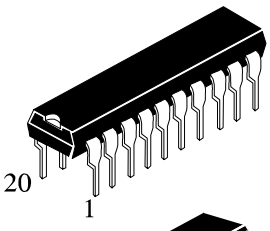
IL6965

Telephone Speech Network with Dialer Interface

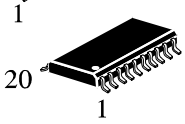
The IL6965 is a bipolar integrated circuit for use in electronic telephones.

The IL6965 has low operating voltage, it provides an excellent branch performance.

It has line voltage increasing circuit by the external terminal. Transmitting and receiving gains automatically vary according to the line current.



N SUFFIX
PLASTIC



DW SUFFIX
SOIC

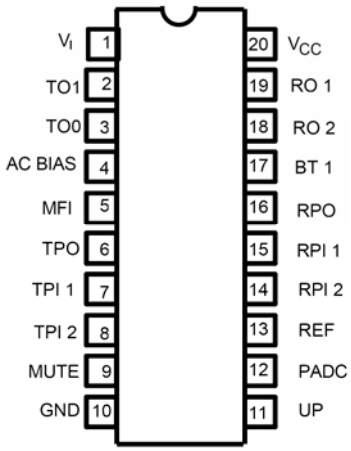
ORDERING INFORMATION

IL6965N Plastic DIP
IL6965D Plastic SOIC
T_A = -30° to 70° C

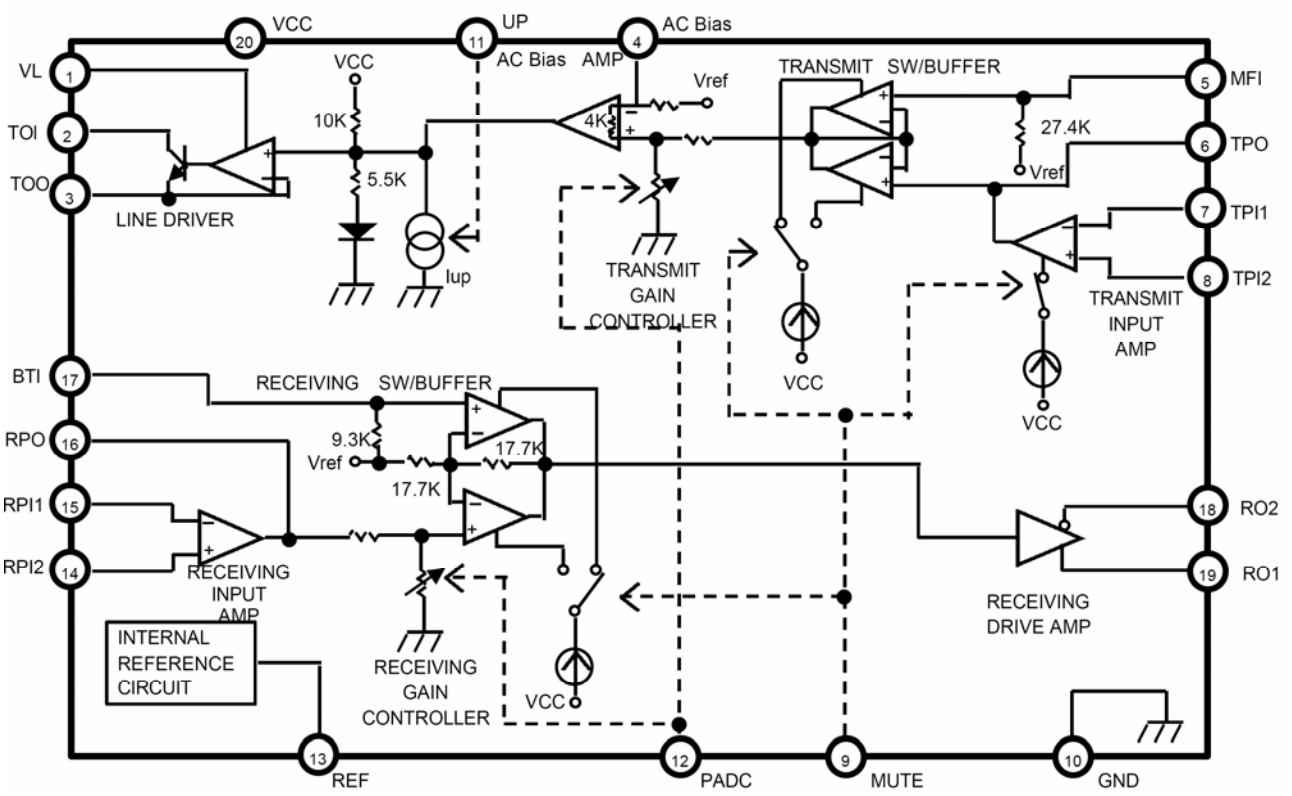
FEATURES

- Externally adjustable transmitting, receiving and sidetone gains.
- Switching between transmitting output and DTMF output is possible.
- Direct interface with light and compact ceramic transmitter-receiver is possible.
- Receiver follow impedance type can also be used.
- Gain is automatically controlled according to the line current. (Auto-PAD function)
- The line voltage can be increased by the external terminal (Up function).
- PKG is 20pin DIP & SOP

PIN ASSIGNMENT



BLOCK DIAGRAM



Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Value	Unit
Line Voltage	V_L	15	V
Line Current	I_L	150	mA
Power Dissipation	P_D	1300	mW
Operating Temperature	T_{opr}	−30 ~ 70	°C
Storage Temperature	T_{stg}	−55 ~ 150	°C

Electrical Characteristics (Ta = 25°C)

Parameter	Symbol	Test Cir-cuit	Test Condition	Min.	Typ.	Max.	Unit
Line Voltage	V_L	1	IL=20mA	2.9	3.2	3.6	V
			IL=120mA	9	11	14	V
Internal Power Supply Voltage	V_{CC}	1	IL=20mA	1.75	1.90	2.20	V
			IL=120mA	5.8	6.1	6.6	V

Parameter	Sym -bol	Test Cir- cuit	Test Conditon		Min,.	Typ.	Max.	Unit
Line Voltage Rise up Amount	ΔV_L	2	IL=20mA		1.1	1.5	2.1	V
Transmit Gain	G_T	4	IL=20mA	f = 1KHz	43	46	48	dB
			IL=120mA	V_{in} = –55dBV	40	43.2	45	dB
Receiving Gain	G_R	5	IL=20mA	f = 1KHz	40	43.5	46	dB
			IL=120mA	V_{in} = –55dBV	34.5	38	40.5	dB
MF Gain	G_{MF}	6	IL=20mA	f = 1KHz	24	26.8	28	dB
			IL=120mA	V_{in} = –30dBV	21.5	24	25.5	dB
Beep Gain	G_{BP}	8	IL=20mA	f = 1KHz	21	24	27	dB
			IL=120mA	V_{in} = –30dBV	21.5	24.5	27.5	dB
Transmit Dynamic Range	D_{RT}	4	IL=20mA	Distortion	2.0	—	—	$V_{p.p}$
			IL=120mA	Ratio 4%	4.0	—	—	$V_{p.p}$
Receiving Dynamic Range	D_{RR}	5	IL=20mA	Distortion	3.0	—	—	$V_{p.p}$
			IL=120mA	Ratio 10%	6.0	—	—	$V_{p.p}$
MFI Input Resistance	ZI(MF)	—			21	30	—	kΩ
BTI Input Resistance	ZI(BP)	—			7	10	—	kΩ
AC BIAS Input Resistance	ZI(AB)	—			21	30	—	kΩ
MUTE Terminal High Level Input Voltage	V_{IH}(MU)	—	IL=20mA-120mA		V_{CC} - 0.5	—	V_{CC}	V
MUTE Terminal Low Level Input Voltage	V_{IL}(MU)	—	IL=20mA-120mA		0	—	0.2	V

Reference data

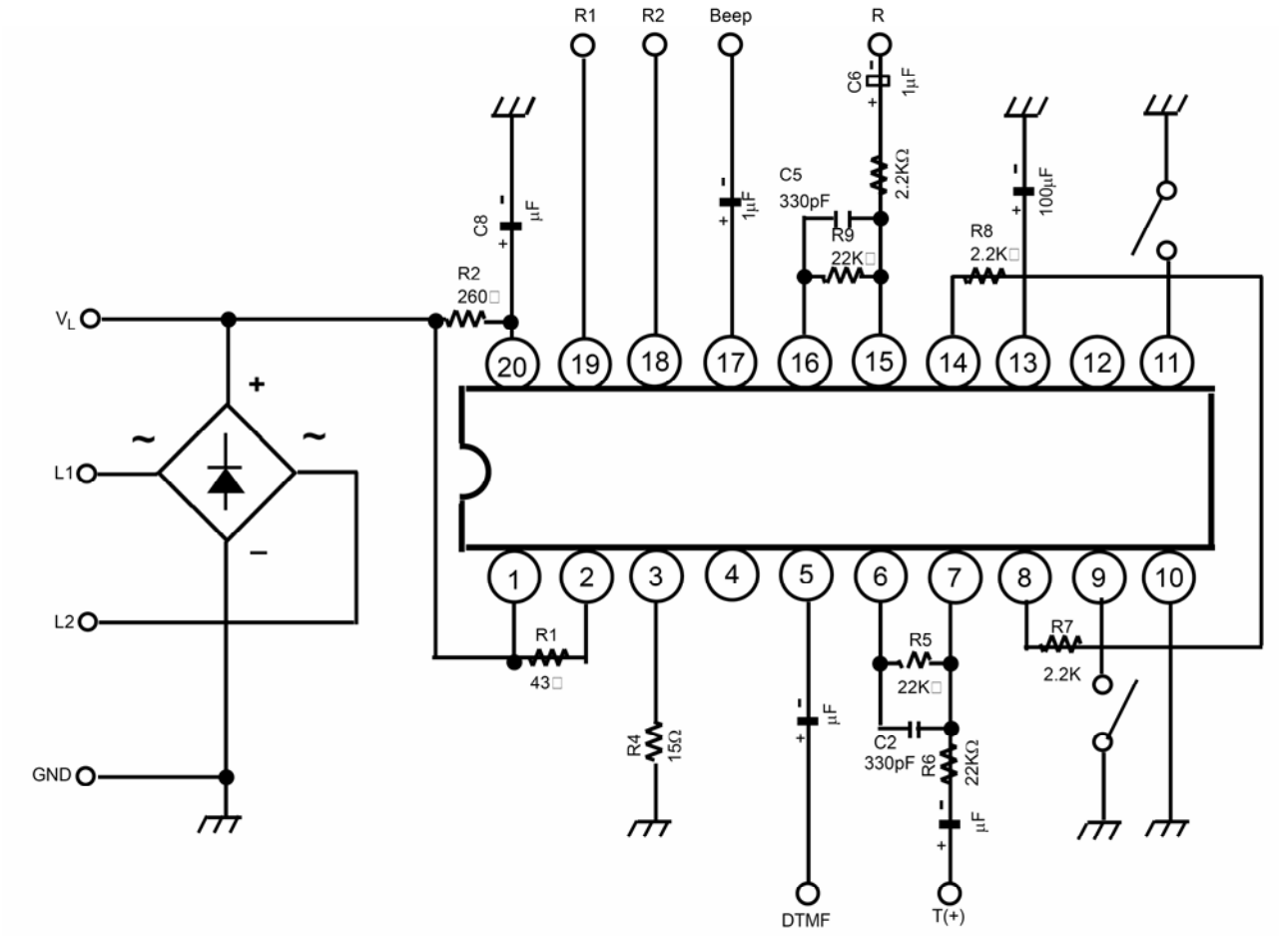
Parameter	Symbol	Test Cir- cuit	Test Condition		Typ	Unit
Internal Reference Voltage	V_{REF}	3	IL=20mA		0.66	V
			IL=120mA		2.8	V
RO1, RO2 Output Impedance	Z_{RO}	—	IL=30mA f=1KHz		200	□
Total Receiving Gain	G_R (Total)	11	IL=20mA	(Balancing Network	14.5	dB
			IL=120mA	circuit included.)	9.0	dB
MUTE Terminal Input Current	I_{IL}(MU)	9	IL=20mA V_{IL}=0.2V		-50	μA
UP Terminal Input Current	I_{IL}(MP)	10	IL=20mA at GND connection		-35	μA
AC Impedance	|Z|TEL	—	IL=50mA f=1KHZ		580	□
Phase	θ	—	IL=50mA f=1KHZ		3	DEG

Pin Descriptions

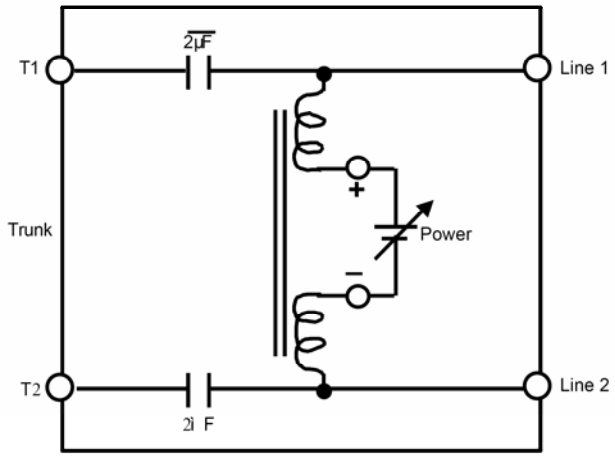
Pin No.	Symbol	Function	Explanation
1	VL	Line Current flow-in and Line Voltage terminal	Connected to positive output of diode bridge circuit. DC potential of this terminal determines line voltage and if AC signal is not input, the highest DC potential appears. Transmit output signal and output signal of opposite transfer side are intermingled and output at this terminal in actual use.
2	TOI	Current flow-in terminal of transmit output	Connected to VL terminal (① pin) through 43 Ω . Since almost all the line currents flow in from this terminal, set allowable power of resistance 43 Ω to be connected to VL terminal from this terminal considering the maximum line cur-rent expected to be used.
3	TOO	Current output terminal of transmit output	Connected to GND terminal (⑩ pin) through 15 Ω . Since almost all the line currents flow out from this terminal, set allowable power of resistance 15 Ω to be connected to GND terminal from this terminal considering the maximum line cur-rent expected to be used. Transmit signal is sent from this terminal. Signal of this ter-minal varies current which is input from line through con-nected resistance 15 Ω , and makes it be output at VL terminal (① pin)
4	AC Bias	AC signal reference Voltage terminal	When AC signal is input to this terminal through capacitor (for blocking DC), signal is sent to line, Input from this ter-minal is output to line without any relation to gain control (PAD) or MUTE since this input does not pass through gain control circuit or MUTE function
5	MFI	Input terminal of DTMF or external input signal	Signal which is input to this terminal is output at VL terminal (① pin) only when MUTE terminal (⑨ pin) is in "L" state. Since this terminal is biased to almost the same potential as REF terminal (⑬ pin), avoid direct impressing external DC potential by using capacitor at inputting external terminal.
6	TPO	Output terminal of transmit input Amp.	Makes negative feedback to TPI1 terminal (⑦ pin)
7	TPI1	Inversion input terminal of transmit input Amp.	Receives negative feedback from TPO terminal (⑥ pin)
8	TPI2	Non-inversion input terminal of transmit input Amp.	Applies DC bias to this terminal from REF terminal (⑬ pin) through resistance

Pin No.	Symbol	Function	Explanation
9	MUTE	MUTE terminal	Switching terminal of transmit signal with MFI input signal in transmitting system. Switching terminal of receiving signal with BTI input signal in receiving system. "L" State—Signal which is input from MFI is output to VL terminal (① pin) Signal which is input from BTI is output to terminals RO1 and RO2. "H" or " OPEN" state Transmitting input signal is output to VL terminal (① pin). Receiving input signal is output to terminals RO1 and RO2(⑲ pin⑱ pin) This terminal is pulled up by constant-current circuit
10	GND	Ground terminal	Connected to negative output of diode bridge circuit.
11	UP	DC impedance control terminal	When this terminal is connected to GND terminal(⑩ pin) directly or through resistance. DC potential of VL terminal (① pin) can be in-creased up to max. 1.5V (TYP.) in the same line current. This function has no relation to the state of MUTE terminal.
12	PADC	Pad control terminal	When this terminal is connected to GND terminal(⑩ pin) or V_{CC} terminal (⑳ pin) through resistance, operation current of gain control (Auto-PAD) performed by line current can be controlled.
13	REF	Internal reference voltage Output terminal	Voltage of this terminal is used as a reference voltage of internal amplifiers. Never used this terminal for an external power supply.
14	RPI2	Non-inversion input terminal of receiving Input Amp.	Apply DC bias to this terminal from REF terminal (⑬ pin) through resistance.
15	RPI1	Inversion Input terminal of receiving input Amp.	Receives negative feedback from RPO terminal (⑯ pin).
16	RPO	Output terminal of Receiving input Amp.	Makes negative feedback to RPI1 terminal(⑮ pin).
17	BTI	Dial confirmation sound (Beep Tone, DTMF), monitor sound input terminal	Signal which is input to this terminal is output to terminals RO1 and RO2 (⑲ pin and⑱ pin) only when MUTE terminal (⑨ pin) is in "L" state. Since this terminal is biased to about the same potentialas REF terminal (③ pin), avoid direct impressing external DC voltage through capacitor at in-putting external signal
18	RO2	Receiving output terminal Inversion output	Output terminal to receiver. Signal of which phase is negative to RO1 terminal (⑲ pin), is output.
19	RO1	Receiving output terminal Non-inversion output	Output terminal to receiver, Signal of which phase is negative to RO2 terminal (⑱ pin), is output
20	V_{CC}	Internal power supply voltage terminal	Power supply of internal amplifiers

Test Circuit

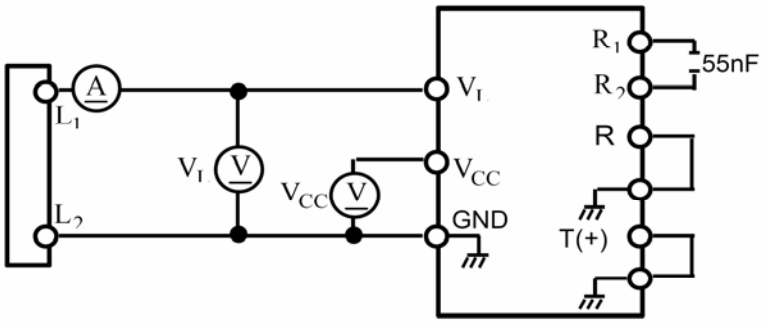


Telephone line Simulation Equivalent circuit

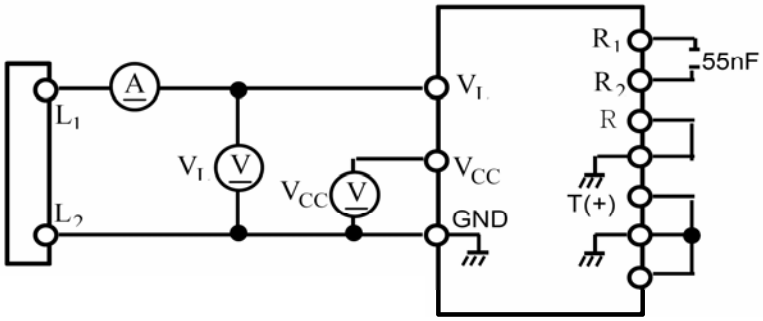


Test Circuit (continued)

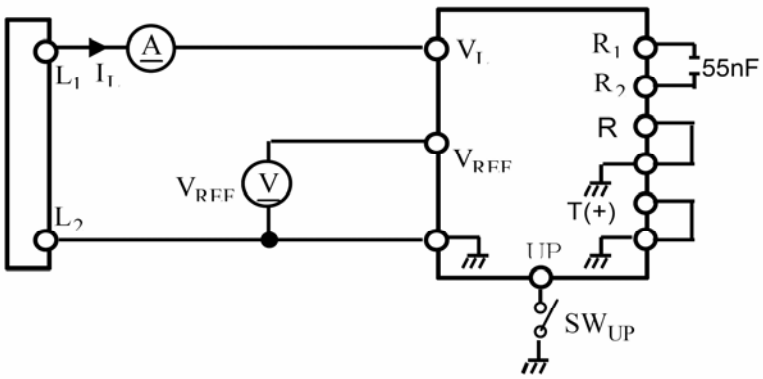
1. V_L, V_{CC}



2. V_L, V_{CC} (UP)

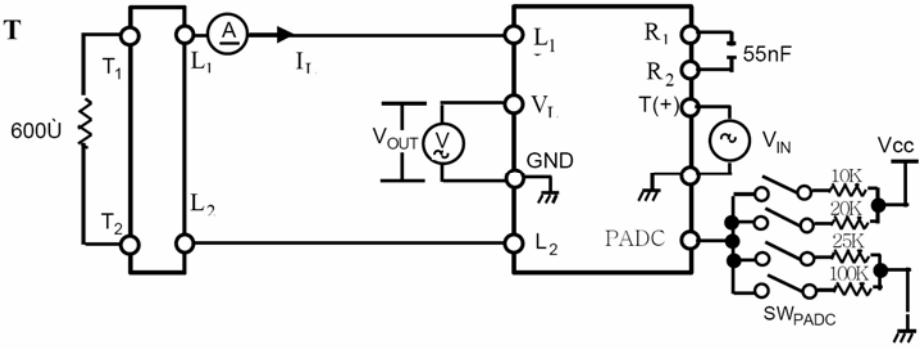


3. V_{REF}



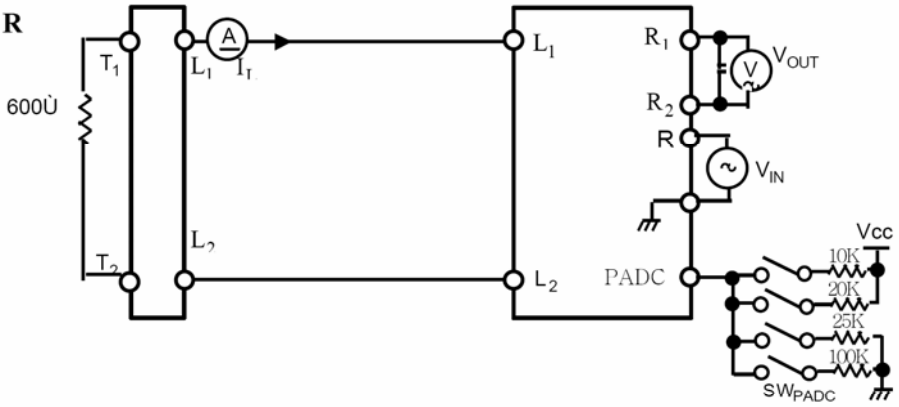
Test Circuit (continued)

4. G_T, DR_T



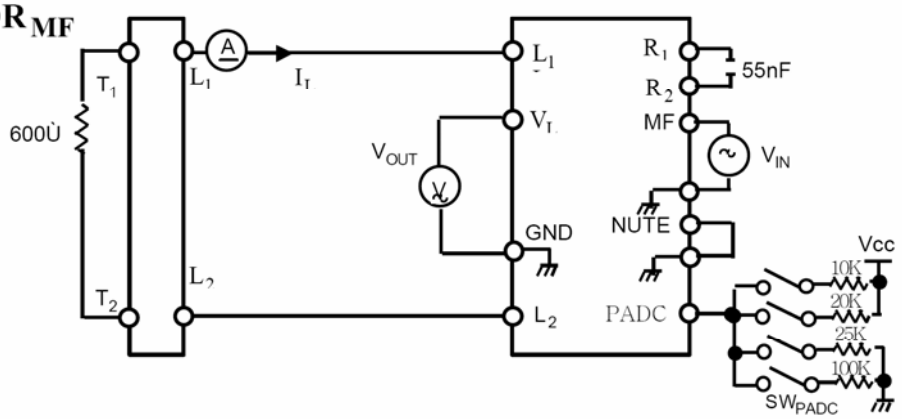
- Transmit Gain, $G_T = 20\log|V_{OUT}/V_{IN}|$ (dB)
- Transmit Dynamic Range: $DR_T = V_{OUT}$ (Vp-p)
  at V_{OUT} : DIST= 4%

5. G_R, DR_R



- Receiving Gain, $G_R = 20\log|V_{OUT}/V_{IN}|$ (dB)
- Receiving Dynamic Range: $DR_R = V_{OUT}$ (Vp-p)
  at V_{OUT} : DIST= 10%

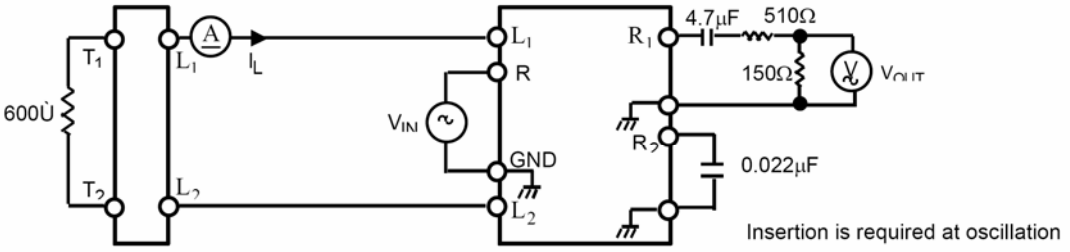
6. G_{MF}, DR_{MF}



- MF Gain, $G_{MF} = 20\log|V_{OUT}/V_{IN}|$ (dB)
- MF Dynamic Range: $DR_{MF} = V_{OUT}$ (Vp-p)
  at V_{OUT} : DIST= 4%

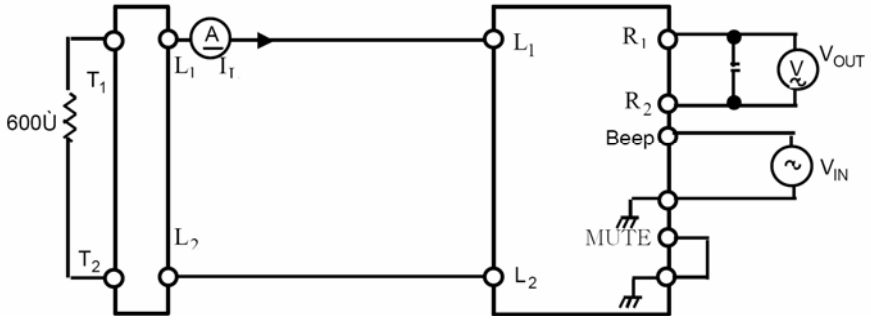
Test Circuit (continued)

7. G_R, DR_R (at R_L=150Ω; Low Impedance Type Receiver)



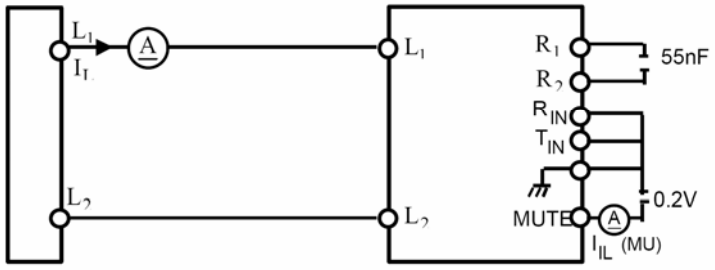
- Receiving Gain, (dB)
- Receiving Dynamic Range: -p)
  at V_{OUT} : DIST= 10%

8. G_{BP}, DR_{BP}



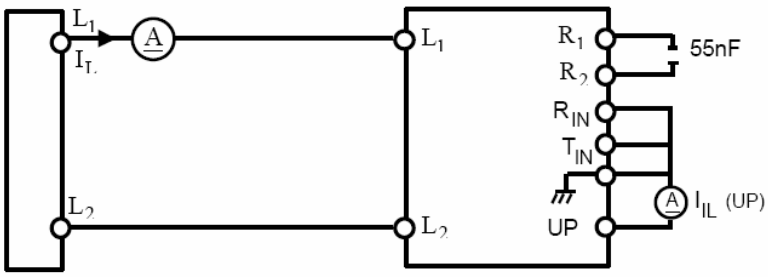
- Beep Gain, $G_{BP} = 20\log|V_{OUT}/V_{IN}|$ (dB)
- Beep Dynamic Range: $DR_{BP} = V_{OUT}$ (Vp-p)
  at V_{OUT} : DIST= 10%

9. G_{IL} (MU)

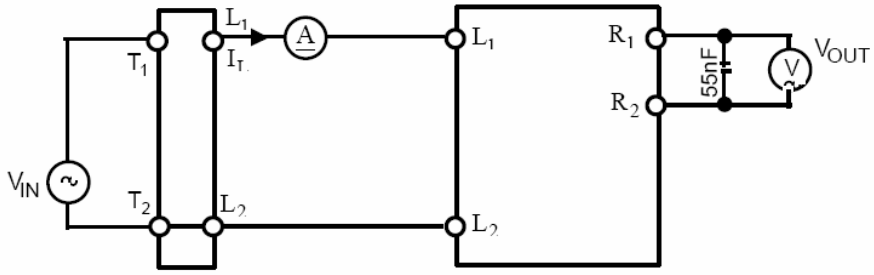


Test Circuit (continued)

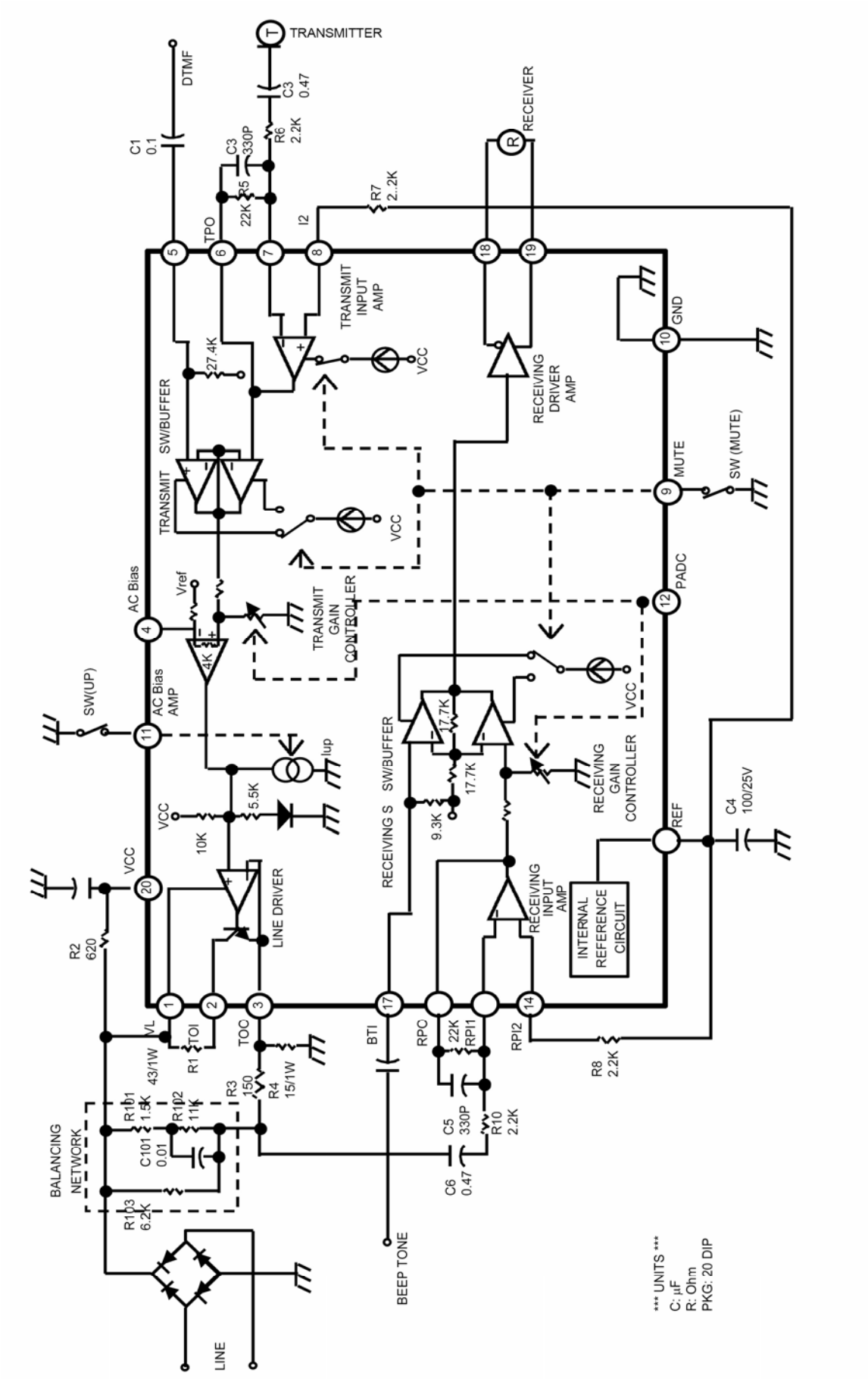
10. I_{IL} (UP)



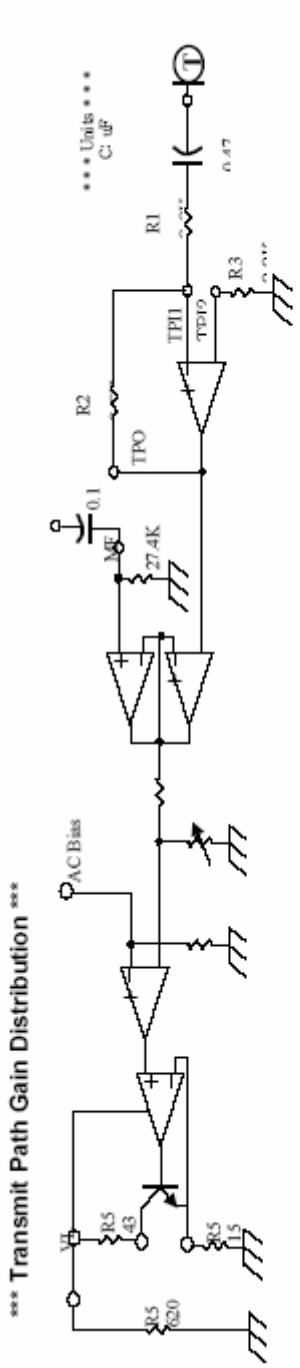
11. G_R (Total)



● Total Receiving Gain, G_R (Total) = 20log | V_{OUT} / V_{IN} | (dB)
*Balancing circuit included

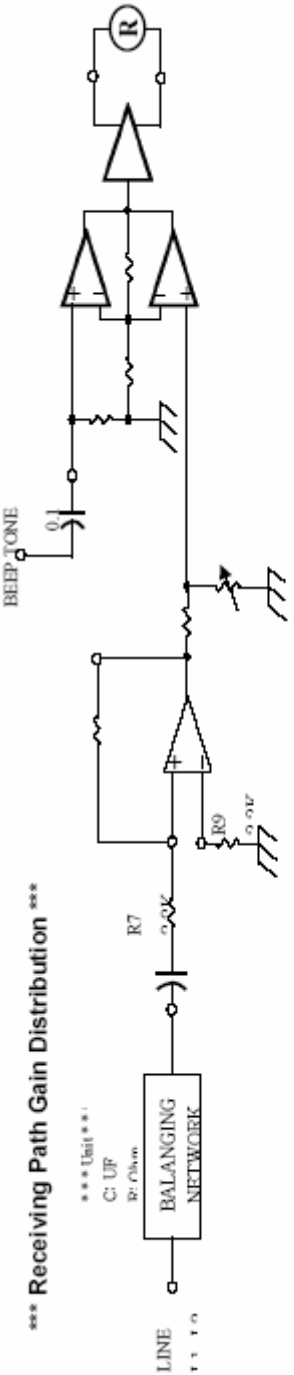

TRANSMITTER
DTMF
RECEIVER
C1 0.1
C3 330P
R6 2.2K
C3 0.47
R5 22K
R7 2.2K
TPO
I2
TRANSMIT INPUT AMP
27.4K
VCC
RECEIVING DRIVER AMP
GND
SW/BUFFER
TRANSMIT
MUTE
SW (MUTE)
AC Bias
Vref
TRANSMIT GAIN CONTROLLER
PADC
4K
AC Bias AMP
SW(UP)
Iup
17.7K
RECEIVING SW/BUFFER
RECEIVING GAIN CONTROLLER
5.5K
9.3K
REF
C4 100/25V
10K
LINE DRIVER
RECEIVING INPUT AMP
INTERNAL REFERENCE CIRCUIT
R2 620
VL
TOI
TOO
BTI
RPC
RPI1
RPI2
43/1W
R1
150
R4 15/1W
R3
22K
R8 2.2K
R101 1.5K
R102 11K
C101 0.01
C5 330P
R10 2.2K
C6 0.47
BALANCING NETWORK
R103 6.2K
BEEP TONE
LINE
*** UNITS ***
C: µF
R: Ohm
PKG: 20 DIP

Gain Distribution



	Line Drive Amp.	AC Bias Amp.	Transmit PAD	Transmit SW/Buffer	Transmit Input Amp.
IL=20mA	26 dB (At line 600 Ohm termination)	0 dB	0 dB	0 dB	20 dB (Externally Adjustable)
IL=120mA			-3 dB		

The Gain value is the one roughly determined



	Balancing Network	Receiving Input Amp.	Receiving PAD	Receiving SW/Buffer	Receiving Input Amp.
IL=20mA	- 29 dB (Externally Adjustable)	20 dB (Externally Adjustable)	0 dB	0 dB	20 dB (Externally Adjustable)
IL=120mA			-5.5 dB		

The Gain value is the one roughly determined

Description Functions

1. Line voltage increasing circuit (up)

The voltage of V_L,V_{CC} or V_{REF} can be increased by connecting UP terminal to GND directly or through the resistance.

The internal equivalent circuit is as shown in the figure.

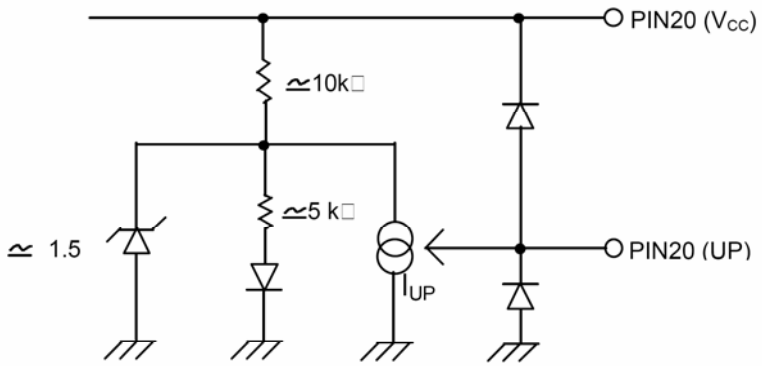
(1) The voltage increased most up to about 1.5V in V_L when UP terminal is directly connected to GND. when the resistance is inserted the voltage increases according to the resistance value. (See graph)

(2) In case of usage with MUTE terminal connected, the line voltage can be increased only at muting.

(3) Avoid impressing the voltage over V_{CC} or under GND.

(4) When not in use, make the circuit opened or connected to V_{CC}.

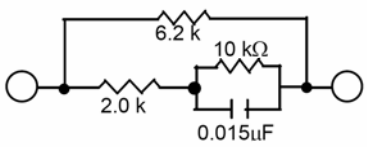
Internal equivalent circuit



2. Side tone protection circuit (Balancing circuit)

The time constant (hereafter referred to as BN constant) of the side tone protection circuit in the example of application circuit is adjusted nearly to 0.4ϕ 7dB. Since the side tone characteristic varies according to this BN time constant, adjust the time constant confirming to the function of the telephone set.

EXAMPLE OF BN TIME CONSTANT

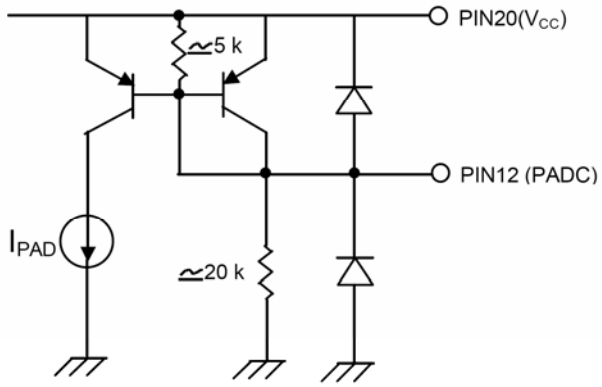


In case of 0.5 ϕ 7dB is determined to be the center.

3. Gain control circuit (PADC)

1) PADC terminal open state. Transmiting and receiving gains vary automatically according to the line current amount (Auto-PAD). With the increase of line current amount; the gain attenuates by about - 3dB at transmiting and about - 5.5dB at receiving.
2) In case PADC terminal is connected to GND by resistance. The gain begins to attenuate with the line current amount less than that when PADC terminal is open. Set the value of resistance to be connected at 25k or over.
3) In case PADC terminal is connected to VCC by resistance. The gain begins to attenuate with the line current amount more than that when PADC terminal is open.
   Set the value of resistance to be connected at 10k or over.

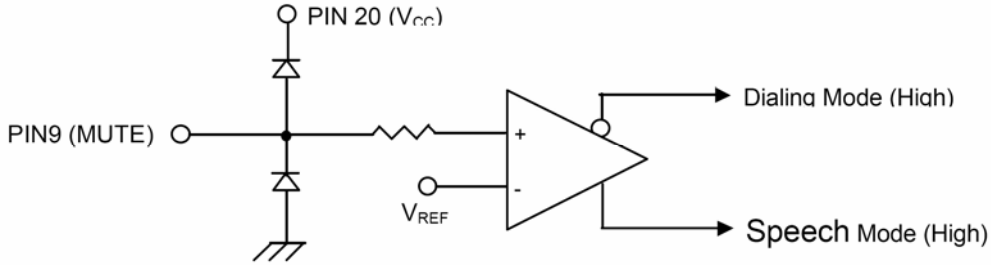
* Internal equivalent circuit.



4. MUTE circuit (MUTE)

The internal equivalent circuit in the MUTE terminal is a shown in the figure below. Since the protective diode is connected between V_{CC} and GND, avoid impressing the voltage over that of VCC or below GND.
This is most suitable for input from the output of open drain or open collector type.

* Internal equivalent circuit.



Application

1. Transmitter

As the transmitter, the condenser microphone. the ceramic type and the dynamic type (speaker type) are available. However, since and of FET or transistor built-in require the bias circuit. Externally provide the bias circuit. For example, refer to the example of the application circuit.

2. Receiver

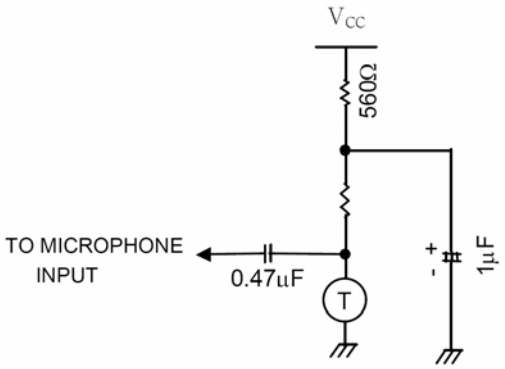
As the receiver, the ceramic type the low-impedance (dynamic type) are available.

(1) Ceramic type; The receiver of equivalent capacity of about 55nF is assumed. In case of the ceramic type, since the large voltage amplitude is generally required at driving, make the receiver function in BTL mode.

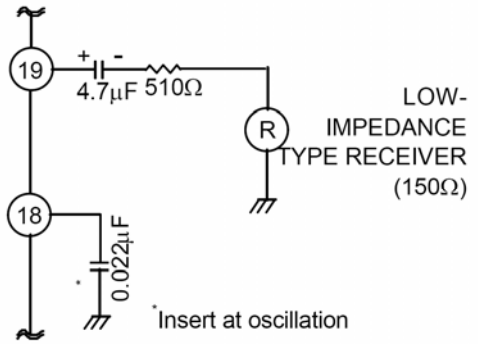
(2) Low-impedance type; The receiver of equivalent resistance of about 150 is assumed. For the connections, refer to the example of application circuit.

3. Example of Application circuit.

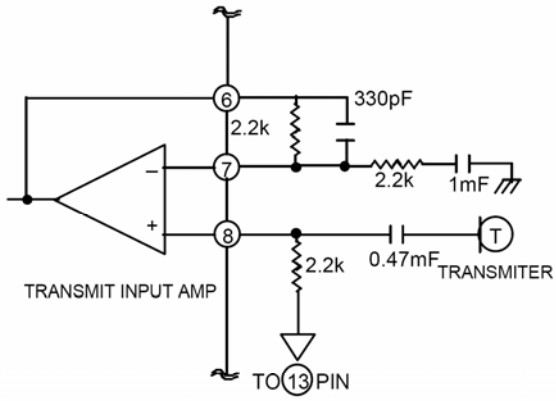
(1) EXAMPLE OF POWER SUPPLY CIRCUIT FOR CONDENSER MICROPHONE



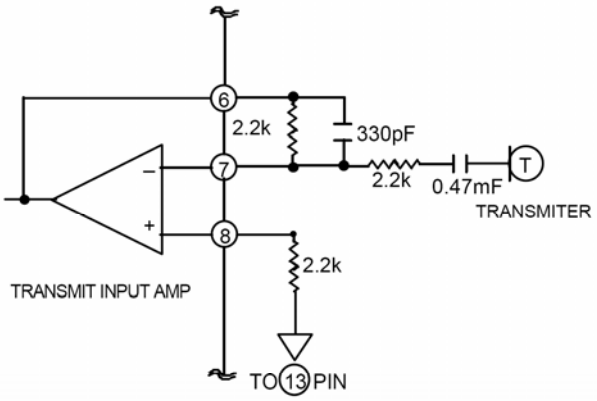
(2) EXAMPLE OF CONNECTION CIRCUIT OF LOW-IMPEDANCE TYPE RECEIVER.



(3) In case of using transmit input amplifier as non-inversion input.



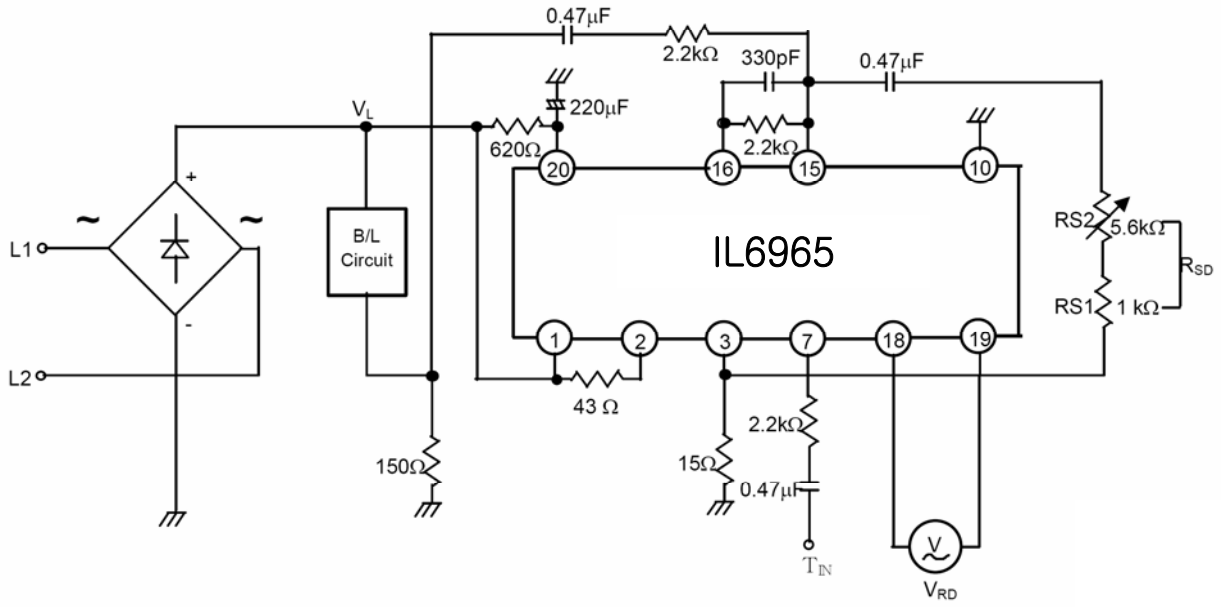
(4) In case of using transmit input amplifier as inversion input.



Note : In test circuit and application circuit, transmit input amplifier is set at inversion input.

4. Side Tone Gain Control.

(1) Alternative application for side tone gin control



- The side tone gain is externally controlled by the resistor R_{SD} (R_{S1}+R_{S2})
- The maximum available control range of side tone gain is 0dB to 14 dB.

(2) Side tone gain, G_{SD} to Resistor, R_{SD}

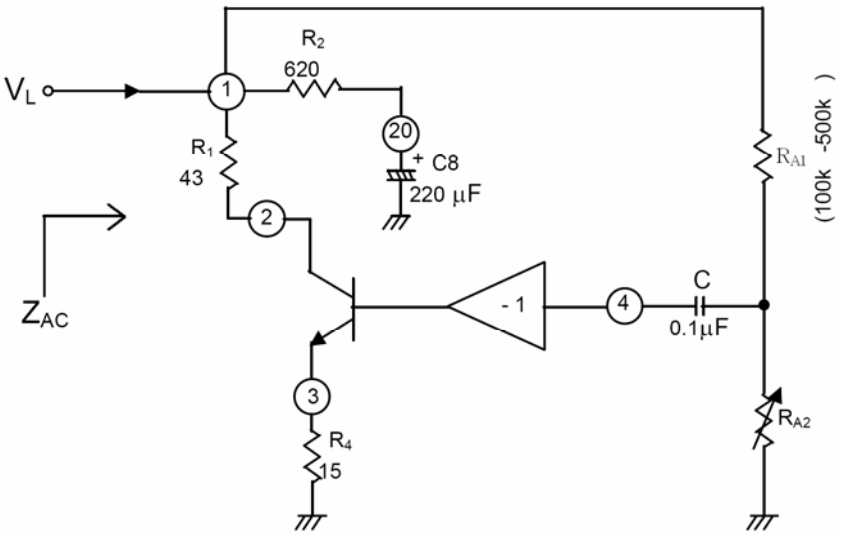
R_{SD} (R_{S1}+R_{S2})	G_{SD}
1k	14.2dB
2k	11.1dB
3k	2.5dB
3.5k	0.2dB
4k	1.6 dB
5k	5.4 dB
6k	7.5 dB

(3) The side tone gain is

$$G_{SD} = 20\log(\frac{V_{RO}}{V_L}) \quad (dB)$$

5. AC Impedance UP control.

(1) Application for AC impedance up control



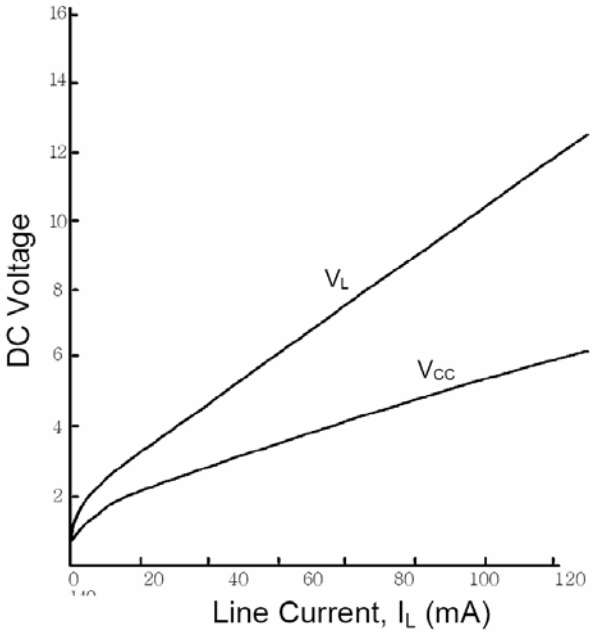
- The AC Impedance (ZAC) can be increased by using AC Bias terminal (Pin).
- The AC Impedance up amount is determined by the external resistors R_1, R_2 value. :

(2) The AC impedance is

$$Z_{AC} \fallingdotseq \frac{VL}{IL} \fallingdotseq \frac{1}{\frac{1}{R_2} \quad \frac{1}{R_4}\left(\frac{R_{A2}}{R_{A1}+R_{A2}}\right)}$$

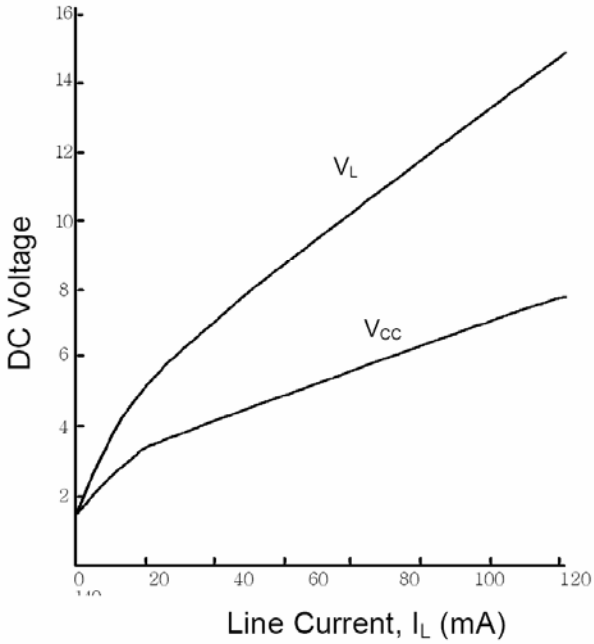
DC Characteristic (Normal)

Test Circuit 1



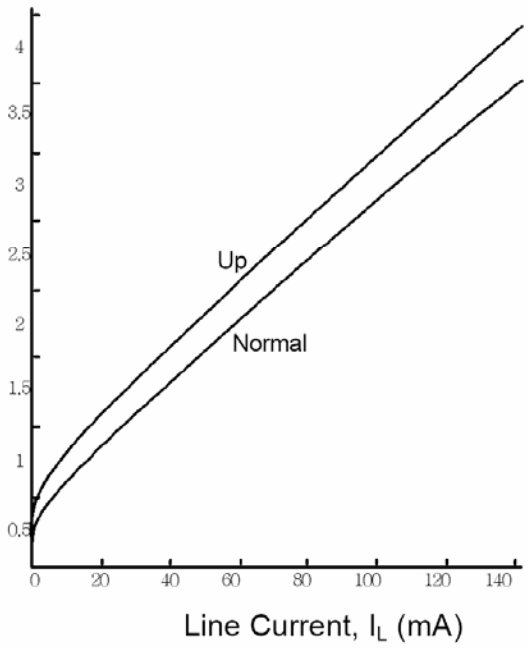
DC Characteristic (UP)

Test Circuit 2



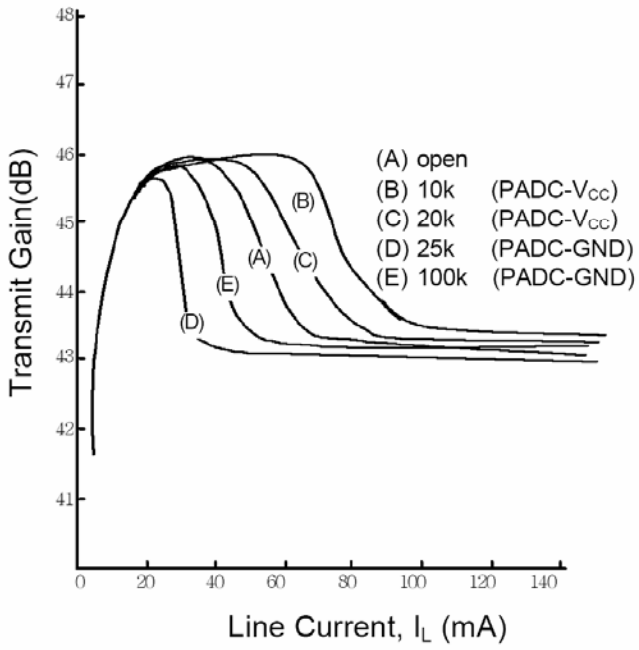
V_{REF} Voltage to Current Characteristic

Test Circuit 3

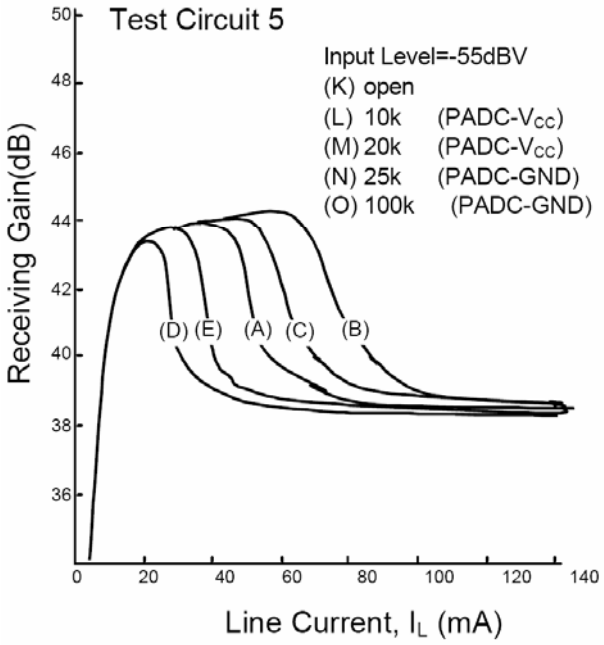


Transmit Gain to Current Characteristic

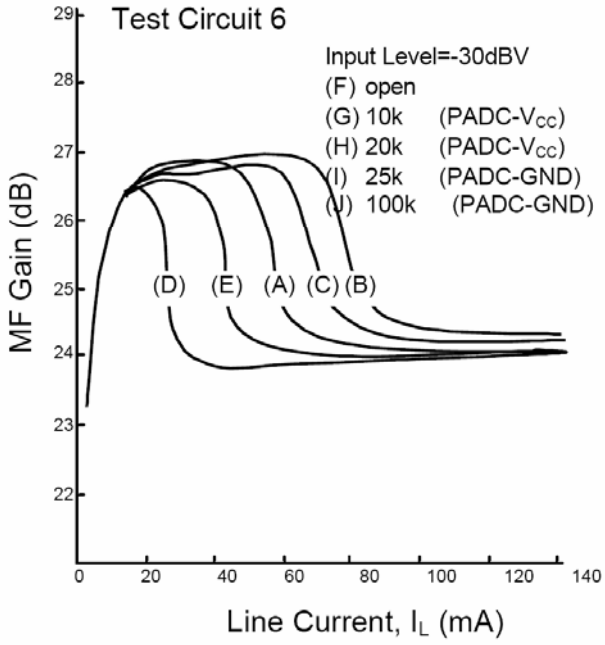
Test Circuit 4



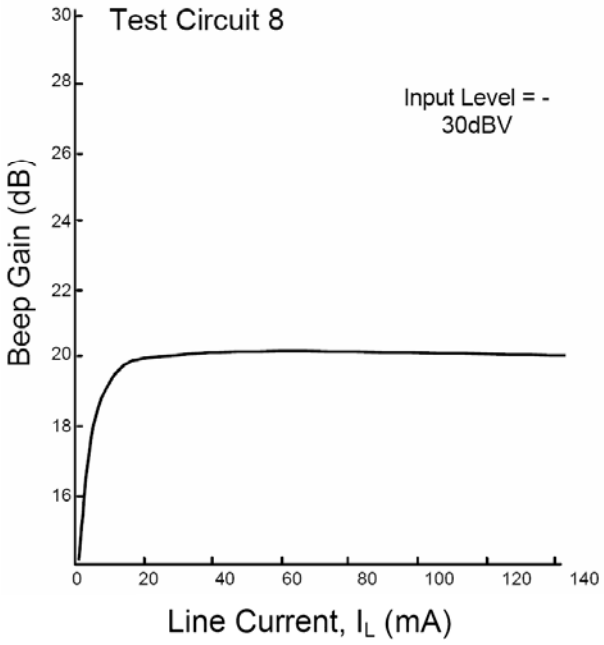
Receiving Gain to Current Characteristic
Input=pin 15, -55dBV
Output=pin 18, pin 19



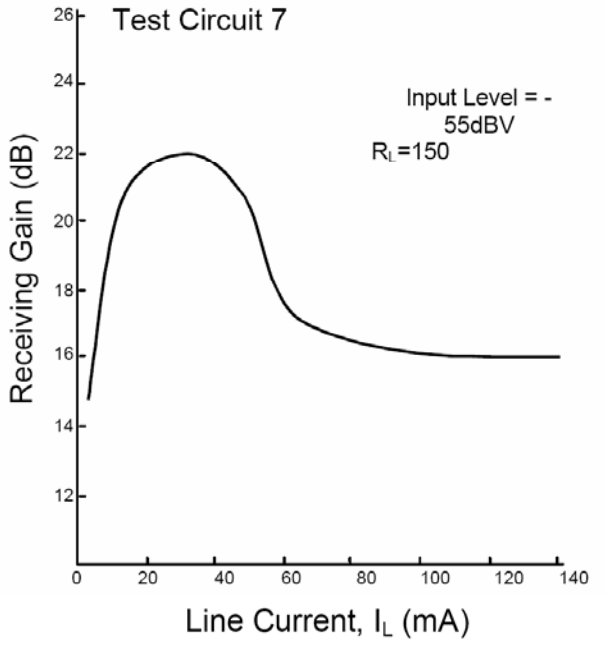
MF Gain to Current Characteristic
Input=pin 15, -30dBVrms
Output=pin 1



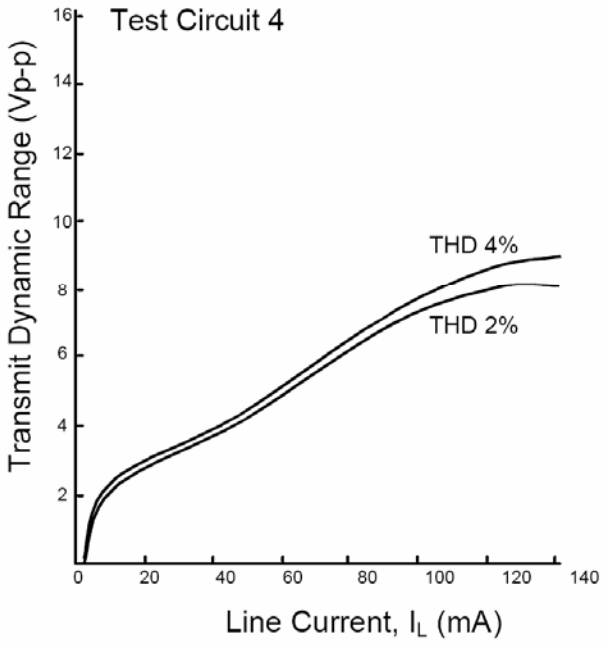
Beep Gain to Current Characteristic

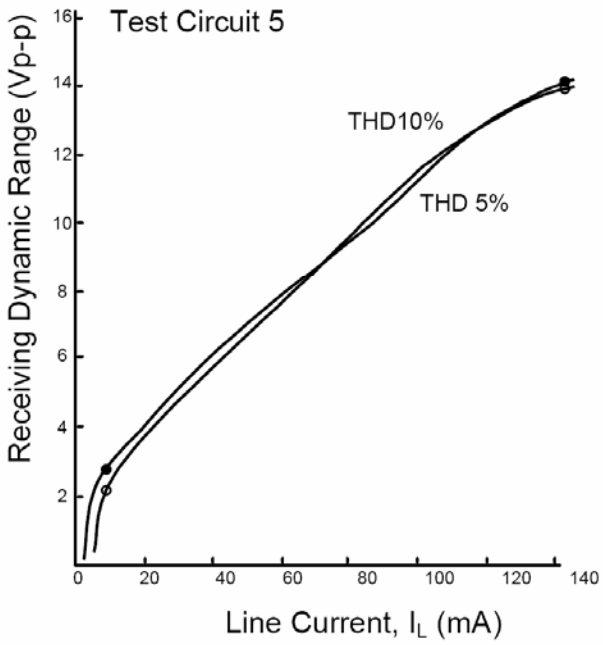


Receiving Gain to Current Characteristic
(at using Low-impedance type receiver ; $R_{L=}150$)

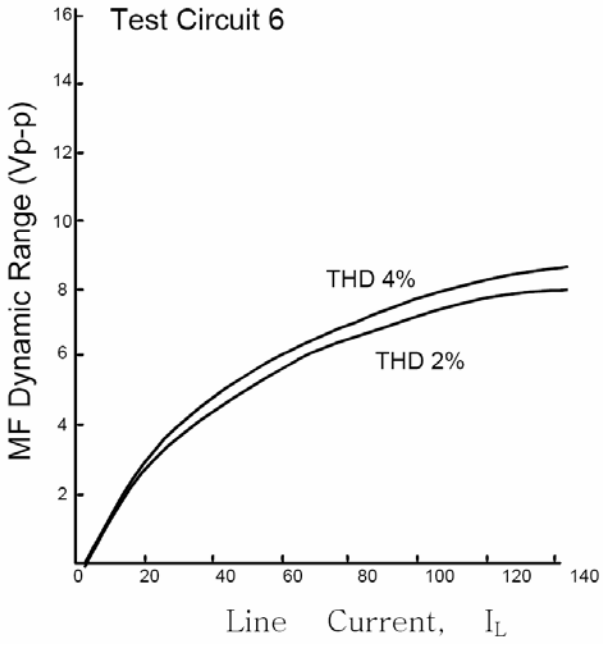


Transmit Dynamic Range to Current Characteristic Receiving Range to Current Characteristic

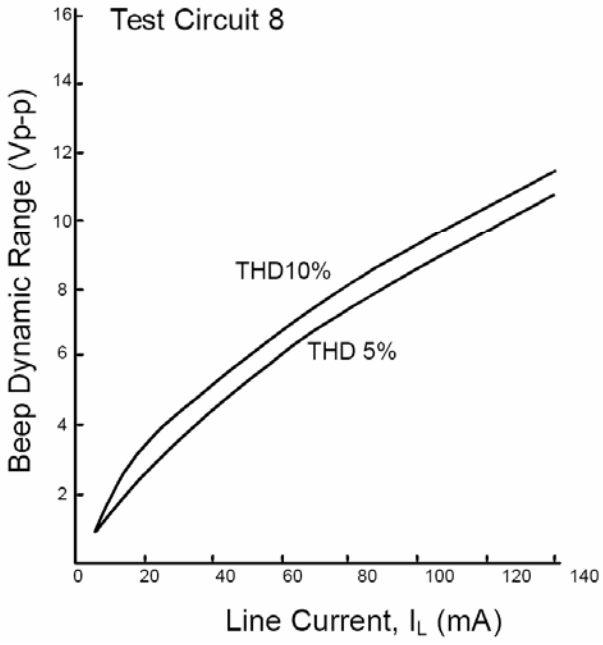




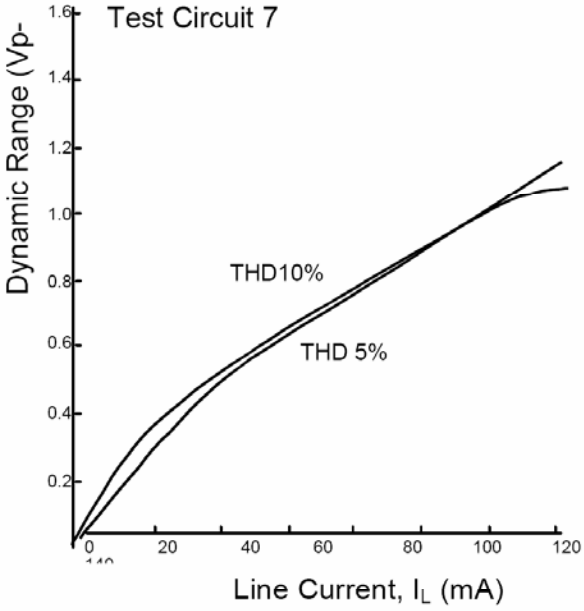
DTMF Dynamic Range to Current Characteristic



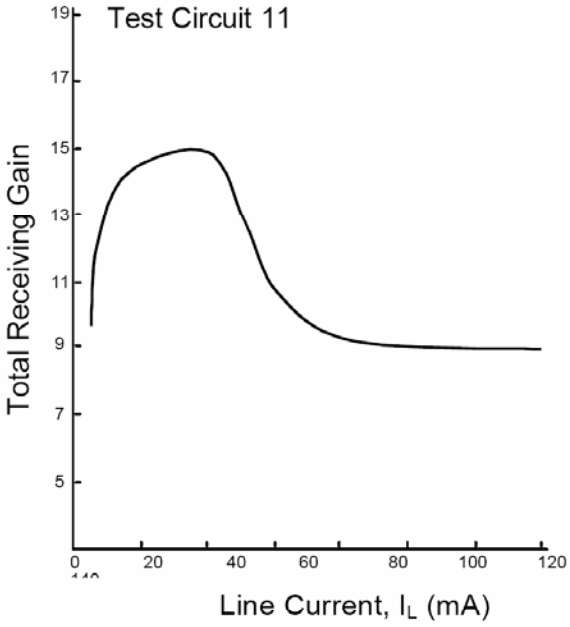
Beep Dynamic Range to Current Charcteristic



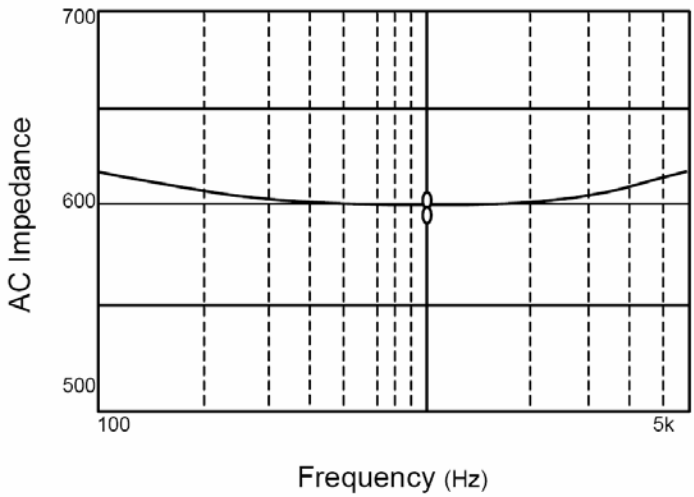
Receiving Dynamic Range to Current Characteristic At using Low-Impedance type Receiver ; R_L=150



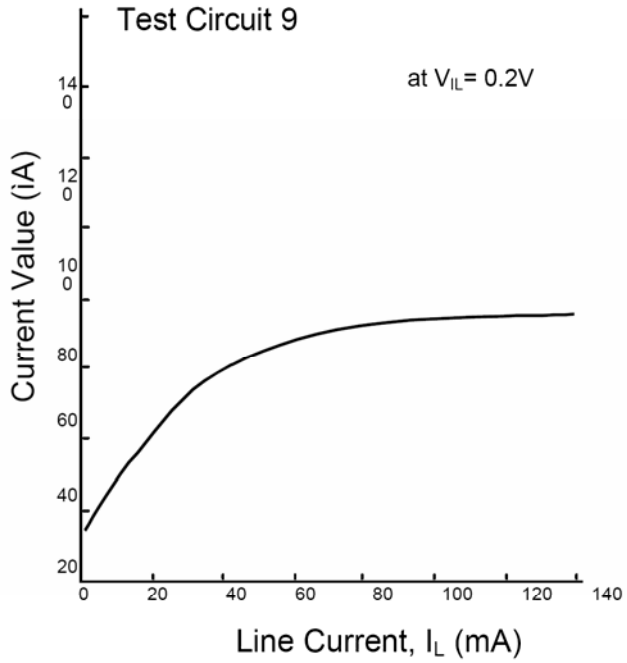
Total Receiving Gain to Current Characteristic (Balancing circuit included)



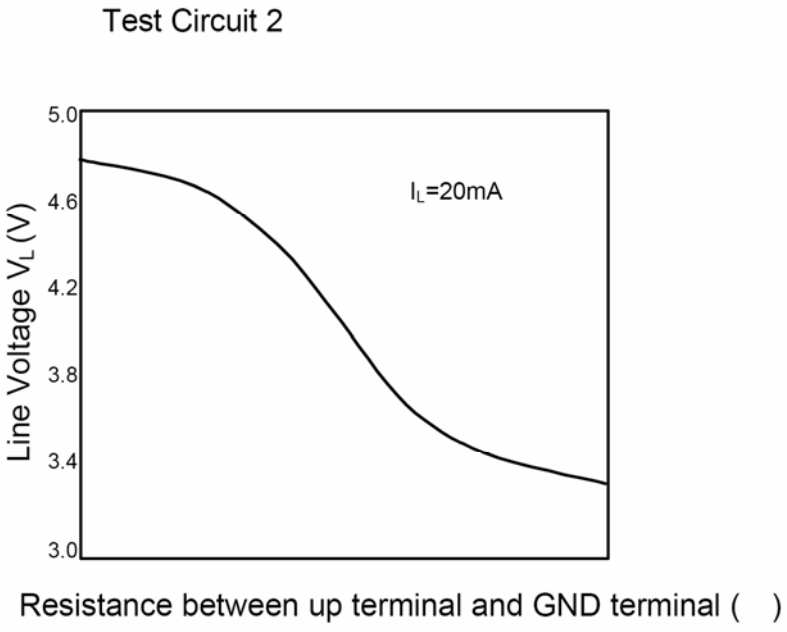
AC Impedance to Frequency Characteristic (I_L = 120 mA)



Mute Terminal pull-up current characteristic

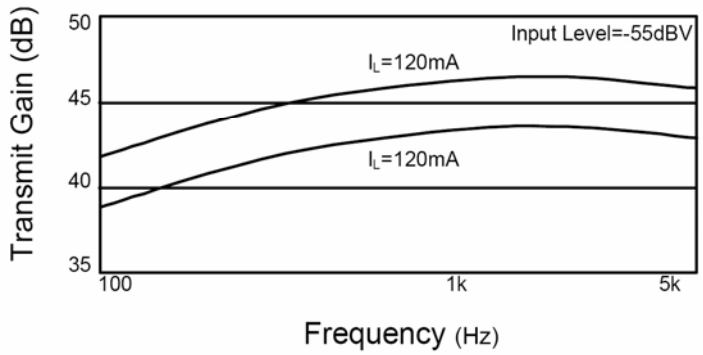


Line Voltage Rise up Characteristic



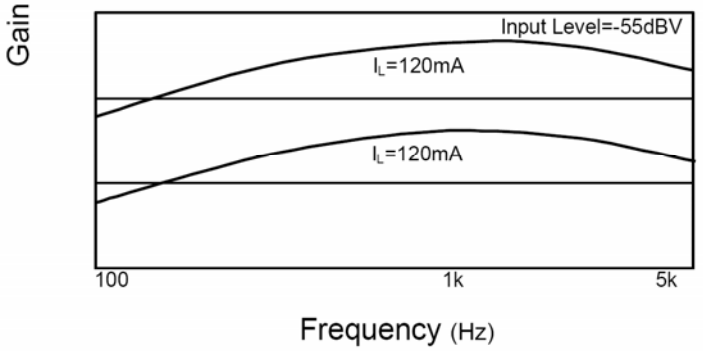
Transmit Gain to Frequency Characteristic

Test Circuit 4

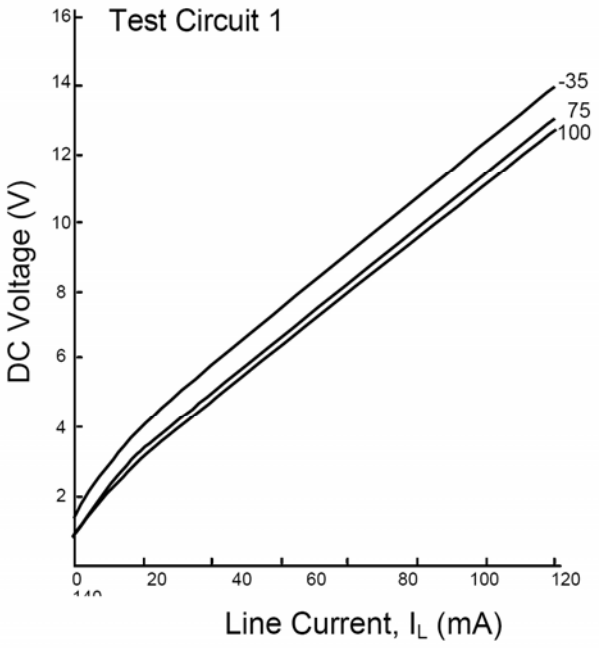


Receiving gain to Frequency Characteristic

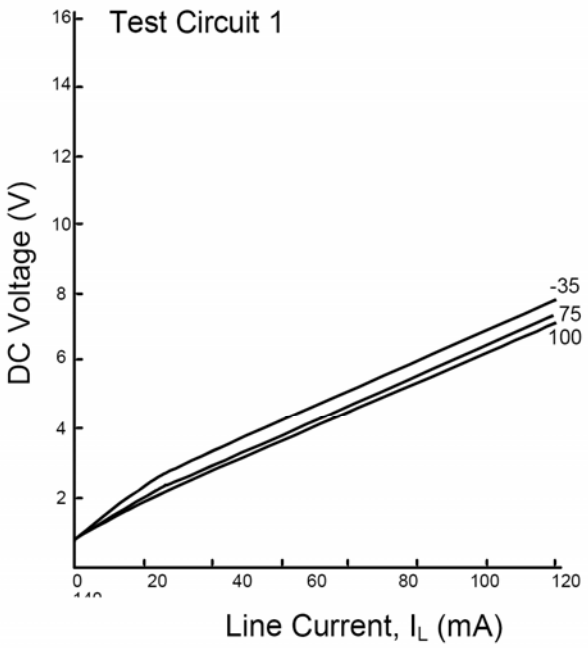
Test Circuit 5



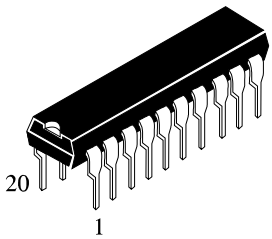
Line Voltage to Temperature Characteristic

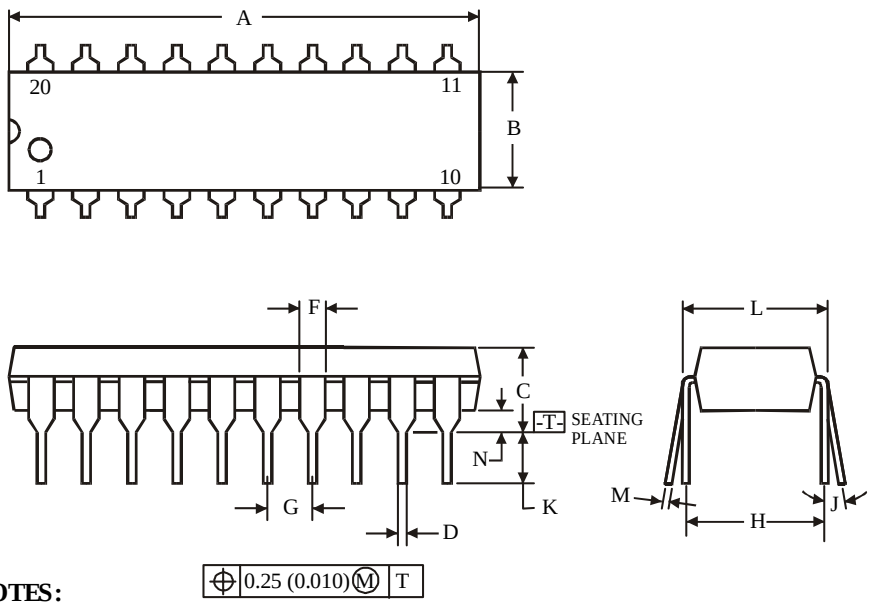


Internal Power Supply Voltage to Temperature Characteristic



N SUFFIX PLASTIC DIP
(MS - 001AD)





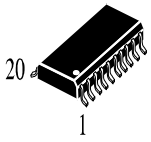
	Dimension, mm	
Symbol	**MIN**	**MAX**
A	24.89	26.92
B	6.10	7.11
C		5.33
D	0.36	0.56
F	1.14	1.78
G	2.54	
H	7.62	
J	0°	10°
K	2.92	3.81
L	7.62	8.26
M	0.20	0.36
N	0.38	

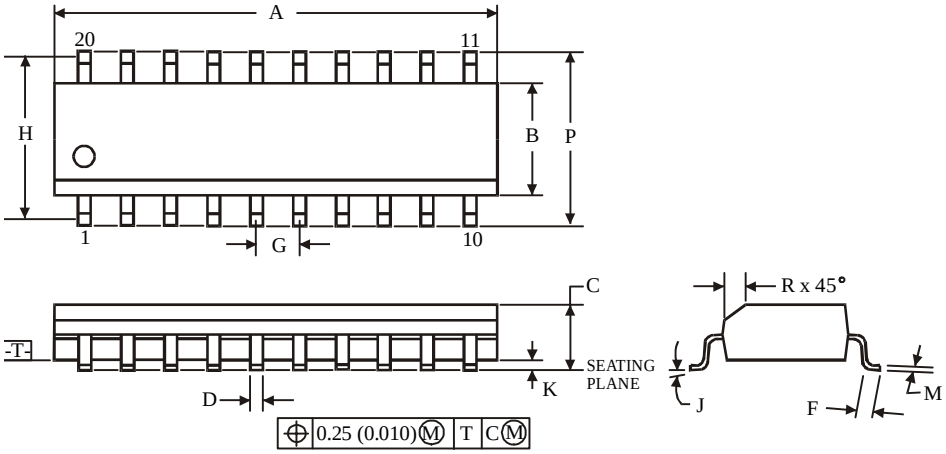
NOTES:

1. Dimensions “A”, “B” do not include mold flash or protrusions.

   Maximum mold flash or protrusions 0.25 mm (0.010) per side.

D SUFFIX SOIC
(MS - 013AC)





	Dimension, mm	
Symbol	**MIN**	**MAX**
A	12.60	13.00
B	7.40	7.60
C	2.35	2.65
D	0.33	0.51
F	0.40	1.27
G	1.27	
H	9.53	
J	0°	8°
K	0.10	0.30
M	0.23	0.32
P	10.00	10.65
R	0.25	0.75

NOTES:

1. Dimensions A and B do not include mold flash or protrusion.
2. Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B – 0.25 mm (0.010) per side.