Speech and loudspeaker amplifier IC with auxiliary inputs/outputs and analog multiplexer

TEA1097TV

FEATURES

Line interface

- Low DC line voltage
- Voltage regulator with adjustable DC voltage
- Symmetrical high impedance inputs (70 kΩ) for dynamic, magnetic or electret microphones
- DTMF input with confidence tone on earphone and/or loudspeaker
- Receive amplifier for dynamic, magnetic or piezo-electric earpieces (with externally adjustable gain)
- AGC: automatic gain control for true line loss compensation.

Supplies

- Provides a strong 3.35 V regulated supply for micro-controller or dialler
- Provides filtered power supply, optimized according to line current and compatible with external voltage or current sources
- Filtered 2 V power supply output for electret microphone
- Compatible with a ringer mode
- $\overline{\text{PD}}$ logic input for power down.

Loudspeaker amplifier

- Single-ended rail-to-rail output
- Externally adjustable gain
- Dynamic limiter to prevent distortion
- Logarithmic volume control via linear potentiometer.

Auxiliary interfaces

- Asymmetrical high input impedance for electret microphone
- General purpose auxiliary output for transmit and receive
- Auxiliary transmit input with high signal level capability dedicated to line transmission
- Auxiliary receive input with high signal level capability
- Integrated multiplexer for channels selection.

APPLICATIONS

- Telephone answering machines
- Telephones with digital handsfree
- Line powered telephone sets
- Cordless telephones
- Fax machines.

GENERAL DESCRIPTION

The TEA1097TV is an analog bipolar circuit dedicated for telephony applications. It includes a line interface, handset microphone and earpiece amplifiers, base microphone and loudspeaker amplifiers, some specific auxiliary inputs/outputs (I/Os) and an analog multiplexer to enable the right transmit and/or receive channels. The multiplexer is controlled by a logic circuitry decoding four logic inputs provided by a micro-controller. Twelve different application modes have been defined and can be accessed by selecting the right logic inputs.

This IC can be supplied by the line and/or by the mains if available (in a cordless telephone or a telephone answering machine for example). It provides a 3.35 V supply for a micro-controller and a 2 V filtered voltage supply for electret microphones. The IC is designed to facilitate the use of the loudspeaker amplifier during ringing phase.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1097TV	VSO40	plastic very small outline package; 40 leads	SOT158-1

QUICK REFERENCE DATA

I_{line} = 15 mA; R_{slpe} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; AUXC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; measured according to test circuits; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{line}	line current operating range	normal operation	11	–	130	mA
		with reduced performance	1	–	11	mA
V_{SLPE}	stabilized voltage between SLPE and GND	I_{line} = 15 mA	tbf	3.7	tbf	V
		I_{line} = 70 mA	tbf	6.15	tbf	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA	tbf	3.0	tbf	V
		I_{line} = 70mA	tbf	5.35	tbf	V
V_{DD}	regulated supply voltage on pin V_{DD}	V_{BB} > 3.35 V + 0.25 V (typ.)	–	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
V_{ESI}	external voltage supply allowed on pin ESI		–	–	6	V
I_{ESI}	external current supply allowed on pin ESI		–	–	140	mA
I_{BB}	current available on pin V_{BB}					
	in speech mode		–	11.5	–	mA
	in digital handsfree application	HFC = HIGH	–	9.5	–	mA
$I_{BB(PD)}$	current consumption on V_{BB} during power down phase	$\overline{PD}$ = LOW; AUXC = LOW	–	500	–	μA
$G_{v(MIC-LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 4 mV (RMS)	tbf	44.6	tbf	dB
$G_{v(IR-RECO)}$	voltage gain from pin IR (referred to LN) to RECO	V_{IR} = 15 mV (RMS)	tbf	29.7	tbf	dB
$\Delta G_{v(QR)}$	gain voltage range between pins RECO and QR		–3	–	+15	dB
$G_{v(TXIN-TXOUT)}$	voltage gain from pin TXIN to TXOUT	V_{TXIN} = 8 mV (RMS); R_{GATX} = 30.1 kΩ; note 1	–	15.2	–	dB
$G_{v(TXAUX-LN)}$	voltage gain from pin TXAUX to LN	V_{TXAUX} = 0.1 V (RMS); note 1	–	12.6	–	dB
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	V_{HFRX} = 20 mV(RMS); R_{GALS} = 255 kΩ; note 1	–	27.8	–	dB
$\Delta G_{v(trx)}$	gain control range for transmit and receive amplifiers affected by the AGC; with respect to I_{line} = 15 mA	I_{line} = 70 mA $G_{v(MIC-LN)}$, $G_{v(IR-RECO)}$ and $G_{v(IR-AUXO)}$	tbf	6.2	tbf	dB

Note

1. When the channel is enabled according to Table 1.

BLOCK DIAGRAM

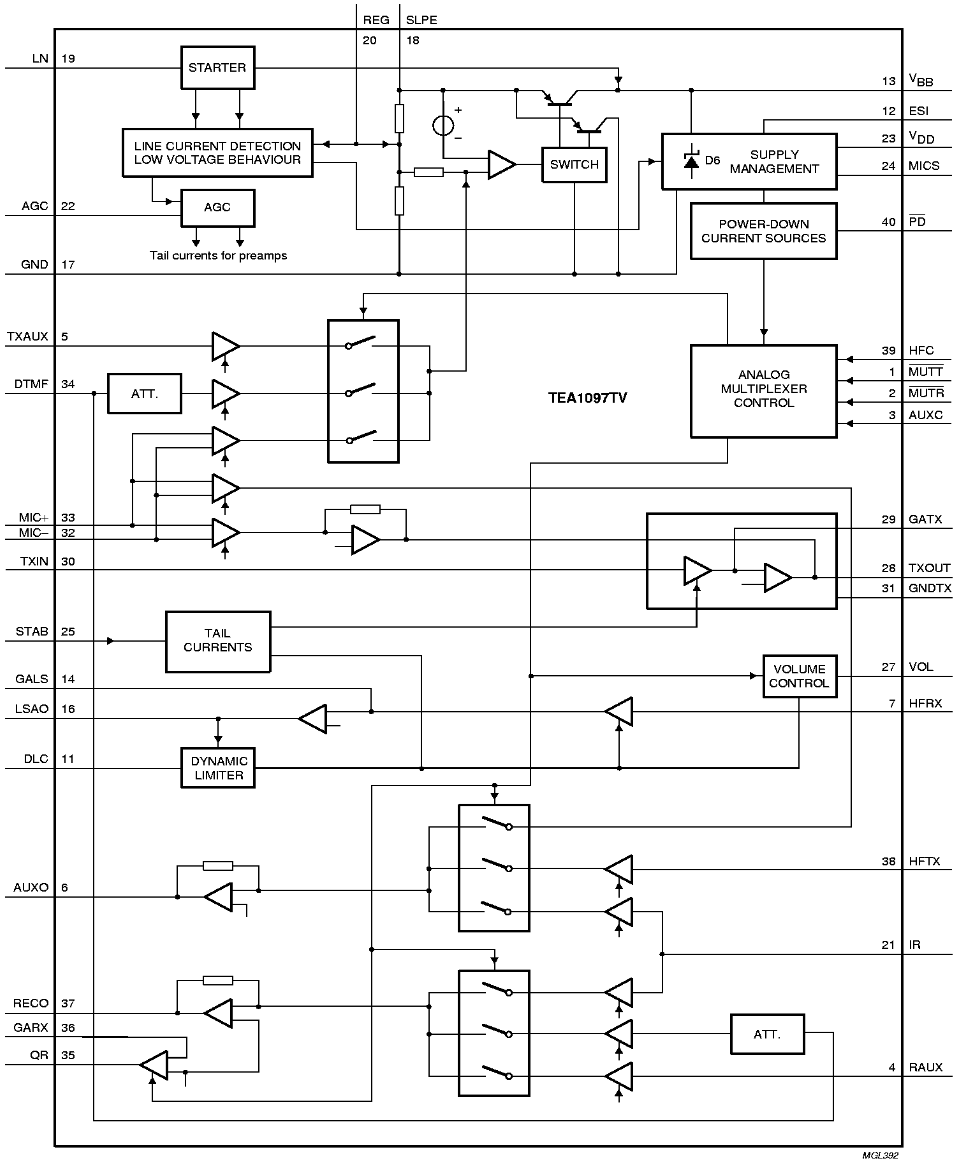


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
$\overline{MUTT}$	1	logic input
$\overline{MUTR}$	2	logic input
AUXC	3	logic input
RAUX	4	auxiliary receive amplifier input
TXAUX	5	auxiliary transmit amplifier input
AUXO	6	auxiliary amplifier output
HFRX	7	receive input for loudspeaker amplifier
n.c.	8	not connected
n.c.	9	not connected
n.c.	10	not connected
DLC	11	dynamic limiter capacitor for the loudspeaker amplifier
ESI	12	external supply input
V_{BB}	13	stabilized supply for internal circuitry
GALS	14	loudspeaker amplifier gain adjustment
n.c.	15	not connected
LSAO	16	loudspeaker amplifier output
GND	17	ground reference
SLPE	18	line current sense
LN	19	positive line terminal
REG	20	line voltage regulator decoupling
IR	21	receive amplifier input
AGC	22	automatic gain control / line loss compensation
V_{DD}	23	3.3 V regulated voltage supply for microcontrollers
MICS	24	microphone supply
STAB	25	reference current adjustment
n.c.	26	not connected
VOL	27	loudspeaker volume adjustment
TXOUT	28	base microphone amplifier output
GATX	29	base microphone amplifier gain adjustment
TXIN	30	base microphone amplifier input
GNDTX	31	ground reference for microphone amplifiers
MIC–	32	negative handset microphone amplifier input
MIC+	33	positive handset microphone amplifier input
DTMF	34	dual tone multi-frequency input
QR	35	earpiece amplifier output
GARX	36	earpiece amplifier gain adjustment
RECO	37	receive amplifier output
HFTX	38	transmit input for auxiliary receive amplifier
HFC	39	logic input
$\overline{PD}$	40	power-down input

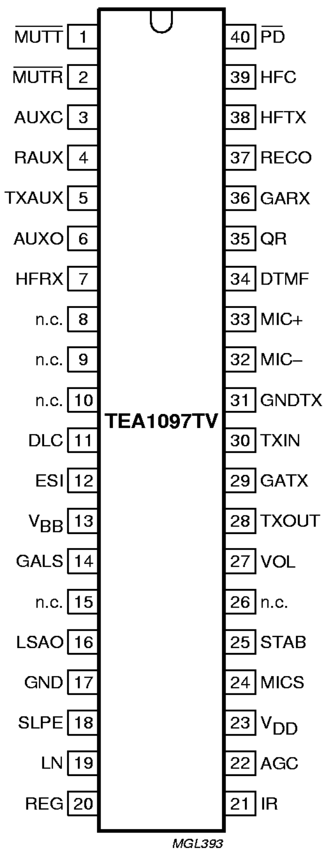


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

All data given in this chapter are typical values, except when otherwise specified.

Supplies

LINE INTERFACE AND INTERNAL SUPPLY (PINS LN, SLPE, REG AND V_{BB})

The supply for the TEA1097TV and its peripherals is obtained from the line. The IC generates a stabilized reference voltage (V_{ref}) between pins SLPE and GND. This reference voltage is equal to 3.7 V for line currents lower than 18 mA. It than increases linearly with the line current and reaches the value of 6.15 V for line currents higher than 46 mA. For line currents below 9 mA, the internal reference voltage generating V_{ref} is automatically adjusted to a lower value. This is the so-called low voltage area and the TEA1097TV has limited performances in this area (see “Low voltage behaviour” section). This reference voltage is temperature compensated.

The voltage between pins SLPE and REG is used by the internal regulator to generate the stabilized reference voltage and is decoupled by means of a capacitor between pins LN and REG. This capacitor converted into an equivalent inductance realizes the set impedance conversion from its DC value (R_{SLPE}) to its AC value (done by an external impedance).

The IC regulates the line voltage at pin LN and it can be calculated as follows:

$$V_{LN} = V_{ref} + R_{SLPE} \times I_{SLPE}$$

$$I_{SLPE} = I_{line} - I^{x}$$

where:

I_{line} = line current

I^{x} = current consumed on pin LN (approximately a few μA)

I_{SLPE} = current flowing through the R_{SLPE} resistor

The preferred value for R_{SLPE} is 20 Ω. Changing this value will affect more than the DC characteristics; it also influences the transmit gains to the line, the gain control characteristic, the sidetone level and the maximum output swing on the line.

As can be seen from Fig.4, the internal circuitry is supplied by pin V_{BB}, which is a strong supply point combined with the line interface. The line current is flowing through the R_{SLPE} resistor and is sunk by the V_{BB} voltage stabilizer, becoming available for a loudspeaker amplifier or any peripheral IC. Its voltage is equal to 3.0 V for line currents lower than 18 mA. It than increases linearly with the line current and reaches the value of 5.35 V for line currents greater than 46 mA. It is temperature compensated.

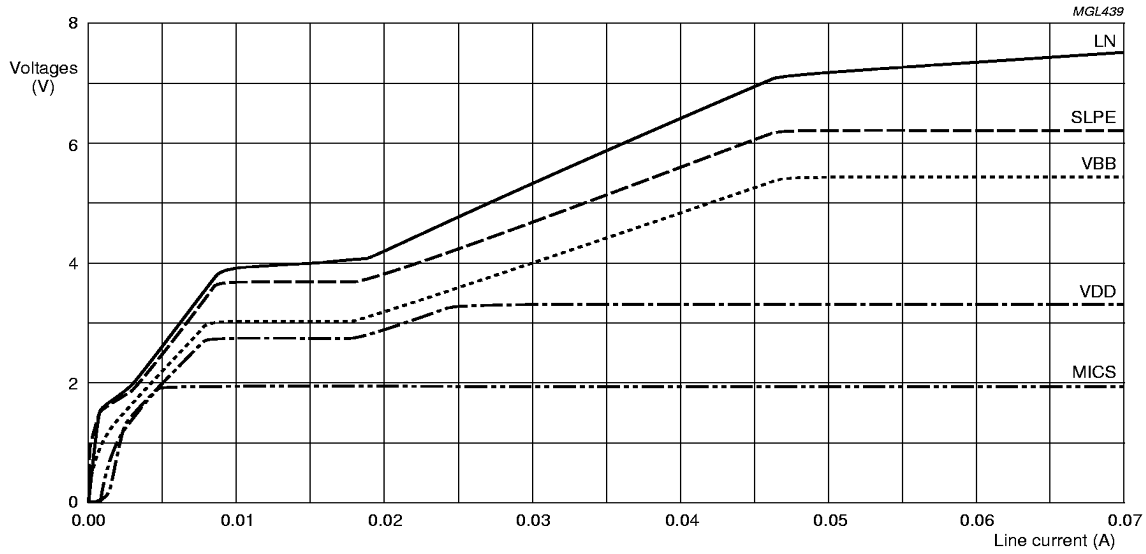


Fig.3 Main voltages versus line current.

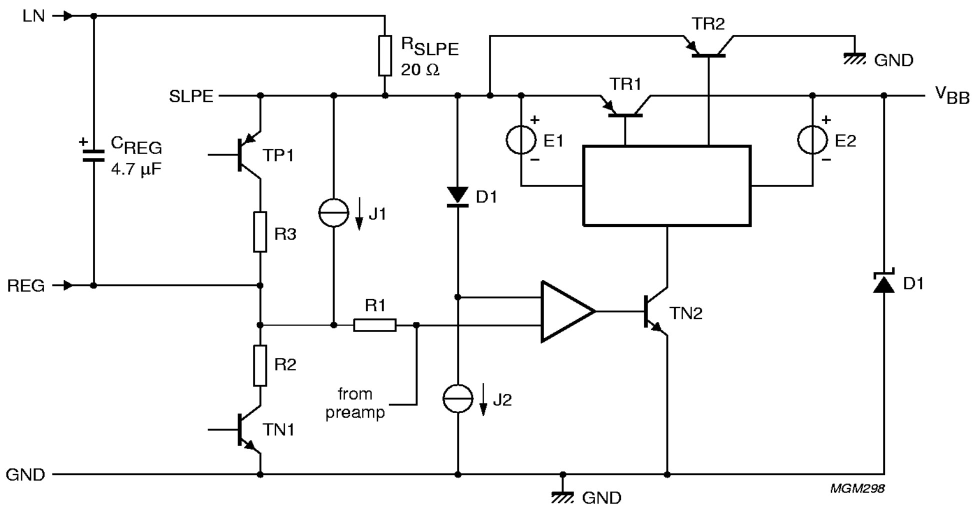


Fig.4 Line interface principle.

The aim of the current switch TR1-TR2 is to reduce distortion of large AC line signals. Current I_{SLPE} is supplied to V_{BB} via TR1 when the voltage on SLPE is greater than V_{BB} + 0.25 V. When the voltage on SLPE is lower than this value, the current I_{SLPE} is shunted to GND via TR2.

The reference voltage V_{ref} can be increased by connecting an external resistor between pins REG and SLPE. For large line currents, this increase can slightly affect some dynamic performances such as maximum signal level on the line for 2% THD. The voltage on pin V_{BB} is not affected by this external resistor.

EXTERNAL SUPPLY (PINS ESI AND V_{BB})

The TEA1097TV can be supplied by the line as well as by external power sources (voltage or current sources) that must be connected at pin ESI.

The IC will choose which supply to use according to the voltage it can provide. A voltage supply on ESI is efficient only if its value is greater than the working voltage of the internal V_{BB} voltage stabilizer. Otherwise the IC continues to be line powered. The current consumed on this source is at least equal to the internal consumption. It depends on the voltage difference between the value forced on ESI and the working voltage of the internal stabilizer. The current required increases with the voltage difference to manage. The excess current compared to the internal consumption becomes then available for other purposes such as supplying a loudspeaker amplifier. The voltage source should not exceed 6 V. If the value of the external voltage source can be lower than the working voltage of the internal stabilizer, an external diode is required to avoid reverse current flowing into the external power supply.

In case of current source, the voltage on V_{BB} and ESI depends on the current available. It is internally limited to 6.6 V. The current source should not exceed 140 mA.

V_{DD} SUPPLY FOR MICRO-CONTROLLER (PIN V_{DD})

The voltage on V_{DD} supply point follows the voltage on V_{BB} with a difference typically equal to 250 mV and is internally limited to 3.35 V. This voltage is temperature compensated. This supply point can provide a current up to 3 mA typically. Its internal consumption stays low (a few 10 nA) as long as V_{DD} does not exceed 1.5 V.

An external voltage can be connected on V_{DD} with limited extra consumption on V_{DD} (typically 120 μA). This voltage source should not be lower than 3.5 V and higher than 6 V.

V_{BB} and V_{DD} can supply external circuits in the limits of currents provided either from the line or from ESI, taking into account the internal current consumption.

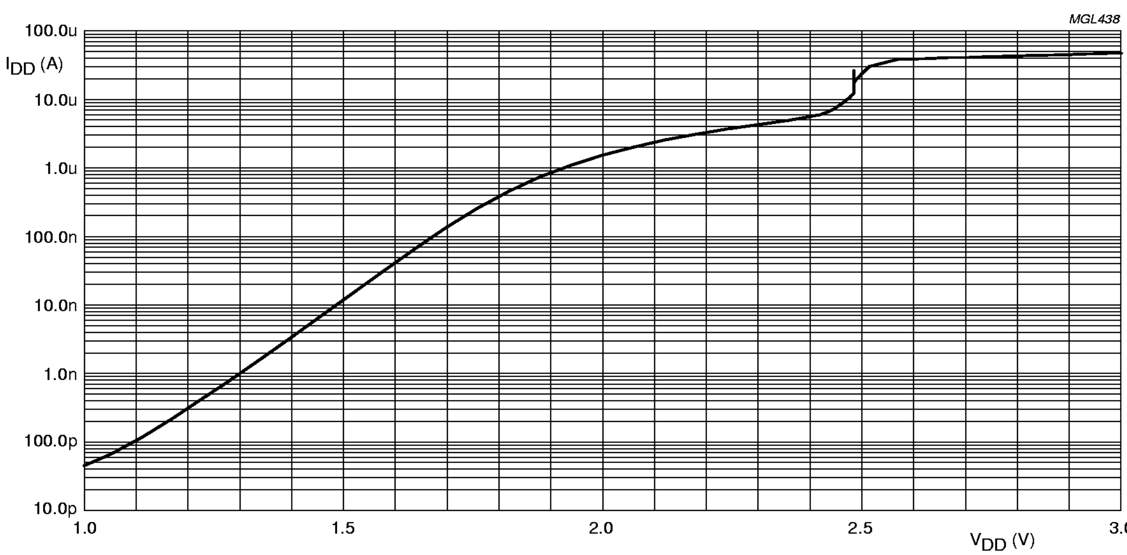


Fig.5 Current consumption on V_{DD}.

SUPPLY FOR MICROPHONE (PINS MICS AND GNDTX)

The MICS output can be used as a supply for an electret microphone. Its voltage is equal to 2 V; it can source current up to 1 mA and has an output impedance equal to 200 Ω.

LOW VOLTAGE BEHAVIOUR

For line currents below 9 mA, the reference voltage is automatically adjusted to a lower value; the V_{BB} voltage follows the SLPE voltage with 250 mV difference. The excess current available for other purposes than DC biasing of the IC becomes small. In this low voltage area, the IC has limited performances.

When the V_{BB} voltage reaches 2.7 V, the V_{BB} detector of the receive dynamic limiter on LSAO acts continuously, discharging the DLC capacitor. In DC condition, the loudspeaker is automatically disabled below this voltage.

When V_{BB} becomes lower than 2.5 V, the TEA1097TV is forced in a low voltage mode whatever the levels on the logic inputs are. It is a speech mode with reduced performances only enabling the microphone channel (between the MIC inputs and LN) and the earpiece amplifier. These two channels are able to deliver signals for line currents as small as 3 mA. The HFC input is tied to GND sinking a current typically equal to 300 μA

POWER-DOWN MODE (PINS $\overline{PD}$ AND AUXC)

To reduce consumption during dialling or register recall (flash), the TEA1097TV is provided with a power-down input ($\overline{PD}$). When the voltage on both pins $\overline{PD}$ and AUXC is LOW, the current consumption from V_{BB} and V_{DD} is reduced to 500 μA. Therefore a capacitor of 470 μF on V_{BB} is sufficient to power the TEA1097TV during pulse dialling or flash. The $\overline{PD}$ input has a pull-up structure, while AUXC has a pull-down structure. In this mode, the capacitor C_{REG} is internally disconnected.

RINGER MODE (PINS ESI, V_{BB}, AUXC AND $\overline{PD}$)

The TEA1097TV is designed to be activated during the ringing phase. The loudspeaker amplifier can be used for the melody signal. The IC must be powered by an external supply on ESI, while applying a ‘high’ level on the logic input AUXC and a ‘low’ level on $\overline{PD}$ input. Only the HFRX input and the LSAO output are activated, in order to limit the current consumption. Some dynamic limitation is provided to prevent V_{BB} from being discharged below 2.7 V.

Transmit channels (pins MIC+, MIC−, DTMF, TXAUX, and LN)

HANDSET MICROPHONE AMPLIFIER (PINS MIC+, MIC− AND LN)

The TEA1097TV has symmetrical microphone inputs. The input impedance between MIC+ and MIC− is typically equal to 70 kΩ. The voltage gain between pins MIC+/MIC− and LN is set to 44.6 dB. Without limitation from the output, the microphone input stage can accommodate signals up to 18 mV (RMS) at room temperature for 2% of total harmonic distortion (THD). The microphone inputs are biased at one diode voltage.

Automatic gain control is provided for line loss compensation.

DTMF AMPLIFIER (PINS DTMF, LN AND RECO)

The TEA1097TV has an asymmetrical DTMF input. The input impedance between DTMF and GND is typically equal to 20 kΩ. The voltage gain between pins DTMF and LN is set to 25.7 dB. Without limitation from the output, the input stage can accommodate signals up to 180 mV (RMS) at room temperature for 2% of total harmonic distortion (THD).

When the DTMF amplifier is enabled, dialling tones may be sent on the line. These tones can be heard in the earpiece or in the loudspeaker at a low level. This is called the confidence tone. The voltage attenuation between pins DTMF and RECO is typically equal to −16.5 dB.

The DC biasing of this input is 0 V.

The automatic gain control has no effect on these channels.

AUXILIARY TRANSMIT AMPLIFIER (PINS TXAUX AND LN)

The TEA1097TV has an asymmetrical auxiliary input TXAUX. The input impedance between TXAUX and GND is typically equal to 20 kΩ. The voltage gain between pins TXAUX and LN is set to 12 dB. Without limitation from the output, the input stage can accommodate signals up to 1.2 V (RMS) at room temperature for 2% of total harmonic distortion (THD). The TXAUX input is biased at two diodes voltage.

Automatic gain control is provided for line loss compensation.

MICROPHONE MONITORING ON TXOUT (PINS MIC+, MIC– AND TXOUT)

The voltage gain between the microphone inputs MIC+/MIC– and the output TXOUT is set to 49.8 dB. This channel gives an image of the signal sent on the line while speaking in the handset microphone. Using an external circuitry, this signal can be used for several purposes such as sending dynamic limitation or anti-howling in a listening-in application. The TXOUT output is biased at two diodes voltage.

The automatic gain control has no effect on these channels.

Receive channels (pins IR, RAUX, RECO, GARX and QR)

RX AMPLIFIER (PINS IR AND RECO)

The receive amplifier has one input IR which is referred to the line. The input impedance between pins IR and LN is typically equal to 20 kΩ and the DC biasing between these pins is equal to one diode voltage. The gain between pins IR (referred to LN) and RECO is typically equal to 29.7 dB. Without limitation from the output, the input stage can accommodate signals up to 50 mV (RMS) at room temperature for 2% of total harmonic distortion (THD).

This receive amplifier has a rail-to-rail output RECO, which is designed for use with high ohmic (real) loads (larger than 5 kΩ). This output is biased at two diodes voltage.

Automatic gain control is provided for line loss compensation.

EARPIECE AMPLIFIER (PINS GARX AND QR)

The earpiece amplifier is an operational amplifier having its output (QR) and its inverting input (GARX) available. Its input signal comes, via a decoupling capacitor, from the receive RECO output. It is used in combination with two resistors to get the required gain or attenuation compared to the receive gain. It can be chosen between –3 dB and 15 dB.

Two external capacitors C_{GAR} (connected between GAR and QR) and C_{GARS} (connected between GAR and GND) ensure stability. The C_{GAR} capacitor provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant C_{GAR} x R_{E2}. The relationship C_{GARS} >= 10 x C_{GAR} must be fulfilled.

The earpiece amplifier has a rail-to-rail output QR, biased at two diodes voltage. It is designed for use with low ohmic (real) loads (150 Ω) or capacitive loads (100 nF in series with 100 Ω).

When the amplifier is turned off, the signal present on the earpiece is equal to the ratio between the load on QR and R_{E1} +R_{E2}

AUXILIARY RECEIVE AMPLIFIER (PINS RAUX AND RECO)

The auxiliary receive amplifier has an asymmetrical input RAUX; it uses the RECO output. Its input impedance between pins RAUX and GND is typically equal to 20 kΩ. The voltage gain between pins RAUX and RECO is equal to −2.3 dB. Without any limitation from the output, the input stage can accommodate signals up to 0.9 V (RMS) at room temperature for 2% of total harmonic distortion (THD).

This auxiliary amplifier has a rail-to-rail output RECO, which is designed for use with high ohmic (real) loads (larger than 5 kΩ). This output is biased at two diodes voltage.

The automatic gain control has no effect on this channel.

Auxiliary amplifiers using AUXO (pins MIC+, MIC–, HFTX, IR and AUXO)

The TEA1097TV has an auxiliary output AUXO, biased at two diodes voltage. This output stage is a rail-to-rail one, designed for use with high ohmic (real) loads (larger than 5 kΩ). The AUXO output amplifier is used in three different channels, two transmit channels and one receive channel.

AUXILIARY AMPLIFIERS USING THE MICROPHONE INPUTS (PINS MIC+, MIC– AND AUXO)

The auxiliary transmit amplifier using the microphone MIC+/MIC– inputs has a gain of 25.2 dB referred to AUXO. Without limitation from the output, the input stage can accommodate signals up to 18 mV (RMS) at room temperature for 2% of total harmonic distortion (THD).

The automatic gain control has no effect on this channel.

AUXILIARY AMPLIFIERS USING HFTX (PINS HFTX AND AUXO)

The auxiliary transmit amplifier using the HFTX input has a gain of 15.2 dB referred to AUXO. The input stage is designed to achieve less than 2% at room temperature of total harmonic distortion (THD) for maximum output signal on AUXO.

The automatic gain control has no effect on this channel.

RX AMPLIFIER USING IR (PINS IR AND AUXO)

The auxiliary receive amplifier uses pin IR as input. The input is referred to LN and the DC biasing between these two pins is one diode voltage. The voltage gain between the input IR (referred to LN) and the output AUXO is typically equal to 32.8 dB, which compensates typically the attenuation provided by the anti-sidetone network.

The input stage is designed to achieve less than 2% at room temperature of total harmonic distortion (THD) for maximum output signal on AUXO.

Automatic gain control is provided for line loss compensation.

AGC (pin AGC)

The TEA1097TV performs automatic line loss compensation, which fits well with the true line attenuation. The automatic gain control varies the gain of some transmit and receive amplifiers in accordance with the DC line current. The control range is 6.2 dB for $G_{v(MIC-LN)}$,$G_{v(IR-RECO)}$, $G_{v(IR-AUXO)}$ and 6.6dB for $G_{v(TXAUX-LN)}$, which corresponds approximately to a line length of 5.5 km for a 0.5 mm twisted-pair copper cable.

To enable this gain control, the pin AGC must be shorted to pin LN. The start current for compensation corresponds to a line current equal to typically 23 mA and the stop current to 57 mA. The start current can be increased by connecting an external resistor between pins AGC and LN. It can be increased up to 40 mA (using a resistor typically equal to 80 kΩ). The start and stop current will be maintained in a ratio equal to 2.5. By leaving the AGC pin opened, the gain control is disabled and no line loss compensation is performed.

Base microphone channel: pins TXIN, GATX, TXOUT and GNDTX (see Fig.6)

The TEA1097TV has an asymmetrical base microphone input TXIN with an input resistance of 20 kΩ. The DC biasing of the input is 0 V.

The output TXOUT is biased at two diodes voltage and has a current capability equal to 20 µA (RMS). The gain of the microphone amplifier (from pins TXIN to TXOUT) can be adjusted from 0 dB up to 31 dB to suit specific application requirements. The gain is proportional to the value of R_{GATX} and equals 15.2 dB with R_{GATX} = 30.1 kΩ. Without limitation from the output, the microphone input stage can accommodate signals up to 18 mV (RMS) at room temperature for 2% of total harmonic distortion (THD).

A capacitor can be connected in parallel with R_{GATX} to provide a first-order low-pass filter.

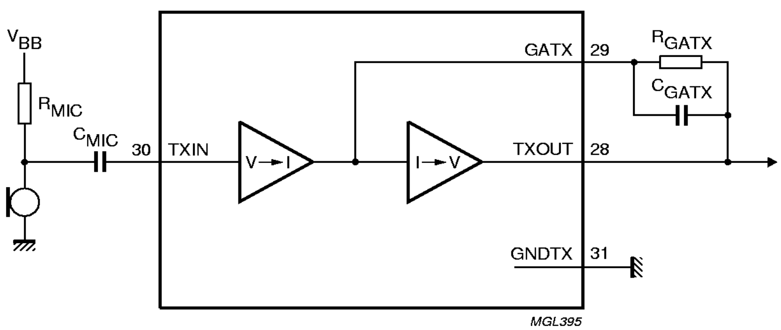


Fig.6 Base microphone channel.

Loudspeaker channel

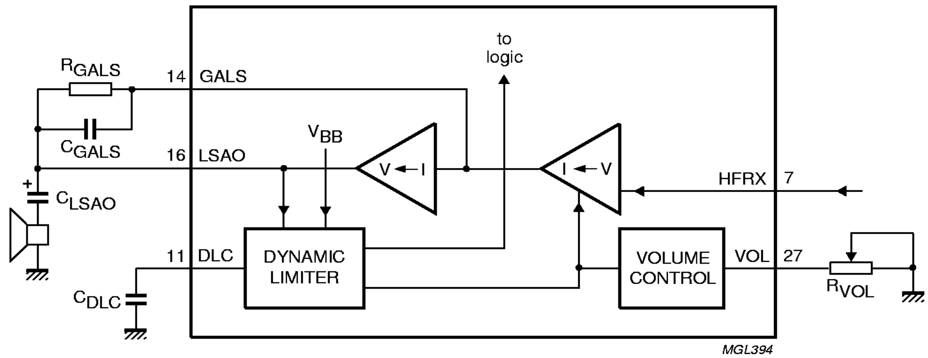


Fig.7 Loudspeaker channel.

LOUDSPEAKER AMPLIFIER: PINS HFRX, GALS AND LSAO

The TEA1097TV has an asymmetrical input for the loudspeaker amplifier with an input resistance of 20 kΩ between HFRX and GND. It is biased at two diodes voltage. The input stage can accommodate signals up to 580 mV (RMS) at room temperature for 2% of total harmonic distortion (THD).

The rail-to-rail output stage is designed to power a loudspeaker down to 8Ω connected as a single-ended load (between LSAO and GND). When the circuit is externally supplied, the maximum output power is typically equal to 280mW for 6V applied on ESI.

The gain of the loudspeaker amplifier can be adjusted from 0 dB up to 35 dB to suit specific application requirements. The gain from HFRX to LSAO is proportional to the value of R_{GALS} and equals 27.8 dB with R_{GALS} = 255 kΩ. A capacitor connected in parallel with R_{GALS} can be used to provide a first-order low-pass filter.

VOLUME CONTROL: PIN VOL

The loudspeaker amplifier gain can be adjusted with the potentiometer R_{VOL}. A linear potentiometer can be used to obtain logarithmic control of the gain at the loudspeaker amplifier. Each 1.9 kΩ increase of R_{VOL} results in a gain loss of 3 dB.

DYNAMIC LIMITER: PIN DLC

The dynamic limiter of the TEA1097TV prevents clipping of the loudspeaker output stage and protects the operation of the circuit when the supply voltage at V_{BB} falls below 2.7 V.

Hard clipping of the loudspeaker output stage is prevented by rapidly reducing the gain when the output stage starts to saturate. The time in which gain reduction is effected (clipping attack time) is approximately a few milliseconds. The circuit stays in the reduced gain mode until the peaks of the loudspeaker signals no longer cause saturation. The gain of the loudspeaker amplifier then returns to its normal value within the clipping release time (typically 100 ms). Both attack and release times are proportional to the value of the capacitor C_{DLC}. The total harmonic distortion of the loudspeaker output stage, in reduced gain mode, stays below 1% up to 10 dB (minimum) of input voltage overdrive [providing V_{HFRX} is below 580 mV (RMS)].

When the supply voltage drops below an internal threshold voltage of 2.7 V, the gain of the loudspeaker amplifier is rapidly reduced (approximately 1 ms). When the supply voltage exceeds 2.7 V, the gain of the loudspeaker amplifier is increased again.

By forcing a level lower than 0.2 V on pin DLC, the loudspeaker amplifier is muted.

Logic inputs

Table 1 Selection of transmit and receive channels for 12 different application modes

LOGIC INPUTS					FEATURES	APPLICATION EXAMPLES
$\overline{PD}$	HFC	$\overline{MUTT}$	$\overline{MUTR}$	AUXC		
0	X	X	X	1	HFRX to LSAO	ringer mode
0	X	X	X	0		flash, DC dialling
1	0	0	0	0	DTMF to LN; DTMF to RECO; QR and MICS are active	DTMF dialling (telephone set)
1	0	0	1	0	MIC to AUXO; RAUX to RECO; QR and MICS are active	cordless intercom with handset
1	0	1	1	0	MIC to LN; IR to RECO; IR to AUXO; MIC to TXOUT; QR and MICS are active	handset conversation (telephone set)
1	0	1	0	1	TXAUX to LN; IR to AUXO	conversation using auxiliary I/O; cordless: digital handsfree in mobile
1	1	0	1	1	RAUX to RECO; HFRX to LSAO	listening on the loudspeaker
1	1	0	0	1	TXAUX to LN; IR to AUXO; RAUX to RECO; HFRX to LSAO	answering machine: play and record messages; listen the recorded message on the loudspeaker
1	1	0	0	0	DTMF to LN; DTMF to RECO; HFRX to LSAO; QR and MICS are active	DTMF dialling in handsfree or group listening modes
1	1	1	0	1	TXAUX to LN; IR to AUXO; IR to RECO; HFRX to LSAO	answering machine: play and record messages while listening in the loudspeaker
1	1	0	1	0	TXIN to TXOUT; HFTX to AUXO; RAUX to RECO; HFRX to LSAO; MICS is active	cordless intercom with base
1	1	1	1	0	TXIN to TXOUT; TXAUX to LN; IR to RECO; IR to AUXO; HFRX to LSAO; MICS is active	digital handsfree conversation
1	1	1	0	0	MIC to LN; IR to RECO; IR to AUXO; HFRX to LSAO; MIC to TXOUT; QR and MICS are active	handset conversation with listening-in

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive continuous line voltage		GND – 0.4	12	V
	repetitive line voltage during switch-on or line interruption		GND – 0.4	13.2	V
V_{ESI}	positive continuous voltage on pin ESI		GND – 0.4	6	V
I_{ESI}	input current at pin ESI		–	140	mA
$V_{n(max)}$	maximum voltage on pins REG, SLPE, IR, AGC		GND – 0.4	V_{LN} + 0.4	V
	maximum voltage on all other pins except V_{DD}		GND – 0.4	V_{BB} + 0.4	V
I_{line}	maximum line current		–	130	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C	–	400	mW
T_{stg}	IC storage temperature		–40	+125	°C
T_{amb}	operating ambient temperature		–25	+75	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	115	K/W

CHARACTERISTICS

I_{line} = 15 mA; R_{slpe} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; AUXC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; measured according to test circuits; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
LINE INTERFACE AND INTERNAL SUPPLY (PINS LN, SLPE, REG AND V_{BB})						
V_{SLPE}	stabilized voltage between SLPE and GND	I_{line} = 15 mA	tbf	3.7	tbf	V
		I_{line} = 70 mA	tbf	6.15	tbf	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA	tbf	3.0	tbf	V
		I_{line} = 70 mA	tbf	5.35	tbf	V
I_{line}	line current for voltage increase					
	start current		–	18	–	mA
	stop current		–	46	–	mA
$\Delta V_{SLPE(T)}$	stabilized voltage variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±60	–	mV
$\Delta V_{BB(T)}$	regulated voltage variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±30	–	mV
I_{BB}	current available on pin V_{BB}					
	in speech mode		–	11.5	–	mA
	in digital handsfree application	HFC = HIGH	–	9.5	–	mA
V_{LN}	line voltage	I_{line} = 1 mA	–	1.6	–	V
		I_{line} = 4 mA	–	2.4	–	V
		I_{line} = 15 mA	tbf	4	tbf	V
		I_{line} = 130 mA	–	8.5	9.3	V
EXTERNAL SUPPLY (PIN ESI)						
V_{ESI}	external voltage supply allowed on pin ESI		–	–	6	V
I_{ESI}	input current on pin ESI	V_{ESI} = 3.5 V	–	3.1	–	mA
I_{ESI}	external current supply allowed on pin ESI		–	–	140	mA
V_{ESI}	voltage on pin ESI when supplied by a current source	I_{ESI} = 140 mA	–	6.6	–	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
SUPPLY FOR PERIPHERALS (PIN V_{DD})						
V_{DD}	regulated supply voltage on V_{DD}	V_{BB} > 3.35 V + 0.25 V (typ.)	–	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
$\Delta V_{DD(T)}$	regulated voltage variation with temperature referred to 25°C	T_{amb} = –25 to +75°C; V_{BB} > 3.35 V + 0.25 V (typ.)	–	±30	–	mV
I_{DD}	current consumption on V_{DD}	in trickle mode; I_{line} = 0 mA; V_{DD} = 1.5 V; V_{BB} discharging	–	15	150	nA
		V_{DD} > 3.35 V	–	120	–	µA
$I_{DD(o)}$	current available for peripherals	V_{DD} = 3.35 V	–	–	–3	mA
SUPPLY FOR MICROPHONE (PIN MICS)						
V_{MICS}	supply voltage for a microphone		–	2	–	V
I_{MICS}	current available on MICS		–	–	–1	mA
POWER DOWN INPUT (PIN $\overline{PD}$)						
V_{IL}	low level input voltage		GND–0.4	–	GND+0.3	V
V_{IH}	high level input voltage		GND+1.8	–	V_{BB} +0.4	V
$I_{\overline{PD}}$	input current		–	–3	–6	µA
$I_{BB(PD)}$	current consumption on V_{BB} during power down phase	$\overline{PD}$ = LOW; AUXC = LOW	–	500	–	µA
RINGER MODE (PINS $\overline{PD}$, AUXC, HFRX, LSAO)						
I_{ESI}	input current on pin ESI	$\overline{PD}$ = LOW; AUXC = HIGH; V_{ESI} = 3.5 V	–	3.2	–	mA
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	$\overline{PD}$ = LOW; AUXC = HIGH; V_{ESI} = 3.5 V V_{HFRX} = 20 mV (RMS); R_{GALS} = 255 kΩ	–	28	–	dB
Preamplifier inputs (pins MIC+, MIC–, IR, DTMF, TXIN, HFTX, HFRX, TXAUX, RAUX)						
$\lvert Z_{i(MIC)} \rvert$	input impedance					
	differential between pins MIC+ and MIC–		–	70	–	kΩ
	single-ended between pins MIC+/MIC– and GNDTX		–	35	–	kΩ
$\lvert Z_{i(IR)} \rvert$	input impedance between pins IR and LN		–	20	–	kΩ
$\lvert Z_{i(DTMF)} \rvert$	input impedance between pins DTMF and GND		–	20	–	kΩ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\lvert Z_{i(TXIN)}\rvert$	input impedance between pins TXIN and GNDTX		–	20	–	kΩ
$\lvert Z_{i(HFTX)}\rvert$	input impedance between pins HFTX and GND		–	20	–	kΩ
$\lvert Z_{i(HFRX)}\rvert$	input impedance between pins HFRX and GND		–	20	–	kΩ
$\lvert Z_{i(TXAUX)}\rvert$	input impedance between pins TXAUX and GND		–	20	–	kΩ
$\lvert Z_{i(RAUX)}\rvert$	input impedance between pins RAUX and GND		–	20	–	kΩ
TX amplifiers; see note 1						
TX HANDSET MICROPHONE AMPLIFIER (PINS MIC+, MIC– AND LN)						
$G_{v(MIC\text{-}LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 5 mV (RMS)	tbf	44.6	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
CMRR	common mode rejection ratio		–	80	–	dB
THD	total harmonic distortion at LN	V_{LN} = 1.4 V (RMS)	–	–	2	%
		I_{line} = 4 mA; V_{LN} = 0.12 V (RMS)	–	–	10	%
$V_{no(LN)}$	noise output voltage at pin LN; pins MIC+/MIC– shorted through 200 Ω	psophometrically weighted (p53 curve)	–	–77.5	–	dBmp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = LOW; AUXC = LOW	60	80	–	dB
DTMF AMPLIFIER (PINS DTMF, LN AND RECO)						
$G_{v(DTMF\text{-}LN)}$	voltage gain from pin DTMF to LN	V_{DTMF} = 50 mV (RMS)	tbf	25.7	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; MUTT = HIGH; MUTR = HIGH; AUXC = LOW	60	80	–	dB
$G_{v(DTMF\text{-}RECO)}$	voltage gain from pin DTMF to RECO	V_{DTMF} = 50 mV (RMS)	–	–16.5	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TX AUXILIARY AMPLIFIER USING TXAUX (PINS TXAUX AND LN)						
$G_{v(TXAUX-LN)}$	voltage gain from pin TXAUX to LN	V_{TXAUX} = 0.1 V (RMS)	tbf	12.6	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
THD	total harmonic distortion at LN	V_{LN} = 1.4 V (RMS)	–	–	2	%
$V_{TXAUX(rms)}$	Maximum input voltage at TXAUX (RMS value)	I_{line} = 70 mA; THD = 2%	1	1.2	–	V
$V_{no(LN)}$	noise output voltage at pin LN; pin TXAUX shorted to GND through 200 Ω in series with 10 µF	psophometrically weighted (p53 curve)	–	–80.5	–	dBmp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; AUXC = LOW	60	80	–	dB
MICROPHONE MONITORING ON TXOUT (PINS MIC+, MIC– AND TXOUT)						
$G_{v(MIC-TXOUT)}$	voltage gain from pin MIC+/MIC– to TXOUT	V_{MIC} = 2 mV (RMS)	tbf	49.8	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.35	–	dB
RX amplifiers; see note 1						
RX AMPLIFIERS USING IR (PINS IR AND RECO)						
$G_{v(IR-RECO)}$	voltage gain from pin IR (referred to LN) to RECO	V_{IR} = 15 mV (RMS)	tbf	29.7	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{IR/LN(rms)}$	Maximum input voltage on IR (referred to LN) (RMS value)	I_{line} = 70 mA; THD = 2%	40	50	–	mV
$V_{RECO(rms)}$	Maximum output voltage on RECO (RMS value)	THD = 2%	0.75	0.9	–	V
$V_{no(RECO)(rms)}$	noise output voltage at pin RECO; pin IR is an open circuit (RMS value)	psophometrically weighted (p53 curve)	–	–88	–	dBVp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; AUXC = LOW	60	80	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
RX EARPIECE AMPLIFIER (PINS GARX AND QR)						
$\Delta G_{v(QR)}$	gain voltage range between pins RECO and QR		–3	–	+15	dB
$V_{QR(rms)}$	maximum output voltage on QR (RMS value)	sine wave drive; R_L = 150 Ω; THD < 2%	0.75	0.9	–	V
$V_{no(QR)(rms)}$	noise output voltage at pin QR; pin IR is an open circuit (RMS value)	$G_{v(QR)}$ = 0 dB; psophometrically weighted (p53 curve)	–	–88	–	dBVp
RX AMPLIFIER USING RAUX (PINS RAUX AND RECO)						
$G_{v(RAUX-RECO)}$	voltage gain from pin RAUX to RECO	V_{RAUX} = 0.4 V (RMS)	tbf	–2.3	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
$V_{RAUX(rms)}$	Maximum input voltage on RAUX (RMS value)	THD = 2%	0.8	0.95	–	V
$V_{no(RECO)(rms)}$	noise output voltage at pin RECO; pin RAUX shorted to GND through 200 Ω in series with 10 µF (RMS value)	psophometrically weighted (p53 curve)	–	–100	–	dBVp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; AUXC = LOW	60	80	–	dB
Auxiliary amplifiers using AUXO; see note 1						
TX AUXILIARY AMPLIFIER USING MIC+ AND MIC– (PINS MIC+, MIC– AND AUXO)						
$G_{v(MIC-AUXO)}$	voltage gain from pin MIC+/MIC– to AUXO	V_{MIC} = 10 mV (RMS)	tbf	25.2	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75°C	–	±0.3	–	dB
$V_{MIC(rms)}$	Maximum input voltage on MIC+/MIC- (RMS value)	THD = 2%	–	18	-	mV
$V_{no(AUXO)}$	noise output voltage at pin AUXO; pins MIC+/MIC– shorted to GNDTX through 200 Ω in series with 10 µF (RMS value)	psophometrically weighted (p53 curve)	–	–91	–	dBVp

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TX AUXILIARY AMPLIFIER USING HFTX (PINS HFTX AND AUXO)						
$G_{v(HFTX-AUXO)}$	voltage gain from pin HFTX to AUXO	V_{HFTX} = 100 mV (RMS)	tbf	15.2	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75°C	–	±0.1	–	dB
$V_{AUXO(rms)}$	Maximum output voltage on AUXO (RMS value)	THD = 2%	0.8	0.9	–	V
$V_{no(AUXO)}$	noise output voltage at pin AUXO; pin HFTX shorted to GND through 200 Ω in series with 10 µF (RMS value)	psophometrically weighted (p53 curve)	–	–91.5	–	dBVp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = LOW; MUTT =LOW ; MUTR = HIGH; AUXC = LOW	60	80	–	dB
RX AMPLIFIER USING IR (PINS IR AND AUXO)						
$G_{v(IR-AUXO)}$	voltage gain from pin IR (referred to LN) to AUXO	V_{IR} = 8 mV (RMS)	tbf	32.8	tbf	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75°C	–	±0.3	–	dB
$V_{AUXO(rms)}$	Maximum output voltage on AUXO (RMS value)	THD = 2%	0.8	0.9	–	V
$V_{no(AUXO)(rms)}$	noise output voltage at pin AUXO; pin IR is an open circuit (RMS value)	psophometrically weighted (p53 curve)	–	–85	–	dBVp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC = HIGH; MUTT = LOW; MUTR = HIGH; AUXC = HIGH	60	80	–	dB
Automatic Gain Control (pin AGC)						
$\Delta G_{v(trx)}$	gain control range for transmit and receive amplifiers affected by the AGC; with respect to I_{line} = 15 mA	I_{line} = 70 mA; $G_{v(MIC-LN)}$; $G_{v(IR-RECO)}$; $G_{v(IR-AUXO)}$	tbf	6.2	tbf	dB
		I_{line} = 70 mA; $G_{v(TXAUX-LN)}$	tbf	6.6	tbf	dB
I_{start}	highest line current for maximum gain		–	23	–	mA
I_{stop}	lowest line current for maximum gain		–	57	–	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Logic inputs (pins HFC, AUXC, $\overline{MUTT}$, $\overline{MUTR}$)						
V_{IL}	low level input voltage		GND–0.4	–	GND+0.3	V
V_{IH}	high level input voltage		GND+1.8	–	V_{BB}+0.4	V
I	input current					
	for pins HFC and AUXC		–	3	6	μA
	for pins $\overline{MUTT}$ and $\overline{MUTR}$		–	–2.5	–6	μA
Base microphone amplifier (pins TXIN, TXOUT and GATX); see note 1						
$G_{v(TXIN-TXOUT)}$	voltage gain from pin TXIN to TXOUT	V_{TXIN} = 8 mV (RMS); R_{GATX} = 30.1 kΩ	–	15.2	–	dB
ΔG_v	voltage gain adjustment with R_{GATX}		–15	–	+16	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75°C	–	±0.15	–	dB
$V_{no(TXOUT)(rms)}$	noise output voltage at pin TXOUT; pin TXIN is shorted through 200 Ω in series with 10 μF to GNDTX (RMS value)	psophometrically weighted (p53 curve)	–	–101	–	dBVp
$\Delta G_{v(m)}$	gain reduction if not activated	HFC =HIGH; MUTT = LOW; MUTR = LOW; AUXC = LOW	60	80	–	dB
Loudspeaker amplifier (pins HFRX, LSAO, GALS and VOL); see note 1						
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	V_{HFRX} = 20 mV (RMS); R_{GALS} = 255 kΩ	tbf	27.8	tbf	dB
ΔG_v	voltage gain adjustment with R_{GALS}		–28	–	+7	dB
$\Delta G_{v(f)}$	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.3	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referred to 25°C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$\Delta G_{v(vol)}$	voltage gain variation related to ΔR_{VOL} = 1.9 kΩ		–	–3	–	dB
$V_{HFRX(rms)}$	maximum input voltage at pin HFRX (RMS value)	I_{line} = 70 mA; R_{GALS} = 33 kΩ; for 2% THD in the input stage	450	580	–	mV
$V_{no(LSAO)(rms)}$	noise output voltage at pin LSAO; pin HFRX is open circuit (RMS value)	psophometrically weighted (p53 curve)	–	–79	–	dBVp

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{LSAO(rms)}$	output voltage (RMS value)	I_{BB} = 0 mA; I_{DD} = 1 mA				
		I_{line} = 18 mA	–	0.9	–	V
		I_{line} = 30 mA	–	1.2	–	V
		I_{line} > 50 mA	–	1.6	–	V
$I_{LSAO(max)}$	maximum output current at pin LSAO (peak value)	external supply on ESI	150	300	–	mA
Dynamic limiter (pins LSAO and DLC); see note 1						
t_{att}	attack time	when V_{HFRX} jumps from 20 mV rms to 20 mV rms + 10 dB	–	–	5	ms
		when V_{BB} jumps below $V_{BB(th)}$	–	1	–	ms
t_{rel}	release time	when V_{HFRX} jumps from 20 mV rms + 10 dB to 20 mV rms	–	100	–	ms
THD	Total Harmonic Distortion at V_{HFRX} = 20 mV + 10 dB	$t > t_{att}$	–	0.1	2	%
$V_{BB(th)}$	V_{BB} limiter threshold		–	2.7	–	V
Mute Loudspeaker (pin DLC); see note 1						
$V_{DLC(th)}$	threshold voltage required on pin DLC to obtain mute receive condition		GND–0.4	–	GND+0.2	V
$I_{DLC(th)}$	threshold current sourced by pin DLC in mute receive condition	V_{DLC} = 0.2 V	–	100	–	μA
$\Delta G_{vrx(m)}$	voltage gain reduction in mute receive condition	V_{DLC} = 0.2 V	60	80	–	dB

Note

1. When the channel is enabled according to Table 1.

TEST AND APPLICATION INFORMATION

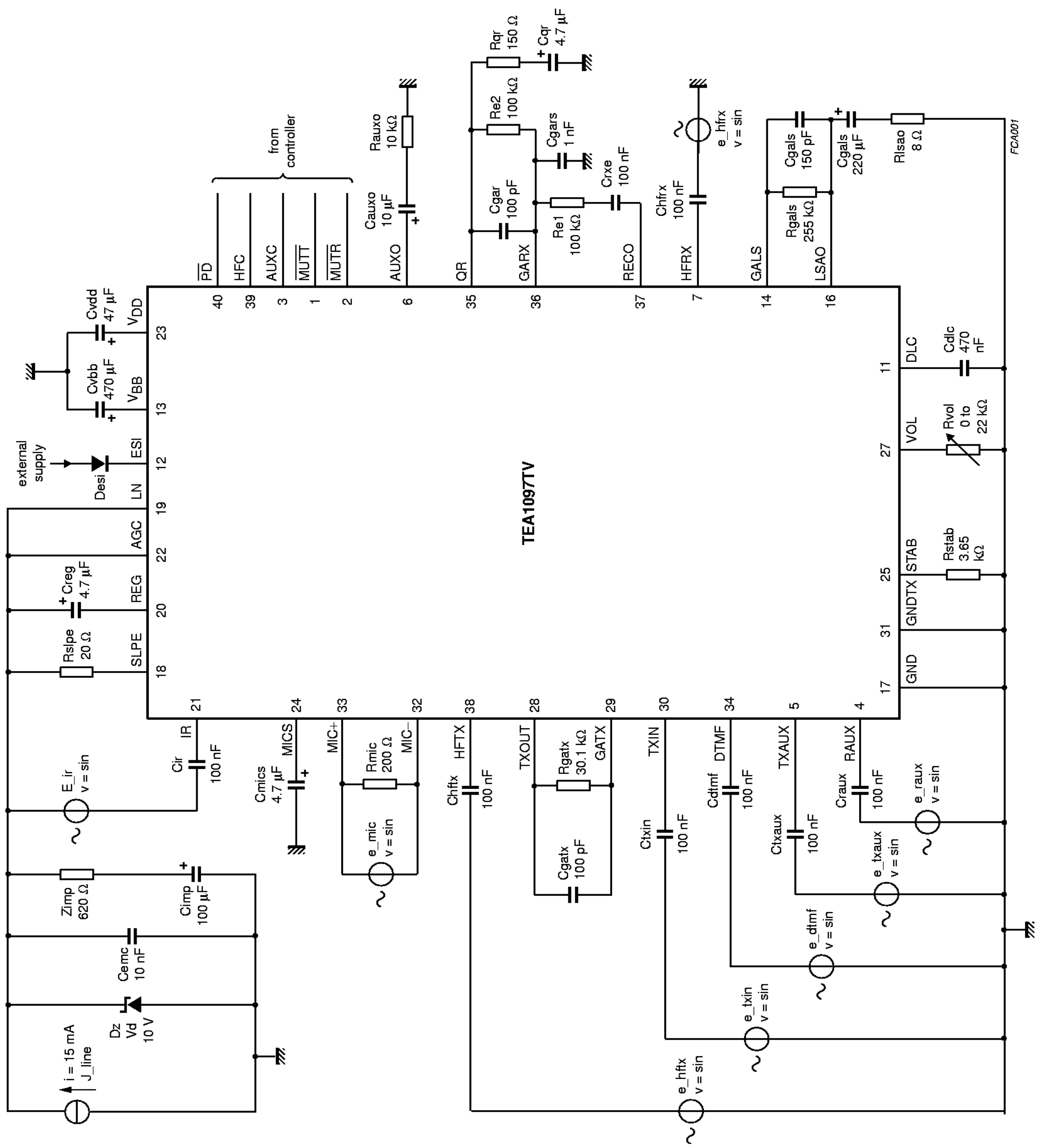


Fig.8 Test circuit.

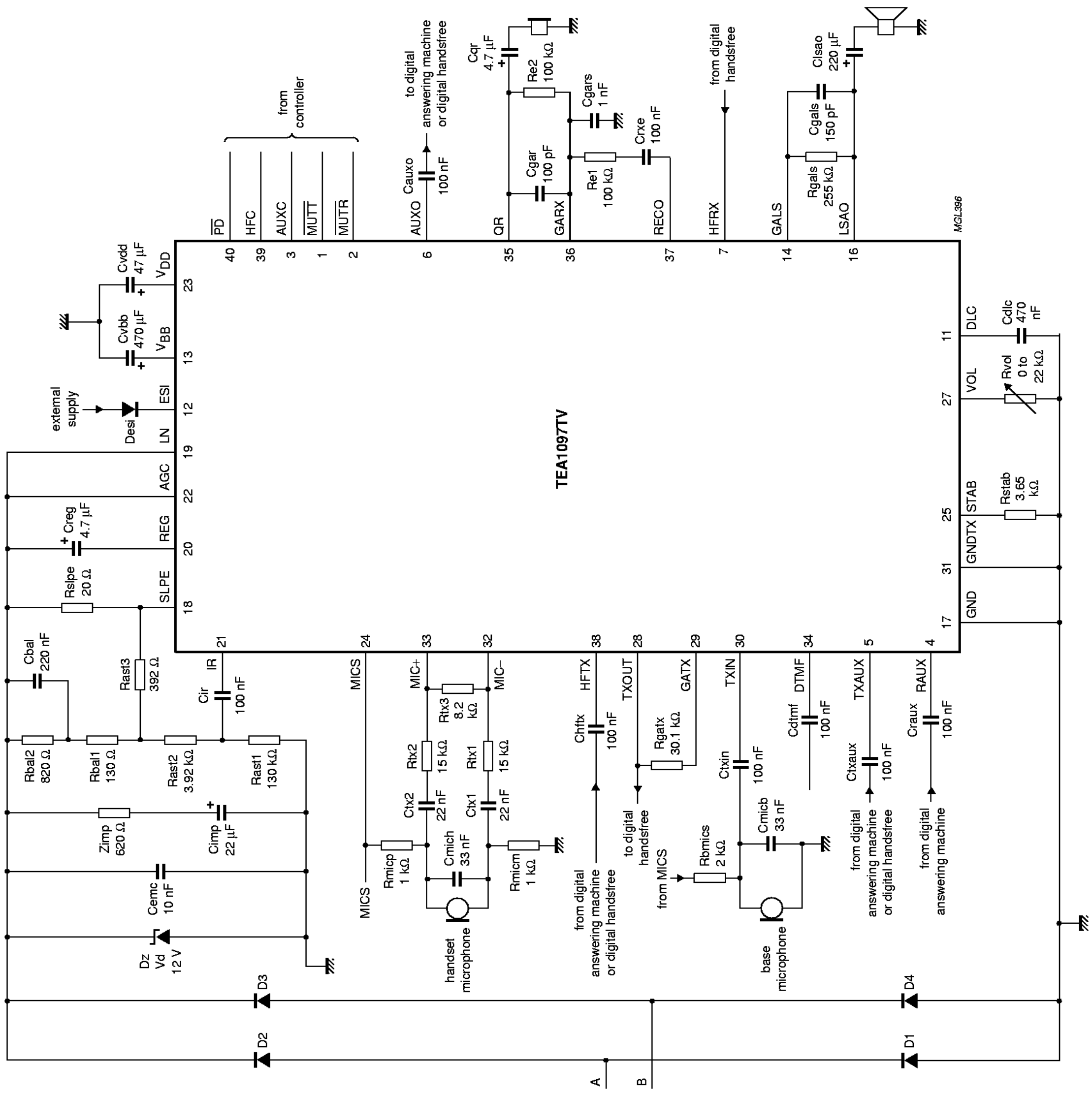
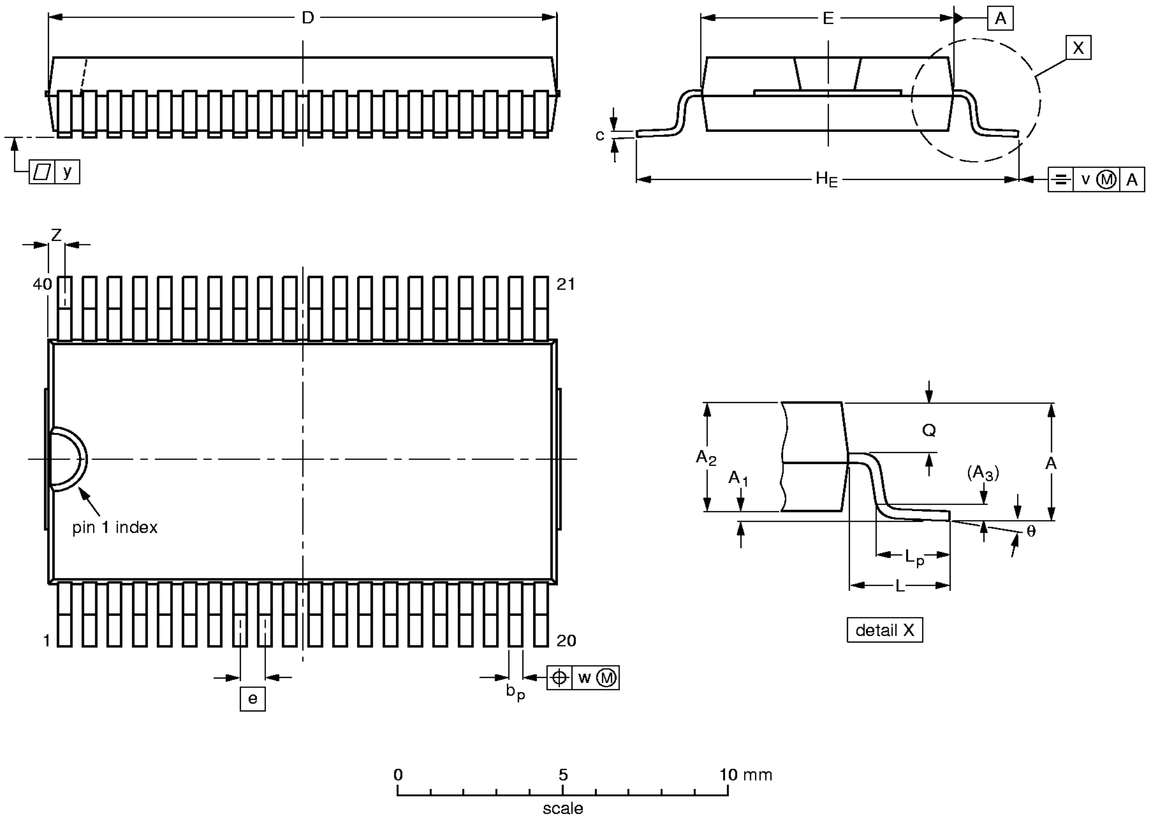


Fig.9 Basic application diagram.

PACKAGE OUTLINE

VSO40: plastic very small outline package; 40 leads **SOT158-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D(1)	E(2)	e	H_E	L	L_p	Q	v	w	y	Z(1)	θ
mm	2.70	0.3 0.1	2.45 2.25	0.25	0.42 0.30	0.22 0.14	15.6 15.2	7.6 7.5	0.762	12.3 11.8	2.25	1.7 1.5	1.15 1.05	0.2	0.1	0.1	0.6 0.3	7° 0°
inches	0.11	0.012 0.004	0.096 0.089	0.010	0.017 0.012	0.0087 0.0055	0.61 0.60	0.30 0.29	0.03	0.48 0.46	0.089	0.067 0.059	0.045 0.041	0.008	0.004	0.004	0.024 0.012	

Notes

1. Plastic or metal protrusions of 0.4 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT158-1						~~92-11-17~~ 95-01-24

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (order code 9398 652 90011).

Reflow soldering

Reflow soldering techniques are suitable for all VSO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Wave soldering

Wave soldering techniques can be used for all VSO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.