DATA SHEET

TEA1095
Voice switched speakerphone IC

Product specification
Supersedes data of 1996 Mar 22
File under Integrated Circuits, IC03

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Philips
Semiconductors

PHILIPS

Voice switched speakerphone IC TEA1095

FEATURES

- External power supply with power-down function
- Transmit channel with:
  - externally adjustable gain
  - transmit mute function
- Receive channel with:
  - externally adjustable gain
  - logarithmic volume control via a linear potentiometer
  - receive 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
- Cordless telephones
- Answering machines
- Fax machines
- Hands-free car kits.

GENERAL DESCRIPTION

The TEA1095 is a bipolar circuit, that in conjunction with a member of the TEA106X, TEA111X families of transmission or TEA1096 transmission/listening-in circuits offers a hands-free function. It incorporates a transmit amplifier, a receiver channel amplifier and a duplex controller with signal and noise monitors on both channels.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1095	DIP24	plastic dual in-line package; 24 leads (600 mil)	SOT101-1
TEA1095T	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1
TEA1095TS	SSOP24	plastic shrink small outline package; 24 leads; body width 5.3 mm	SOT340-1

QUICK REFERENCE DATA

V_{BB} = 5 V; V_{GND} = 0 V; f = 1 kHz; T_{amb} = 25 °C; MUTETX = LOW; MUTERX = LOW; PD = LOW; R_{VOL} = 0 Ω; measured in test circuit of Fig.11; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{BB}	supply voltage		2.9	–	12.0	V
I_{BB}	current consumption from pin V_{BB}		–	2.7	3.8	mA
G_{vtx}	voltage gain from TXIN to TXOUT in transmit mode	V_{TXIN} = 1 mV (RMS); R_{GATX} = 30.1 kΩ	–	15.5	–	dB
ΔG_{vtxr}	voltage gain adjustment with R_{GATX}		–15.5	–	+24.5	dB
G_{vrx}	voltage gain from RXIN to RXOUT in receive mode	V_{RXIN} = 20 mV (RMS); R_{GARX} = 16.5 kΩ	–	6.5	–	dB
ΔG_{vrxr}	voltage gain adjustment with R_{GARX}		–20.5	–	+19.5	dB
SWRA	switching range		–	40	–	dB
ΔSWRA	switching range adjustment	with R_{SWR} referenced to R_{SWR} = 365 kΩ	–40	–	+12	dB
T_{amb}	operating ambient temperature		–25	–	+75	°C

BLOCK DIAGRAM

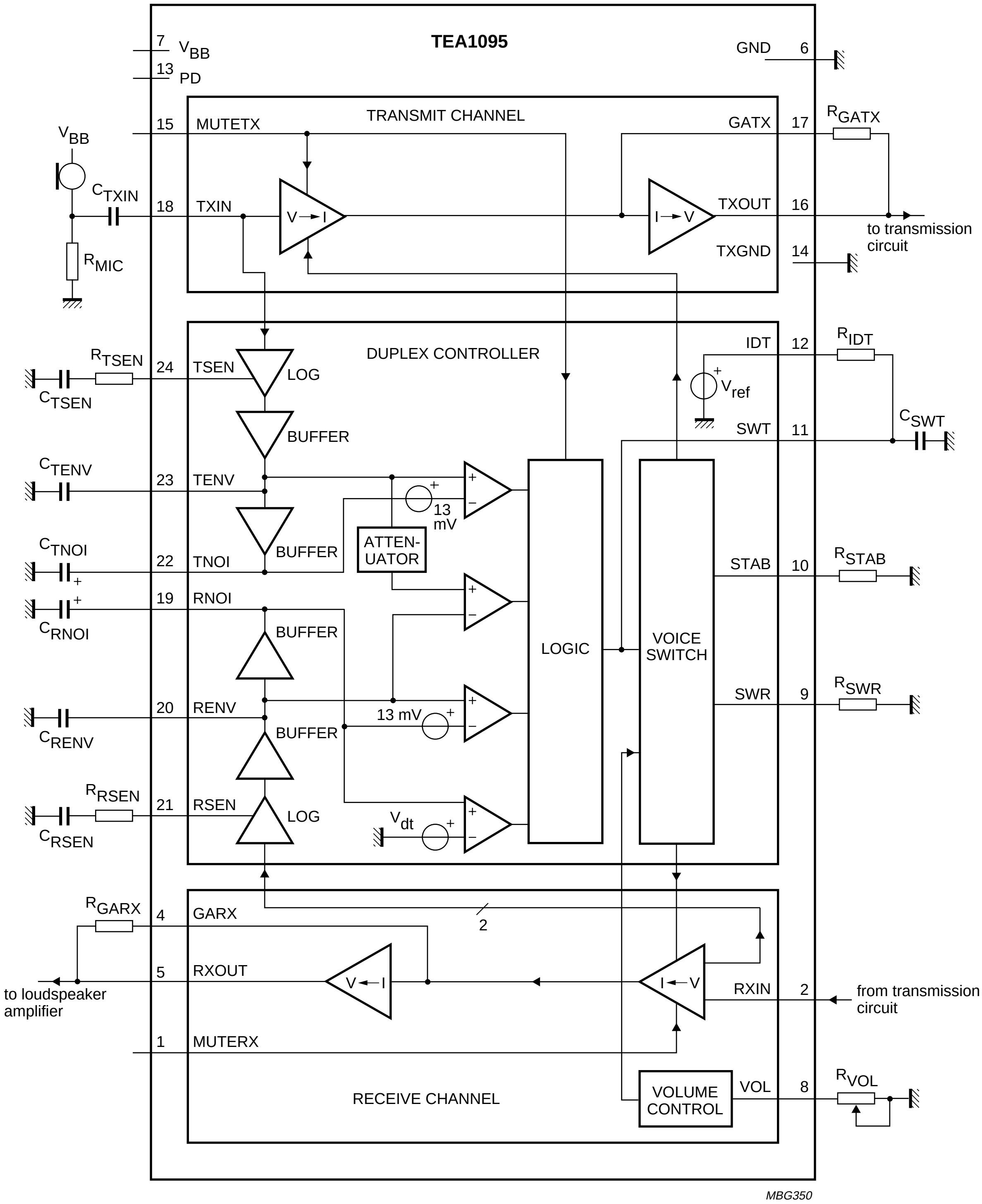


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
MUTERX	1	receiver channel mute input
RXIN	2	receiver amplifier input
n.c.	3	not connected
GARX	4	receiver gain adjustment
RXOUT	5	receiver amplifier output
GND	6	ground reference
V_{BB}	7	supply voltage input
VOL	8	receiver volume adjustment
SWR	9	switching range adjustment
STAB	10	reference current adjustment
SWT	11	switch-over timing adjustment
IDT	12	idle mode timing adjustment
PD	13	power-down input
TXGND	14	ground reference for the transmit channel
MUTETX	15	transmit channel mute input
TXOUT	16	transmit amplifier output
GATX	17	transmit gain adjustment
TXIN	18	transmit amplifier input
RNOI	19	receive noise envelope timing adjustment
RENV	20	receive signal envelope timing adjustment
RSEN	21	receive signal envelope sensitivity adjustment
TNOI	22	transmit noise envelope timing adjustment
TENV	23	transmit signal envelope timing adjustment
TSEN	24	transmit signal envelope sensitivity adjustment

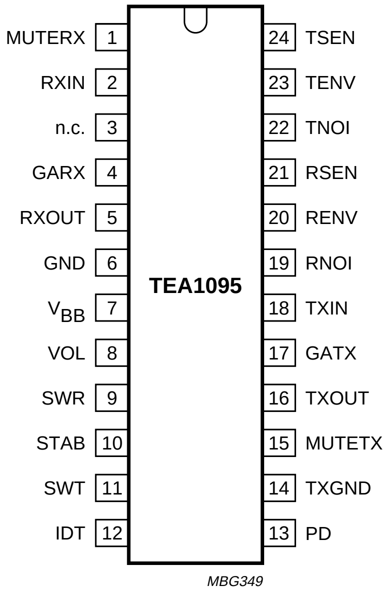


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

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

A principle diagram of the TEA1096 is shown on the left side of Fig.3. The TEA1096 is a transmission and listening-in circuit. It incorporates a receiving amplifier for the earpiece, a transmit amplifier for the microphone, a loudspeaker amplifier and a hybrid. For more details on the TEA1096 circuit (please refer to *Data Handbook IC03*). The right side of Fig.3 shows a principle diagram of the TEA1095, a hands-free add-on circuit with a transmit amplifier, a receiver amplifier and a duplex controller.

As can be seen from Fig.3, 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 TEA1095 detects which channel has the ‘largest’ signal and then controls the gains of the transmit amplifier and the receiver amplifier such 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 transmit amplifier is at its maximum and the gain of the receiver amplifier is at its minimum.
2. Receive mode (Rx mode): the gain of the receiver amplifier is at its maximum and the gain of the transmit 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.

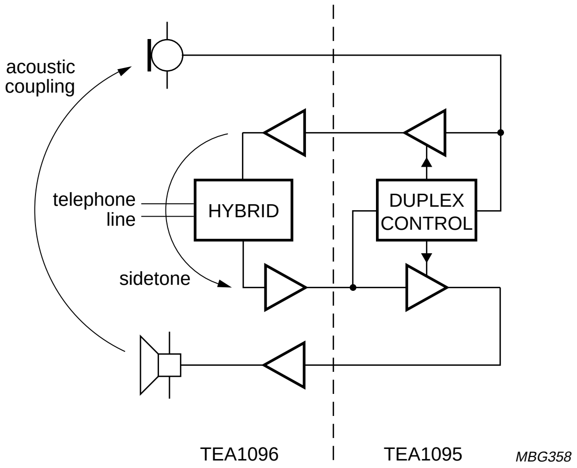


Fig.3 Hands-free telephone set principles.

Supply: pins V_{BB}, GND and PD

The TEA1095 must be supplied with an external stabilized voltage source between pins V_{BB} and GND. In idle mode, without any signal, the internal supply current is 2.7 mA at V_{BB} = 5 V.

To reduce current consumption during pulse dialling or register recall (flash), the TEA1095 is provided with a power-down (PD) input. When the voltage on PD is HIGH, the current consumption from V_{BB} is 140 μA.

Transmit channel: pins TXIN, GATX, TXOUT, TXGND and MUTETX

The TEA1095 has an asymmetrical transmit input (TXIN) with an input resistance of 20 kΩ. The gain of the input stage varies according to the mode of the TEA1095. 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 TXOUT is 20 μA (RMS).

In the transmit mode, the overall gain of the transmit amplifier (from pin TXIN to TXOUT) can be adjusted from 0 dB to 40 dB to suit application specific requirements. The gain is proportional to the value of R_{GATX} and equals 15.5 dB with R_{GATX} = 30.1 kΩ.

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

By applying a HIGH level on pin MUTETX, the transmit amplifier is muted and the TEA1095 is automatically forced into the receive mode.

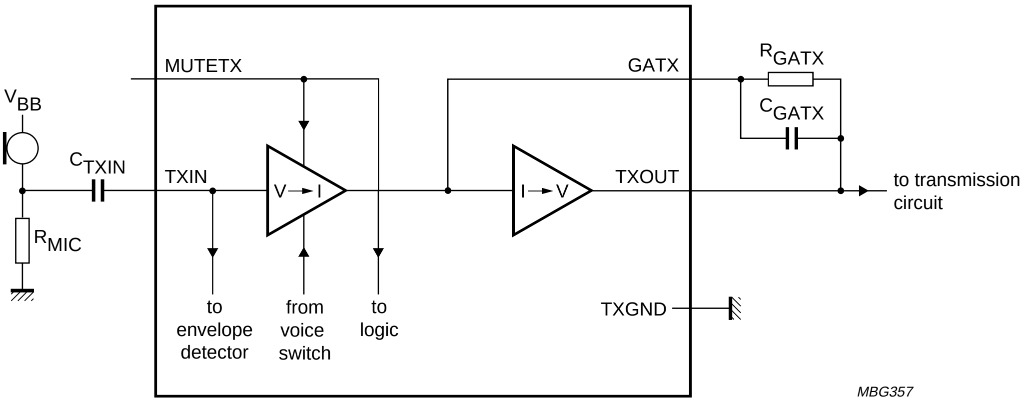


Fig.4 Transmit channel.

Receive channel

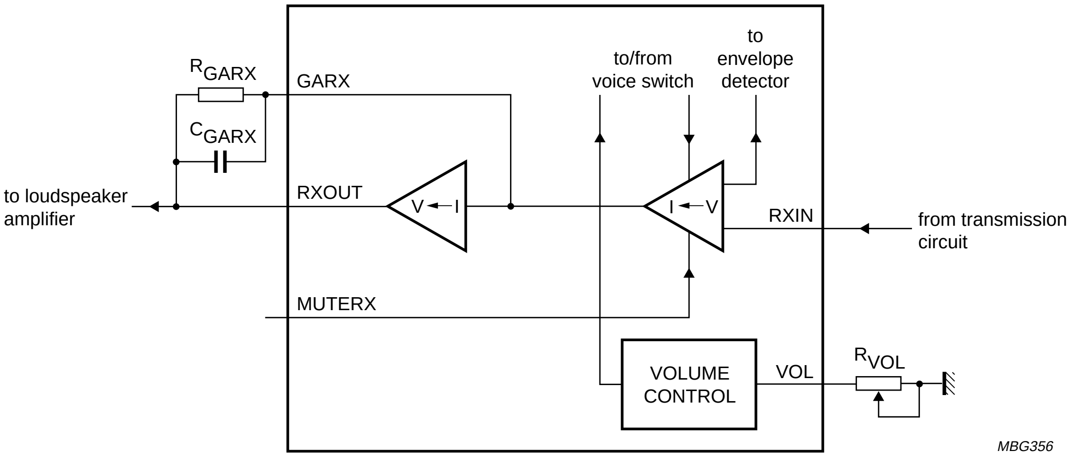


Fig.5 Receive channel.

Receiver amplifier: pins RXIN, GARX, RXOUT and MUTERX

The TEA1095 has an asymmetrical input (RXIN) for the receiver amplifier with an input resistance of 20 kΩ. The gain of the input stage varies according to the mode of the TEA1095. 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.

In the receive mode, the overall gain of the receive amplifier can be adjusted from –14 dB to +26 dB to suit application specific requirements. The gain from RXIN to RXOUT is proportional to the value of R_{GARX} and equals 6.5 dB with R_{GARX} = 16.5 kΩ. A capacitor connected in parallel with R_{GARX} can be used to provide a first-order low-pass filter.

By applying a HIGH level on pin MUTERX, the receiver amplifier is muted and the TEA1095 is automatically forced into the transmit mode.

Volume control: pin VOL

The receiver amplifier gain can be adjusted with the potentiometer R_{VOL}. A linear potentiometer can be used to obtain logarithmic control of the gain of the receiver amplifier. Each 950 Ω 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.

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 envelopes detectors are shown in Fig.6.

For the transmit channel, the input signal at TXIN is 40 dB amplified to TSEN. For the receive channel, the input signal at RXIN 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.12), it is assumed that V_{TXIN} = 1 mV (RMS) and V_{RXIN} = 100 mV (RMS) nominal and both R_{TSEN} and R_{RSEN} have a value of 10 kΩ. 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 µA and a maximum sink current of 1 µA. Together with the capacitors 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 µA sourced current corresponds to a maximum rise-slope of the signal envelope of 85 dB/ms. This is enough to track normal speech signals. The 1 µA current sunk by TENV or RENV corresponds to a maximum fall-slope of 0.7 dB/ms. This is enough for a smooth envelope and also eliminates the effect of echoes on switching behaviour.

To determine the noise level, the signal on TENV and RENV are buffered to TNOI and RNOI. These buffers have a maximum source current of 1 µA and a maximum sink current of 120 µA. Together with the capacitors C_{TNOI} and C_{RNOI}, the timing can be set. In the basic application of Fig.12, the value of both capacitors is 4.7 µF. At room temperature, the 1 µA sourced current corresponds to a maximum rise-slope of the noise envelope of approximately 0.07 dB/ms. This is small enough to track background noise and not to be influenced by speech bursts. The 120 µA current that is sunk corresponds to a maximum fall-slope of approximately 8.5 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 dB/ms. The behaviour of the signal envelope and noise envelope monitors is illustrated in Fig.7.

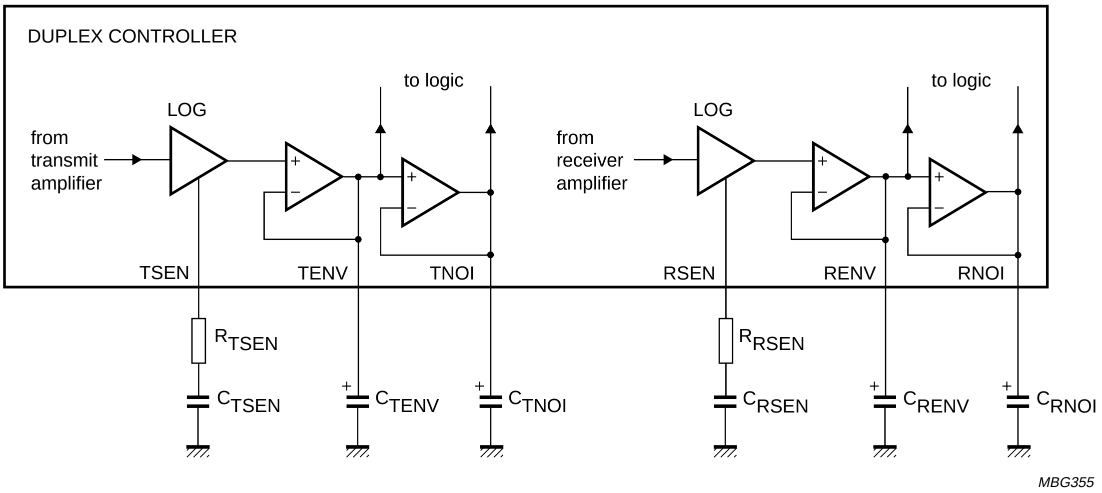


Fig.6 Signal and noise envelope detectors.

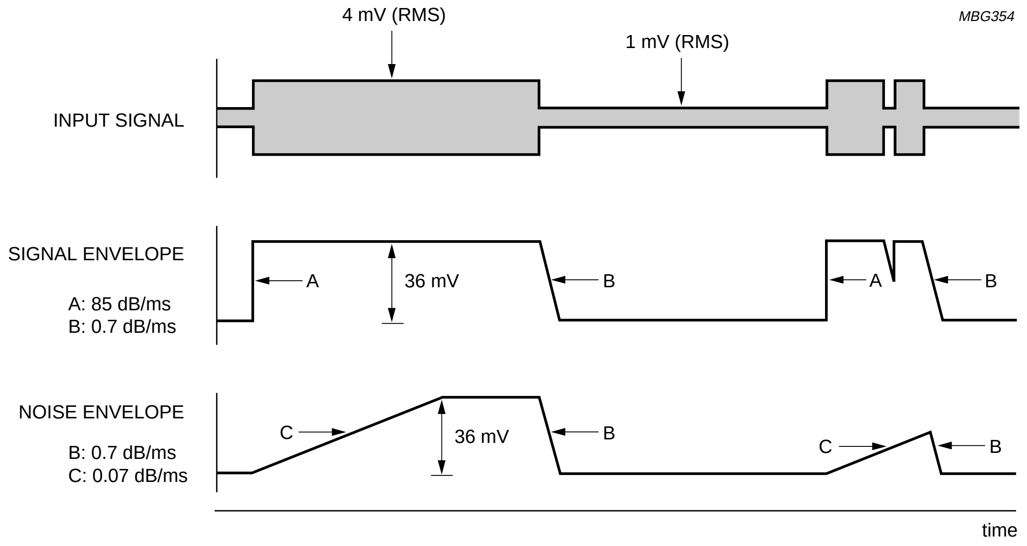
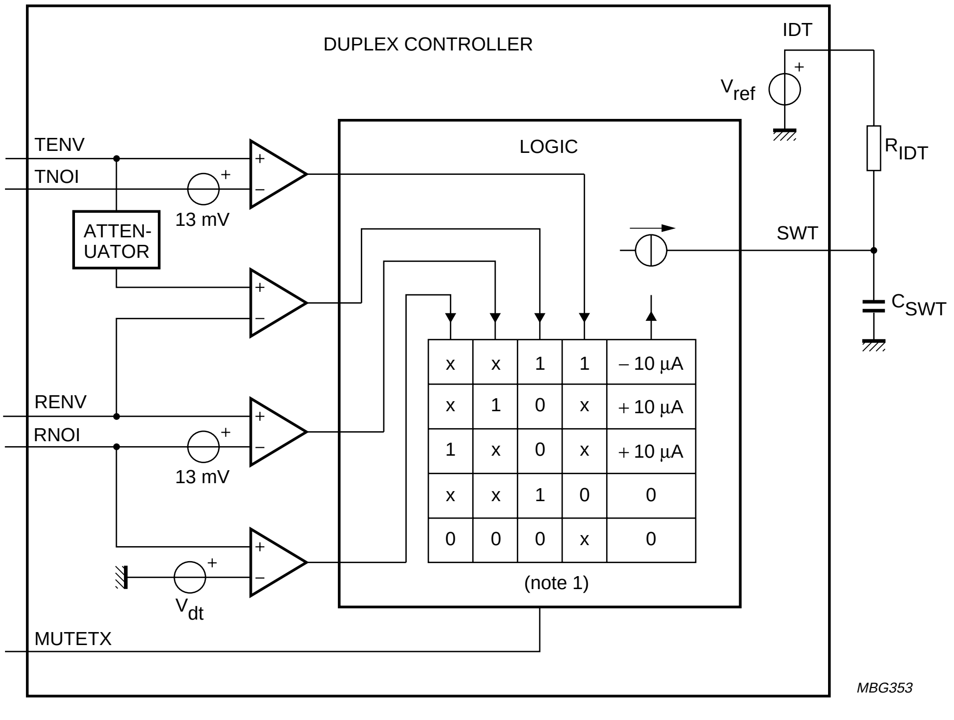


Fig.7 Signal and noise envelope waveforms.



(1) When MUTETX = HIGH +10 μA is forced. When MUTERX = HIGH −10 μA is forced.

Fig.8 Decision logic.

DECISION LOGIC: PINS IDT AND SWT

The TEA1095 selects its mode 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 $V_{ENV-NOI}$ = 13 mV. This so called speech/noise threshold is implemented in both channels.

The signal on TXIN 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 transmit 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 TEA1095 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 application, does not consider the input signals at RXIN as noise when they have a level greater than 42 mV (RMS). This level is proportional to R_{RSEN}.

As can be seen from Fig.8, 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 µA (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 TEA1095 and can vary between –400 mV and +400 mV.

Table 1 Modes of TEA1095

$V_{SWT} - V_{IDT}$ (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.12, C_{SWT} is chosen at 220 nF and R_{IDT} at 2.2 MΩ. This enables a switch-over time from transmit to receive mode or vice-versa of approximately 13 ms (580 mV swing on SWT). The switch-over time from idle mode to transmit mode or receive mode is approximately 4 ms (180 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 s (idle mode time).

The inputs MUTETX and MUTERX overrule the decision logic. When MUTETX goes HIGH, the capacitor C_{SWT} is charged with 10 µA resulting in the receive mode. When the voltage on pin MUTERX goes HIGH, the capacitor C_{SWT} is discharged with 10 µA resulting in the transmit mode.

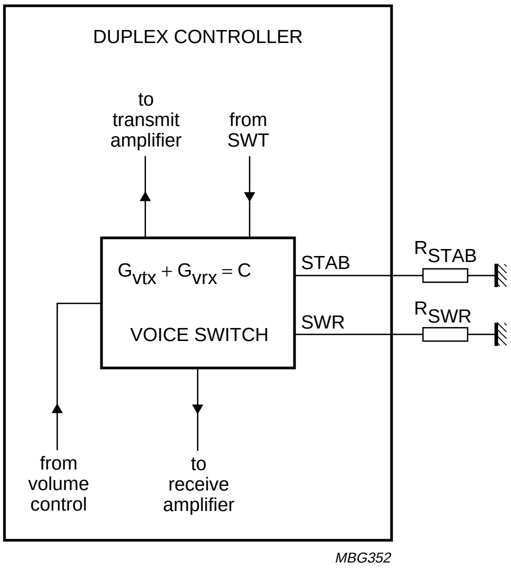
VOICE-SWITCH: PINS STAB AND SWR

A diagram of the voice-switch is illustrated in Fig.9. With the voltage on SWT, the TEA1095 voice-switch regulates the gains of the transmit and the receive channel such that the sum of both is kept constant.

In the transmit mode, the gain of the transmit amplifier is at its maximum and the gain of the receive amplifier is at its minimum. In the receive mode, the opposite applies. In the idle mode, both transmit and receive 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 dB. R_{STAB} should be equal to 3.65 kΩ and sets an internally used reference current. In the basic application diagram given in Fig.12, R_{SWR} is equal to 365 kΩ which results in a switching range of 40 dB. The switch-over behaviour is illustrated in Fig.10.

In the receive mode, the gain of the receive amplifier can be reduced using the volume control. Since the voice-switch keeps the sum of the gains constant, the gain of the transmit amplifier is increased at the same time (see dashed curves in Fig.10). In the transmit mode however, the volume control has no influence on the gain of the transmit amplifier or the gain of the receive amplifier. Consequently, the switching range is reduced when the volume is reduced. At maximum reduction of volume, the switching range becomes 0 dB.



Where C = constant.

Fig.9 Voice switch.

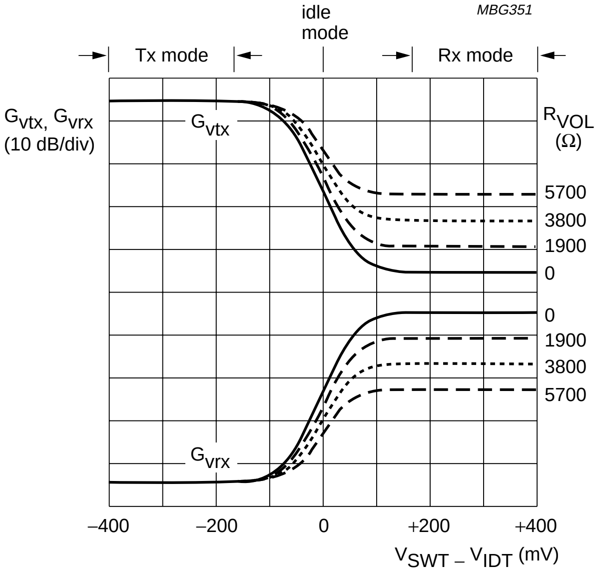


Fig.10 Switch-over behaviour.

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} and RXIN		V_{GND} – 0.4	V_{BB} + 0.4	V
$V_{RIN(max)}$	maximum voltage on pin RXIN		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
T_{stg}	IC storage temperature		–40	+125	°C
T_{amb}	operating ambient temperature		–25	+75	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air		
	TEA1095	50	K/W
	TEA1095T	75	K/W
	TEA1095TS	104	K/W

CHARACTERISTICS

V_{BB} = 5 V; V_{GND} = 0 V; f = 1 kHz; T_{amb} = 25 °C; MUTETX = LOW; MUTERX = LOW; PD = LOW; R_{VOL} = 0 Ω; measured in test circuit of Fig.11; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (V_{BB}, PD and GND)						
V_{BB}	supply voltage		2.9	–	12.0	V
I_{BB}	current consumption from pin V_{BB}		–	2.7	3.8	mA
POWER-DOWN INPUT PD						
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}	power-down input current	PD = HIGH	–	2.5	5	µA
$I_{BB(PD)}$	current consumption from pin V_{BB} in power-down mode	PD = HIGH	–	140	190	µA
Transmit channel (TXIN, GATX, TXOUT, MUTETX and TXGND)						
TRANSMIT AMPLIFIER						
$\lvert Z_i \rvert$	input impedance between pins TXIN and TXGND		17	20	23	kΩ
G_{vtx}	voltage gain from TXIN to TXOUT in transmit mode	V_{TXIN} = 1 mV (RMS); R_{GATX} = 30.1 kΩ	–	15.5	–	dB
ΔG_{vtxr}	voltage gain adjustment with R_{GATX}		–15.5	–	+24.5	dB
ΔG_{vtxT}	voltage gain variation with temperature referenced to 25 °C	V_{TXIN} = 1 mV (RMS); T_{amb} = –25 to +75 °C	–	±0.3	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
ΔG_{vtxf}	voltage gain variation with frequency referenced to 1 kHz	V_{TXIN} = 1 mV (RMS); f = 300 to 3400 Hz	–	±0.3	–	dB
V_{notx}	noise output voltage at pin TXOUT	pin TXIN connected to TXGND through 200 Ω in series with 10 µF; psophometrically weighted (P53 curve)	–	–100	–	dBmp
TRANSMIT MUTE INPUT MUTETX						
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_{MUTETX}	input current	MUTETX = HIGH	–	2.5	5	µA
ΔG_{vtxm}	voltage gain reduction with MUTETX active	MUTETX = HIGH	–	80	–	dB
Receive channel (RXIN, GARX, RXOUT and MUTERX)						
RECEIVE AMPLIFIER						
$\lvert Z_i \rvert$	input impedance between pins RXIN and GND		17	20	23	kΩ
G_{vrx}	voltage gain from RXIN to RXOUT in receive mode	V_{RXIN} = 20 mV (RMS); R_{GARX} = 16.5 kΩ	–	6.5	–	dB
ΔG_{vrxr}	voltage gain adjustment with R_{GARX}		–20.5	–	+19.5	dB
ΔG_{vrxT}	voltage gain variation with temperature referenced to 25 °C	V_{RXIN} = 20 mV (RMS); T_{amb} = –25 to +75 °C	–	±0.3	–	dB
ΔG_{vrxf}	voltage gain variation with frequency referenced to 1 kHz	V_{RXIN} = 20 mV (RMS); f_i = 300 to 3400 Hz	–	±0.3	–	dB
$V_{norx(rms)}$	noise output voltage at pin RXOUT (RMS value)	input RXIN short-circuited through 200 Ω in series with 10 µF; psophometrically weighted (P53 curve)	–	20	–	µV
ΔG_{vrxv}	voltage gain variation referenced to ΔR_{VOL} = 950 Ω	when total attenuation does not exceed the switching range	–	3	–	dB
RECEIVE MUTE INPUT MUTERX						
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_{MUTERX}	input current	MUTERX = HIGH	–	2.5	5	µA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
ΔG_{vrxm}	gain reduction with MUTERX active	MUTERX = HIGH	–	80	–	dB
Envelope and noise detectors (TSEN, TENV, TNOI, RSEN, RENV and RNOI)						
PREAMPLIFIERS						
$G_{v(TSEN)}$	voltage gain from TXIN to TSEN		–	40	–	dB
$G_{v(RSEN)}$	voltage gain between RXIN to RSEN		–	0	–	dB
LOGARITHMIC COMPRESSOR AND SENSITIVITY ADJUSTMENT						
$\varphi_{det(TSEN)}$	sensitivity detection on pin TSEN; voltage change on pin TENV when doubling the current from TSEN	I_{TSEN} = 0.8 to 160 μA	–	18	–	mV
$\varphi_{det(RSEN)}$	sensitivity detection on pin RSEN; voltage change on pin RENV when doubling the current from RSEN	I_{RSEN} = 0.8 to 160 μA	–	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 1	–	±3	–	mV
NOISE ENVELOPE DETECTORS						
$I_{source(NOI)}$	maximum current sourced from pins TNOI or RNOI		0.75	1	1.25	μA
$I_{sink(NOI)}$	maximum current sunk by pins TNOI or RNOI		–	120	–	μA
ΔV_{NOI}	voltage difference between pins RNOI and TNOI	when 2 μA is sourced from both RSEN and TSEN; noise detectors tracking; note 1	–	±3	–	mV
DIAL TONE DETECTOR						
$V_{RINDT(rms)}$	threshold level at pin RXIN (RMS value)		–	42	–	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Decision logic (IDT and SWT)						
SIGNAL RECOGNITION						
$\Delta V_{Srx(th)}$	threshold voltage between pins RENV and RNOI to switch-over from receive to idle mode	$V_{RXIN} < V_{RINDT}$; note 2	–	13	–	mV
$\Delta V_{Stx(th)}$	threshold voltage between pins TENV and TNOI to switch-over from transmit to idle mode	note 2	–	13	–	mV
SWITCH-OVER						
$I_{source(SWT)}$	current sourced from pin SWT when switching to receive mode		7.5	10	12.5	µA
$I_{sink(SWT)}$	current sunk by pin SWT when switching to transmit mode		7.5	10	12.5	µA
$I_{idle(SWT)}$	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 $R_{SWR} = 365\ k\Omega$	–40	–	+12	dB
$\lvert\Delta G_v\rvert$	voltage gain variation from transmit mode to idle mode on both channels		–	20	–	dB
G_{tr}	gain tracking ($G_{vtx} + G_{vrx}$) during switching, referenced to idle mode		–	±0.5	–	dB

Notes

1. Corresponds to ±1 dB tracking.
2. Corresponds to 4.3 dB noise/speech recognition level.

TEST AND APPLICATION INFORMATION

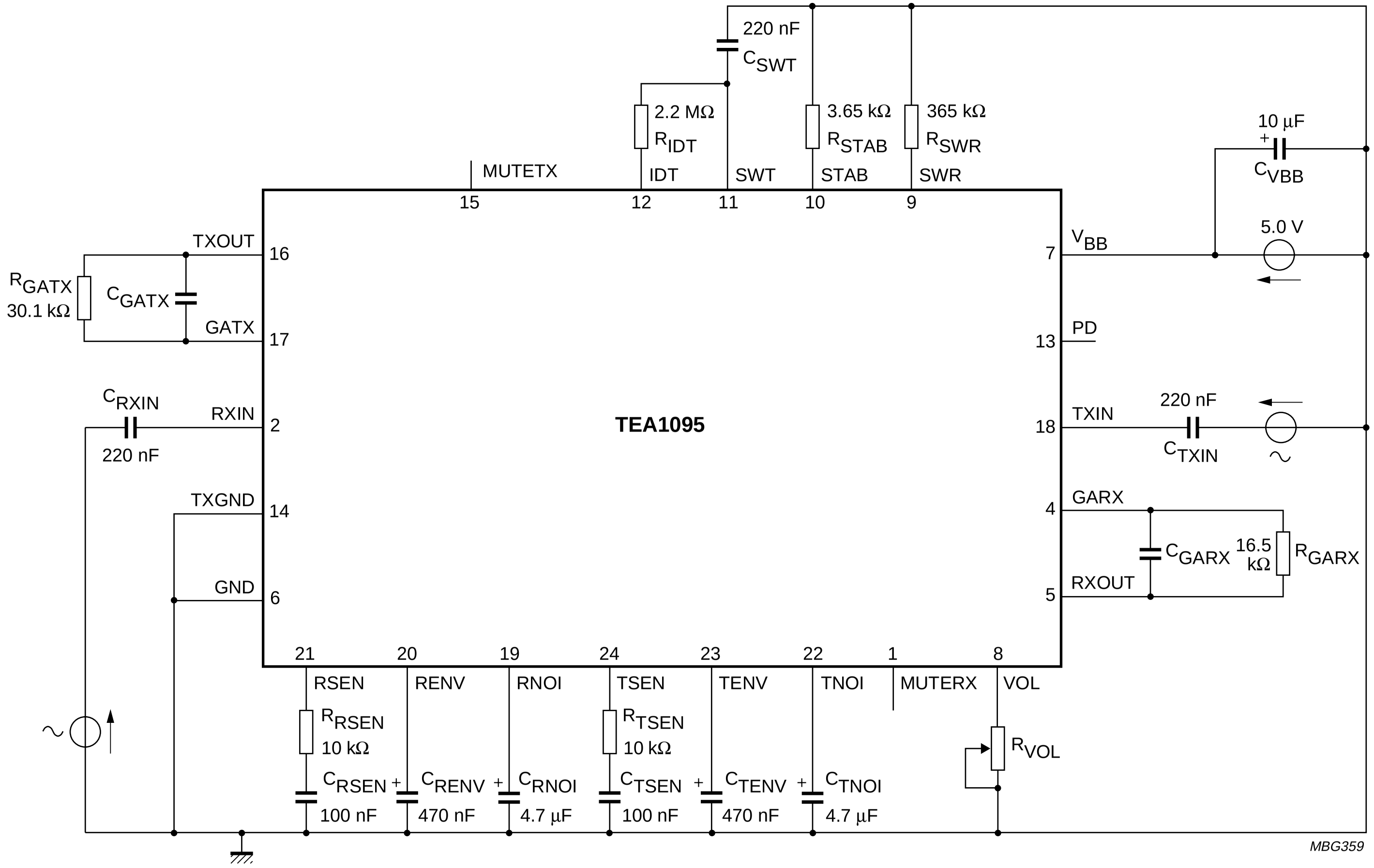


Fig.11 Test circuit.

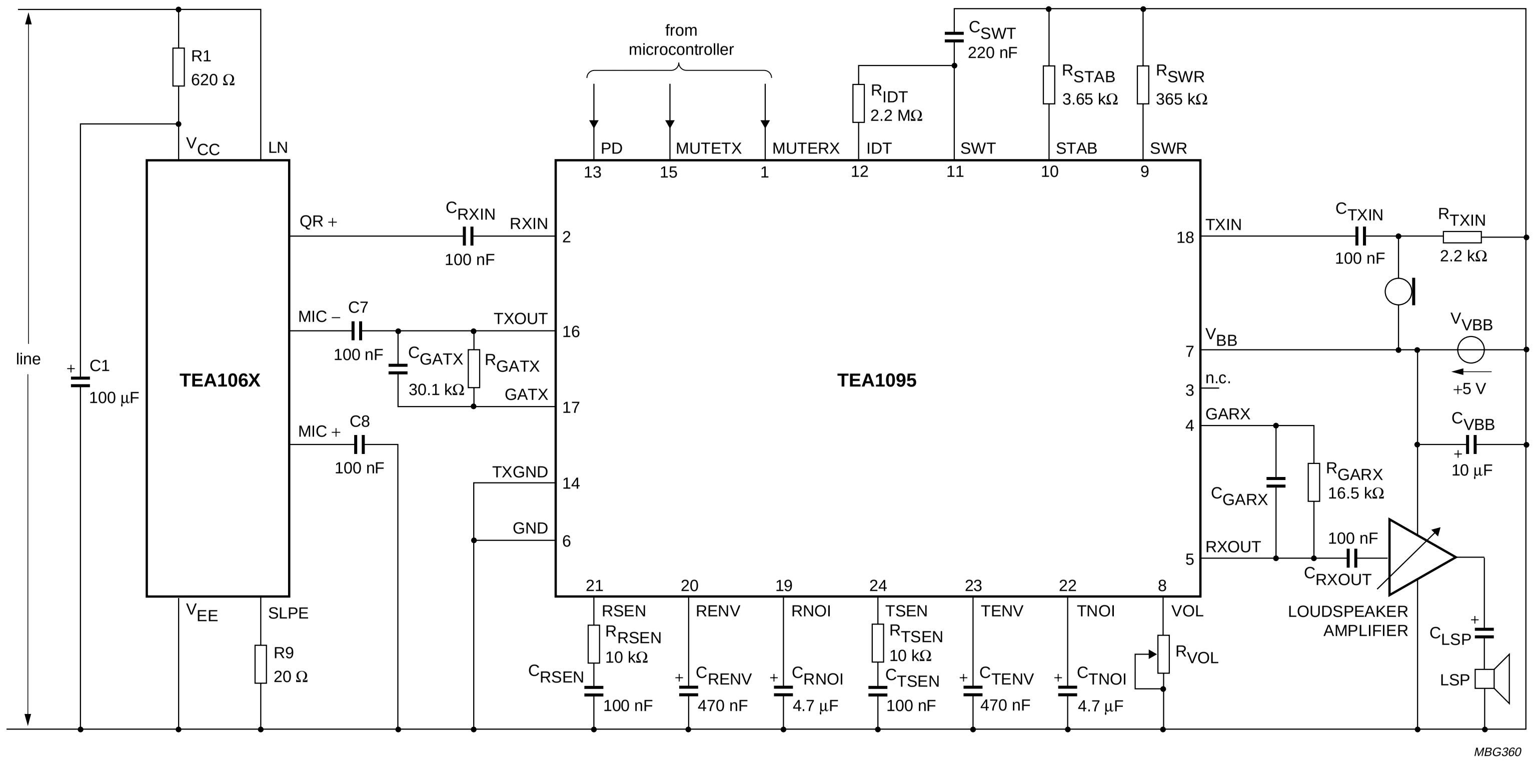
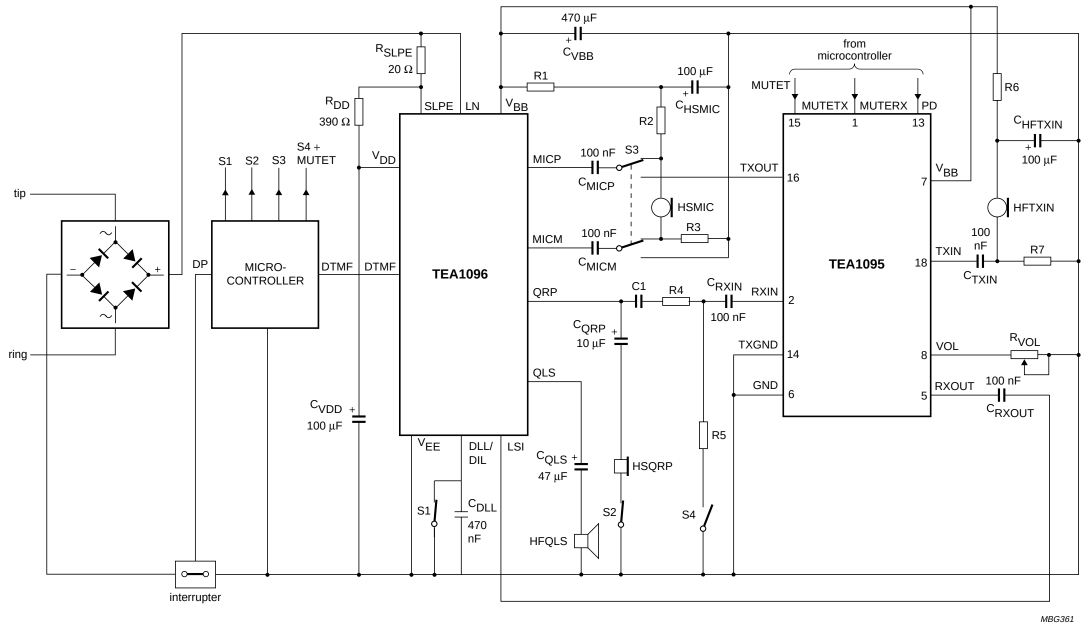


Fig.12 Basic application diagram.

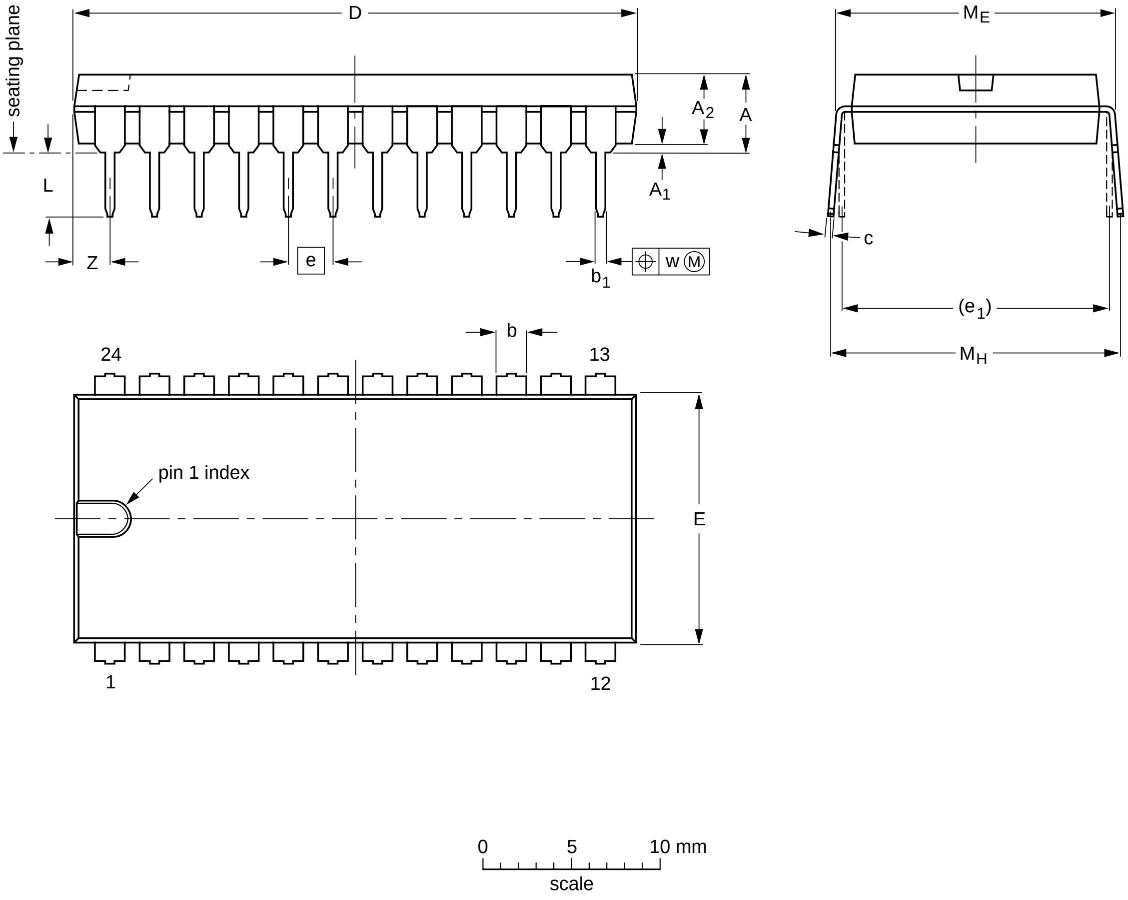


MODE	SWITCH				MUTET
	S1	S2	S3	S4	
Hands-free	OPEN	OPEN	TXOUT	OPEN	LOW
Handset	CLOSED	CLOSED	HSMIC	OPEN	DON’T CARE
Handset plus listening-in	OPEN	CLOSED	HSMIC	CLOSED	HIGH

Fig.13 Application example.

PACKAGE OUTLINES

DIP24: plastic dual in-line package; 24 leads (600 mil) SOT101-1

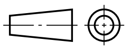


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

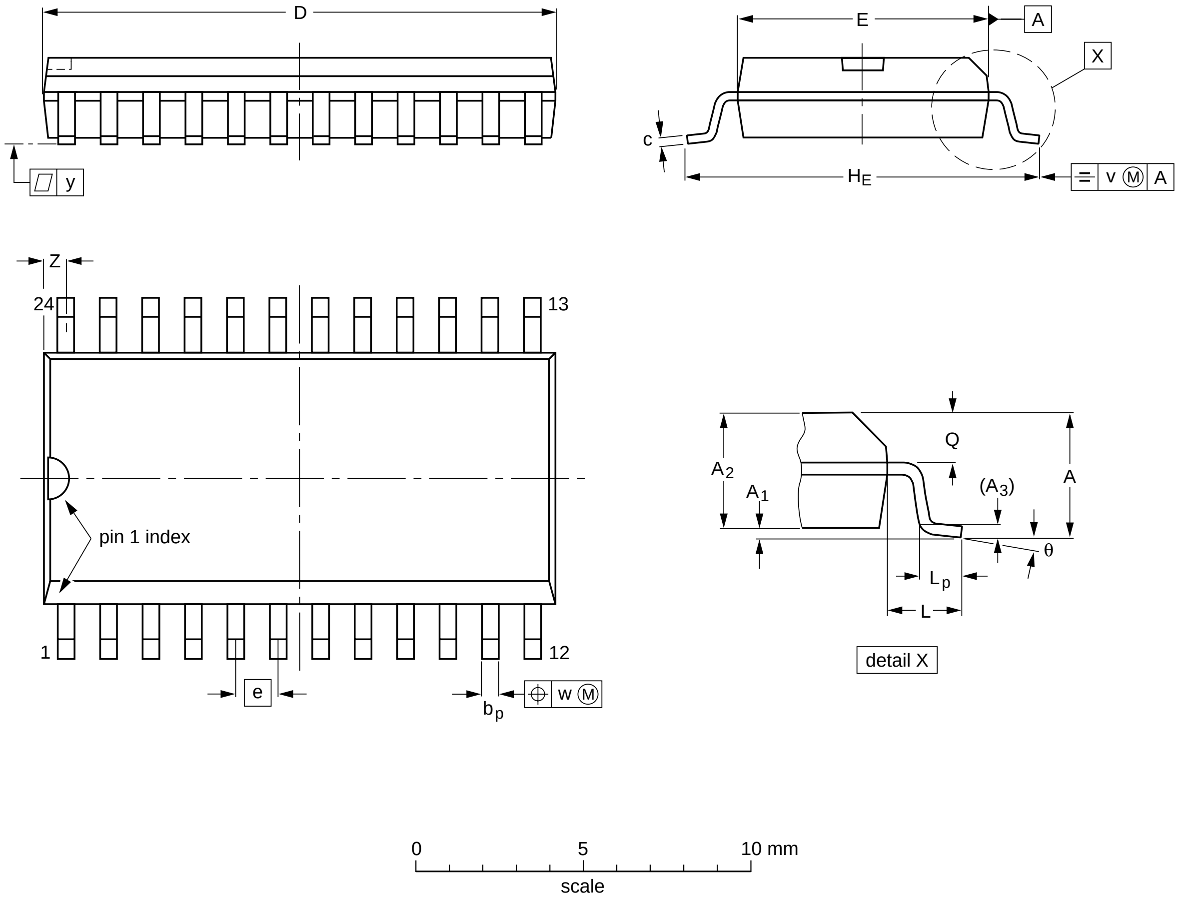
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	5.1	0.51	4.0	1.7 1.3	0.53 0.38	0.32 0.23	32.0 31.4	14.1 13.7	2.54	15.24	3.9 3.4	15.80 15.24	17.15 15.90	0.25	2.2
inches	0.20	0.020	0.16	0.066 0.051	0.021 0.015	0.013 0.009	1.26 1.24	0.56 0.54	0.10	0.60	0.15 0.13	0.62 0.60	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

SO24: plastic small outline package; 24 leads; body width 7.5 mm **SOT137-1**



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

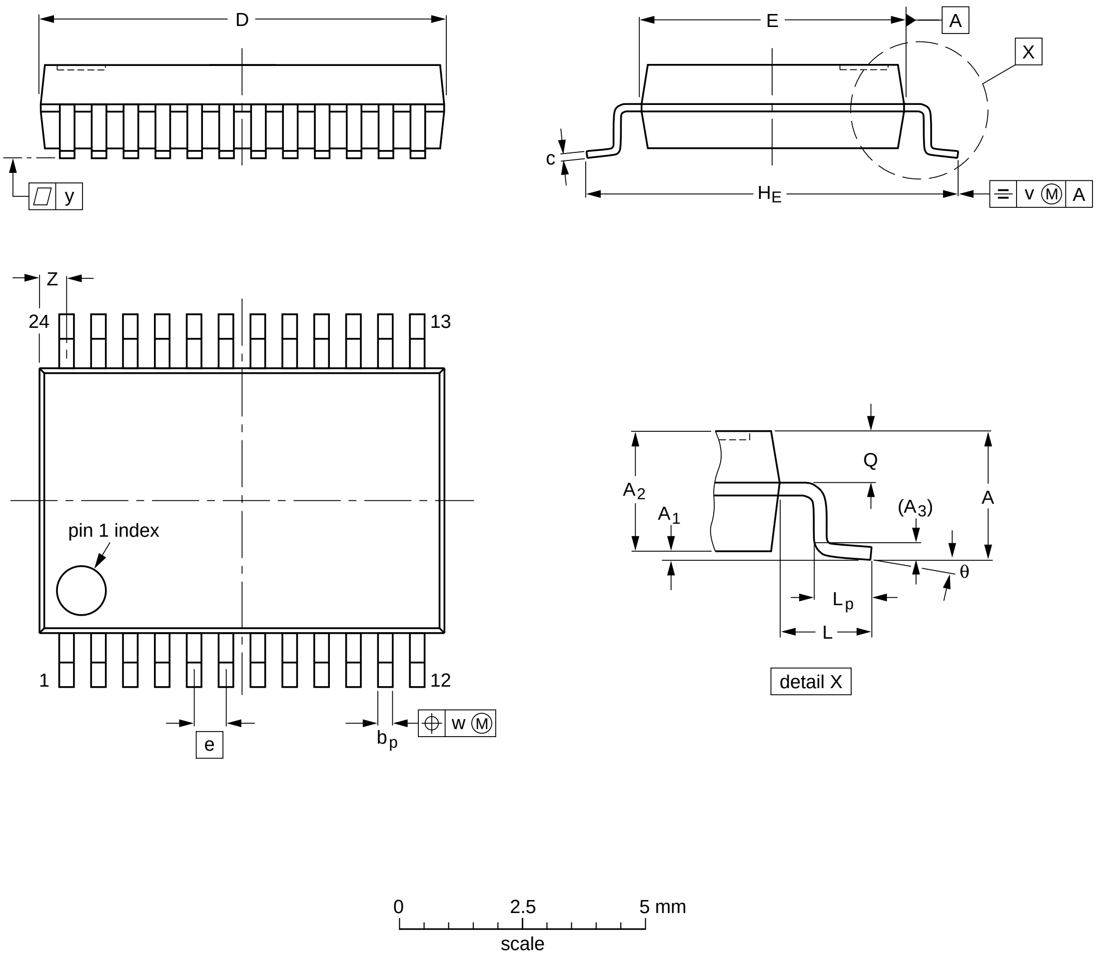
UNIT	A max.	A_1	A_2	A_3	b_p	c	D(1)	E(1)	e	H_E	L	L_p	Q	v	w	y	Z(1)	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	15.6 15.2	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.61 0.60	0.30 0.29	0.050	0.419 0.394	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				~~95-01-24~~ 97-05-22

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

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.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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