2}	V_I = 0 V			–0.2	μA
KI/O High Level Output Current	I_{OH3}	V_0 = 2.5 V	–1.5	–2.0	–4.0	mA
KI/O Low Level Output Current	I_{OL3}	V_0 = 2.1 V	25	50	100	μA
S-IN High Level Input Current	I_{IH3}	V_I = 3.0 V	6		15	μA
S-IN High Level Input Current	$I_{IH3'}$	V_I = 3.0 V, without pull-down resistor			0.2	μA
S-IN Low Level Input Current	I_{IL3}	V_I = 0 V			–0.2	μA
KI High Level Input Voltage	V_{IH1}		2.1		3.0	V
KI Low Level Input Voltage	V_{IL1}	V_I = 3.0 V	0		0.9	V
KI/O High Level Input Voltage	V_{IH2}		1.3		3.0	V
KI/O Low Level Input Voltage	V_{IL2}		0		0.4	V
S-IN High Level Input Voltage	I_{IH3}		1.1		3.0	V
S-IN Low Level Input Voltage	I_{IL3}		0		0.4	V
AC Pull-Up Resistor	R_1	V_I = 0 V	0.3		3.0	kΩ
AC Pull-Down Resistor	R_2	V_I = 2.7 V	150	400	1500	kΩ
AC High Level Input Voltage	V_{IH4}		1.8		3.0	V
AC Low Level Input Voltage	V_{IL4}		0		1.2	V

DC Programming Characteristics (T_A = 25±5 °C, V_{DD} = 6.0±0.25 V, V_{PP} = 12.5±0.5 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
High-level input voltage	V_{IH1}	Other than CLK	0.7 V_{DD}		V_{DD}	V
	V_{IH2}	CLK	V_{DD}–0.5		V_{DD}	V
Low-level input voltage	V_{IL1}	Other than CLK	0		0.3 V_{DD}	V
	V_{IL2}	CLK	0		0.4	V
Input leakage current	I_{LI}	V_{IN} = V_{IL} or V_{IH}			10	μA
High-level output voltage	V_{OH}	I_{OH} = –1 mA	V_{DD}–1.0			V
Low-level output voltage	V_{OL}	I_{OL} = 1.6 mA			0.4	V
V_{DD} supply current	I_{DD}				30	mA
V_{PP} supply current	I_{PP}	MD0 = V_{IL}, MD1 = V_{IH}			30	mA

Cautions 1. Keep V_{PP} to within +13.5 V including the overshoot.

2. Apply V_{DD} before V_{PP}, and turn it off after V_{PP}.

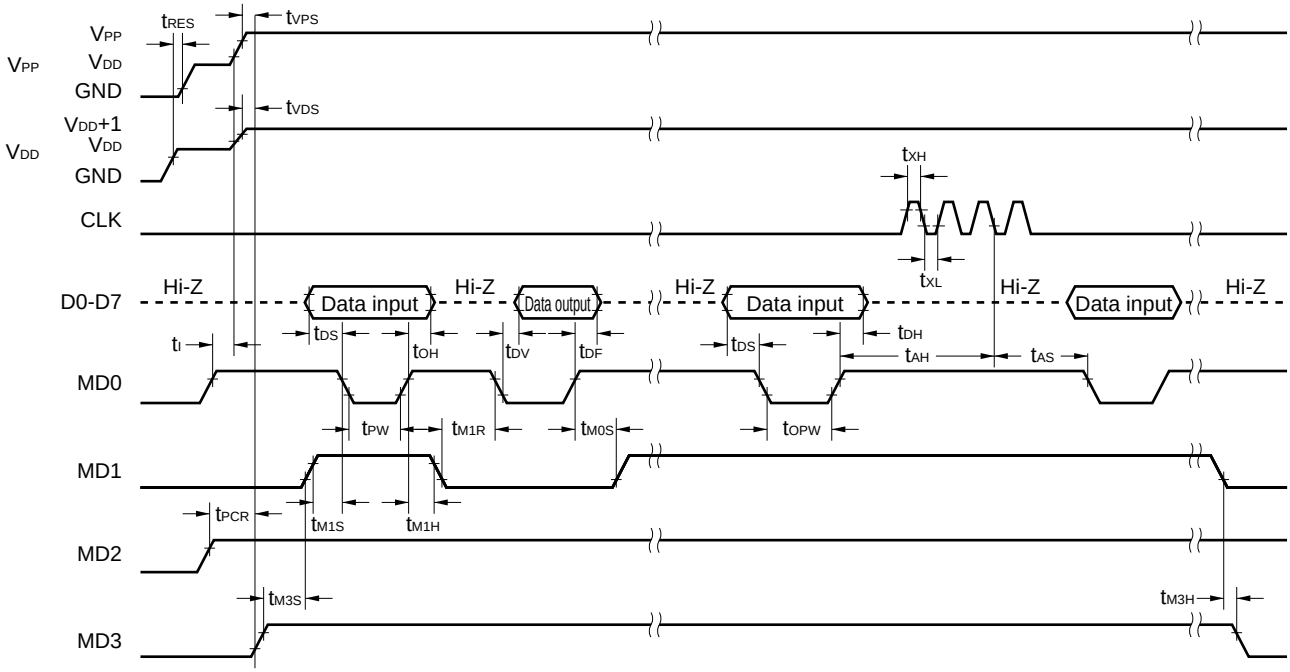
AC Programming Characteristics (T_A = 25±5 °C, V_{DD} = 6.0±0.25 V, V_{PP} = 12.5±0.5 V)

Parameter	Symbol	**Note 1**	Conditions	MIN.	TYP.	MAX.	Unit
Address setup time[Note 2] (vs. MD0↓)	t_{AS}	t_{AS}		2			μs
MD1 setup time (vs. MD0↓)	t_{M1S}	t_{OES}		2			μs
Data setup time (vs. MD0↓)	t_{DS}	t_{DS}		2			μs
Address hold time[Note 2] (vs. MD0↑)	t_{AH}	t_{AH}		2			μs
Data hold time (vs. MD0↑)	t_{DH}	t_{DH}		2			μs
MD0↑→ data output float delay time	t_{DF}	t_{DF}		0		130	ns
V_{PP} setup time (vs. MD3↑)	t_{VPS}	t_{VPS}		2			μs
V_{DD} setup time (vs. 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 (vs. MD1↑)	t_{M0S}	t_{CES}		2			μs
MD0 ↓→ data output delay time	t_{DV}	t_{DV}	MD0 = MD1 = V_{IL}			1	μs
MD1 hold time (vs. MD0↑)	t_{M1H}	t_{OEH}	t_{M1H} + t_{M1R} ≥ 50 μs	2			μs
MD1 recovery time (vs. MD0↓)	t_{M1R}	t_{OR}		2			μs
Program counter reset time	t_{PCR}	—		10			μs
CLK input high-, low-level widths	t_{XH}, t_{XL}	—		0.125			μs
CLK input frequency	f_X	—				4.19	MHz
Initial mode set time	t_I	—		2			μs
MD3 setup time (vs. MD1↑)	t_{M3S}	—		2			μs
MD3 hold time (vs. MD1↓)	t_{M3H}	—		2			μs
MD3 setup time (vs. MD0↓)	t_{M3SR}	—	On reading program memory	2			μs
Address[Note 2] → data output delay time	t_{DAD}	t_{ACC}	On reading program memory			2	μs
Address[Note 2] → data output hold time	t_{HAD}	t_{OH}	On reading program memory	0		130	ns
MD3 hold time (vs. MD0↑)	t_{M3HR}	—	On reading program memory	2			μs
MD3 ↓→ data output float delay time	t_{DFR}	—	On reading program memory			2	μs
Reset setup time	t_{RES}			10			μs

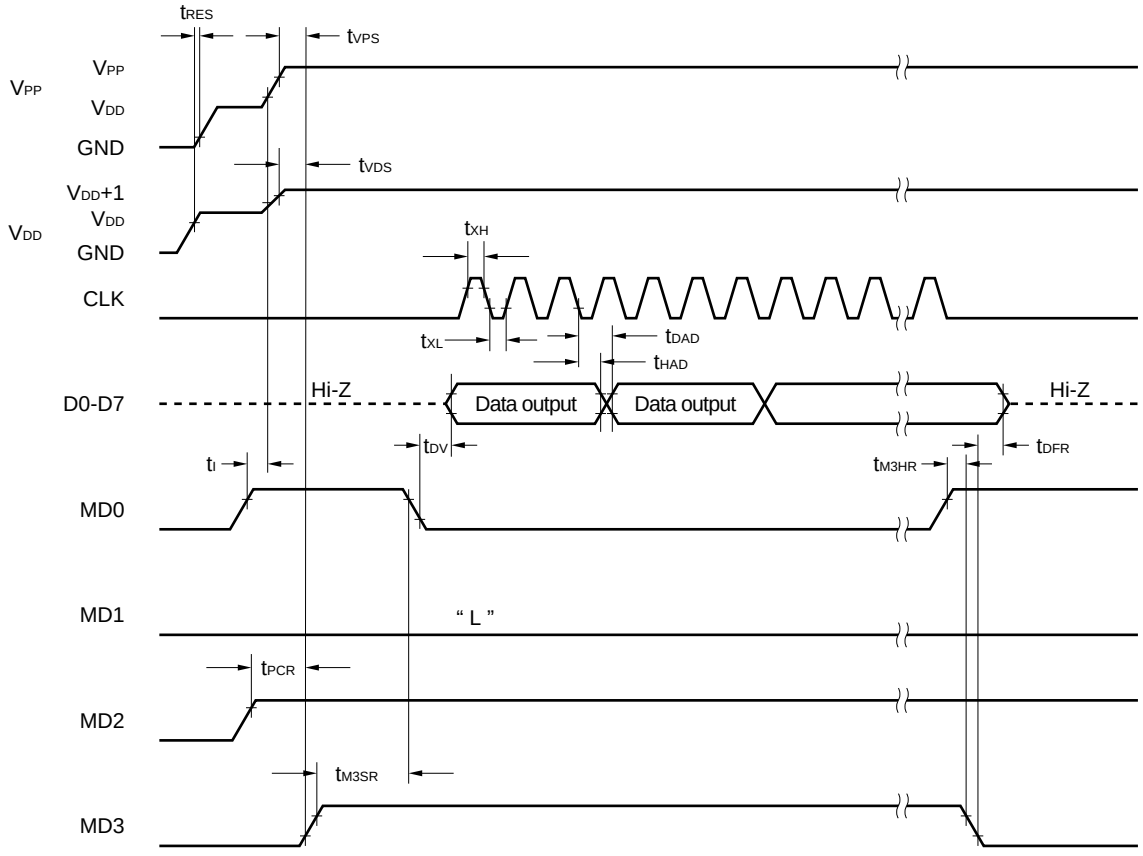
Notes 1. Corresponding symbols of μPD27C256A (the μPD27C256A is a maintenance product).

2. The internal address signal is incremented by one at the falling edge of CLK input at the third clock.

PROGRAM MEMORY WRITE TIMING

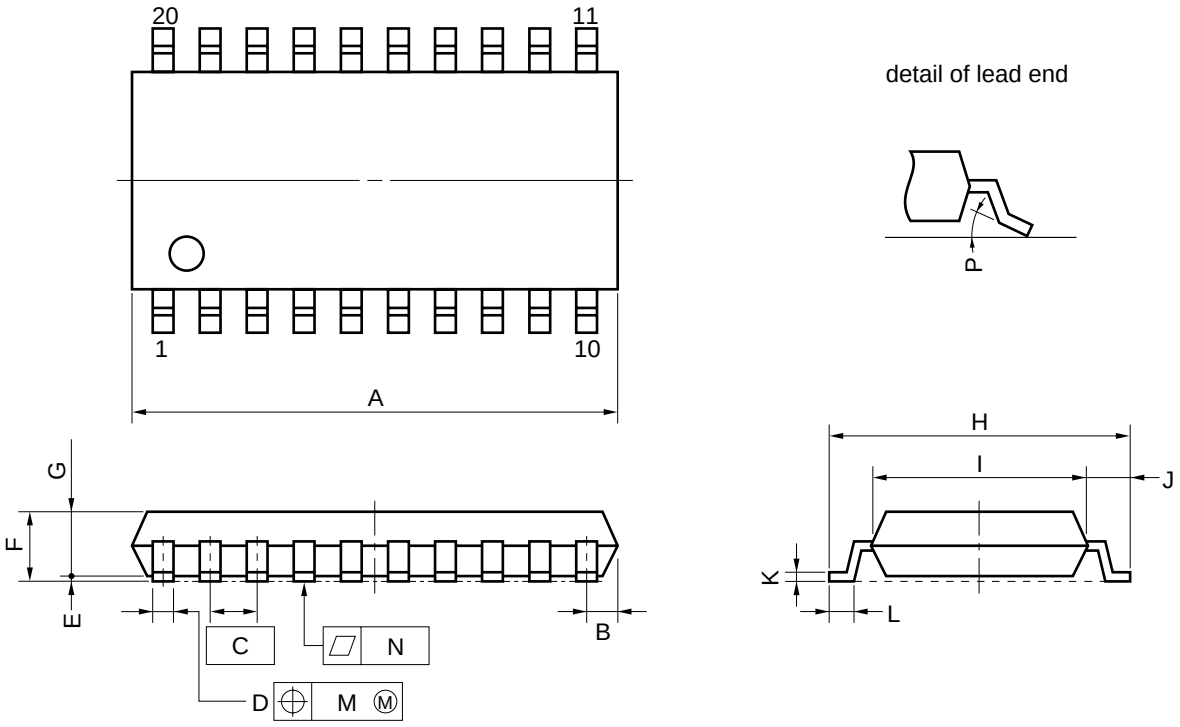


PROGRAM MEMORY READ TIMING



21. PACKAGE DRAWINGS

★ 20 PIN PLASTIC SOP (300 mil)



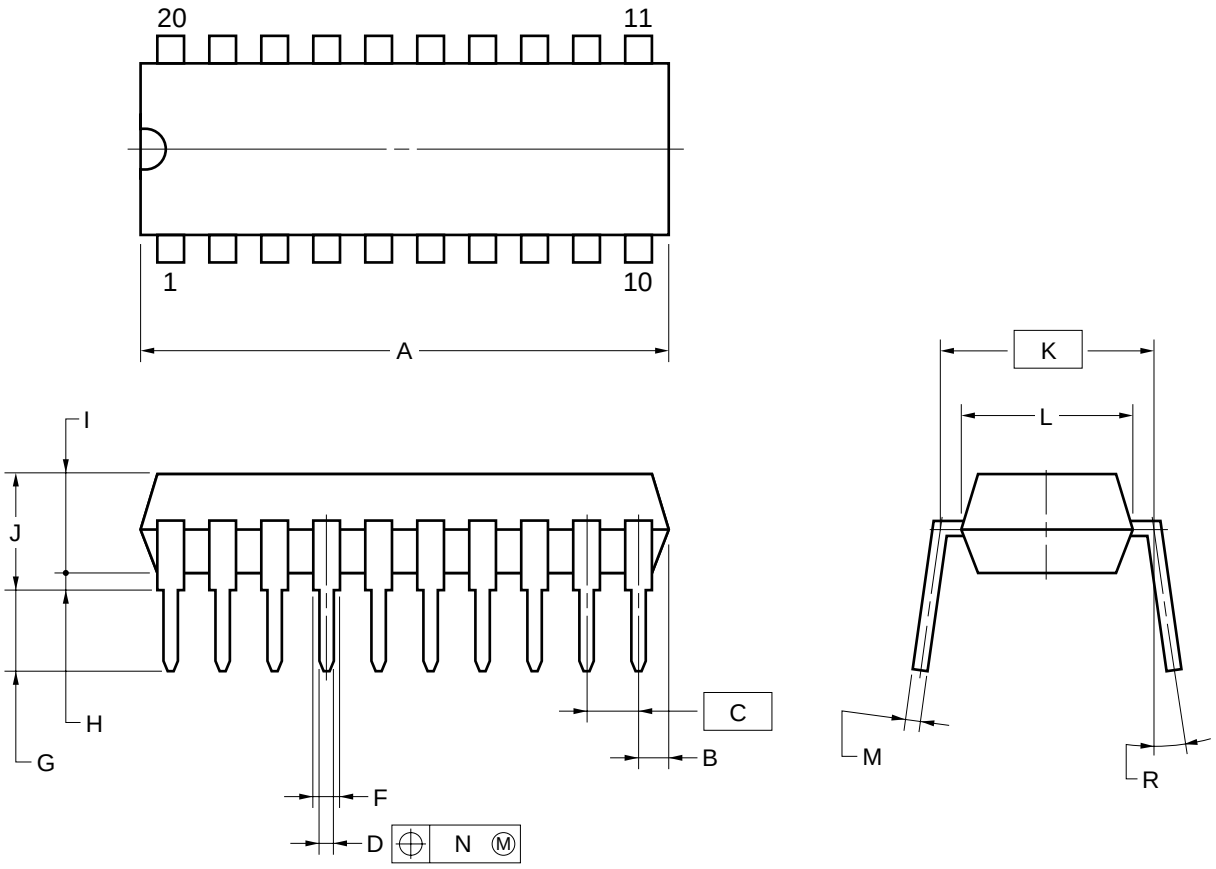
NOTE

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	13.00 MAX.	0.512 MAX.
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	$0.40^{+0.10}_{-0.05}$	$0.016^{+0.004}_{-0.003}$
E	0.1±0.1	0.004±0.004
F	1.8 MAX.	0.071 MAX.
G	1.55	0.061
H	7.7±0.3	0.303±0.012
I	5.6	0.220
J	1.1	0.043
K	$0.20^{+0.10}_{-0.05}$	$0.008^{+0.004}_{-0.002}$
L	0.6±0.2	$0.024^{+0.008}_{-0.009}$
M	0.12	0.005
N	0.10	0.004
P	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$

P20GM-50-300B, C-4

★ 20PIN PLASTIC SHRINK DIP (300 mil)



NOTES

1) Each lead centerline is located within 0.17 mm (0.007 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	19.57 MAX.	0.771 MAX.
B	1.78 MAX.	0.070 MAX.
C	1.778 (T.P.)	0.070 (T.P.)
D	0.50 ± 0.10	$0.020^{+0.004}_{-0.005}$
F	0.85 MIN.	0.033 MIN.
G	3.2 ± 0.3	0.126 ± 0.012
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.5	0.256
M	$0.25^{+0.10}_{-0.05}$	$0.010^{+0.004}_{-0.003}$
N	0.17	0.007
R	0~15°	0~15°

P20C-70-300B-1

22. RECOMMENDED SOLDERING CONDITIONS

It is recommended that μPD6124A and 6600A be soldered under the following conditions.

★ For details on the recommended soldering conditions, refer to Information Document, **Semiconductor Device Mounting Technology Manual (C10535E)**.

For other soldering methods and conditions, consult NEC.

Table 22-1. Soldering Conditions of Surface-Mount Type

μPD61P24GS: 20-pin plastic SOP (300 mil)

Soldering Method	Soldering Conditions
Partial Heating	Pin temperature: 300°C max., time: 3 seconds max. (per device side)

Table 22-2. Soldering Conditions of Through-Hole Type

μPD61P24CS: 20-pin plastic shrink DIP (300 mil)

Soldering Method	Soldering Conditions
Wave Soldering (Only for pin part)	Solder bath temperature: 260°C max., time: 10 seconds max.
Partial Heating	Pin temperature: 300°C max., time: 3 seconds max. (per pin)

Caution When soldering this product using of wave soldering, exercise care that the solder does not come in direct contact with the package.

APPENDIX A. μPD612× SERIES PRODUCT LIST

★

Item \ Part Number	μPD6124A	μPD6600A	μPD61P24	μPD6125A	μPD6126A
ROM capacity	1002 × 10 bits (mask ROM)	512 × 10 bits (mask ROM)	1002 × 10 bits (one-time PROM)	1002 × 10 bits (mask ROM)	
RAM capacity	32 × 5 bits				
I/O pin	8 pins ($K_{I/O0-7}$)			12 pins ($K_{I/O0-7}$, I/O_{00-03})	16 pins ($K_{I/O0-7}$, I/O_{00-03}, I/O_{10-13})
S-IN pin	Provided				
Current consumption (f_{OSC} = STOP) (MAX.)	2 μA		1 μA		
S-IN high-level input current (MAX.)	30 μA		15 μA		
Transmission carrier frequency	$f_{OSC}/12$, $f_{OSC}/8$				
Low-voltage detection (reset) function	Provided		None		
Mask option	Provided		None (fixed)	Provided	
Supply voltage	V_{DD} = 2.2 to 5.5 V	V_{DD} = 2.2 to 3.6 V	V_{DD} = 2.2 to 5.5 V	V_{DD} = 2.0 to 6.0 V	
Package	• 20-pin plastic SOP (300 mil) • 20-pin plastic shrink DIP (300 mil)			• 24-pin plastic SOP (300 mil) • 24-pin plastic shrink DIP (300 mil)	• 28-pin plastic SOP (375 mil)

APPENDIX B. DEVELOPMENT TOOLS

The following tools are available for program development using the μPD61P24.

Document	Document No.
μPS612X Series Emulator	—Note 1
μPS61P24 Assembler	—Note 1
★ PROM Programmer	AF-9703Note 2, 3 AF-9704Note 2, 3 AF-9705Note 3 AF-9706Note 3
μPD61P24 Program Adapter	AF9807BNote 3

Notes 1. These are products from I.C Corp. For details, consult I.C Corp.

I.C Corp.
6th Barnet Gotanda Bldg.
1-9-5 Higashi-Gotanda, Shinagawa-ku, Tokyo 141
Tel. 03-3447-3793
Fax. 03-3440-5606

2. Not available.

3. These are products from Ando Electric Co., Ltd. For details, consult Ando Electric Co., Ltd.

Ando Electric Co., Ltd.
4-19-7 Kamata, Ota-ku, Tokyo 144
Tel. 0120-40-0211(toll-free)

Caution Use a writing program after assembling the program, convert the HEX file to a ROM file by using the PROM utility program "UPDPROM" (refer to AS612X Assembler User's Manual(IEM-1016)).

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS device behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

Regional Information

Some information contained in this document may vary from country to country. Before using any NEC product in your application, please contact the NEC office in your country to obtain a list of authorized representatives and distributors. They will verify:

- Device availability
- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

In addition, trademarks, registered trademarks, export restrictions, and other legal issues may also vary from country to country.

NEC Electronics Inc. (U.S.)
Santa Clara, California
Tel: 800-366-9782
Fax: 800-729-9288

NEC Electronics (Germany) GmbH
Duesseldorf, Germany
Tel: 0211-65 03 02
Fax: 0211-65 03 490

NEC Electronics (UK) Ltd.
Milton Keynes, UK
Tel: 01908-691-133
Fax: 01908-670-290

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The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

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