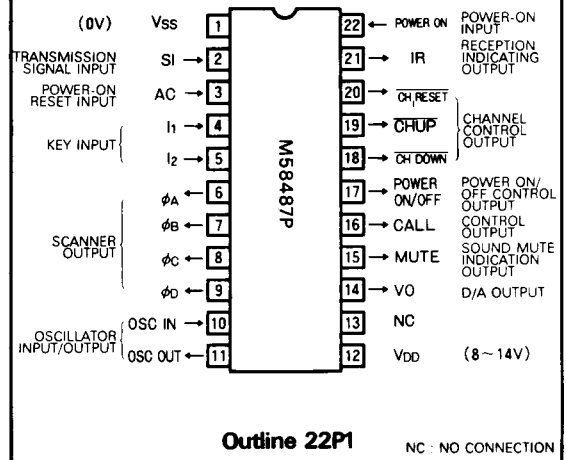## 22-FUNCTION REMOTE CONTROL RECEIVER

DESCRIPTION

The M58487P is a 22-function remote-control receiver circuit manufactured by aluminum-gate CMOS technology for use in television receivers, audio equipment, and the like, using infrared for transmission. It enables direct control of 8 functions at the receiver.

The M58487P is intended for use with an M58480P or M58484P transmitter.

FEATURES

● Single power supply
● Wide supply voltage range: 8V~14V
● Low power dissipation
● On-chip oscillator
● Low-cost LC or ceramic oscillator used in determining the reference frequency (480kHz or 455kHz)
● Information is transmitted by means of pulse code modulation
● Good noise immunity—instructions are not executed unless same code is received three or more times in succession.
● Single transmission frequency (40kHz or 38kHz) for carrier wave
● 16 TV channels selected directly
● Three analog functions—volume, brightness, and color saturation—are independently controlled to 64 stages by three 6-bit D/A converters
● 8 commands are controlled at the M58487P receiver
● Has large tolerance in operating frequency between the transmitter and the receiver
● Can be connected with an M51231P or equivalent touch control channel selector IC

PIN CONFIGURATION (TOP VIEW)

Outline 22P1   NC : NO CONNECTION

APPLICATIONS

● Remote-control receiver for TV or other applications

FUNCTIONS

The M58487P is designed to decode and execute instructions after three successive receptions of the identical instruction code, providing a good noise immunity.

Instructions comprise direct selection of 16 channels, channel position up and down, volume up and down, brightness up and down, color saturation up and down, normalization of volume, brightness and color saturation, sound mute on and off, TV main power on and off, and output CALL on and off.

In addition, 8 functional instructions can be entered from the receiver side.

BLOCK DIAGRAM
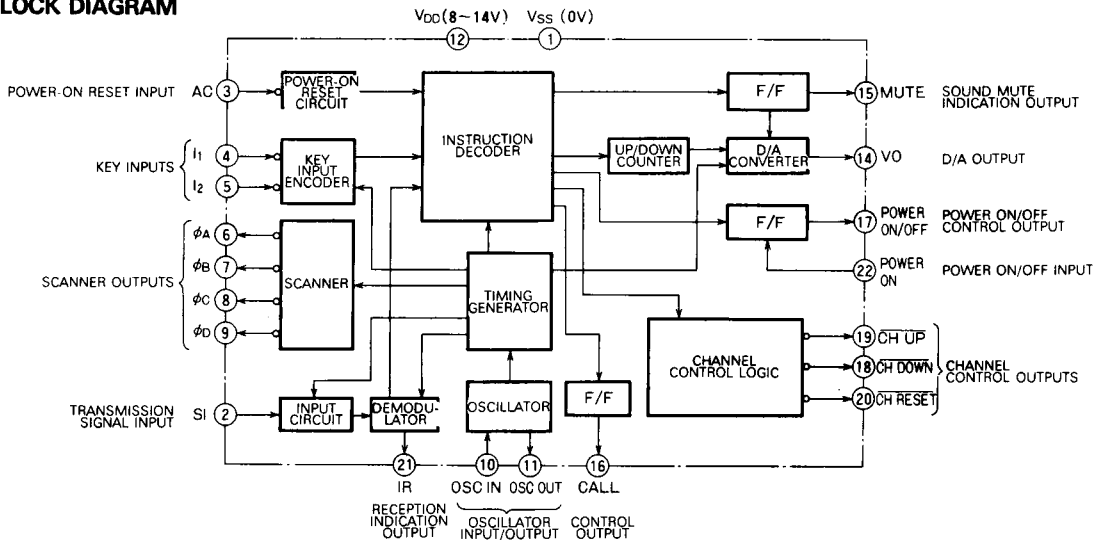
22-FUNCTION REMOTE CONTROL RECEIVER

FUNCTION DESCRIPTION

Oscillator

As the oscillator is on-chip, oscillation frequency is easily obtained by connecting an external LC network or ceramic resonator between the OSC IN and OSC OUT terminals. Figs. 1 and 2 show typical oscillators.

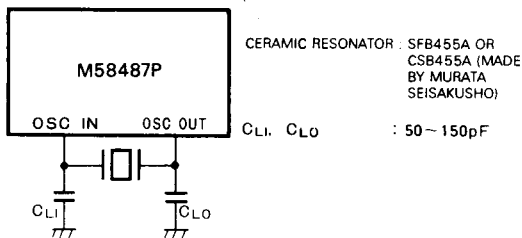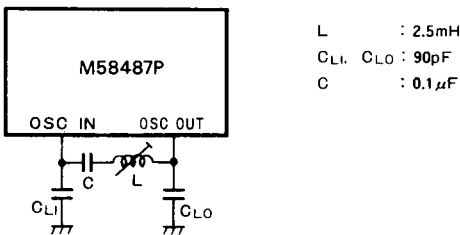**Fig. 1 An example of an oscillator (when a ceramic resonator is used)**

Fig. 2 An example of an oscillator (when a LC network is used)

Reception Signal Input Circuit and Demodulation Circuit

The reception signal caught by the photo detector is amplified in the amplifier and added to the SI, where it is converted into a pulse signal in the input circuit to be sent to the demodulation circuit. In the demodulation circuit, the pulse interval of the pulse signal is judged and then converted into the digital code to be sent to the instruction decoder.

SI is applied as amplified, either through a capacitor coupling (Fig. 3) or directly as a pulse signal (Figs. 4 and 5). A Schmitt trigger circuit is provided in the SI input circuit for preventing spurious operation due to noise.
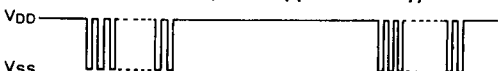
Fig. 3 SI input waveform (when applied through a capacitor coupling)

Fig. 4 SI input waveform (when applied directly)

Fig. 5 SI input waveform (when applied directly)

Instruction Decoder

The instruction decoder starts to function after receiving the same instruction code three or more times in succession from the demodulation circuit.

Table 1 shows the relations between the reception code and instruction function. To prevent spurious operation, there is no code 000000.

Table 1 Relations between reception codes and instructions

D_1	D_2	D_3	D_4	D_5	D_6	Function	Remarks
1	1	0	0	0	0	VO UP	Volume up
0	0	1	0	0	0	VO DOWN	Volume down
1	0	0	1	0	0	MUTE	Sound mute on/off
0	1	0	1	0	0	VO($1/3$)	Normalization of volume
1	0	1	1	0	0	CALL	Output CALL on/off
0	1	1	1	0	0	POWER ON/OFF	Power on/off
0	0	0	0	1	0	CH 1	
1	0	0	0	1	0	CH 2	
0	1	0	0	1	0	CH 3	
1	1	0	0	1	0	CH 4	
0	0	1	0	1	0	CH 5	
1	0	1	0	1	0	CH 6	
0	1	1	0	1	0	CH 7	
1	1	1	0	1	0	CH 8	Direct channel selection (Direct access)
0	0	0	1	1	0	CH 9	
1	0	0	1	1	0	CH 10	
0	1	0	1	1	0	CH 11	
1	1	0	1	1	0	CH 12	
0	0	1	1	1	0	CH 13	
1	0	1	1	1	0	CH 14	
0	1	1	1	1	0	CH 15	
1	1	1	1	1	0	CH 16	

Key Inputs

8 different instructions are input by a 2×4 keyboard matrix consisting of inputs $I_1 \sim I_2$ and scanner outputs $\phi A \sim \phi D$. Protection is also available against chattering within 10ms.

As entry priority is given to each key, depression of more than two keys at the same time makes the key with higher priority effective. For the scanner output, priority is given in the order of ϕA, ϕB, ϕC, and ϕD, and I_1 takes precedence over I_2 if the scan output is the same. When two or more keys are depressed at the same time, scanner outputs may short-circuit, disabling all functions.

While one of the keys is depressed, instructions from the transmitter are ignored.

Table 2 shows the relations between the keyboard matrix and the instructions.

Table 2 Relations between keyboard matrix and instructions

Key input / Scanner output	ϕD	ϕC	ϕB	ϕA
I_1	POWER ON/OFF	VO UP	MUTE	CH UP
I_2	CALL	VO DOWN	VO($1/3$)	CH DOWN

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Indication of Reception

As soon as an identical code is received three times, output IR turns from low-level to high-level. Thus reception of an instruction from the transmitter can be indicated by an LED connected to the output IR.

Output VO

As the 6-bit D/A converter is contained internally, analog value can be controlled to 64 stages independently. The D/A converter is pulse-width modulator, the reception frequency is 1.25kHz (when f_{OSC} = 480kHz) and minimum pulse width is 12.5μs.

Analog value can be incremented/decremented at a rate of about 1 step/0.1 second through the remote control or the key input. The time required for increasing the analog value from the minimum to the maximum is about 6.6 seconds (when f_{OSC} = 480kHz).

It is also possible to set the analog value to 1/3 of its maximum value by means of the remote control or the key input (normalization).

Sound Mute

Sound mute on/off is controlled through the remote control or the key input. When sound mute is on, output VO goes low, and output MUTE goes high.

Sound mute is automatically released from ON when the output VO is either incremented or decremented by remote control or the key input.

Channel Control

Channel control is attained through outputs $\overline{\text{CH UP}}$, $\overline{\text{CH DOWN}}$ and $\overline{\text{CH RESET}}$. With respect to direct channel selection by the remote-control operation, a single pulse appears on output $\overline{\text{CH RESET}}$ first, and then the pulses whose number is deducted by one from the selected channel appear on the output $\overline{\text{CH UP}}$. Up and down channel switching is controlled by presenting a single pulse on the output $\overline{\text{CH UP}}$ or $\overline{\text{CH DOWN}}$. Thus it can be connected with an M51231P or equivalent touch-control channel selector IC.

Fig. 6 Timing chart of channel control (when fosc = 480kHz)
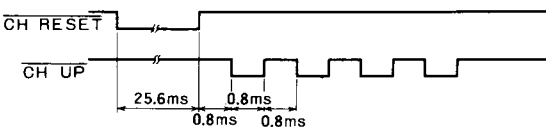
During direct channel selection, up or down, output VO goes low for 50~100ms.

Outputs, $\overline{\text{CH UP}}$, $\overline{\text{CH DOWN}}$, and $\overline{\text{CH RESET}}$ are the open-drain type of N-channel transistor.

Power On/Off

The remote control or the key input makes it possible to turn the POWER ON/OFF output from low to high or vice versa. While the POWER ON/OFF output is low, all channel and analog controls through the remote control are disabled, as are all through the keyboard.

Output CALL

The output CALL is turned high or low by remote control or the key input. This output effects on/off control of channel number indication or change of receiving modes of multi-channel broadcasting.

Power-on Reset

Attaching a capacitor to terminal AC activates the power-on reset when power is on to the M58487P.

Activation of the power-on reset function sets output VO to 1/3 of its maximum value and turns the POWER ON/OFF and CALL outputs to low-level.

An Example of an Application Circuit
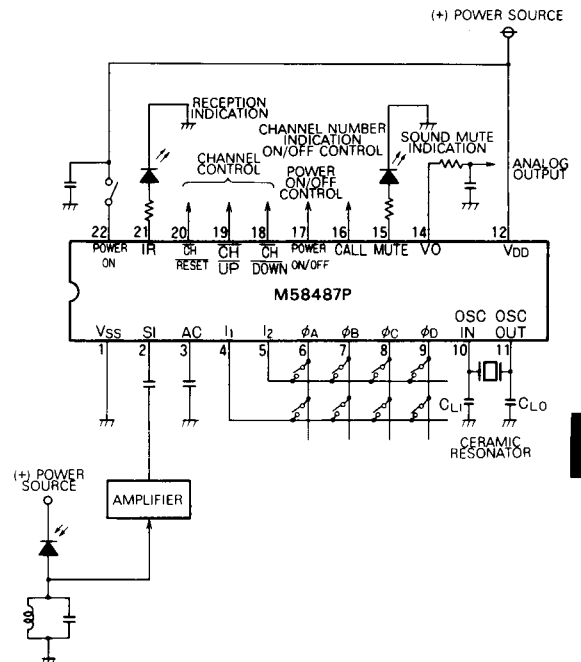
22-FUNCTION REMOTE CONTROL RECEIVER

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Limits	Unit
V_{DD}	Supply voltage	With respect to V_{SS}	$-0.3 \sim 15$	V
V_I	Input voltage		$V_{SS} \leqq V_I \leqq V_{DD}$	V
V_O	Output voltage		$V_{SS} \leqq V_O \leqq V_{DD}$	V
P_d	Maximum power dissipation	$Ta = 25°C$	300	mW
T_{opr}	Operating free-air temperature range		$-30 \sim 70$	°C
T_{stg}	Storage temperature range		$-40 \sim 125$	°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Limits			Unit
		Min	Nom	Max	
V_{DD}	Supply voltage	8	12	14	V
f_{OSC}	Oscillation frequency		455		kHz
			480		kHz
V_I	Input voltage, SI	5			V_{P-P}

ELECTRICAL CHARACTERISTICS (Ta = 25°C , V_{DD} = 12V , unless otherwise noted.)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{DD}	Operating supply voltage	$Ta = -30 \sim 70°C$, $f_{OSC} = 455kHz$	8	12	14	V
I_{DD}	Supply current	$f_{OSC} = 455kHz$		2	5	mA
R_I	Pull-up resistances, I_1, I_2			20		kΩ
I_{OL}	Low-level output currents, $\phi_A \sim \phi_D$	$V_O = 12V$	5			mA
I_{OL}	Low-level output currents, CH RESET, CH UP, CH DOWN	$V_O = 12V$	20			mA
I_{OZH}	Off-state output currents, CH RESET, CH UP, CH DOWN	$V_O = 12V$			1	μA
I_{OH}	High-level output current, VO	$V_O = 0$ V	-7			mA
I_{OL}	Low-level output current, VO	$V_O = 12V$	7			mA
I_{OH}	High-level output currents, POWER ON/OFF, CALL, MUTE	$V_O = 0$ V	-20			mA
I_{OL}	Low-level output currents, POWER ON/OFF, CALL, MUTE	$V_O = 12V$	5			mA
I_{OH}	High-level output current, IR	$V_O = 0$ V	-15			mA
I_{OL}	Low-level output current, IR	$V_O = 12V$	5			mA

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