

Transmission Interface with Loudspeaking Facility

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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 Ω
Supply current	I_{CC}	typ.	1 mA
Voltage gain, transmitting amplifier			
MIC1 input	A_{vd}	typ.	44,1 dB
MIC2 input	A_{vd}	typ.	20 dB
MIC3 input	A_{vd}	typ.	20 dB
DTMF input	A_{vd}	typ.	25,6 dB
Voltage gain, receiving amplifier	A_{vd}	typ.	27 dB
Gain adjustment range			
transmitting amplifier	ΔA_{vd}	typ.	$\pm 6 \text{ dB}$
receiving amplifier	ΔA_{vd}	typ.	$\pm 8 \text{ dB}$
Range of gain control with line current, all amplifiers	ΔA_{vd}	typ.	6 dB
Exchange supply voltage range	V_{exch}		24 to 60 V
Exchange feeding bridge resistance	R_{exch}		400 or 800 Ω
Operating ambient temperature range	T_{amb}		-25 to +70 $^{\circ}\text{C}$

PACKAGE OUTLINE

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

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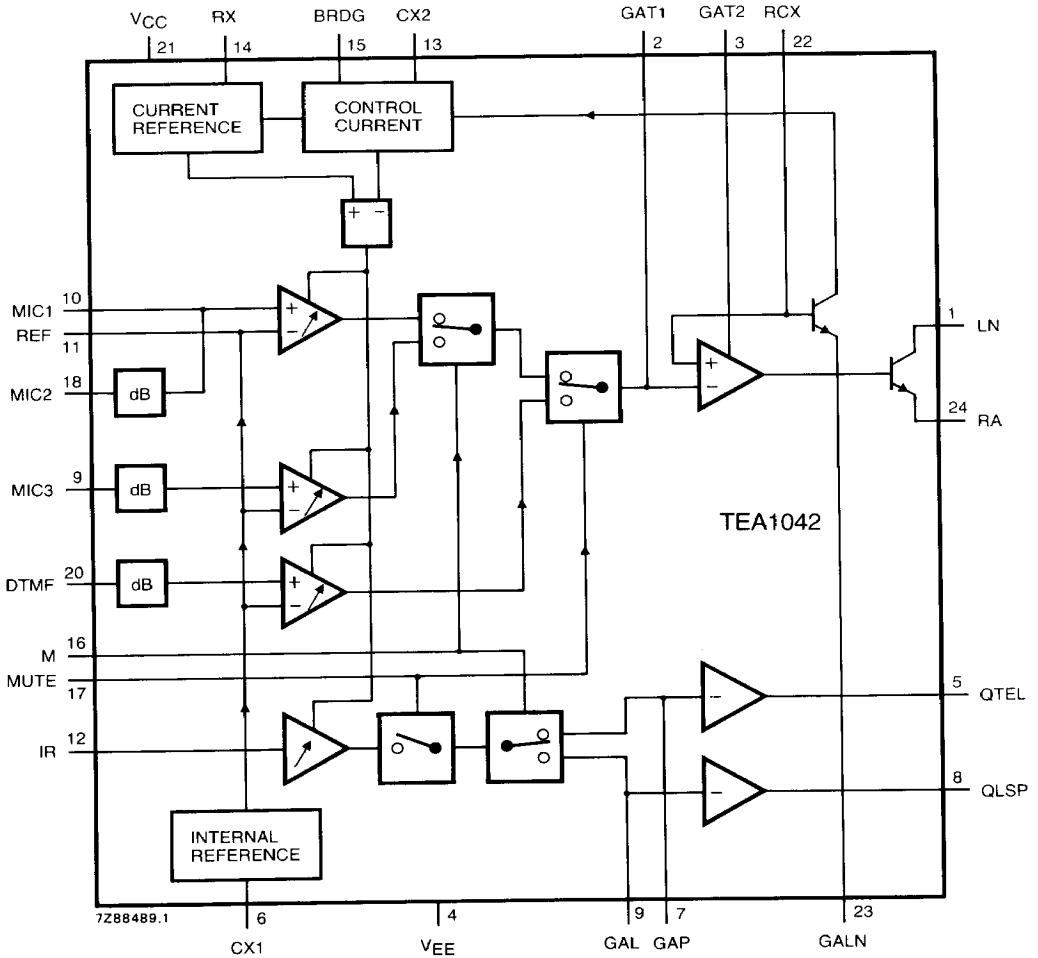


Fig. 1 Block diagram. The blocks marked dB are attenuators. The M and MUTE inputs operate analogue switches that activate or inhibit the inputs and outputs as required by their function.

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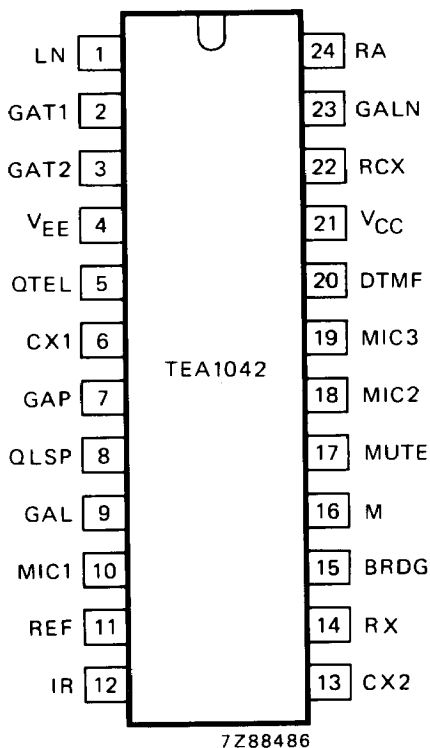


Fig. 2 Pinning diagram.

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_{CC}, V_{EE}, 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_{CC} (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_{CC} (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_{amb} = 25 °C to:

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

I_{LN} being the current diverted via LN.

A regulator decoupling capacitor has to be connected between RCX (pin 22) and V_{EE}, the negative line terminal (pin 4), a smoothing capacitor has to be connected between V_{CC} (pin 21) and V_{EE}, and a stabilizing capacitor between CX2 (pin 13) and V_{EE}. Further a decoupling capacitor has to be connected between CX1 (reference decoupling; pin 6) and V_{EE} (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_{CC} (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 Ω or more. The QLSP output is intended to drive a power amplifier. Its output impedance is less than 1 k Ω .

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_{EE} (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 Ω feeding bridge in the exchange, a HIGH level for 800 Ω .

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_{line}	max.	140 mA
I_{line}	max.	250 mA
T_{stg}		-40 to +125 °C
T_{amb}		-25 to +70 °C
T_j	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
Supply: LN and V_{CC} (pins 1 and 21)					
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
Mode (handset/base selection) input M (pin 16)					
Input voltage					
HIGH level	V_{IH}	1	—	V_{CC}	V
LOW level	V_{IL}	0	—	0,2	V
Input current	$-I_{16}$	—	8	20	μA
Attenuation of non-selected signals	$-\Delta A_{vd}$	45	—	—	dB
Low-impedance handset microphone input MIC1 and reference voltage pin REF (pins 10 and 11)					
Input impedance	$ Z_{10-11} $	—	3	—	kΩ
Voltage gain, see Fig. 7	A_{vd}	43,1	44,1	45,1	dB
High-impedance handset microphone input MIC2 (pin 18)					
Input impedance	$ Z_{18-4} $	40	48	—	kΩ
Voltage gain, see Fig. 7	A_{vd}	19	20	21	dB
Base microphone input MIC3 (pin 19)					
Input impedance	$ Z_{19-4} $	40	48	—	kΩ
Voltage gain, see Fig. 7	A_{vd}	19	20	21	dB
DTMF input (pin 20)					
Input impedance	$ Z_{20-4} $	10	15	—	kΩ
Voltage gain, see Fig. 7	A_{vd}	24,6	25,6	26,6	dB
Gain adjustment pins; transmitting amplifier: GAT1 and GAT2 (pins 2 and 3)					
Gain adjustment range	ΔA_{vd}	—	± 6	—	dB
Gain variation with frequency, $f = 300$ to 4000 Hz	ΔA_{vd}	—	± 0,5	—	dB
Gain variation with temperature at $I_{line} = 50$ mA; $T_{amb} = -5$ to + 45 °C	ΔA_{vd}	—	± 0,5	—	dB

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CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
Transmitting amplifier output LN (pin 1)					
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	—	μV
MUTE input (pin 17)					
Input voltage					
HIGH level	V_{IH}	1	—	V_{CC}	V
LOW level	V_{IL}	0	—	0,2	V
Input current	$-I_{17}$	—	8	20	μA
Attenuation of non-selected signals	$-\Delta A_{vd}$	45	—	—	dB
Receiving amplifier input IR (pin 12)					
Input impedance	$ Z_{12-4} $	—	10	—	$\text{k}\Omega$
Telephone output QTEL (pin 5)					
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 Hz	ΔA_{vd}	—	$\pm 0,5$	—	dB
Gain variation with temperature at $I_{line} = 50 \text{ mA}$; $T_{amb} = -5$ to $+45 \text{ }^\circ\text{C}$	ΔA_{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	—	μV
Gain adjustment pin; telephone amplifier: GAP (pin 7)					
Gain adjustment range	ΔA_{vd}	—	± 8	—	dB
Loudspeaker preamplifier output QLSP (pin 8)					
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 Hz	ΔA_{vd}	—	$\pm 0,5$	—	dB
Gain variation with temperature	ΔA_{vd}	—	$\pm 0,5$	—	dB
Psophometrically weighted* noise output voltage at $I_{line} = 15 \text{ mA}$	$v_{O(rms)}$	—	40	—	μV
Output impedance	$ Z_{8-4} $	—	—	1	$\text{k}\Omega$
Gain adjustment pin; loudspeaker preamplifier: GAL (pin 9)					
Gain adjustment range	ΔA_{vd}	—	± 8	—	dB



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CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
Selection input for gain control adaptation to feeding bridge impedance BRDG (pin 15)					
Input voltage					
HIGH level	V_{IH}	1	—	V_{CC}	V
LOW level	V_{IL}	0	—	0,2	V
Input current	$-I_{15}$	—	8	20	μA
Gain control with line current pin GALN (pin 23)					
Gain control range	ΔA_{vd}	—	6	—	dB
Highest line current for maximum gain, R11 = 105 k Ω ;					
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 Ω ;					
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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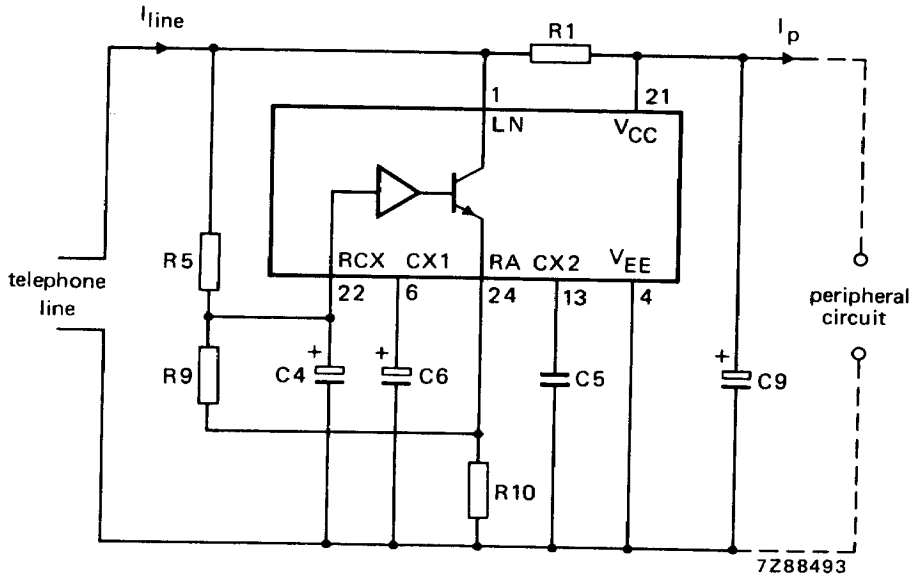


Fig. 3 Supply arrangement.

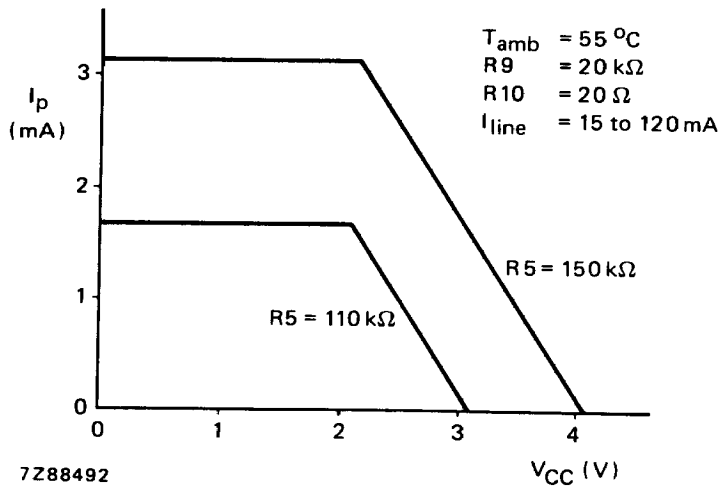


Fig. 4 Maximum current I_p available from V_{CC} for external (peripheral) circuits.



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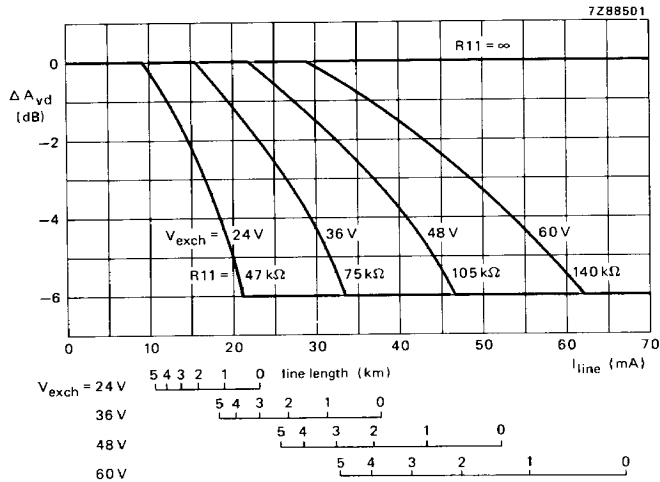


Fig. 5 Gain variation with line current, with R11 as a parameter, and with the BRDG input HIGH, i.e. the circuit optimized for 800 Ω. The values chosen for R11 suit the usual values for the supply voltage of the exchange. The curves are valid for 0,5 mm twisted-pair cables with an attenuation of 1,2 dB/km and a d.c. resistance of 176 Ω/km.

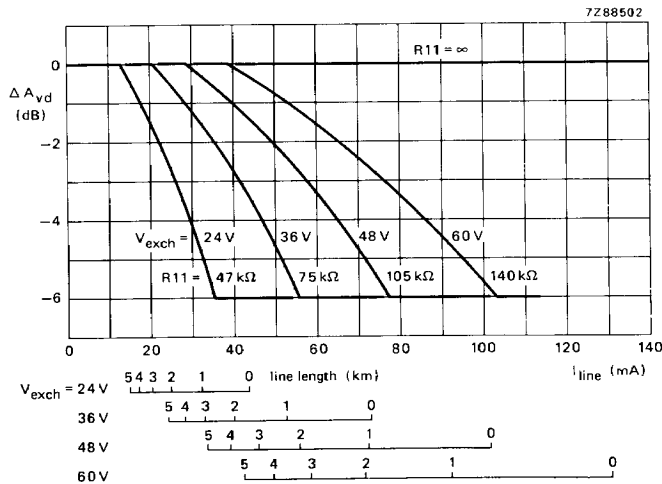


Fig. 6 Gain variation with line current, with R11 as a parameter, and with the BRDG input LOW, i.e. the circuit optimized for 400 Ω. The values chosen for R11 suit the usual values for the supply voltage of the exchange. The curves are valid for 0,5 mm twisted-pair cables with an attenuation of 1,2 dB/km and a d.c. resistance of 176 Ω/km.

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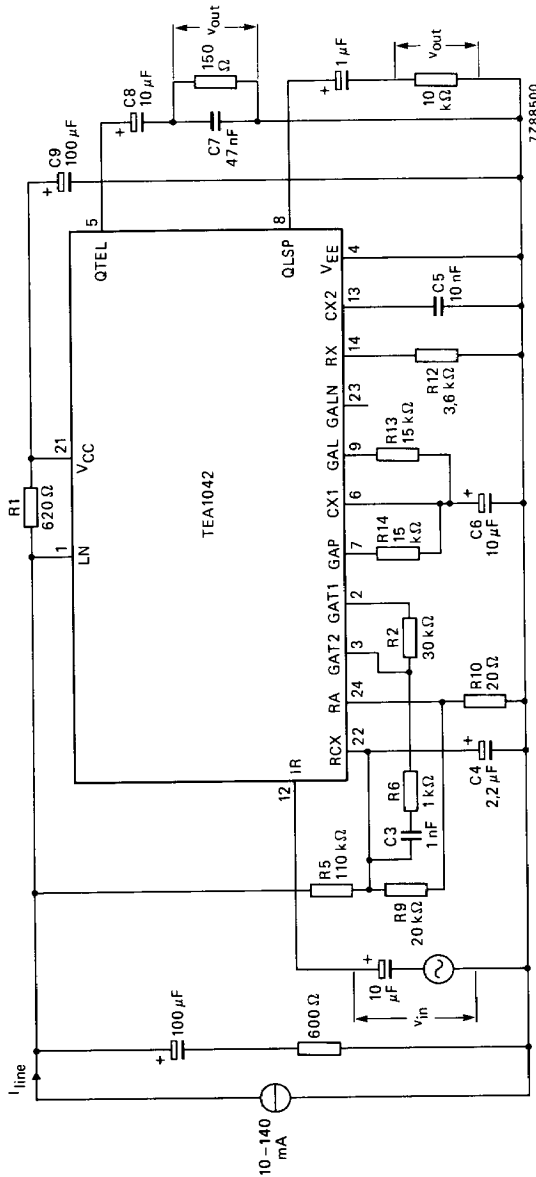


Fig. 8 Test circuit for defining voltage gain of QTEL and QLSP outputs. Gain is defined as: $A_{vd} = 20 \log |v_{out}/v_{in}|$. For measuring the QTEL output the M input should be HIGH and the MUTE input LOW, for measuring the QLSP output M and MUTE should both be LOW.



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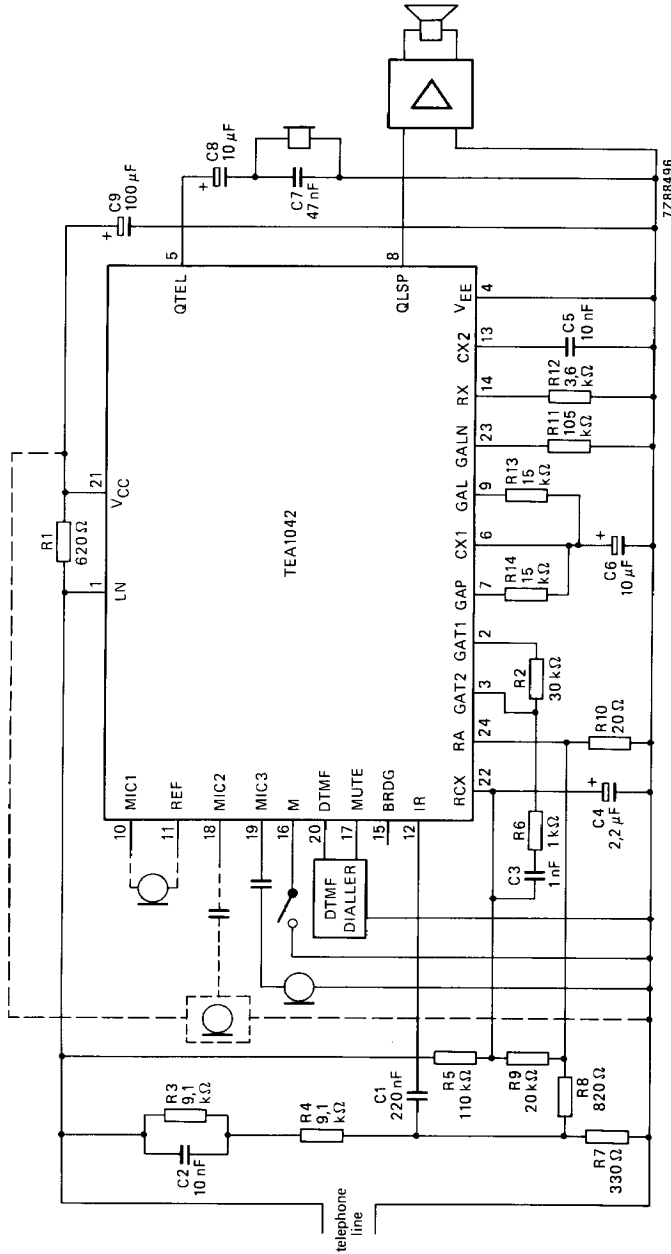


Fig. 9 Typical application of the TEA1042 in an electronic handsfree telephone set. The connections to the MIC1 and MIC2 inputs are alternatives. The connection to the BRDG input is not shown, see the Functional Description. The diagram does not show voice switches and associated control circuits required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

APPLICATION INFORMATION SUPPLIED ON REQUEST