

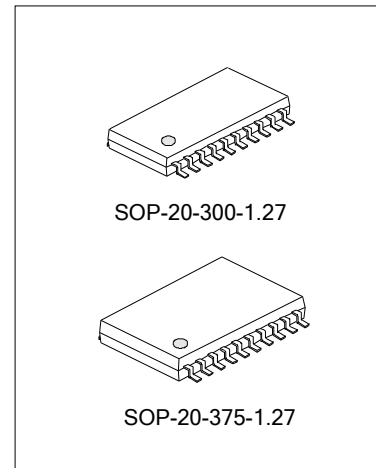
## INFRARED REMOTE CONTROL TRANSMITTER OF 8521 CODE FORMAT

### DESCRIPTION

The SC8521 can be used in infrared remote control transmitters. It generates output pulses, in accordance with the RC5 protocol, when a key is pressed. The IC does not contain a software programmable processor. However, it does contain a ROM in which the codes that have to be transmitted are stored. The oscillator frequency may be optionally chosen as 432KHz. For 432KHz additional external capacitors must be connected. When a key in the key-matrix is pressed a driveline will be connected to a sense line. This causes the oscillator to start and a corresponding code will be generated conforming to the RC5 protocol.

Seven drive lines ( $\overline{DR0}$  to  $\overline{DR6}$ ) and eight sense lines (SN0 to SN7) may be connected via the key matrix to scan the keys.

When two or more keys are activated simultaneously no transmission will take place.

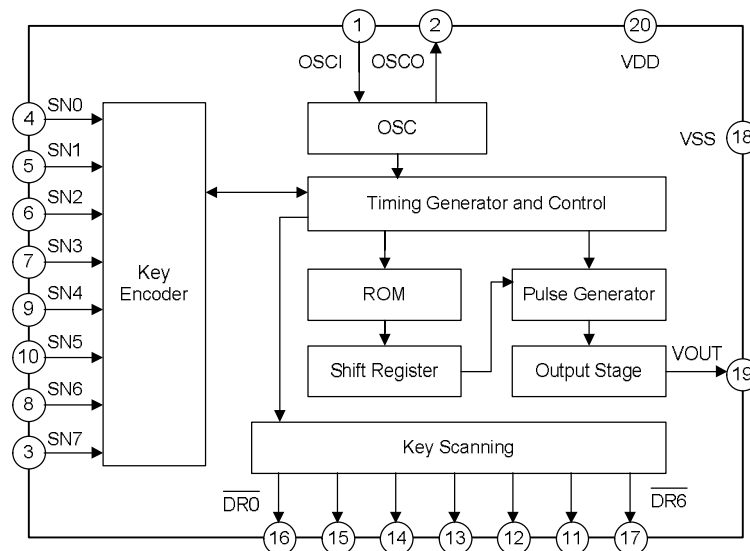


- \* Power-down and key wake-up
- \* High output current ( $\leq 45\text{mA}$ )
- \* Oscillator frequency of 432KHz
- \* Multiple key protection
- \* Option of 25% or 33% duty factor

### FEATURES

- \* RC5 protocol
- \* Maximum of 56 keys (20-pin version)
- \* Option of multi-system or single system transmitter
  - Multi-system: maximum 8 system, selection by key
  - Single system: maximum 8 different systems per IC, selection by jumper wire or switch.

### BLOCK DIAGRAM

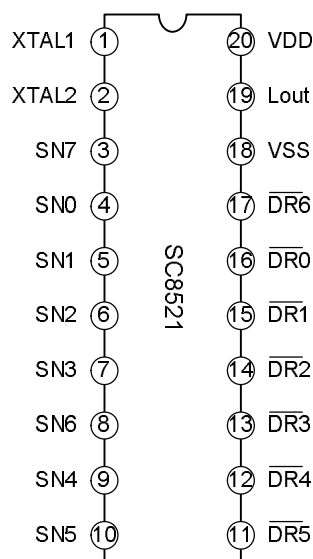


**ABSOLUTE MAXIMUM RATING**

Characteristics	Symbol	Value	Unit
Supply Voltage	VDD	5	V
Power Dissipation	PD	25	mW
Thermal Derating	$K_{\theta}$	10	mW/°C
Storage Temperature	TSTG	-65 ~ +150	°C
Operating Temperature	TOPR	-20 ~ +80	°C

**ELECTRICAL CHARACTERISTICS** (T<sub>amb</sub>=25°C, unless otherwise specified)

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Operating supply voltage	VDD		2.2	--	4.5	V
Supply current	IDD	VDD=3V; TA=25°C	--	--	2	mA
Quiescent current	IDD(q)	VDD=3V; TA=25°C	--	--	1	μA
Operating ambient temperature	TA		-10	--	+50	°C
<b>Sense lines (input only and will have a weak internal pull-up resistance)</b>						
LOW level input voltage	V <sub>IL</sub>		--	--	0.3VDD	V
HIGH level input voltage	V <sub>IH</sub>		0.7VDD	--	--	V
Pull-up resistance	R <sub>pu</sub>	VDD=3V	50	--	100	KΩ
<b>Driver lines (output only; open drain; maximum on-resistance when LOW)</b>						
Maximum on-resistance	R <sub>on</sub>	VDD=3V	--	--	2	KΩ
<b>Output drive (has a weak pull-up resistance)</b>						
Source current	I <sub>sink</sub>	VDD=3V; V <sub>O</sub> =1.5V	3.5	4.5	5.5	mA

**PIN CONFIGURATIONS**


**PIN DESCRIPTION**
**20-pin dual in-line and small outline package (SO-20)**

Pin No.	Symbol	Description
1	XTAL1	Oscillator input
2	XTAL2	Oscillator output
3	SN7	Sense line 7 for key matrix
4	SN0	Sense line 0 for key matrix
5	SN1	Sense line 1 for key matrix
6	SN2	Sense line 2 for key matrix
7	SN3	Sense line 3 for key matrix
8	SN6	Sense line 6 for matrix
9	SN4	Sense line 4 for matrix
10	SN5	Sense line 5 for matrix
11	$\overline{\text{DR5}}$	Drive line 5 for key matrix (active LOW)
12	$\overline{\text{DR4}}$	Drive line 4 for key matrix (active LOW)
13	$\overline{\text{DR3}}$	Drive line 3 for key matrix (active LOW)
14	$\overline{\text{DR2}}$	Drive line 2 for key matrix (active LOW)
15	$\overline{\text{DR1}}$	Drive line 1 for key matrix (active LOW)
16	$\overline{\text{DR0}}$	Drive line 0 for key matrix (active LOW)
17	$\overline{\text{DR6}}$	Drive line 6 for key matrix (active LOW)
18	VSS	Ground
19	Lout	Output signal
20	VDD	Power supply

**FUNCTION DESCRIPTION**
**1. Key numbering for matrix is given in tables 1**
**Table1 key numbering for 20-pin package**

Driver lines	Sense lines							
	SN0	SN7	SN1	SN2	SN3	SN6	SN4	SN5
$\overline{\text{DR5}}$	0: BANK0	1	2	3	4	5	6	7
$\overline{\text{DR4}}$	8: BANK1	9	10	11	12	13	14	15
$\overline{\text{DR3}}$	16: BANK2	17	18	19	20	21	22	23
$\overline{\text{DR2}}$	24: BANK3	25	26	27	28	29	30	31
$\overline{\text{DR1}}$	32: BANK4	33	34	35	36	37	38	39
$\overline{\text{DR0}}$	40: BANK5	41	42	43	44	45	46	47
$\overline{\text{DR6}}$	48: BANK6	49	50	51	52	53	54	55

**Note:** SN0 connected GND, send BANK7 code. BANK0----7 see the following code table.

When the keys have been scanned the key-number of the activated key serves as the address of the ROM to obtain the required codeword. Consequently, key numbers 6, 7, 14, 15, 22, 23, 30, 31, 38, 39 and 40 to 55 will not be addressed.

The ROM contains 8 banks of 64 code words. Thus for each key a maximum of 8 different code words may be generated. With multi-system use, 8 different systems (e.g. TV, VCR, tuner, CD etc.) may be selected. Apart from the system bits the command bits may also be different in different banks (true multi-function keys). Selection can be performed using the keys. For each key three bank selected bits are present that determine which bank will be selected for the next key.

For each key an 'inhibit' bit is also present. When this bit is at logic 1 at an address in a given bank, and when the corresponding key is pressed (when this bank has been selected) no transmission will take place.

A single system option is available however, whereby instead of keys jumper wire and/or a switch may be used for bank selection. Using this option it is possible to program different transmitter models in one IC and select the required bank by means of jumper wire. Instead of a jumper wire a side-switch may also be used to change the generated code temporarily (select different bank) to obtain multi-function keys. With this option the jumper wires or switch must be connected between sense line SN0 and one of the drivelines  $\overline{DR0}$  to  $\overline{DR6}$  or ground. This means that SN0 cannot be used to connect keys and the maximum number of keys will be 49 keys for a 20-pin package.

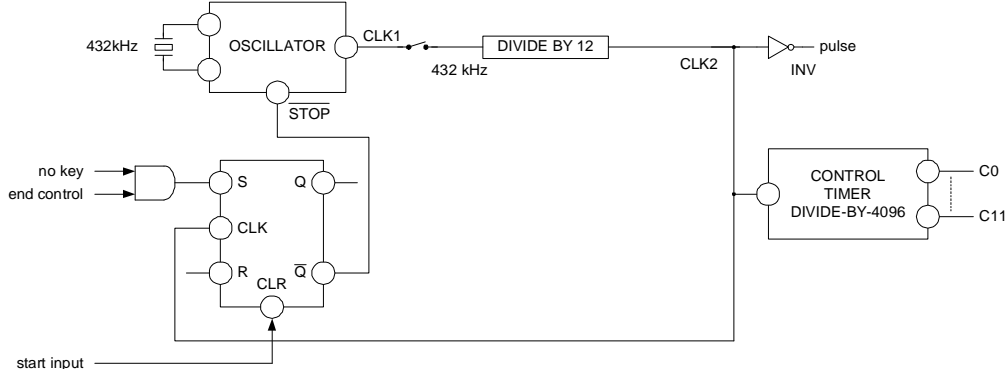
It is not possible to use a combination of jumper wires and selection keys for bank selection in one unit. The output of the ROM is loaded into a shift register that provides the input bits for the pulse generator. This pulse generator drives the output pin.

## 2. Timing generator

A schematic diagram of the timing generator is illustrated the oscillator frequency is 432KHz. The timing generator is stopped when no key is activated and started again when a key is pressed.

The output of the oscillator (CLK1) is divided by 12 for 432KHz. Selection is achieved using a mask option. The output of the divider is CLK2 which is used for clocking of the control timer. The frequency of CLK2 is 36 KHz and the inverse is used to generate the output pulses in the subcarrier frequency. By mask option the duty factor can be chosen to be 25% or 33%.

The control timer has a length of 4096 subcarrier (pulse) periods. This is equal to the transmission repetition time. A bit time is equal to 64 pulses and the repetition time is 64 bit times. The control timer provides the timing of the key scanning, the ROM access and the code transmission. When the control timer has arrived at a certain state and no key has been pressed for at least 28 ms, a stop signal will be generated which will stop the oscillator. All drivelines will then be set to logic 0. As soon as a key is pressed one of the sense lines will become logic 0. This will generate a start signal, which will restart the oscillator.



Timer schematic diagram

### 3. Single system

SN0 should be connected to one of the drivelines or ground.

The bank that will be selected is equal to drive line number to which SN0 is connected. When connected to ground the number will be 7. This achieved by loading the bank select flip-flops BS0 to BS2 with the contents of C5 to C7 of the control timer when sense line SN0 is at logic 0. In this way it is possible to use two different systems in one transmitter by using a side switch. With this option SN0 cannot be used to connect keys, so the maximum number of keys will be lower (49 keys with 20-pin IC).

### 4. Multi system

The bank is selected by key for maximum 8 different systems (e.g. TV, VCR, CD, etc.), any key is flexible for bank selection. When a user inserts a new battery, the default bank is always in bank 7. If only bank 7 is used, then maximum number of key can be 56 keys for a 20-pin IC.

### 5. ROM



A schematic diagram of the ROM is illustrated. The ROM is divided into 8 banks of  $2 \times 64$  bytes. Bank selection is performed using flip-flops BS0 to BS2 that are the 3 highest bits of the address. With the 'single system' these bits are loaded from the 3 MSBs of the scan control when SN0 = 0. At power-on the bank select flip-flops will be in an arbitrary state.

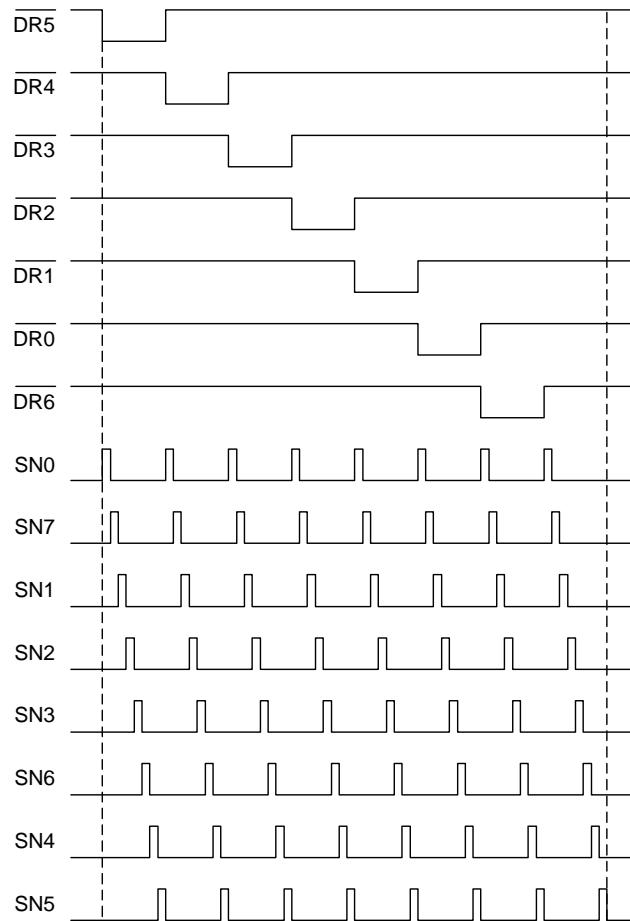
When a key was activated, the key number is stored in the 6-bit key register. This register forms the lower bits of the ROM address. For each command the ROM will be accessed twice. This gives 16 bits in total (M0L to M7L and M0H to M7H). The bits are described in Table 2.

**Table2 ROM bit description**

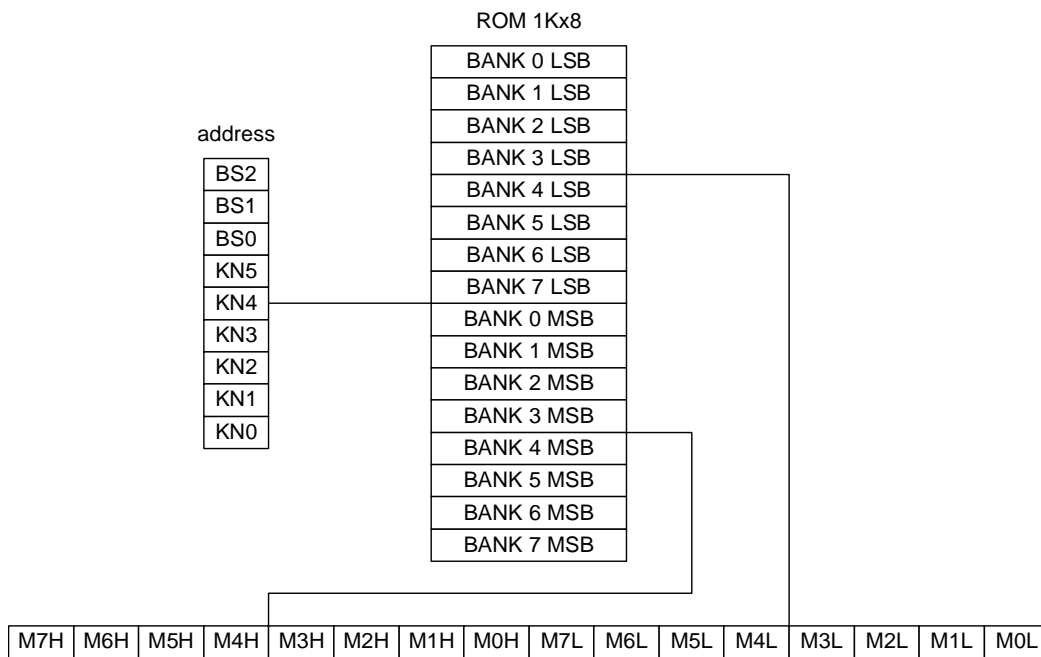
Bits	Function
M0L to M5L	Command bits 0 to 5
M6L	Field bit. This bit indicates whether command codes 0 to 63 are used (field bit is at logic 1) or command codes 64 to 127 are used (field bit is at logic 0).
M7L	Inhibit bit. When this bit is at logic 1 no transmission will take place. When this bit is at logic 0 the appropriate code word will be transmitted.
M0H to M4H	System bits 0 to 4
M5H to M7H	Bank select. Will be stored in BS0 to BS2 when the 'multi-system' option is selected. With single system bits M5H to M7H are don't care.

### 6. Pulse output

The bits of the remote control word, as indicated by the addressed ROM locations, are loaded into a shift register every bit-time this register is shifted. The output is used to generate a logic1 in the biphase (Manchester) coding, modulated with a frequency of 36 KHz. The duty factor of the modulation pulses may be selected (optionally) to be 25% or 33.3%. The output of the pulse generator controls the output driver that can provide a maximum current of 5 mA.



Scan timing.



ROM schematic diagram

**SYSTEM DEVELOPMENT**

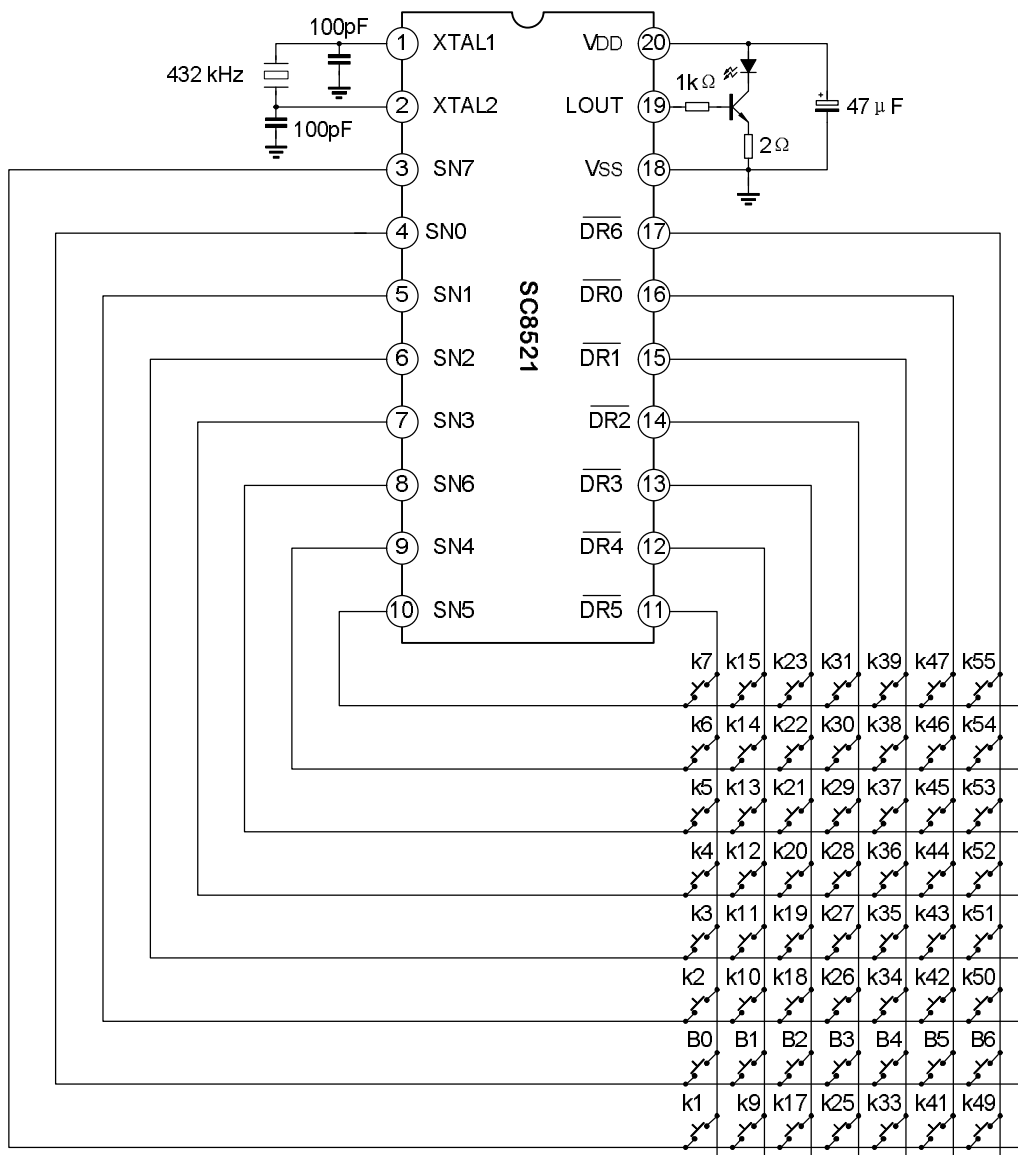
**1. Software (SC8521)**

A PC program is provided that enables the user to fill in system and command codes for each keys number in each bank. This program converts the input data into a ROM code-file needed to produce the metal mask and to program an EPROM to be used in the hardware emulator.

**2. Hardware**

An emulator is available that functionally emulates the IC. An EPROM with the ROM code information is inserted into the emulator to produce the required remote control codes corresponding to the keys in the prototype device.

**APPLICATION CIRCUIT**



Application diagram (SO20 package)

**INSTRUCTION AND SIGNAL OUTPUT FORMAT (Binary)**

Key	Bank0	Bank1	Bank2	Bank3
k0	/	/	/	/
k1	10000111010011	11000100101110	11001011100100	11010100101011
k2	10000111010010	11000100011101	11001011010011	11010100011101
k3	11000111101100	11000100011111	11001011010010	11010100110010
k4	11000000001100	10000100100000	11001011001100	11010100111111
k5	11000111010001	10000100101100	11001011100101	10010100101100
k6	11000111011110	11000100101101	11001011001111	11010100101101
k7	11000111010000	11000100011100	11001011001101	11010100011100
k8	/	/	/	/
k9	10000111001110	11000100000011	11001011000011	11010100000011
k10	10000111001101	11000100100001	10001011011011	11010100100001
k11	10000000100001	11000100100000	10001011011001	11010100100000
k12	11000111111010	10000100001111	11001011100000	11010101111111
k13	11000111010111	11000100001001	11001011001001	11010100001001
k14	11000000100100	11000100110101	11001011100001	11010100110101
k15	11000111010110	11000100000110	11001011000110	11010100000110
k16	/	/	/	/
k17	10000111000100	10000100110100	11001011011010	11010000001101
k18	11000111011101	11000100001010	11001011101001	11010100001011
k19	/	10000100110001	10001011111110	10010000001111
k20	10000111000101	10000100001100	11001011010110	11010001101011
k21	11000111110110	10000100110111	11001011010111	11010001011111
k22	11000111010101	10000100000101	11001011111110	11010001101110
k23	11000111110101	10000100110110	11001011010000	11010000010000
k24	/	/	/	/
k25	10000000111010	11000100000010	11001011000010	11010100000010
k26	10000000010001	10000100110011	10001011010001	10010100110011
k27	10000000010010	10000100110010	10001011010000	10010100110010
k28	11000000001101	10000100011000	11001011100010	11010010111111
k29	11000111011001	11000100001000	11001011001000	11010100001000
k30	10000000010000	11000100110000	11001011100011	11010100110000
k31	11000111011000	11000100000101	11001011000101	11010100000101
k32	/	/	/	/
k33	11000111011101	11000100000001	11001011000001	11000100000001
k34	11000111011100	11000100111011	10001011011010	11010100111011
k35	10000000010101	11000100101010	10001011011000	11010100110100
k36	11000000100011	11000100101000	10001011111111	11010001111111
k37	11000111011011	11000100000111	11001011000111	11010100000111

(To be continued)

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Key	Bank0	Bank1	Bank2	Bank3
k38	10000111111111	11000100110110	11001011101101	11010100110110
k39	11000111011010	11000100000100	11001011000100	11010100000100
k40	/	/	/	/
k41	11000111000000	11000100010001	/	10010000000000
k42	/	11000100010000	/	10010000000110
k43	11000111011100	11000100100100	10001011011101	11010100100100
k44	11000111010100	11000100000000	11001011000000	11010100000000
k45	/	10000100110000	/	11010000001111
k46	11000111100111	10000100000110	10001011011100	11010100001111
k47	/	11000100001100	/	
k48	/	/	/	/
k49	10000111000011	11000100101011	11001011011011	11010000100110
k50	11000111010011	11000100001111	11001011101110	11010001001100
k51	11000111010010	10000100101011	11001011101011	10010100101011
k52	10000111000110	10000100001011	11001011011000	11010001100001
k53	11000111110111	10000100000011	11001011011001	11010001011110
k54	11000111011111	10000100000100	11001011111111	11010001100000
k55	11000111110100	10000100101111	11001011010001	11010000010001

Key	Bank4	Bank5	Bank6	Bank7
k0	/	/	/	/
k1	11010100011101	10000000101101	10000000101101	11000000110010
k2	11010001011111	10000000101100	10000000101100	11000000110110
k3	11010001011110	10000000101011	10000000101011	11000000110111
k4	11010100001100	11000000001100	11000000001100	11000000001100
k5	11010100011100	10000000101111	10000000101111	11000000110101
k6	10010100101011	10000000111110	10000000111110	10000000111110
k7	11010100101011	10000000101110	10000000101110	11000000110100
k8	/	/	/	/
k9	11010100000011	11000000000011	11000000000011	11000000000011
k10	11010100100001	11000000100110	10000000100001	11000000100110
k11	11010100100000	10000000010110	10000000010110	11000000010000
k12	11010100101101	11000000001110	11000000001110	11000000001110
k13	11010100001001	11000000001001	11000000001001	11000000001001
k14	11010100110101	11000000100100	11000000100100	11000000100100
k15	11010100000110	11000000000110	11000000000110	11000000000110
k16	/	/	/	/
k17	11010000011010	11000000101100	11000000101100	11000000101100
k18	11010001111111	11000000010000	10000000011001	10000000011001

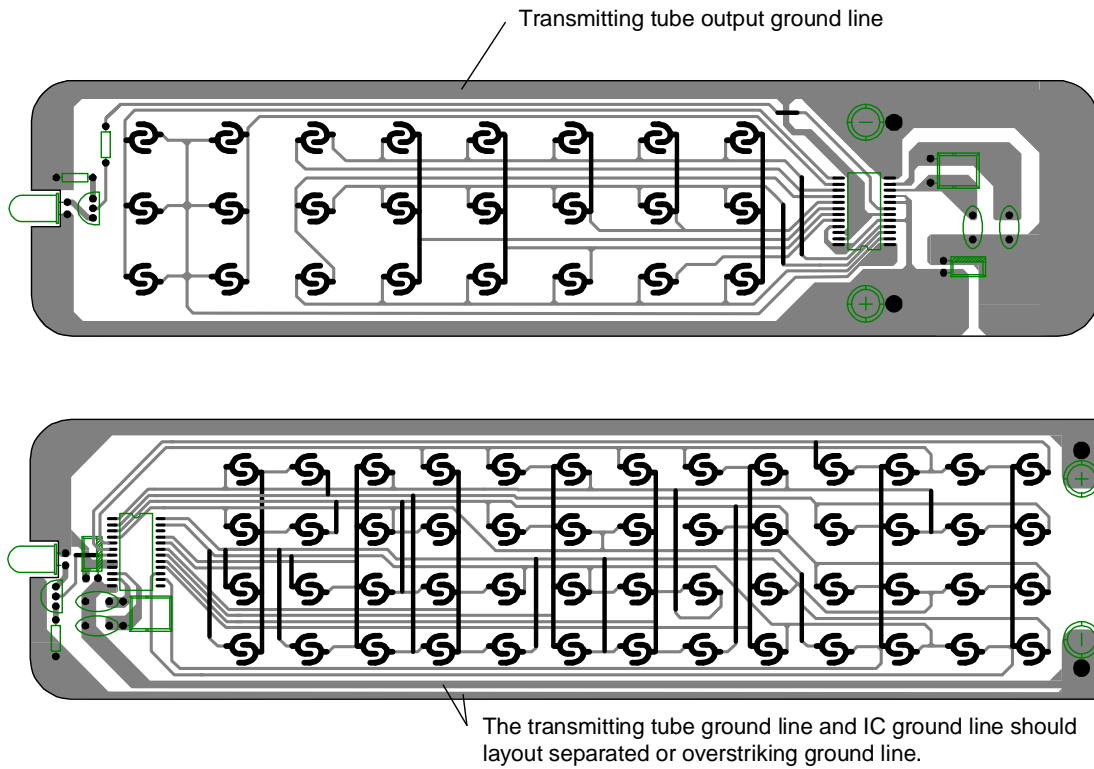
(To be continued)

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Key	Bank4	Bank5	Bank6	Bank7
k19	11010100111011	/	1000000100101	/
k20	1101000010110	1100000101011	1100000101011	1100000101011
k21	1101000010111	1100000101010	1100000101010	1100000101010
k22	11010010111111	1100000100001	1000000100111	1100000001011
k23	1101000010000	1100000101011	1100000101011	1100000101101
k24	/	/	/	/
k25	11010100000010	1100000000010	1100000000010	1100000000010
k26	11010100110010	1000000010001	1000000010001	1100000100001
k27	11010100110100	1000000010010	1000000010010	1100000111011
k28	11010100001011	1100000001101	1100000001101	1100000001101
k29	11010100001000	1100000001000	1100000001000	1100000001000
k30	11010100110110	1000000010000	1000000010000	1100000100000
k31	11010100000101	1100000000101	1100000000101	1100000000101
k32	/	/	/	/
k33	11000100000001	1100000000001	1100000000001	1100000000001
k34	11010001100001	1000000110101	1000000110101	1000000110101
k35	11010001100000	1000000010101	1000000010101	1100000010001
k36	11010000100110	11000000100011	11000000100011	11000000100011
k37	11010100000111	1100000000111	1100000000111	1100000000111
k38	10010100101100	1100000001111	1100000001111	1100000001111
k39	11010100000100	1100000000100	1100000000100	1100000000100
k40	/	/	/	/
k41	/	11000111000000	1000000011010	11000111000000
k42	/	/	1000000011111	/
k43	10010100110011	11000000111000	11000000111000	11000000111000
k44	11010100000000	11000000000000	11000000000000	11000000000000
k45	11010100110000	10000000110001	10000000110001	/
k46	10010100110010	11000000100010	11000000100010	11000000100010
k47		11000111111010	11000111111010	11000111111010
k48	/	/	/	/
k49	11010000011011	11000000111100	11000000111100	11000000111100
k50	11010100111111	11000000010001	10000000011000	10000000011000
k51	11010100100100	11000000111111	11000000111111	11000000111111
k52	11010000011000	11000000101001	11000000101001	11000000101001
k53	11010000011001	10000000111010	10000000111010	11000000011110
k54	11010101111111	11000000100000	10000000100110	11000000001010
k55	11010000010001	11000000101110	11000000101110	11000000101110

1. The number after K is the key code number.
2. The number after B is BANK0, BANK1 number. When SN0 connect the GND, it sends BANK7.
3. Don't compatible with PCA8521pins.

PCB WIRE LAYOUT SCHEMATIC



The above IC only use to hint, not to specified.

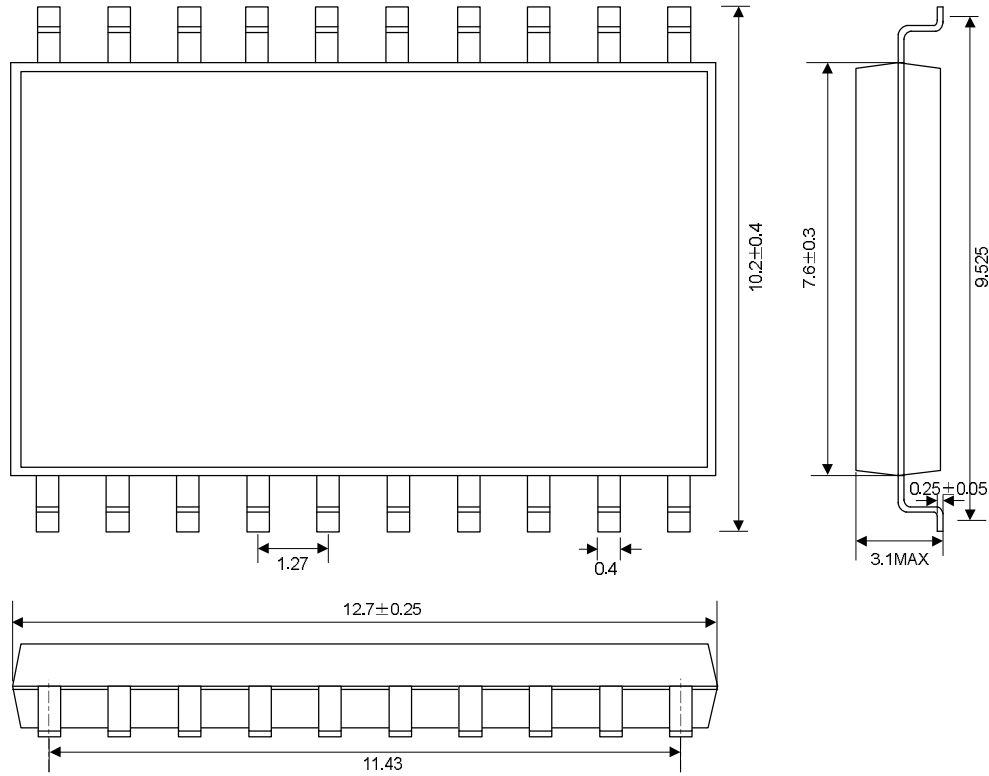
**Note:**

- \* In wire layout, the power filter capacitor should near to IC.
- \* In wire layout, should avoid power line and ground line too long.
- \* Recommended infrared transmit unit and IC ground line should layout separated, or overstriking lines.
- \* The emitter of triode connect 1Ω resistor at least.
- \* Recommended triode use 9014.

PACKAGE OUTLINE

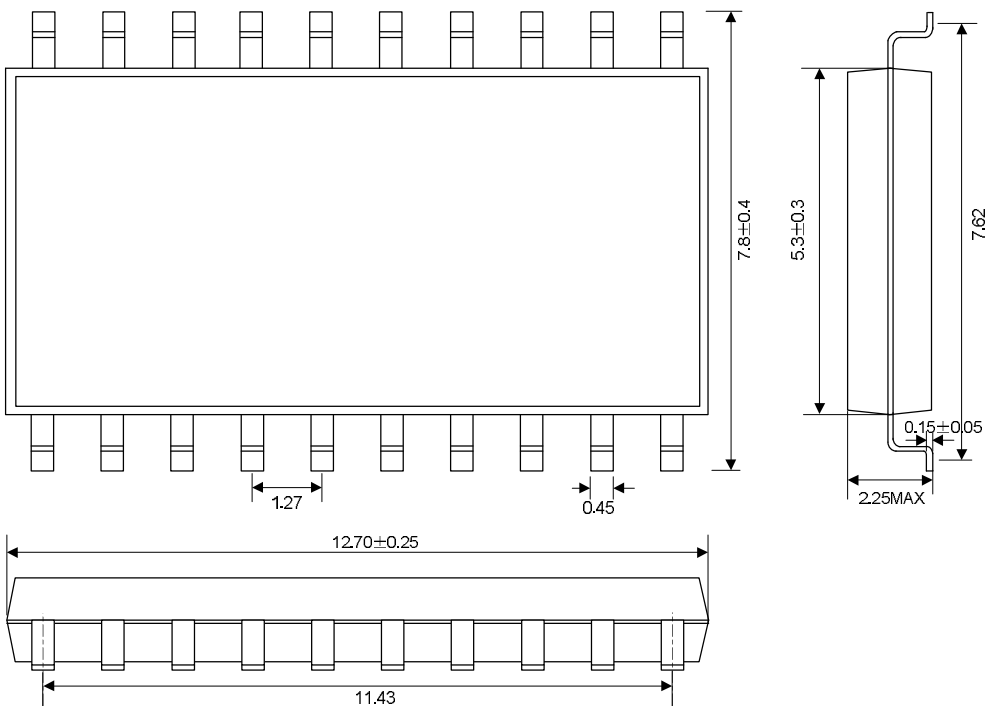
SOP-20-375-1.27

Unit: mm



SOP-20-300-1.27

UNIT: mm





#### HANDLING MOS DEVICES:

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.

**Note:** IC oscillator input mustn't be on the outside layer, thus to avoid the abnormal working when human body touches the remote controller without crust in testing.

## ATTACHMENT

## Revision History

Data	REV	Description	Page
2001.09.18	1.0	Original	
2001.01.03	1.1	Modify the order of the pin in key matrix table	4
2002.01.19	1.2	Modify the diode direction in "APPLICATION CIRCUIT"	9
		Add the Binary "instruction and signal output format table"	10~13
		Add the note of instruction table.	13~14
2002.03.01	1.3	The 102pF capacitor change to 100pF in "APPLICATION CIRCUIT"	9
		Add the "PCB wire layout schematic"	14
		Modify the "Package outline"	15