GENERAL DESCRIPTION

The SM5221-001/002 is an infrared remote control encoder LSI utilizing CMOS technology. The transmission code consists of "leader pulse", "16 bit customer code", and "16 bit data code". Using Micro-processors for decoder, various applications can be realized.

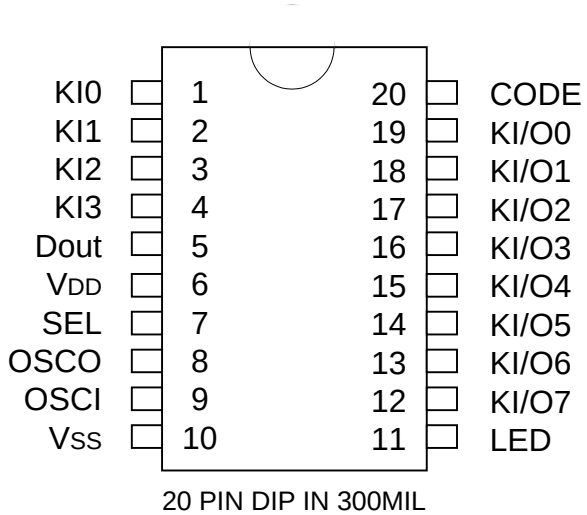
FEATURES

* Low voltage operation ..... VDD=2.0 to 3.3V
* Low power consumption ..... IDD < 1μA at standby mode
* 32 function keys and 3 double action keys
* 64 + 6 function codes are available. (Using SEL terminal)
* 65536 customer codes can be selected. (Using external R, Diode-SM5024A or internal MASK ROM-SM5024B)
* 20pin SOP or DIP

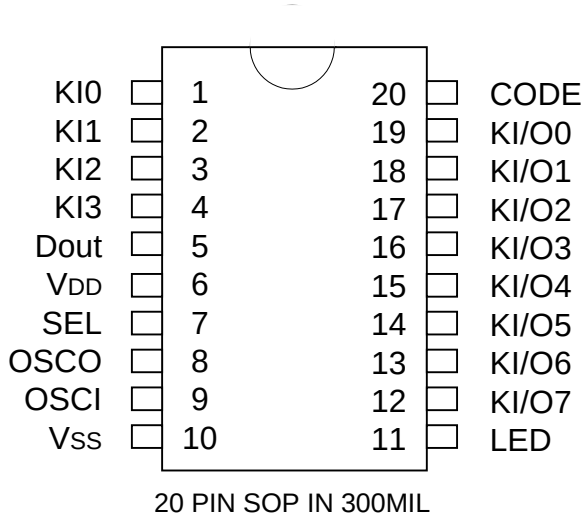
APPLICATIONS

* Audio Remote Control
* Video Remote Control
* Consumer Product Remote Control

PIN ASSIGNMENTS (TOP VIEW)



20 PIN DIP IN 300MIL



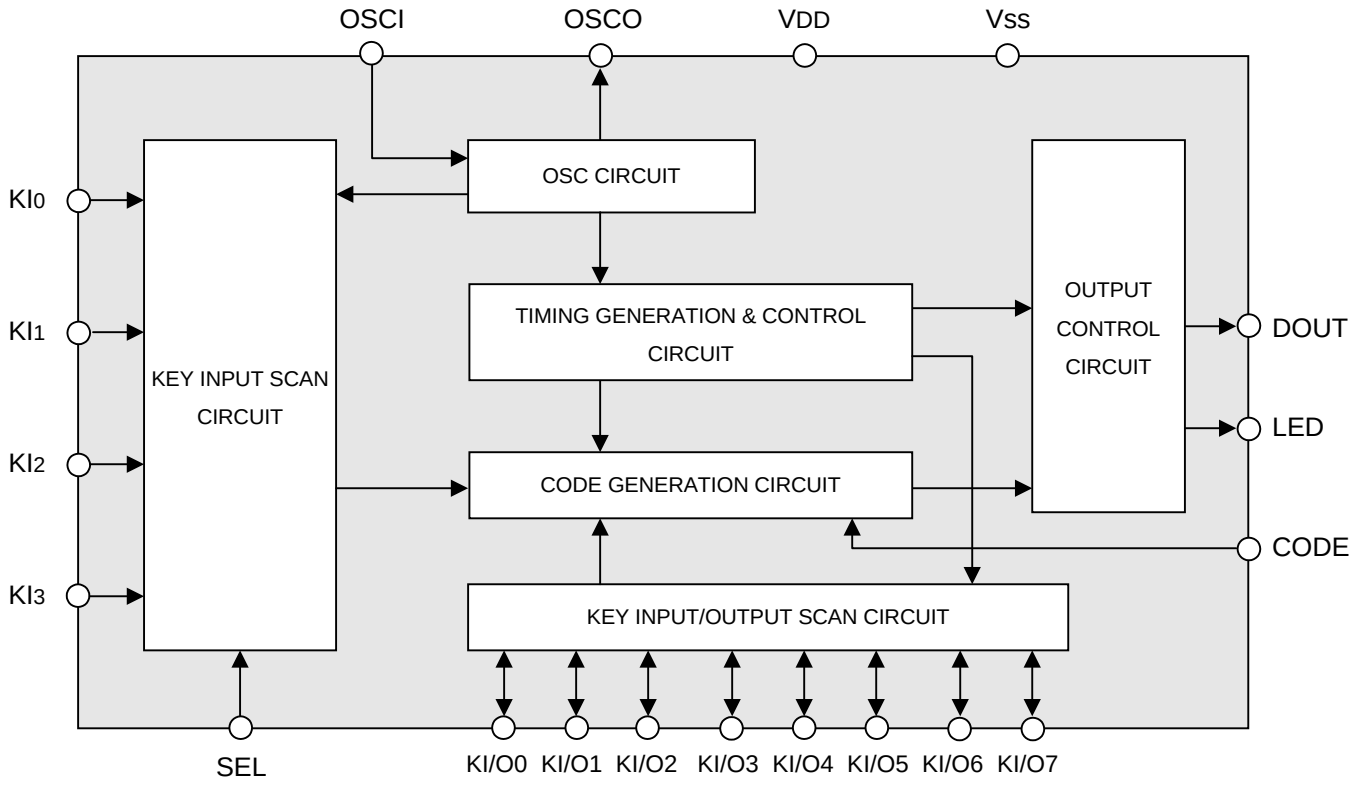
20 PIN SOP IN 300MIL

PIN DESCRIPTION

No.	Pin Name	I / O	Function
1	KI0	I	Scan Key Input 0 With Pull Low
2	KI1	I	Scan Key Input 1 With Pull Low
3	KI2	I	Scan Key Input 2 With Pull Low
4	KI3	I	Scan Key Input 3 With Pull Low
5	DOUT	O	Remote Output
6	VDD	POWER	Postive Power Supply
7	SEL	I	Data Select
8	OSCO	O	Oscillator Output
9	OSCI	I	Oscillator Input
10	VSS	POWER	Negative Power Supply (substrate)
11	LED	O	Indicator For Tramsmission
12	KI/O7	I / O	Key Scan 7
13	KI/O6	I / O	Key Scan 6
14	KI/O5	I / O	Key Scan 5
15	KI/O4	I / O	Key Scan 4
16	KI/O3	I / O	Key Scan 3
17	KI/O2	I / O	Key Scan 2
18	KI/O1	I / O	Key Scan 1
19	KI/O0	I / O	Key Scan 0
20	CODE	I / O	Customer Code Select Input

Pin Name	No.	I / O	Function
KI0	1	I	Scan Key Input 0 With Pull Low
KI1	2	I	Scan Key Input 1 With Pull Low
KI2	3	I	Scan Key Input 2 With Pull Low
KI3	4	I	Scan Key Input 3 With Pull Low
KI/O0	19	I / O	Key Scan 0
KI/O1	18	I / O	Key Scan 1
KI/O2	17	I / O	Key Scan 2
KI/O3	16	I / O	Key Scan 3
KI/O4	15	I / O	Key Scan 4
KI/O5	14	I / O	Key Scan 5
KI/O6	13	I / O	Key Scan 6
KI/O7	12	I / O	Key Scan 7
DOUT	5	O	Remote Output
SEL	7	I	Data Select
LED	11	O	Indicator For Tramsmission
CODE	20	I / O	Customer Code Select Input
OSCO	8	O	Oscillator Output
OSCI	9	I	Oscillator Input
VDD	6	POWER	Postive Power Supply
VSS	10	POWER	Negative Power Supply (substrate)

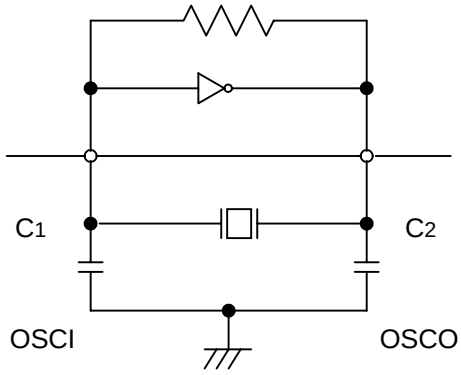
BLOCK DIAGRAM



FUNCTION DESCRIPTION

(1) Oscillation

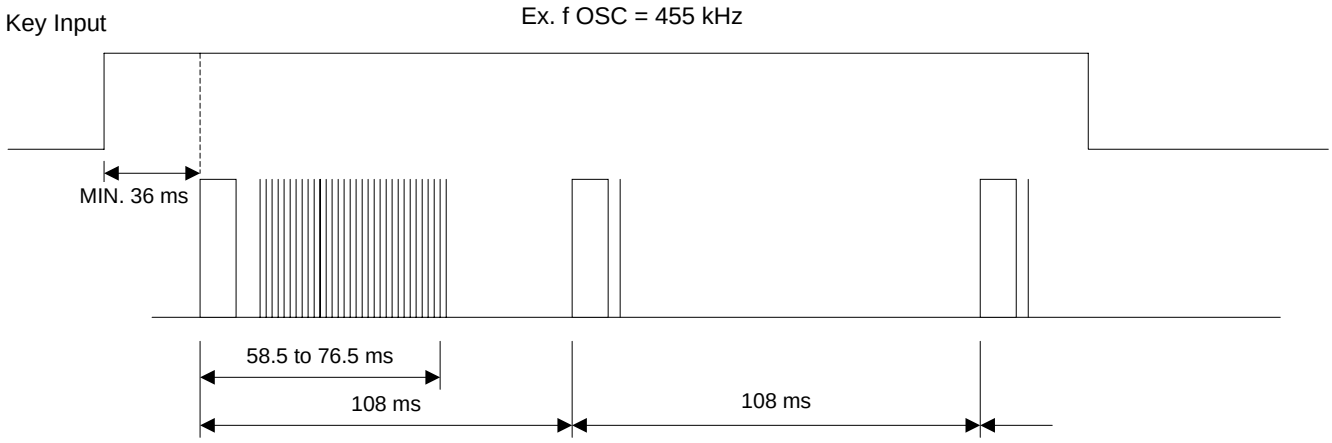
The SM5221-001/002 oscillation circuit is designed for use of a 400 kHz or 500 kHz ceramic resonator, but there may be mutual influence between variations in the IC and ceramic resonator resulting in abnormal oscillation. The oscillation circuit starts to operate when a key is depressed.



(2) Key Scan

A pull-down resistor is inserted
keys are depressed simultaneously, transmission is disabled by the multi-depression prevention circuit.

When a key is depressed, reading of the custom code and key data code is started, and DOUT output begins 36 ms later, so that if the key is being depressed during this 36 ms interval one transmission is performed. If a key is held down for 108 ms or longer, consecutive transmissions of the leader code only are performed while the key is depressed.



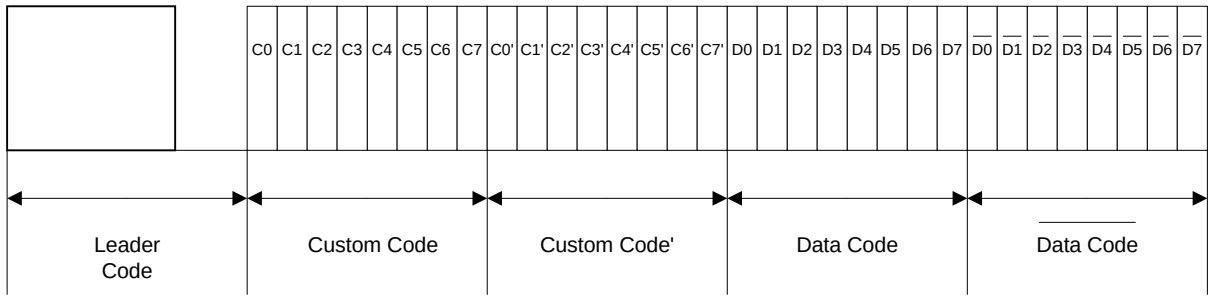
(3) Data Code D_7 Control

Data code D7 can be controlled by this pin, allowing 64 kinds of data to be transmitted.
D7 is set to "0" by connecting the SEL pin to VDD, and to "1" by connecting the SEL pin to VSS. As the input of this pin is high-impedance, it must be connected to either VDD or VSS.

TRANSMISSION CODE

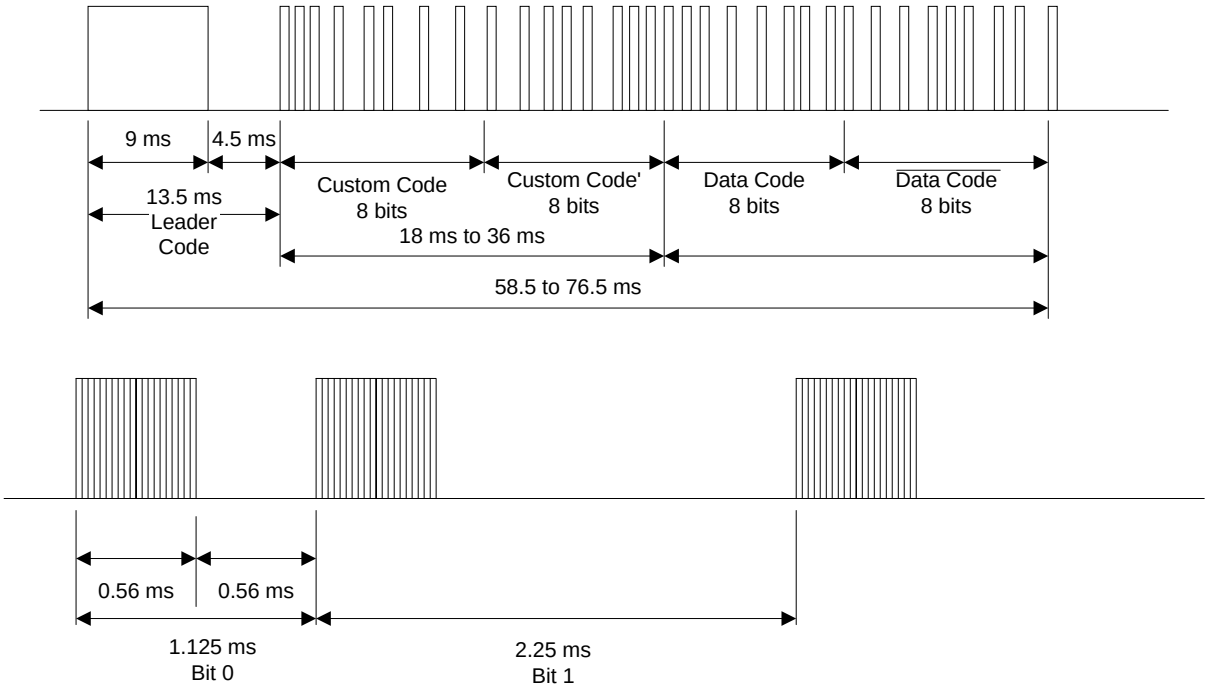
(1) DOUT Output

The transmission code consists of a leader code, 16-bit custom code, and 8-bit data code. The inverse code of the data code is also sent simultaneously, giving a total configuration of 32 bits per transmission.

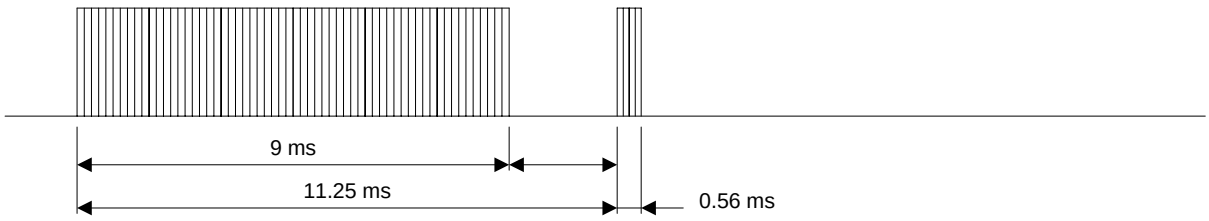


DOUT Output Code

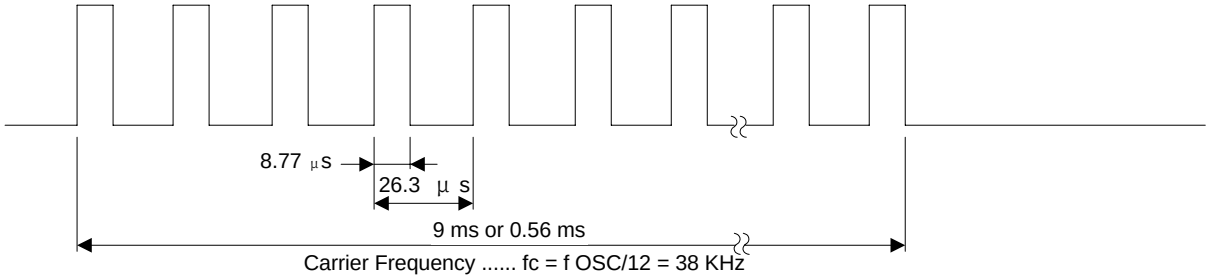
The leader code consists of a 9 ms carrier waveform plus a 4.5 ms OFF waveform, and is used as the leader for the following code. The code uses the PPM (Pulse Position Modulation) method, with "1" and "0" differentiated by the time between pulses reference following diagram. Each code consists of 8 bits, and simultaneous transmission of the inverse code.



Continous Code



Carrier

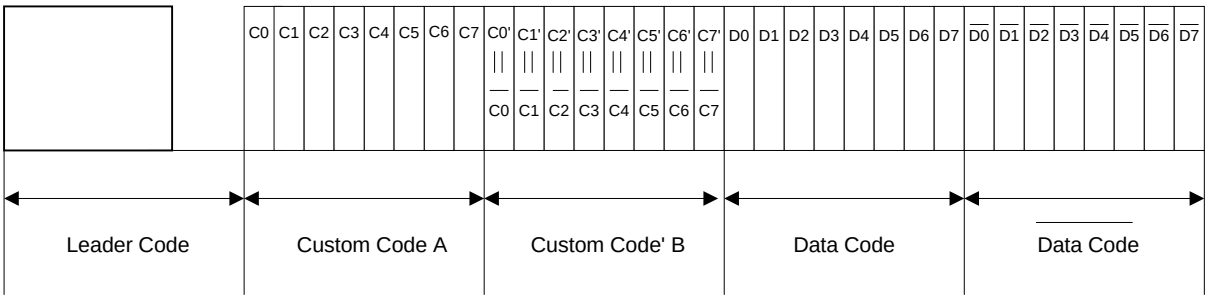


(2) Custom Code Extension

The custom code can be set by the diodes connected to the CODE pin and the KI/O pins. Connecting the CODE pin and KI/O pins via diodes gives a corresponding custom code of "1", while no connection gives "0".

The above output codes can be obta

further extend the number of custom codes, 200 kΩ pull up resistors are added to pins KI/O0 through KI/O7,and the bit corresponding to a pin from among the custom code' outputs is output without being inverted.



DOUT Output Code

*: Pull-up resistor added to pins KI/O0 and KI/O2.
C0 and C2 output without inversion (non-inverted bits).

(3) Custom Code

The DOUT output custom code can be set in any of 65536 ways by means of the diodes attached to the CODE (Custom Code Select) pin and the KI/O pins and the pull-up resistors attached to the KI/O pins. When a code other than code 00000000 (no diode connection) is used.

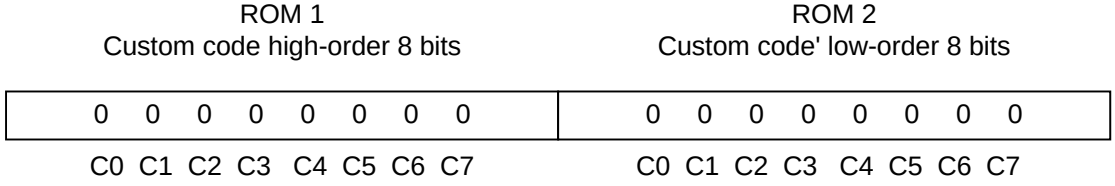
(4) Custom Code Mask ROM Specification

The custom code can also be set by mask ROM. When the mask ROM specification is used the custom code can be set without the connection of external diodes and resistors, and by combining external diodes and resistors with mask ROM it is possible to output a code with different contents from those set by the mask ROM. When mask ROM specification is used, (Ver. I) or (Ver. II) can be selected.

	Custom Code High-Order 8 Bits	**Custom Code' Low-Order 8 Bits**
Ver. I	Determined by logical OR of internal ROM1 and external diode positions.	Determined by logical OR of interanl ROM2 and external pull-up resistor positions
Ver. II	C0, C1, C2: Determined by wiring one of pins KI/O0 thru KI/O7 to CCS pin. C3 thru C7: Determined by internal ROM3 and absence/presence of KI/O6 & KI/O7 external pull-up resistors.	Determined by logical OR of internal ROM2 and external pull-up resistor (KI/O0 thru KI/O5) positions.

* Standard product SM5221-001/002 uses the Ver. I specification

Internal ROM is set as follows:



* Standard product SM5221-002 uses the Ver. II specification.

Internal ROM is set as follows:

ROM 3
C7, C6, C5,C4,C3 of Custom Code High-Order 8 Bits

Pull-Up resistor

ROM3	C7	C6	C5	C4	C3	KI / O6	KI / O7
ROM 3 - 0	0	0	0	0	0	No	No
ROM 3 - 1	1	0	0	1	1	No	Yes
ROM 3 - 2	1	0	0	0	0	Yes	No
ROM 3 - 3	1	1	1	0	1	Yes	Yes

ROM2
Custom code' low-order 8 bits

0	0	0	0	0	0	0	0
$C_{0'}$	$C_{1'}$	$C_{2'}$	$C_{3'}$	$C_{4'}$	$C_{5'}$	$C_{6'}$	$C_{7'}$

(Ver. I)

Internal custom code ROM1 and ROM2 (total
(ROM1) corresponding to the external diodes, and 8 bits the part (ROM2) corresponding to the external pull-up resistors.

(Ver. II)

With Ver. II, the CODE pin does not have the function of reading the external diodes.
Internal custom code ROM2 and ROM3 (total 28 bits) are effective, with 20 bits being the part (ROM3) for setting the 4 channels of custom code C7, C6, C5, C4 and C3 as 5 bits each, and 8 bits being the part (ROM2) corresponding to the external pull-up resistors (excluding KI/O6 and KI/O7).
With Ver. II 0/1 allocation to C2, C1 and C0 of the custom code high-order bits is set as shown in the following table according to the pin connection status of KI/O0 through KI/O7.

CCS-	C2	C1	C0
KI/O0	0	0	0
KI/O1	0	0	1
KI/O2	0	1	0
KI/O3	0	1	1
KI/O4	1	0	0
KI/O5	1	0	1
KI/O6	1	1	0
KI/O7	1	1	1

When CODE pin is open
(C2 C1 C0) = (0, 0, 0)

KEY DATA CODE

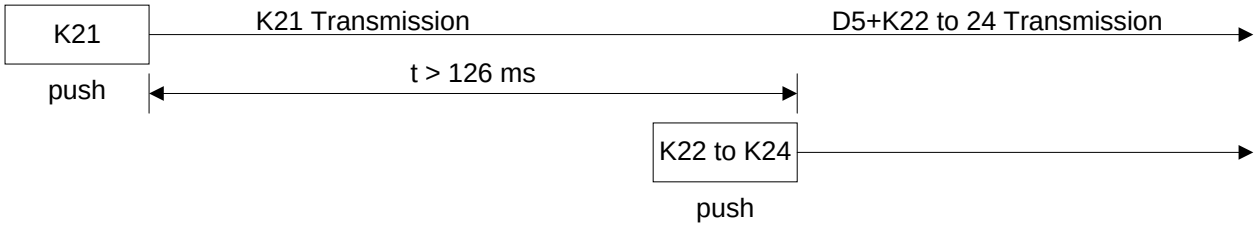
Key	Connection					Data Code							
	KI0	KI1	KI2	KI3	KI/O	D0	D1	D2	D3	D4	D5	D6	D7
K 1	*				KI/O0	0	0	0	0	0	0	0	0/1
K 2		*				1	0	0	0	0	0	0	0/1
K 3			*			0	1	0	0	0	0	0	0/1
K 4				*		1	1	0	0	0	0	0	0/1
K 5	*				KI/O1	0	0	1	0	0	0	0	0/1
K 6		*				1	0	1	0	0	0	0	0/1
K 7			*			0	1	1	0	0	0	0	0/1
K 8				*		1	1	1	0	0	0	0	0/1
K 9	*				KI/O2	0	0	0	1	0	0	0	0/1
K10		*				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	*				KI/O3	0	0	1	1	0	0	0	0/1
K14		*				1	0	1	1	0	0	0	0/1
K15			*			0	1	1	1	0	0	0	0/1
K16				*		1	1	1	1	0	0	0	0/1
K17	*				KI/O4	0	0	0	0	1	0	0	0/1
K18		*				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	*				KI/O5	0	0	1	0	1	0	0	0/1
K22		*				1	0	1	0	1	0	0	0/1
K23			*			0	0	1	0	1	0	0	0/1
K24				*		1	0	1	0	1	0	0	0/1
K25	*				KI/O6	0	0	0	1	1	0	0	0/1
K26		*				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	*				KI/O7	0	0	1	1	1	0	0	0/1
K30		*				1	0	1	1	1	0	0	0/1
K31			*			0	1	1	1	1	0	0	0/1
K32				*		1	1	1	1	1	0	0	0/1

DOUBLE KEY OPERATION

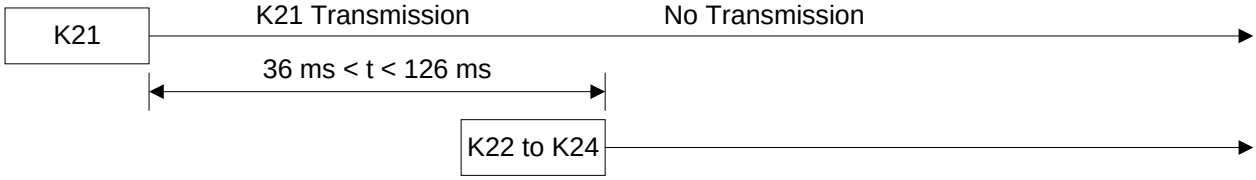
When more than two keys except K21 + K22, K21 +K23 and K21 +K24 are depressed at the same time, the transmission output stops.
Double key operation is useful for tape deck recording operation.
Double key operation form are following.

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

(a) Operation

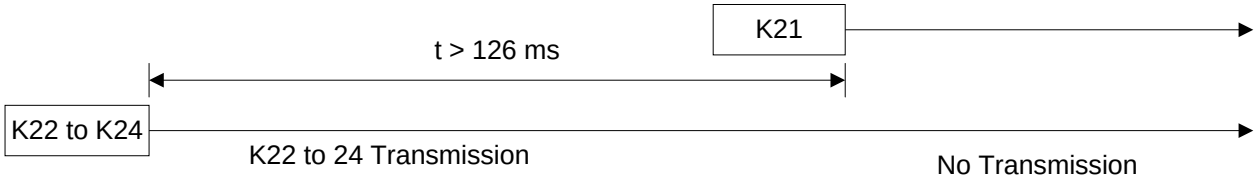


(b) No operation



(c) No operation

(d) No operation



CUSTOMER CODE ROM FORMAT

This LSI has customer code table ROM on the chip. So user can generate customer codes without external parts.
The customer code ROM format is following.

Ver.1 or 2 SEL		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
		0	0	0	0	0	0	0	0		
ROM 1		1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	ROM PULL	SEL UP
ROM 2		1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	K/IO_6	K/IO_7
ROM 3	**0**	1/0	1/0	1/0	1/0	1/0	0	0	0	NO	NO
	1	1/0	1/0	1/0	1/0	1/0	0	0	0	NO	YES
	2	1/0	1/0	1/0	1/0	1/0	0	0	0	YES	NO
	3	1/0	1/0	1/0	1/0	1/0	0	0	0	YES	YES

1) Ver. 1 or Ver. 2 selection ..... Ver. 1 = 01H, Ver. 2 = 02H
2) When a user selects Ver. 1, ROM1 is available for the customer code (C7 to C0) election.
3) ROM2 is available for the customer code' (C7' to C0') selection.
4) When a user selects Ver. 2, ROM3 is available for the customer code (C7 to C3) selection. And a user can select ROM3-0, ROM3-1, ROM3-2 or ROM3-3 by the KI/O6 and KI/O7 pull up resistances.

ABSOLUTE MAXIMUM RATINGS (Ta = 25 ℃)

Characteristic	Symbol	Value	Unit
Supply Voltage	VDD	6.0	V
Input Voltage	VIN	-0.3 to VDD	V
Power Dissipation	Pd	250	mW
Operating Temperature	Topt	-20 to +75	℃
Storage Temperature	Tstg	-40 to +125	℃

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	2.0	3.0	3.3	V
Oscillation Frequency	fosc	400	455	500	KHz
Input Voltage	VIN	0		VDD	V
Custom code select Pull up Resistance	Rup	160	200	240	KΩ

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 3.0 V)

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply Voltage	V_{DD}	2.0	3.0	3.3	V	
Current Consumption 1	I_{DD1}		0.1	1.0	mA	f osc = 455 kHz
Current Consumption 2	I_{DD2}			1.0	μA	f osc = STOP
DOUT High Level Output Current	I_{OH1}		-8.0		mA	Vo = 1.5 V
DOUT Low Level Output Currenl	I_{OL1}		30		μA	Vo = 0.3 V
LED High Level Output Current	I_{OH2}	-15	-30		μA	Vo = 2.7 V
LED Low Level Output Current	I_{OL2}	1	1.5		mA	Vo = 0.3 V
KI High Level Input Current	I_{IH1}	5		30	μA	V_{IN} = 3.0 V
KI Low Level Input Current	I_{IL1}			-0.2	μA	V_{IN} = 0 V
KI High Level Input Voltage	V_{IH1}	0.7 V_{DD}		V_{DD}	V	
KI Low Level Input Voltage	V_{IL1}	0		0.3V_{DD}	V	
KI/O High Level Input Voltage	V_{IH2}	1.3		V_{DD}	V	
KI/O Low Level Input Voltage	V_{IL2}	0		0.4	V	
KI/O High Level Input Current	I_{IH2}	2		7	μA	V_{IN} = 3.0 V
KI/O Low Level Input Current	I_{IL2}			-0.2	μA	V_{IN} = 0 V
KI/O High Level Output Current	I_{OH3}	1.0		2.5	mA	Vo = 2.5 V
KI/O Low Level Output Current	I_{OL3}	35		100	μA	Vo = 1.7 V
CODE High Level Input Voltage	V_{IH3}	1.1			V	
CODE High Level Input Current	I_{IH3}			0.2	μA	Pull up V_{IN} = 3.0 V
CODE Low Level Input Current	I_{IL3}	-3		-10	μA	Pull up V_{IN} = 0 V
CODE High Level Input Current	I_{IH4}	5		30	μA	Pull down V_{IN} = 3.0 V
CODE Low Level Input Current	I_{IL4}			-0.2	μA	Pull down V_{IN} = 0 V

APPLICATION CIRCUIT