

# IR3N81A Speaker Phone IC

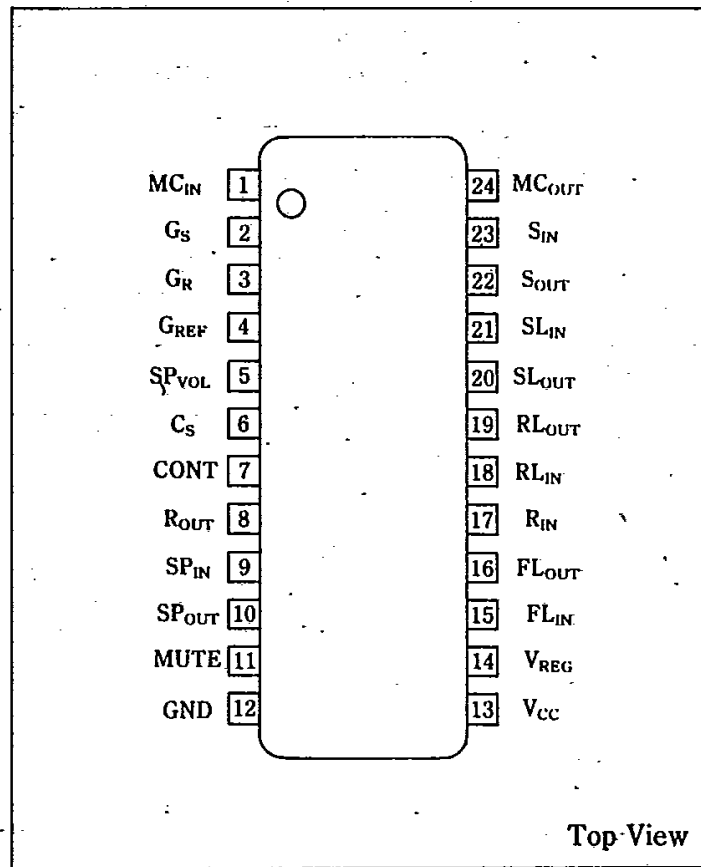
## Description

The IR3N81A is a speaker-phone IC for use in a hand-free telephone set. It is designed for operation at low voltage, with a minimum number of external parts.

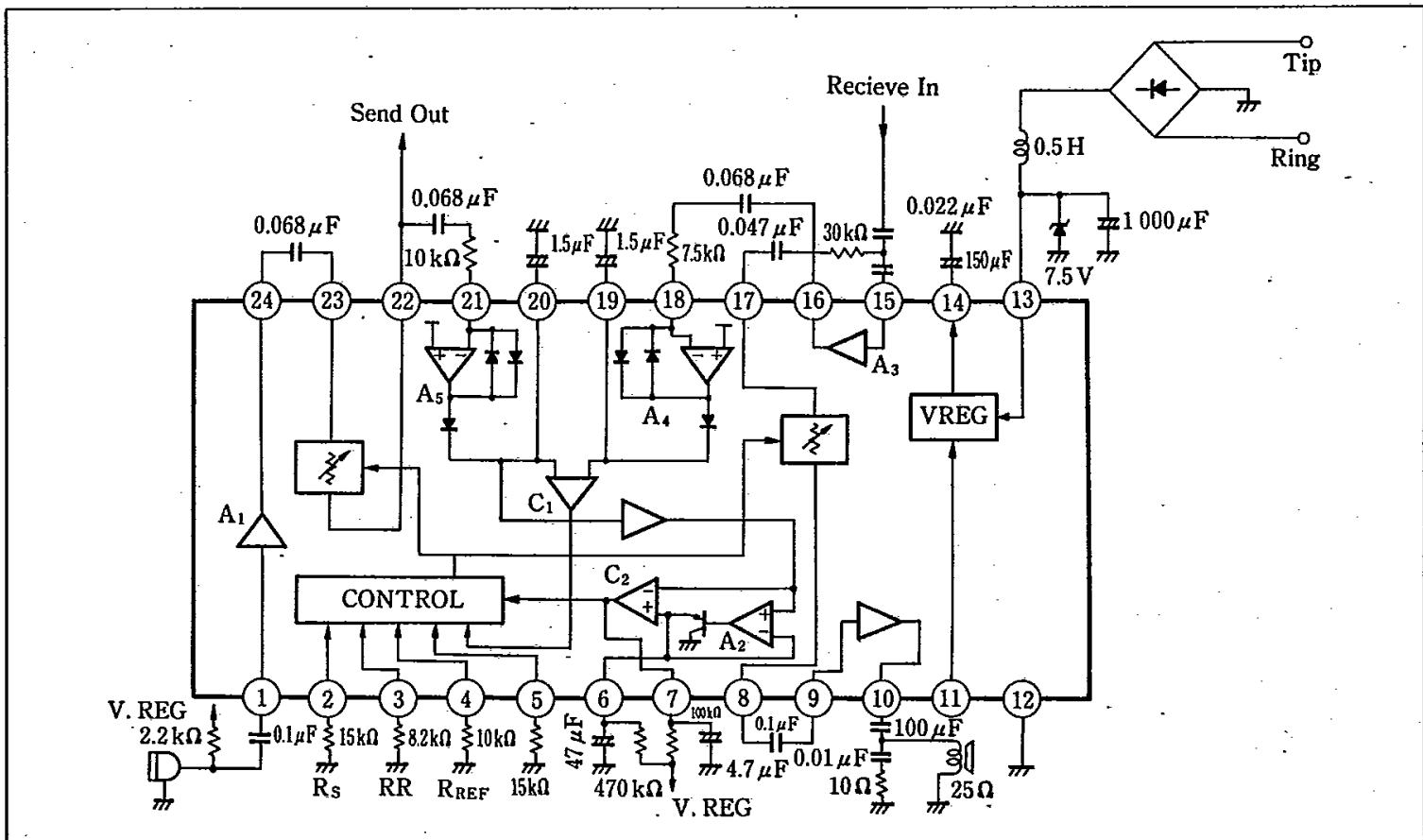
## Features

1. Built-in total functions of speaker phone except for speech network
2. Low power operation (MIN  $V_{CC} = 2.8V$ )
3. Built-in voice detection circuit
4. Minimal external parts count
5. 24-pin shrink-dual-in-line package

## Pin Connections



## Block Diagram



## Pin Description

Pin No.	Symbol	Function	Pin. No.	Symbol	Function
1	MC <sub>IN</sub>	MIC amp input	24	MC <sub>OUT</sub>	MIC amp output
2	G <sub>S</sub>	Transmit attenuation adjustment	23	S <sub>IN</sub>	Transmit attenuator input
3	G <sub>R</sub>	Receive attenuation adjustment	22	S <sub>OUT</sub>	Transmit attenuator output
4	G <sub>REF</sub>	Attenuation reference adjustment	21	SL <sub>IN</sub>	Transmit log amp input
5	SP <sub>VOL</sub>	Speaker volume	20	SL <sub>OUT</sub>	Transmit log amp output
6	C <sub>S</sub>	Time const. adjustment of voice detection	19	LR <sub>OUT</sub>	Receive log amp output
7	CONT	Speaker volume	20	SL <sub>OUT</sub>	Transmit log amp output
8	R <sub>OUT</sub>	Receive attenuation output	17	RL <sub>IN</sub>	Receive attenuator input
9	SP <sub>IN</sub>	Speaker amp input	16	FL <sub>OUT</sub>	Filter amp output
10	SP <sub>OUT</sub>	Speaker amp output	15	FL <sub>IN</sub>	Filter amp input
11	MUTE	Mute	14	V <sub>REG</sub>	Voltage regulator output
12	GND	Ground	13	V <sub>CC</sub>	Supply voltage

## Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	V <sub>CC</sub>		12	V
Input voltage	V <sub>IN</sub>	Pin 11	V <sub>CC</sub>	V
Output current	I <sub>O</sub>	Pin 10	100	mA
Power dissipation	P <sub>D</sub>	T <sub>a</sub> =60°C	800	mW
Operating temperature	T <sub>OPR</sub>		-20~60	°C
Storage temperature	T <sub>STG</sub>		-55~150	°C

## Electrical Characteristics (1)

(V<sub>CC</sub>=6.5V, T<sub>a</sub>=25°C, f=1kHz)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Test circuit
Operating supply voltage	V <sub>CC</sub>	T <sub>a</sub> =-20~60°C	2.8		11	V	
Supply voltage	I <sub>CC</sub>	Operating	3	6	10	mA	③
		Muting			800	μA	
<b>Transmit Attenuator</b>							
Receive attenuation	A <sub>SR</sub>	*R <sub>0</sub> =9.1kΩ, V <sub>R</sub> =0V	22		35	dB	①
Transmit attenuation	A <sub>SS</sub>	*R <sub>0</sub> =9.1kΩ, V <sub>R</sub> =0V	-10		-3	dB	①
Input resistance	R <sub>IS</sub>		30	50	70	kΩ	
<b>Receive Attenuator</b>							
Transmit attenuation	A <sub>RS</sub>	*R <sub>0</sub> =9.1kΩ, V <sub>R</sub> =0V	24		38	dB	①
Receive attenuation	A <sub>RR</sub>	*R <sub>0</sub> =9.1kΩ, V <sub>R</sub> =0V	-10		-3	dB	①
Input resistance	R <sub>IR</sub>		30	50	70	kΩ	
<b>Others</b>							
Mic amp voltage gain	G <sub>M</sub>		30	32	34	dB	⑤
Mic amp max input voltage	V <sub>IN MAX</sub>	Input voltage not to saturate for output			15	mV <sub>rms</sub>	
Mic amp input resistance	R <sub>MI</sub>		18	30	45	kΩ	
Speaker amp voltage gain	G <sub>SP</sub>		24	26	28	dB	⑥
Speaker amp input resistance	R <sub>SP</sub>		30	50	70	kΩ	
Speaker amp output power	P <sub>SP</sub>	R <sub>L</sub> =25Ω, THD=5%	25	30		mW	⑦
Filter amp voltage gain	G <sub>FL</sub>		4	6	8	dB	⑧
Filter amp input resistance	R <sub>FL</sub>		18	30	45	kΩ	
Voltage regulator output	V <sub>REG</sub>	V <sub>CC</sub> ≥6.5V	4.5	5.0	5.5	V	④
Mute voltage	V <sub>IH</sub>	Mute mode	2.0			V	④
	V <sub>IL</sub>	Operating mode			0.8	V	④

\*R<sub>R</sub>=R<sub>S</sub>=R<sub>REF</sub>=R<sub>0</sub>

SHARP

## ■ Electrical Characteristics (2)

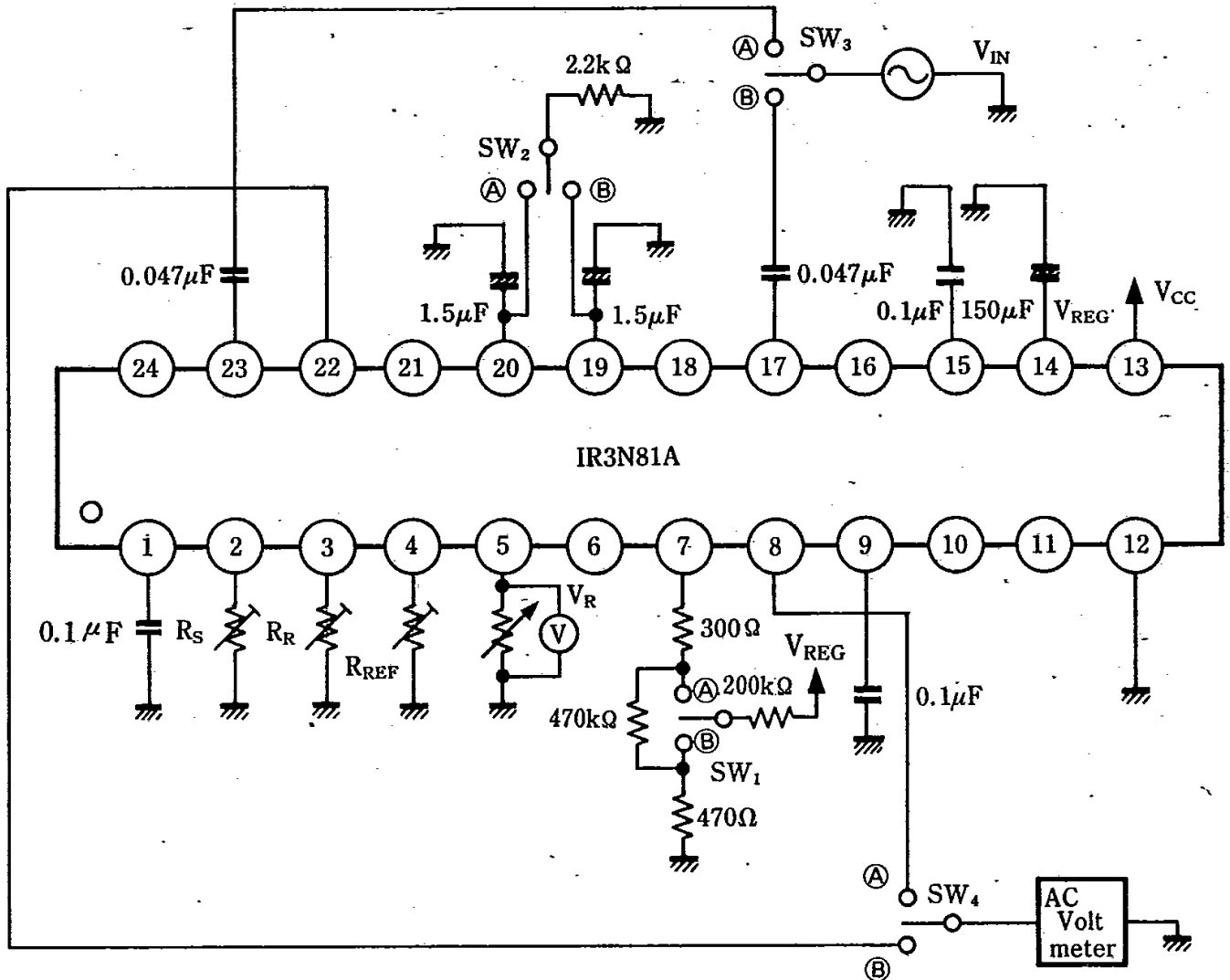
( $2.8V \leq V_{CC} \leq 11V$ ,  $-20^{\circ}C \leq T_a \leq 60^{\circ}C$ ,  $f=1kHz$ )

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Test circuit
Supply voltage	$I_{CC}$	Operating	3	6	10	mA	③
		Muting			800	$\mu A$	③
<b>Transmit attenuator</b>							
Receive attenuation	$A_{SR}$	* $R_0=9.1k\Omega$ , $V_R=0V$	15		45	dB	①
Transmit attenuation	$A_{SS}$	* $R_0=9.1k\Omega$ , $V_R=0V$	-10		-3	dB	①
Input resistance	$R_{IS}$		28	50	89	k $\Omega$	
<b>Receive attenuator</b>							
Transmit attenuation	$A_{RS}$	* $R_0=9.1k\Omega$ , $V_R=0V$	16		45	dB	①
Receive attenuation	$A_{RR}$	* $R_0=9.1k\Omega$ , $V_R=0V$	-10		-3	dB	①
Input resistance	$R_{IR}$		25	50	80	k $\Omega$	
<b>Others</b>							
Mic amp voltage gain	$G_M$		30	32	34	dB	⑤
Mic amp input resistance	$R_{MI}$		16	30	50	k $\Omega$	
Speaker amp voltage gain	$G_{SP}$		20	26	28	dB	⑥
Speaker amp input resistance	$R_{SP}$		24	50	80	k $\Omega$	
Speaker amp output power	$P_{SP}$	$V_{CC} \geq 6.5V$ $R_L=25\Omega$ , THD=5%		30		mW	⑦
Filter amp voltage gain	$G_{FL}$		3	6	8	dB	⑧
Filter amp input resistance	$R_{FL}$		13	30	50	k $\Omega$	
Voltage regulator output	$V_{REG}$	$V_{CC} \geq 6.5V$	4.5	5.0	5.5	V	④
Mute voltage	$V_{IH}$	Mute mode	2.0			V	④
	$V_{IL}$	Operating mode			0.8	V	④

\* $R_R=R_S=R_{REF}=R_0$

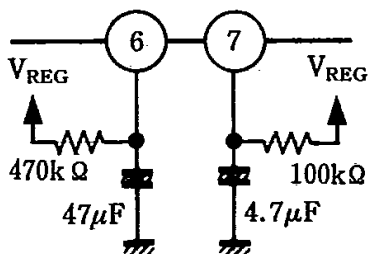
## Test circuits

### (1) Transmit mode, Receive mode attenuation test circuit



Attenuator	Parameter	SW			
		1	2	3	4
Receiver	Receive attenuation	(A)	(A)	(A)	(A)
	Transmit attenuation	(B)	(B)	(A)	(A)
Transmitter	Receive attenuation	(A)	(A)	(B)	(B)
	Transmit attenuation	(B)	(B)	(B)	(B)

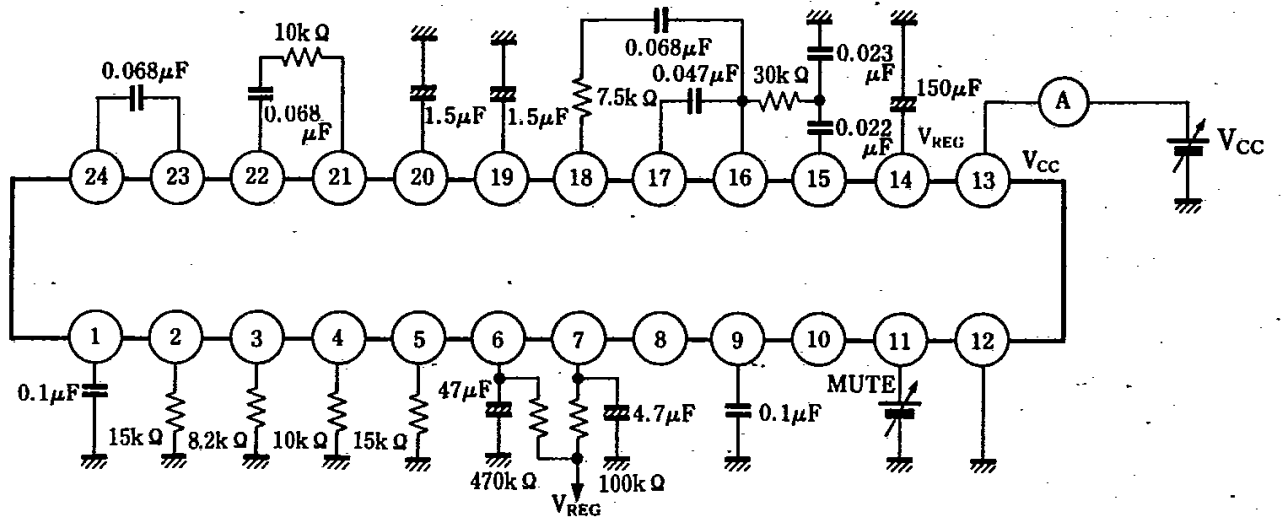
### (2) Idle mode attenuation test circuit



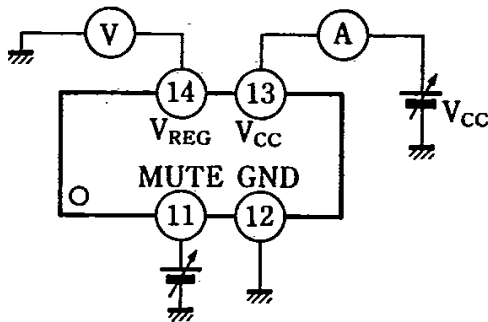
Attenuator	Parameter	SW		
		2	3	4
Receiver	Idle mode attenuation	(B)	(A)	(A)
Transmitter	Idle mode attenuation	(B)	(B)	(B)

\* Others are the same as shown in ①

**(3) Supply current test circuit**



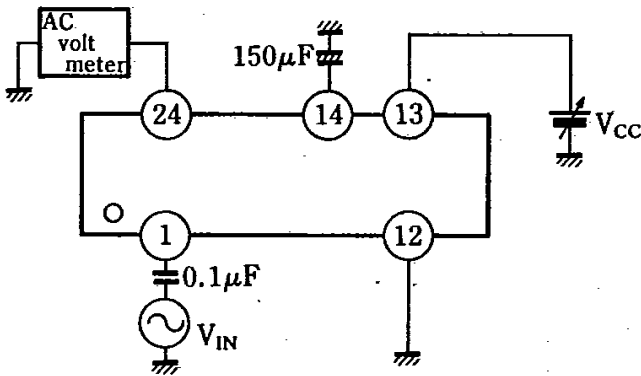
**(4) Regulated voltage, Mute voltage test circuit**



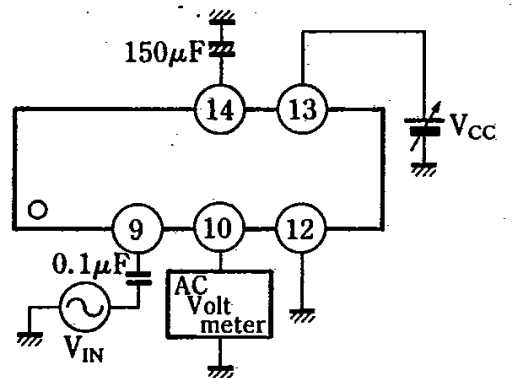
Operating mode  $V \leq 0.8V$   
Mute mode  $V \leq 2.0V$

\* Others are the same as shown in ③

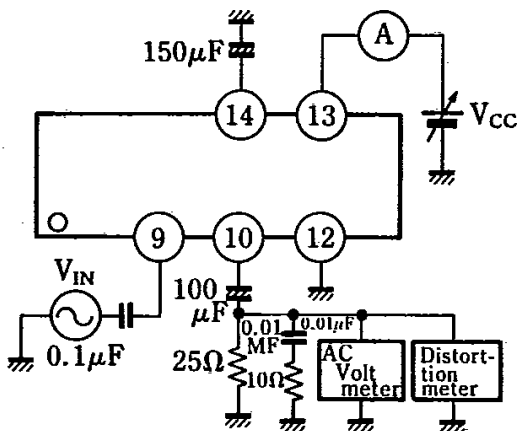
**(5) MIC Amp voltage gain test circuit**



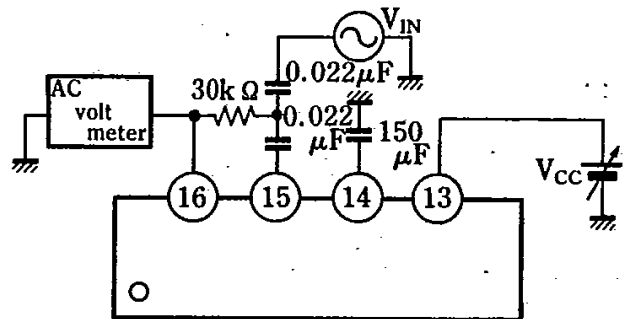
**(6) SP. Amp voltage gain test circuit**



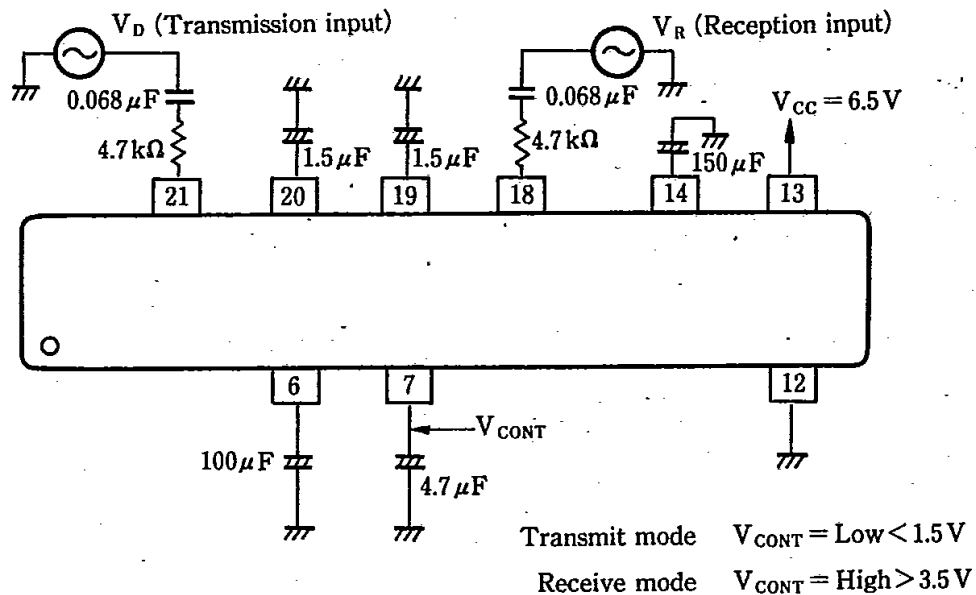
**(7) SP. Amp output power test circuit**



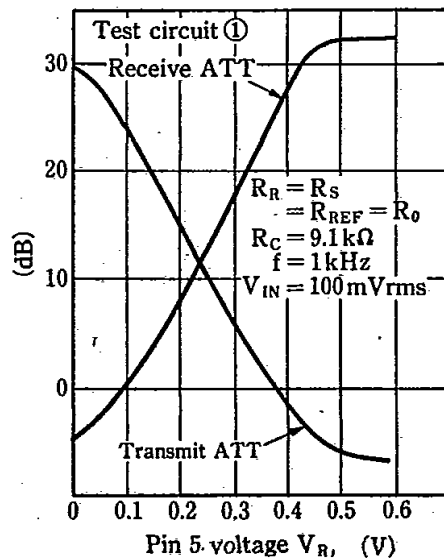
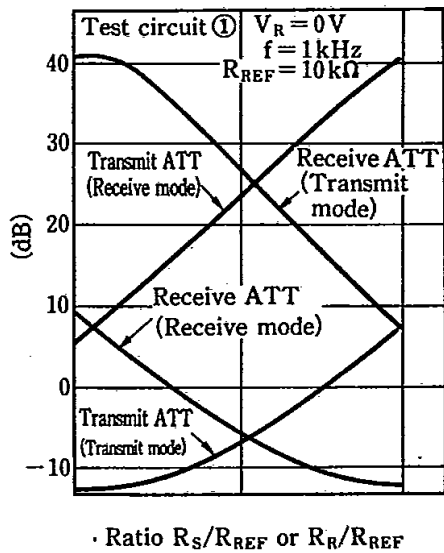
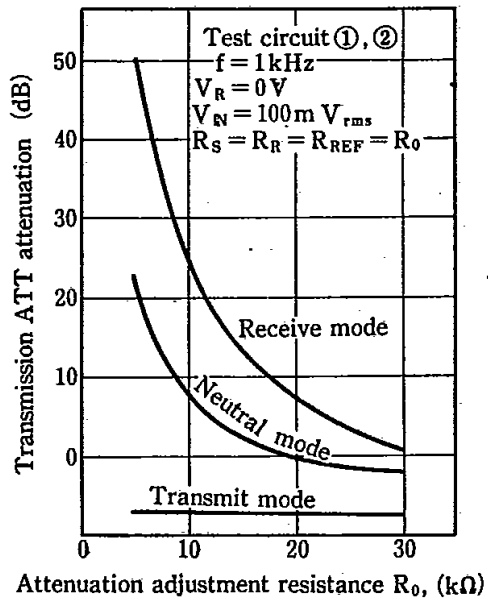
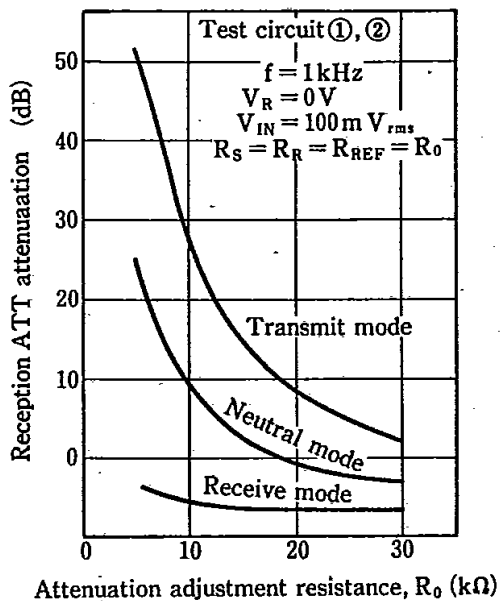
**(8) Filter Amp voltage gain test circuit**

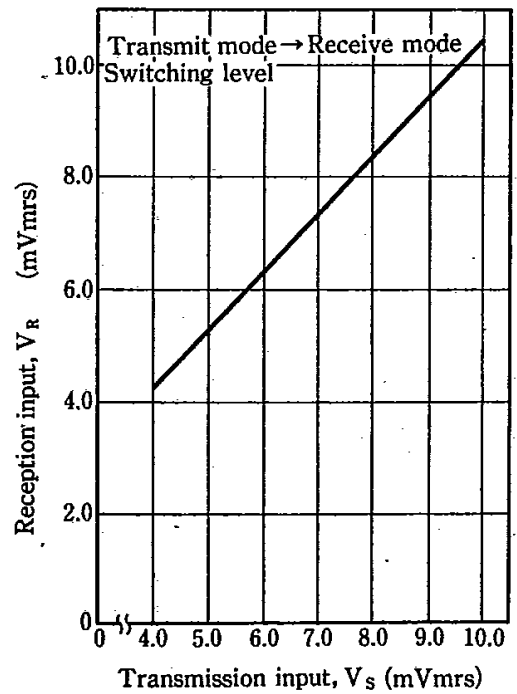
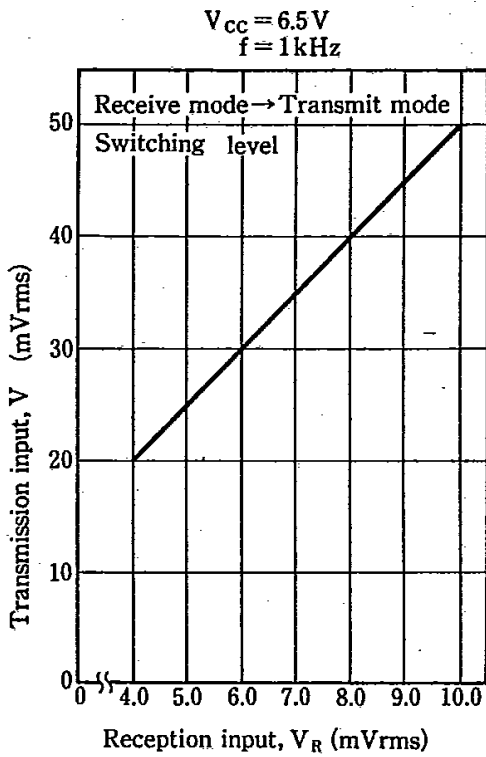
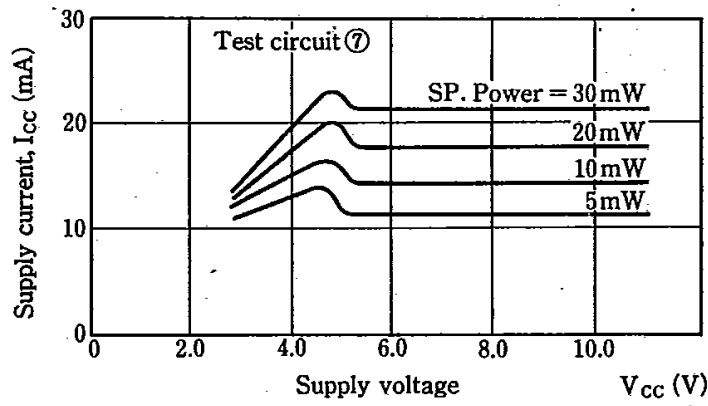
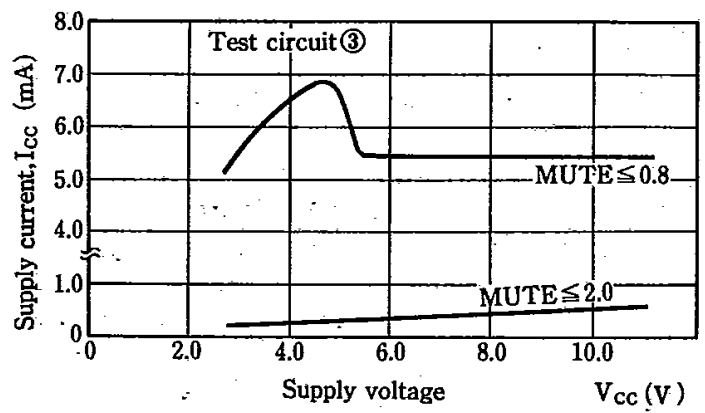
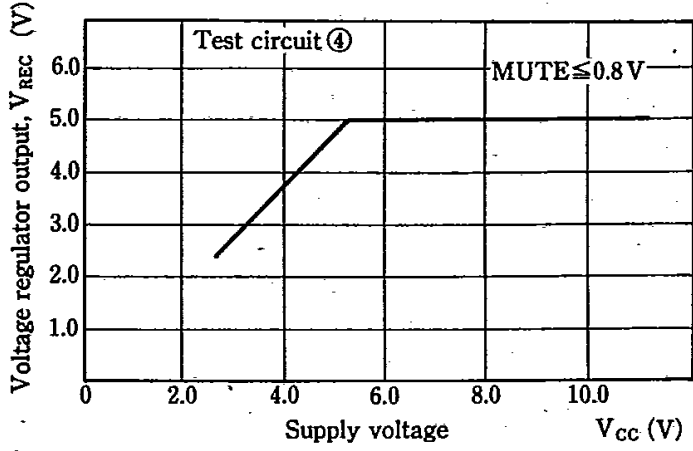


(9) Receive → Transmit, Transmit → Receive switching level test circuit



Electrical Characteristic Curves





## Principles of Operation

Refer to the block diagram and the application circuit diagram.

### (1) Voice switching circuit

The reception signals introduced from the speech network pass through the filter to the input (pin 18) of the log amplifier as AC current. The resistor connected to pin 18 converts the voltage to current.

The voltage which is generated by logarithmically compressing the input current value is output at pin 19 of the log amplifier. Likewise, the sending signal is also processed in the same circuit. These two log amplifier outputs are input to the comparator which determines which is the larger of the two. This result is then used to control the attenuator. Three modes, i.e., receive, transmit and neutral, are created, combining the output from the comparator C1 with that of the comparator C2 in the voice detection circuit.

In receive mode, the attenuation level is low in the receiving section (from pin 17 to pin 8), while that in the sending section (from pin 23 to pin 22) is high. In transmit mode the opposite is true. The attenuation level in the receiving section is high and that in the sending section is low. In neutral mode, the attenuation levels in the receiving and sending sections are almost the same, lying approximately midway between the respective attenuation levels of transmit and receive modes.

Comparator		State
C1	C2	
Transmit	Transmit	Transmit
Transmit	Receive	Neutral
Receive	Receive	Receive

\* When C1 is in receive mode, C2 does not set in transmit mode

### (2) Voice detection capability

After the microphone amplifier output is applied to the input (pin 21) of the log amplifier and logarithmically compressed, it is amplified by a factor of two in the noninverting amplifier A6.

When the A6 amplifier output does not vary or decreases in level, the input to amplifier A2 becomes the same as the output and it acts as a voltage follower.

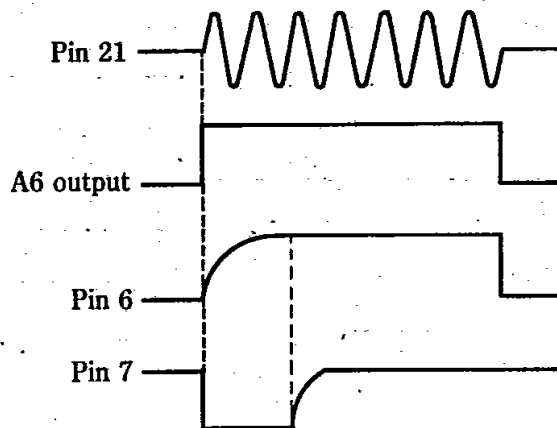


Fig. 1 Voice Detection Flow Chart

On the other hand, an offset of 18mV is provided by the comparator C2, the output of which is designed to be high when both input voltages are the same. This controls the attenuator by putting the circuit in transmit mode when the output (pin 7) of the comparator C2 is low.

Since the output of the amplifier A2 is a sink output, if the A2 input level increases, there will be a constant increase in the potential at pin 6, when it is determined with  $47\mu\text{F}$  and  $470\text{k}\Omega$ . That is, if the C2 output (pin 7) goes instantaneously low when the output of A6 goes up, and if the potential at pin 6 reaches the A6 output level, the output of the comparator C2, determined with  $4.7\mu\text{F}$  and  $100\text{k}\Omega$ , will increase by a constant amount.

Effective use is made of this capability when the IC is used in an environment with high background noise. The  $4.7\mu\text{F}$  of capacitance on pin 7 is also used for noise reduction when switching between transmit and receive modes. By increasing the value, noise can be reduced, but too high of a capacitance value may cause the initial voice signal to be missed. Therefore, a moderate capacitance value must be used in an actual system.

### (3) Volume control

The volume of the reception signal is controlled by the variable resistor connected to pin 5. A lower voltage applied to pin 5 results in a greater volume.

The attenuation level in the attenuator of the reception section is set by the values of the resistors connected to pins 3 and 4. When  $R_{\text{REF}}$  is fixed, the attenuation level increases as the value of  $R_R$  becomes smaller. The attenuation level in the attenuator of the transmission section is set by the values of the resistors connected to pins 2 and 4. When  $R_{\text{REF}}$  is fixed, the attenuation level increases as the value of  $R_S$  becomes larger.



#### (4) Stabilizing power supply

When a 6.5V to 11V potential is supplied to the  $V_{CC}$  terminal (pin 13), the stabilizing power supply outputs 5.0V to the  $V_{REG}$  output (pin 14) during normal operation.

The function of the stabilizing power supply is inhibited by applying an "H" level voltage (2.0V to 11V) to the MUTE pin (pin 11) ( $V_{REG} \rightarrow 0V$ ). Bringing pin 11 to the "L" level puts the stabilizing power supply back into operation. The same effect is achieved by opening pin 11.

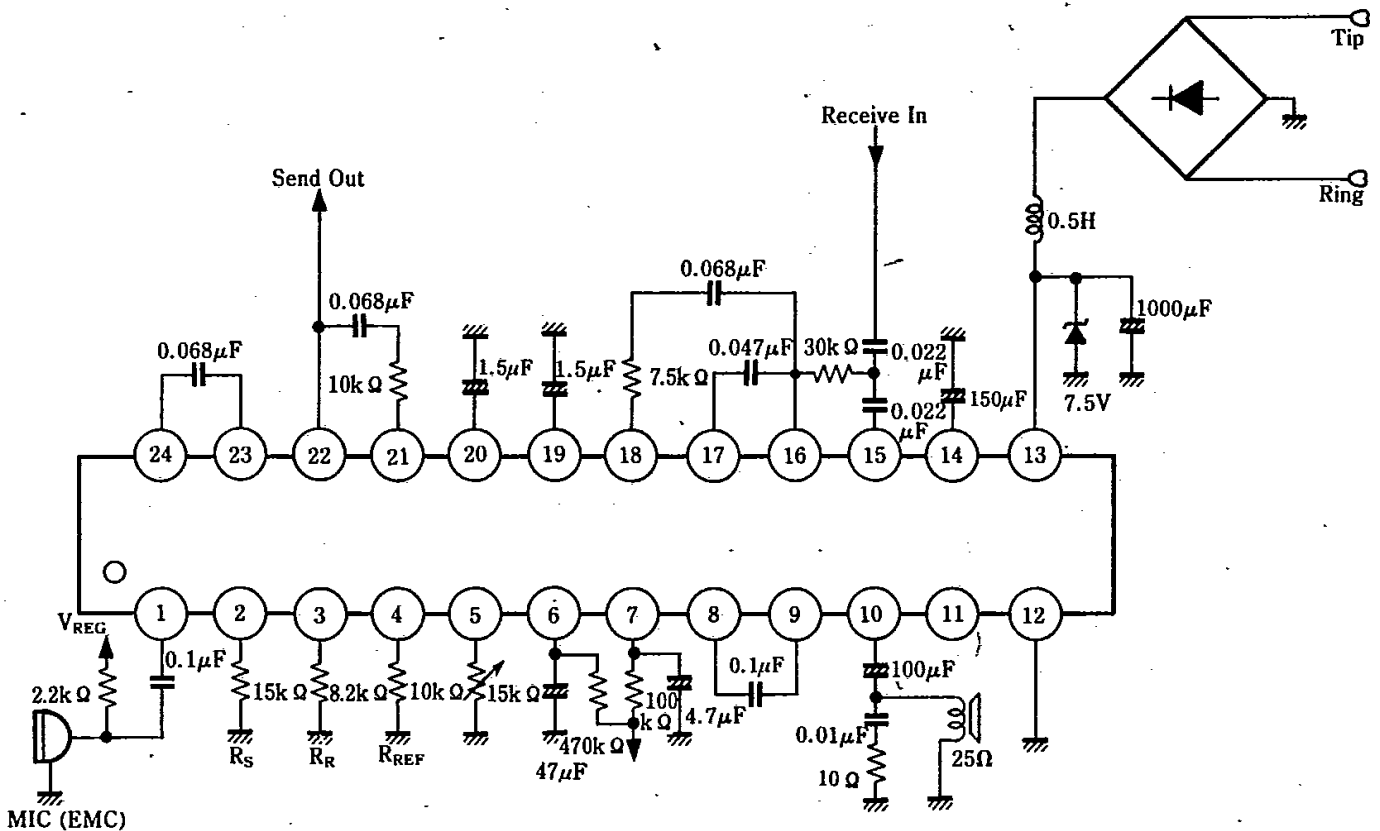
#### (5) Amplifier

The microphone amplifier has a gain of 32dB (TYP) with  $30k\Omega$  (TYP) of input impedance.

The speaker amplifier has a gain of 26dB (TYP) with  $50k\Omega$  (TYP) of input impedance.

The filter amplifier has a gain of 6dB (TYP) and forms an external high-pass filter. Its input impedance is  $30k\Omega$ .

### Application Circuit Example



This configuration is a test circuit example. A telephone set that can provide optimal values for external parts should be selected.

# Operation Test Circuit Example

