

## Transmission Interface with Loudspeaking Facility

TEA1042

### GENERAL DESCRIPTION

The TEA1042 is a bipolar integrated circuit performing all speech and line interface functions in electronic telephone sets. It is especially designed for handsfree loudspeaking equipment.

Its features are:

- Supplied from telephone line current
- Voltage regulator with adjustable d.c. voltage drop and d.c. resistance
- High and low-impedance handset microphone inputs
- High-impedance base microphone input
- Handset/base selection input
- Muting input for pulse or DTMF dialling
- Gain setting facility on all amplifiers
- Line current dependent gain control facility with corrections for the exchange supply voltage and its feeding bridge resistance
- Supply output for additional circuits.

### QUICK REFERENCE DATA

Line voltage at $I_{line} = 15 \text{ mA}$	$V_{line}$	typ.	4.2 V
Line current operating range	$I_{line}$		10 to 140 mA
Telephone line impedance	$ Z_{line} $	nom.	600 $\Omega$
Supply current	$I_{CC}$	typ.	1 mA
Voltage gain, transmitting amplifier	$A_{vd}$	typ.	44.1 dB
MIC1 input	$A_{vd}$	typ.	20 dB
MIC2 input	$A_{vd}$	typ.	20 dB
MIC3 input	$A_{vd}$	typ.	25.6 dB
DTMF input	$A_{vd}$	typ.	27 dB
Voltage gain, receiving amplifier	$A_{vd}$	typ.	27 dB
Gain adjustment range	$\Delta A_{vd}$	typ.	$\pm 6 \text{ dB}$
transmitting amplifier	$\Delta A_{vd}$	typ.	$\pm 8 \text{ dB}$
receiving amplifier			
Range of gain control with line current, all amplifiers	$\Delta A_{vd}$	typ.	6 dB
Exchange supply voltage range	$V_{exch}$		24 to 60 V
Exchange feeding bridge resistance	$R_{exch}$		400 or 800 $\Omega$
Operating ambient temperature range	$T_{amb}$		-25 to +70 $^{\circ}\text{C}$

### PACKAGE OUTLINE

24-lead DIL; plastic (SOT-101A).

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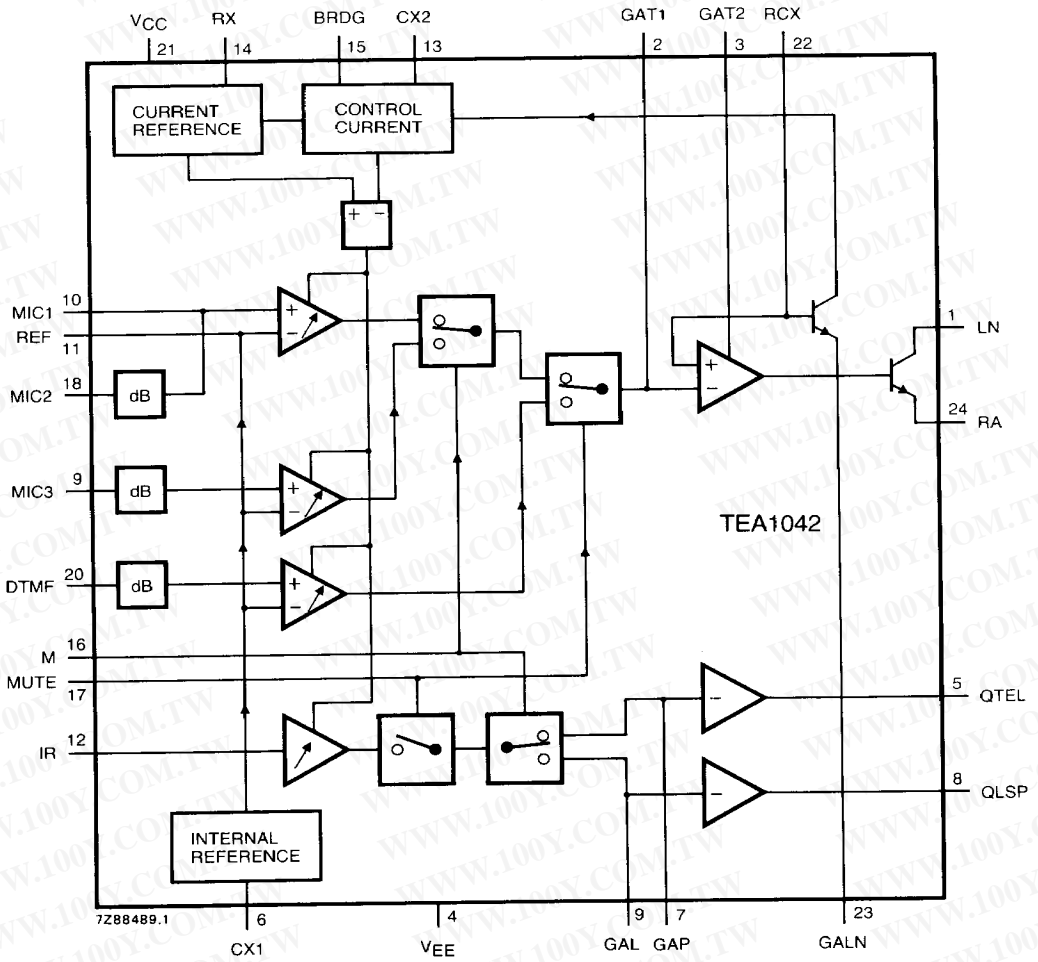


Fig. 1 Block diagram. The blocks marked dB are attenuators. The M and MUTE inputs operate analogue switches that activate or inhibit the inputs and outputs as required by their function.

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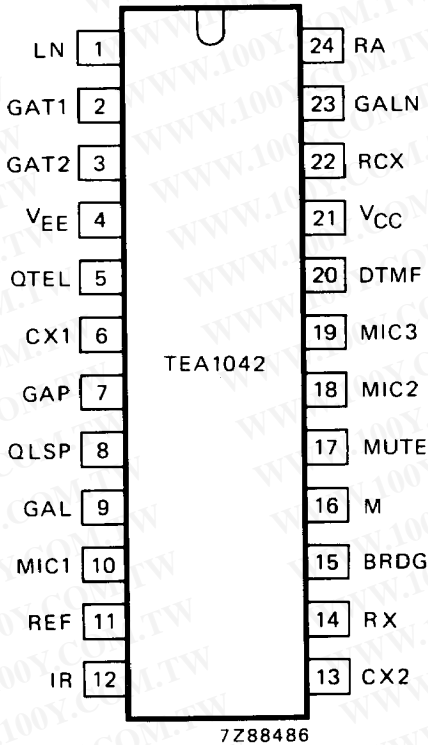


Fig. 2 Pinning diagram.

**PINNING**

1	LN	positive line terminal
2	GAT1	gain adjustment; transmitting amplifier
3	GAT2	gain adjustment; transmitting amplifier
4	VEE	negative line terminal
5	QTEL	handset telephone output
6	CX1	reference decoupling
7	GAP	gain adjustment; telephone amplifier
8	QLSP	loudspeaker preamplifier output
9	GAL	gain adjustment; loudspeaker preamplifier
10	MIC1	low-impedance handset microphone input
11	REF	reference voltage
12	IR	receiving amplifier input
13	CX2	external stabilizing capacitor
14	RX	external resistor
15	BRDG	selection input for gain control adaptation to feeding bridge impedance
16	M	mode (handset/base selection) input
17	MUTE	mute input
18	MIC2	high-impedance handset microphone input
19	MIC3	base microphone input
20	DTMF	dual-tone multi-frequency input
21	VCC	positive supply
22	RCX	line voltage adjustment and voltage regulator decoupling
23	GALN	gain control with line current; all amplifiers
24	RA	d.c. resistance adjustment

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### FUNCTIONAL DESCRIPTION

The TEA1042 contains two receiving amplifiers, a transmitting amplifier, means to switch the inputs and the outputs, means to adjust the gain of all amplifiers individually, means to vary the gain with the line current and means to adjust the d.c. voltage drop and d.c. resistance. See the block diagram, Fig. 1.

**Supply:** LN, V<sub>CC</sub>, V<sub>EE</sub>, RA, CX1 and CX2 (pins 1, 21, 4, 24, 6 and 13)

The circuit is supplied from the line current, the arrangement is shown in Fig. 3. The circuit develops its own supply voltage at V<sub>CC</sub> (pin 21). This supply voltage may also be used to supply an external circuit, e.g. a CMOS pulse or DTMF dialler or an electret microphone amplifier stage. The current available for this circuit depends on external components, see Fig. 4.

All line current has to flow through the circuit. If the line current exceeds the current required by the circuit itself via V<sub>CC</sub> (pin 21), i.e. about 1 mA, plus the current required by the peripheral circuits connected to this pin, then the excess current is diverted via LN, the positive line terminal (pin 1), to RA (d.c. resistance adjustment; pin 24).

The minimum line voltage may be chosen by external resistor R5 and the variation with line current by external resistor R10. The circuit regulates the line voltage at T<sub>amb</sub> = 25 °C to:

$$V_{\text{line}} = V_{\text{LN}} = \frac{R5 + R9}{R9} \times 0,62 + I_{\text{LN}} \times R10,$$

I<sub>LN</sub> being the current diverted via LN.

A regulator decoupling capacitor has to be connected between RCX (pin 22) and V<sub>EE</sub>, the negative line terminal (pin 4), a smoothing capacitor has to be connected between V<sub>CC</sub> (pin 21) and V<sub>EE</sub>, and a stabilizing capacitor between CX2 (pin 13) and V<sub>EE</sub>. Further a decoupling capacitor has to be connected between CX1 (reference decoupling; pin 6) and V<sub>EE</sub> (pin 4).

The dynamic impedance that the circuit presents to the line in the speech band is determined primarily by resistor R1 connected between LN (pin 1) and V<sub>CC</sub> (pin 21).

**Mode (handset/base selection) input M** (pin 16)

The mode input permits selection of operation via the handset or via the base. A HIGH level on the M input or an open circuit selects handset operation, i.e. it activates the microphone inputs MIC1 and MIC2 and the handset telephone output QTEL. A LOW level on M selects the base microphone input MIC3 and the loudspeaker preamplifier output QLSP.

**Microphone inputs MIC1, MIC2 and MIC3** (pins 10, 18 and 19)

Handset and base may be equipped with a sensitive microphone, e.g. an electret microphone with pre-amplifier. This has to be connected to the MIC2 or MIC3 input respectively. The available gain from these inputs is typ. 20 dB.

The handset may also be equipped with an insensitive low-impedance microphone, e.g. a dynamic or magnetic microphone. This has to be connected between MIC1 (pin 10) and (REF (pin 11)). The available gain from this input is typ. 44,1 dB.

**Dual-tone multi-frequency input DTMF and mute input MUTE** (pins 20 and 17)

A HIGH level on the MUTE input inhibits all microphone inputs and the telephone and loudspeaker outputs QTEL and QLSP and enables the DTMF input, a LOW level does the reverse. Switching the MUTE input will not produce any clicks on the line or in the telephone or loudspeaker. The available gain from the DTMF input is typ. 25,6 dB.

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### Telephone output QTEL and loudspeaker preamplifier output QLSP (pins 5 and 8)

As described before, the M input determines which of the outputs QTEL and QLSP will be activated. The receiving amplifier input IR (pin 12) is the input for both outputs. For both outputs the available gain is typ. 27 dB. The output QTEL is intended for telephone capsules with an impedance of 150  $\Omega$  or more. The QLSP output is intended to drive a power amplifier. Its output impedance is less than 1 k $\Omega$ .

### Gain adjustment: GAT1, GAT2, GAP and GAL (pins 2, 3, 7 and 9)

The gain of the transmitting amplifier may be adjusted by an external resistor R2 connected between GAT1 and GAT2 (pins 2 and 3; see Fig. 9). This adjustment influences the sensitivity of the inputs MIC1, MIC2, MIC3 and DTMF to the same amount. The gain is proportional to R2 and inversely proportional to R10 and R12.

The gain of the telephone amplifier may be adjusted by an external resistor R14 between GAP (pin 7) and CX1 (pin 6). The gain is proportional to R14 and inversely proportional to R12.

The gain of the loudspeaker preamplifier may be adjusted by an external resistor R13 between GAL (pin 9) and CX1 (pin 6). The gain is proportional to R13 and inversely proportional to R12.

### Gain control with line current: GALN (pin 23)

The circuit offers a facility to automatically vary the gain of all its amplifiers with the line current. In this way the circuit compensates for differences in line attenuation. The variation is accomplished by connecting an external resistor R11 between GALN (pin 23) and V<sub>EE</sub> (pin 4). The value of this resistor should be chosen in accordance with the supply voltage of the exchange (see Figs 5 and 6).

If no gain variation with line current is required the GALN connection may be left open. All amplifiers have their maximum gain then.

### Selection input for gain control adaptation to feeding bridge impedance: BRDG (pin 15)

A LOW level at the BRDG input optimizes the gain control characteristics of the circuit for a 400  $\Omega$  feeding bridge in the exchange, a HIGH level for 800  $\Omega$ .

### Side tone suppression

In the circuit diagram shown in Fig. 9 side tone suppression is obtained with components C2, R3, R4, R7 and R8. Their component values have to be chosen to suit the cable type used. This network attenuates the signal from the telephone line to the IR input of the receiving amplifier. This attenuation may be adjusted by choosing the value of R7 without affecting the side tone suppression.

### RATINGS

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

Supply current

d.c.

non-repetitive (t < 100 h)

Storage temperature range

Operating ambient temperature range

Junction temperature

I <sub>line</sub>	max.	140 mA
I <sub>line</sub>	max.	250 mA
T <sub>stg</sub>	-40 to +125	°C
T <sub>amb</sub>	-25 to +70	°C
T <sub>j</sub>	max.	150 °C

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### CHARACTERISTICS

$I_{line} = 10$  to  $140$  mA;  $f = 1000$  Hz;  $T_{amb} = 25$  °C, unless otherwise specified.

parameter	symbol	min.	typ.	max.	unit
<b>Supply: LN and V<sub>CC</sub> (pins 1 and 21)</b>					
Line voltage					
$I_{line} = 15$ mA	$V_{line}$	4	4,2	4,4	V
$I_{line} = 50$ mA	$V_{line}$	—	—	5,8	V
$I_{line} = 100$ mA	$V_{line}$	—	—	7,3	V
Variation with temperature	$\Delta V_{line}/\Delta T$	8	10	12	mV/K
Line current operating range	$I_{line}$	10	—	140	mA
Supply current at $V_{CC} = 2$ V	$I_{CC}$	—	—	1	mA
<b>Mode (handset/base selection) input M (pin 16)</b>					
Input voltage					
HIGH level	$V_{IH}$	1	—	$V_{CC}$	V
LOW level	$V_{IL}$	0	—	0,2	V
Input current	$-I_{16}$	—	8	20	$\mu$ A
Attenuation of non-selected signals	$-\Delta A_{vd}$	45	—	—	dB
<b>Low-impedance handset microphone input MIC1 and reference voltage pin REF (pins 10 and 11)</b>					
Input impedance	$ Z_{10-11} $	—	3	—	k $\Omega$
Voltage gain, see Fig. 7	$A_{vd}$	43,1	44,1	45,1	dB
<b>High-impedance handset microphone input MIC2 (pin 18)</b>					
Input impedance	$ Z_{18-4} $	40	48	—	k $\Omega$
Voltage gain, see Fig. 7	$A_{vd}$	19	20	21	dB
<b>Base microphone input MIC3 (pin 19)</b>					
Input impedance	$ Z_{19-4} $	40	48	—	k $\Omega$
Voltage gain, see Fig. 7	$A_{vd}$	19	20	21	dB
<b>DTMF input (pin 20)</b>					
Input impedance	$ Z_{20-4} $	10	15	—	k $\Omega$
Voltage gain, see Fig. 7	$A_{vd}$	24,6	25,6	26,6	dB
<b>Gain adjustment pins; transmitting amplifier: GAT1 and GAT2 (pins 2 and 3)</b>					
Gain adjustment range	$\Delta A_{vd}$	—	$\pm 6$	—	dB
Gain variation with frequency, $f = 300$ to $4000$ Hz	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB
Gain variation with temperature at $I_{line} = 50$ mA; $T_{amb} = -5$ to $+45$ °C	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB

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## CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
<b>Transmitting amplifier output LN (pin 1)</b>					
Output voltage at $I_{line} = 15 \text{ mA}$ ; $R_{line} = 600 \Omega$ ; $d = 2\%$	$V_{LN(rms)}$	1,4	—	—	V
Psophometrically weighted* noise output voltage at $I_{line} = 15 \text{ mA}$ ; $R_{line} = 600 \Omega$	$v_{LN(rms)}$	—	245	—	$\mu\text{V}$
<b>MUTE input (pin 17)</b>					
Input voltage					
HIGH level	$V_{IH}$	1	—	$V_{CC}$	V
LOW level	$V_{IL}$	0	—	0,2	V
Input current	$-I_{17}$	—	8	20	$\mu\text{A}$
Attenuation of non-selected signals	$-\Delta A_{vd}$	45	—	—	dB
<b>Receiving amplifier input IR (pin 12)</b>					
Input impedance	$ Z_{12-4} $	—	10	—	k $\Omega$
<b>Telephone output QTEL (pin 5)</b>					
Voltage gain at $I_{line} = 15 \text{ mA}$ ; $R_{load} = 150 \Omega$ ; $R_{13} = 15 \text{ k}\Omega$ ; see Fig. 8	$A_{vd}$	26	27	28	dB
Gain variation with frequency, $f = 300$ to $4000 \text{ Hz}$	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB
Gain variation with temperature at $I_{line} = 50 \text{ mA}$ ; $T_{amb} = -5$ to $+45 \text{ }^\circ\text{C}$	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB
Maximum output voltage at $I_{line} = 15 \text{ mA}$ ; $R_{load} = 150 \Omega$ ; $d = 2\%$	$v_O(rms)$	350	—	—	mV
Psophometrically weighted* noise output voltage at $I_{line} = 15 \text{ mA}$	$v_O(rms)$	—	40	—	$\mu\text{V}$
<b>Gain adjustment pin; telephone amplifier: GAP (pin 7)</b>					
Gain adjustment range	$\Delta A_{vd}$	—	$\pm 8$	—	dB
<b>Loudspeaker preamplifier output QLSP (pin 8)</b>					
Voltage gain at $I_{line} = 15 \text{ mA}$ ; $R_{load} = 10 \text{ k}\Omega$ ; $R_{14} = 15 \text{ k}\Omega$ ; see Fig. 8	$A_{vd}$	—	27	—	dB
Gain variation with frequency, $f = 300$ to $4000 \text{ Hz}$	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB
Gain variation with temperature	$\Delta A_{vd}$	—	$\pm 0,5$	—	dB
Psophometrically weighted* noise output voltage at $I_{line} = 15 \text{ mA}$	$v_O(rms)$	—	40	—	$\mu\text{V}$
Output impedance	$ Z_{8-4} $	—	—	1	k $\Omega$
<b>Gain adjustment pin; loudspeaker preamplifier: GAL (pin 9)</b>					
Gain adjustment range	$\Delta A_{vd}$	—	$\pm 8$	—	dB

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## CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
<b>Selection input for gain control adaptation to feeding bridge impedance BRDG (pin 15)</b>					
Input voltage					
HIGH level	$V_{IH}$	1	—	$V_{CC}$	V
LOW level	$V_{IL}$	0	—	0,2	V
Input current	$-I_{15}$	—	8	20	$\mu A$
<b>Gain control with line current pin GALN (pin 23)</b>					
Gain control range	$\Delta A_{vd}$	—	6	—	dB
Highest line current for maximum gain, R11 = 105 k $\Omega$ ;					
BRDG = HIGH ( $R_{exch} = 800 \Omega$ )	$I_{line}$	22,5	25	27,5	mA
BRDG = LOW ( $R_{exch} = 400 \Omega$ )	$I_{line}$	31,5	35	38,5	mA
Lowest line current for minimum gain, R11 = 105 k $\Omega$ ;					
BRDG = HIGH ( $R_{exch} = 800 \Omega$ )	$I_{line}$	49,5	55	60,5	mA
BRDG = LOW ( $R_{exch} = 400 \Omega$ )	$I_{line}$	81	90	99	mA

\* P53 curve.

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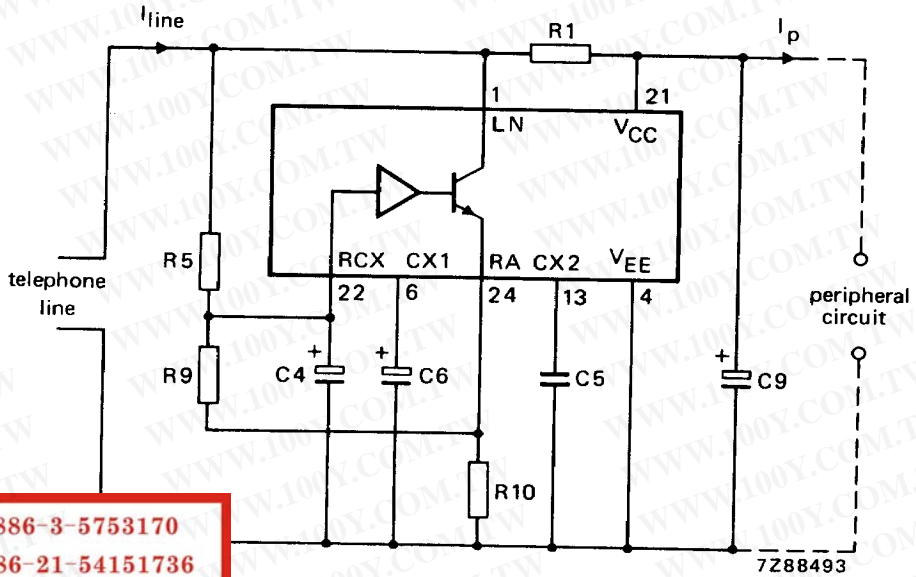


Fig. 3 Supply arrangement.

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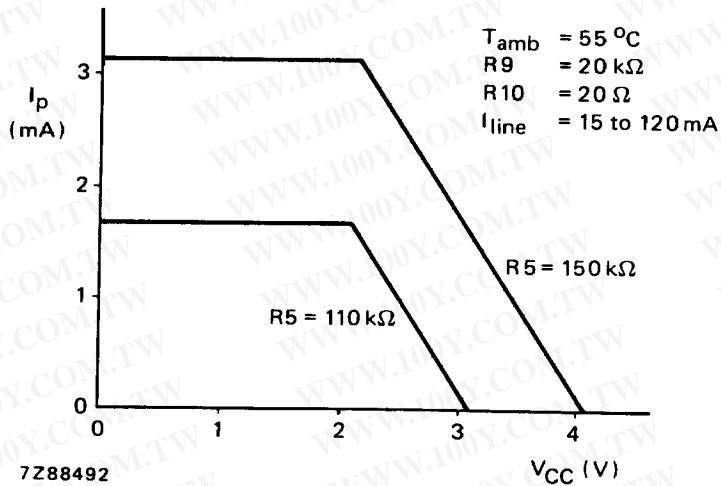


Fig. 4 Maximum current  $I_p$  available from  $V_{CC}$  for external (peripheral) circuits.

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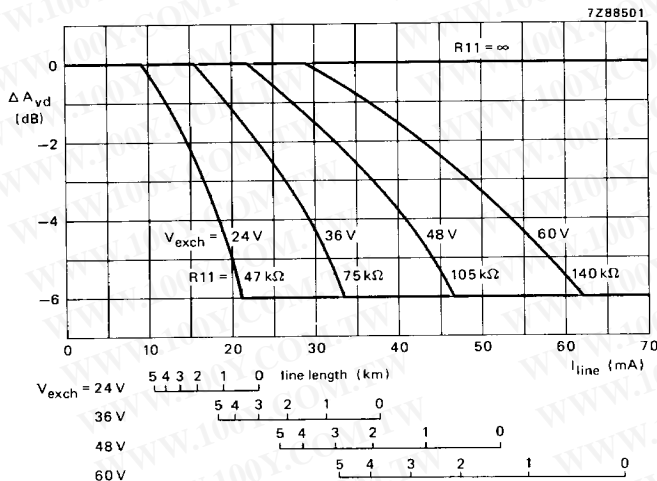


Fig. 5 Gain variation with line current, with  $R_{11}$  as a parameter, and with the BRDG input HIGH, i.e. the circuit optimized for  $800 \Omega$ . The values chosen for  $R_{11}$  suit the usual values for the supply voltage of the exchange. The curves are valid for 0,5 mm twisted-pair cables with an attenuation of 1,2 dB/km and a d.c. resistance of  $176 \Omega/km$ .

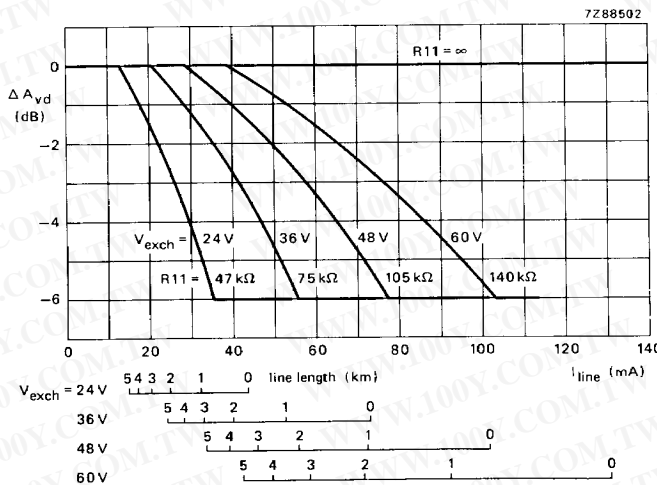


Fig. 6 Gain variation with line current, with  $R_{11}$  as a parameter, and with the BRDG input LOW, i.e. the circuit optimized for  $400 \Omega$ . The values chosen for  $R_{11}$  suit the usual values for the supply voltage of the exchange. The curves are valid for 0,5 mm twisted-pair cables with an attenuation of 1,2 dB/km and a d.c. resistance of  $176 \Omega/km$ .

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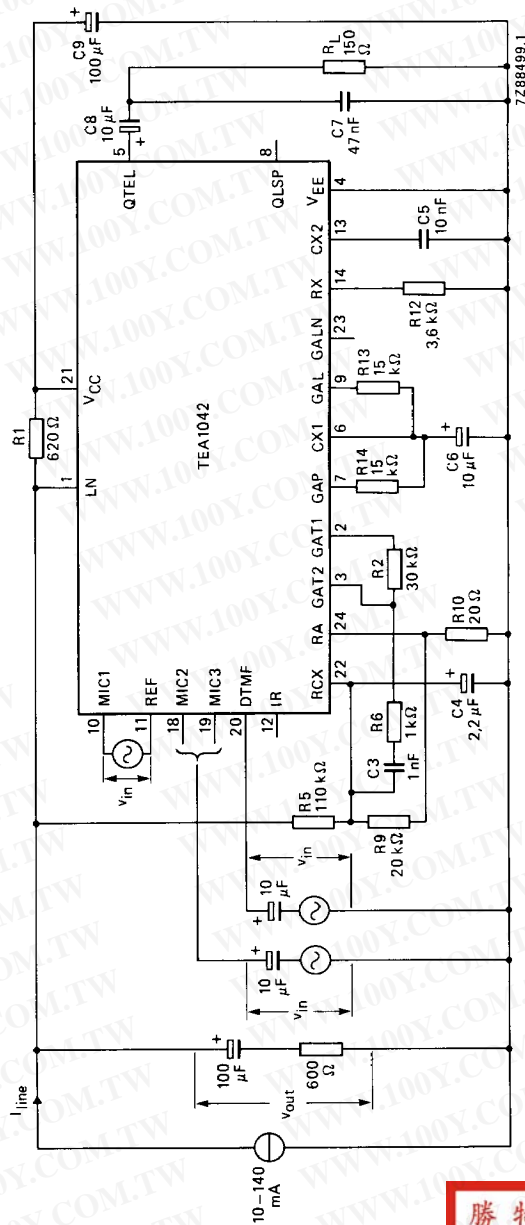


Fig. 7 Test circuit for defining voltage gain of MIC1, MIC2, MIC3 and DTMF inputs. Gain is defined as:  $A_{vd} = 20 \log |v_{out}/v_{in}|$ . For measuring the MIC1 or MIC2 input the M input should be HIGH and the MUTE input LOW, for measuring the MIC3 input M and MUTE should both be LOW and for measuring the DTMF input M and MUTE should be HIGH. Inputs not under test should be open.

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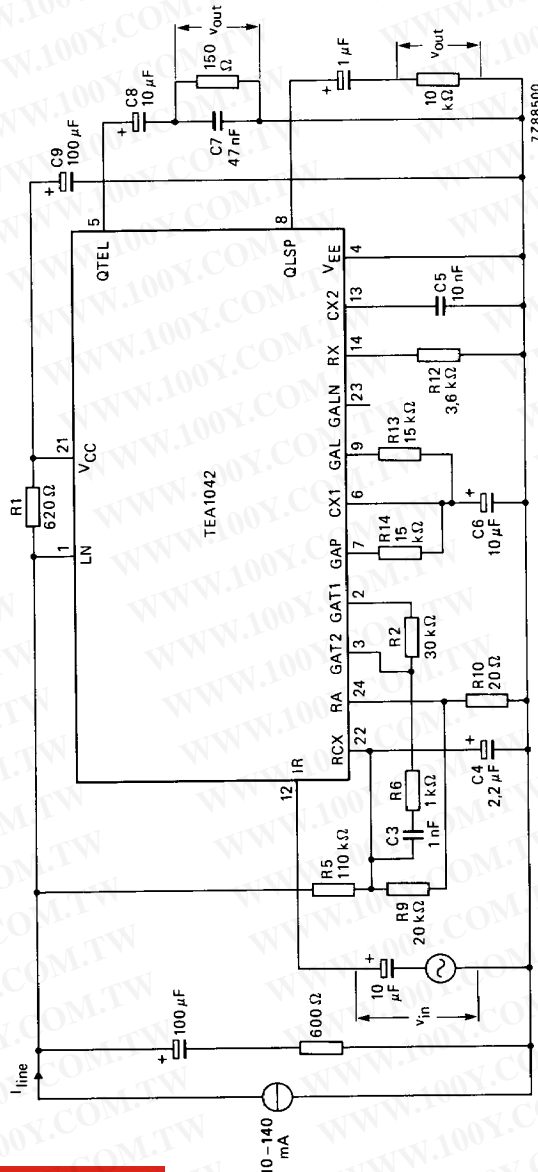


Fig. 8 Test circuit for defining voltage gain of QTEL and QLSP outputs. Gain is defined as:  $A_{vd} = 20 \log |v_{out}/v_{in}|$ . For measuring the QTEL output the MUTE input should be HIGH and the MUTE input LOW, for measuring the QLSP output M and MUTE should both be LOW.

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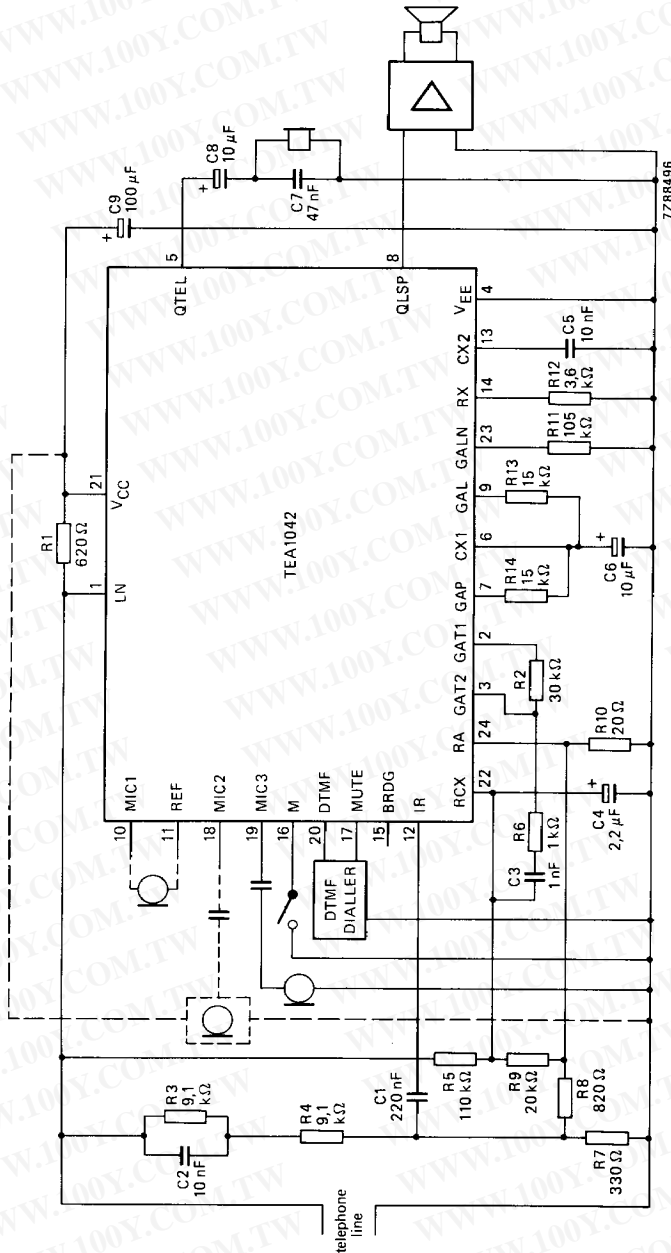


Fig. 9 Typical application of the TEA1042 in an electronic handsfree telephone set. The connections to the MIC1 and MIC2 inputs are alternatives. The connection to the BRDG input is not shown, see the Functional Description. The diagram does not show voice switches and associated control circuits required in a practical circuit for stable loudspeaking operation.

APPLICATION INFORMATION SUPPLIED ON REQUEST