DATA SHEET

TEA1098A
Speech and handsfree IC

Product specification
Supersedes data of 2000 Jun 08
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Philips
Semiconductors

PHILIPS

Speech and handsfree IC TEA1098A

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
- Earphone amplifier for dynamic, magnetic or piezo-electric earpieces (with externally adjustable gain)
- Digital volume control on earphone amplifier (4 steps)
- Automatic Gain Control (AGC) for true line loss compensation
- Microphone mute
- Key tone mode.

Supplies

- Provides a strong 3.35 V regulated supply for microcontroller or dialler
- Provides filtered power supply, optimized according to line current
- Filtered 2.0 V power supply output for electret microphone
- $\overline{\text{PD}}$ logic input for power-down.

Handsfree

- Asymmetrical high input impedance for electret microphone
- Loudspeaker amplifier with single-ended rail-to-rail output and externally adjustable gain
- Dynamic limiter on loudspeaker amplifier to prevent distortion
- Digital volume control on loudspeaker amplifier (8 steps)
- Duplex controller consisting of:
  - Signal and noise envelope monitors for both channels (with adjustable sensitivities and timing)
  - Decision logic (with adjustable switch-over and Idle mode timing)
  - Voice switch control (with adjustable switching range and constant sum of gain during switching).

APPLICATIONS

- Line powered telephone sets.

GENERAL DESCRIPTION

The TEA1098A is an analog bipolar circuit dedicated for telephony applications. It includes a line interface, handset (HS) microphone and earpiece amplifiers, handsfree (HF) microphone and loudspeaker amplifiers and a duplex controller with signal and noise monitors on both channels. Digital volume control is available both on earphone and loudspeaker amplifiers.

This IC provides a 3.35 V strong supply for a microcontroller and a 2.0 V filtered voltage supply for an electret microphone.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1098ATV	VSO40	plastic very small outline package; 40 leads	SOT158-1
TEA1098AUH	–	bare die; on foil	–

QUICK REFERENCE DATA

I_{line} = 15 mA; R_{SLPE} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C for TEA1098ATV; T_j = 25 °C for TEA1098AUH; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; $\overline{MUTE}$ = HIGH; $\overline{BPC}$ = 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	3.4	3.7	4.0	V
		I_{line} = 70 mA	5.7	6.1	6.5	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA	2.75	3.0	3.25	V
		I_{line} = 70 mA	4.9	5.3	5.7	V
V_{DD}	regulated supply voltage on pin V_{DD}	V_{BB} > 3.35 V + 0.25 V (typ.)	3.1	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
I_{BB}	current available on pin V_{BB}					
	in speech mode		–	11	–	mA
	in handsfree mode		–	9	–	mA
$I_{BB(PD)}$	current consumption on pin V_{BB} during power-down phase	$\overline{PD}$ = LOW	–	460	–	μA
$G_{v(MIC-LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 5 mV (RMS)	43.3	44.3	45.3	dB
$G_{v(IR-RECO)}$	voltage gain from pin IR (referenced to LN) to RECO	V_{IR} = 15 mV (RMS); HFC = HIGH	28.7	29.7	30.7	dB
$\Delta G_{v(RECO-EARO)}$	gain voltage range between pins RECO and EARO		–3	–	+15	dB
$G_{v(TXI-TXO)}$	voltage gain from pin TXI to TXO	V_{TXI} = 3 mV (RMS); R_{GATX} = 30.1 kΩ	12.7	15.2	17.7	dB
$G_{v(HFTX-LN)}$	voltage gain from pin HFTX to LN	V_{HFTX} = 15 mV (RMS)	33.5	34.7	35.9	dB
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	V_{HFRX} = 30 mV (RMS); R_{GALS} = 255 kΩ; I_{line} = 70 mA	25.5	28	30.5	dB
SWR	switching range		–	40	–	dB
ΔSWR	switching range adjustment	with R_{SWR} referenced to 365 kΩ	–40	–	+12	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	5.45	6.45	7.45	dB

BLOCK DIAGRAM

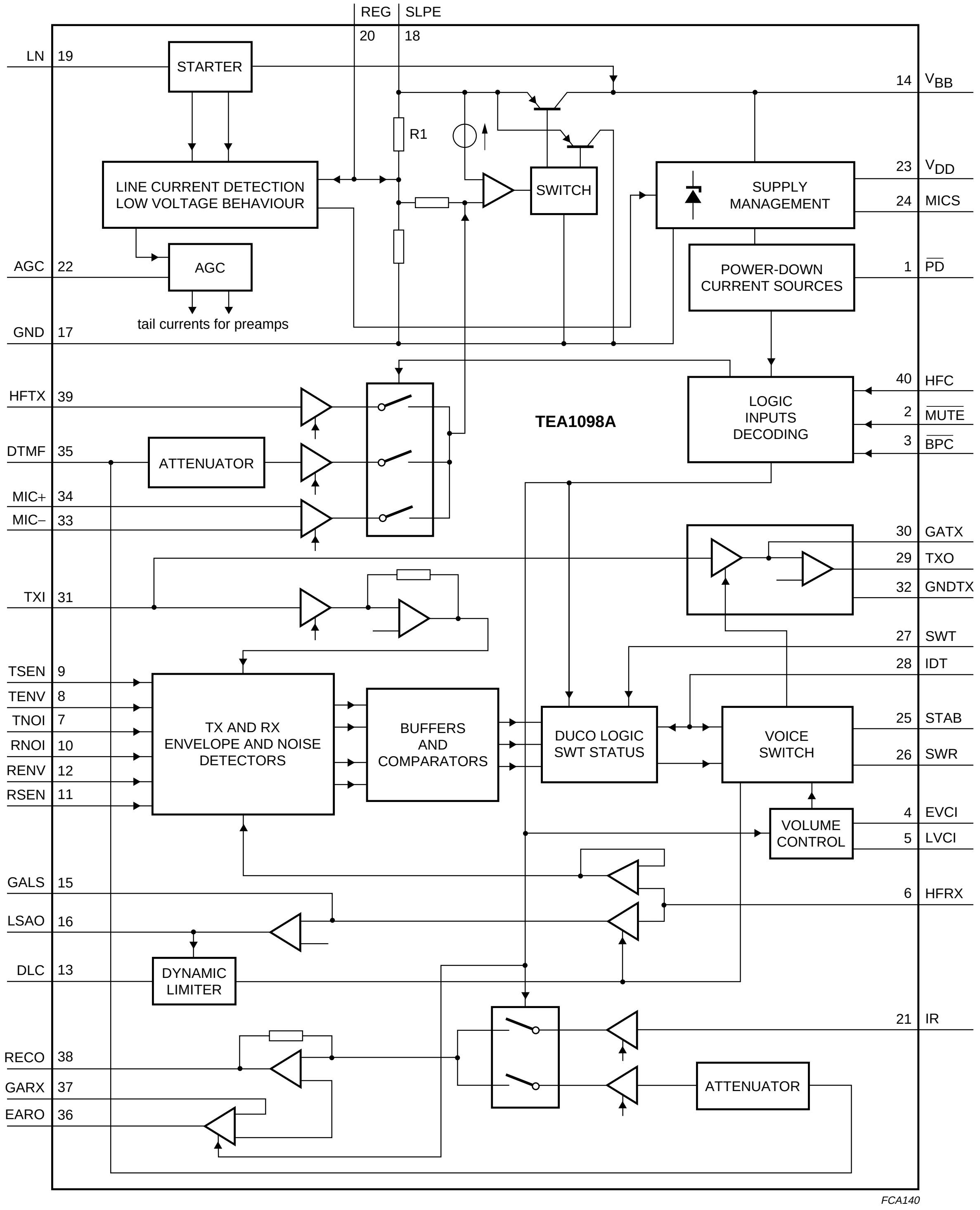


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	PAD	DESCRIPTION
	TEA1098ATV	TEA1098AUH	
$\overline{\text{PD}}$	1	40	power-down input (active LOW)
$\overline{\text{MUTE}}$	2	41	logic input (active LOW)
$\overline{\text{BPC}}$	3	42	logic input (active LOW)
EVCI	4	43	logic input for digital volume control (earpiece and loudspeaker LSB)
LVCI	5	44	logic input for digital volume control (loudspeaker MSB)
HFRX	6	1	receive input for loudspeaker amplifier
TNOI	7	2	transmit noise envelope timing adjustment
TENV	8	3	transmit signal envelope timing adjustment
TSEN	9	4	transmit signal envelope sensitivity adjustment
RNOI	10	5	receive noise envelope timing adjustment
RSEN	11	6	receive signal envelope sensitivity adjustment
RENV	12	7	receive signal envelope timing adjustment
DLC	13	8	dynamic limiter capacitor for the loudspeaker amplifier
V_{BB}	14	9	stabilized supply for internal circuitry
GALS	15	10	loudspeaker amplifier gain adjustment
LSAO	16	11	loudspeaker amplifier output
n.c.	–	12	not connected
GND	17	13	ground reference
SLPE	18	14 and 15	line current sense
LN	19	16	positive line terminal
REG	20	17	line voltage regulator decoupling
IR	21	18	receive amplifier input
AGC	22	19	automatic gain control/line loss compensation
V_{DD}	23	20	3.35 V regulated voltage supply for microcontrollers
MICS	24	21	microphone supply
STAB	25	22	reference current adjustment
SWR	26	23	switching range adjustment
n.c.	–	24	not connected
SWT	27	25	switch-over timing adjustment
IDT	28	26	Idle mode timing adjustment
TXO	29	27	handsfree microphone amplifier output
GATX	30	28	handsfree microphone amplifier gain adjustment
TXI	31	29	handsfree microphone amplifier input
GNDTX	32	30 and 31	ground reference for microphone amplifiers
MIC–	33	32	negative handset microphone amplifier input
MIC+	34	33	positive handset microphone amplifier input
DTMF	35	34	dual tone multi-frequency input
EARO	36	35	earpiece amplifier output

SYMBOL	PIN	PAD	DESCRIPTION
	TEA1098ATV	TEA1098AUH	
GARX	37	36	earpiece amplifier gain adjustment
RECO	38	37	receive amplifier output
HFTX	39	38	transmit input for line amplifier
HFC	40	39	logic input

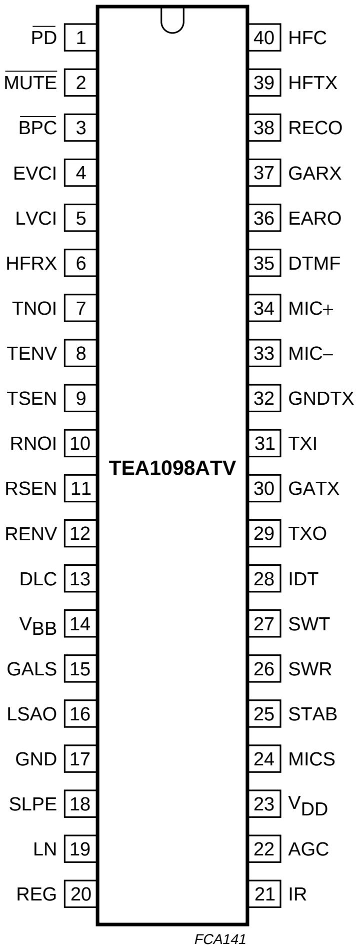


Fig.2 Pin configuration.

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 TEA1098A 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 6.1 V for line currents higher than 45 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 TEA1098A has limited performances in this area (see Section “Low voltage behaviour”). 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 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.

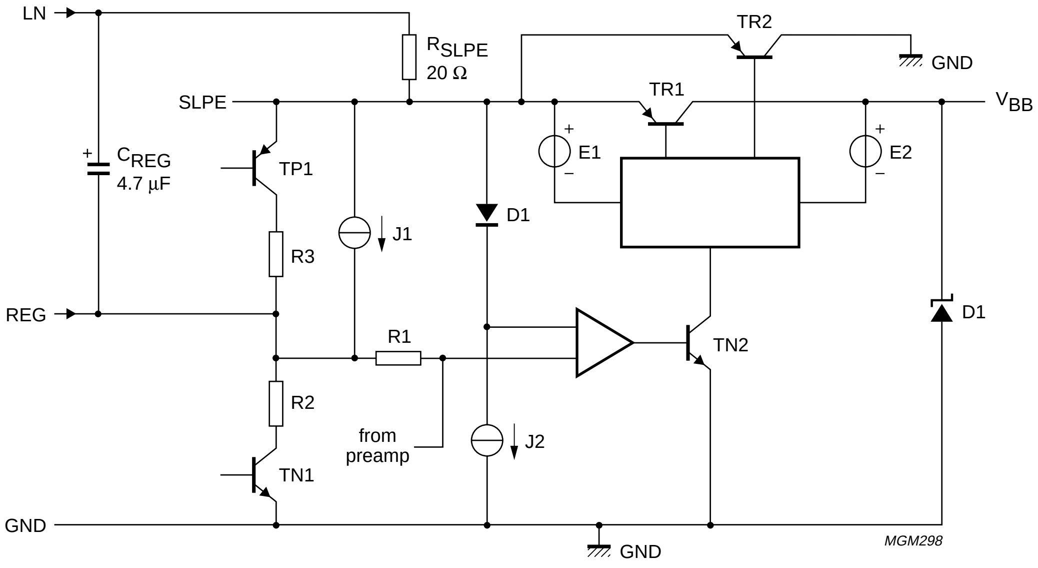


Fig.3 Line interface principle.

As can be seen from Fig.3, 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, thus 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 5.3 V for line currents greater than 45 mA. It is temperature compensated.

The aim of the current switch TR1 and 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; see Fig.4 for the main DC voltages.

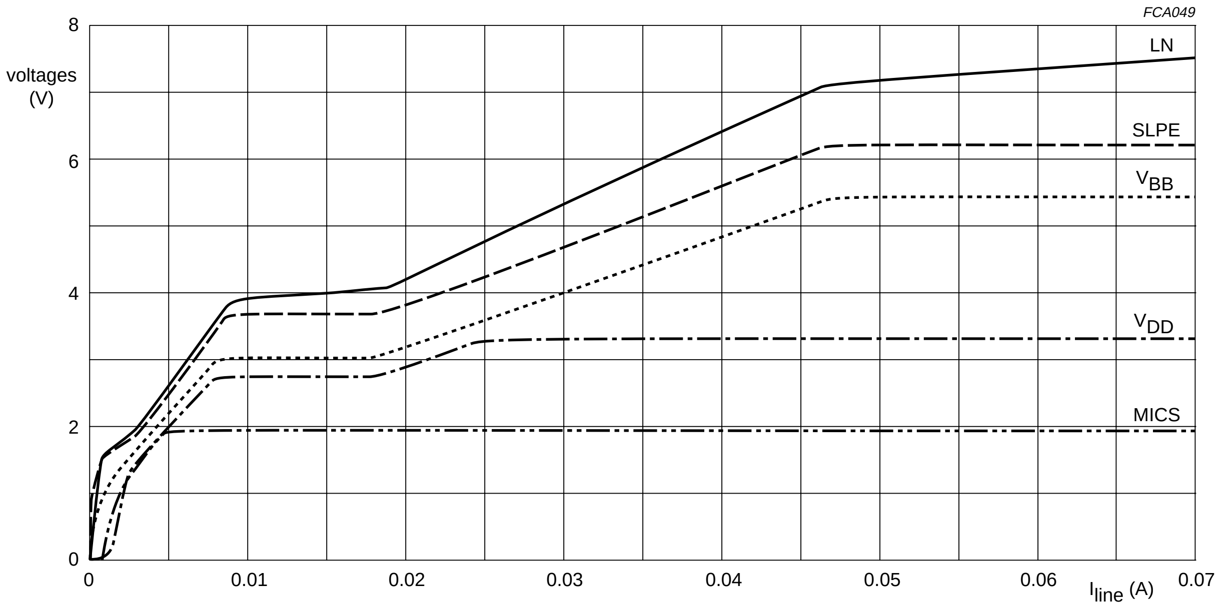


Fig.4 Main DC voltages.

V_{DD} SUPPLY FOR MICROCONTROLLER (PIN V_{DD})

The voltage on the 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.

V_{DD} can also be used as an input; in this case the voltage will be stabilised to 3.35 V up to 75 mA input current.

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

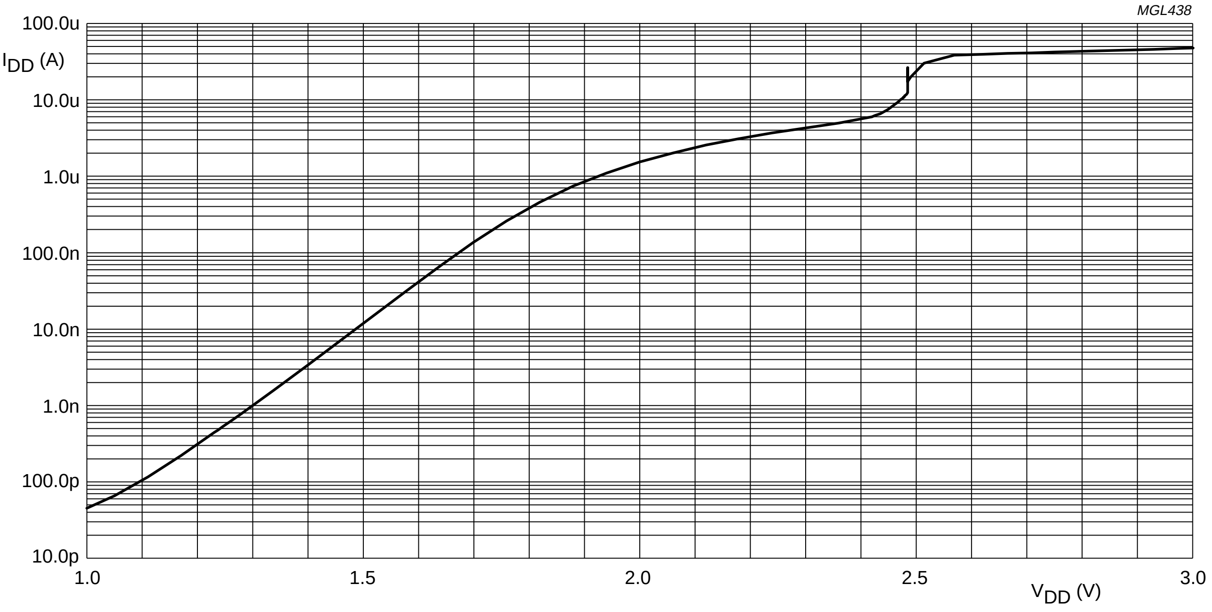


Fig.5 Current consumption on V_{DD}.

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 2.0 V; it can source a 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 becomes lower than 2.7 V, the V_{BB} detector of the receive dynamic limiter on pin LSAO acts continuously, discharging the capacitor connected to pin DLC. In the DC condition, the loudspeaker is then automatically disabled below this voltage.

When V_{BB} goes below 2.5 V, the TEA1098A is forced into 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 (PIN $\overline{PD}$)

To reduce consumption during dialling or register recall (flash), the TEA1098A is provided with a power-down input ($\overline{PD}$). When the voltage on pin $\overline{PD}$ is LOW, the current consumption from V_{BB} and V_{DD} is reduced to 460 μA typically. Therefore a capacitor of 470 μF on V_{BB} is sufficient to power the TEA1098A during pulse dialling or flash. The $\overline{PD}$ input has a pull-up structure. In this mode, the capacitor C_{REG} is internally disconnected.

Transmit channels (pins MIC+, MIC–, DTMF, HFTX and LN)

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

The TEA1098A has symmetrical microphone inputs. The input impedance between pins MIC+ and MIC– is typically 70 kΩ. The voltage gain between pins MIC+/MIC– and LN is set to 44.3 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 TEA1098A has an asymmetrical DTMF input. The input impedance between pins DTMF and GND is typically 20 kΩ. The voltage gain between pins DTMF and LN is set to 25.35 dB. Without limitation from the output, the input stage can accommodate signals up to 180 mV (RMS) at room temperature for 2% of 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 –16.5 dB in handsfree mode (HFC HIGH), and –28.2 dB in handset mode (HFC LOW).

The DC biasing of this input is 0 V.

The automatic gain control has no effect on these channels.

HANDSFREE TRANSMIT AMPLIFIER (PINS HFTX AND LN)

The TEA1098A has an asymmetrical HFTX input, which is mainly intended for use in combination with the TXO output. The input impedance between pins HFTX and GND is typically 20 kΩ. The voltage gain between pins HFTX and LN is set to 34.7 dB. Without limitation from the output, the input stage can accommodate signals up to 95 mV (RMS) at room temperature for 2% of THD. The HFTX input is biased at two diodes voltage.

Automatic gain control is provided for line loss compensation.

Receive channels (pins IR, RECO, GARX, EARO and EVCI)

RX AMPLIFIER (PINS IR, RECO AND EVCI)

The receive amplifier has one input IR which is referred to the line. The input impedance between pins IR and LN is typically 20 kΩ and the DC biasing between these pins is equal to one diode voltage.

When HFC = 0, the gain between pins IR (referred to LN) and RECO is typically 17.2 dB which compensates typically 15 dB lower than attenuation of the anti-sidetone network. The receive amplifier gain can be digitally increased with the 4-level logic input EVCI, providing 4 steps of 4.85 dB which apply in all handset receive modes. A proportional voltage decoder at pin EVCI (see Fig.17) defines a gain of 17.2 dB when EVCI = 0 (minimum gain) and 31.7 dB (maximum gain) when EVCI = V_{DD}; intermediate steps correspond to EVCI = $\frac{1}{3}V_{DD}$ and EVCI = $\frac{2}{3}V_{DD}$ levels. Without limitation from the output, the input stage can accommodate signals up to 50 mV (RMS) at room temperature for 2% of THD.

When HFC = 1, the gain is set automatically to 29.7 dB which compensate the anti-sidetone network attenuation minus 2.3 dB.

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 EARO)

The earpiece amplifier is an operational amplifier having its output (EARO) and its inverting input (GARX) available. Its input signal comes, via a decoupling capacitor, from the receive output RECO. It is used in combination with two resistors to get the required gain or attenuation compared to the receive gain. The typical resistor ratio is 4, which gives a 12 dB gain. The gain range can be chosen between 0 dB and 20 dB.

Two external capacitors C_{GAR} (connected between pins GAR and EARO) and C_{GARS} (connected between pins 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 $C_{GAR} \times R_{E2}$. The relationship $C_{GARS} \geq 10 \times C_{GAR}$ must be fulfilled.

The earpiece amplifier has a rail-to-rail output EARO, 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).

AGC (pin AGC)

The TEA1098A 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 6.45 dB for $G_{v(MIC-LN)}$ and $G_{v(IR-RECO)}$ and 6.8 dB for $G_{v(HFTX-LN)}$, 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, pin AGC must be shorted to pin LN. The start current for compensation corresponds to a line current of 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 80 kΩ). The start and stop current will be maintained in a ratio equal to 2.5. By leaving the AGC pin open-circuit, the gain control is disabled and no line loss compensation is performed.

Handsfree application

As can be seen from Fig.6, a loop is formed via the sidetone network in the line interface part and the acoustic coupling between loudspeaker and microphone of the handsfree part.

When this loop gain is greater than 1, howling occurs. 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 TEA1098A detects which channel has the ‘largest’ signal and then controls the gains of the microphone and loudspeaker amplifiers so that the sum of the gains remains constant.

As a result, in handsfree application, 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.

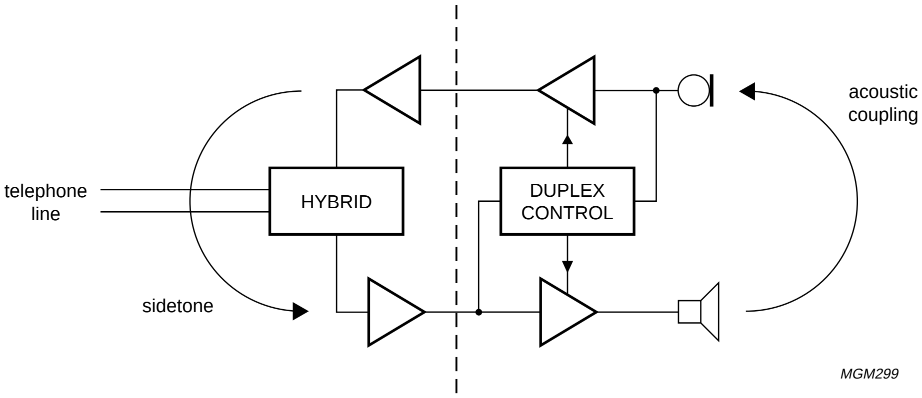


Fig.6 Handsfree telephone set principles.

HANDSFREE MICROPHONE CHANNEL (PINS TXI, GATX, TXO AND GNDTX; SEE Fig.7)

The TEA1098A has an asymmetrical handsfree microphone input (pin TXI) with an input resistance of 20 kΩ. The DC biasing of the input is 0 V. The gain of the input stage varies according to the mode of the TEA1098A. 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.

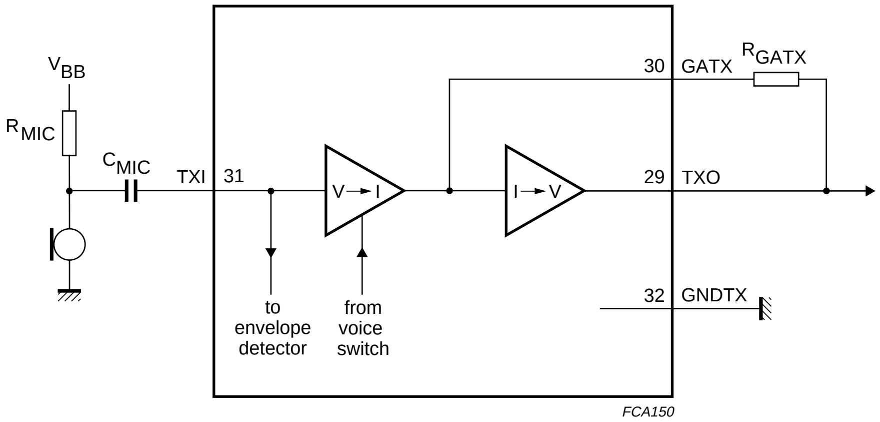


Fig.7 Handsfree microphone channel.

Switch-over from one mode to the other is smooth and click-free. The output TXO is biased at two diodes voltage and has a current capability equal to 20 µA (RMS). In the transmit mode, the overall gain of the microphone amplifier (from pins TXI to TXO) 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 THD.

LOUDSPEAKER CHANNEL

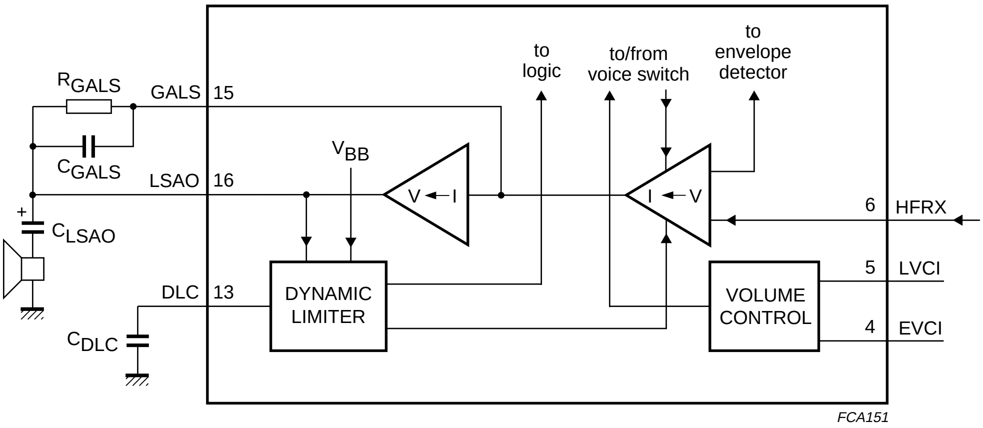


Fig.8 Loudspeaker channel.

Loudspeaker amplifier (pins HFRX, GALS and LSAO)

The TEA1098A has an asymmetrical input for the loudspeaker amplifier with an input resistance of 20 kΩ between pins HFRX and GND. It is biased at two diodes voltage. Without limitation from the output, the input stage can accommodate signals up to 580 mV (RMS) at room temperature for 2% of THD.

The gain of the input stage varies according to the mode of the TEA1098A. 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 pins LSAO and GND).

In the receive mode, the overall 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 28 dB with R_{GALS} = 255 kΩ. A capacitor connected in parallel with R_{GALS} is recommended and provides a first-order low-pass filter.

Digital volume control (pins LVCI and EVCI)

The loudspeaker amplifier gain can be adjusted (attenuated) with the LVCI logic input (as MSB) and the 4-level input EVCI (as LSBs). This combination provides 8 steps of –3.85 dB which apply in all handsfree receive modes. Maximum gain (27 dB) is obtained for LVCI = V_{DD} and EVCI = V_{DD}; minimum gain (0 dB) is defined by LVCI = 0 and EVCI = 0. In-between steps correspond to the combination of LVCI with EVCI intermediary levels of $\frac{1}{3}V_{DD}$ and $\frac{2}{3}V_{DD}$ (see Fig.17). E.g. the first attenuation step is given by LVCI = V_{DD} and EVCI = $\frac{2}{3}V_{DD}$.

Dynamic limiter (pin DLC)

The dynamic limiter of the TEA1098A 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 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 2% 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 and the TEA1098A 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 illustrated in Fig.9.

For the transmit channel, the input signal at pin TXI is 40 dB amplified to TSEN. For the receive channel, the input signal at pin HFRX 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.17) it is assumed that V_{TXI} = 1 mV (RMS) and V_{HFRX} = 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 feeding the compressed signals to pins TENV and RENV have a maximum source current of 120 μA and a maximum sink current of 1 μA. Capacitors C_{TENV} and C_{RENV} set the timing of the signal envelope monitors. 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 sufficient 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 sufficient for a smooth envelope and also eliminates the effect of echoes on switching behaviour.

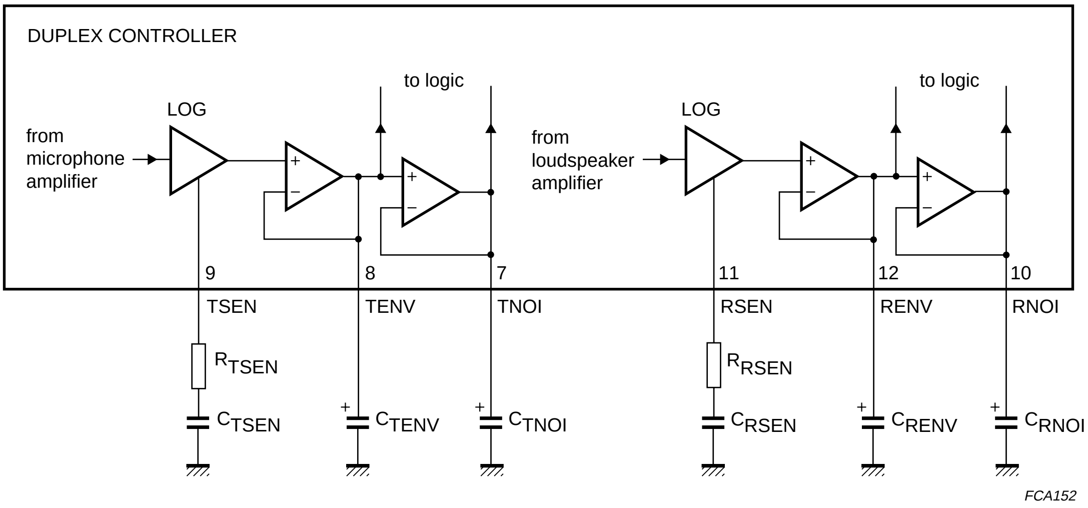


Fig.9 Signal and noise envelope detectors.

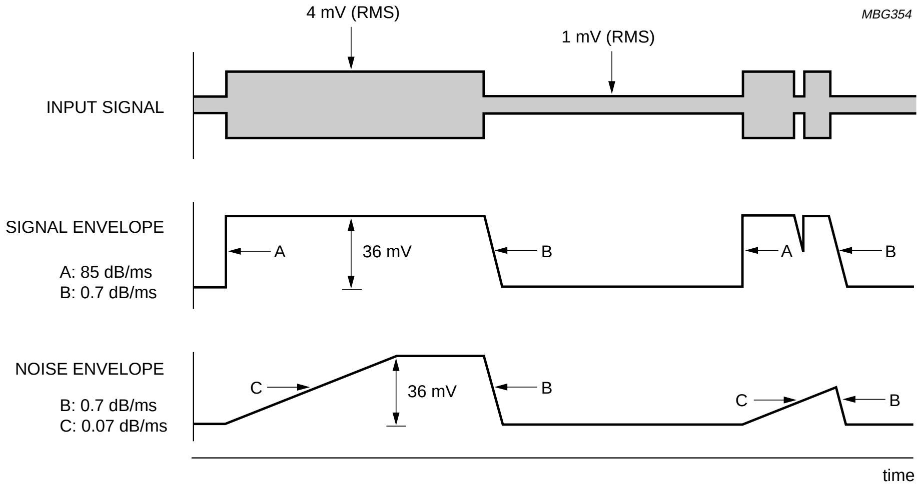
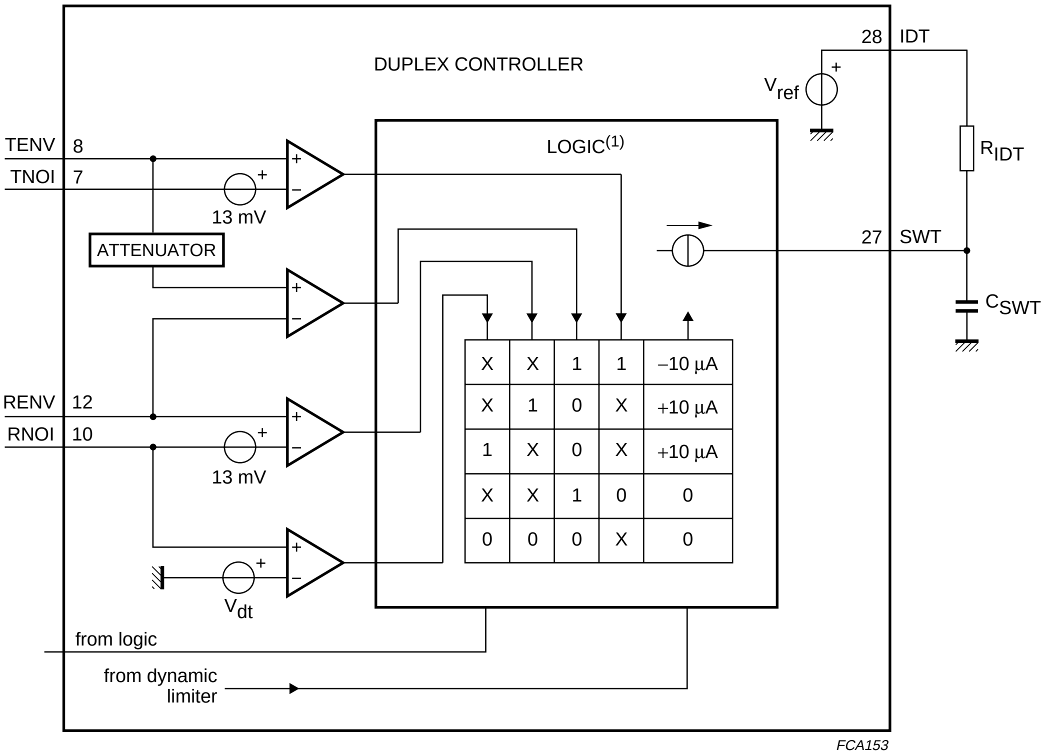


Fig.10 Signal and noise envelope waveforms.

To determine the noise level, the signals on pins TENV and RENV are buffered to pins TNOI and RNOI. These buffers have a maximum source current of 1 μA and a maximum sink current of 120 μA. Capacitors C_{TNOI} and C_{RNOI} set the timing. In the basic application, see Fig.17, 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.10.

Decision logic (pins IDT and SWT)



X	X	1	1	−10 μA
X	1	0	X	+10 μA
1	X	0	X	+10 μA
X	X	1	0	0
0	0	0	X	0

(1) When DLC < 0.2 V, −10 μA is forced.

Fig.11 Decision logic.

The TEA1098A 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 $V_{ENV} - V_{NOI}$ = 13 mV. This so-called speech/noise threshold is implemented in both channels.

The signal on pin TXI contains both speech and the signal from the loudspeaker (acoustic coupling). When receiving, the contribution from the loudspeaker overrules the speech. As a result, the signal envelope on pin TENV is formed mainly by the loudspeaker signal. To correct this, an attenuator is connected between pin 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 TEA1098A 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 HFRX and GND as noise when they have a level greater than 25 mV (RMS). This level is proportional to R_{RSEN}.

In the same way, a transmit detector is integrated which, in standard applications, does not consider input signals between pins TXI and GNDTX as noise when they have a level greater than 0.75 mV (RMS). This level is proportional to R_{TSEN}.

As can be seen from Fig.11, 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 pin SWT becomes equal to the voltage on pin IDT via the high-ohmic resistor R_{IDT} (idling). The resulting voltage difference between pins SWT and IDT determines the mode of the TEA1098A and can vary between –400 and +400 mV (see Table 1).

Table 1 Modes of TEA1098A

$V_{SWT} - V_{IDT}$ (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.17, C_{SWT} is 220 nF and R_{IDT} is 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 pin SWT). The switch-over time from Idle mode to transmit mode or receive mode is approximately 4 ms (180 mV swing on pin 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 input at pin DLC overrules the decision logic. When the voltage on pin DLC goes lower than 0.2 V, the capacitor C_{SWT} is discharged with 10 µA thus resulting in the transmit mode.

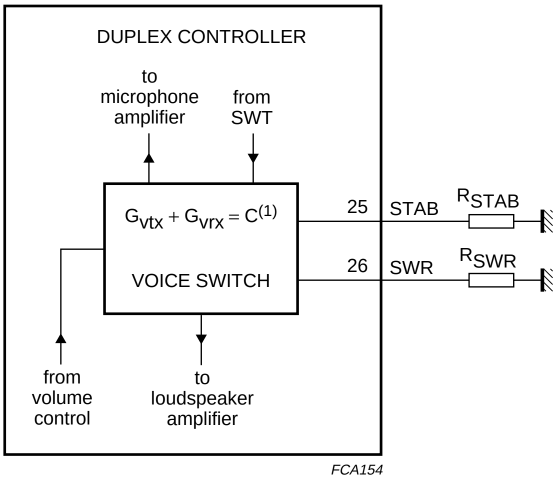
Voice switch (pins STAB and SWR)

A diagram of the voice switch is illustrated in Fig.12. With the voltage on pin SWT, the TEA1098A voice switch regulates the gains of the transmit and the receive channels 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 dB. R_{STAB} should be 3.65 kΩ and sets an internally used reference current. In the basic application diagram given in Fig.17, R_{SWR} is 365 kΩ which results in a switching range of 40 dB. The switch-over behaviour is illustrated in Fig.13.

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.13). 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 dB.



(1) C = constant.

Fig.12 Voice switch.

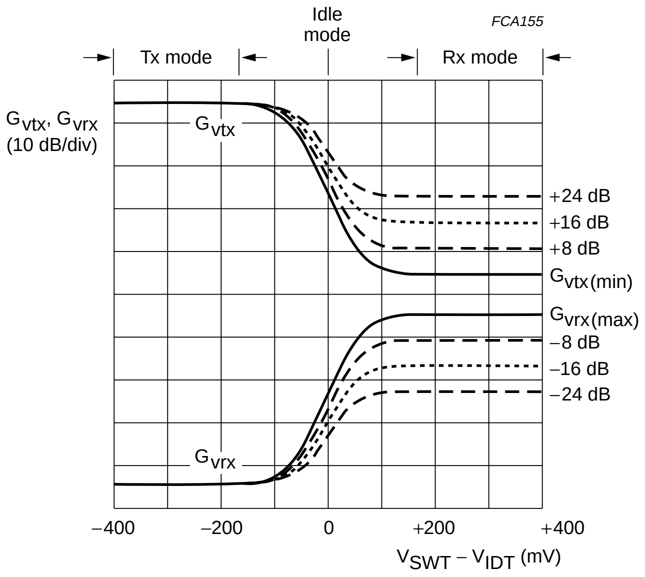


Fig.13 Switch-over behaviour.

Logic inputs

The actions of the logic inputs $\overline{\text{BPC}}$ and $\overline{\text{MUTE}}$, combined with the HFC input are detailed in Table 2.

Table 2 Table of switch management

LOGIC INPUTS			FEATURES	APPLICATION
HFC	**$\overline{\text{MUTE}}$**	**$\overline{\text{BPC}}$**		
0	0	0	DTMF to RECO; RECO to EARO; MICS is active	handset beep mode
0	0	1	DTMF to LN; DTMF to RECO; RECO to EARO; MICS is active	handset dialling mode
0	1	0	IR to RECO; RECO to EARO; MICS is active	handset secret mode
0	1	1	MIC to LN; IR to RECO; RECO to EARO; MICS is active	handset conversation mode
1	0	0	DTMF to RECO; HFRX to LSAO; MICS is active	handsfree beep mode
1	0	1	DTMF to LN; DTMF to RECO; HFRX to LSAO; MICS is active	handsfree dialling mode
1	1	0	IR to RECO; HFRX to LSAO; MICS is active	handsfree secret mode
1	1	1	TXI to TXO; HFTX to LN; IR to RECO; HFRX to LSAO; MICS is active	handsfree conversation mode

LIMITING VALUES

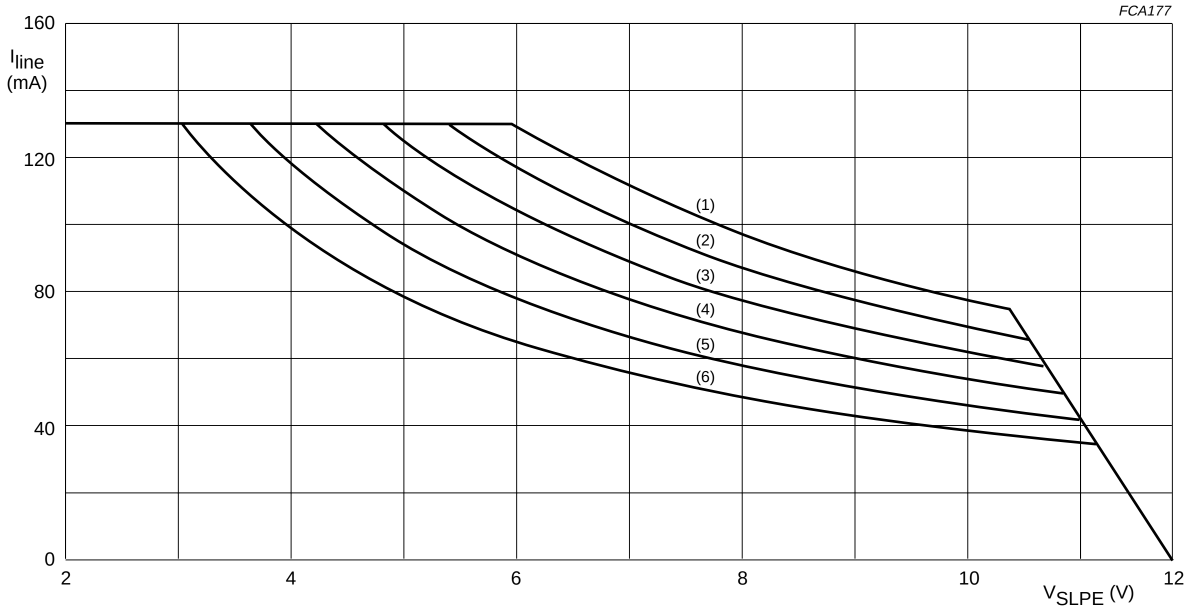
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive continuous line voltage		–0.4	+12	V
	repetitive line voltage during switch-on or line interruption		–0.4	+13.2	V
$V_{n(max)}$	maximum voltage on pins REG, SLPE, IR and AGC		–0.4	V_{LN} + 0.4	V
	maximum voltage on all other pins except V_{DD}		–0.4	V_{BB} + 0.4	V
I_{line}	maximum line current		–	130	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C			
	TEA1098ATV	see Fig.14	–	400	mW
	TEA1098AUH	see Fig.15	–	720	mW
T_{stg}	storage temperature		–40	+125	°C
T_{amb}	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		
	TEA1098ATV		117	K/W
	TEA1098AUH		note 1	–

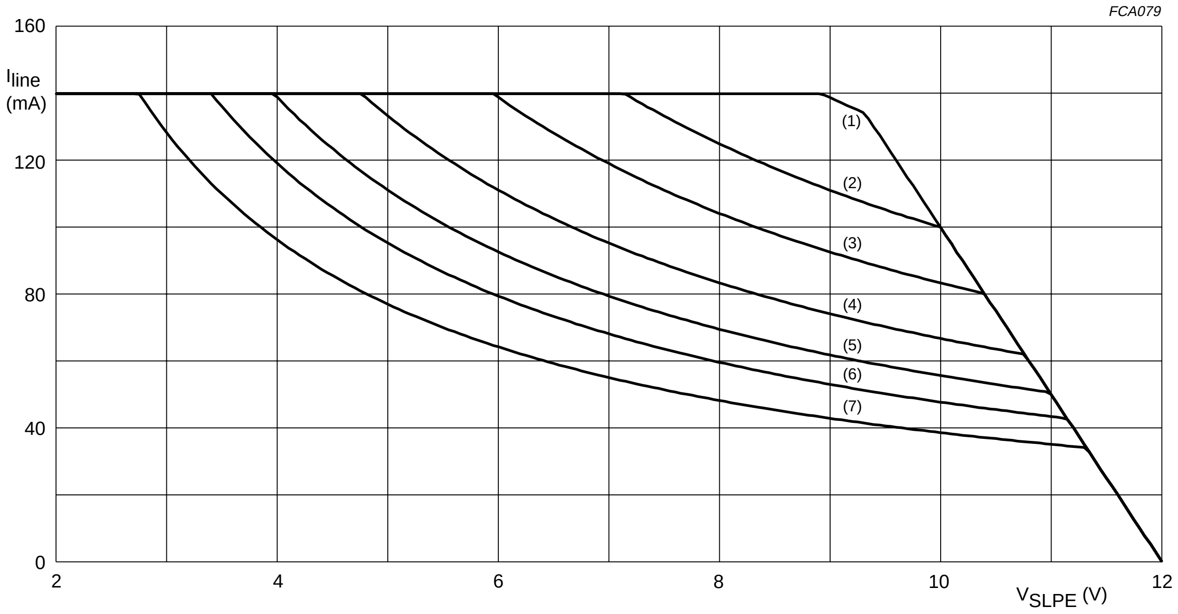
Note

1. The value is to be determined by the customer in the application.



LINE	T_{amb} (°C)	P_{tot} (mW)
(1)	25	790
(2)	35	710
(3)	45	630
(4)	55	550
(5)	65	470
(6)	75	390

Fig.14 Safe operating area (TEA1098ATV).



LINE	P_{tot} (mW)
(1)	40
(2)	50
(3)	60
(4)	75
(5)	90
(6)	105
(7)	130

Fig.15 Safe operating area (TEA1098AUH).

CHARACTERISTICS

I_{line} = 15 mA; R_{SLPE} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C for TEA1098ATV; T_j = 25 °C for TEA1098AUH; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; $\overline{MUTE}$ = HIGH; $\overline{BPC}$ = HIGH; all DC levels are referenced to GND; 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	3.4	3.7	4	V
		I_{line} = 70 mA	5.7	6.1	6.5	V
V_{REF}	stabilized voltage with an external resistor R_{VA} between REG and SLPE	R_{VA} = 40 kΩ	–	4.5	–	V
$\Delta V_{REF(T)}$	stabilized voltage variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±60	–	mV
V_{LN}	line voltage	I_{line} = 1 mA	–	1.55	–	V
		I_{line} = 4 mA	–	2.35	–	V
		I_{line} = 15 mA	3.7	4.0	4.3	V
		I_{line} = 130 mA	–	8.7	9.3	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA; I_{BB} = 0	2.75	3.0	3.25	V
		I_{line} = 70 mA; I_{BB} = 0	4.9	5.3	5.7	V
I_{line}	line current for voltage increase	start current	–	18	–	mA
		stop current	–	45	–	mA
$\Delta V_{BB(T)}$	regulated voltage variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±30	–	mV
I_{BB}	current available on pin V_{BB}	in speech mode	–	11	–	mA
		in handsfree mode	–	9	–	mA
SUPPLY FOR PERIPHERALS (PIN V_{DD})						
V_{DD}	supply output voltage	V_{BB} > 3.35 V + 0.25 V (typ.)	3.1	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
$\Delta V_{DD(T)}$	regulated voltage variation with temperature referenced 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
$I_{DD(ext)}$	current sunk from external source	in ringer mode; I_{line} = 0; V_{DD} = 3.35 V	–	–	75	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{DD(O)}$	current available for peripherals	V_{DD} = 3.3 V	–	–3	–	mA
SUPPLY FOR MICROPHONE (PIN MICS)						
V_{MICS}	supply voltage for a microphone		–	2.0	–	V
POWER-DOWN INPUT (PIN $\overline{PD}$)						
V_{IL}	LOW-level input voltage		–0.4	–	+0.3	V
$I_{i(PD)(l)}$	input current at low voltage		–	–3	–6	µA
V_{IH}	HIGH-level input voltage		1.4	–	V_{BB} + 0.3	V
$I_{BB(PD)}$	current consumption on V_{BB} during power-down phase	$\overline{PD}$ = LOW	–	460	–	µA
Preamplifier inputs (pins MIC+, MIC–, IR, DTMF, TXI, HFTX and HFRX)						
$\lvert Z_{i(MIC)}\rvert$	input impedance differential between pins MIC+ and MIC– single-ended between pins MIC+/MIC– and GNDTX		 – –	 70 35	 – –	 kΩ 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
$\lvert Z_{i(TXI)}\rvert$	input impedance between pins TXI 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
TX amplifiers						
TX HANDSET MICROPHONE AMPLIFIER (PINS MIC+, MIC– AND LN)						
$G_{v(MIC-LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 5 mV (RMS)	43.3	44.3	45.3	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\Delta G_{v(T)}$	gain variation with temperature referenced 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	–	dBmp
$\Delta G_{v(mute)}$	gain reduction when muted	$\overline{\text{MUTE}}$ = 0; see Table 2	60	80	–	dB
$\Delta G_{v(MIC)(mute)}$	gain reduction in microphone mute mode	V_{MIC} = 10 mV (RMS); $\overline{\text{MUTE}}$ = 1; $\overline{\text{BPC}}$ = 0; see Table 2	60	–	–	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)	24.35	25.35	26.35	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
$\Delta G_{v(mute)}$	gain reduction if not active	$\overline{\text{MUTE}}$ = 1; see Table 2	60	80	–	dB
$G_{v(DTMF\text{-}RECO)}$	voltage gain from pin DTMF to RECO in handsfree mode	V_{DTMF} = 50 mV (RMS); $\overline{\text{MUTE}}$ = 0; HFC = 1	–	–17	–	dB
$G_{v(DTMF\text{-}RECO)}$	voltage gain from pin DTMF to RECO in handset mode	V_{DTMF} = 50 mV (RMS); $\overline{\text{MUTE}}$ = 0; HFC = 0; EVCI = 0	–	–28.2	–	dB
$\Delta G_{v(DTMF\text{-}RECO)}$	digital volume control adjustment range in handset mode	V_{DTMF} = 50 mV (RMS); $\overline{\text{MUTE}}$ = 0; HFC = 0	–	–12.75	–	dB
$\Delta G_{v(DTMF\text{-}RECO)}$	digital volume control adjustment step in handset mode	$\overline{\text{MUTE}}$ = 0; HFC = 0; per step	–	4.25	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TX AMPLIFIER USING HFTX (PINS HFTX AND LN)						
$G_{v(HFTX\text{-}LN)}$	voltage gain from pin HFTX to LN	V_{HFTX} = 15 mV (RMS)	33.5	34.7	35.9	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75°C	–	±0.35	–	dB
THD	total harmonic distortion at LN	V_{LN} = 1.4 V (RMS)	–	–	2	%
$V_{HFTX(rms)}$	maximum input voltage at HFTX (RMS value)	I_{line} = 70 mA; THD = 2%	–	85	–	mV
$V_{no(LN)}$	noise output voltage at pin LN; pin HFTX shorted to GND through 200 Ω in series with 10 µF	psophometrically weighted (p53 curve)	–	–77	–	dBmp
$\Delta G_{v(m)}$	gain reduction when muted	$\overline{\text{MUTE}}$ = 0; see Table 2	60	80	–	dB
$\Delta G_{v(MIC)(mute)}$	gain reduction in microphone mute mode	$\overline{\text{MUTE}}$ = 1; $\overline{\text{BPC}}$ = 0; see Table 2	60	–	–	dB
RX amplifiers						
RX AMPLIFIERS USING IR (PINS IR AND RECO)						
$G_{v(IR\text{-}RECO)(HF)}$	voltage gain from IR to RECO (handsfree mode)	V_{IR} = 4 mV (RMS); HFC = 1	28.4	29.4	30.4	dB
$G_{v(IR\text{-}RECO)(HS)}$	voltage gain from IR to RECO (handset mode)	V_{IR} = 4 mV (RMS); HFC = 0; EVCI = 0	16.2	17.2	18.2	dB
$\Delta G_{v(IR\text{-}RECO)}$	digital volume control adjustment range in handset mode	V_{IR} = 4 mV (RMS); HFC = 0; EVCI = V_{DD}	13	14.5	16	dB
$\Delta G_{v(IR\text{-}RECO)}$	digital volume control adjustment step in handset mode	HFC = 0; per step	–	+4.85	–	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 referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{IR(max)(rms)}$	maximum input voltage on IR (referenced to LN) (RMS value)	I_{line} = 70 mA; THD = 2%	–	50	–	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{RECO(max)(rms)}$	maximum output voltage on RECO (RMS value)	THD = 2%; $G_{v(RECO-EARO)}$ = 12 dB	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)	–	–84	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not active	$\overline{\text{MUTE}}$ = 0; see Table 2	60	80	–	dB
RX EARPIECE AMPLIFIER (PINS GARX AND EARO)						
$\Delta G_{v(RECO-EARO)}$	gain voltage range between pins RECO and EARO		0	–	20	dB
$V_{EARO(max)(rms)}$	maximum output voltage on EARO (RMS value)	sine wave drive; R_L = 150 Ω; THD < 2%	0.75	0.9	–	V
$V_{no(EARO)(rms)}$	noise output voltage at pin EARO; pin IR is an open-circuit (RMS value)	$G_{v(EARO)}$ = 12 dB; EVCI = 0; psophometrically weighted (p53 curve)	–	–84	–	dBVp
Automatic Gain Control (pin AGC)						
$\Delta G_{v(trx)}$	gain control range for transmit and receive signals affected by the AGC; with respect to I_{line} = 15 mA	I_{line} = 70 mA; $G_{v(MIC-LN)}$; $G_{v(IR-RECO)}$; R_{AGC} = 0;	5.45	6.45	7.45	dB
		I_{line} = 70 mA for $G_{v(HFTX-LN)}$; R_{AGC} = 0	5.8	6.8	7.8	dB
I_{start}	highest line current for maximum gain		–	23	–	mA
I_{stop}	lowest line current for maximum gain		–	57	–	mA
ΔI_{start}	I_{start} adjustment range with R_{AGC}		–	–	40	mA
Logic inputs (pins HFC, $\overline{\text{MUTE}}$, and $\overline{\text{BPC}}$)						
V_{IL}	LOW-level input voltage		–0.4	–	+0.3	V
V_{IH}	HIGH-level input voltage		1.4	–	V_{BB} + 0.3	V
$I_{i(l)}$	input current at low voltage	V_{BB} = 3.0 V				
	for pin HFC		–	0	–	µA
	for pin $\overline{\text{MUTE}}$		–	–5	–	µA
	for pin $\overline{\text{BPC}}$		–	–2.5	–	µA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{i(h)}$	input current at high voltage	V_{BB} = 3.0 V				
	for pin HFC		–	2.5	–	µA
	for pin $\overline{\text{MUTE}}$		–	0	–	µA
	for pin $\overline{\text{BPC}}$		–	0	–	µA
Handsfree mode (HFC = HIGH)						
HF MICROPHONE AMPLIFIER (PINS TXI, TXO AND GATX)						
$G_{v(TXI-TXO)}$	voltage gain from pin TXI to TXO	V_{TXI} = 3 mV (RMS); R_{GATX} = 30.1 kΩ	12.7	15.2	17.7	dB
ΔG_v	voltage gain adjustment with R_{GATX}		–15	–	+16	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.15	–	dB
$V_{no(TXO)(rms)}$	noise output voltage at pin TXO; pin TXI is shorted through 200 Ω and 10 µF to GNDTX	psophometrically weighted (p53 curve); $G_{v(TXI)}$ = 15 dB; RMS value	–	–101	–	dBVp
$\Delta G_{v(mute)}$	gain reduction when muted	$\overline{\text{MUTE}}$ = 0; see Table 2	60	80	–	dB
$\Delta G_{v(SEC)}$	gain reduction in secret mode	V_{txi} = 10 mV (RMS); $\overline{\text{MUTE}}$ = 1; BPC = 0; see Table 2	60	–	–	dB
HF LOUDSPEAKER AMPLIFIER (PINS HFRX, LSAO, GALS AND DLC)						
$G_{v(HFRX-LSAO)}$	nominal voltage gain from pin HFRX to LSAO	V_{HFRX} = 30 mV (RMS); R_{GALS} = 255 kΩ; LVCI = V_{DD}; EVCI = V_{DD}	24.5	27	29.5	dB
$\Delta G_{v(HFRX-LSAO)}$)	digital volume control adjustment range	V_{HFRX} = 30 mV (RMS); R_{GALS} = 255 kΩ	25.5	27	28.5	dB
$\Delta G_{v(step)}$	digital volume adjustment step	per step	–	3.85	–	dB
ΔG_v	voltage gain adjustment with R_{GALS}		–28	–	+7	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.3	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{HFRX(max)(rms)}$	maximum input voltage at pin HFRX (RMS value)	I_{line} = 70 mA; R_{GALS} = 33 kΩ; for 2% THD in the input stage	–	580	–	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{no(LSAO)(rms)}$	noise output voltage at pin LSAO; pin HFRX is open-circuit (RMS value)	psophometrically weighted (p53 curve); LVCI = V_{DD}; EVCI = V_{DD}	–	–79	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not active	see Table 2	60	–	–	dB
$V_{LSAO(rms)}$	output voltage capability (RMS value) at pin LSAO with sine wave signal and loaded with 50 Ω + 220 µF; G_{vLSAO} = 28 dB	I_{BB} = 1 mA; I_{DD} = 1 mA	–	–	–	
		I_{line} = 18 mA	–	0.9	–	V
		I_{line} = 30 mA	–	1.3	–	V
		I_{line} > 50 mA	–	1.6	–	V
$I_{LSAO(max)}$	maximum output current at pin LSAO (peak value)		150	300	–	mA
DYNAMIC LIMITER (PINS LSAO AND DLC)						
t_{att}	attack time	when V_{HFRX} jumps up from 20 mV to 20 mV +10 dB	–	–	5	ms
		when V_{BB} drops below $V_{BB(th)}$	–	1	–	ms
t_{rel}	release time	when V_{HFRX} jumps down from 20 mV +10 dB to 20 mV	–	100	–	ms
THD	total harmonic distortion	V_{HFRX} = 20 mV + 10 dB; $G_{v(LSAO)}$ = 28 dB; t > t_{att}	–	1	2	%
$V_{BB(th)}$	V_{BB} limiter threshold		–	2.7	–	V
MUTE RECEIVE (PIN DLC)						
$V_{DLC(th)}$	threshold voltage required on pin DLC to obtain mute receive condition		–	–	0.2	V
$I_{DLC(th)}$	Start-up current sourced by pin DLC	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
TX AND RX ENVELOPE AND NOISE DETECTORS (PINS TSEN, TENV, TNOI, RSEN, RENV AND RNOI)						
Preamplifiers						
$G_{v(TSEN)}$	voltage gain from pin TXI to TSEN		–	40	–	dB
$G_{v(RSEN)}$	voltage gain from pin HFRX to RSEN		–	0	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
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 to 160 μA	–	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 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		–1.25	–1	–0.75	μA
ΔV_{ENV}	voltage difference between RENV and TENV	10 μA sourced from both RSEN and TSEN; signal detectors tracking; note 1	–	±3	–	mV
Noise envelope detectors						
$I_{source(NOI)}$	maximum current sourced from pin TNOI or RNOI		0.75	1	1.25	μA
$I_{sink(NOI)}$	maximum current sunk by pin TNOI or RNOI		–	–120	–	μA
ΔV_{NOI}	voltage difference between pins RNOI and TNOI	5 μA sourced from both RSEN and TSEN; noise detectors tracking; note 1	–	±3	–	mV
DIAL TONE DETECTOR						
$V_{HFRX(th)(rms)}$	threshold level at pin HFRX (RMS value)	R_{RSEN} = 10 kΩ; C_{RSEN} = 100 nF	–	25	–	mV
TX LEVEL LIMITER						
$V_{TXI(th)(rms)}$	threshold level at pin TXI (RMS value)	R_{TSEN} = 10 kΩ	–	0.75	–	mV
DECISION LOGIC (PINS IDT AND SWT)						
Signal recognition						
$\Delta V_{Strx(th)}$	threshold voltage between RENV/RNOI or between TENV/TNOI to switch-over from Idle mode to RX/TX mode	$V_{HFRX} < V_{HFRX(th)}$; $V_{TXI} < V_{TXI(th)}$; note 2	–	13	–	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
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		–12.5	–10	–7.5	µA
$I_{idle(SWT)}$	current sourced from pin SWT in Idle mode		–	0	–	µA
VOICE SWITCH (PINS STAB AND SWR)						
SWR	switching range		–	40	–	dB
ΔSWR	switching range adjustment	with R_{SWR} referenced to 365 kΩ	–40	–	+12	dB
$\|\Delta G_v\|$	voltage gain variation from active modes to Idle mode	SWRA = 40 dB	–	±20	–	dB
G_{tr}	gain tracking (G_{vtx} + G_{vrx}) during switching, referred 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

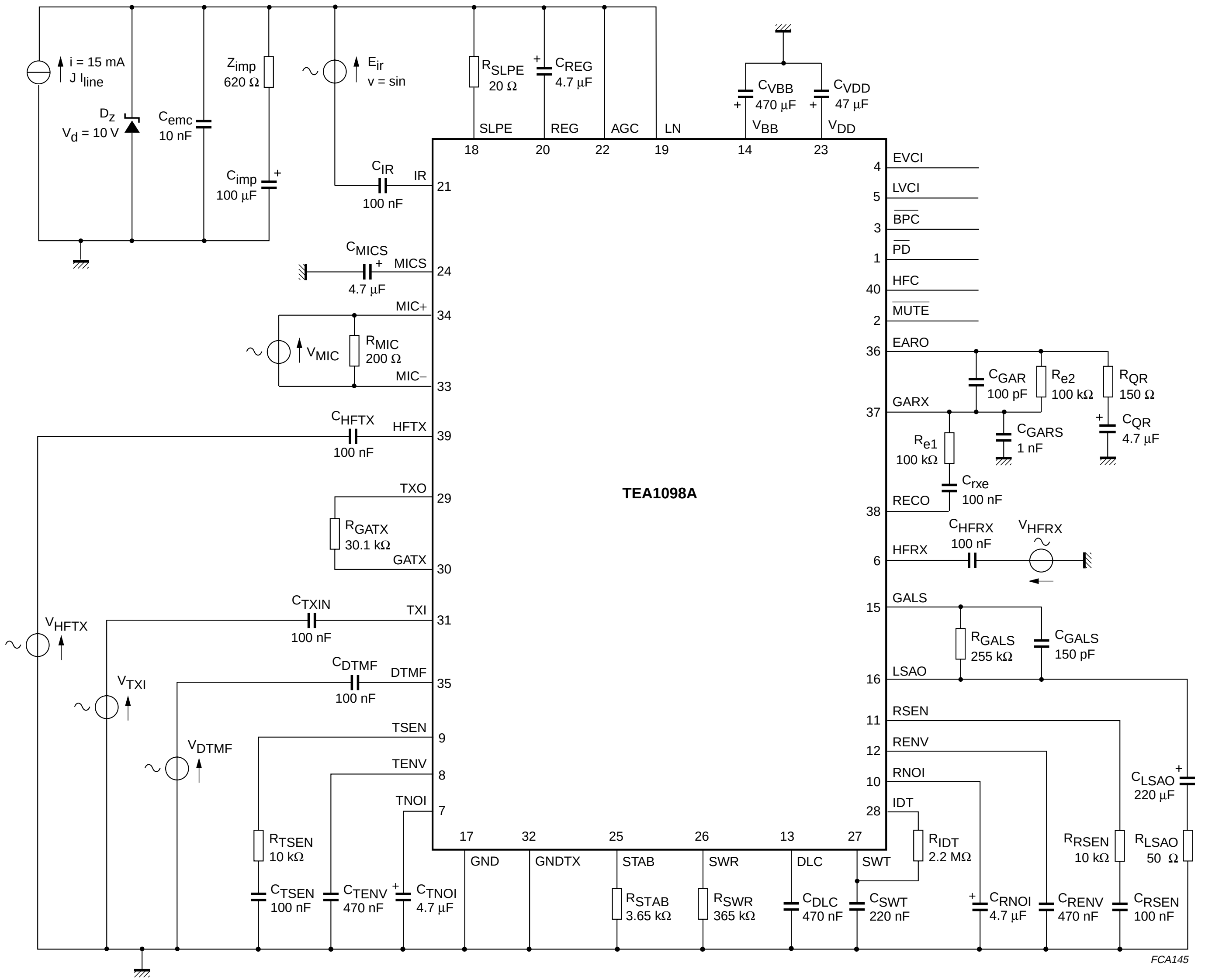


Fig.16 Test configuration.

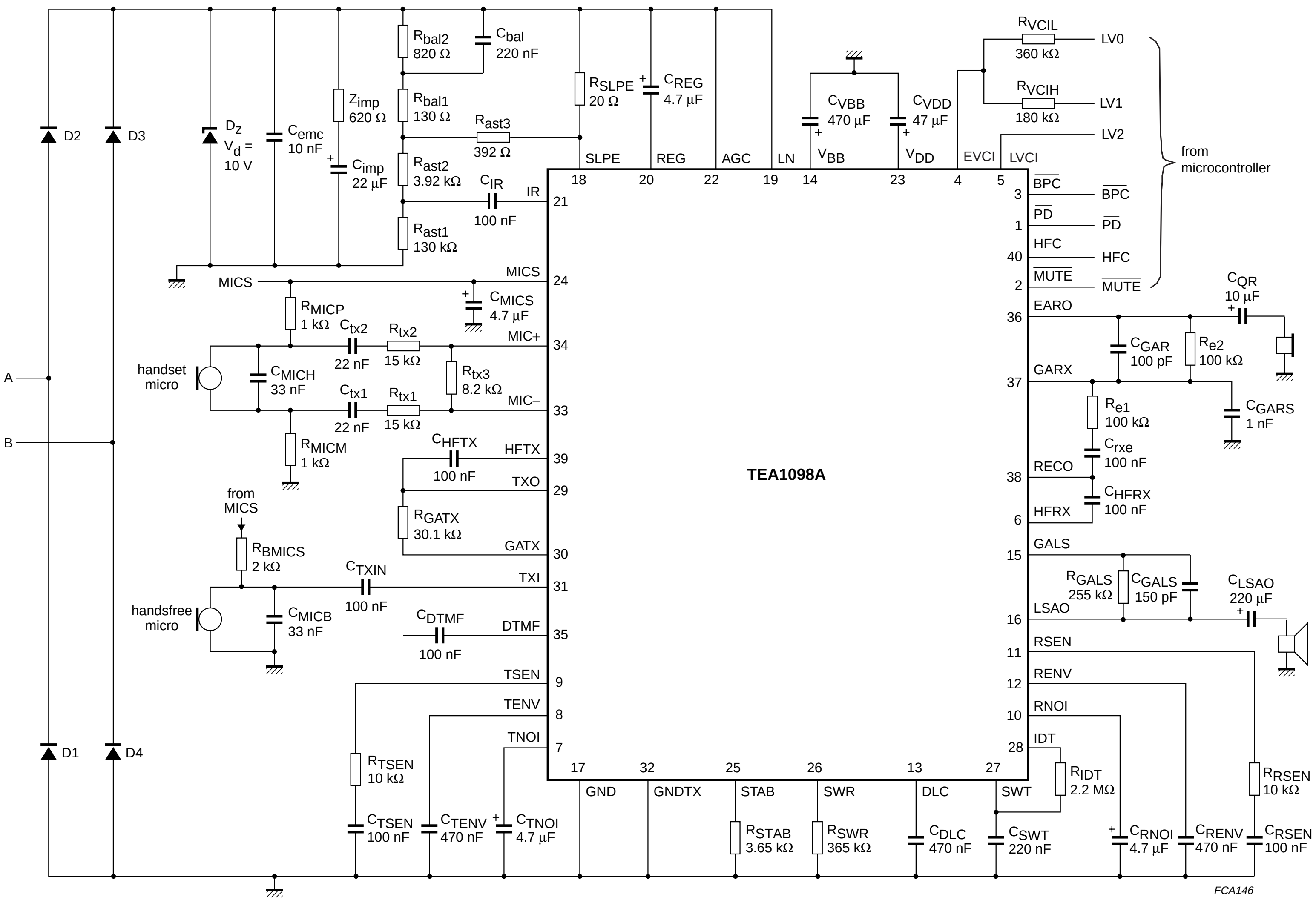


Fig.17 Basic application diagram.

BONDING PAD LOCATIONS FOR TEA1098AUH

SYMBOL	PAD	COORDINATES	
		x	y
HFRX	1	137.5	3139.2
TNOI	2	137.5	2944
TENV	3	137.5	2605.8
TSEN	4	137.5	2375.5
TNOI	5	137.5	2164.5
RSEN	6	137.5	1945.2
RENV	7	137.5	1721.8
DLC	8	137.5	1494.5
V_{BB}	9	137.5	1050.2
GALS	10	137.5	616.8
LSAO	11	185.2	128
n.c.	12	401.2	128
GND	13	861.5	128
SLPE	14	1125	128
SLPE	15	1348.2	128
LN	16	1537.5	128
REG	17	1704.8	128
IR	18	1888.8	128
AGC	19	2084	128
V_{DD}	20	2251	128.2
MICS	21	2503.8	127
STAB	22	2703.8	128.5
SWR	23	2897	128
n.c.	24	2944.8	343
SWT	25	2944.8	570
IDT	26	2945	784
TXO	27	2945	973.8
GATX	28	2945	1182
TXI	29	2945	1390
GNDTX	30	2945	1581
GNDTX	31	2945	1747.8
MIC–	32	2945	1917.2
MIC+	33	2945	2129
DTMF	34	2945	2931
EARO	35	2940	3136.8
GARX	36	2651	3171.2
RECO	37	2451.8	3171.2
HFTX	38	2170.8	3171.2
HFC	39	1934.2	3171.2
$\overline{PD}$	40	1678.8	3171.2
$\overline{MUTE}$	41	1425	3171.2
$\overline{BPC}$	42	1177	3171.2
EVCI	43	942.2	3171.2
LVCI	44	738.5	3171.2

All x/y coordinates represent the position of the centre of the pad (in µm) with respect to the origin (x/y = 0/0) of the die (see Fig.18). The size of all pads is 80 μm^2.

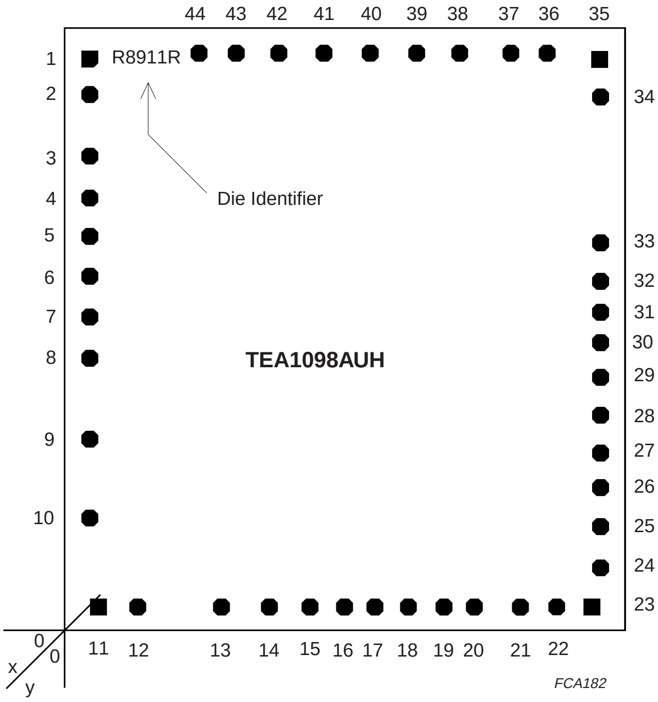
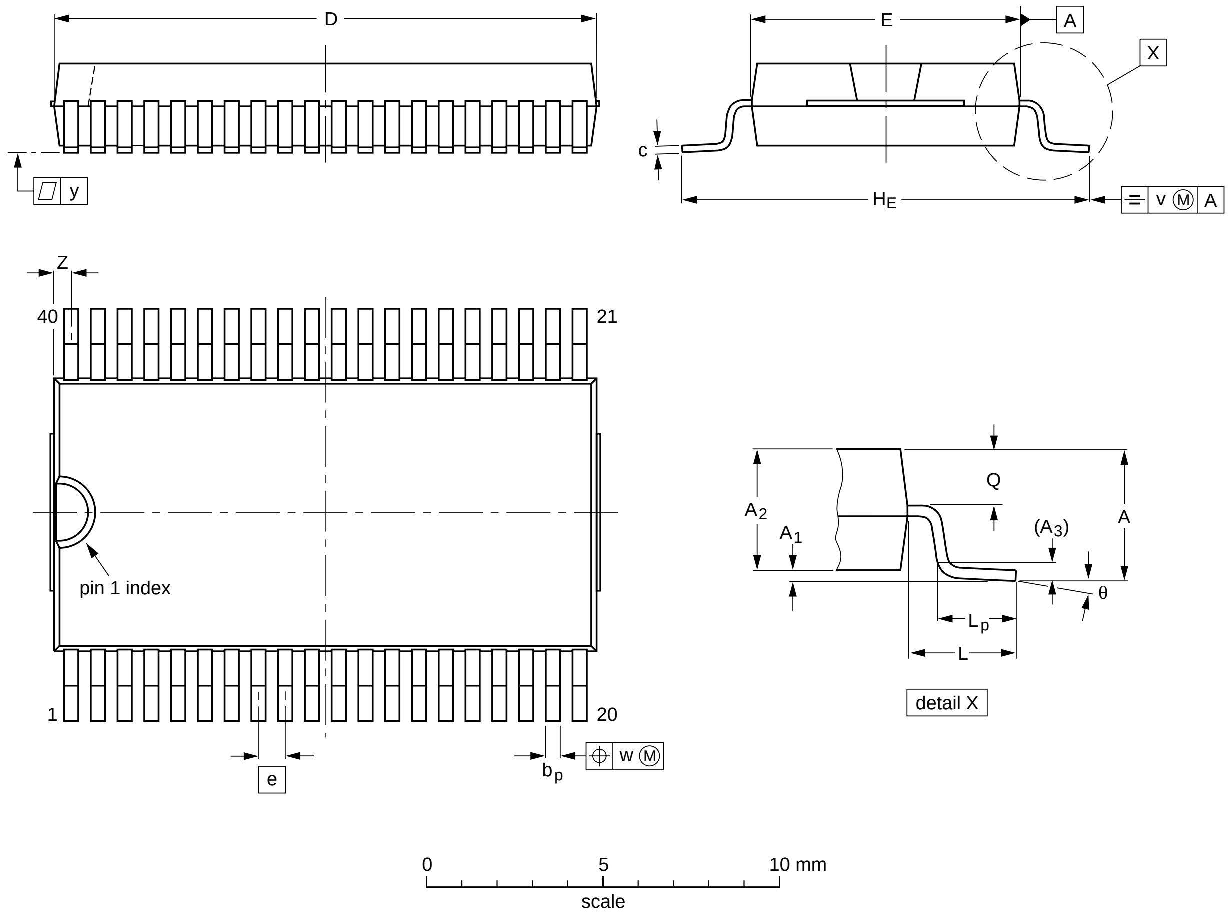


Fig.18 TEA1098AUH bonding pad locations.

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 to soldering surface mount packages

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"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	**REFLOW**(1)
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *“Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods”*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

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DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS (1)
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Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
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Note

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