

## LOW VOLTAGE VERSATILE TELEPHONE TRANSMISSION CIRCUIT WITH DIALLER INTERFACE

### GENERAL DESCRIPTION

The TEA1067 is a bipolar integrated circuit performing all speech and line interface functions required in fully electronic telephone sets. It performs electronic switching between dialling and speech. The circuit is able to operate down to a DC line voltage of 1.6 V (with reduced performance) to facilitate the use of more telephone sets in parallel.

### Features

- Low DC line voltage; operates down to 1.6 V (excluding polarity guard)
- Voltage regulator with adjustable static resistance
- Provides supply with limited current for external circuitry
- Symmetrical high-impedance inputs (64 k $\Omega$ ) for dynamic, magnetic or piezoelectric microphones
- Asymmetrical high-impedance input (32 k $\Omega$ ) for electret microphone
- DTMF signal input with confidence tone
- Mute input for pulse or DTMF dialling
- Power down input for pulse dial or register recall
- Receiving amplifier for magnetic, dynamic or piezoelectric earpieces
- Large gain setting range on microphone and earpiece amplifiers
- Line current dependent line loss compensation facility for microphone and earpiece amplifiers
- Gain control adaptable to exchange supply
- DC line voltage adjustment capability

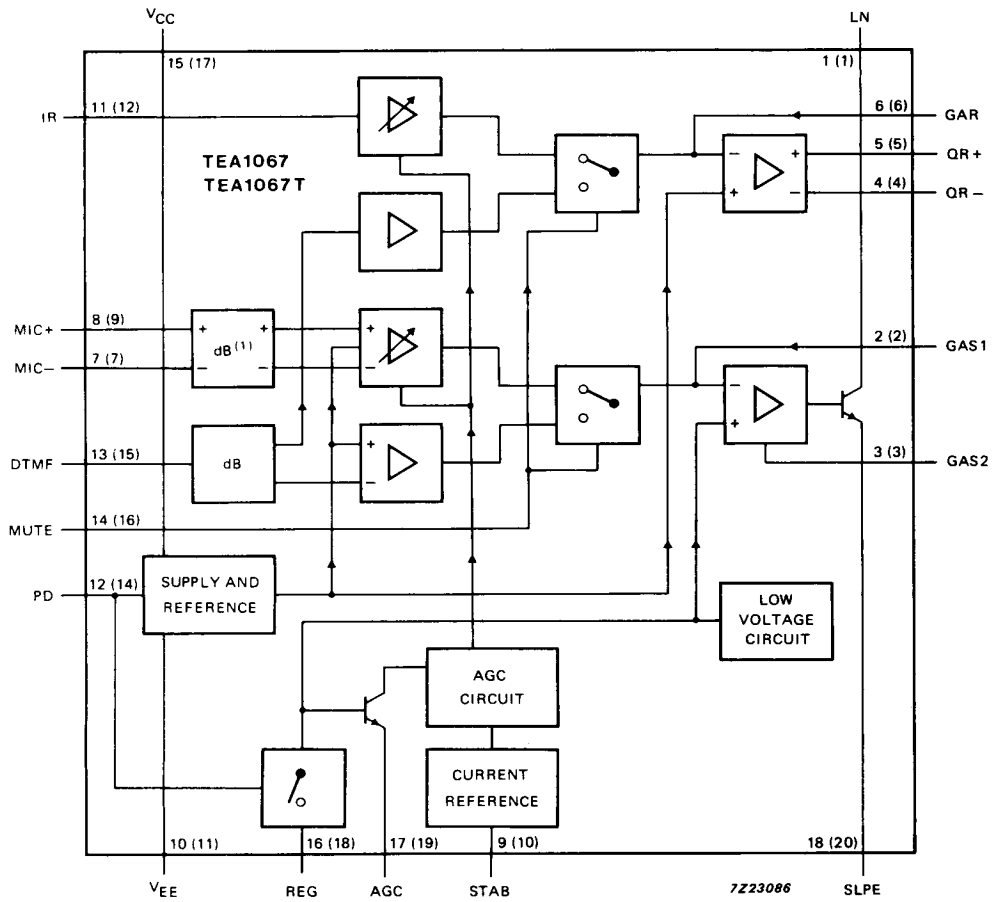
### QUICK REFERENCE DATA

parameter	conditions	symbol	min.	typ.	max.	unit
Line voltage	$I_{line} = 15 \text{ mA}$	$V_{LN}$	3.65	3.9	4.15	V
Line current operating range	normal operation					
	TEA1067	$I_{line}$	11	—	140	mA
	TEA1067T	$I_{line}$	11	—	140	mA
Internal supply current	with reduced performance	$I_{line}$	1	—	11	mA
	power down					
	input LOW	$I_{CC}$	—	1	1.35	mA
	input HIGH	$I_{CC}$	—	55	82	$\mu\text{A}$
Supply voltage for peripherals	$I_{line} = 15 \text{ mA}; I_p = 1.4 \text{ mA};$ mute input HIGH	$V_{CC}$	2.2	2.4	—	V
	$I_{line} = 15 \text{ mA}; I_p = 0.9 \text{ mA};$ mute input HIGH	$V_{CC}$	2.5	—	—	V
Voltage gain range						
microphone amplifier		$G_v$	44	—	52	dB
receiving amplifier		$G_v$	20	—	45	dB
Line loss compensation						
gain control range		$\Delta G_v$	5.5	5.9	6.3	dB
Exchange supply voltage range		$V_{exch}$	36	—	60	V
Exchange feeding bridge						
resistance range		$R_{exch}$	0.4	—	1	k $\Omega$

### PACKAGE OUTLINES

TEA1067: 18-lead DIL; plastic (SOT102).

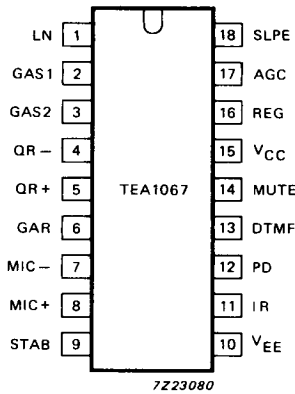
TEA1067T: 20-lead mini-pack; plastic (SO20; SOT163A).



Figures in parenthesis refer to TEA1067T.

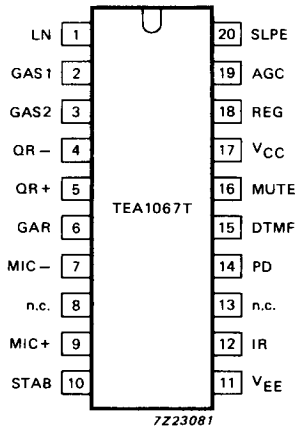
Fig. 1 Block diagram.

**PINNING**



- 1 LN positive line terminal
- 2 GAS1 gain adjustment; transmitting amplifier
- 3 GAS2 gain adjustment; transmitting amplifier
- 4 QR- inverting output; receiving amplifier
- 5 QR+ non-inverting output receiving amplifier
- 6 GAR gain adjustment; receiving amplifier
- 7 MIC- inverting microphone input
- 8 MIC+ non-inverting microphone input
- 9 STAB current stabilizer
- 10 V<sub>EE</sub> negative line terminal
- 11 IR receiving amplifier input
- 12 PD power-down input
- 13 DTMF dual-tone multi-frequency input
- 14 MUTE mute input
- 15 V<sub>CC</sub> positive supply decoupling
- 16 REG voltage regulator decoupling
- 17 AGC automatic gain control input
- 18 SLPE slope (DC resistance) adjustment

Fig. 2 (a) Pinning diagram for TEA1067 18-lead DIL version.



- 1 LN positive line terminal
- 2 GAS1 gain adjustment; transmitting amplifier
- 3 GAS2 gain adjustment; transmitting amplifier
- 4 QR- inverting output; receiving amplifier
- 5 QR+ non-inverting output receiving amplifier
- 6 GAR gain adjustment, receiving amplifier
- 7 MIC- inverting microphone input
- 8 n.c. not connected
- 9 MIC+ non-inverting microphone input
- 10 STAB current stabilizer
- 11 V<sub>EE</sub> negative line terminal
- 12 IR receiving amplifier input
- 13 n.c. not connected
- 14 PD power-down input
- 15 DTMF dual-tone multi-frequency input
- 16 MUTE mute input
- 17 V<sub>CC</sub> positive supply decoupling
- 18 REG voltage regulator decoupling
- 19 AGC automatic gain control input
- 20 SLPE slope (DC resistance) adjustment

Fig. 2 (b) Pinning diagram for TEA1067T 20-lead mini-pack version.

## FUNCTIONAL DESCRIPTION

**Supply: V<sub>CC</sub>, LN, SLPE, REG and STAB**

Power for the TEA1067 and its peripheral circuits is usually obtained from the telephone line. The IC develops its own supply at V<sub>CC</sub> and regulates its voltage drop. The supply voltage V<sub>CC</sub> may also be used to supply external circuits e.g. dialling and control circuits.

Decoupling of the supply voltage is performed by a capacitor between V<sub>CC</sub> and V<sub>EE</sub> while the internal voltage regulator is decoupled by a capacitor between REG and V<sub>EE</sub>.

The DC current drawn by the device will vary in accordance with varying values of the exchange voltage (V<sub>exch</sub>), the feeding bridge resistance, (R<sub>exch</sub>) and the DC resistance of the telephone line (R<sub>line</sub>).

The TEA1067 has an internal current stabilizer working at a level determined by a 3.6 kΩ resistor connected between STAB and V<sub>EE</sub> (see Fig. 6). When the line current (I<sub>line</sub>) is more than 0.5 mA greater than the sum of the IC supply current (I<sub>CC</sub>) and the current drawn by the peripheral circuitry connected to V<sub>CC</sub> (I<sub>p</sub>) the excess current is shunted to V<sub>EE</sub> via LN.

The regulated voltage on the line terminal (V<sub>LN</sub>) can be calculated as:

$$V_{LN} = V_{ref} + I_{SLPE} \times R_9; \text{ or } V_{LN} = V_{ref} + [(I_{line} - I_{CC} - 0.5 \times 10^{-3} \text{ A}) - I_p] \times R_9$$

Where V<sub>ref</sub> is an internally generated temperature compensated reference voltage of 3.6 V and R<sub>9</sub> is an external resistor connected between SLPE and V<sub>EE</sub>. In normal use the value of R<sub>9</sub> would be 20 Ω. Changing the value of R<sub>9</sub> will also affect microphone gain, DTMF gain, gain control characteristics, side-tone level and maximum output swing on LN, and the DC characteristics (especially at the lower voltages).

Under normal conditions, when I<sub>SLPE</sub> ≥ I<sub>CC</sub> + 0.5 mA + I<sub>p</sub>, the static behaviour of the circuit is that of a 3.6 V regulator diode with an internal resistance equal to that of R<sub>9</sub>. In the audio frequency range the dynamic impedance is largely determined by R<sub>1</sub>. Fig. 3 shows the equivalent impedance of the circuit.

At line currents below 9 mA the internal reference voltage is automatically adjusted to a lower value (typically 1.6 V at 1 mA). This means that the operation of more sets in parallel is possible with DC line voltages (excluding the polarity guard) down to an absolute minimum voltage of 1.6 V. With line currents below 9 mA the circuit has limited sending and receiving levels. The internal reference voltage can be adjusted by means of an external resistor (R<sub>VA</sub>). This resistor connected between LN and REG will decrease the internal reference voltage, connected between REG and SLPE it will increase the internal reference voltage.

Current (I<sub>p</sub>) available from V<sub>CC</sub> for peripheral circuits depends on the external components used. Fig. 9 shows this current for V<sub>CC</sub> > 2.2 V. If MUTE is LOW when the receiving amplifier is driven the available current is further reduced. Current availability can be increased by connecting the supply IC (TEA1081) in parallel with R<sub>1</sub>, as shown in Fig. 16 (c), or by increasing the DC line voltage by means of an external resistor (R<sub>VA</sub>) connected between REG and SLPE.

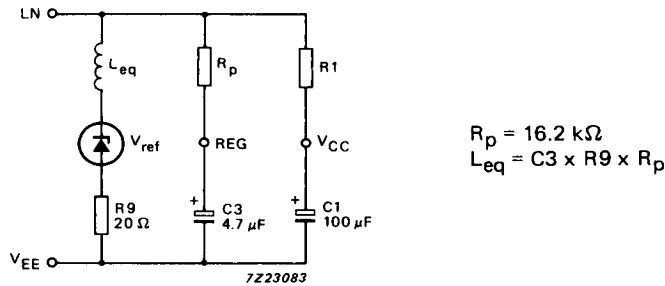


Fig. 3 Equivalent impedance circuit.

#### Microphone inputs (MIC+ and MIC-) and gain adjustment pins (GAS1 and GAS2)

The TEA1067 has symmetrical microphone inputs. Its input impedance is  $64 \text{ k}\Omega$  ( $2 \times 32 \text{ k}\Omega$ ) and its voltage gain is typically 52 dB (when  $R7 = 68 \text{ k}\Omega$ , see Fig. 13). Dynamic, magnetic, piezoelectric or electret (with built-in FET source followers) microphones can be used. Microphone arrangements are shown in Fig. 10.

The gain of the microphone amplifier can be adjusted between 44 dB and 52 dB to suit the sensitivity of the transducer in use. The gain is proportional to the value of  $R7$  which is connected between GAS1 and GAS2. Stability is ensured by the external capacitor  $C6$  which is connected between GAS1 and SLPE. The value of  $C6$  is 100 pF but this may be increased to obtain a first-order low-pass filter. The cut-off frequency corresponds to the time constant  $R7 \times C6$ .

#### Mute input (MUTE)

When MUTE is HIGH the DTMF input is enabled and the microphone and receiving amplifier inputs are inhibited. The reverse is true when MUTE is LOW or open-circuit. MUTE switching causes only negligible clicking on the earpiece outputs and line. If the number of parallel sets in use causes a drop in line current to below 6 mA the speech amplifiers remain active independent to the DC level applied to the MUTE input.

#### Dual-tone multi-frequency input (DTMF)

When the DTMF input is enabled dialling tones may be sent onto the line. The voltage gain from DTMF to LN is typically 25.5 dB (when  $R7 = 68 \text{ k}\Omega$ ) and varies with  $R7$  in the same way as the microphone gain. The signalling tones can be heard in the earpiece at a low level (confidence tone).

#### Receiving Amplifier (IR, QR+, QR- and GAR)

The receiving amplifier has one input (IR), one non-inverting complementary output (QR+) and an inverting complementary output (QR-). These outputs may be used for single-ended or differential drive depending on the sensitivity and type of earpiece used (see Fig. 11). IR to QR+ gain is typically 31 dB (when  $R4 = 100 \text{ k}\Omega$ ), this is sufficient for low-impedance magnetic or dynamic microphones which are suited for single-ended drive. Using both outputs for differential drive gives an additional gain of 6 dB. This feature can be used when the earpiece impedance exceeds  $450 \Omega$  (high-impedance dynamic or piezoelectric types).

**FUNCTIONAL DESCRIPTION** (continued)**Receiving Amplifier (IR, QR+, QR– and GAR)** (continued)

The receiving amplifier gain can be adjusted between 20 and 39 dB with single-ended drive and between 26 and 45 dB with differential drive, to match the sensitivity of the transducer in use. The gain is set with the value of R4 which is connected between GAR and QR+. Overall receive gain between LN and QR+ is calculated by subtracting the anti-sidetone network attenuation (32 dB) from the amplifier gain. Two external capacitors C4 and C7, ensure stability. C4 is normally 100 pF and C7 is 10 x the value of C4. The value of C4 may be increased to obtain a first-order low-pass filter. The cut-off frequency will depend on the time constant  $R4 \times C4$ .

The output voltage of the receiving amplifier is specified for continuous-wave drive. The maximum output voltage will be higher under speech conditions where the peak to RMS ratio is higher.

**Automatic gain control input (AGC)**

Automatic line loss compensation is achieved by connecting a resistor (R6) between AGC and VEE. The automatic gain control varies the gain of the microphone amplifier and the receiving amplifier in accordance with the DC line current. The control range is 5.9 dB. This corresponds to a line length of 5 km for a 0.5 mm diameter copper twisted-pair cable with a DC resistance of 176  $\Omega$ /km and an average attenuation 1.2 dB/km. Resistor R6 should be chosen in accordance with the exchange supply voltage and its feeding bridge resistance (see Fig. 12 and Table 1). The ratio of start and stop currents of the AGC curve is independent of the value of R6. If no automatic line loss compensation is required the AGC may be left open-circuit. The amplifiers, in this condition, will give their maximum specified gain.

**Power-down input (PD)**

During pulse dialling or register recall (timed loop break) the telephone line is interrupted. During these interruptions the telephone line provides no power for the transmission circuit or circuits supplied by V<sub>CC</sub>. The charge held on C1 will bridge these gaps. This bridging is made easier by a HIGH level on the PD input which reduces the typical supply current from 1 mA to 55  $\mu$ A and switches off the voltage regulator preventing discharge through LN. When PD is HIGH the capacitor at REG is disconnected with the effect that the voltage stabilizer will have no switch-on delay after line interruptions. This minimizes the contribution of the IC to the current waveform during pulse dialling or register recall. When this facility is not required PD may be left open-circuit.

**Side-tone suppression**

The anti-sidetone network, R1//Z<sub>line</sub>, R2, R3, R9 and Z<sub>bal</sub>, (see Fig. 4) suppresses transmitted signal in the earpiece. Compensation is maximum when the following conditions are fulfilled:

- (a)  $R9 \times R2 = R1 (R3 + \{R8/Z_{bal}\})$ ;
- (b)  $(Z_{bal}/\{Z_{bal} + R8\}) = (Z_{line}/\{Z_{line} + R1\})$

If fixed values are chosen for R1, R2, R3, and R9 then condition (a) will always be fulfilled when  $|R8/Z_{bal}| \ll R3$ . To obtain optimum side-tone suppression condition (b) has to be fulfilled resulting in:

$$Z_{bal} = (R8/R1) Z_{line} = k \cdot Z_{line} \text{ where } k \text{ is a scale factor; } k = (R8/R1)$$

The scale factor (k), dependent on the value of R8, is chosen to meet the following criteria:

- (a) Compatibility with a standard capacitor from the E6 or E12 range for Z<sub>bal</sub>
- (b)  $|Z_{bal}/R8| \ll R3$  to fulfill condition (a) and thus ensuring correct anti-sidetone bridge operation
- (c)  $|Z_{bal} + R8| \gg R9$  to avoid influencing the transmitter gain

In practice Z<sub>line</sub> varies considerably with the line type and length. The value chosen for Z<sub>bal</sub> should therefore be for an average line length thus giving optimum setting for short or long lines.

**Example**

The line balance impedance ( $Z_{bal}$ ) at which the optimum suppression is present can be calculated by: suppose  $Z_{line} = 210 \Omega + (1265 \Omega/140 \text{ nF})$ , representing a 5 km line of 0.5 mm diameter, copper, twisted-pair cable matched to  $600 \Omega$  ( $176 \Omega/\text{km}$ ;  $38 \text{ nF}/\text{km}$ ). When  $k = 0.64$  then  $R_8 = 390 \Omega$ ;  $Z_{bal} = 130 \Omega + (820 \Omega//220 \text{ nF})$ .

The anti-sidetone network for the TEA1060 family shown in Fig. 4 attenuates the signal received from the line by 32 dB before it enters the receiving amplifier. The attenuation is almost constant over the whole audio frequency range. Fig. 5 shows a conventional Wheatstone bridge anti-sidetone circuit that can be used as an alternative. Both bridge types can be used with either resistive or complex set impedances.

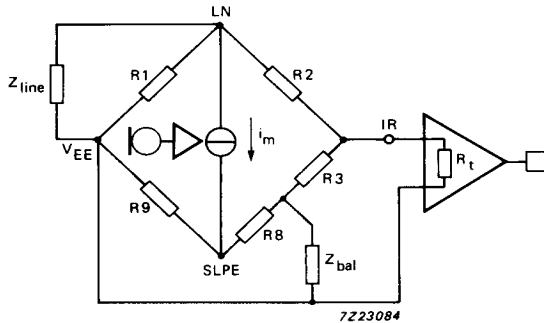


Fig. 4 Equivalent circuit of TEA1060 anti-sidetone bridge.

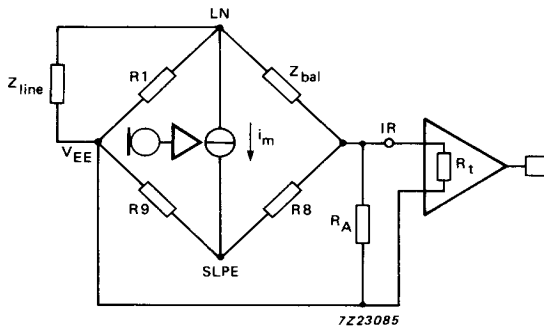


Fig. 5 Equivalent circuit of an anti-sidetone network in a Wheatstone bridge configuration.

More information can be found in the designer guide; 9398 341 10011

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

parameter	conditions	symbol	min.	max.	unit
Positive continuous line voltage		$V_{LN}$	—	12	V
Repetitive line voltage during switch-on line interruption		$V_{LN}$	—	13.2	V
Repetitive peak line voltage for a 1 ms pulse per 5 s	$R9 = 20 \Omega$ ; $R10 = 13 \Omega$ (Fig. 15)	$V_{LN}$	—	28	V
Line current TEA1067(1)	$R9 = 20 \Omega$	$I_{line}$	—	140	mA
Line current TEA1067T (1)	$R9 = 20 \Omega$	$I_{line}$	—	140	mA
Voltage on all other pins		$V_i$	—	$V_{CC} + 0.7$	V
		$-V_i$	—	0.7	V
Total power dissipation (2)	$R9 = 20 \Omega$				
TEA1067		$P_{tot}$	—	769	mW
TEA1067T		$P_{tot}$	—	550	mW
Storage temperature range		$T_{stg}$	−40	+ 125	°C
Operating ambient temperature range		$T_{amb}$	−25	+ 75	°C
Junction temperature		$T_j$	—	+ 125	°C

- (1) Mostly dependent on the maximum required  $T_{amb}$  and on the voltage between LN and SLPE. See Figs 6 and 7 to determine the current as a function of the required voltage and the temperature.
- (2) Calculated for the maximum ambient temperature specified  $T_{amb} = 75 \text{ °C}$  and a maximum junction temperature of  $125 \text{ °C}$ .

**THERMAL RESISTANCE**

From junction to ambient in free air

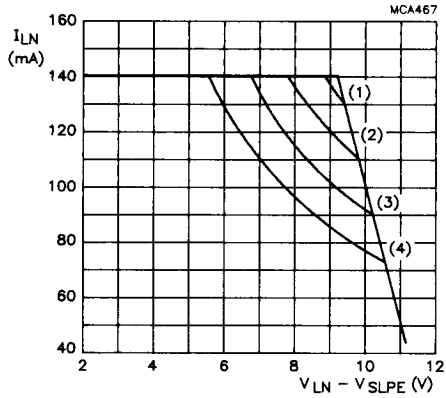
TEA1067

 $R_{th\ j-a}$  typ. 65 K/W

TEA1067T mounted on glass epoxy board 41 x 19 x 1.5 mm

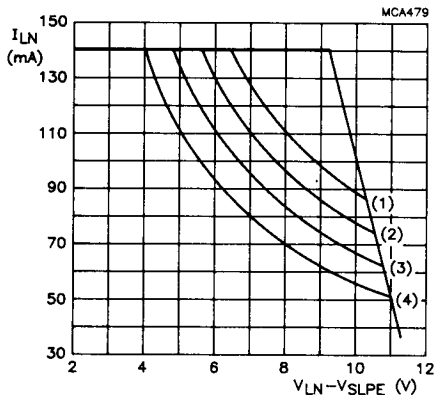
 $R_{th\ j-a}$  typ. 90 K/W





	$T_{amb}$	$P_{tot}$
(1)	45 °C	1231 mW
(2)	55 °C	1077 mW
(3)	65 °C	923 mW
(4)	75 °C	769 mW

Fig. 6 TEA1067 safe operating area.



	$T_{amb}$	$P_{tot}$
(1)	45 °C	888 mW
(2)	55 °C	777 mW
(3)	65 °C	666 mW
(4)	75 °C	555 mW

Fig. 7 TEA1067T safe operating area.

## CHARACTERISTICS

 $I_{line} = 11$  to  $140$  mA;  $V_{EE} = 0$  V;  $f = 800$  Hz;  $T_{amb} = 25$  °C; unless otherwise specified

parameter	condition	symbol	min.	typ.	max.	unit
<b>Supply; LN and VCC</b>						
Voltage drop over circuit, between LN and VEE	microphone inputs open					
	$I_{line} = 1$ mA	$V_{LN}$	—	1.6	—	V
	$I_{line} = 4$ mA	$V_{LN}$	1.75	2.0	2.25	V
	$I_{line} = 7$ mA	$V_{LN}$	2.25	2.8	3.35	V
	$I_{line} = 11$ mA	$V_{LN}$	3.55	3.8	4.05	V
	$I_{line} = 15$ mA	$V_{LN}$	3.65	3.9	4.15	V
	$I_{line} = 100$ mA	$V_{LN}$	4.9	5.6	6.5	V
	$I_{line} = 140$ mA	$V_{LN}$	—	—	7.5	V
Variation with temperature	$I_{line} = 15$ mA	$\Delta V_{LN}/\Delta T$	-3	-1	1	mV/K
Voltage drop over circuit, between LN and VEE with external resistor $R_{VA}$	$I_{line} = 15$ mA; $R_{VA}$ (LN to REG) = 68 k $\Omega$		3.1	3.4	3.7	V
	$I_{line} = 15$ mA; $R_{VA}$ (REG to SLPE) = 39 k $\Omega$		4.2	4.5	4.8	V
Supply current	PD = LOW; $V_{CC} = 2.8$ V	$I_{CC}$	—	1.0	1.35	mA
Supply current	PD = HIGH; $V_{CC} = 2.8$ V	$I_{CC}$	—	55	82	$\mu$ A
Supply voltage available for peripheral circuitry	$I_{line} = 15$ mA; MUTE = HIGH					
	$I_p = 1.4$ mA	$V_{CC}$	2.2	2.4	—	V
	$I_p = 0$ mA	$V_{CC}$	2.95	3.2	—	V
<b>Microphone inputs</b>						
<b>MIC+ and MIC-</b>						
Input impedance (differential) between MIC- and MIC+		$ Z_i $	51	64	77	k $\Omega$
Input impedance (single-ended) MIC- or MIC+ to VEE		$ Z_i $	25.5	32	38.5	k $\Omega$
Common mode rejection ratio		kCMR	—	82	—	dB
Voltage gain MIC+/MIC- to LN	$I_{line} = 15$ mA; $R_7 = 68$ k $\Omega$	$G_v$	51	52	53	dB

parameter	conditions	symbol	min.	typ.	max.	unit
<b>Microphone inputs MIC+ and MIC- (continued)</b>						
Gain variation with frequency at f = 300 Hz and f = 3400 Hz	w.r.t. 800 Hz	$\Delta G_{vf}$	-0.5	$\pm 0.2$	+0.5	dB
Gain variation with temperature at -25 °C and +75 °C	w.r.t. 25 °C without R6; $I_{line} = 50$ mA	$\Delta G_{vT}$	-	$\pm 0.2$	-	dB
<b>Dual-tone multi-frequency input DTMF</b>						
Input impedance		$ Z_{i} $	16.8	20.7	24.6	k $\Omega$
Voltage gain from DTMF to LN	$I_{line} = 15$ mA; R7 = 68 k $\Omega$	$G_v$	24.5	25.5	26.5	dB
Gain variation with frequency at f = 300 Hz and f = 3400 Hz	w.r.t. 800 Hz	$\Delta G_{vf}$	-0.5	$\pm 0.2$	+0.5	dB
Gain variation with temperature at -25 °C and +75 °C	w.r.t. 25 °C $I_{line} = 50$ mA	$\Delta G_{vT}$	-	$\pm 0.2$	-	dB
<b>Gain adjustment GAS1 and GAS2</b>						
Gain variation of the transmitting amplifier by varying R7 between GAS1 and GAS2		$\Delta G_v$	-8	-	0	dB
<b>Sending amplifier output LN</b>						
Output voltage	$I_{line} = 15$ mA THD = 2% THD = 10%	$V_{LN(rms)}$ $V_{LN(rms)}$	- 1.9	1.9 2.2	- -	V V
	$I_{line} = 4$ mA; THD = 10%	$V_{LN(rms)}$	-	0.8	-	V
	$I_{line} = 7$ mA; THD = 10%	$V_{LN(rms)}$	-	1.4	-	V
Noise output voltage	$I_{line} = 15$ mA; R7 = 68 k $\Omega$ ; 200 $\Omega$ between MIC- and MIC+; psophometrically weighted (P53 curve)	$V_{no(rms)}$	-	-72	-	dBmp

## CHARACTERISTICS (continued)

parameter	conditions	symbol	min.	typ.	max.	unit
<b>Receiving amplifier input IR</b>						
Input impedance		$ Z_i $	17	21	25	$k\Omega$
<b>Receiving amplifier outputs QR+ and QR-</b>						
Output impedance (single-ended)		$ Z_o $	—	4	—	$\Omega$
Voltage gain from IR to QR+ or QR-						
single-ended	$I_{line} = 15 \text{ mA}$ $R_4 = 100 \text{ k}\Omega$ $R_L$ (from QR+ or QR-) = $300 \Omega$	$G_v$	30	31	32	dB
differential	$R_L$ (from QR+ or QR-) = $600 \Omega$	$G_v$	36	37	38	dB
Gain variation with frequency at $f = 300 \text{ Hz}$ and $f = 3400 \text{ Hz}$	w.r.t. $800 \text{ Hz}$	$\Delta G_{vf}$	-0.5	-0.2	0	dB
Gain variation with temperature at $-25 \text{ }^\circ\text{C}$ and $+75 \text{ }^\circ\text{C}$	w.r.t. $25 \text{ }^\circ\text{C}$ without $R_6$ ; $I_{line} = 50 \text{ mA}$	$\Delta G_{vT}$	—	$\pm 0.2$	—	dB
Output voltage	sinewave drive $I_{line} = 15 \text{ mA}$ ; $I_p = 0 \text{ mA}$ ; THD = 2% $R_4 = 100 \text{ k}\Omega$					
single-ended	$R_L = 150 \Omega$ $R_L = 450 \Omega$	$V_{o(rms)}$ $V_{o(rms)}$	0.25 0.45	0.29 0.55	— —	V V
differential	$f = 3400 \text{ Hz}$ ; series $R = 100 \Omega$ ; $C_L = 47 \text{ nF}$	$V_{o(rms)}$	0.65	0.80	—	V
Output voltage	THD = 10%; $R_L = 150 \Omega$ $R_4 = 100 \text{ k}\Omega$ $I_{line} = 4 \text{ mA}$ $I_{line} = 7 \text{ mA}$	$V_{o(rms)}$ $V_{o(rms)}$	— —	15 130	— —	mV mV
Noise output voltage	$I_{line} = 15 \text{ mA}$ ; $R_4 = 100 \text{ k}\Omega$ ; IR open-circuit psophometrically weighted; (P53 curve)					
single-ended	$R_L = 300 \Omega$	$V_{no(rms)}$	—	50	—	$\mu\text{V}$
differential	$R_L = 600 \Omega$	$V_{no(rms)}$	—	100	—	$\mu\text{V}$

parameter	conditions	symbol	min.	typ.	max.	unit
<b>Gain adjustment GAR</b>						
Gain variation of receiving amplifier achievable by varying R4 between GAR and QR		$\Delta G_V$	-11	-	+8	dB
<b>Mute input</b>						
Input voltage HIGH		$V_{IH}$	1.5	-	$V_{CC}$	V
Input voltage LOW		$V_{IL}$	-	-	0.3	V
Input current		$I_{MUTE}$	-	8	15	$\mu A$
Gain reduction MIC+ or MIC- to LN	MUTE = HIGH	$\Delta G_V$	-	70	-	dB
Voltage gain from DTMF to QR+ or QR-	MUTE = HIGH; R4 = 100 k $\Omega$ ; single-ended; R <sub>L</sub> = 300 $\Omega$	$G_V$	-21	-19	-17	dB
<b>Power-down input PD</b>						
Input voltage HIGH		$V_{IH}$	1.5	-	$V_{CC}$	V
Input voltage LOW		$V_{IL}$	-	-	0.3	V
Input current		$I_{PD}$	-	5	10	$\mu A$
<b>Automatic gain control input AGC</b>						
Controlling the gain from IR to QR+/QR- and the gain from MIC+/MIC- to LN; R6 between AGC and V <sub>EE</sub>	R6 = 110 k $\Omega$					
Gain control range	$I_{line} = 70$ mA	$\Delta G_V$	-5.5	-5.9	-6.3	dB
Highest line current for maximum gain		$I_{line}$	-	23	-	mA
Minimum line current for minimum gain		$I_{line}$	-	61	-	mA
Reduction of gain between $I_{line} = 15$ mA and $I_{line} = 35$ mA		$\Delta G_V$	-1.0	-1.5	-2.0	dB

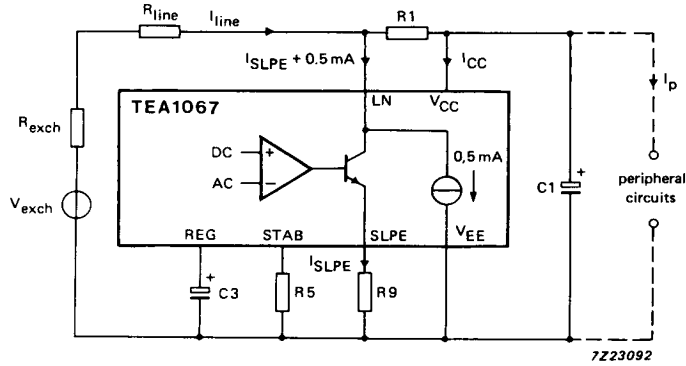
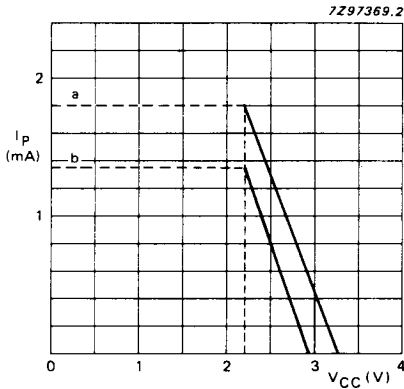


Fig. 8 Supply arrangement.



- (a)  $I_p = 1.8 \text{ mA}$
- (b)  $I_p = 1.35 \text{ mA}$
- $I_{line} = 15 \text{ mA}$  at  $V_{LN} = 3.9 \text{ V}$
- $R1 = 620 \Omega$  and  $R9 = 20 \Omega$ .

Fig. 9 Typical current  $I_p$  available from  $V_{CC}$  for peripheral circuitry with  $V_{CC} \geq 2.2 \text{ V}$ . Curve (a) is valid when the receiving amplifier is not driven or when MUTE = HIGH, curve (b) is valid when MUTE = LOW and the receiving amplifier is driven;  $V_o(rms) = 150 \text{ mV}$ ,  $R_L = 150 \Omega$  asymmetrical. The supply possibilities can be increased simply by setting the voltage drop over the circuit  $V_{LN}$  to a higher value by means of resistor  $R_{VA}$  connected between REG and SLPE.

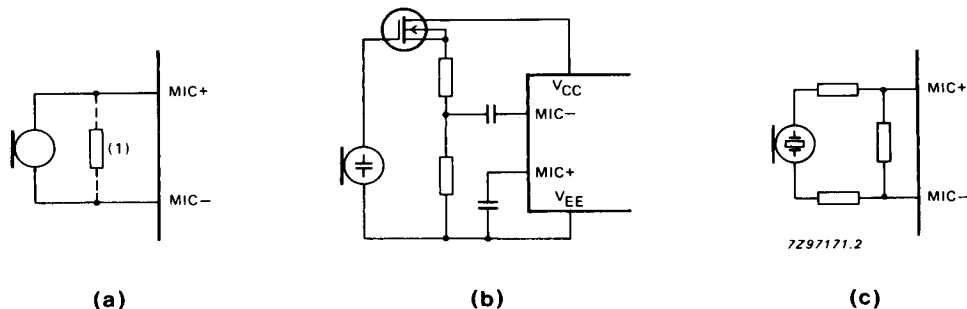


Fig. 10 Alternative microphone arrangements.

- (a) Magnetic or dynamic microphone. The resistor marked (1) may be connected to decrease the terminating impedance.
- (b) Electret microphone.
- (c) Piezoelectric microphone.

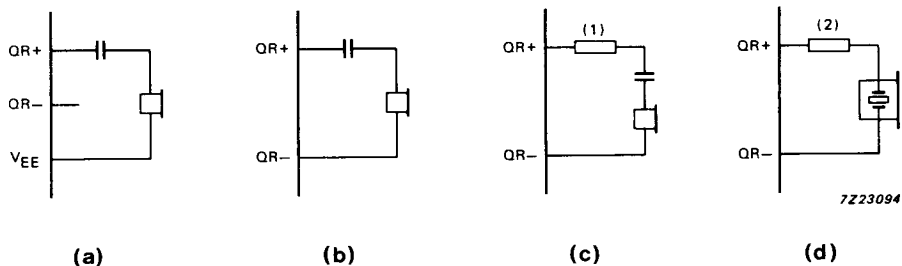


Fig. 11 Alternative receiver arrangements.

- (a) Dynamic earpiece with less than 450  $\Omega$  impedance.
- (b) Dynamic earpiece with more than 450  $\Omega$  impedance.
- (c) Magnetic earpiece with more than 450  $\Omega$  impedance. The resistor marked (1) may be connected to prevent distortion (inductive load).
- (d) Piezoelectric earpiece. The resistor marked (2) is required to increase the phase margin (capacitive load).

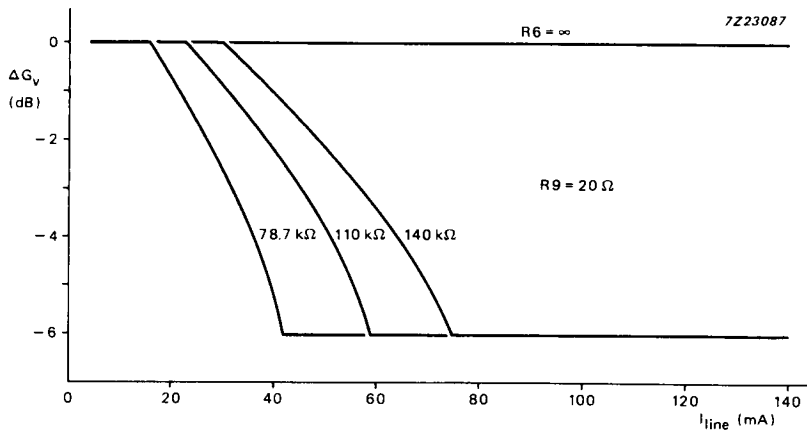


Fig. 12 Variation of gain with line current, with R6 as a parameter.

**Table 1** Values of resistor R6 for optimum line loss compensation, for various usual values of exchange supply voltage ( $V_{exch}$ ) and exchange feeding bridge resistance ( $R_{exch}$ );  $R9 = 20 \Omega$ .

		$R_{exch} (\Omega)$			
		400	600	800	1000
		$R6 (k\Omega)$			
$V_{exch}$ (V)	36	100	78.7	X	X
	48	140	110	93.1	82
	60	X	X	120	102



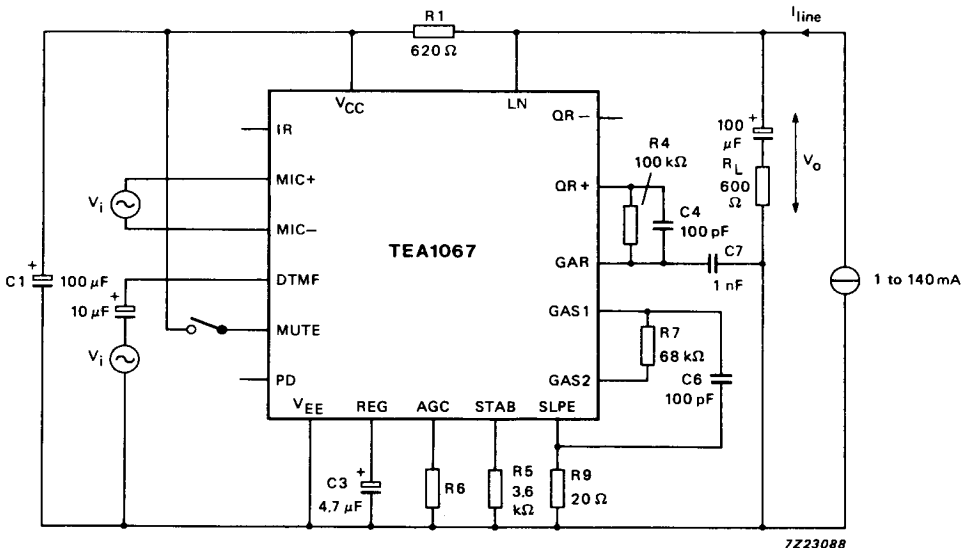


Fig. 13 Test circuit for defining voltage gain of MIC+, MIC- and DTMF inputs. Voltage gain is defined as:  $G_V = 20 \log |V_O/V_i|$ . For measuring the gain from MIC+ and MIC- the MUTE input should be LOW or open, for measuring the DTMF input MUTE should be HIGH. Inputs not under test should be open.

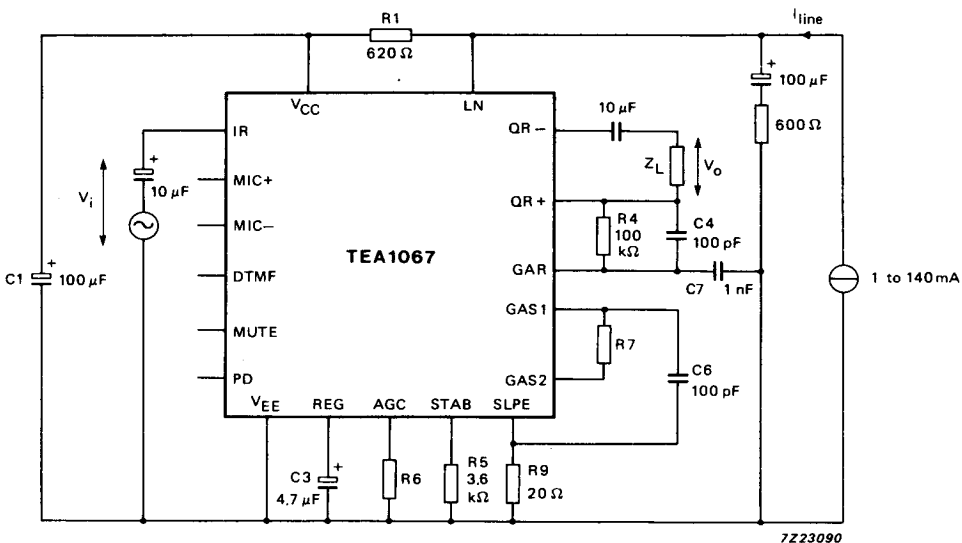


Fig. 14 Test circuit for defining voltage gain of the receiving amplifier. Voltage gain is defined as;  $G_V = 20 \log |V_O/V_i|$ .

## APPLICATION INFORMATION

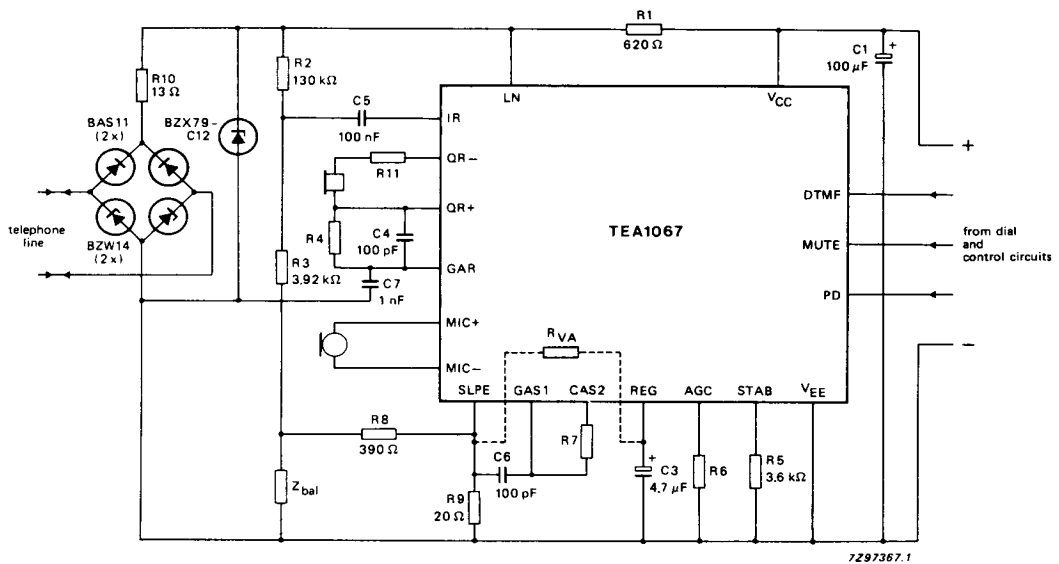


Fig. 15 Typical application of the TEA1067, shown here with a piezoelectric earpiece and DTMF dialling. The bridge to the left, the zener diode and R10 limit the current into the circuit and the voltage across the circuit during line transients. Pulse dialling or register recall require a different protection arrangement.

The DC line voltage can be set to a higher value by the resistor  $R_{VA}$  (REG to SLPE).

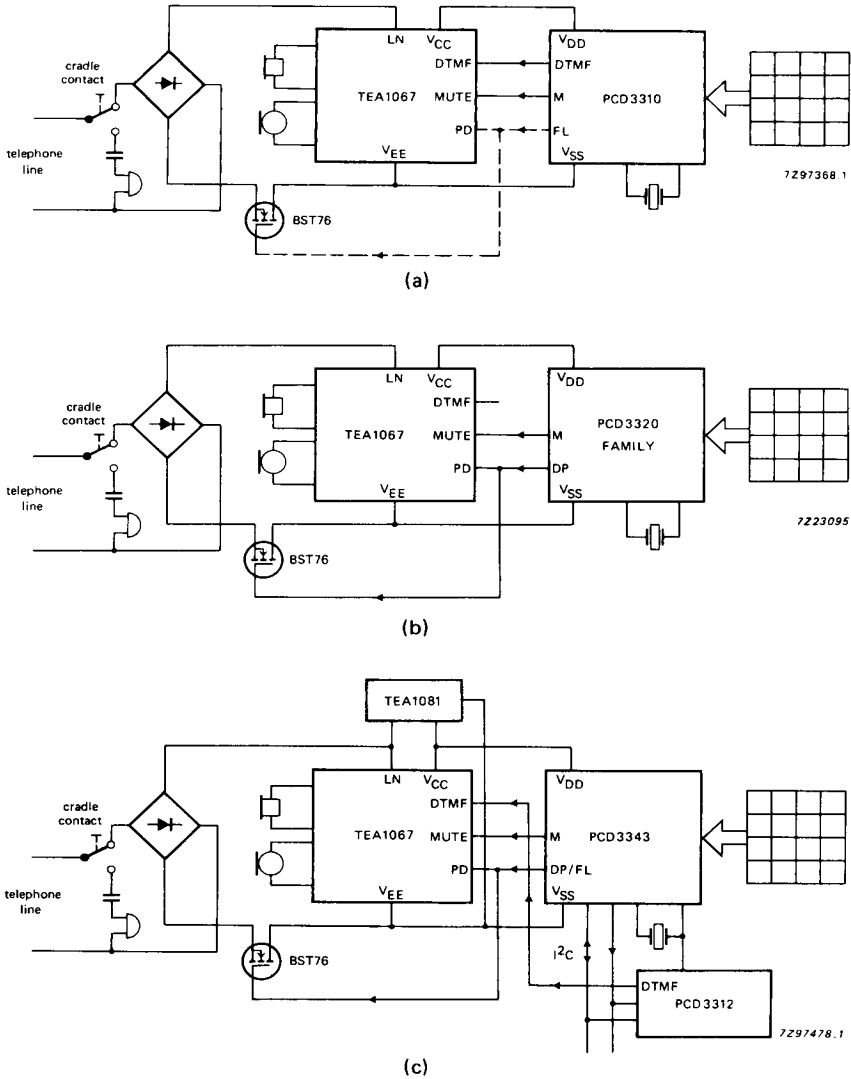


Fig. 16 Typical applications of the TEA1067 (simplified).

(a) DTMF-Pulse set with CMOS dialling circuit PCD3310.

The dashed lines show an optional flash (register recall by timed loop break).

(b) Pulse dial set with one of the PCD3320 family of CMOS interrupted current-loop dialling circuits.

(c) Dual-standard (pulse and DTMF) feature phone with the PCD3343 CMOS controller and the PCD3312 CMOS DTMF generator with I<sup>2</sup>C-bus. Supply is provided by the TEA1081 supply circuit.