DATA SHEET

NEC

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MOS INTEGRATED CIRCUIT

μPD6121, 6122

REMOTE CONTROL TRANSMISSION CMOS IC

The μPD6121, 6122 are infrared remote control transmission ICs using the NEC transmission format that are ideally suited for TVs, VCRs, audio equipment, air conditioners, etc. By combining external diodes and resistors, a maximum of 65,536 custom codes can be specified. These ICs come in small packages, thus facilitating the design of light and compact remote control transmitters. *

The NEC transmission format consists of leader codes, custom codes (16 bits), and data codes (16 bits). It can be used for various systems through decoding by a microcontroller.

FEATURES

- Low-voltage operation: V_{DD} = 2.0 to 3.3 V
- Low current dissipation: 1 μA Max. (at standby)
- Custom codes: 65,536 (set by external diodes and resistors) *
- Data codes:
  - μPD6121: 32 codes (single input), 3 codes (double input), expandable up to 64 codes through SEL pin
  - μPD6122: 64 codes (single input), 3 codes (double input), expandable up to 128 codes through SEL pin
- μPD6121, 6122 are transmission code-compatible (NEC transmission format) with the μPD1913C**Note**, 1943G**Note**, 6102G**Note**, and 6120C**Note**.
- Pin compatibility:
  - μPD6121G-001 is pin-compatible with the μPD1943G (However, capacitance of capacitor connected to oscillator pin and other parameters vary)
  - μPD6122G-001 is pin-compatible with the μPD6102G (However, capacitance of capacitor connected to oscillator pin and other parameters vary)
- Standard products (Ver. I, Ver. II specifications) *

Note Provided for maintenance purpose only

- **When using this product (in NEC transmission format), please order custom codes from NEC.**
- **New custom codes for the μPD6121G-002, μPD6122G-002 cannot be ordered.**

The information in this document is subject to change without notice.

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The mark * shows revised points.

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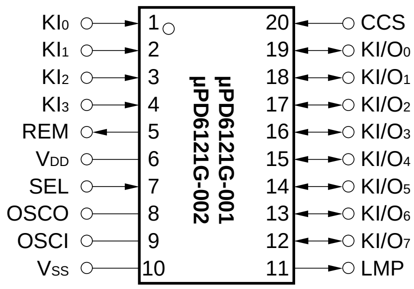
* ORDERING INFORMATION

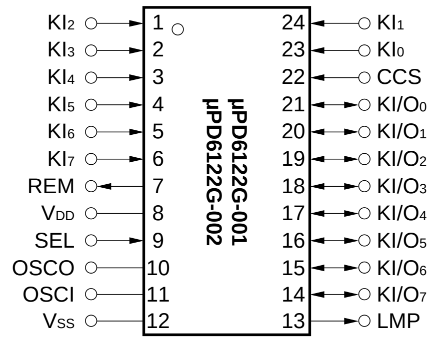
Part number	Package	Description
μPD6121G-001	20-pin plastic SOP (375 mil)	Standard (Ver I spec.)
μPD6121G-002	20-pin plastic SOP (375 mil)	Standard (Ver II spec.)
μPD6122G-001	24-pin plastic SOP (375 mil)	Standard (Ver I spec.)
μPD6122G-002	24-pin plastic SOP (375 mil)	Standard (Ver II spec.)

PIN CONFIGURATION (Top View)

- μPD6121



- μPD6122



PIN IDENTIFICATIONS

CCS :	Custom code selection input	REM :	Remote output
KI_0 - KI_7 :	Key input	SEL :	SEL input
KI/O_0 - KI/O_7 :	Key input/output	V_{DD} :	Power supply pin
LMP :	Lamp output	V_{SS} :	GND pin
OSCI, OSCO:	Resonator connection pin		

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BLOCK DIAGRAM

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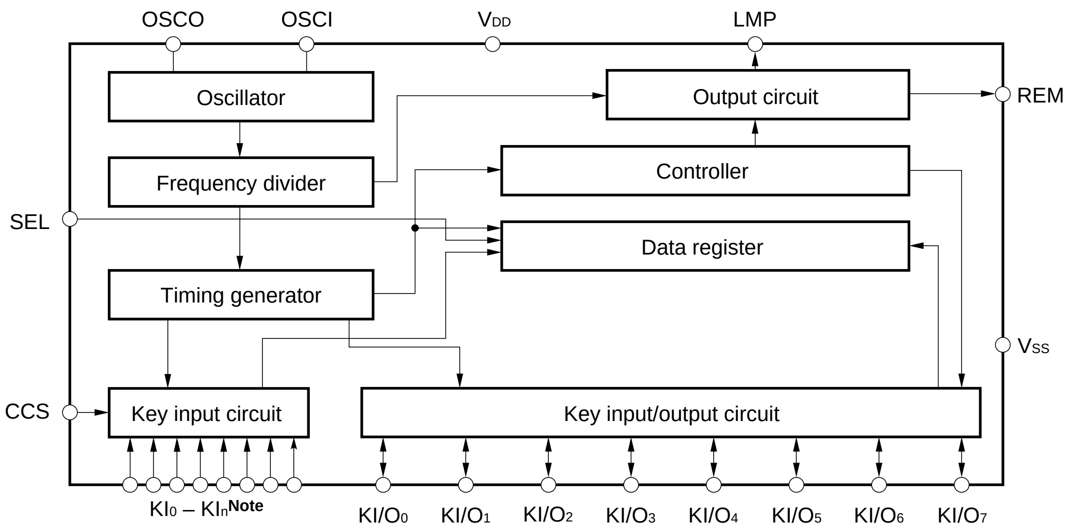

Note μPD6121: KI_0 - KI_3

μPD6122: KI_0 - KI_7

DIFFERENCES BETWEEN PRODUCTS

Item \ Part number	μPD6121	μPD6122
Operating voltage	V_{DD} = 2.0 to 3.3 V	
Current consumption (at standby)	1 μA MAX.	
Custom codes	65,536 (16-bit setting)	
Data codes	32 x 2	64 x 2
No. of KI pins	4	8
No. of KI/O pins	8	
SEL pin	Provided	
Transmission format	NEC transmission format	
Package	20-pin plastic SOP (375 mil)	24-pin plastic SOP (375 mil)

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1. PIN FUNCTIONS

(1) Key input pins (KI_0 to KI_7), key input/output pins (KI/O_0 to KI/O_7)

A pull-down resistor is placed between key input pins and a V_{SS} pin. When several keys are pressed simultaneously, the transmission of the corresponding signals is inhibited by a multiple-input prevention circuit. In the case of double-key input, transmission is inhibited if both keys are pressed simultaneously (within 36 ms interval); if not pressed simultaneously, the priority of transmission is first key, then second key.

When a key is pressed, the custom code and data code reading is initiated, and 36 ms later, output to REM output is initiated. Thus if the key is pressed during the initial 36 ms, one transmission is performed. If a key is kept pressed for 108 ms or longer, only leader codes are consecutively transmitted until the key is released.

Keys can be operated intermittently at intervals as short as 126 ms (interval between two on's), making this an extremely fast-response system.

(2) Resonator connection pins (OSCI, OSCO)

The oscillator starts operating when it receives a key input. Use a ceramic resonator with a frequency between 400 and 500 kHz.

(3) Power-supply pin

The power supply voltage is supplied by two 3-V batteries. A broad range of operating power supply voltage is allowed, from 2.0 to 3.3 V. The supply current falls below 1 μA when the oscillator is inactive when no keys are pressed.

(4) REM output pin

The REM output pin outputs the transmission code, which consists of the leader code, custom code (16 bits), and data code (16 bits) (Refer to **2. NEC TRANSMISSION FORMAT (REM OUTPUT)**).

(5) SEL input pin

By controlling D_7 of the data code with this pin, the μPD6121 and μPD6122 can transmit 64 and 128 different data codes, respectively. By connecting the SEL pin to V_{DD} or V_{SS}, D_7 is set to "0" or "1", respectively.

This pin has high-impedance input, therefore be sure to connect it either to V_{DD} or V_{SS}.

(6) CCS input pin

By placing a diode between the CCS pin and the KI/O pin, it is possible to set a custom code. When a diode is connected, the corresponding custom code is "1", and when not connected, it is "0".

(7) LMP output pin

The LMP pin outputs a low-level signal while the REM pin outputs a transmission code.

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2. NEC TRANSMISSION FORMAT (REM OUTPUT)

The NEC transmission format consists of the transmission of a leader code, 16-bit custom codes (Custom Code, Custom Code'), and 16-bit data codes (Data Code, $\overline{\text{Data Code}}$) at one time, as shown in Figure 2-1.

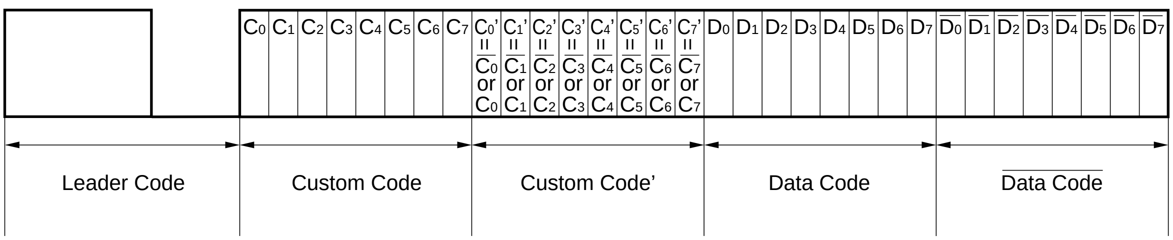
Also refer to **4. REMOTE OUTPUT WAVEFORM**.

$\overline{\text{Data Code}}$ is the inverted code of Data Code.

The leader code consists of a 9-ms carrier waveform and a 4.5-ms OFF waveform and is used as leader for the ensuing code to facilitate reception detection.

Codes use the PPM (Pulse Position Modulation) method, and the signals "1" and "0" are fixed by the interval between pulses.

Figure 2-1. REM Output Code



Cautions 1. Use any of the possible 256 kinds of custom codes specified with 00xxH (diode not connected), as desired. If intending to use custom codes other than 00xxH, please consult NEC in order to avoid various types of errors from occurring between systems.

2. When receiving data in the NEC transmission format, check that the 32 bits made up of the 16-bit custom code (Custom Code, Custom Code') and the 16-bit data code (Data Code, $\overline{\text{Data Code}}$) are fully decoded, and that there are no signals with the 33rd bit and after (be sure to check also $\overline{\text{Data Code}}$).

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* 3. CUSTOM CODE (CUSTOM CODE, CUSTOM CODE') SETTING

The custom code is set in two different ways depending on whether Ver I or Ver II specifications are employed.

Figure 3-1. Custom Code Setting

	Higher 8 bits of custom code	Lower 8 bits of custom code'
Ver I	Fixed by external diode bit	Fixed by external pull-up resistor bit
Ver II	C_0, C_1, C_2 ... Fixed by connecting CCS pin and either one of pins KI/O_0 to KI/O_7 C_3 to C_7 ... Fixed by absence or presence of external pull-up resistor for KI/O_6, KI/O_7	Fixed by external pull-up resistor (KI/O_0 to KI/O_5) bit

Remark The μPD6121-001 has Ver I specifications and is pin-compatible with the μPD1943G, and the μPD6122-001 has Ver I specifications and is pin-compatible with the μPD6102G.
If used as pin-compatible products, please note the following points.
① Connect the SEL pin to V_{DD}.
② Change the capacitance of the capacitor connected to the resonator connection pin (Refer to **9. ELECTRICAL SPECIFICATIONS**).

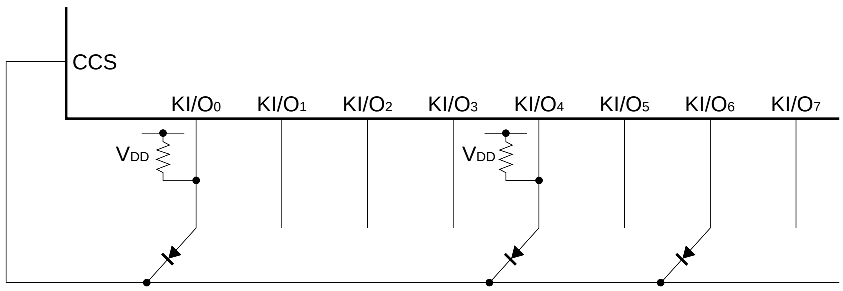
A custom code setting example is shown below.

* 3.1 Standard versions with Ver I specs. (μPD6121-001, μPD6122-001)

Each of the higher 8 bits of the custom code is set to "1" when a diode is connected between the CCS pin and the corresponding KI/O pin, and is set to "0" when no diode is connected. If a pull-up resistor is connected to the KI/O pin corresponding to one of the lower 8 bits of the custom code', the bit is first set to "1". Based on the 1's information of the lower 8 bits of the custom code', the corresponding bit of the higher 8 bits of the custom code is then captured and not inverted. The non-inverted value is finally overwritten to the corresponding bit of the lower 8 bits of the custom code'. The inverse occurs when no pull-up resistor is connected.
It follows from the above that the custom code can be set in 65,536 different ways depending on whether or not a diode and/or pull-up resistor are present.
Please refer to **Figure 3-2 Example of Custom Code Setting for Ver I Specifications (μPD6121-001, 6122-001)**.

Figure 3-2. Example of Custom Code Setting for Ver I Specifications (μPD6121-001, 6122-001)

Configuration example



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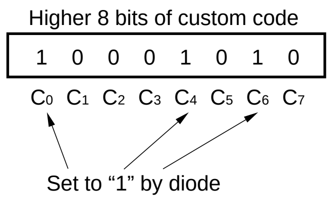
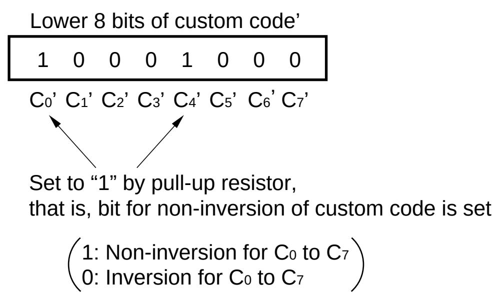
The higher 8 bits of the custom code are determined by the diode connected to the CCS pin and KI/O pin.

Set custom code



The inversion/non-inversion of the lower 8 bits of the custom code’ is determined by the pull-up resistor connected to the KI/O pin.

Set custom code



When the above-described setting is done, the following custom code is output.

Custom code

Higher 8 bits of custom code								Lower 8 bits of custom code’							
1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	1
C_0	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_0'	C_1'	C_2'	C_3'	C_4'	C_5'	C_6'	C_7'
								C_0	$\overline{C_1}$	$\overline{C_2}$	$\overline{C_3}$	C_4	$\overline{C_5}$	$\overline{C_6}$	$\overline{C_7}$

Remark Codes are transmitted from the LSB.

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* 3.2 Standard versions with Ver II specs. (μPD6121-002, 6122-002)

In Ver II, the CCS pin does not have the external diode reading function.
The allocation of C_2, C_1 and C_0 of the higher 8 bits of the custom code is done by connecting the CCS pin to any one of the KI/O_0 to KI/O_7 pins, as shown below.

Pin connected to CCS pin	C_2	C_1	C_0
KI/O_0	0	0	0
KI/O_1	0	0	1
KI/O_2	0	1	0
KI/O_3	0	1	1
KI/O_4	1	0	0
KI/O_5	1	0	1
KI/O_6	1	1	0
KI/O_7	1	1	1

When CCS pin is open, (C_2 C_1 C_0) = (0 0 0)

* The allocation of C_7, C_6, C_5, C_4 and C_3 of the higher 8 bits of the custom code is as follows depending on whether a pull-up resistor is provided.

Pull-up Resistor		C_7 to C_3 of Higher 8 bits of Custom Code				
KI/O_6	KI/O_7	C_7	C_6	C_5	C_4	C_3
Not Provided	Not Provided	0	0	0	0	0
Not Provided	Provided	1	0	0	1	1
Provided	Not Provided	1	0	0	0	0
Provided	Provided	1	1	1	0	1

Caution **In Ver II, it is not possible to set all custom codes.**
Also, new custom codes cannot be ordered for Ver II products; therefore, Ver I products should be used if new custom codes are required.

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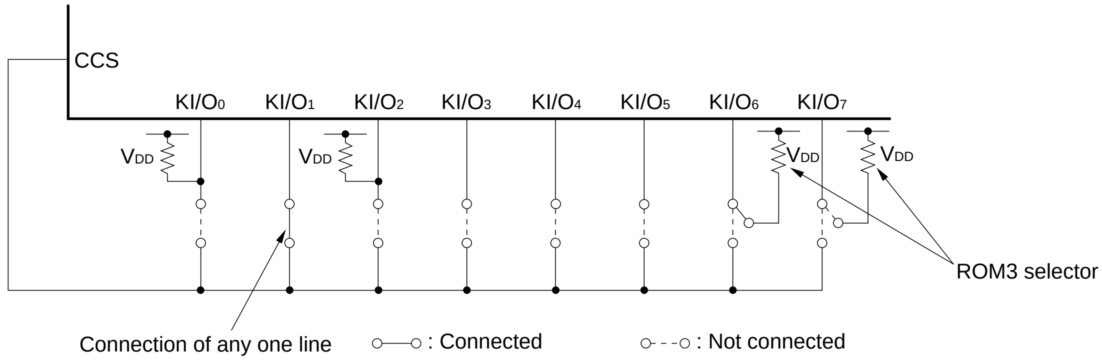
Figure 3-3. Example of Custom Code Setting for Ver II Specifications (μPD6121-002, 6122-002)

Configuration Example



C_2, C_1 and C_0 of the higher 8 bits of the custom code are fixed by connecting the CCS pin to KI/O_0 to KI/O_7. Therefore, in the configuration example, they become [1 0 0].
C_0 C_1 C_2

C_7, C_6, C_5, C_4 and C_3 of the higher 8 bits of the custom code are selected and fixed by the pull-up resistor connected to KI/O_6 and KI/O_7 in four channels.

C_7	C_6	C_5	C_4	C_3	Pull-up resistor KI/O_6	Pull-up resistor KI/O_7
1	0	1	1	0	Disconnected	Disconnected
0	0	1	1	1	Disconnected	Connected
1	1	0	1	1	Connected	Disconnected
1	1	1	1	1	Connected	Connected

*

In this configuration example, C_3 to C_7 of the higher 8 bits of the custom code become [1 1 0 1 1].
C_3 C_4 C_5 C_6 C_7

The inversion/non-inversion of the lower 8 bits of the custom code' is fixed by the bit of the external pull-up resistor of KI/O_0 to KI/O_5. *

External setting (Refer to Configuration Example)
Lower 8 bits of custom code'

1	0	1	0	0	0	0	0
C_0'	C_1'	C_2'	C_3'	C_4'	C_5'	C_6'	C_7'

Pull-up resistor bit
(KI/O_0, KI/O_2)

Bit for non-inversion of custom code is set
(1: Non-inversion for C_0 to C_7
0: Inversion for C_0 to C_7)

Caution C_6' and C_7' are fixed to 0.

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As noted above, setting the pull-up resistor and connection, produces the following custom code.

Custom code

*

Higher 8 bits of custom code								Lower 8 bits of custom code'							
1	0	0	1	1	0	1	1	1	1	0	0	0	1	0	0
C_0	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_0'	C_1'	C_2'	C_3'	C_4'	C_5'	C_6'	C_7'
								C_0	$\overline{C_1}$	C_2	$\overline{C_3}$	$\overline{C_4}$	$\overline{C_5}$	$\overline{C_6}$	$\overline{C_7}$

Remark Codes are transmitted from the LSB.

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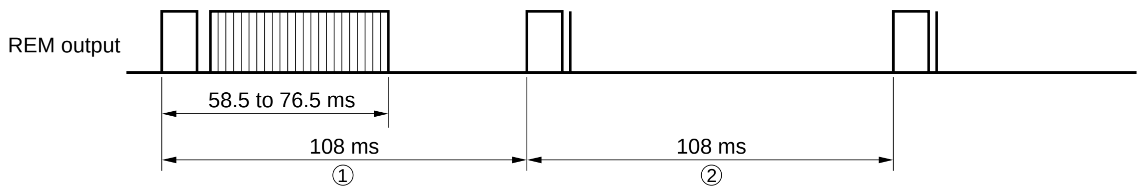
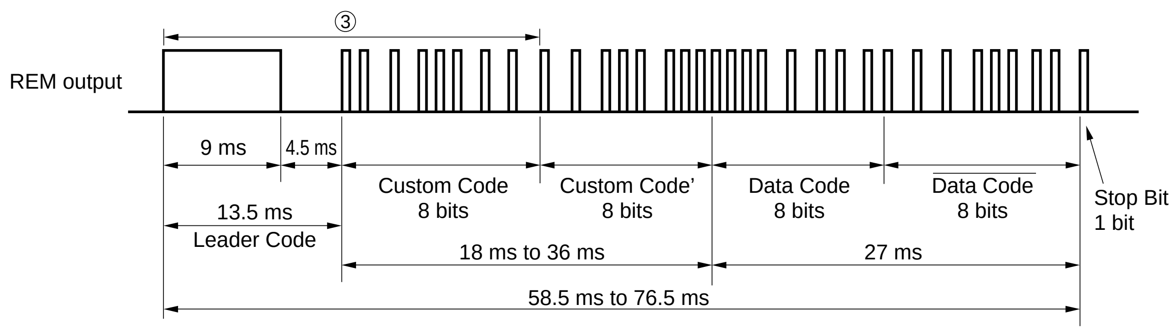
4. REMOTE OUTPUT WAVEFORM (NEC TRANSMISSION FORMAT: ONE-SHOT COMMAND TRANSMISSION MODE)

- **When fosc = 455 kHz**

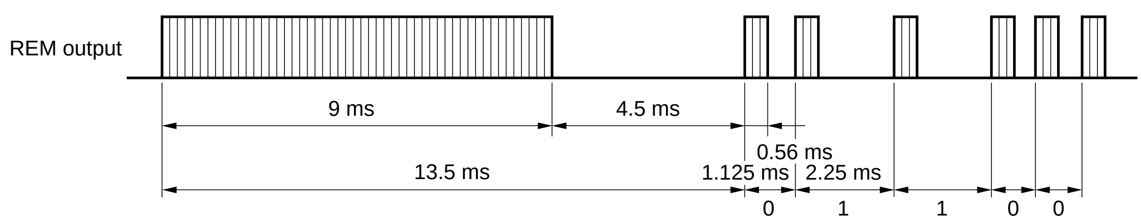
(1) Remote (REM) output (from stage ②, transmission occurs only when key is kept depressed)



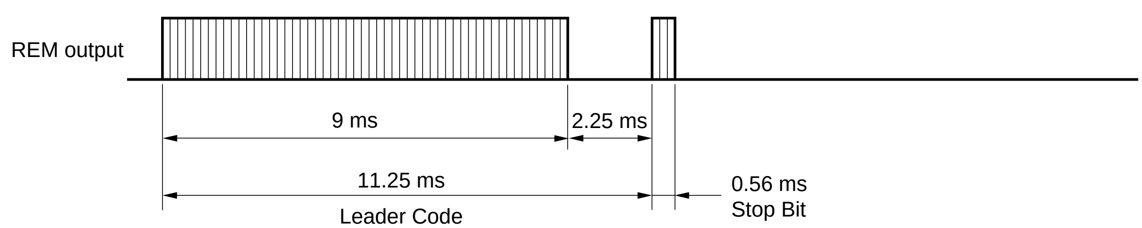
(2) Magnification of stage ①



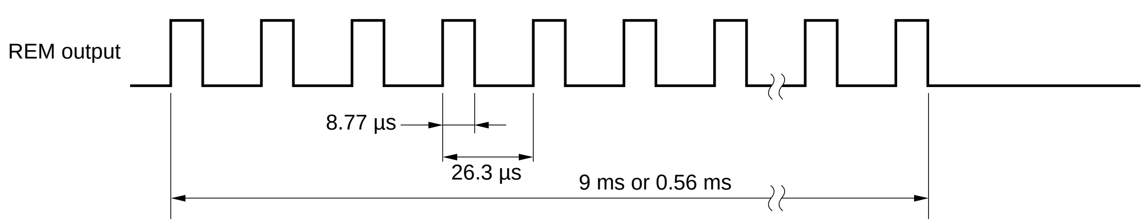
(3) Magnification of waveform ③



(4) Magnification of waveform ②



(5) Carrier waveform (Magnification of HIGH period of codes)



Carrier frequency: fc = fosc/12 = 38 kHz

Remark If a key is kept depressed, the second and subsequent times, only the leader code and the stop bit are transmitted, which allows power savings for the infrared-emitting diode. If a command is issued continuously in the same way the second and subsequent times as the first time, refer to **7. ONE-SHOT/CONTINUOUS COMMAND TRANSMISSION MODE**.

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* 5. KEY DATA CODES (SINGLE INPUT)

KEY	CONNECTION					DATA CODE								NOTES
	KI_0	KI_1	KI_2	KI_3	KI/O	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7 Note	
K1	*					0	0	0	0	0	0	0	0/1	
K2		*			KI/O_0	1	0	0	0	0	0	0	0/1	
K3			*			0	1	0	0	0	0	0	0/1	
K4				*		1	1	0	0	0	0	0	0/1	
K5	*					0	0	1	0	0	0	0	0/1	
K6		*			KI/O_1	1	0	1	0	0	0	0	0/1	μPD1913C } Unavailable
K7			*			0	1	1	0	0	0	0	0/1	μPD6120C }
K8				*		1	1	1	0	0	0	0	0/1	
K9	*					0	0	0	1	0	0	0	0/1	
K10		*			KI/O_2	1	0	0	1	0	0	0	0/1	
K11			*			0	1	0	1	0	0	0	0/1	
K12				*		1	1	0	1	0	0	0	0/1	
K13	*					0	0	1	1	0	0	0	0/1	
K14		*			KI/O_3	1	0	1	1	0	0	0	0/1	μPD1913C } Unavailable
K15			*			0	1	1	1	0	0	0	0/1	μPD6120C }
K16				*		1	1	1	1	0	0	0	0/1	
K17	*					0	0	0	0	1	0	0	0/1	
K18		*			KI/O_4	1	0	0	0	1	0	0	0/1	
K19			*			0	1	0	0	1	0	0	0/1	
K20				*		1	1	0	0	1	0	0	0/1	
K21	*					0	0	1	0	1	0	0	0/1	
K22		*			KI/O_5	1	0	1	0	1	0	0	0/1	
K23			*			0	1	1	0	1	0	0	0/1	
K24				*		1	1	1	0	1	0	0	0/1	
K25	*					0	0	0	1	1	0	0	0/1	
K26		*			KI/O_6	1	0	0	1	1	0	0	0/1	
K27			*			0	1	0	1	1	0	0	0/1	
K28				*		1	1	0	1	1	0	0	0/1	
K29	*					0	0	1	1	1	0	0	0/1	
K30		*			KI/O_7	1	0	1	1	1	0	0	0/1	μPD1913C } Unavailable
K31			*			0	1	1	1	1	0	0	0/1	μPD6120C }
K32				*		1	1	1	1	1	0	0	0/1	

K1–K32: • μPD6121 • μPD6122

KEY	CONNECTION					DATA CODE								NOTES
	KI_4	KI_5	KI_6	KI_7	KI/O	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	
K33	*					0	0	0	0	0	0	1	0/1	μPD1943G }
K34		*			KI/O_0	1	0	0	0	0	0	1	0/1	μPD1913C } Unavailable
K35			*			0	1	0	0	0	0	1	0/1	μPD6120C }
K36				*		1	1	0	0	0	0	1	0/1	μPD6121G }
K37	*					0	0	1	0	0	0	1	0/1	μPD1943G }
K38		*			KI/O_1	1	0	1	0	0	0	1	0/1	μPD1913C } Unavailable
K39			*			0	1	1	0	0	0	1	0/1	μPD6120C }
K40				*		1	1	1	0	0	0	1	0/1	μPD6121G }
K41	*					0	0	0	1	0	0	1	0/1	μPD1943G }
K42		*			KI/O_2	1	0	0	1	0	0	1	0/1	μPD1913C } Unavailable
K43			*			0	1	0	1	0	0	1	0/1	μPD6120C }
K44				*		1	1	0	1	0	0	1	0/1	μPD6121G }
K45	*					0	0	1	1	0	0	1	0/1	μPD1943G }
K46		*			KI/O_3	1	0	1	1	0	0	1	0/1	μPD1913C } Unavailable
K47			*			0	1	1	1	0	0	1	0/1	μPD6120C }
K48				*		1	1	1	1	0	0	1	0/1	μPD6121G }
K49	*					0	0	0	0	1	0	1	0/1	μPD1943G }
K50		*			KI/O_4	1	0	0	0	1	0	1	0/1	μPD1913C } Unavailable
K51			*			0	1	0	0	1	0	1	0/1	μPD6120C }
K52				*		1	1	0	0	1	0	1	0/1	μPD6121G }
K53	*					0	0	1	0	1	0	1	0/1	μPD1943G }
K54		*			KI/O_5	1	0	1	0	1	0	1	0/1	μPD1913C } Unavailable
K55			*			0	1	1	0	1	0	1	0/1	μPD6120C }
K56				*		1	1	1	0	1	0	1	0/1	μPD6121G }
K57	*					0	0	0	1	1	0	1	0/1	μPD1943G }
K58		*			KI/O_6	1	0	0	1	1	0	1	0/1	μPD1913C } Unavailable
K59			*			0	1	0	1	1	0	1	0/1	μPD6120C }
K60				*		1	1	0	1	1	0	1	0/1	μPD6121G }
K61	*					0	0	1	1	1	0	1	0/1	μPD1943G }
K62		*			KI/O_7	1	0	1	1	1	0	1	0/1	μPD1913C } Unavailable
K63			*			0	1	1	1	1	0	1	0/1	μPD6120C }
K64				*		1	1	1	1	1	0	1	0/1	μPD6121G }

K33–K64: • μPD6122 only

Note Bit D_7 is “0” when the SEL pin is connected to V_{DD}, and “1” when it is connected to V_{SS}.

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6. DOUBLE-INPUT OPERATION

All keys are provided with a multiple-input prevention circuit. When two or more keys are pressed simultaneously, no signal is transmitted; but when the keys K21 and K22, K21 and K23, or K21 and K24 are pressed together, D_5 is set to “1”. However, the way keys are pressed determines the priority: If K22/K23/K24 are pressed 126 ms or longer after K21 is pressed, transmission is performed in this mode.

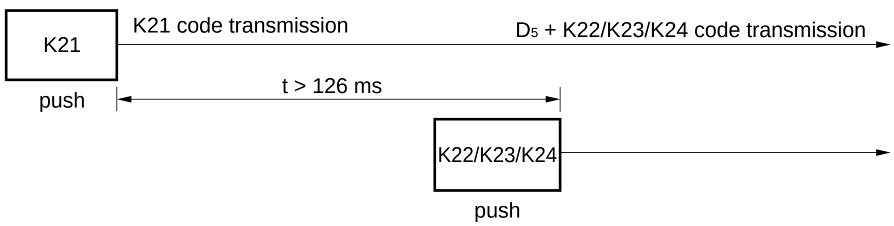
Double-input key operation is ideally suited for tape recording error prevention applications.

Double-Input Operation Key Codes

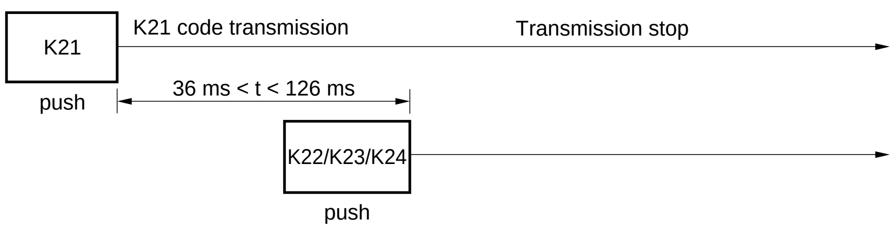
KEY	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
K21 + K22	1	0	1	0	1	1	0	0/1
K21 + K23	0	1	1	0	1	1	0	0/1
K21 + K24	1	1	1	0	1	1	0	0/1

Double-Input Operation Timing

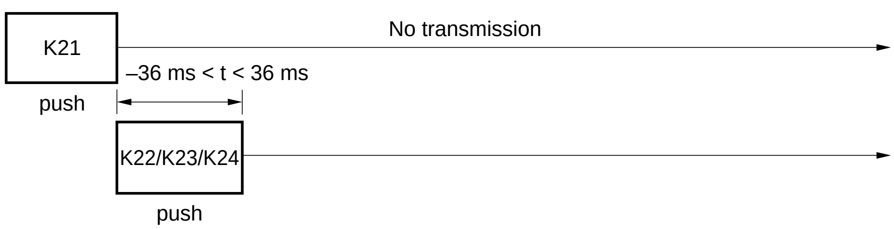
① Double-input transmission



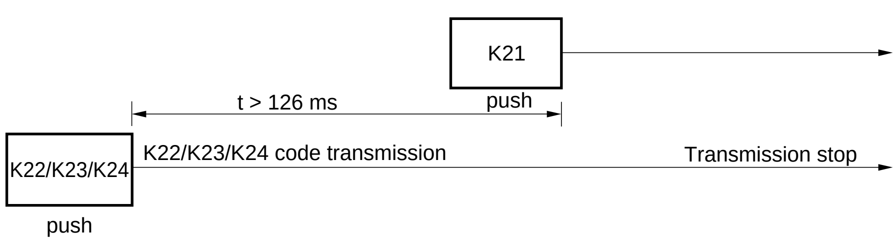
② No operation



③ No operation



④ No operation



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7. ONE-SHOT/CONTINUOUS COMMAND TRANSMISSION MODE

7.1 One-shot Command Transmission Mode

In order to reduce the average transmission current, the μPD6120C, 6121G, and 6122G transmit data only once, and thereafter transmit just the leader code and stop bit indicating that a key is depressed. As a result, this transmission method (one-shot command transmission mode) has the following characteristics.

Advantages

- Average transmission current is reduced to 1/3 to 1/4 compared with continuous command transmission mode
- Reduced software load for reception program (not all commands are processed all the time)
- This mode distinguishes when a key is pressed several times successively and when a key is kept depressed.

Disadvantages

- If a command is not read the first time, it cannot be read a second time
- If a signal transmission is interrupted while continuous commands are executed, subsequent commands cannot be executed.

Moreover, when f_{OSC} = 455 kHz, the average current to the infrared-emitting diode is roughly equivalent to 3 % of the peak current.

I_{AVE} = (9 ms + 0.56 ms)/108 ms x 1/3 (duty) = 2.95 % (first command is ignored)

7.2 Continuous Command Transmission Mode

A continuous command transmission mode for transmitting data a second or more times is also available.

As shown in Figure 7-2, it is possible to continuously transmit commands for all the keys or for individual key output lines simply by adding a diode D and connecting it to KI_0 or KI/O.

In this case, the average transmission current is larger than that in the one-shot command transmission mode.

When f_{OSC} = 455 kHz, the average current to the infrared-emitting diode is roughly equivalent to 9 % of the peak current.

I_{AVE} = (9 ms + 0.56 ms x 33)/108 ms x 1/3 (duty) = 8.48 %

Cautions 1. If the double input key (K21-K24) is used in the continuous command transmission mode, double-input key transmission is not performed (D_5 does not become 1).

2. When the voltage drop of the REM output is large, the signal is not transmitted accurately. Therefore, keep the REM output current within 1 mA.

Figure 7-1 shows the continuous command transmission mode.

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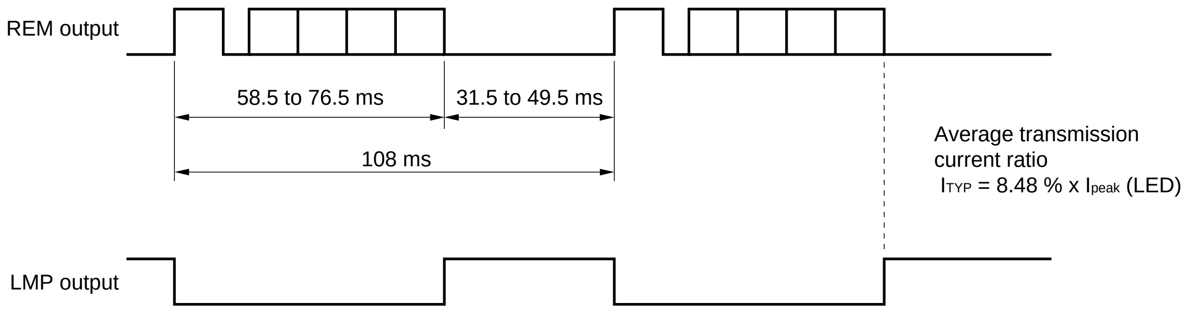
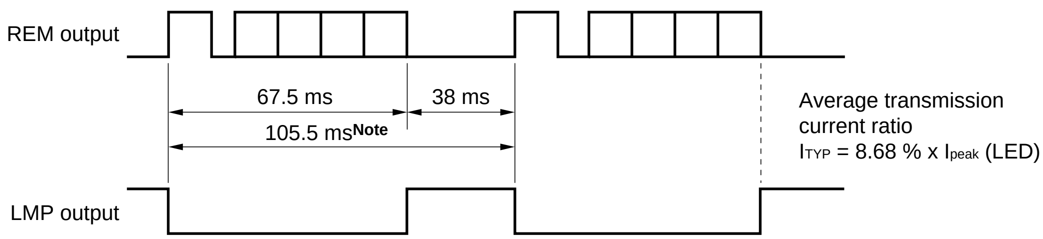
Figure 7-1. Continuous Command Transmission Mode (When f_{OSC} = 455 kHz)

(1) μPD6120C, 6121G, 6122G

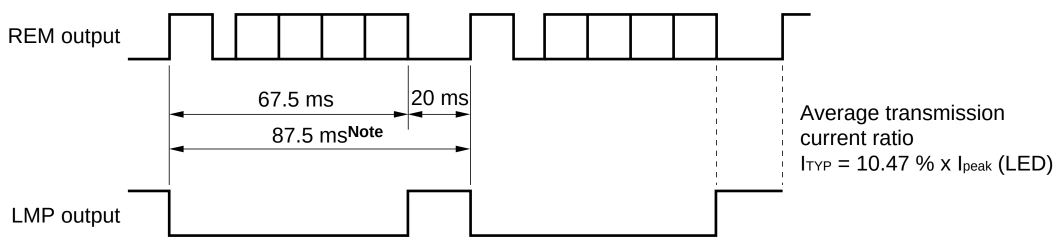


(2) μPD1913C, 1943G, 6102G

① K_1 to K_{20}, K_{33} to K_{52} (KO_0 to KO_4)



② K_{21} to K_{32}, K_{53} to K_{64} (KO_5 to KO_7)



Note In the case of the μPD1913C, 1943G and 6102G, the transmission repeat cycle (T) varies depending on the key.

Remark I_{TYP} = I_{AVE} x I_{peak} (LED)
I_{AVE} = (9 ms + 0.56 ms x 33)/T ms x 1/3 (duty)

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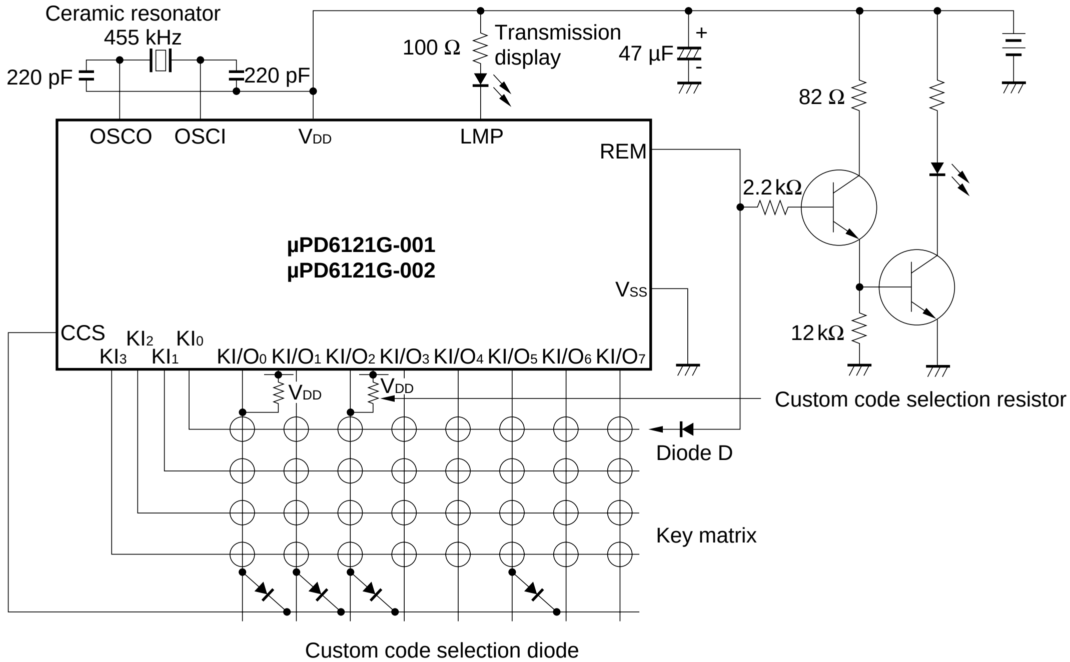
Figure 7-2. Application Circuit for Continuous Command Transmission Mode

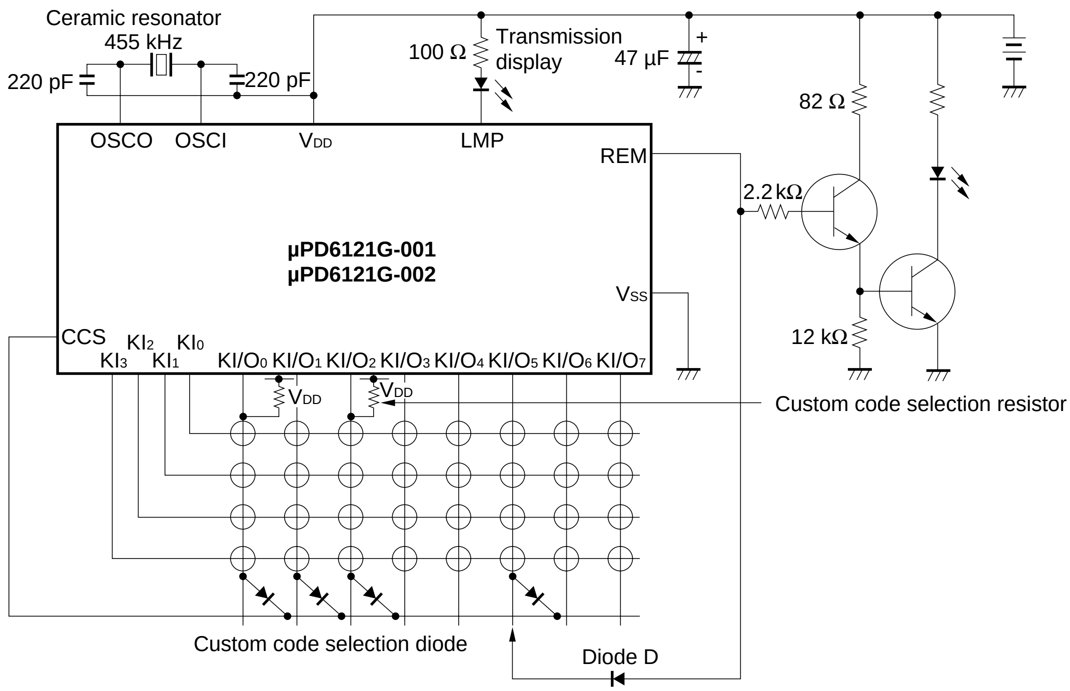
① **Continuous command transmission for all keys**Note 1

REM output is input to KI_0 with diode D.



② **Continuous command transmission for key output lines**

REM output is input to KI/O with diode D.



Continuous command transmission can be performed for keys whose KI/O output lines have received diode D inputNote 2.

* **Notes 1.** Double-key transmission cannot be performed.

2. If the KI/O_5 output line (double-input key) is in the continuous command transmission mode, double-input key transmission is not performed (D_5 does not become 1).

Caution When the voltage drop of the REM output is large, the signal is not transmitted accurately. Therefore, keep the REM output current within 1 mA.

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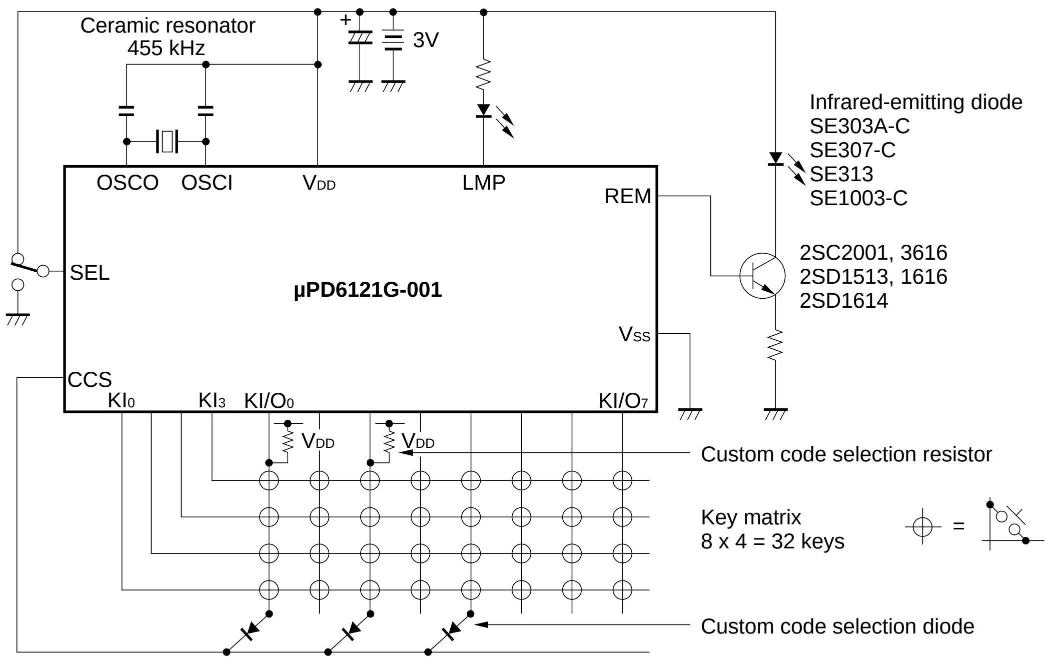
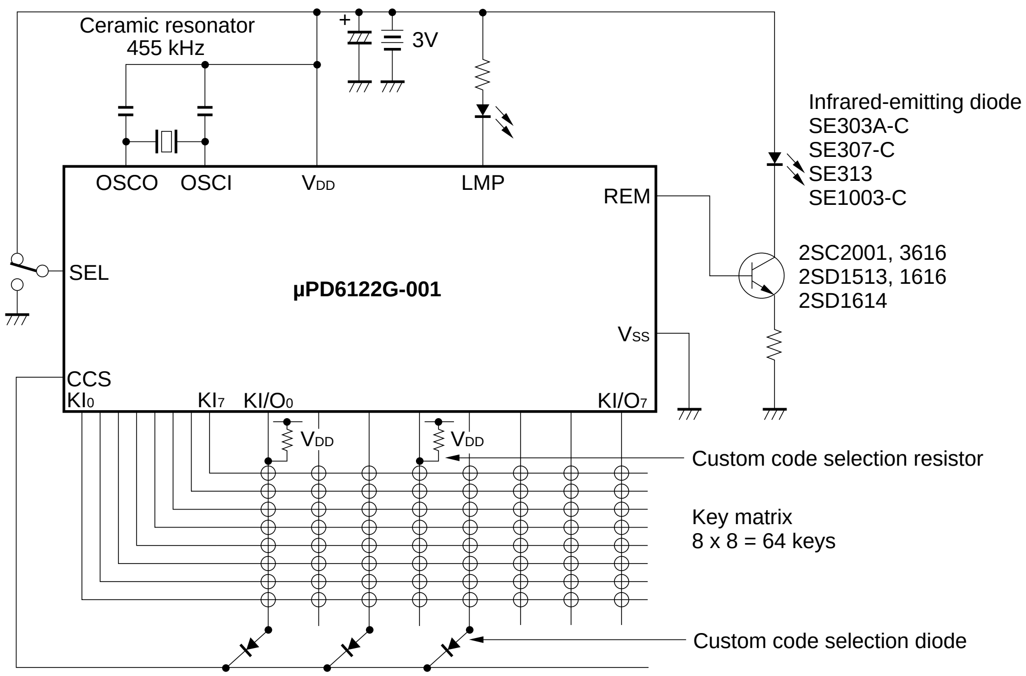
8. APPLICATION CIRCUIT EXAMPLE

(1) Example application circuit using μPD6121



(2) Example application circuit using μPD6122



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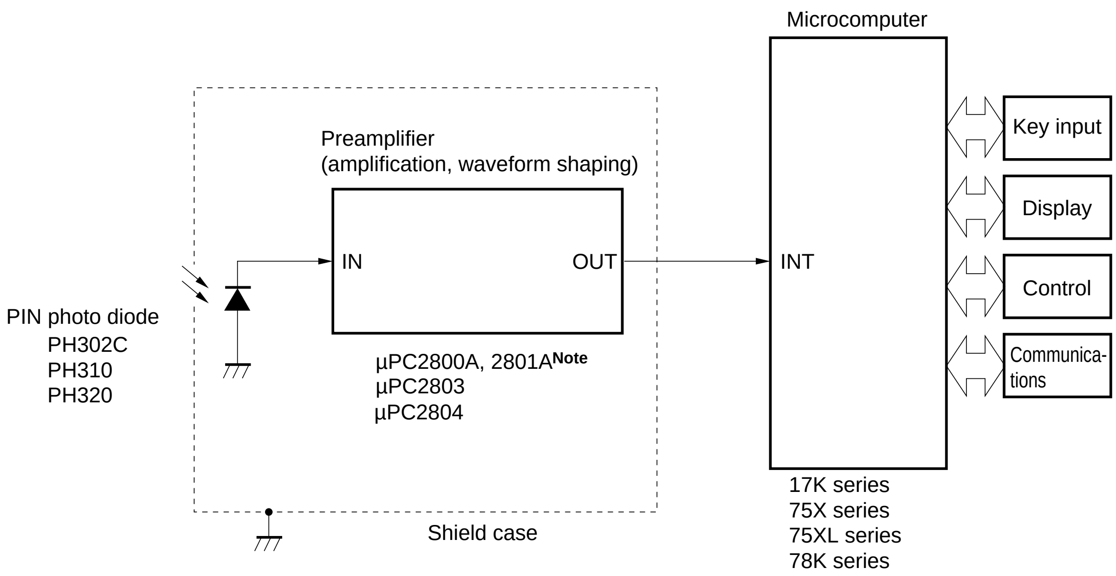
* **(3) Application circuit example, receive side**



Note The μPC2801A's active level is high.

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9. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25 °C)

Parameter	Symbol	Ratings	Unit
Supply voltage	V_{DD}	–0.3 to +6.0	V
Input voltage	V_I	–0.3 to V_{DD} + 0.3	V
Power dissipation	P_D	250	mW
Operating ambient temperature	T_A	–20 to +75	°C
Storage temperature	T_{stg}	–40 to +125	°C

Recommended Operating Conditions (T_A = –20 to +75 °C)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{DD}	2.0	3.0	3.3	V
Oscillation frequency	f_{OSC}	400	455	500	kHz
Input voltage	V_I	0		V_{DD}	V
Custom code select pull-up resistor	R_{UP}	160	200	240	kΩ

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

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply current 1	I_{DD1}	f_{OSC} = 455 kHz		0.1	1	mA
Supply current 2	I_{DD2}	f_{OSC} = STOP			1	μA
REM output current High	I_{OH1}	V_O = 1.5 V	–5	–8		mA
REM output current Low	I_{OL1}	V_O = 0.3 V	15	30		μA
LMP output current High	I_{OH2}	V_O = 2.7 V	–15	–30		μA
LMP output current Low	I_{OL2}	V_O = 0.3 V	1	1.5		mA
KI input current High	I_{IH1}	V_I = 3.0 V	10		30	μA
KI input current Low	I_{IL1}	V_I = 0 V			–0.2	μA
KI, SEL input voltage High	V_{IH1}		2.1		3.0	V
KI, SEL input voltage Low	V_{IL1}		0		0.9	V
KI/O input voltage High	V_{IH2}		1.3			V
KI/O input voltage Low	V_{IL2}				0.4	V
KI/O input current High	I_{IH2}	V_I = 3.0 V	2		7	μA
KI/O input current Low	I_{IL2}	V_I = 0 V			–0.2	μA
KI/O output current High	I_{OH3}	V_O = 2.5 V	–1.0		–2.5	mA
KI/O output current Low	I_{OL3}	V_O = 1.7 V	35		100	μA
CCS input voltage High	V_{IH3}		1.1			V
CCS input current High	I_{IH3}	Pull-up, V_I = 3.0 V			0.2	μA
CCS input current Low	I_{IL3}	Pull-up, V_I = 0 V	–3		–8	μA
CCS input current High	I_{IH4}	Pull-down, V_I = 3.0 V	10		30	μA
CCS input current Low	I_{IL4}	Pull-down, V_I = 0 V			–0.2	μA

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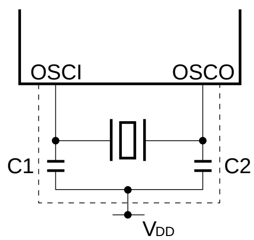
Recommended Ceramic Resonators (T_A = –20 to +75 °C, V_{DD} = 2.0 to 3.3 V)

- μPD6121, 6122

Maker	Product	Recommended constant [pF]		Operating voltage [V]	
		C_1	C_2	MIN.	MAX.
Murata Seisakusho Corp.	CSB455E	220	220	2.0	3.3
	CSB480E	220	220	2.0	3.3
Toko Corp.	CRK455	120	300	2.0	3.3
Kyocera Corp.	KBR-455BTLR	220	220	2.0	3.3

Example of external circuit



Caution **If using an oscillation circuit, wire the area enclosed in the dotted line in the figure in the manner indicated below in order to avoid negative effects such as from stray capacitance of wires.**

- **Keep wiring as short as possible.**
- **Do not cross other signal lines. Do not design wiring close to lines with large fluctuating current.**
- **Make sure that the connection point of the oscillation circuit's capacitor has the same potential as V_{DD}.**
- **Do not extract signals from the oscillation circuit.**

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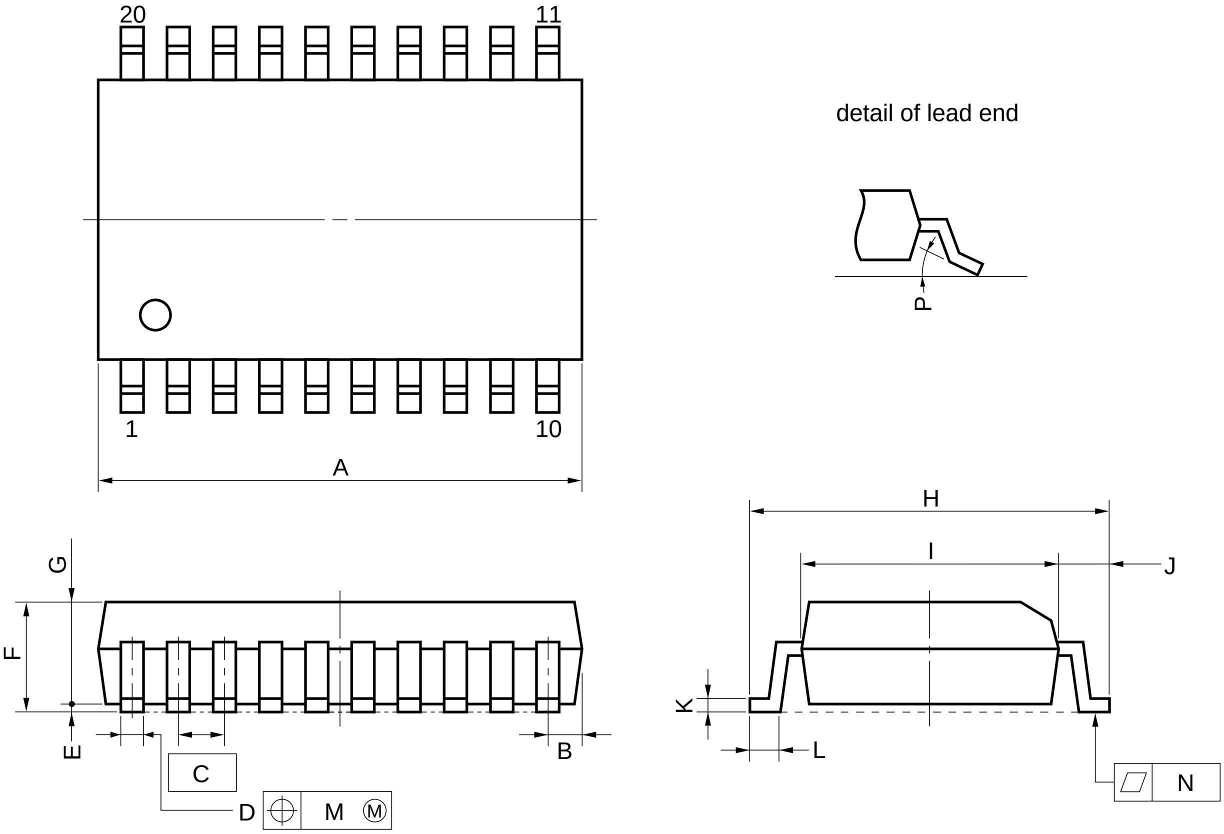
10. PACKAGE DRAWINGS

*

(1) Package for the μPD6121

20 PIN PLASTIC SOP (375 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	0.125±0.075	0.005±0.003
F	2.9 MAX.	0.115 MAX.
G	2.50	0.098
H	10.3±0.3	$0.406^{+0.012}_{-0.013}$
I	7.2	0.283
J	1.6	0.063
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	0.8±0.2	$0.031^{+0.009}_{-0.008}$
M	0.12	0.005
N	0.15	0.006
P	$3^\circ{}^{+7^\circ}_{-3^\circ}$	$3^\circ{}^{+7^\circ}_{-3^\circ}$

P20GM-50-375B-4

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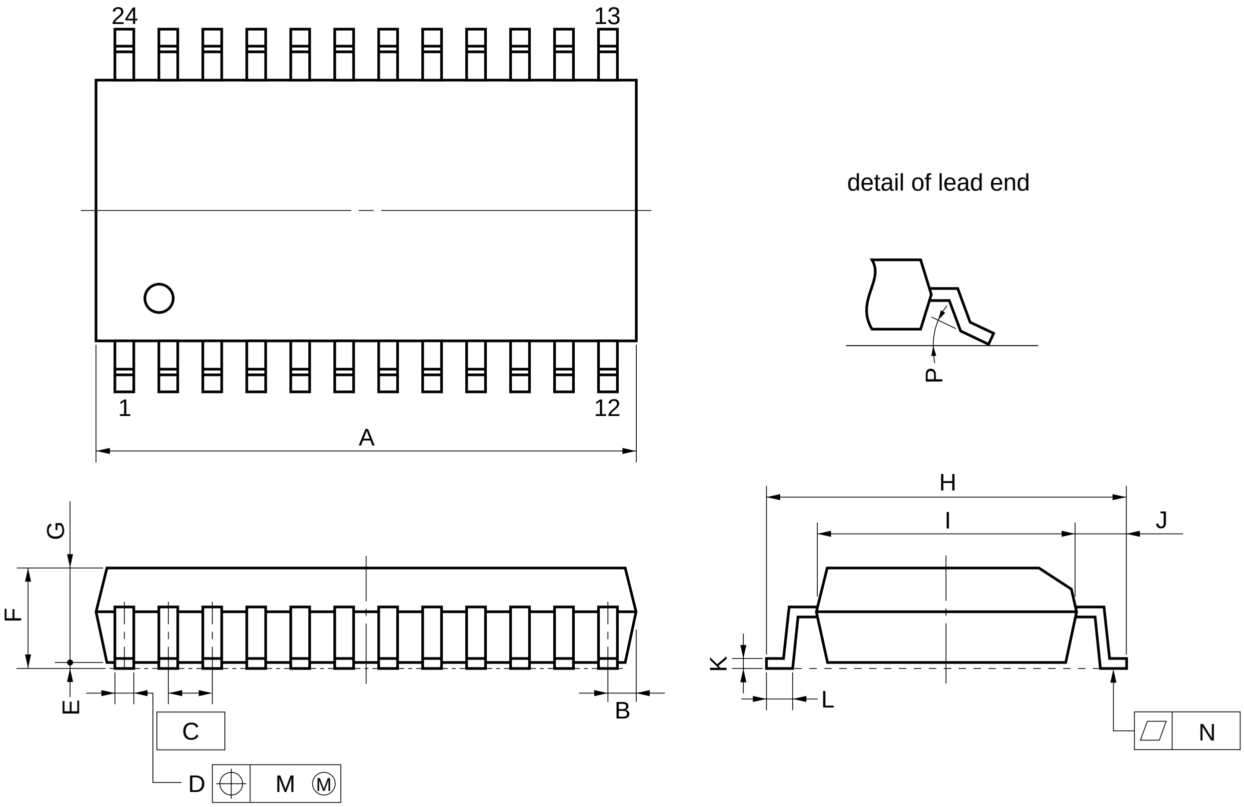
* (2) Package for the μPD6122

24 PIN PLASTIC SOP (375 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	15.54 MAX.	0.612 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	2.9 MAX.	0.115 MAX.
G	2.50	0.098
H	10.3±0.3	$0.406^{+0.012}_{-0.013}$
I	7.2	0.283
J	1.6	0.063
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	0.8±0.2	$0.031^{+0.009}_{-0.008}$
M	0.12	0.005
N	0.15	0.006
P	$3°^{+7°}_{-3°}$	$3°^{+7°}_{-3°}$

P24GM-50-375B-3

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11. RECOMMENDED SOLDERING CONDITIONS

The following conditions (see table below) must be met when soldering this product.

For more details, refer to the NEC document **SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (IEI-1207)**.

Please consult an NEC sales representative in case an other soldering process is used, or in case soldering is done under different conditions.

Table 11-1. Soldering Conditions for Surface Mounting

μPD6121G-001: 20-pin plastic SOP (375 mil) *
μPD6121G-002: 20-pin plastic SOP (375 mil)
μPD6122G-001: 24-pin plastic SOP (375 mil)
μPD6122G-002: 24-pin plastic SOP (375 mil)

Soldering Process	Soldering Conditions	Symbol
Infrared ray reflow	Peak temperature of package surface: 230 °C, Reflow time: 30 seconds or less (210 °C or higher), Number of reflow processes: 1	IR30-00-1
VPS	Peak temperature of package surface: 215 °C, Reflow time: 40 seconds or less (200 °C or higher), Number of reflow processes: 1	VP15-00-1
Wave soldering	Solder temperature: 260 °C or lower, Reflow time: 10 seconds or less, Number of reflow processes: 1 Preheat temperature: 120 °C or lower (at package surface)	WS60-00-1
Partial heating	Pin temperature: 300 °C or lower, Time: 3 seconds or less (per device side)	—

Caution Do not apply more than one soldering method at any one time, except for the partial heating method.

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* APPENDIX. REMOTE CONTROL TRANSMISSION IC AND MICROCONTROLLER LIST

- Single-function remote control transmission ICs (NEC transmission format)

Parameter \ Part number	μPD6121	μPD6122
Operating voltage	V_{DD} = 2.0 to 3.3 V	
Operating clock	f_{OSC} = 400 to 500 kHz ceramic resonator	
Transmission format	Leader / 16-bit custom code / 8-bit data code / 8-bit $\overline{\text{data code}}$	
Modulation method	PPM 0 ····· 1 ····· 38-kHz carrier modulation (fosc = 455 kHz)	
Custom code	16-bit setting	
Data code	32 x 2	64 x 2
No. of keys	32	64
Package	20-pin SOP (375 mil)	24-pin SOP (375 mil)

Cautions 1. New custom codes are not available for the following standard products.
μPD6121G, 6122G Ver II standard products (-002)
2. If products other than listed in Caution 1 are used, please contact NEC for custom codes.

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• Single-Function 4-bit Single-Chip Microcontroller *

Parameter \ Part number	μPD6133	μPD6134	μPD6604[Note 1]
ROM capacity	512 x 10 bits	1002 x 10 bits	
RAM capacity	32 x 4 bits		
Oscillator	Ceramic oscillator		RC oscillator
S_0 (S-IN)	Read with P_{01} register (left shift instruction excluded, standby cancellation function provided)		
$S_1/\overline{LED}$ (S-OUT)	I/O (standby cancellation function provided)		
Key matrix (without Di)	8 x 6 = 48 keys		
Timer clock	$f_X/8$, $f_X/16$		
Stack	Also usable for RAM R_F (1 level)		
Carrier frequency	f_X, $f_X/8$, $f_X/12$, high level $f_X/2$, $f_X/16$, $f_X/24$ (software specified)		
Instruction execution time	8 μs (f_X = 1 MHz)		
Operating frequency	f_X = 300 kHz to 1 MHz		
Power supply voltage	V_{DD} = 1.8 to 3.6 V		
Operating ambient temperature	T_A = –40 to +85 °C		
Charge/discharge function (NOP)	Not provided (NOP instruction provided)		
Low voltage detector	Low level is output to $\overline{RESET}$ pin at detection		
Package	• 20-pin plastic SOP	• 20-pin plastic SOP • 20-pin plastic shrink DIP	• 20-pin plastic SOP • 20-pin plastic shrink SOP
PROM version	μPD61F35 (flash EEPROM™)[Note 2]		

Notes 1. Under development

2. This product's pin configuration is the same as that of the 20-pin μPD6133, 6134, and 6604, but the package is a 24-pin SOP shrink DIP package.

Caution If using the NEC transmission format, please contact NEC for the custom code.

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* • 4-Bit Single-Chip Microcontroller for Programmable Remote Control Transmission

Parameter / Part number	μPD6600	μPD6600A	μPD6124	μPD6124A	μPD6125A
ROM capacity	512 x 10 bits		1002 x 10 bits		
RAM capacity	32 x 5 bits				
Oscillator	Ceramic oscillator				
S_0 (S-IN)	Read with left shift instruction				
S_1/LED (S-OUT)	Output				
Key matrix (without Di)	8 x 4 = 32 keys				8 x 8 = 64 keys
Timer clock	f_X/8				
Stack	Also usable for RAM (3 levels)				
Carrier frequency	f_X/8, f_X/12 (mask option)				
Instruction execution time	16 μs (f_X = 500 kHz)				
Operating frequency	f_X = 400 kHz to 500 kHz				
Power supply voltage	V_{DD} = 2.0 to 3.6 V	V_{DD} = 2.2 to 3.6 V	V_{DD} = 2.0 to 6.0 V	V_{DD} = 2.2 to 5.5 V	V_{DD} = 2.0 to 6.0 V
Operating ambient temperature	T_A = –20 to +75 °C				
Charge/discharge function (NOP)	Provided				
Low voltage detector	Not provided	Low level is output to S-OUT pin at detection	Not provided	Low level is ouput to S-OUT pin at detection	Not provided
Package	• 20-pin plastic SOP • 20-pin plastic shrink DIP				• 24-pin plastic SOP • 24-pin plastic shrink DIP
PROM version	μPD61P24 (one-time PROM)				—

Caution If using the NEC transmission format, please contact NEC for the custom code.

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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.

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The application circuits and their parameters are for references only and are not intended for use in actual design-in's.

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NEC devices are classified into the following three quality grades:
"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices in "Standard" unless otherwise specified in NEC's Data Sheets or Data Books.
If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact NEC Sales Representative in advance.
Anti-radioactive design is not implemented in this product.

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