

Hands free IC**TEA1094; TEA1094A****FEATURES**

- Low power consumption
- Power-down function (TEA1094A only)
- Microphone channel with:
 - externally adjustable gain
 - microphone mute function.
- Loudspeaker channel with:
 - externally adjustable gain
 - dynamic limiter to prevent distortion
 - rail-to-rail output stage for single-ended load drive
 - logarithmic volume control via linear potentiometer
 - loudspeaker mute function.
- Duplex controller consisting of:
 - signal envelope and noise envelope monitors for both channels with:
 - externally adjustable sensitivity
 - externally adjustable signal envelope time constant
 - externally adjustable noise envelope time constant
 - decision logic with:
 - externally adjustable switch-over timing
 - externally adjustable idle mode timing
 - externally adjustable dial tone detector in receive channel
 - voice switch control with:
 - adjustable switching range
 - constant sum of gain during switching
 - constant sum of gain at different volume settings.

APPLICATIONS

- Mains, battery or line-powered telephone sets with hands-free/listening-in functions
- Cordless telephones
- Answering machines
- Fax machines.

GENERAL DESCRIPTION

The TEA1094 and TEA1094A are bipolar circuits intended for use in mains, battery or line-powered telephone sets, cordless telephones, answering machines and Fax machines. In conjunction with a member of the TEA106X, TEA111X families of transmission circuits, the devices offer a hands-free function. They incorporate a microphone amplifier, a loudspeaker amplifier and a duplex controller with signal and noise monitors on both channels.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1094	DIP28	plastic dual in-line package; 28 leads (600 mil)	SOT117-1
TEA1094A	DIP24	plastic dual in-line package; 24 leads (600 mil)	SOT101-1
TEA1094T	SO28	plastic small outline package; 28 leads; body width 7.5 mm	SOT136-1
TEA1094AT	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1
TEA1094AM	SSOP24	plastic shrink small outline package; 24 leads; body width 5.3 mm	SOT340-1

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QUICK REFERENCE DATA

$V_{BB} = 5\text{ V}$; $V_{GND} = 0\text{ V}$; $f = 1\text{ kHz}$; $T_{amb} = 25\text{ °C}$; $MUTET = \text{LOW}$; $PD = \text{LOW}$ (TEA1094A only); $R_L = 50\text{ }\Omega$; $R_{VOL} = 0\text{ }\Omega$; measured in test circuit of Fig.12; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{BB}	supply voltage		3.3	–	12.0	V
I_{BB}	current consumption from pin V_{BB}		–	3.1	4.4	mA
G_{vtx}	voltage gain from pin MIC to pin MOUT in transmit mode	$V_{MIC} = 1\text{ mV (RMS)}$; $R_{GAT} = 30.1\text{ k}\Omega$	13	15.5	18	dB
ΔG_{vtxr}	voltage gain adjustment with R_{GAT}		–15.5	–	+15.5	dB
G_{vrX}	voltage gain in receive mode; the difference between RIN1 and RIN2 to LSP	$V_{RIN} = 20\text{ mV (RMS)}$; $R_{GAR} = 66.5\text{ k}\Omega$; $R_L = 50\text{ }\Omega$	16	18.5	21	dB
ΔG_{vrXr}	voltage gain adjustment with R_{GAR}		–18.5	–	+14.5	dB
$V_{O(p-p)}$	output voltage (peak-to-peak value)	$V_{RIN} = 150\text{ mV (RMS)}$; $R_{GAR} = 374\text{ k}\Omega$; $R_L = 33\text{ }\Omega$; $V_{BB} = 9.0\text{ V}$; note 1	–	7.5	–	V
SWRA	switching range		–	40	–	dB
$\Delta SWRA$	switching range adjustment with R_{SWR} referenced to $R_{SWR} = 365\text{ k}\Omega$		–40	–	+12	dB
T_{amb}	operating ambient temperature		–25	–	+75	°C

Note

1. Corresponds to 200 mW output power.

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BLOCK DIAGRAM

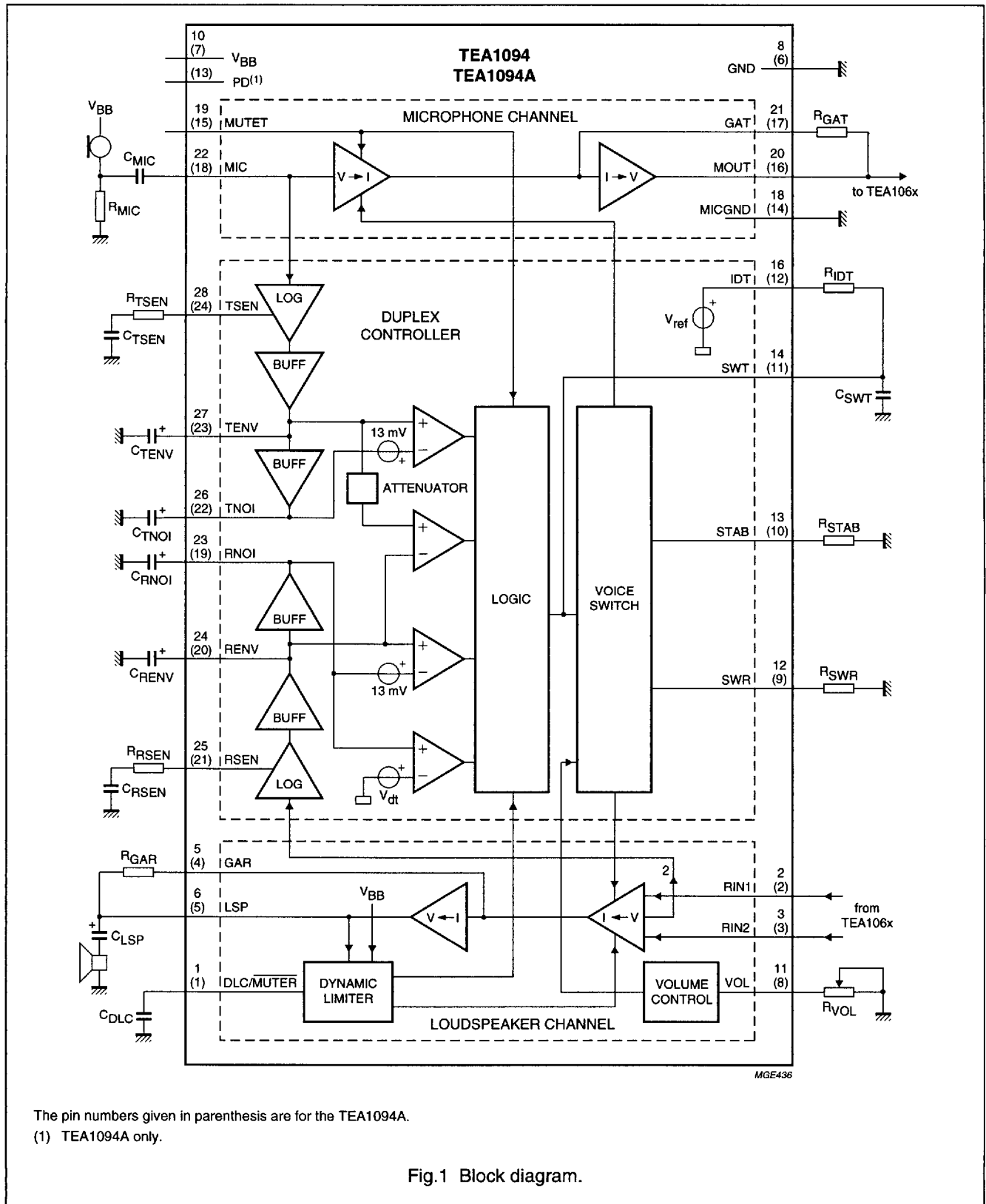


Fig.1 Block diagram.

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PINNING

SYMBOL	PINS		DESCRIPTION
	TEA1094	TEA1094A	
DLC/MUTER	1	1	dynamic limiter timing adjustment; receiver channel mute input
RIN1	2	2	receiver amplifier input 1
RIN2	3	3	receiver amplifier input 2
n.c.	4	–	not connected
GAR	5	4	receiver gain adjustment
LSP	6	5	loudspeaker amplifier output
n.c.	7	–	not connected
GND	8	6	ground reference
n.c.	9	–	not connected
V _{BB}	10	7	supply voltage
VOL	11	8	receiver volume adjustment
SWR	12	9	switching range adjustment
STAB	13	10	reference current adjustment
SWT	14	11	switch-over timing adjustment
n.c.	15	–	not connected
IDT	16	12	idle mode timing adjustment
PD	–	13	power-down input
n.c.	17	–	not connected
MICGND	18	14	ground reference for the microphone amplifier
MUTET	19	15	transmit channel mute input
MOUT	20	16	microphone amplifier output
GAT	21	17	microphone gain adjustment
MIC	22	18	microphone input
RNOI	23	19	receive noise envelope timing adjustment
RENV	24	20	receive signal envelope timing adjustment
RSEN	25	21	receive signal envelope sensitivity adjustment
TNOI	26	22	transmit noise envelope timing adjustment
TENV	27	23	transmit signal envelope timing adjustment
TSEN	28	24	transmit signal envelope sensitivity adjustment

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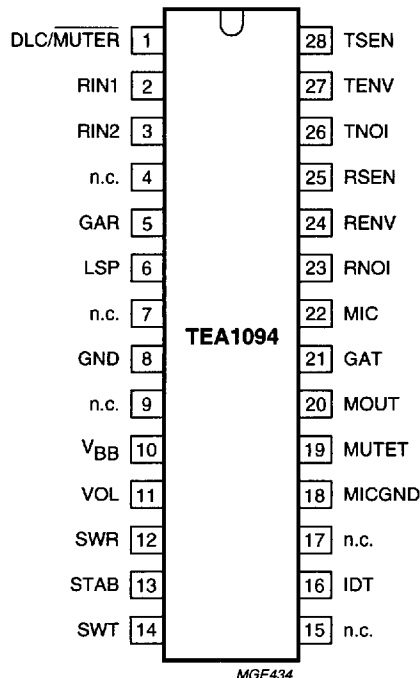


Fig.2 Pin configuration (TEA1094).

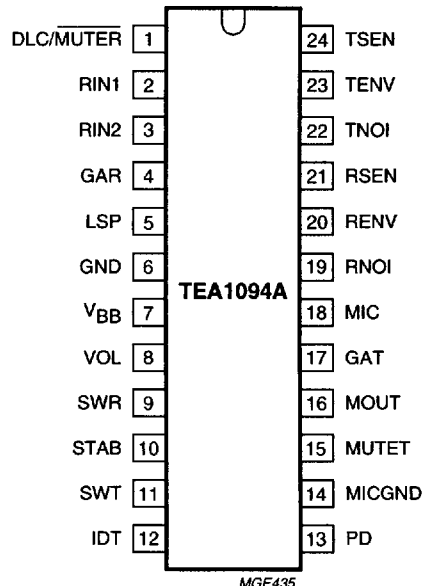


Fig.3 Pin configuration (TEA1094A).

FUNCTIONAL DESCRIPTION

General

The values given in the functional description are typical values unless otherwise specified.

A principle diagram of the TEA106X is shown on the left side of Fig.4. The TEA106X is a transmission circuit of the TEA1060 family intended for hand-set operation. It incorporates a receiving amplifier for the earpiece, a transmit amplifier for the microphone and a hybrid. For more details on the TEA1060 family, please refer to "data Handbook IC03". The right side of Fig.4 shows a principle diagram of the TEA1094 and TEA1094A, hands-free add-on circuits with a microphone amplifier, a loudspeaker amplifier and a duplex controller.

As can be seen from Fig.4, a loop is formed via the sidetone network in the transmission circuit and the acoustic coupling between loudspeaker and microphone of the hands-free circuit. When this loop gain is greater than 1, howling is introduced. In a full duplex application, this would be the case.

The loop-gain has to be much lower than 1 and therefore

has to be decreased to avoid howling. This is achieved by the duplex controller. The duplex controller of the TEA1094 and TEA1094A detects which channel has the 'largest' signal and then controls the gain of the microphone amplifier and the loudspeaker amplifier so that the sum of the gains remains constant.

As a result, the circuit can be in three stable modes:

1. Transmit mode (Tx mode).

The gain of the microphone amplifier is at its maximum and the gain of the loudspeaker amplifier is at its minimum.

2. Receive mode (Rx mode).

The gain of the loudspeaker amplifier is at its maximum and the gain of the microphone amplifier is at its minimum.

3. Idle mode.

The gain of the amplifiers is halfway between their maximum and minimum value.

The difference between the maximum gain and minimum gain is called the switching range.

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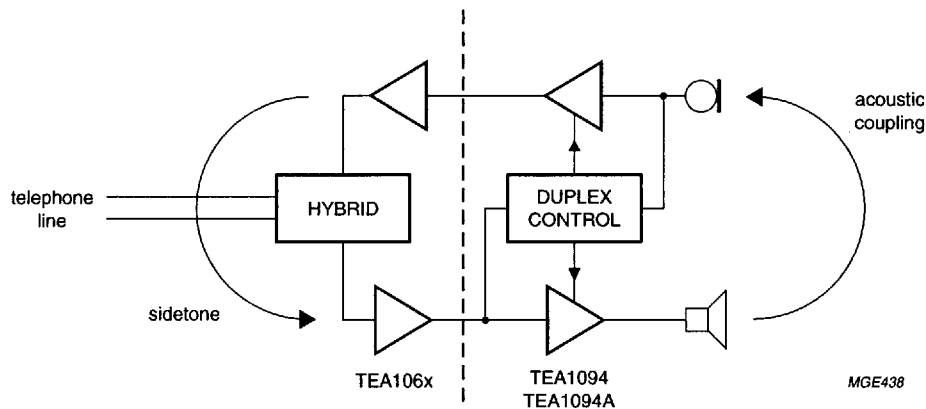


Fig.4 Hands-free telephone set principles.

Supply: pins V_{BB} , GND and PD

The TEA1094 and TEA1094A must be supplied with an external stabilized voltage source between pins V_{BB} and GND. In the idle mode, without any signal, the internal supply current is 3.1 mA at $V_{BB} = 5$ V.

To reduce the current consumption during pulse dialling or register recall (flash), the TEA1094A is provided with a power-down (PD) input. When the voltage on PD is HIGH the current consumption from V_{BB} is 180 μ A.

Microphone channel: pins MIC, GAT, MOUT, MICGND and MUTET (see Fig.5)

The TEA1094 and TEA1094A have an asymmetrical microphone input MIC with an input resistance of 20 k Ω . The gain of the input stage varies according to the mode of the TEA1094 and TEA1094A. In the transmit mode, the gain is at its maximum; in the receive mode, it is at its minimum and in the idle mode, it is halfway between maximum and minimum.

Switch-over from one mode to the other is smooth and click-free. The output capability at pin MOUT is 20 μ A (RMS).

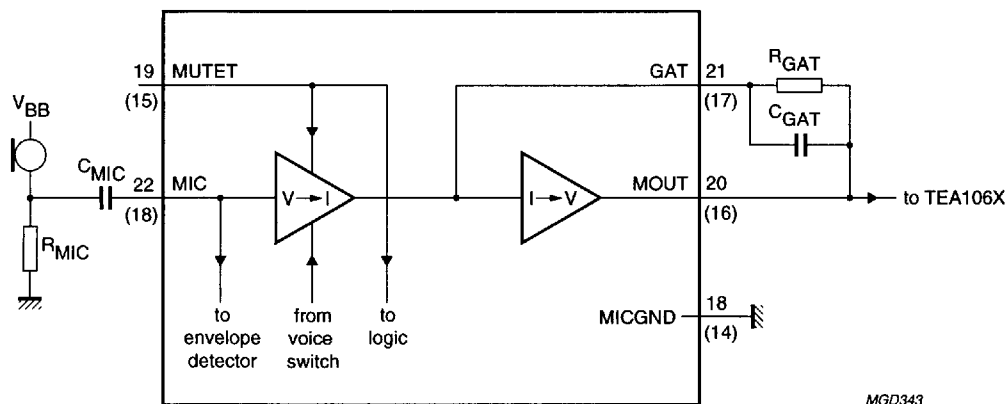
In the transmit mode, the overall gain of the microphone amplifier (from pins MIC to MOUT) can be adjusted from 0 dB up to 31 dB to suit specific application requirements. The gain is proportional to the value of R_{GAT} and equals 15.5 dB with $R_{GAT} = 30.1$ k Ω .

A capacitor must be connected in parallel with R_{GAT} to ensure stability of the microphone amplifier. Together with R_{GAT} , it also provides a first-order low-pass filter.

By applying a HIGH level on pin MUTET, the microphone amplifier is muted and the TEA1094 and TEA1094A are automatically forced into the receive mode.

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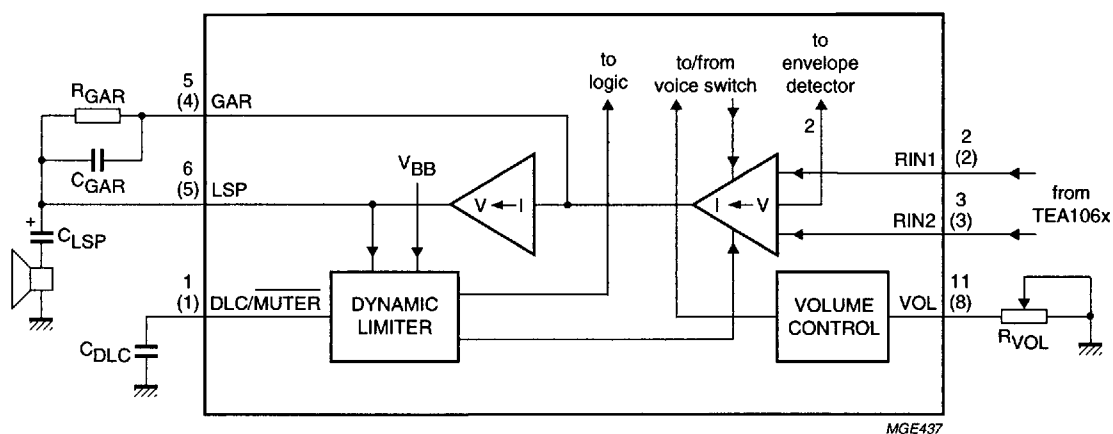
TEA1094; TEA1094A



The pin numbers given in parenthesis refer to the TEA1094A.

Fig.5 Microphone channel.

Loudspeaker channel



The pin numbers given in parenthesis refer to the TEA1094A.

Fig.6 Loudspeaker channel.

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LOUDSPEAKER AMPLIFIER: PINS RIN1, RIN2, GAR AND LSP

The TEA1094 and TEA1094A have symmetrical inputs for the loudspeaker amplifier with an input resistance of $40\text{ k}\Omega$ between RIN1 and RIN2 ($2 \times 20\text{ k}\Omega$). The input stage can accommodate signals up to 390 mV (RMS) at room temperature for 2% of total harmonic distortion (THD). The gain of the input stage varies according to the mode of the TEA1094 and TEA1094A. In the receive mode, the gain is at its maximum; in the transmit mode, it is at its minimum and in the idle mode, it is halfway between maximum and minimum. Switch-over from one mode to the other is smooth and click-free. The rail-to-rail output stage is designed to power a loudspeaker connected as a single-ended load (between LSP and GND).

In the receive mode, the overall gain of the loudspeaker amplifier can be adjusted from 0 dB up to 33 dB to suit specific application requirements. The gain from RIN1 and RIN2 to LSP is proportional to the value of R_{GAR} and equals 18.5 dB with $R_{\text{GAR}} = 66.5\text{ k}\Omega$. A capacitor connected in parallel with R_{GAR} 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 $950\text{ }\Omega$ increase of R_{VOL} results in a gain loss of 3 dB . The maximum gain reduction with the volume control is internally limited to the switching range.

DYNAMIC LIMITER: PIN DLC/MUTER

The dynamic limiter of the TEA1094 and TEA1094A prevents clipping of the loudspeaker output stage and protects the operation of the circuit when the supply voltage at V_{BB} falls below 2.9 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 250 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 5% up to 10 dB (minimum) of input voltage overdrive [providing V_{RIN} is below 390 mV (RMS)].

When the supply voltage drops below an internal threshold voltage of 2.9 V , the gain of the loudspeaker amplifier is rapidly reduced (approximately 1 ms). When the supply voltage exceeds 2.9 V , the gain of the loudspeaker amplifier is increased again.

By forcing a level lower than 0.2 V on pin $\text{DLC}/\overline{\text{MUTER}}$, the loudspeaker amplifier is muted and the TEA1094 (TEA1094A) is automatically forced into the transmit mode.

Duplex controller

SIGNAL AND NOISE ENVELOPE DETECTORS: PINS TSEN, TENV, TNOI, RSEN, RENV AND RNOI

The signal envelopes are used to monitor the signal level strength in both channels. The noise envelopes are used to monitor background noise in both channels. The signal and noise envelopes provide inputs for the decision logic. The signal and noise envelope detectors are shown in Fig.7.

For the transmit channel, the input signal at MIC is 40 dB amplified to TSEN. For the receive channel, the differential signal between RIN1 and RIN2 is 0 dB amplified to RSEN. The signals from TSEN and RSEN are logarithmically compressed and buffered to TENV and RENV respectively. The sensitivity of the envelope detectors is set with R_{TSEN} and R_{RSEN} . The capacitors connected in series with the two resistors block any DC component and form a first-order high-pass filter. In the basic application, see Fig.13, it is assumed that $V_{\text{MIC}} = 1\text{ mV}$ (RMS) and $V_{\text{RIN}} = 100\text{ mV}$ (RMS) nominal and both R_{TSEN} and R_{RSEN} have a value of $10\text{ k}\Omega$. With the value of C_{TSEN} and C_{RSEN} at 100 nF , the cut-off frequency is at 160 Hz .

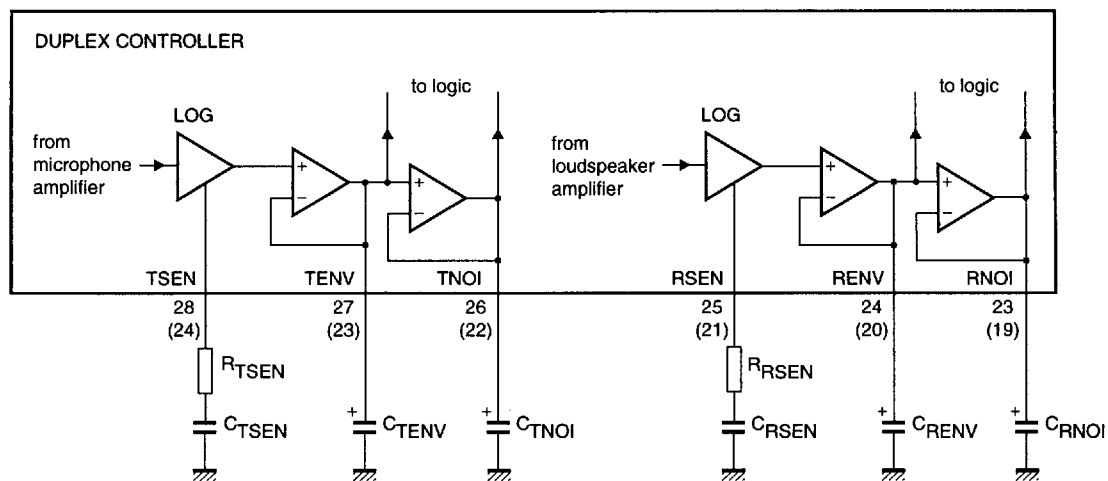
The buffer amplifiers leading the compressed signals to TENV and RENV have a maximum source current of $120\text{ }\mu\text{A}$ and a maximum sink current of $1\text{ }\mu\text{A}$. Together with the capacitor C_{TENV} and C_{RENV} , the timing of the signal envelope monitors can be set. In the basic application, the value of both capacitors is 470 nF . Because of the logarithmic compression, each 6 dB signal increase means 18 mV increase of the voltage on the envelopes TENV or RENV at room temperature. Thus, timings can be expressed in dB/ms . At room temperature, the $120\text{ }\mu\text{A}$ sourced current corresponds to a maximum rise-slope of the signal envelope of $85\text{ dB}/\text{ms}$. This is sufficient to track normal speech signals. The $1\text{ }\mu\text{A}$ current sunk by TENV or RENV corresponds to a maximum fall-slope of $0.7\text{ dB}/\text{ms}$. This is sufficient for a smooth envelope and also eliminates the effect of echoes on switching behaviour.

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To determine the noise level, the signals on TENV and RENV are buffered to TNOI and RNOI. These buffers have a maximum source current of $1\ \mu\text{A}$ and a maximum sink current of $120\ \mu\text{A}$. Together with the capacitors C_{TNOI} and C_{RNOI} , the timing can be set. In the basic application of Fig.13 the value of both capacitors is $4.7\ \mu\text{F}$. At room temperature, the $1\ \mu\text{A}$ sourced current corresponds to a maximum rise-slope of the noise envelope of approximately $0.07\ \text{dB/ms}$.

This is small enough to track background noise and not to be influenced by speech bursts. The $120\ \mu\text{A}$ current that is sunk corresponds to a maximum fall-slope of approximately $8.5\ \text{dB/ms}$. However, during the decrease of the signal envelope, the noise envelope tracks the signal envelope so it will never fall faster than approximately $0.7\ \text{dB/ms}$. The behaviour of the signal envelope and noise envelope monitors is illustrated in Fig.8.



The pin numbers given in parenthesis refer to the TEA1094A.

MGD223

Fig.7 Signal and noise envelope detectors.

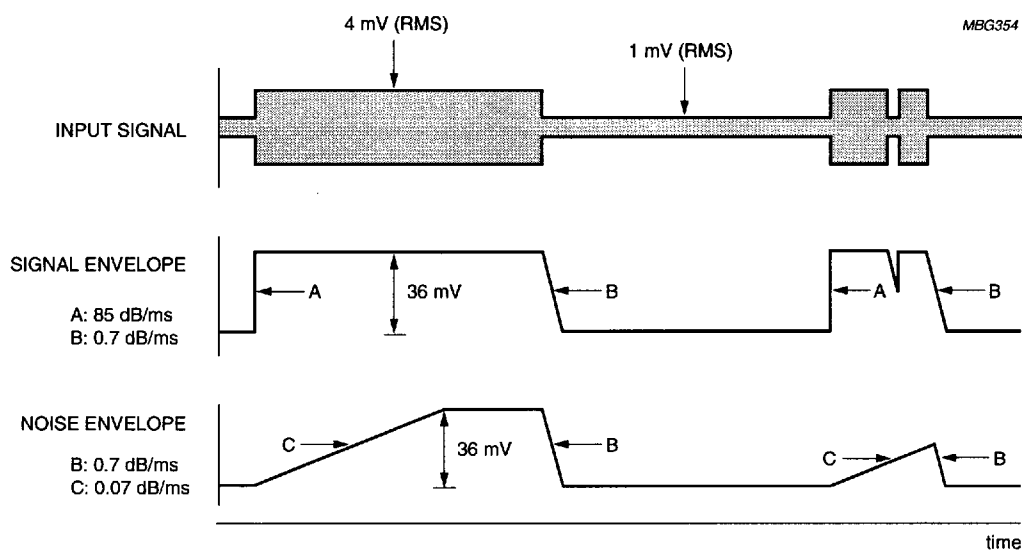
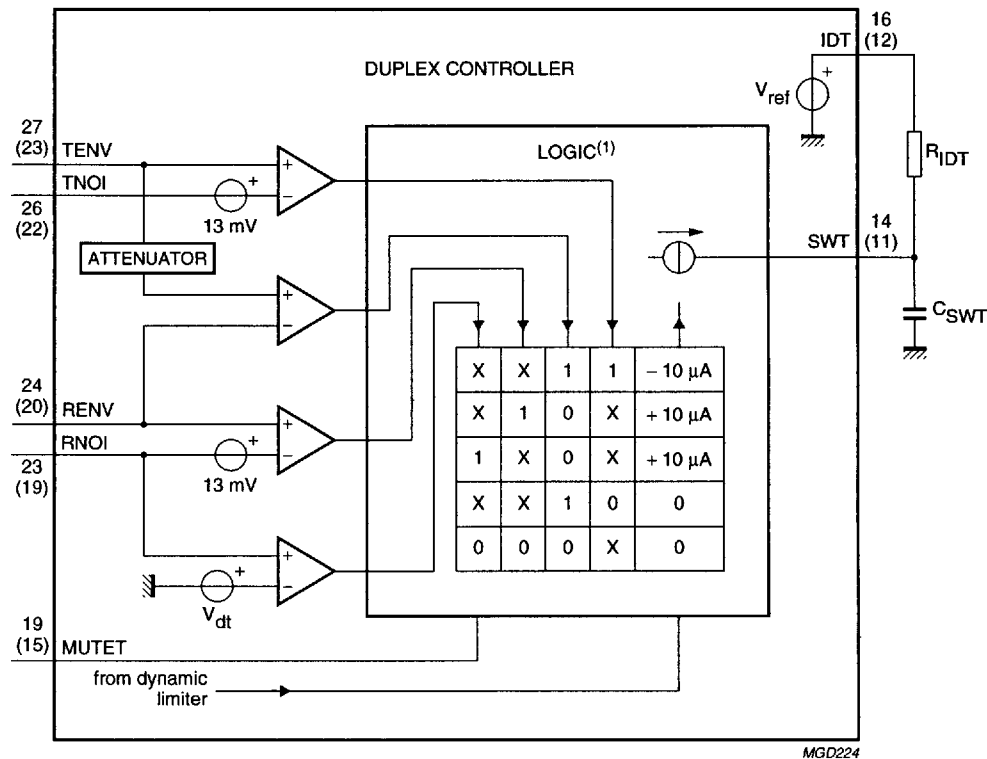


Fig.8 Signal and noise envelope waveforms.

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DECISION LOGIC: PINS IDT AND SWT



The pin numbers given in parenthesis refer to the TEA1094A.

(1) When MUTET = HIGH, +10 μ A is forced.

When DLC/MUTET < 0.2 V, -10 μ A is forced.

Fig.9 Decision logic.

The TEA1094 and TEA1094A select their modes of operation (transmit, receive or idle mode) by comparing the signal and the noise envelopes of both channels. This is executed by the decision logic. The resulting voltage on pin SWT is the input for the voice-switch.

To facilitate the distinction between signal and noise, the signal is considered as speech when its envelope is more than 4.3 dB above the noise envelope. At room temperature, this is equal to a voltage difference $V_{ENV} - V_{NOI} = 13$ mV. This so called speech/noise threshold is implemented in both channels.

The signal on MIC contains both speech and the signal coming from the loudspeaker (acoustic coupling). When receiving, the contribution from the loudspeaker overrules the speech.

As a result, the signal envelope on TENV is formed mainly by the loudspeaker signal. To correct this, an attenuator is connected between TENV and the TENV/RENV comparator. Its attenuation equals that applied to the microphone amplifier.

When a dial tone is present on the line, without monitoring, the tone would be recognized as noise because it is a signal with a constant amplitude. This would cause the TEA1094 (TEA1094A) to go into the idle mode and the user of the set would hear the dial tone fade away. To prevent this, a dial tone detector is incorporated which, in standard applications, does not consider input signals between RIN1 and RIN2 as noise when they have a level greater than 127 mV (RMS). This level is proportional to R_{RSEN} .

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As can be seen from Fig.9, the output of the decision logic is a current source. The logic table gives the relationship between the inputs and the value of the current source. It can charge or discharge the capacitor C_{SWT} with a current of $10\ \mu\text{A}$ (switch-over). If the current is zero, the voltage on SWT becomes equal to the voltage on IDT via the high-ohmic resistor R_{IDT} (idling). The resulting voltage difference between SWT and IDT determines the mode of the TEA1094 (TEA1094A) and can vary between -400 and $+400\ \text{mV}$ (see Table 1).

Table 1 Modes of TEA1094; TEA1094A

$V_{SWT} - V_{IDT} \text{ (mV)}$	MODE
< -180	transmit mode
0	idle mode
> 180	receive mode

The switch-over timing can be set with C_{SWT} , the idle mode timing with C_{SWT} and R_{IDT} . In the basic application given in Fig.13, C_{SWT} is $220\ \text{nF}$ and R_{IDT} is $2.2\ \text{M}\Omega$. This enables a switch-over time from transmit mode to receive mode or vice-versa of approximately $13\ \text{ms}$ ($580\ \text{mV}$ swing on SWT). The switch-over time from idle mode to transmit mode or receive mode is approximately $4\ \text{ms}$ ($180\ \text{mV}$ swing on SWT).

The switch-over time, from receive mode or transmit mode to idle mode, is equal to $4 \times R_{IDT}C_{SWT}$ and is approximately 2 seconds (idle mode time).

The inputs MUTET and $\overline{\text{DLC/MUTER}}$ overrule the decision logic. When MUTET goes HIGH, the capacitor C_{SWT} is charged with $10\ \mu\text{A}$ thus resulting in the receive mode. When the voltage on pin $\overline{\text{DLC/MUTER}}$ goes lower than $0.2\ \text{V}$, the capacitor C_{SWT} is discharged with $10\ \mu\text{A}$ thus resulting in the transmit mode.

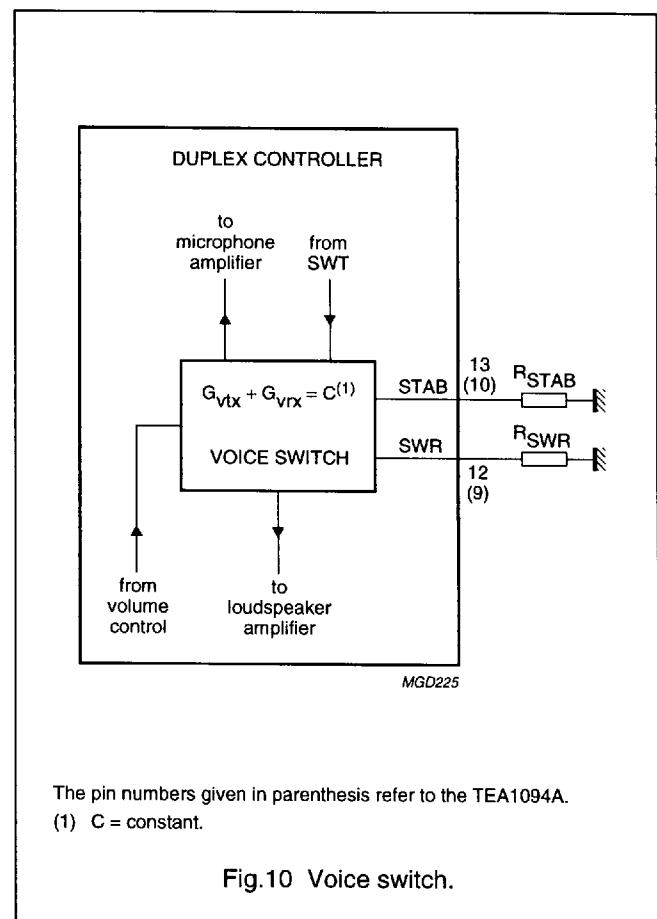
VOICE-SWITCH: PINS STAB AND SWR

A diagram of the voice-switch is illustrated in Fig.10. With the voltage on SWT, the TEA1094 (TEA1094A) voice-switch regulates the gains of the transmit and the receive channel so that the sum of both is kept constant.

In the transmit mode, the gain of the microphone amplifier is at its maximum and the gain of the loudspeaker amplifier is at its minimum. In the receive mode, the opposite applies. In the idle mode, both microphone and loudspeaker amplifier gains are halfway.

The difference between maximum and minimum is the so called switching range. This range is determined by the ratio of R_{SWR} and R_{STAB} and is adjustable between 0 and $52\ \text{dB}$. R_{STAB} should be $3.65\ \text{k}\Omega$ and sets an internally used reference current. In the basic application diagram given in Fig.13, R_{SWR} is $365\ \text{k}\Omega$ which results in a switching range of $40\ \text{dB}$. The switch-over behaviour is illustrated in Fig.11.

In the receive mode, the gain of the loudspeaker amplifier can be reduced using the volume control. Since the voice-switch keeps the sum of the gains constant, the gain of the microphone amplifier is increased at the same time (see dashed curves in Fig.11). In the transmit mode, however, the volume control has no influence on the gain of the microphone amplifier or the gain of the loudspeaker amplifier. Consequently, the switching range is reduced when the volume is reduced. At maximum reduction of volume, the switching range becomes $0\ \text{dB}$.



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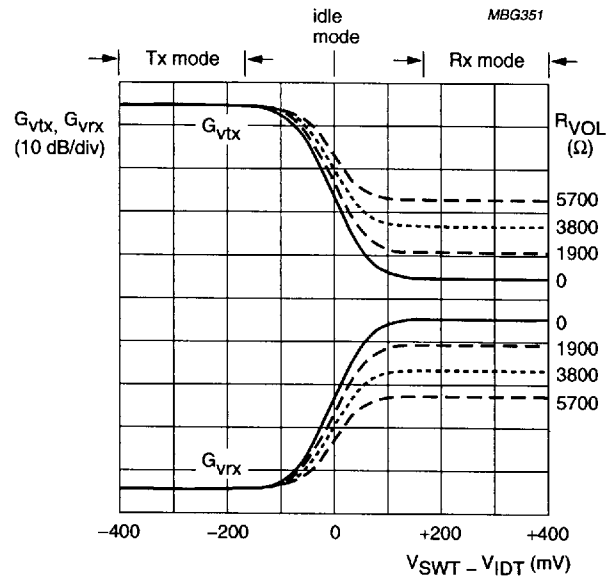


Fig.11 Switch-over behaviour.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{n(max)}$	maximum voltage on all pins; except pins V_{BB} , RIN1 and RIN2		$V_{GND} - 0.4$	$V_{BB} + 0.4$	V
$V_{RIN(max)}$	maximum voltage on pins RIN1 and RIN2		$V_{GND} - 1.2$	$V_{BB} + 0.4$	V
$V_{BB(max)}$	maximum voltage on pin V_{BB}		$V_{GND} - 0.4$	12.0	V
P_{tot}	total power dissipation TEA1094 TEA1094A TEA1094T TEA1094AT TEA1094AM	$T_{amb} = 75\text{ }^{\circ}\text{C}$	—	1000 910 625 590 438	mW mW mW mW mW
T_{stg}	IC storage temperature		-40	+125	$^{\circ}\text{C}$
T_{amb}	operating ambient temperature		-25	+75	$^{\circ}\text{C}$

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THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient in free air		
	TEA1094	45	K/W
	TEA1094A	50	K/W
	TEA1094T	70	K/W
	TEA1094AT	75	K/W
	TEA1094AM	104	K/W

CHARACTERISTICS

$V_{BB} = 5\text{ V}$; $V_{GND} = 0\text{ V}$; $f = 1\text{ kHz}$; $T_{amb} = 25\text{ °C}$; $MUTET = \text{LOW}$; $PD = \text{LOW}$ (TEA1094A only); $R_L = 50\text{ }\Omega$; $R_{VOL} = 0\text{ }\Omega$; measured in test circuit of Fig.12; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (V_{BB}, GND and PD)						
V_{BB}	supply voltage		3.3	–	12.0	V
I_{BB}	current consumption from pin V_{BB}		–	3.1	4.4	mA
POWER-DOWN INPUT PD (TEA1094A ONLY)						
V_{IL}	LOW level input voltage		$V_{GND} - 0.4$	–	0.3	V
V_{IH}	HIGH level input voltage		1.5	–	$V_{BB} + 0.4$	V
I_{PD}	input current	PD = HIGH	–	2.5	5	μA
$I_{BB(PD)}$	current consumption from pin V_{BB} in power-down condition	PD = HIGH	–	180	240	μA
Microphone channel (MIC, GAT, MOUT, MUTET and MICGND)						
MICROPHONE AMPLIFIER						
$ Z_i $	input impedance between pins MIC and MICGND		17	20	23	$\text{k}\Omega$
G_{vtx}	voltage gain from pin MIC to MOUT in transmit mode	$V_{MIC} = 1\text{ mV (RMS)}$	13	15.5	18	dB
ΔG_{vtxr}	voltage gain adjustment with R_{GAT}		–15.5	–	+15.5	dB
ΔG_{vtxT}	voltage gain variation with temperature referenced to 25 °C	$V_{MIC} = 1\text{ mV (RMS)}$; $T_{amb} = -25\text{ to }+75\text{ °C}$	–	± 0.3	–	dB
ΔG_{vtxf}	voltage gain variation with frequency referenced to 1 kHz	$V_{MIC} = 1\text{ mV (RMS)}$; $f = 300\text{ to }3400\text{ Hz}$	–	± 0.3	–	dB
V_{notx}	noise output voltage at pin MOUT	pin MIC connected to MICGND through 200 Ω in series with 10 μF ; psophometrically weighted (P53 curve)	–	–100	–	dBmp

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TRANSMIT MUTE INPUT MUTET						
V_{IL}	LOW level input voltage		$V_{GND} - 0.4$	–	0.3	V
V_{IH}	HIGH level input voltage		1.5	–	$V_{BB} + 0.4$	V
I_{MUTET}	input current	MUTET = HIGH	–	2.5	5	μA
ΔG_{vtxm}	voltage gain reduction with MUTET active	MUTET = HIGH	–	80	–	dB
Loudspeaker channel (RIN1, RIN2, GAR, LSP and DLC/MUTER)						
LOUDSPEAKER AMPLIFIER						
$ Z_i $	input impedance	between pins RIN1 or RIN2 and GND	17	20	23	$k\Omega$
		between pins RIN1 and RIN2	34	40	46	$k\Omega$
G_{vrx}	voltage gain in receive mode; between RIN1 and RIN2 to LSP	$V_{RIN} = 20 \text{ mV (RMS)}$	16	18.5	21	dB
ΔG_{vrxr}	voltage gain adjustment with R_{GAR}		–18.5	–	+14.5	dB
ΔG_{vrxT}	voltage gain variation with temperature referenced to 25 °C	$V_{RIN} = 20 \text{ mV (RMS)}$; $T_{amb} = -25 \text{ to } +75 \text{ }^\circ\text{C}$	–	± 0.3	–	dB
ΔG_{vrxf}	voltage gain variation with frequency referenced to 1 kHz	$V_{RIN} = 20 \text{ mV (RMS)}$; $f = 300 \text{ to } 3400 \text{ Hz}$	–	± 0.3	–	dB
$V_{RIN(rms)}$	maximum input voltage between RIN1 and RIN2 (RMS value)	$R_{GAR} = 11.8 \text{ k}\Omega$; for 2% THD in input stage	–	390	–	mV
$V_{norx(rms)}$	noise output voltage at pin LSP (RMS value)	inputs RIN1 and RIN2 short-circuited through 200Ω in series with $10 \mu F$; psophometrically weighted (P53 curve)	–	80	–	μV
CMRR	common mode rejection ratio		–	50	–	dB
ΔG_{vrxv}	voltage gain variation related to $\Delta R_{VOL} = 950 \Omega$	when total attenuation does not exceed the switching range	–	3	–	dB
OUTPUT CAPABILITY						
$V_{OSE(p-p)}$	output voltage (peak-to-peak value)	$V_{RIN} = 300 \text{ mV (RMS)}$; note 1	3.5	4.5	–	V
		$V_{RIN} = 150 \text{ mV (RMS)}$; $R_{GAR} = 374 \text{ k}\Omega$; $R_L = 33 \Omega$; $V_{BB} = 9.0 \text{ V}$; note 2	–	7.5	–	V
I_{OM}	maximum output current at LSP (peak value)		150	500	–	mA

Hands free IC

TEA1094; TEA1094A

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DYNAMIC LIMITER						
t_{att}	attack time when V_{RIN} jumps from 20 mV to 20 mV + 10 dB	$R_{GAR} = 374 \text{ k}\Omega$	–	–	5	ms
t_{rel}	release time when V_{RIN} jumps from 20 mV + 10 dB to 20 mV	$R_{GAR} = 374 \text{ k}\Omega$	–	250	–	ms
THD	total harmonic distortion at $V_{RIN} = 20 \text{ mV} + 10 \text{ dB}$	$R_{GAR} = 374 \text{ k}\Omega$; $t > t_{att}$	–	0.9	5	%
$V_{BB(th)}$	V_{BB} limiter threshold		–	2.9	–	V
t_{att}	attack time when V_{BB} jumps below $V_{BB(th)}$		–	1	–	ms
MUTE RECEIVE						
$V_{DLC(th)}$	threshold voltage required on pin DLC/MUTER to obtain mute receive condition		$V_{GND} - 0.4$	–	0.2	V
$I_{DLC(th)}$	threshold current sourced by pin DLC/MUTER in mute receive condition	$V_{DLC} = 0.2 \text{ V}$	–	100	–	μA
ΔG_{vrxm}	voltage gain reduction in mute receive condition	$V_{DLC} < 0.2 \text{ V}$	–	80	–	dB
Envelope and noise detectors (TSEN, TENV, RSEN, RENV, RNOI and TNOI)						
PREAMPLIFIERS						
$G_v(TSEN)$	voltage gain from MIC to TSEN		37.5	40	42.5	dB
$G_v(RSEN)$	voltage gain between RIN1 and RIN2 to RSEN		–2.5	0	+2.5	dB
LOGARITHMIC COMPRESSOR AND SENSITIVITY ADJUSTMENT						
$\Delta V_{det}(TSEN)$	sensitivity detection on pin TSEN; voltage change on pin TENV when doubling the current from TSEN	$I_{TSEN} = 0.8 \text{ to } 160 \text{ }\mu\text{A}$	–	18	–	mV
$\Delta V_{det}(RSEN)$	sensitivity detection on pin RSEN; voltage change on pin RENV when doubling the current from RSEN	$I_{RSEN} = 0.8 \text{ to } 160 \text{ }\mu\text{A}$	–	18	–	mV
SIGNAL ENVELOPE DETECTORS						
$I_{source}(ENV)$	maximum current sourced from pin TENV or RENV		–	120	–	μA
$I_{sink}(ENV)$	maximum current sunk by pin TENV or RENV		0.75	1	1.25	μA
ΔV_{ENV}	voltage difference between pins RENV and TENV	when 10 μA is sourced from both RSEN and TSEN; envelope detectors tracking; note 3	–	± 3	–	mV

Hands free IC

TEA1094; TEA1094A

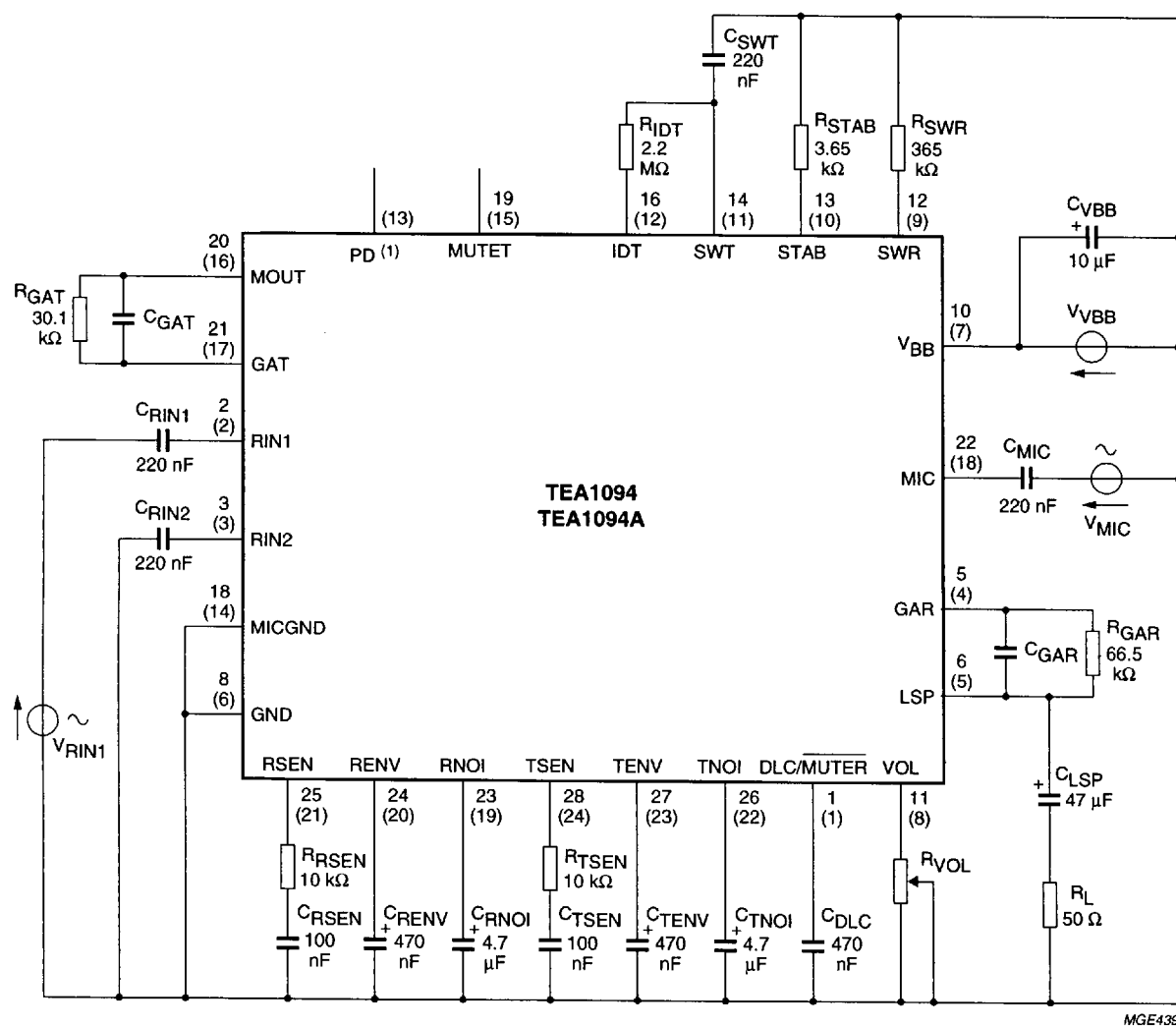
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
NOISE ENVELOPE DETECTORS						
$I_{\text{source}}(\text{NOI})$	maximum current sourced from pins TNOI or RNOI		0.75	1	1.25	μA
$I_{\text{sink}}(\text{NOI})$	maximum current sunk by pins TNOI or RNOI		–	120	–	μA
ΔV_{NOI}	voltage difference between pins RNOI and TNOI	when 5 μA is sourced from both RSEN and TSEN; noise detectors tracking; note 3	–	± 3	–	mV
DIAL TONE DETECTOR						
$V_{\text{RINDT}}(\text{rms})$	threshold level at pins RIN1 and RIN2 (RMS value)		–	127	–	mV
Decision logic (IDT and SWT)						
SIGNAL RECOGNITION						
$\Delta V_{\text{Srx}}(\text{th})$	threshold voltage between pins RENV and RNOI to switch-over from receive to idle mode	$V_{\text{RIN}} < V_{\text{RINDT}}$; note 4	–	13	–	mV
$\Delta V_{\text{Stx}}(\text{th})$	threshold voltage between pins TENV and TNOI to switch-over from transmit to idle mode	note 4	–	13	–	mV
SWITCH-OVER						
$I_{\text{source}}(\text{SWT})$	current sourced from pin SWT when switching to receive mode		7.5	10	12.5	μA
$I_{\text{sink}}(\text{SWT})$	current sunk by pin SWT when switching to transmit mode		7.5	10	12.5	μA
$I_{\text{idle}}(\text{SWT})$	current sourced from pin SWT in idle mode		–	0	–	μA
Voice switch (STAB and SWR)						
SWRA	switching range		–	40	–	dB
ΔSWRA	switching range adjustment	with R_{SWR} referenced to 365 k Ω	–40	–	+12	dB
$ \Delta G_v $	voltage gain variation from transmit mode to idle mode on both channels		–	20	–	dB
G_{tr}	gain tracking ($G_{\text{vtx}} + G_{\text{vrX}}$) during switching, referenced to idle mode		–	± 0.5	–	dB

Notes

1. Corresponds to 50 mW output power.
2. Corresponds to 200 mW output power.
3. Corresponds to ± 1 dB tracking.
4. Corresponds to 4.3 dB noise/speech recognition level.

Hands free IC

TEA1094; TEA1094A



The pin numbers given in parenthesis refer to the TEA1094A.

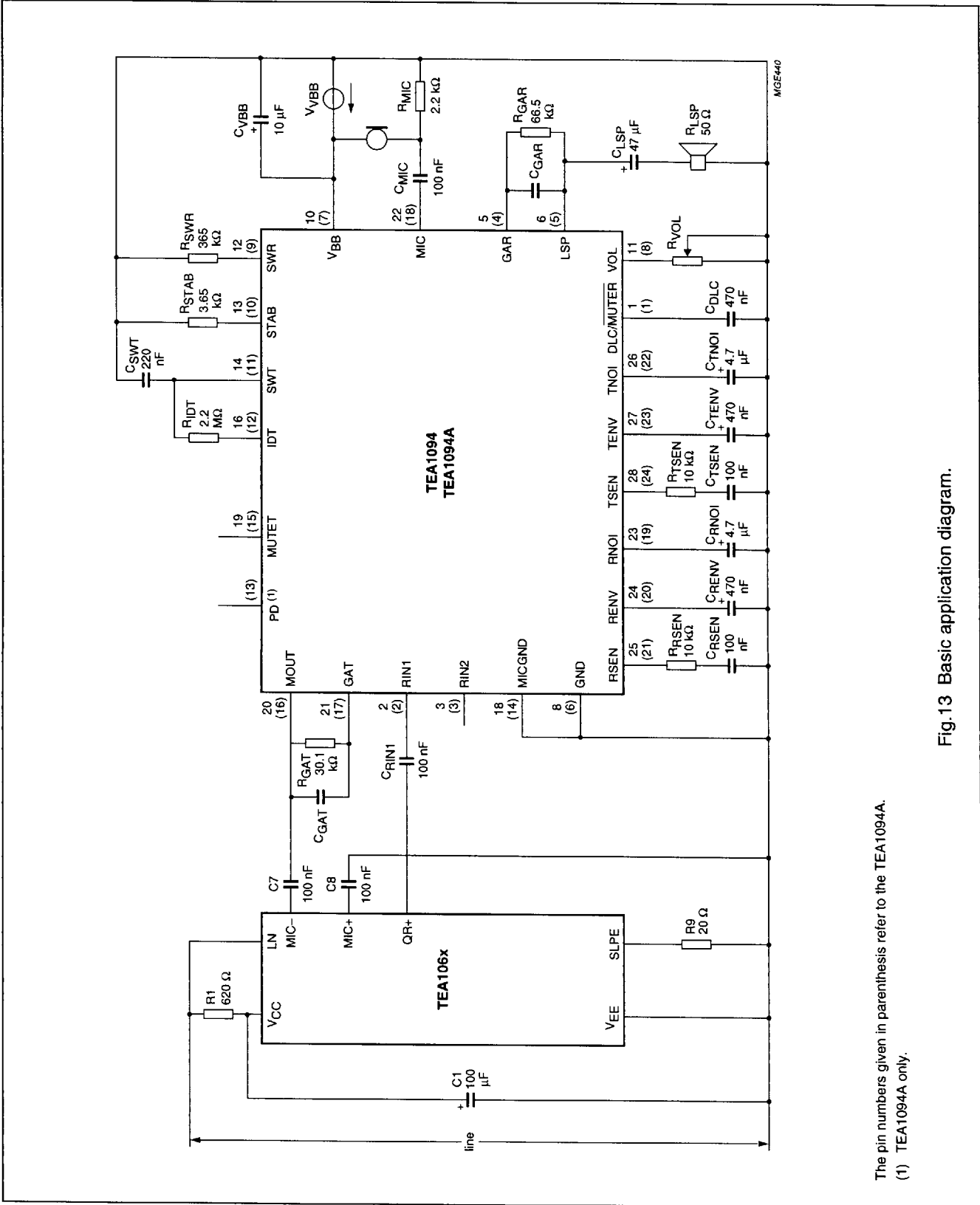
(1) TEA1094A only.

Fig.12 Test circuit.

Hands free IC

TEA1094; TEA1094A

APPLICATION INFORMATION



The pin numbers given in parenthesis refer to the TEA1094A.
(1) TEA1094A only.

Hands free IC

TEA1094; TEA1094A

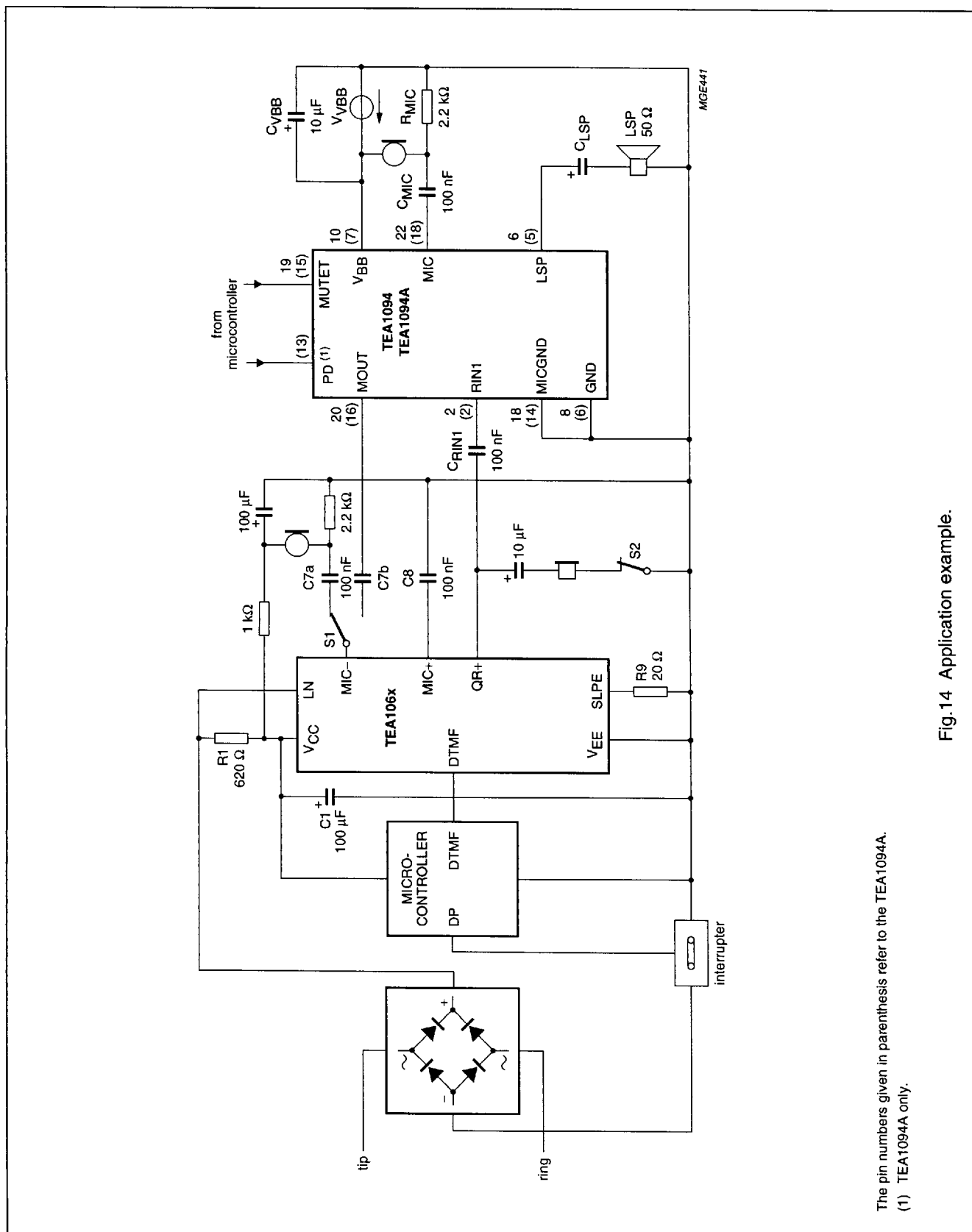


Fig.14 Application example.

The pin numbers given in parenthesis refer to the TEA1094A.
(1) TEA1094A only.

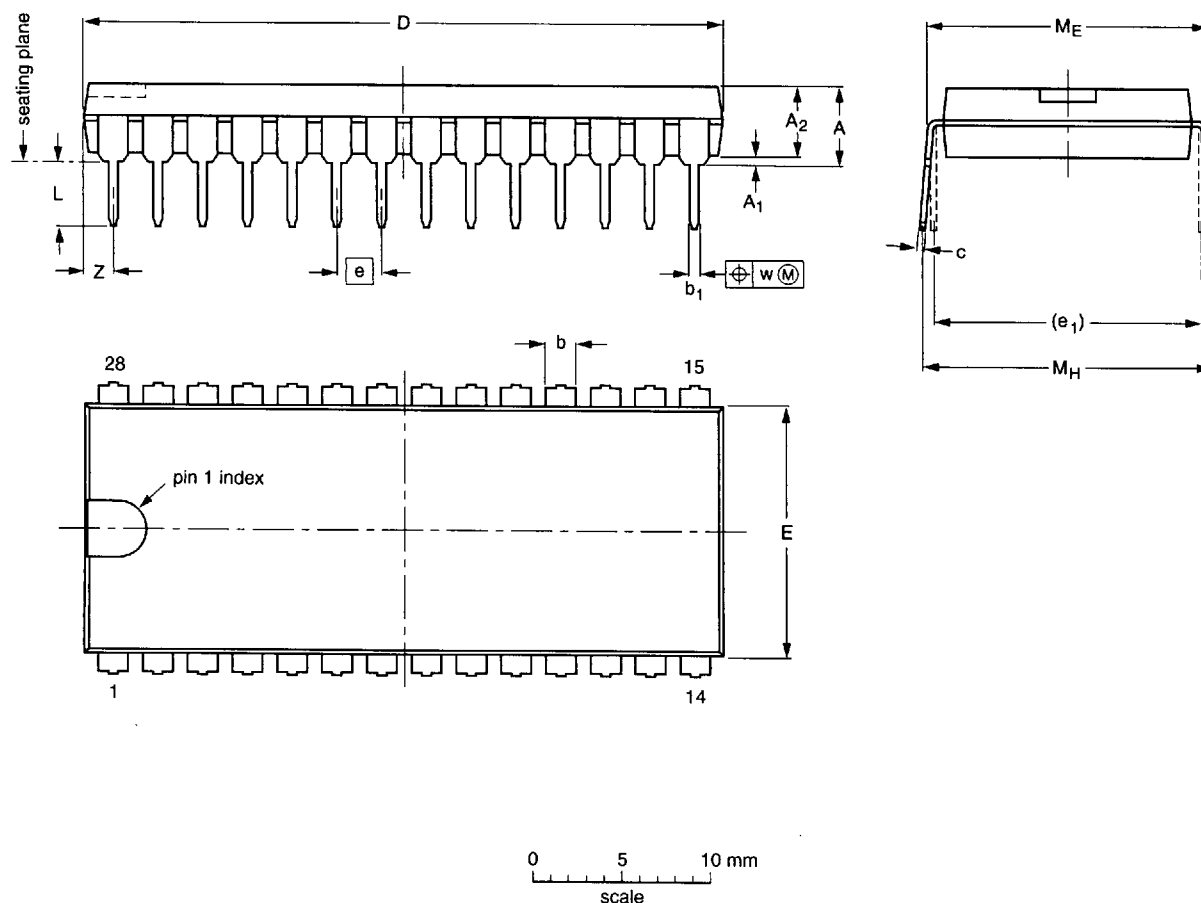
Hands free IC

TEA1094; TEA1094A

PACKAGE OUTLINES

DIP28: plastic dual in-line package; 28 leads (600 mil)

SOT117-1




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

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	5.1	0.51	4.0	1.7 1.3	0.53 0.38	0.32 0.23	36.0 35.0	14.1 13.7	2.54	15.24	3.9 3.4	15.80 15.24	17.15 15.90	0.25	1.7
inches	0.20	0.020	0.16	0.066 0.051	0.020 0.014	0.013 0.009	1.41 1.34	0.56 0.54	0.10	0.60	0.15 0.13	0.62 0.60	0.68 0.63	0.01	0.067

Note

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

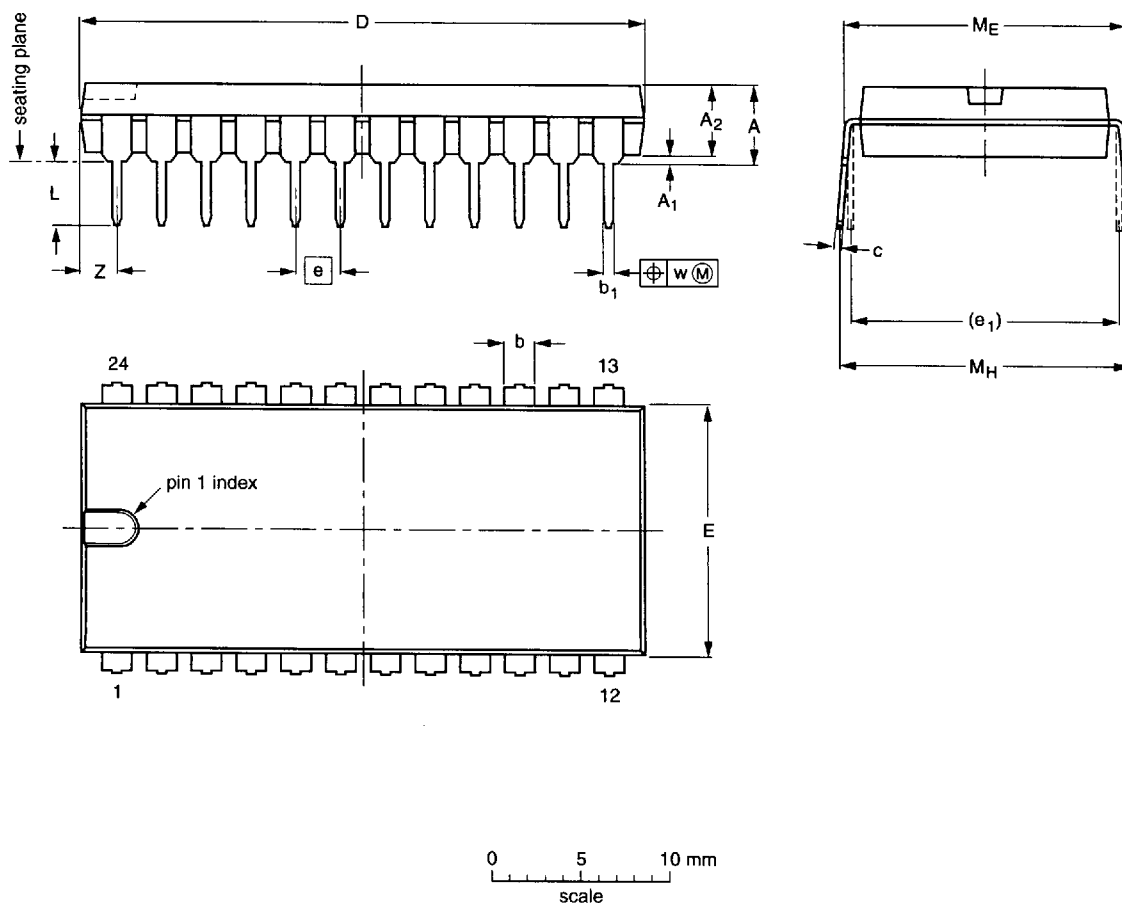
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT117-1	051G05	MO-015AH				92-11-17 95-01-14

Hands free IC

TEA1094; TEA1094A

DIP24: plastic dual in-line package; 24 leads (600 mil)

SOT101-1




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

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	5.1	0.51	4.0	1.7 1.3	0.53 0.38	0.32 0.23	32.0 31.4	14.1 13.7	2.54	15.24	3.9 3.4	15.80 15.24	17.15 15.90	0.25	2.2
inches	0.20	0.020	0.16	0.066 0.051	0.021 0.015	0.013 0.009	1.26 1.24	0.56 0.54	0.10	0.60	0.15 0.13	0.62 0.60	0.68 0.63	0.01	0.087

Note

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

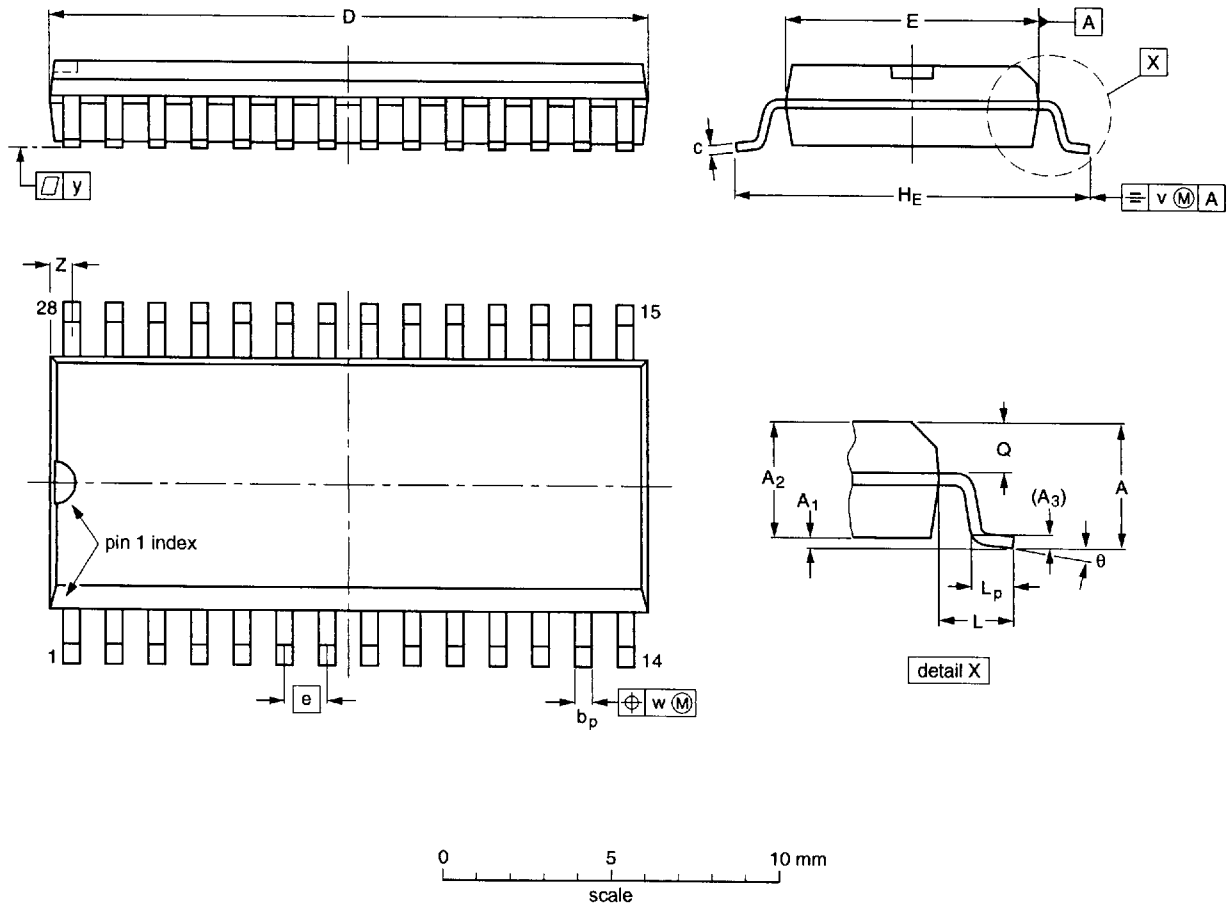
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT101-1	051G02	MO-015AD				92-11-17 95-01-23

Hands free IC

TEA1094; TEA1094A

SO28: plastic small outline package; 28 leads; body width 7.5 mm

SOT136-1



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 ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	18.1 17.7	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.71 0.69	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

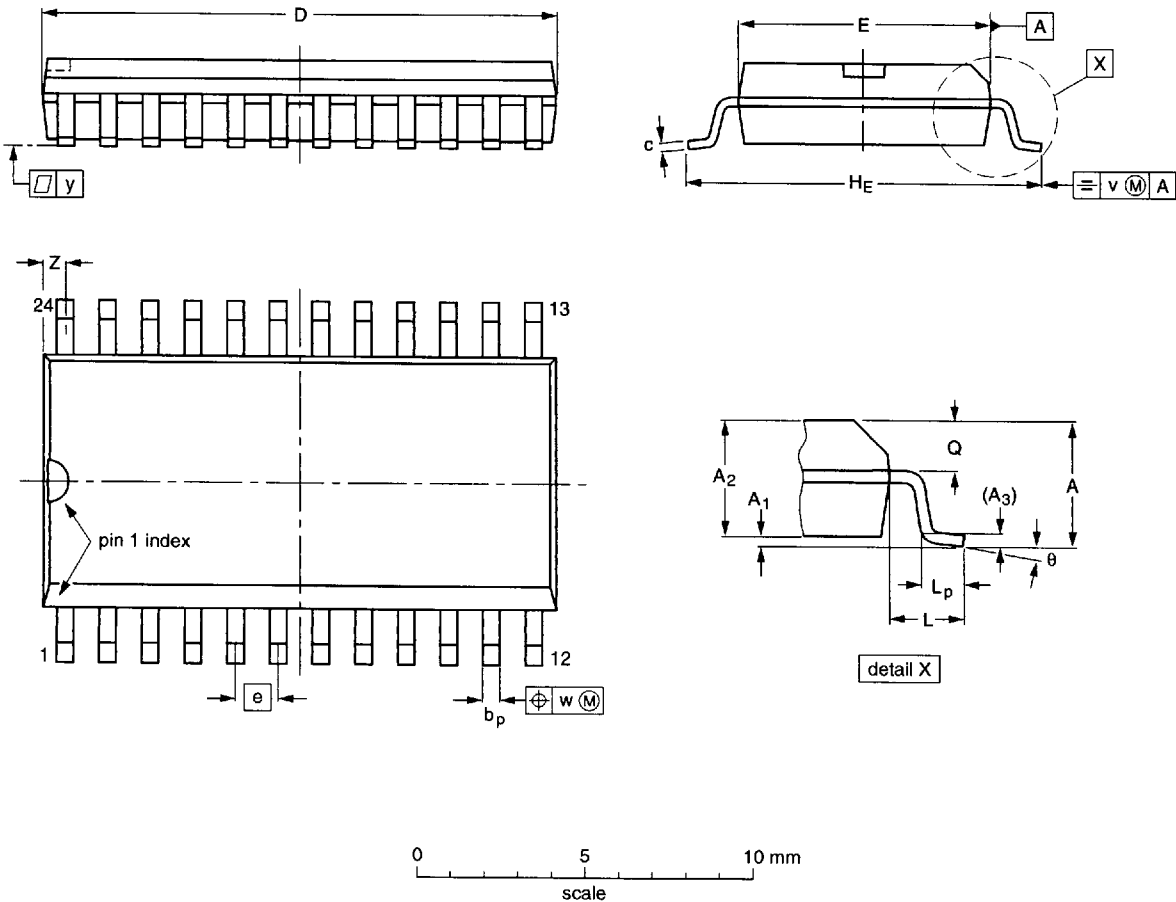
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT136-1	075E06	MS-013AE				91-08-13 95-01-24

Hands free IC

TEA1094; TEA1094A

SO24: plastic small outline package; 24 leads; body width 7.5 mm

SOT137-1



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 ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	15.6 15.2	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.61 0.60	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

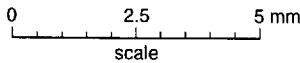
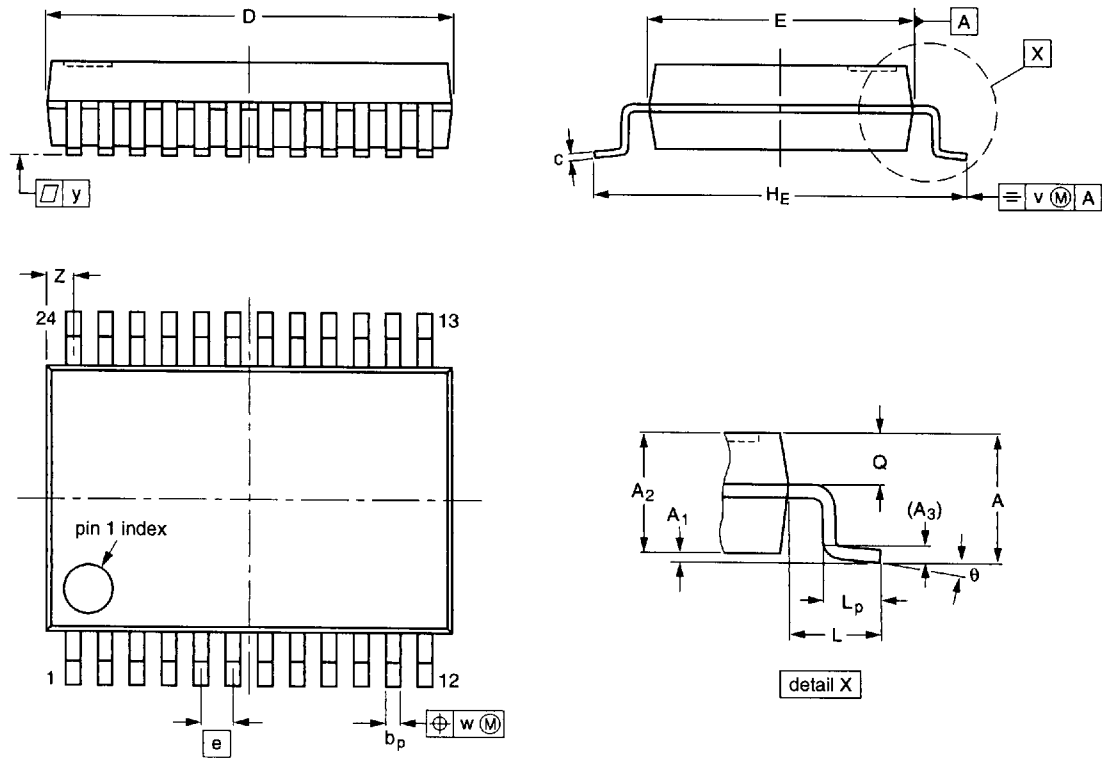
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT137-1	075E05	MS-013AD				92-11-17 95-01-24

Hands free IC

TEA1094; TEA1094A

SSOP24: plastic shrink small outline package; 24 leads; body width 5.3 mm

SOT340-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	8.4 8.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	0.8 0.4	8° 0°

Note
1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT340-1		MO-150AG				93-09-08 95-02-04

Hands free IC

TEA1094; TEA1094A

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 *"IC Package Databook"* (order code 9398 652 90011).

DIP**SOLDERING BY DIPPING OR BY WAVE**

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

SO and SSOP**REFLOW SOLDERING**

Reflow soldering techniques are suitable for all SO and SSOP 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 is **not** recommended for SSOP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

If wave soldering cannot be avoided, the following conditions must be 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 and must incorporate solder thieves at the downstream end.**

Even with these conditions, only consider wave soldering SSOP packages that have a body width of 4.4 mm, that is SSOP16 (SOT369-1) or SSOP20 (SOT266-1).

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.