NEC

MOS INTEGRATED CIRCUIT

μPD6P4B

4-BIT SINGLE-CHIP MICROCONTROLLER FOR INFRARED REMOTE CONTROL TRANSMISSION

DESCRIPTION

The μPD6P4B is a microcontroller for infrared remote control transmitters which is provided with a one-time PROM as the program memory.

Because users can write programs for the μPD6P4B, it is ideal for program evaluation and small-scale production of the application systems using the μPD62, 63, 63A, or 64.

★ **When reading this document, also refer to the μPD62 Data Sheet (U14208E) and the μPD63, 63A, 64 Data Sheet (U11371E).**

FEATURES

- Program memory (one-time PROM): 1002 × 10 bits
- Data memory (RAM): 32 × 4 bits
- Built-in carrier generation circuit for infrared remote control
- 9-bit programmable timer: 1 channel
- Command execution time: 16 μs (when operating at f_X = 4 MHz: ceramic oscillation)
- Stack level: 1 level (Stack RAM is for data memory RF as well.)
- I/O pins ($K_{I/O}$): 8 units
- Input pins (K_I): 4 units
- Sense input pin (S_0): 1 unit
- $S_1/\overline{LED}$ pin (I/O): 1 unit (In output mode, this is the remote control transmission display pin.)
- Power supply voltage: V_{DD} = 2.2 to 3.6 V (at f_X = 4 MHz)
  V_{DD} = 2.7 to 3.6 V (at f_X = 8 MHz)
- Operating ambient temperature: T_A = –40 to +85 °C
- Oscillator frequency: f_X = 2.4 to 8 MHz
- POC circuit

APPLICATION

Infrared remote control transmitter (for AV and household electric appliances)

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Printed in Japan

The mark ★ shows major revised points.

ORDERING INFORMATION

Part Number	Package
μPD6P4BGS	20-pin plastic SOP (300 mil)
★ μPD6P4BMC-5A4	20-pin plastic SSOP (300 mil)

PIN CONFIGURATION (TOP VIEW)

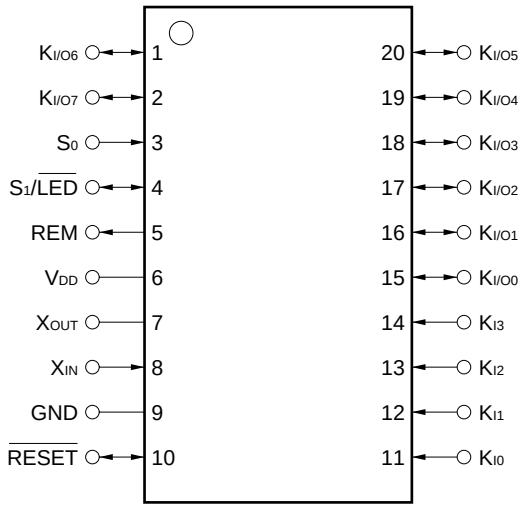
20-pin Plastic SOP (300 mil)

- **μPD6P4BGS**

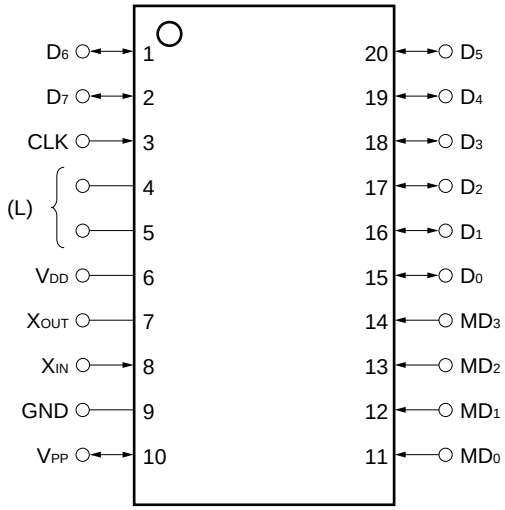
★ **20-pin Plastic SSOP (300 mil)**

- **μPD6P4BMC-5A4**

(1) Normal operating mode

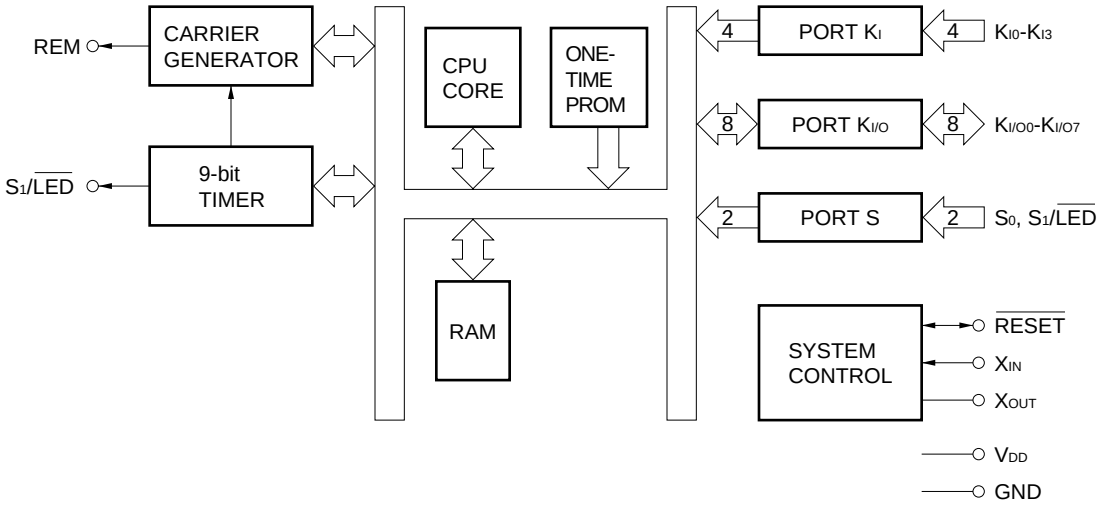


(2) PROM programming mode



Caution Round brackets ( ) indicate the pins not used in the PROM programming mode.
L : Connect each of these pins to GND via a pull-down resistor.

BLOCK DIAGRAM



LIST OF FUNCTIONS

Item	μPD6P4B
ROM capacity	1002 × 10 bits One-time PROM
RAM capacity	32 × 4 bits
Stack	1 level (shared with RF of RAM)
I/O pin	Key input (K_I) : 4 pins Key I/O ($K_{I/O}$) : 8 pins Key expansion input (S_0, S_1) : 2 pins Remote control transmitter display output ($\overline{LED}$) : 1 pin (shared with S_1 pin)
Number of keys	32 keys 48 keys (when expanded by key expansion input) 96 keys (when expanded by key expansion input and diode)
Clock frequency	Ceramic oscillation f_X = 2.4 to 4 MHz f_X = 4 to 8 MHz**Note**
Instruction execution time	16 μs (at f_X = 4 MHz)
Carrier frequency	$f_X/8$, $f_X/16$, $f_X/64$, $f_X/96$, $f_X/128$, $f_X/192$, no carrier (high level)
Timer	9-bit programmable timer : 1 channel
POC circuit	Provided
Supply voltage	V_{DD} = 2.2 to 3.6 V (f_X = 2.4 to 4 MHz), V_{DD} = 2.7 to 3.6 V (f_X = 4 to 8 MHz)
Operating ambient temperature	• T_A = –40 to +85 °C • T_A = –20 to +70 °C (when using POC circuit)
★ Package	• 20-pin plastic SOP (300 mil) • 20-pin plastic SSOP (300 mil)

Note It is necessary to design the application circuit so that the $\overline{RESET}$ pin goes low at a supply voltage of less than 2.7 V.

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1. PIN FUNCTIONS

1.1 Normal Operating Mode

Pin No.	Symbol	Function	Output Format	When Reset
1 2 15-20	$K_{I/O0}$-$K_{I/O7}$	These pins refer to the 8-bit I/O ports. I/O switching can be made in 8-bit units. In INPUT mode, a pull-down resistor is added. In OUTPUT mode, they can be used as the key scan output of the key matrix.	CMOS push-pull[Note 1]	High-level output
3	S_0	Refers to the input port. Can also be used as the key return input of the key matrix. In INPUT mode, the availability of the pull-down resistor of the S_0 and S_1 ports can be specified by software in terms in 2-bit units. If INPUT mode is canceled by software, this pin is placed in OFF mode and enters the high-impedance state.	—	High-impedance (OFF mode)
4	$S_1/\overline{LED}$	Refers to the I/O port. In INPUT mode (S_1), this pin can also be used as the key return input of the key matrix. The availability of the pull-down resistor of the S_0 and S_1 ports can be specified by software in 2-bit units. In OUTPUT mode ($\overline{LED}$), it becomes the remote control transmission display output (active low). When the remote control carrier is output from the REM output, this pin outputs the low level from the $\overline{LED}$ output synchronously with the REM signal.	CMOS push-pull	High-level output ($\overline{LED}$)
5	REM	Refers to the infrared remote control transmission output. The output is active high. Carrier frequency: $f_X/8$, $f_X/64$, $f_X/96$, high-level, $f_X/16$, $f_X/128$, $f_X/192$ (usable on software)	CMOS push-pull	Low-level output
6	V_{DD}	Refers to the power supply.	—	—
7 8	X_{OUT} X_{IN}	These pins are connected to system clock ceramic resonators.	—	Low level (oscillation stopped)
9	GND	Refers to the ground.	—	—
10	$\overline{RESET}$	Normally, this pin is a system reset input. By inputting a low level, the CPU can be reset. When resetting with the POC circuit a low level is output. A pull-up resistor is incorporated.	—	—
11-14	K_{I0}-K_{I3}[Note 2]	These pins refer to the 4-bit input ports. They can be used as the key return input of the key matrix. The use of the pull-down resistor can be specified by software in 4-bit units.	—	Input (low-level)

Notes 1. Be careful about this because the drive capability of the low-level output side is held low.

2. In order to prevent malfunction, be sure to input a low level to more than one of pins K_{I0} to K_{I3} when reset is released (when $\overline{RESET}$ pin changes from low level to high level, or POC is released due to supply voltage startup).

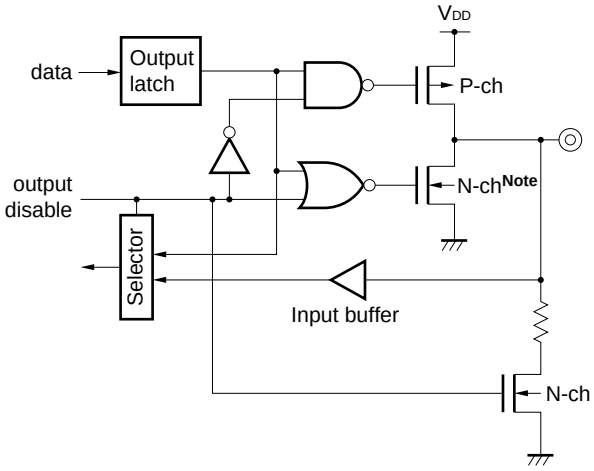
1.2 PROM Programming Mode

Pin No.	Symbol	Function	I/O
1, 2 15-20	D_0-D_7	8-bit data input/output when writing/verifying program memory	I/O
3	CLK	Clock input for updating address when writing/verifying program memory	Input
6	V_{DD}	Power Supply. Supply +6 V to this pin when writing/verifying program memory.	–
7	X_{OUT}	Clock necessary for writing program memory. Connect 4 MHz ceramic resonator to these pins.	–
8	X_{IN}		Input
9	GND	GND	–
10	V_{PP}	Supplies voltage for writing/verifying program memory. Apply +12.5 V to this pin.	–
11-14	MD_0-MD_3	Input for selecting operation mode when writing/verifying program memory.	Input

1.3 INPUT/OUTPUT Circuits of Pins

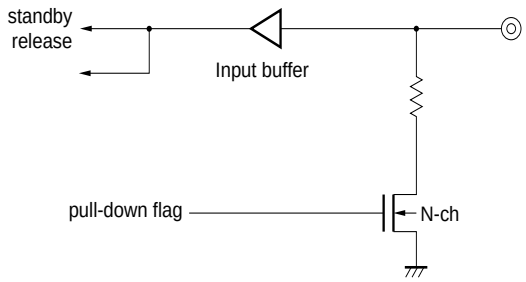
The input/output circuits of the μPD6P4B pins are shown in partially simplified forms below.

(1) $K_{I/O0}$-$K_{I/O7}$

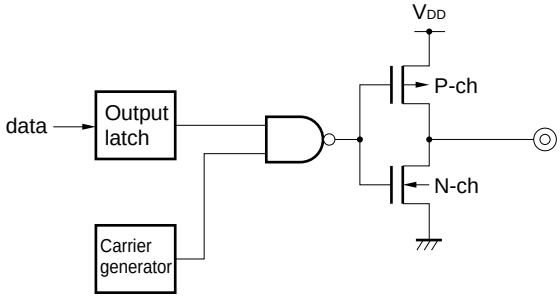


Note The drive capability is held low.

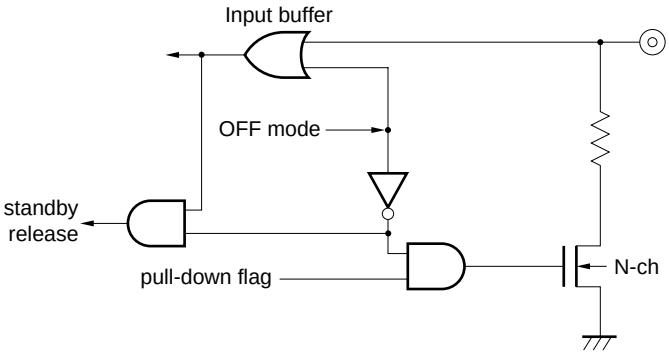
(2) K_{I0}-K_{I3}



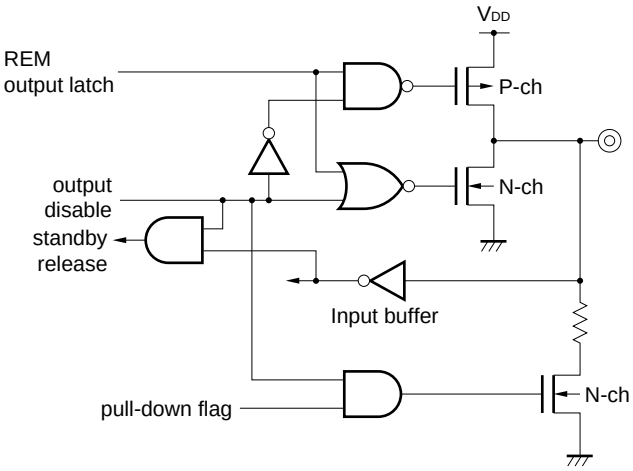
(3) REM



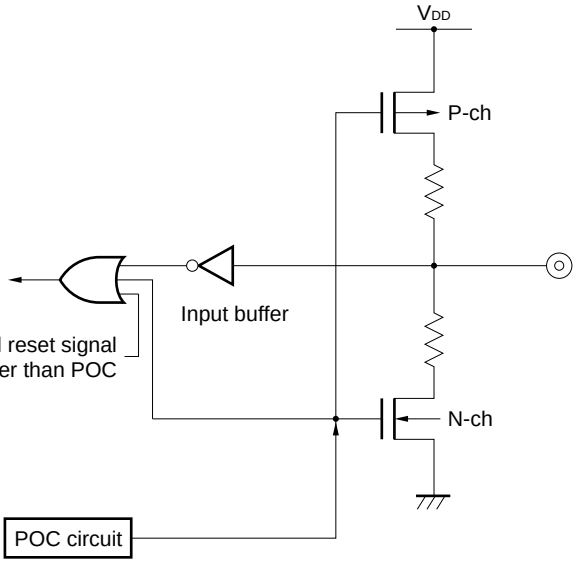
(4) S_0



(5) $S_1/\overline{LED}$



(6) $\overline{RESET}$



1.4 Dealing with Unused Pins

The following connections are recommended for unused pins in the normal operation mode.

Table 1-1. Connections for Unused Pins

Pin		Connection	
		Inside the microcontroller	Outside the microcontroller
$K_{I/O}$	INPUT mode	—	Open
	OUTPUT mode	High-level output	
REM		—	
$S_1/\overline{LED}$		OUTPUT mode ($\overline{LED}$) setting	
S_0		OFF mode setting	Directly connected to GND
K_I		—	
$\overline{RESET}$[Note]		Built-in POC circuit	Open

Note If the circuit is an applied one requiring high reliability, be sure to design it in such a manner that the $\overline{RESET}$ signal is entered externally.

Caution The I/O mode and the terminal output level are recommended to be fixed by setting them repeatedly in each loop of the program.

1.5 Notes on Using K_I Pin at Reset

In order to prevent malfunction, be sure to input a low level to more than one of pins K_{I0} to K_{I3} when reset is released (when $\overline{RESET}$ pin changes from low level to high level, or POC is released due to supply voltage startup).

★ 2. DIFFERENCES AMONG μPD62, 63, 63A, 64, AND μPD6P4B

Table 2-1 shows the differences among the μPD62, 63, 63A, 64, and μPD6P4B.

The only differences among these models are the program memory, supply voltage, system clock frequency, oscillation stabilization wait time, and POC circuit (mask option), and the CPU function and internal peripheral hardware are the same.

The electrical characteristics also differ slightly. For the electrical characteristics, refer to the Data Sheet of each model.

Table 2-1. Differences among μPD62, 63, 63A, 64, and μPD6P4B

(1) When POC circuit (mask option) is provided to μPD62, 63, 63A, and 64

Item	μPD6P4B	μPD62, 63	μPD63A	μPD64
ROM	One-time PROM	Mask ROM		
	1002 × 10 bits (000H to 3E9H)	512 × 10 bits (000H to 1FFH)	768 × 10 bits (000H to 2FFH)	1002 × 10 bits (000H to 3E9H)
Oscillation stabilization wait time • On releasing STOP mode by release condition • On releasing STOP or HALT mode by $\overline{\text{RESET}}$ input and at reset	286/f_X 478/f_X to 926/f_X	52/f_X 246/f_X to 694/f_X		
V_{PP} pin and operating mode select pin	Provided	Not provided		
Electrical specifications	Some electrical specifications, such as data retention voltage and current consumption, differ. For details, refer to Data Sheet of each model.			

(2) When POC circuit (mask option) is not provided to μPD62, 63, 63A, and 64

Item	μPD6P4B	μPD62, 63	μPD63A	μPD64
ROM	One-time PROM	Mask ROM		
	1002 × 10 bits (000H to 3E9)	512 × 10 bits (000H to 1FFH)	768 × 10 bits (000H to 2FFH)	1002 × 10 bits (000H to 3E9H)
Oscillation stabilization wait time • On releasing STOP mode by release condition • On releasing STOP or HALT mode by $\overline{\text{RESET}}$ input and at reset	286/f_X 478/f_X to 926/f_X	52/f_X 246/f_X to 694/f_X		
V_{PP} pin and operating mode select pin	Provided	Not provided		
POC circuit	Incorporated	Not provided		
Supply voltage	V_{DD} = 2.2 to 3.6 V (T_A = –40 to +85 °C)	V_{DD} = 1.8 to 3.6 V (T_A = –40 to +85 °C)		
System clock frequency	• f_X = 2.4 to 4 MHz • f_X = 4 to 8 MHz[Note]	• f_X = 2.4 to 4 MHz • f_X = 2.4 to 8 MHz (V_{DD} = 2.2 to 3.6 V)		
Electrical specifications	Some electrical specifications, such as data retention voltage and current consumption, differ. For details, refer to Data Sheet of each model.			

Note It is necessary to design the application circuit so that the $\overline{\text{RESET}}$ pin goes low when the supply voltage is less than 2.7 V.

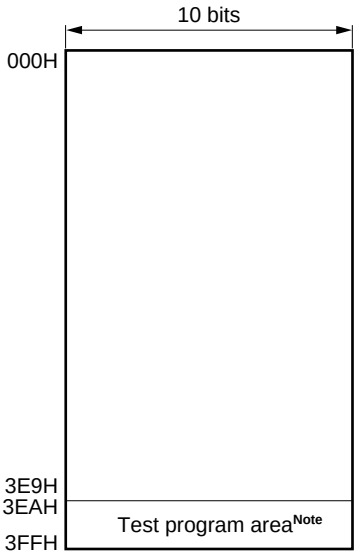
2.1 Program Memory (One-time PROM) ... 1002 steps × 10 bits

This one-time PROM is configured with 10 bits per step and is addressed by the program counter.

The program memory stores programs and table data.

The 22 steps from addresses 3EAH through 3FFH constitute a test program area and must not be used.

Figure 2-1. Program Memory Map



Note Even if execution jumps to the test program area by mistake, it returns to address 000H.

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

The program memory of the μPD6P4B is a one-time PROM of 1002 × 10 bits.

To write or verify this program memory, the pins shown in Table 3-1 are used. Note that no address input pin is used. Instead, the address is updated by using the clock input from the CLK pin.

Table 3-1. Pins Used to Write/Verify Program Memory

Pin Name	Function
V_{PP}	Supplies voltage when writing/verifying program memory. Apply +12.5 V to this pin.
V_{DD}	Power supply. Supply +6 V to this pin when writing/verifying program memory.
CLK	Inputs clock to update address when writing/verifying program memory. By inputting pulse four times to CLK pin, address of program memory is updated.
MD_0-MD_3	Input to select operation mode when writing/verifying program memory.
D_0-D_7	Inputs/outputs 8-bit data when writing/verifying program memory.
X_{IN}, X_{OUT}	Clock necessary for writing program memory. Connect 4 MHz ceramic resonator to this pin.

3.1 Operating Mode When Writing/Verifying Program Memory

The μPD6P4B is set in the program memory write/verify mode when +6 V is applied to the V_{DD} pin and +12.5 V is applied to the V_{PP} pin after the μPD6P4B has been in the reset status (V_{DD} = 5 V, V_{PP} = 0 V) for a specific time. In this mode, the operating modes shown in Table 3-2 can be set by setting the MD_0 through MD_3 pins. Connect all the pins other than those shown in Table 3-1 to GND via pull-down resistor.

Table 3-2. Setting Operation Mode

Setting of Operating Mode						Operation Mode
V_{PP}	V_{DD}	MD_0	MD_1	MD_2	MD_3	
+12.5 V	+6 V	H	L	H	L	Clear program address to 0
		L	H	H	H	Write mode
		L	L	H	H	Verify mode
		H	×	H	H	Program inhibit mode

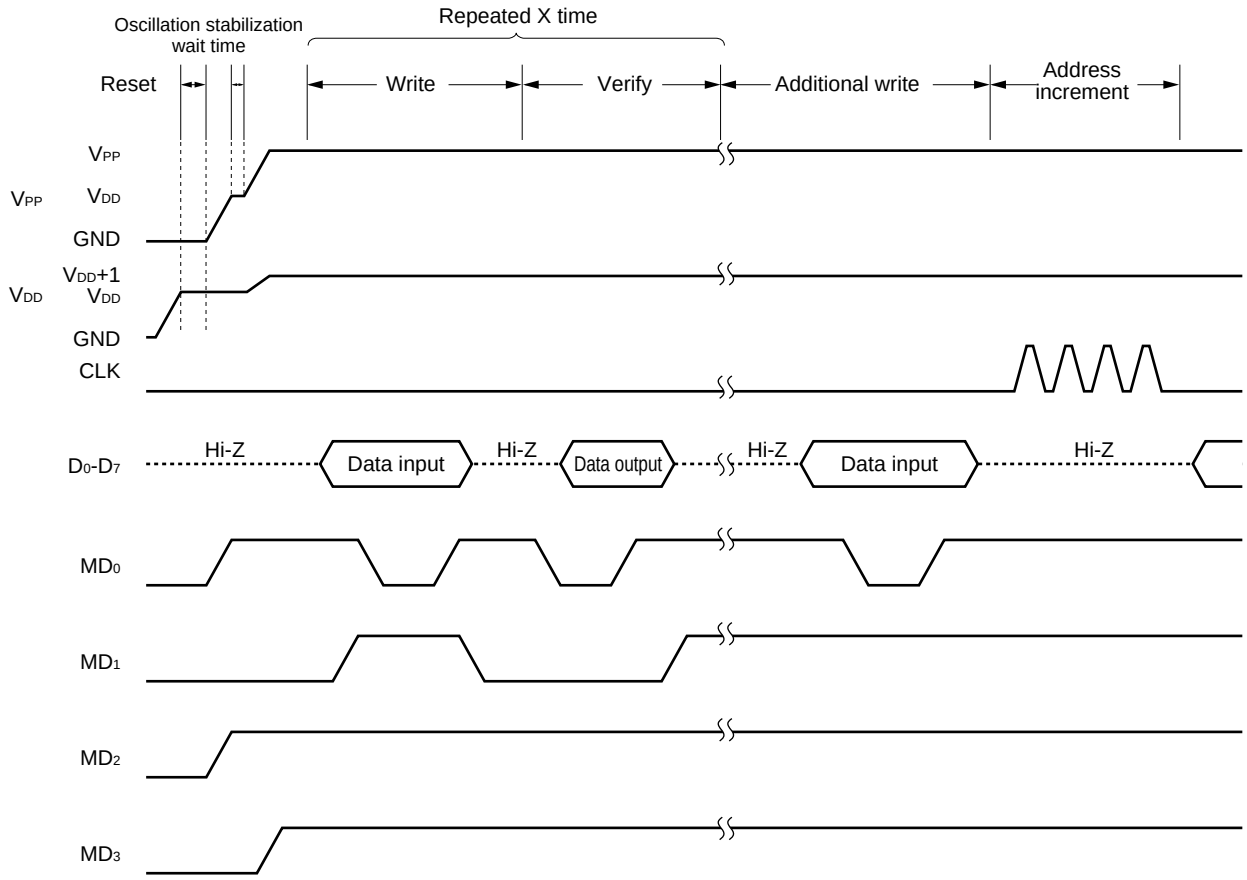
×: don't care (L or H)

3.2 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) Supply 5 V to the V_{PP} pin after waiting for 10 μs.
(4) Wait for 2 ms until oscillation of the ceramic resonator connected across the X_{IN} and X_{OUT} pins stabilizes.
(5) Set the program memory address 0 clear mode by using the mode setting pins.
(6) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(7) Set the program inhibit mode.
(8) Write data to the program memory in the 1-ms write mode.
(9) Set the program inhibit mode.
(10) Set the verify mode. If the data have been written to the program memory, proceed to (11). If not, repeat steps (8) through (10).
(11) Additional writing of (number of times of writing in (8) through (10): X) × 1 ms.
(12) Set the program inhibit mode.
(13) Input a pulse to the CLK pin four times to update the program memory address (+1).
(14) Repeat steps (8) through (13) up to the last address.
(15) Set the 0 clear mode of the program memory address.
(16) Change the voltages on the V_{DD} and V_{PP} pins to 5 V.
(17) Turn off power.

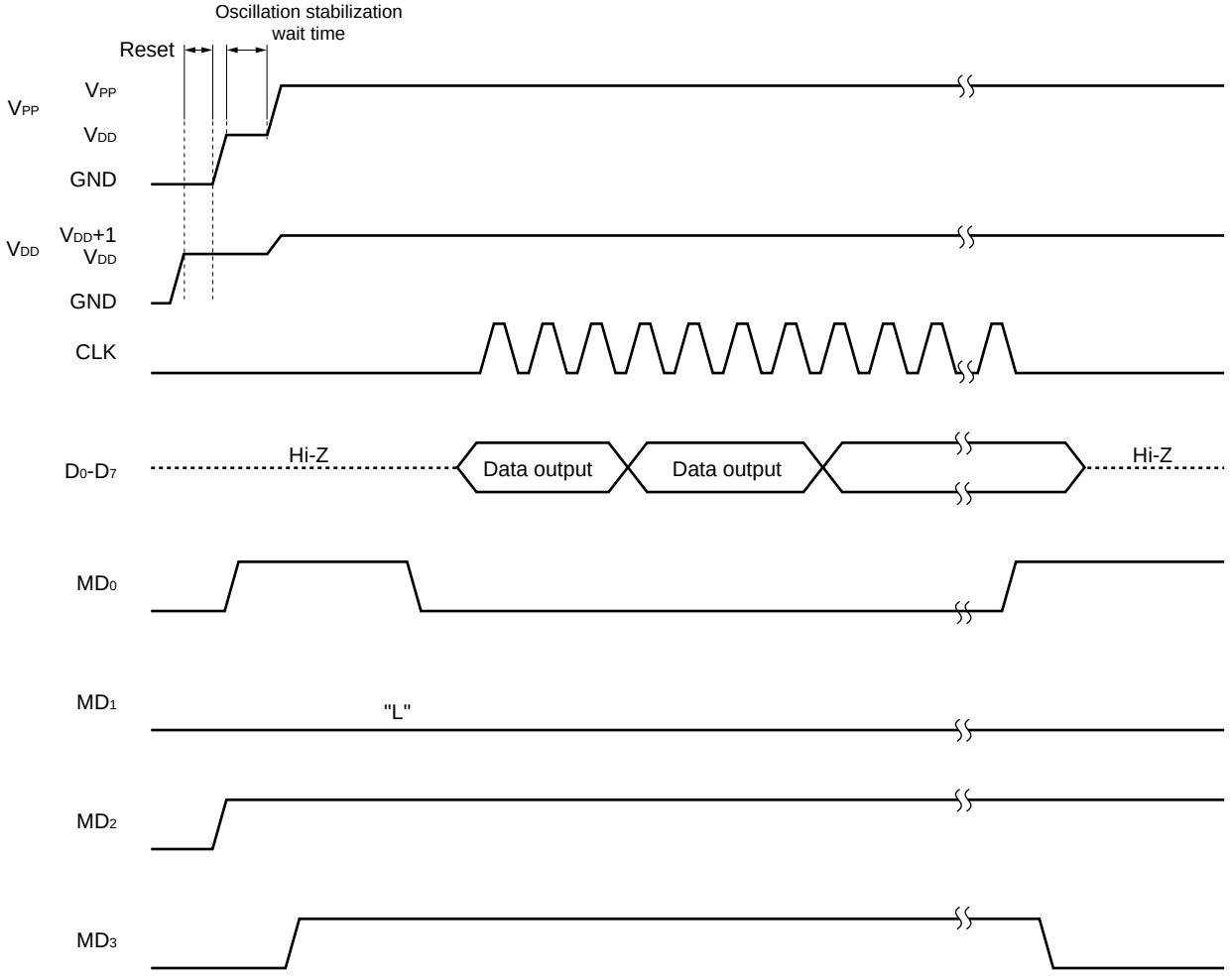
The following figure illustrates steps (2) through (13) above.



3.3 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) Supply 5 V to the V_{PP} pin after waiting for 10 μs.
(4) Wait for 2 ms until oscillation of the ceramic resonator connected across the X_{IN} and X_{OUT} pins stabilizes.
(5) Set the program memory address 0 clear mode by using the mode setting pins.
(6) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(7) Set the program inhibit mode.
(8) Set the verify mode. Data of each address is output sequentially each time the clock pulse is input to the CLK pin four times.
(9) Set the program inhibit mode.
(10) Set the program memory address 0 clear mode.
(11) Change the voltage on the V_{DD} and V_{PP} pins to 5 V.
(12) Turn off power.

The following figure illustrates steps (2) through (10) above.



4. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = +25 °C)

Parameter	Symbol	Test Conditions		Rating	Unit
Power supply voltage	V_{DD}			–0.3 to +7.0	V
	V_{PP}			–0.3 to +13.5	V
Input voltage	V_I	$K_{I/O}$, K_I, S_0, S_1, $\overline{RESET}$		–0.3 to V_{DD} + 0.3	V
Output voltage	V_O			–0.3 to V_{DD} + 0.3	V
High-level output current	I_{OH}**Note**	REM	Peak value	–30	mA
			rms	–20	mA
		$\overline{LED}$	Peak value	–7.5	mA
			rms	–5	mA
		One $K_{I/O}$ pin	Peak value	–13.5	mA
			rms	–9	mA
		Total of $\overline{LED}$ and $K_{I/O}$ pins	Peak value	–18	mA
			rms	–12	mA
Low-level output current	I_{OL}**Note**	REM	Peak value	7.5	mA
			rms	5	mA
		$\overline{LED}$	Peak value	7.5	mA
			rms	5	mA
Operating ambient temperature	T_A			–40 to +85	°C
Storage temperature	T_{stg}			–65 to +150	°C

Note Work out the rms with: [rms] = [Peak value] $\times\sqrt{\text{Duty}}$.

Caution Product quality may suffer if the absolute rating is exceeded for any parameter, even momentarily. In other words, an absolute maxumum rating is a value at which the possibility of psysical damage to the product cannnot be ruled out. Care must therefore be taken to ensure that the these ratings are not exceeded during use of the product.

Recommended Power Supply Voltage Range (T_A = –40 to +85 °C)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage	V_{DD}	f_X = 2.4 to 4 MHz	2.2	3.0	3.6	V
		f_X = 4 to 8 MHz**Note**	2.7	3.0	3.6	V

Note It is necessary to design the application circuit so that the $\overline{RESET}$ pin goes low when the supply voltage is less than 2.7 V.

DC Characteristics (T_A = –40 to +85 °C, V_{DD} = 2.2 to 3.6 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
High-level input voltage	V_{IH1}	$\overline{RESET}$		0.8 V_{DD}		V_{DD}	V
	V_{IH2}	$K_{I/O}$		0.65 V_{DD}		V_{DD}	V
	V_{IH3}	K_I, S_0, S_1		0.65 V_{DD}		V_{DD}	V
Low-level input voltage	V_{IL1}	$\overline{RESET}$		0		0.2 V_{DD}	V
	V_{IL2}	$K_{I/O}$		0		0.3 V_{DD}	V
	V_{IL3}	K_I, S_0, S_1		0		0.15 V_{DD}	V
High-level input leakage current	I_{LH1}	K_I $V_I = V_{DD}$, pull-down resistor not incorporated				3	μA
	I_{LH2}	S_0, S_1 $V_I = V_{DD}$, pull-down resistor not incorporated				3	μA
Low-level input leakage current	I_{UL1}	K_I V_I = 0 V				–3	μA
	I_{UL2}	$K_{I/O}$ V_I = 0 V				–3	μA
	I_{UL3}	S_0, S_1 V_I = 0 V				–3	μA
High-level output voltage	V_{OH1}	REM, $\overline{LED}$, $K_{I/O}$	I_{OH} = –0.3 mA	0.8 V_{DD}			V
Low-level output voltage	V_{OL1}	REM, $\overline{LED}$	I_{OL} = 0.3 mA			0.3	V
	V_{OL2}	$K_{I/O}$	I_{OL} = 15 μA			0.4	V
High-level output current	I_{OH1}	REM	V_{DD} = 3.0 V, V_{OH} = 1.0 V	–5	–9		mA
	I_{OH2}	$K_{I/O}$	V_{DD} = 3.0 V, V_{OH} = 2.2 V	–2.5	–5		mA
Low-level output current	I_{OL1}	$K_{I/O}$	V_{DD} = 3.0 V, V_{OL} = 0.4 V	30	70		μA
			V_{DD} = 3.0 V, V_{OL} = 2.2 V	100	220		μA
Built-in pull-up resistor	R_1	$\overline{RESET}$		25	50	100	kΩ
Built-in pull-down resistor	R_2	$\overline{RESET}$		2.5	5	15	kΩ
	R_3	K_I, S_0, S_1		75	150	300	kΩ
	R_4	$K_{I/O}$		130	250	500	kΩ
Data hold power supply voltage	V_{DDOR}	In STOP mode		1.2		3.6	V
Supply current[Note]	I_{DD1}	Operating mode	f_X = 8 MHz, V_{DD} = 3 V ± 10 %		1.4	2.8	mA
			f_X = 4 MHz, V_{DD} = 3 V ± 10 %		1.1	2.2	mA
	I_{DD2}	HALT mode	f_X = 8 MHz, V_{DD} = 3 V ± 10 %		1.3	2.6	mA
			f_X = 4 MHz, V_{DD} = 3 V ± 10 %		1.0	2.0	mA
	I_{DD3}	STOP mode	V_{DD} = 3 V ± 10 %		1.0	8.0	μA
			V_{DD} = 3 V ± 10 %, T_A = 25 °C		1.0	2.0	μA

Note The POC circuit current and the current flowing in the built-in pull-up resistor are not included.

AC Characteristics (T_A = –40 to +85 °C, V_{DD} = 2.2 to 3.6 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Instruction execution time	t_{CY}			15.9		27	μs
		V_{DD} = 2.7 to 3.6 V[Note 1]		7.9		27	μs
K_I, S_0, S_1 high-level width	t_H			10			μs
		When canceling Standby mode	HALT mode	10			μs
			STOP mode	**Note 2**			μs
$\overline{\text{RESET}}$ low-level width	t_{RSL}			10			μs

Notes 1. When using at f_X = 4 MHz or higher, it is necessary to design the application circuit so that the $\overline{\text{RESET}}$ pin goes low when the supply voltage is less than 2.7 V.

2. 10 + 286/f_X + oscillation growth time

Remark t_{CY} = 64/f_X (f_X: System clock oscillator frequency)

POC Circuit[Note 1] (T_A = –20 to +70 °C)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
POC-detected voltage[Note 2]	V_{POC}		1.8	2.0	2.2	V
POC circuit current	I_{POC}			1.2	1.5	μA

★ **Notes 1.** Operates effectively under the conditions of f_X = 2.4 to 4 MHz.

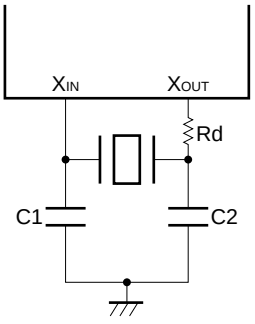
2. Refers to the voltage with which the POC circuit cancels an internal reset. If $V_{POC} < V_{DD}$, the internal reset is canceled.
From the time of $V_{POC} \geq V_{DD}$ until the internal reset takes effect, lag of up to 1 ms occurs. When the period of $V_{POC} \geq V_{DD}$ lasts less than 1 ms, the internal reset may not take effect.

System Clock Oscillator Characteristics (T_A = –40 to +85 °C, V_{DD} = 2.2 to 3.6 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Oscillator frequency	f_X		2.4	3.64	4.0	MHz
(ceramic resonator)		**Note**	2.4	3.64	8.0	MHz

Note When using at f_X = 4 MHz or higher, it is necessary to design the application circuit so that the $\overline{\text{RESET}}$ pin goes low when the supply voltage is less than 2.7 V.

An external circuit example



PROM Programming Mode

DC Programming Characteristics (T_A = 25 °C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.3 V)

Parameter	Symbol	Test 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}	MD_0 = V_{IL}, MD_1 = V_{IH}			30	mA

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

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

AC Programming Characteristics (T_A = 25 °C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.3 V)

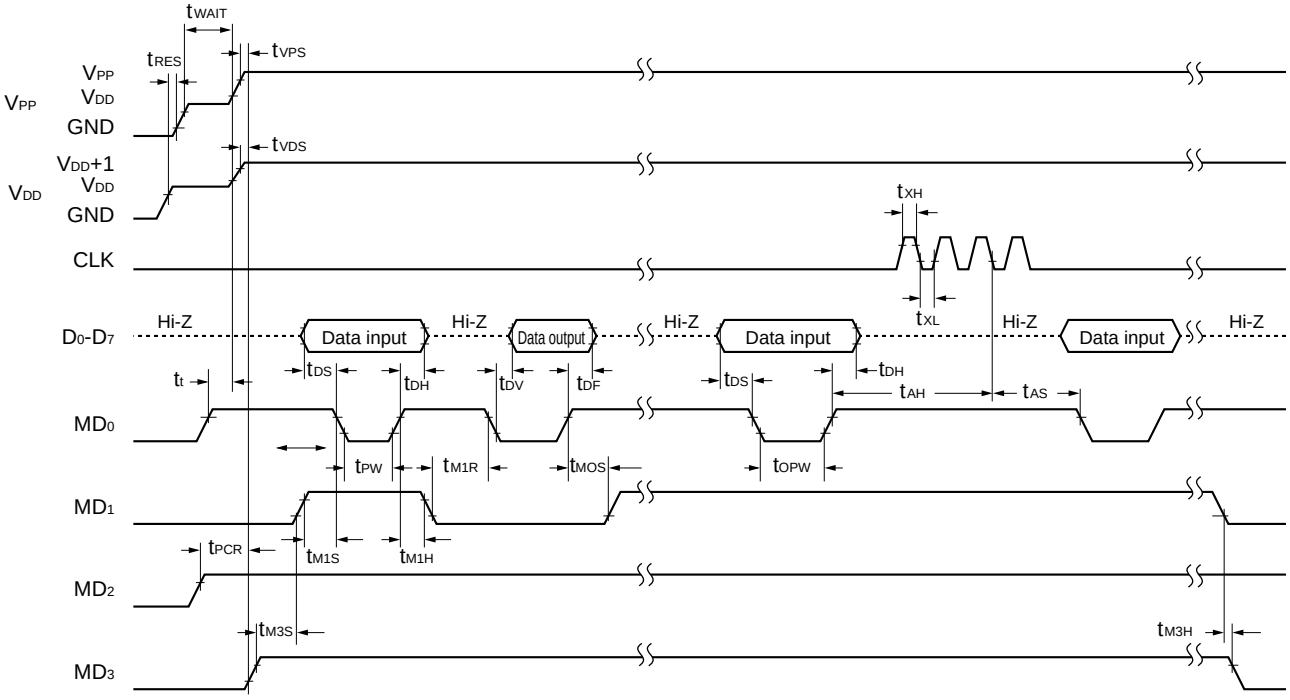
Parameter	Symbol	Note1	Test Conditions	MIN.	TYP.	MAX.	Unit
Address setup time[Note 2] (vs. MD_0↓)	t_{AS}	t_{AS}		2			μs
MD_1 setup time (vs. MD_0↓)	t_{M1S}	t_{OES}		2			μs
Data setup time (vs. MD_0↓)	t_{DS}	t_{DS}		2			μs
Address hold time[Note 2] (vs. MD_0↑)	t_{AH}	t_{AH}		2			μs
Data hold time (vs. MD_0↑)	t_{DH}	t_{DH}		2			μs
MD_0↑→ data output float delay time	t_{DF}	t_{DF}		0		130	ns
V_{PP} setup time (vs. MD_3↑)	t_{VPS}	t_{VPS}		2			μs
V_{DD} setup time (vs. MD_3↑)	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
MD_0 setup time (vs. MD_1↑)	t_{MOS}	t_{CES}		2			μs
MD_0↓→ data output delay time	t_{DV}	t_{DV}	MD0 = MD1 = V_{IL}			1	μs
MD_1 hold time (vs. MD_0↑)	t_{M1H}	t_{OEH}	$t_{M1H}+t_{M1R} \geq 50$ μs	2			μs
MD_1 recovery time (vs. MD_0↓)	t_{M1R}	t_{OR}		2			μs
Program counter reset time	t_{PCR}	–		10			μs
CLK input high-, low-level width	t_{XH}, t_{XL}	–		0.125			μs
CLK input frequency	f_X	–				8	MHz
Initial mode set time	t_I	–		2			μs
MD_3 setup time (vs. MD_1↑)	t_{M3S}	–		2			μs
MD_3 hold time (vs. MD_1↓)	t_{M3H}	–		2			μs
MD_3 setup time (vs. MD_0↓)	t_{M3SR}	–	When program memory is read	2			μs
Address[Note 2] → data output delay time	t_{OAD}	t_{ACC}	When program memory is read			2	μs
Address[Note 2] → data output hold time	t_{HAD}	t_{OH}	When program memory is read	0		130	ns
MD_3 hold time (vs. MD_0↑)	t_{M3HR}	–	When program memory is read	2			μs
MD_3↓→ data output float delay time	t_{DFR}	–	When program memory is read			2	μs
Reset setup time	t_{RES}	–		10			μs
Oscillation stabilization wait time[Note 3]	t_{WAIT}	–		2			ms

Notes 1. Equivalent symbol of the corresponding μPD27C256A (The μPD27C256A is a maintenance product.)

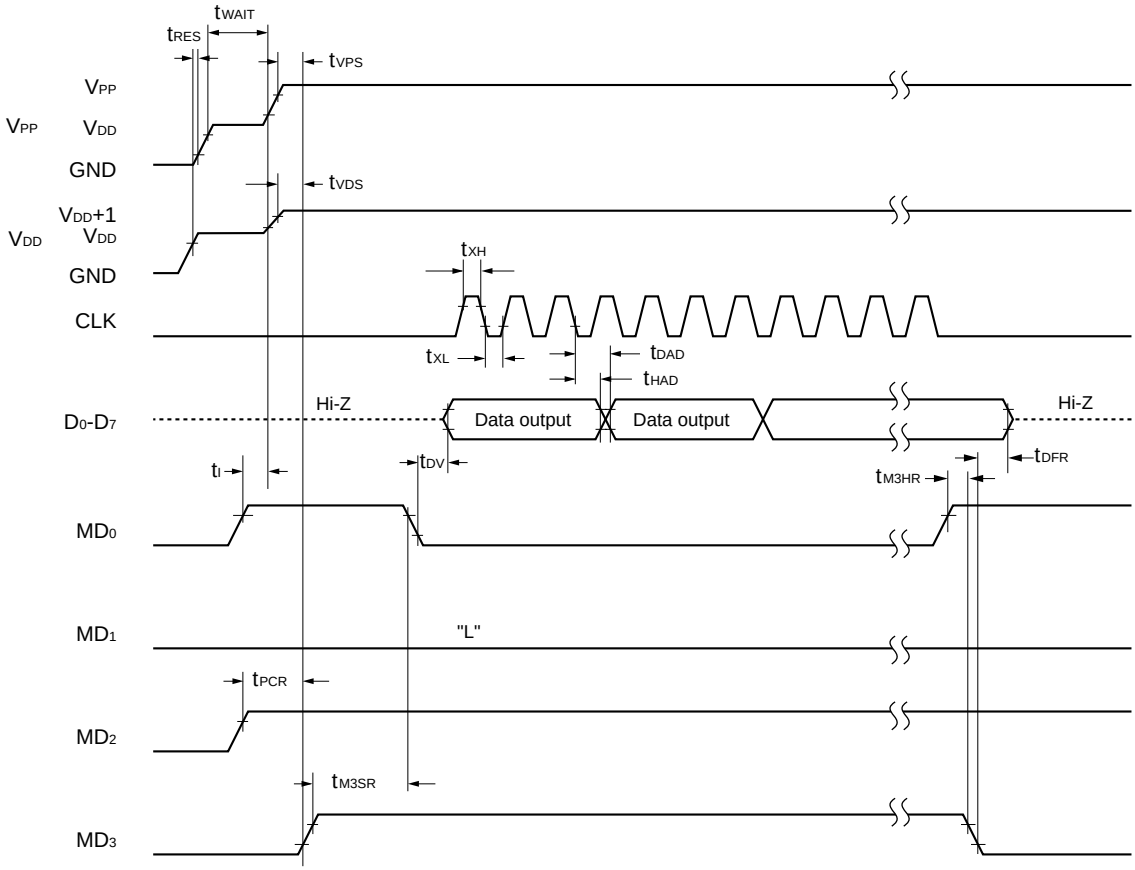
2. The internal address signal is incremented at the falling edge of the third clock of CLK.

3. Connect a 4 MHz ceramic resonator between the X_{IN} and X_{OUT} pins.

Program Memory Write Timing

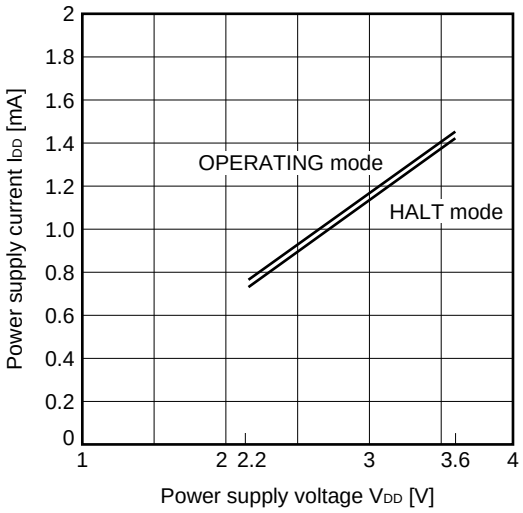


Program Memory Read Timing

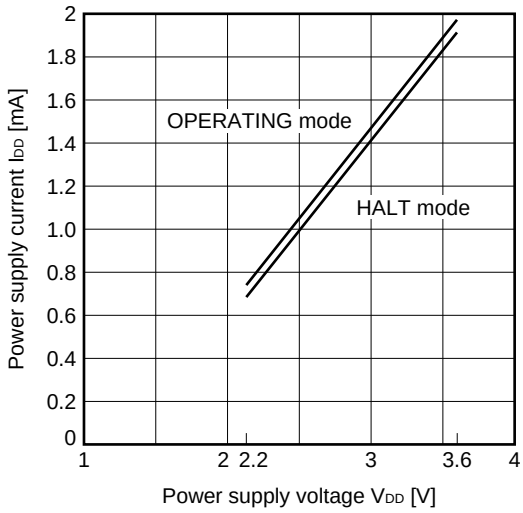


5. CHARACTERISTIC CURVE (REFERENCE VALUES)

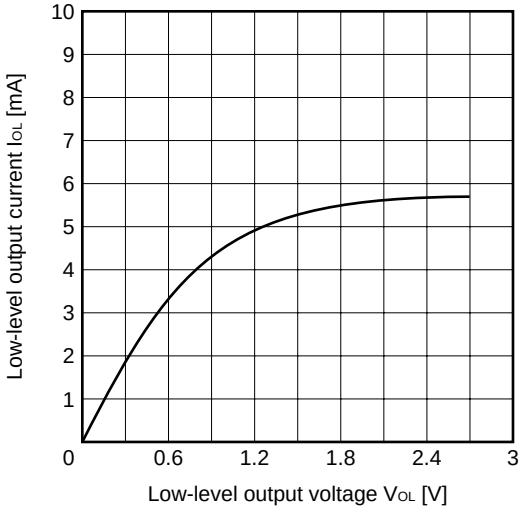
I_{DD} vs V_{DD} (f_X = 4 MHz)
(T_A = 25 °C)



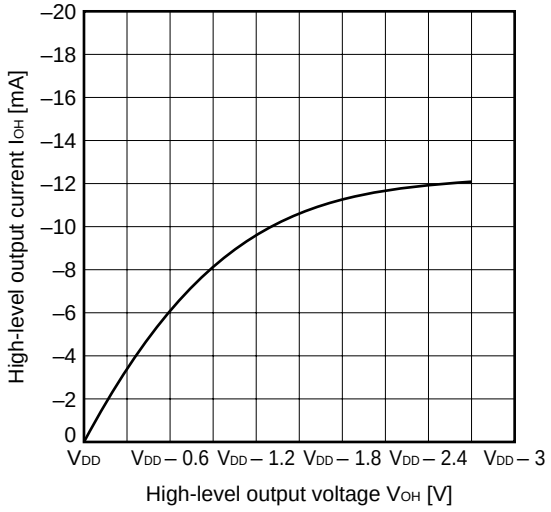
I_{DD} vs V_{DD} (f_X = 8 MHz)
(T_A = 25 °C)



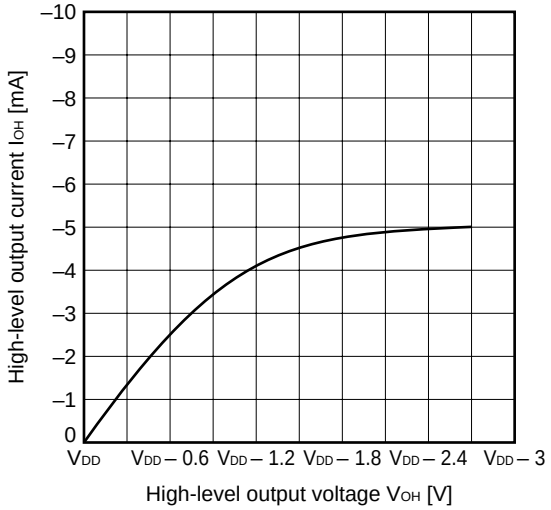
I_{OL} vs V_{OL} (REM, $\overline{LED}$)
(T_A = 25 °C, V_{DD} = 3.0 V)



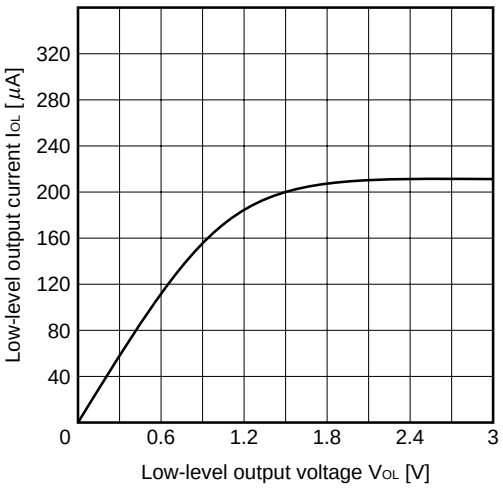
I_{OH} vs V_{OH} (REM)
(T_A = 25 °C , V_{DD} = 3.0 V)



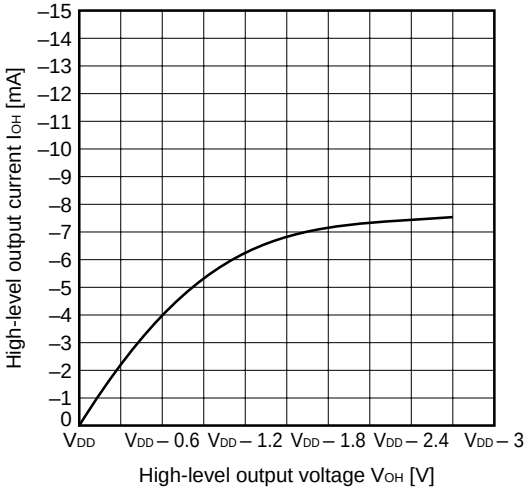
I_{OH} vs V_{OH} ($\overline{LED}$)
(T_A = 25 °C , V_{DD} = 3.0 V)



I_{OL} vs V_{OL} ($K_{I/O}$)
(T_A = 25 °C, V_{DD} = 3.0 V)



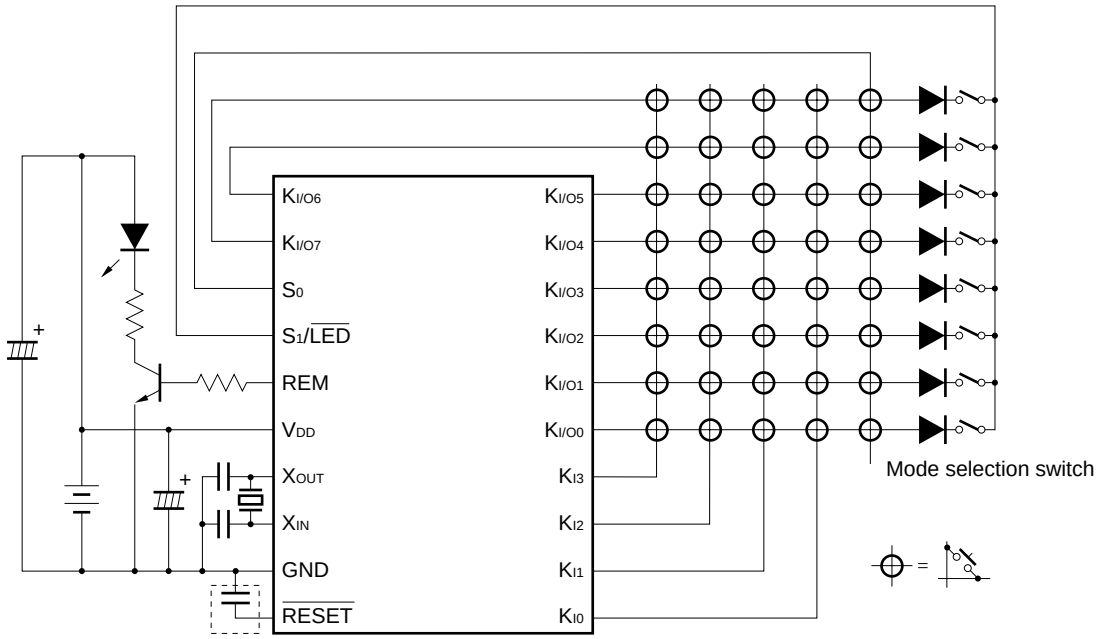
I_{OH} vs V_{OH} ($K_{I/O}$)
(T_A = 25 °C, V_{DD} = 3.0 V)



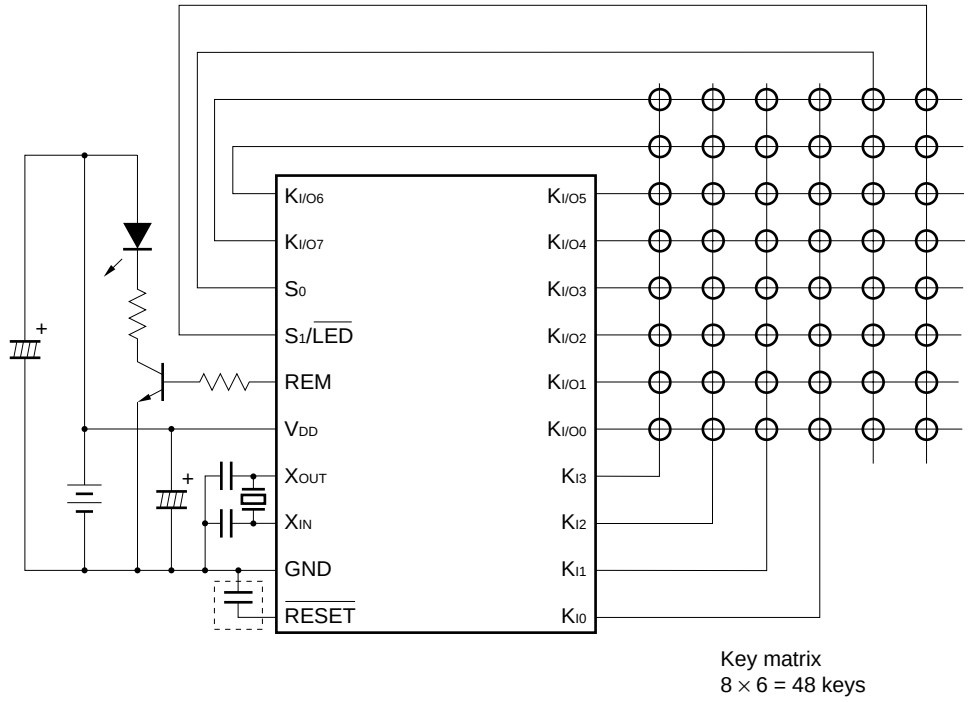
6. APPLIED CIRCUIT EXAMPLE

Example of Application to System

- **Remote-control transmitter (40 keys; mode selection switch accommodated)**



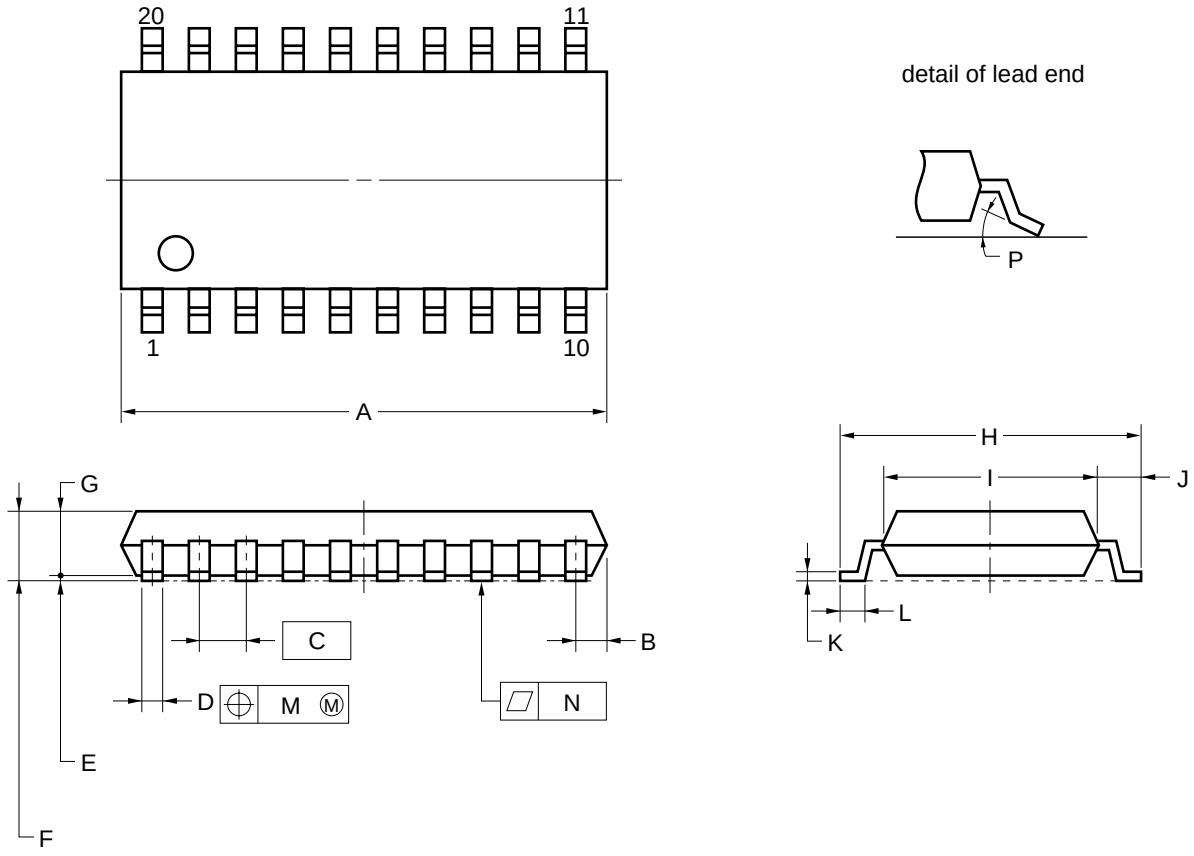
- **Remote-control transmitter (48 keys accommodated)**



Remark When the POC circuit is used effectively, it is not necessary to connect the capacitor enclosed in the dotted lines.

7. PACKAGE DRAWINGS

20 PIN PLASTIC SOP (300 mil)



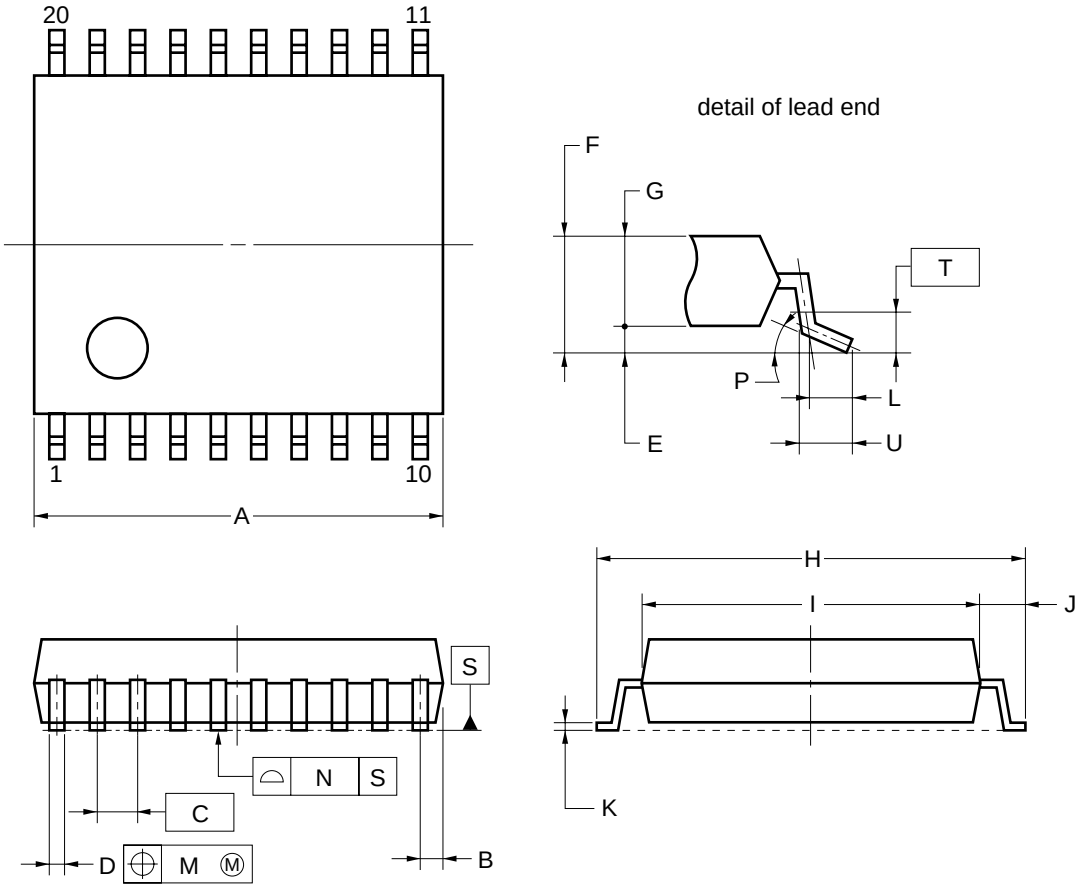
NOTE

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	12.7±0.3	0.500±0.012
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	$0.42^{+0.08}_{-0.07}$	$0.017^{+0.003}_{-0.004}$
E	0.1±0.1	0.004±0.004
F	1.8 MAX.	0.071 MAX.
G	1.55±0.05	0.061±0.002
H	7.7±0.3	0.303±0.012
I	5.6±0.2	$0.220^{+0.009}_{-0.008}$
J	1.1	0.043
K	$0.22^{+0.08}_{-0.07}$	$0.009^{+0.003}_{-0.004}$
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-5

★ 20 PIN PLASTIC SSOP (300 mil)



NOTE

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

ITEM	MILLIMETERS
A	6.65±0.15
B	0.475 MAX.
C	0.65 (T.P.)
D	$0.24^{+0.08}_{-0.07}$
E	0.1±0.05
F	1.3±0.1
G	1.2
H	8.1±0.2
I	6.1±0.2
J	1.0±0.2
K	0.17±0.03
L	0.5
M	0.13
N	0.10
P	$3^{\circ}{}^{+5^{\circ}}_{-3^{\circ}}$
T	0.25
U	0.6±0.15

S20MC-65-5A4-1

8. RECOMMENDED SOLDERING CONDITIONS

Carry out the soldered packaging of this product under the following recommended conditions.

For details of the soldering conditions, refer to information material **Semiconductor Device Mounting Technology Manual (C10535E)**.

For soldering methods and conditions other than the recommended conditions, please consult one of our NEC sales representatives.

Table 8-1. Soldering Conditions for Surface-Mount Type

(1) μPD6P4BGS-×××: 20-pin plastic SOP (300 mil)

Soldering Method	Soldering Condition	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235 °C, Time: 30 secs. max. (210 °C min.), Number of times: Twice max.	IR35-00-2
VPS	Package peak temperature: 215 °C, Time: 40 secs. max. (200 °C min.), Number of times: Twice max.	VP15-00-2
Wave soldering	Solder bath temperature: 260 °C max., Time: 10 secs. max., Number of times: once, Preheating temperature: 120 °C max. (package surface temperature.)	WS60-00-1
Partial heating	Pin temperature: 300 °C or less ; time: 3 secs or less (for each side of the device)	—

Caution Do not use two or more soldering methods in combination (except partial heating).

★ **(2) μPD6P4BMC-5A4: 20-pin plastic SSOP (300 mil)**

Soldering Method	Soldering Condition	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235 °C, Time: 30 secs. max. (210 °C min.), Number of times: Three times max.	IR35-00-3
VPS	Package peak temperature: 215 °C, Time: 40 secs. max. (200 °C min.), Number of times: Three times max.	VP15-00-3
Wave soldering	Solder bath temperature: 260 °C max., Time: 10 secs. max., Number of times: once, Preheating temperature: 120 °C max. (package surface temperature.)	WS60-00-1
Partial heating	Pin temperature: 300 °C or less ; time: 3 secs or less (for each side of the device)	—

Caution Do not use two or more soldering methods in combination (except partial heating).

APPENDIX A. DEVELOPMENT TOOLS

A PROM programmer, program adapter, and emulator are provided for the μPD6P4B.

Hardware

- **PROM programmer (AF-9704[Note], AF-9705[Note], AF-9706[Note])**
  This PROM programmer supports the μPD6P4B.
  By connecting a program adapter to this PROM programmer, the μPD6P4B can be programmed.

  Note These are products of Ando Electric Co., Ltd. For details, consult Ando Electric Co., Ltd (03-3733-1163).

★ - **Program adapter (PA-61P34, PA-61P34BMC)**
  It is used to program the μPD6P4B in combination with AF-9704, AF-9705, or AF-9706.
  The usable package differs depending on the program adapter.
  - PA-61P34 : μPD6P4BGS
  - PA-61P34BMC : μPD6P4BGS, μPD6P4BMC-5A4

- **Emulator (EB-6133[Note])**
  It is used to emulate the μPD6P4B.

  Note This is a product of Naito Densei Machida Mfg. Co., Ltd. For details, consult Naito Densei Machida Mfg. Co., Ltd. (044-822-3813).

Software

- **Assembler (AS6133)**
  - This is a development tool for remote control transmitter software.

Part Number List of AS6133

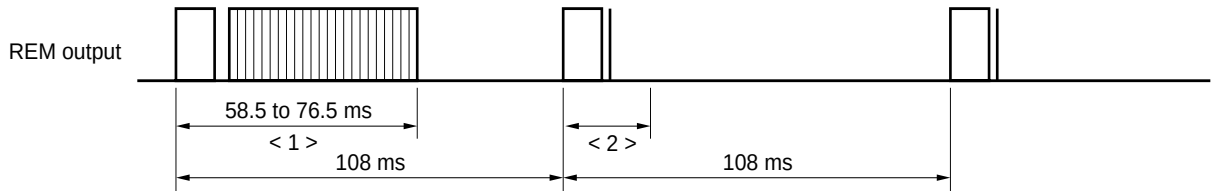
Host Machine	OS	Supply Medium	Part Number
PC-9800 series (CPU: 80386 or more)	MS-DOS™ (Ver. 5.0 to Ver. 6.2)	3.5-inch 2HD	μS5A13AS6133
IBM PC/AT™ compatible	MS-DOS (Ver. 6.0 to Ver. 6.22)	3.5-inch 2HC	μS7B13AS6133
	PC DOS™ (Ver. 6.1 to Ver. 6.3)		

Caution Although Ver.5.0 or later has a task swap function, this function cannot be used with this software.

APPENDIX B. EXAMPLE OF REMOTE-CONTROL TRANSMISSION FORMAT (in the case of NEC transmission format in command one-shot transmission mode)

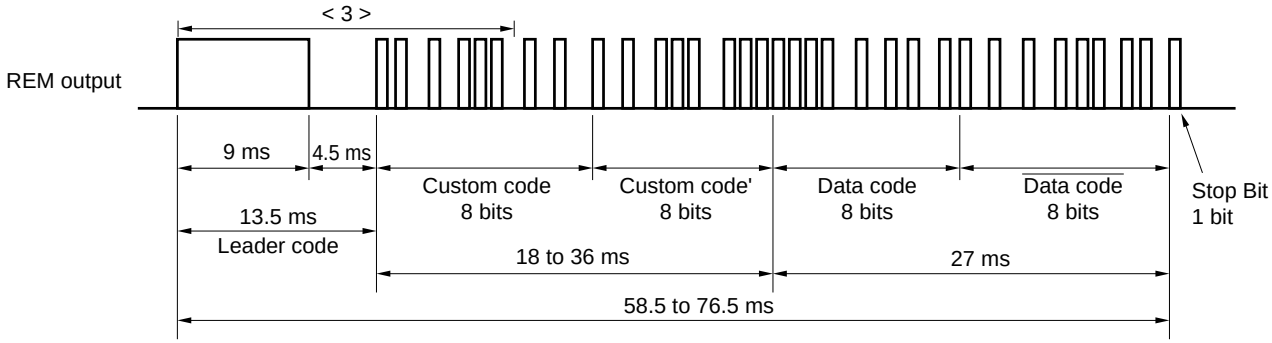
Caution When using the NEC transmission format, please apply for a custom code at NEC.

(1) REM output waveform (From <2> on, the output is made only when the key is kept pressed.)

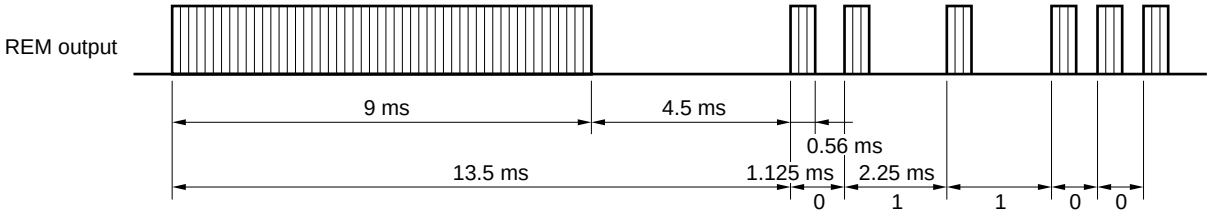


Remark If the key is repeatedly pressed, the power consumption of the infrared light-emitting diode (LED) can be reduced by sending the reader code and the stop bit from the second time.

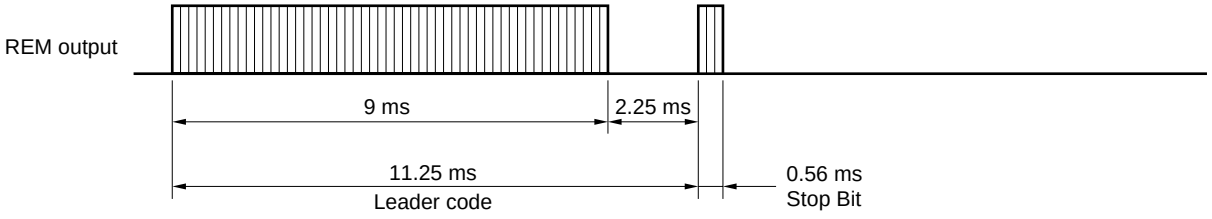
(2) Enlarged waveform of <1>



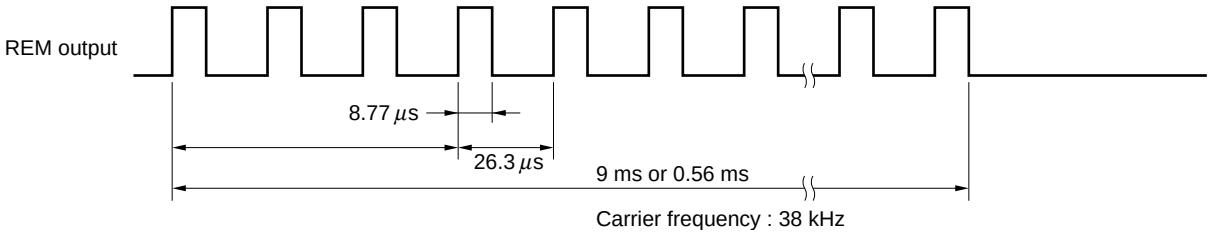
(3) Enlarged waveform of <3>



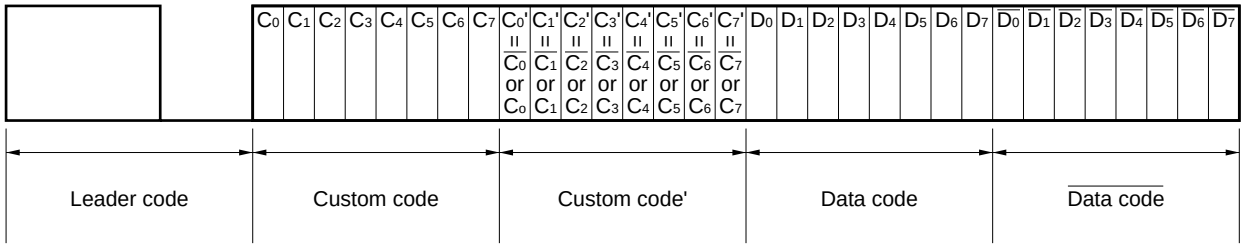
(4) Enlarged waveform of <2>



(5) Carrier waveform (Enlarged waveform of each code's high period)



(6) Bit array of each code



Caution To prevent malfunction with other systems when receiving data in the NEC transmission format, not only fully decode (make sure to check $\overline{\text{Data Code}}$ as well) the total 32 bits of the 16-bit custom codes (Custom Code, Custom Code') and the 16-bit data codes (Data Code, $\overline{\text{Data Code}}$) but also check to make sure that no signals are present.

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 devices 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.

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Fax: 408-588-6130
800-729-9288

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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

NEC Electronics Italiana s.r.l.
Milano, Italy
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Fax: 02-66 75 42 99

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NEC Electronics Hong Kong Ltd.
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Seoul, Korea
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Fax: 02-528-4411

NEC Electronics Singapore Pte. Ltd.
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Fax: 65-250-3583

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