FEATURES

- Low DC line voltage; operates down to 1.6 V (excluding polarity guard)
- Voltage regulator with adjustable DC voltage
- Provides a supply for external circuits
- Symmetrical high impedance transmit inputs (62.5 kΩ) with large signals handling capabilities [up to 1 V (RMS value) with less than 2% THD]
- Receive amplifier for dynamic, magnetic or piezoelectric earpieces
- AGC line loss compensation for transmit and earpiece amplifiers
- DTMF input with confidence tone (TEA1118A only)
- MUTE input for pulse or DTMF dialling (TEA1118A only)
- Transmit mute function, also enabling the DTMF input (TEA1118A only).

GENERAL DESCRIPTION

The TEA1118 and TEA1118A are bipolar integrated circuits that perform all speech and line interface functions required in cordless telephone base stations. The ICs operate at a line voltage down to 1.6 V DC (with reduced performance) to facilitate the use of telephone sets connected in parallel.

The TEA1118A offers in addition to the TEA1118 electronic switching between speech and dialling. Moreover the transmit amplifier can be disabled during speech condition by means of a transmit mute function.

All statements and values refer to all versions unless otherwise specified.

APPLICATIONS

- Cordless telephone base stations
- Fax machines
- Answering machines.

QUICK REFERENCE DATA

I_{line} = 15 mA; V_{EE} = 0 V; R_{SLPE} = 20 Ω; AGC pin connected to V_{EE}; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{line}	line current operating range	normal operation	11	–	140	mA
		with reduced performance	1	–	11	mA
V_{LN}	DC line voltage		3.35	3.65	3.95	V
I_{CC}	internal current consumption	V_{CC} = 2.9 V	–	1.15	1.4	mA
V_{CC}	supply voltage for peripherals	I_P = 0 mA	–	2.9	–	V
G_{vtrx}	typical voltage gain range					
	transmit amplifier (TEA1118A only)	V_{TX} = 200 mV (RMS)	–	–	11.3	dB
	transmit amplifier (TEA1118 only)	V_{TX} = 200 mV (RMS)	5.3	–	11.3	dB
	receive amplifier	V_{IR} = 4 mV (RMS)	19	–	31	dB
ΔG_{vtrx}	gain control range for transmit and receive amplifiers with respect to I_{line} = 15 mA	I_{line} = 75 mA	–	5.8	–	dB

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1118M	SSOP16	plastic shrink small outline package; 16 leads; body width 4.4 mm	SOT369-1
TEA1118T	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
TEA1118AM	SSOP16	plastic shrink small outline package; 16 leads; body width 4.4 mm	SOT369-1
TEA1118AT	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

BLOCK DIAGRAMS

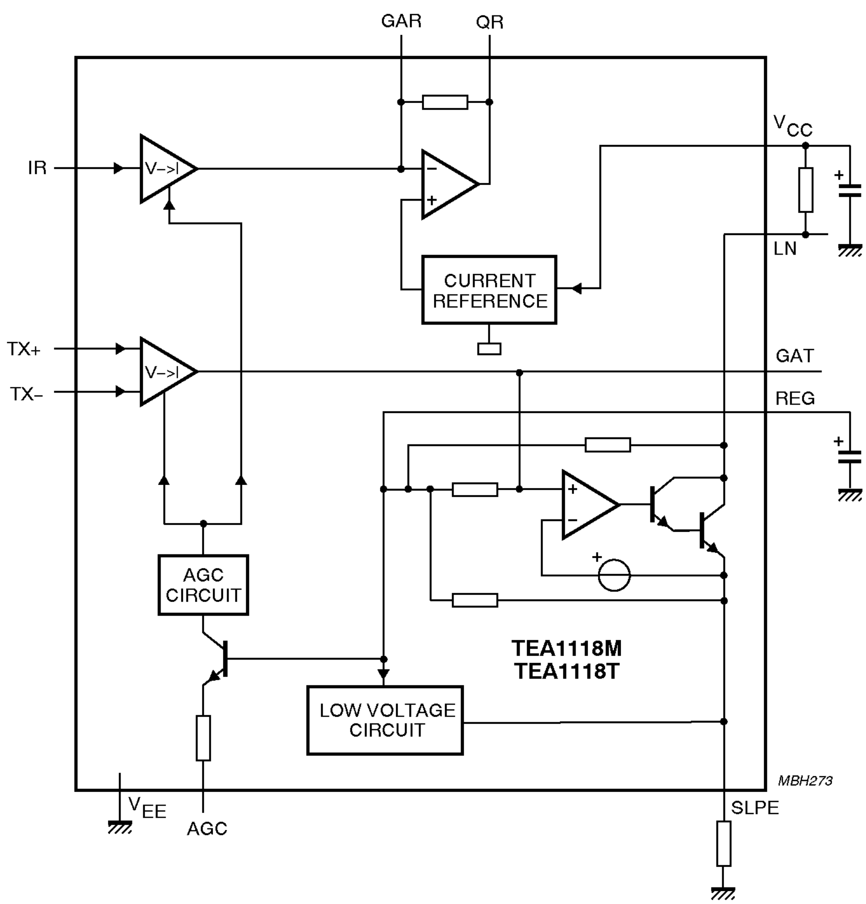


Fig.1 Block diagram (TEA1118).

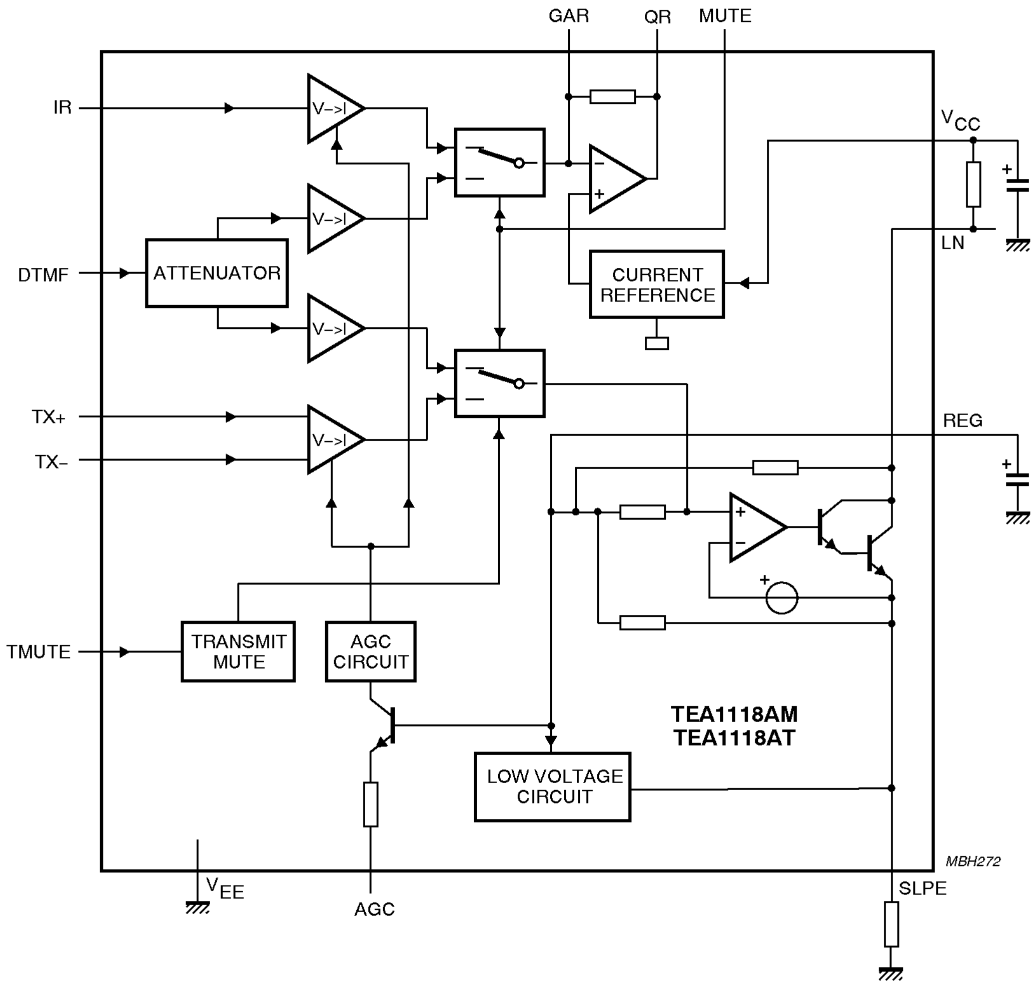


Fig.2 Block diagram (TEA1118A).

PINNING

SYMBOL	TEA1118		TEA1118A		DESCRIPTION
	SO14	SSOP16	SO14	SSOP16	
LN	1	1	1	1	positive line terminal
SLPE	2	2	2	2	slope (DC resistance) adjustment
REG	3	3	3	3	line voltage regulator decoupling
GAT	4	4	–	–	transmit gain adjustment
TMUTE	–	–	4	5	transmit mute input
DTMF	–	–	5	6	dual-tone multi-frequency input
MUTE	–	–	6	8	mute input to select speech or dialling mode
IR	7	9	7	9	receive amplifier input
AGC	8	10	8	10	automatic gain control/line loss compensation
TX−	9	11	9	11	inverting transmit amplifier input
TX+	10	12	10	12	non-inverting transmit amplifier input
V_{EE}	11	13	11	13	negative line terminal
QR	12	14	12	14	receive amplifier output
GAR	13	15	13	15	receive gain adjustment
V_{CC}	14	16	14	16	supply voltage for speech circuit and peripherals
n.c.	5 and 6	5 to 8	–	4 and 7	not connected

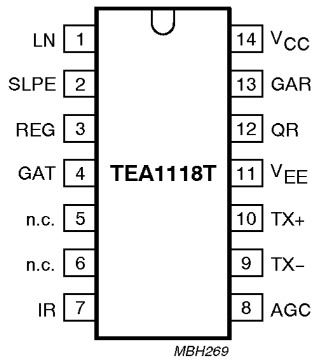


Fig.3 Pin configuration (TEA1118T).

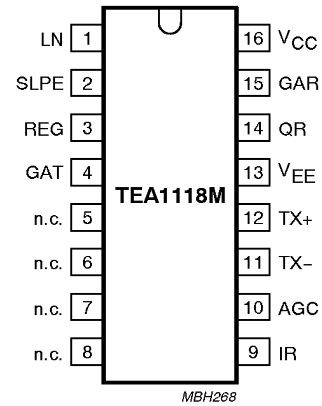


Fig.4 Pin configuration (TEA1118M).

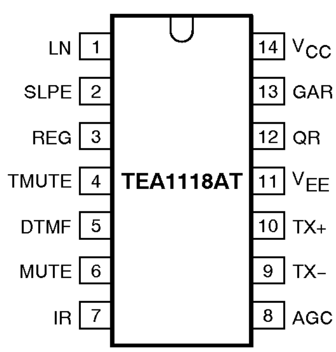


Fig.5 Pin configuration (TEA1118AT).

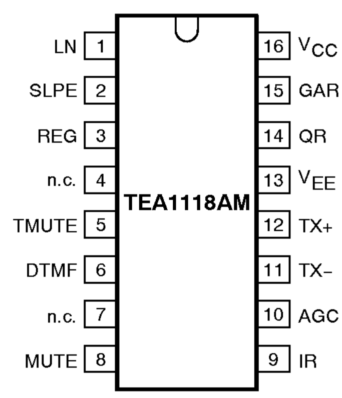


Fig.6 Pin configuration (TEA1118AM).

FUNCTIONAL DESCRIPTION

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

Supplies (pins LN, SLPE, V_{CC} and REG)

The supply for the TEA1118 and TEA1118A and their peripherals is obtained from the telephone line.

The ICs generate a stabilized reference voltage (V_{ref}) between pins LN and SLPE. This reference voltage is equal to 3.35 V, is temperature compensated and can be adjusted by means of an external resistor (R_{VA}). It can be increased by connecting the R_{VA} resistor between pins REG and SLPE (see Fig.11), or decreased by connecting the R_{VA} resistor between pins REG and LN. The voltage at pin REG is used by the internal regulator to generate the stabilized reference voltage and is decoupled by a capacitor (C_{REG}) which is connected to V_{EE}.
This capacitor, converted into an equivalent inductance (see Section "Set impedance"), realizes the set impedance conversion from its DC value (R_{SLPE}) to its AC value (R_{CC} in the audio-frequency range). The voltage at pin SLPE is proportional to the line current. Figure 7 illustrates the supply configuration.

The ICs regulate the line voltage at pin LN, and it can be calculated as follows:

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

$$I_{SLPE} = I_{line} - I_{CC} - I_P - I^* = I_{sh}$$

where:

- I_{line}: line current
- I_{CC}: current consumption of the IC
- I_P: supply current for peripheral circuits
- I^*: current consumed between LN and V_{EE}
- I_{sh}: the excess line current shunted to SLPE (and V_{EE}) via LN.

The preferred value for R_{SLPE} is 20 Ω. Changing R_{SLPE} will affect more than the DC characteristics; it also influences the transmit gain and the DTMF gain (TEA1118A only), the gain control characteristics, the sidetone level and the maximum output swing on the line.

The internal circuitry of the TEA1118 and TEA1118A is supplied from pin V_{CC}. This voltage supply is derived from the line voltage by means of a resistor (R_{CC}) and must be decoupled by a capacitor C_{VCC}. It may also be used to supply peripheral circuits such as dialling or control circuits. The V_{CC} voltage depends on the current consumed by the IC and the peripheral circuits as shown by the formula (see also Figs 8 and 9). R_{CCint} is the internal equivalent resistance of the voltage supply point, and I_{rec} is the current consumed by the output stage of the earpiece amplifier.

$$V_{CC} = V_{CC0} - R_{CCint} \times (I_P - I_{rec})$$

$$V_{CC0} = V_{LN} - R_{CC} \times I_{CC}$$

The DC line current flowing into the set is determined by the exchange supply voltage (V_{exch}), the feeding bridge resistance (R_{exch}), the DC resistance of the telephone line (R_{line}) and the reference voltage (V_{ref}). With line currents below 7.5 mA, the internal reference voltage (generating V_{ref}) is automatically adjusted to a lower value.
This means that more sets can operate in parallel with DC line voltages (excluding the polarity guard) down to an absolute minimum voltage of 1.6 V. At currents below 7.5 mA, the circuit has limited transmit and receive levels. This is called the low voltage area.

Set impedance

In the audio frequency range, the dynamic impedance is mainly determined by the R_{CC} resistor. The equivalent impedance of the circuits is illustrated in Fig.10.

Transmit amplifier (pins TX+, TX− and GAT)

The TEA1118 and TEA1118A have symmetrical transmit inputs. The input impedance between pins TX+ and TX− is equal to 62.5 kΩ; the input impedance between pins TX+/TX− and V_{EE} is equal 36.5 kΩ. The voltage gain from pins TX+/TX− to pin LN is set at 11.3 dB.

Automatic gain control is provided on this amplifier for line loss compensation.

The gain of the TEA1118 can be decreased by connecting an external resistor R_{GAT} between pins GAT and REG. The adjustment range is equal to 6 dB. A capacitor C_{GAT} connected between pins GAT and REG can be used to provide a first-order low-pass filter. The cut-off frequency corresponds to the time constant $C_{GAT} \times (R_{GATint} // R_{GAT})$. R_{GATint} is the internal resistor which sets the gain with a typical value of 27 kΩ.

Transmit mute (pin TMUTE; TEA1118A only)

The transmit amplifier can be disabled by activating the transmit mute function. When TMUTE is LOW, the normal speech mode is entered, depending on the level on MUTE. When TMUTE is HIGH, the transmit amplifier inputs are disabled while the DTMF input is enabled (no confidence tone is provided). The voltage gain between LN and TX+/TX− is attenuated; the gain reduction is 80 dB.

Receive amplifier (pins IR, GAR and QR)

The receive amplifier has one input (IR) and one output (QR). The input impedance between pins IR and V_{EE} is 20 kΩ. The voltage gain from pin IR to pin QR is set at 31 dB. The gain can be decreased by connecting an external resistor R_{GAR} between pins GAR and QR; the adjustment range is 12 dB. Two external capacitors C_{GAR} (connected between GAR and QR) and C_{GARS} (connected between GAR and V_{EE}) ensure stability.

The C_{GAR} capacitor provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant $C_{GAR} \times (R_{GARint} // R_{GAR})$. R_{GARint} is the internal resistor which sets the gain with a typical value of 100 kΩ. The condition $C_{GARS} = 10 \times C_{GAR}$ must be fulfilled to ensure stability.

Automatic gain control is provided on this amplifier for line loss compensation.

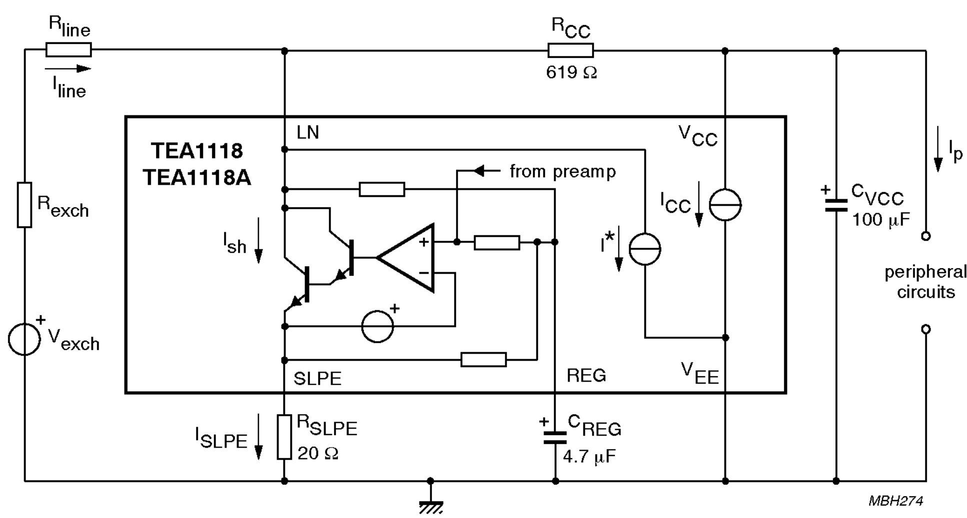
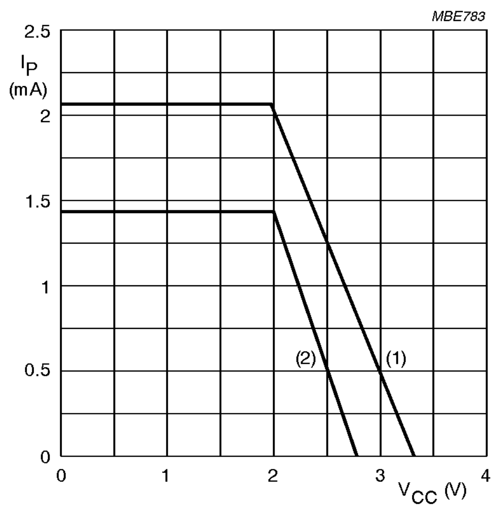


Fig.7 Supply configuration.



(1) With R_{VA} resistor.
(2) Without R_{VA} resistor.

Fig.8 Typical current I_P available from V_{CC} for peripheral circuits at I_{line} = 15 mA.

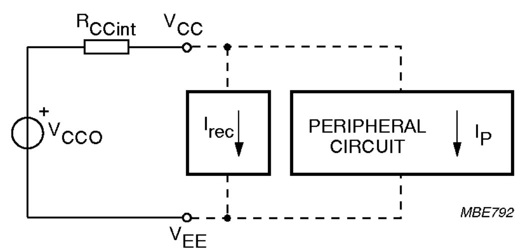
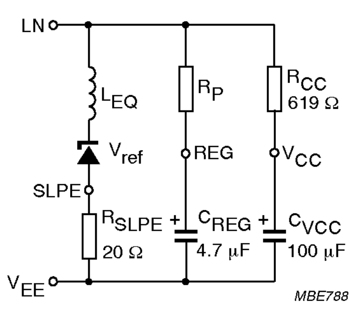
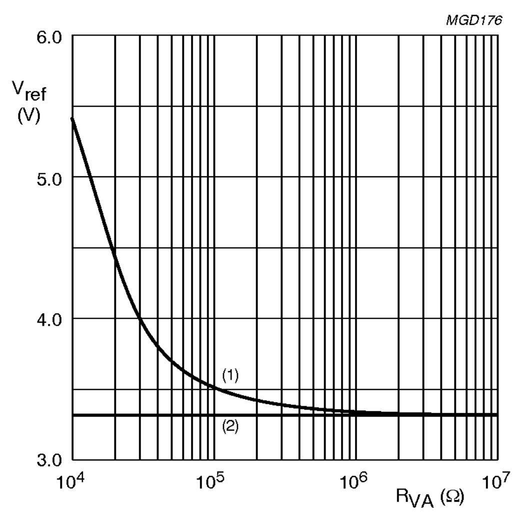


Fig.9 V_{CC} voltage supply for peripheral.



$L_{EQ} = C_{REG} \times R_{SLPE} \times R_P$.
R_P = internal resistance (15.5 kΩ).

Fig.10 Equivalent impedance between LN and V_{EE}.



(1) Influence of R_{VA} on V_{ref}.
(2) V_{ref} without influence of R_{VA}.

Fig.11 Reference voltage adjustment by R_{VA}.

Automatic Gain Control (pin AGC)

The TEA1118 and TEA1118A perform automatic line loss compensation. The automatic gain control varies the gain of the transmit amplifier and the gain of the receive amplifier in accordance with the DC line current.
The control range is 5.8 dB (which corresponds approximately to a line length of 5 km for a 0.5 mm diameter twisted-pair copper cable with a DC resistance of 176 Ω/km and an average attenuation of 1.2 dB/km). The ICs can be used with different configurations of feeding bridge (supply voltage and bridge resistance) by connecting an external resistor R_{AGC} between pins AGC and V_{EE}. This resistor enables the I_{start} and I_{stop} line currents to be increased (the ratio between I_{start} and I_{stop} is not affected by the resistor). The AGC function is disabled when pin AGC is left open-circuit.

DTMF amplifier (pin DTMF; TEA1118A only)

When the DTMF amplifier is enabled, dialling tones may be sent on line. These tones can be heard in the earpiece at a low level (confidence tone).

The TEA1118A has an asymmetrical DTMF input.
The input impedance between DTMF and V_{EE} is 20 kΩ.
The voltage gain from pin DTMF to pin LN is 17.4 dB.

The automatic gain control has no effect on the DTMF amplifier.

Mute function (pin MUTE; TEA1118A only)

The mute function performs the switching action between the speech mode and the dialling mode. When MUTE is LOW or open-circuit, the transmit and receive amplifiers inputs are enabled while the DTMF input is disabled, depending on the TMUTE level. When MUTE is HIGH, the DTMF input is enabled and the transmit and receive amplifiers inputs are disabled.

Sidetone suppression

The TEA1118 and TEA1118A anti-sidetone network comprising $R_{CC}//Z_{line}$, R_{ast1}, R_{ast2}, R_{ast3}, R_{SLPE} and Z_{bal} (see Fig.12) suppresses the transmitted signal in the earpiece. Maximum compensation is obtained when the following conditions are fulfilled:

$$R_{SLPE} \times R_{ast1} = R_{CC} \times (R_{ast2} + R_{ast3})$$

$$k = \frac{[R_{ast2} \times (R_{ast3} + R_{SLPE})]}{(R_{ast1} \times R_{SLPE})}$$

$$Z_{bal} = k \times Z_{line}$$

The scale factor k is chosen to meet the compatibility with a standard capacitor from the E6 or E12 range for Z_{bal}.

In practice, Z_{line} varies considerably with the line type and the line length. Therefore, the value chosen for Z_{bal} should be for an average line length which gives satisfactory sidetone suppression with short and long lines.
The suppression also depends on the accuracy of the match between Z_{bal} and the impedance of the average line.

The anti-sidetone network for the TEA1118 and TEA1118A attenuates the receive signal from the line by 32 dB before it enters the receive amplifier.
The attenuation is almost constant over the whole audio frequency range.

A Wheatstone bridge configuration (see Fig.13) may also be used.

More information on the balancing of an anti-sidetone bridge can be obtained in our publication *“Applications Handbook for Wired Telecom Systems, IC03b”*, order number 9397 750 00811.

MUTE and TMUTE levels for different modes (TEA1118A only)

Table 1 Required MUTE and TMUTE levels to enable the different possible modes

MODE	CHANNEL				MUTE	TMUTE
	TRANSMIT	RECEIVE	DTMF	CONFIDENCE TONE		
Speech	on	on	off	off	LOW	LOW
DTMF dialling	off	off	on	on	HIGH	X(1)
Transmit mute	off	on	on	off	LOW	HIGH

Note

1. X = don’t care.

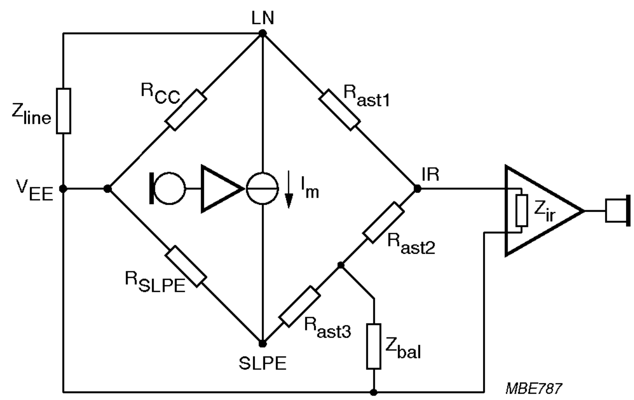


Fig.12 Equivalent circuit of TEA1118 and TEA1118A family anti-sidetone bridge.

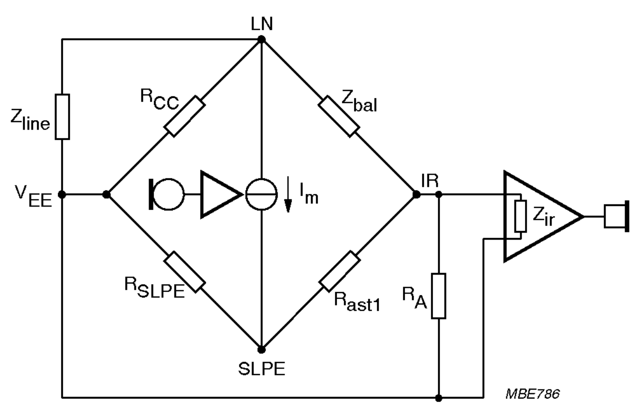


Fig.13 Equivalent circuit of an anti-sidetone network in a Wheatstone bridge configuration.

LIMITING VALUES

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

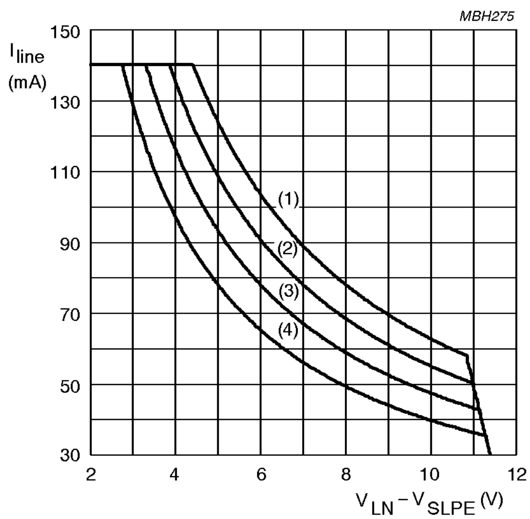
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive continuous line voltage		V_{EE} – 0.4	12	V
	repetitive line voltage during switch-on or line interruption		V_{EE} – 0.4	13.2	V
$V_{n(max)}$	maximum voltage on all pins		V_{EE} – 0.4	V_{CC} + 0.4	V
I_{line}	line current	R_{SLPE} = 20 Ω; see Figs 14 and 15	–	140	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C; see Figs 14 and 15			
	TEA1118T; TEA1118AT		–	384	mW
	TEA1118M; TEA1118AM		–	312	mW
T_{stg}	IC storage temperature		–40	+125	°C
T_{amb}	operating ambient temperature		–25	+75	°C

HANDLING

This device meets class 2 ESD test requirements [Human Body Model (HBM)], in accordance with *“MIL STD 883C - method 3015”*.

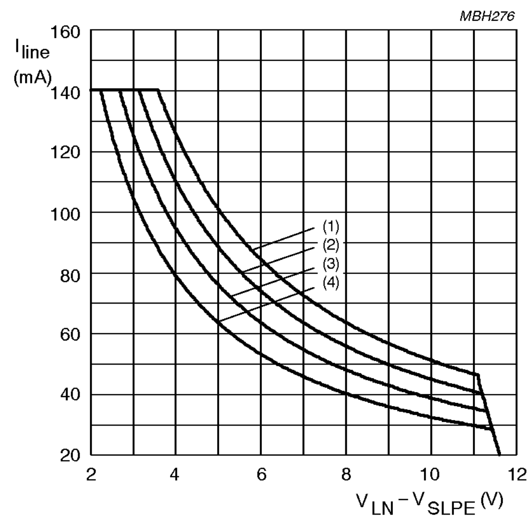
THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient in free air			
	TEA1118T; TEA1118AT		130	K/W
	TEA1118M; TEA1118AM	mounted on epoxy board 40.1 × 19.1 × 1.5 mm	160	K/W



(1) T_{amb} = 45 °C; P_{tot} = 615 mW.
(2) T_{amb} = 55 °C; P_{tot} = 538 mW.
(3) T_{amb} = 65 °C; P_{tot} = 461 mW.
(4) T_{amb} = 75 °C; P_{tot} = 384 mW.

Fig.14 SO14 safe operating area.



(1) T_{amb} = 45 °C; P_{tot} = 500 mW.
(2) T_{amb} = 55 °C; P_{tot} = 437 mW.
(3) T_{amb} = 65 °C; P_{tot} = 375 mW.
(4) T_{amb} = 75 °C; P_{tot} = 312 mW.

Fig.15 SSOP16 safe operating area.

CHARACTERISTICS

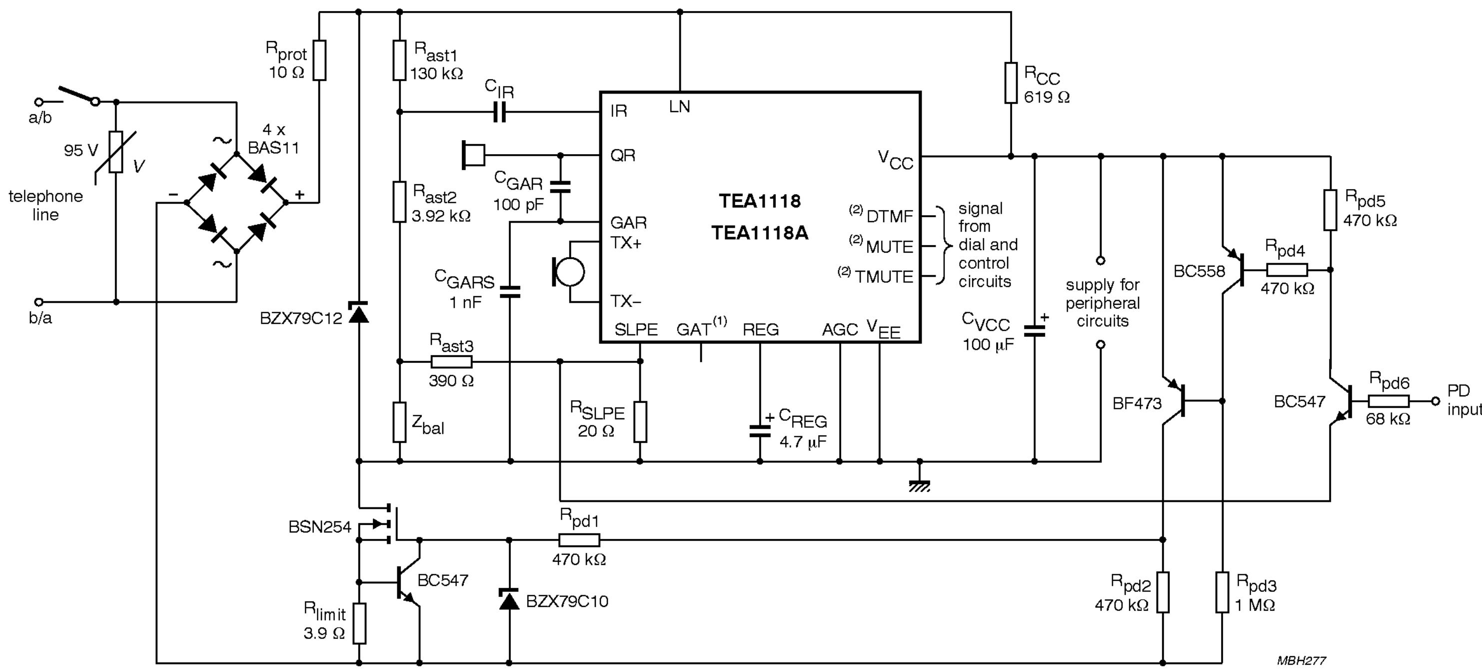
I_{line} = 15 mA; V_{EE} = 0 V; R_{SLPE} = 20 Ω; AGC pin connected to V_{EE}; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies (pins V_{LN}, V_{CC}, SLPE and REG)						
V_{ref}	stabilized voltage between LN and SLPE		3.1	3.35	3.6	V
V_{LN}	DC line voltage	I_{line} = 1 mA	–	1.6	–	V
		I_{line} = 4 mA	–	2.45	–	V
		I_{line} = 15 mA	3.35	3.65	3.95	V
		I_{line} = 140 mA	–	–	6.9	V
$V_{LN(exR)}$	DC line voltage with an external resistor R_{VA}	$R_{VA(SLPE-REG)}$ = 27 kΩ	–	4.4	–	V
$\Delta V_{LN}T$	DC line voltage variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±30	–	mV
I_{CC}	internal current consumption	V_{CC} = 2.9 V	–	1.15	1.4	mA
V_{CC}	supply voltage for peripherals	I_P = 0 mA	–	2.9	–	V
R_{CCint}	equivalent supply voltage resistance	I_P = 0.5 mA	–	550	620	Ω

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Transmit amplifier (pins TX+, TX– and GAT)						
$\|Z_i\|$	input impedance					
	differential between pins TX+ and TX–		–	62.5	–	kΩ
	single-ended between pins TX+/TX– and V_{EE}		–	36.5	–	kΩ
G_{vtx}	voltage gain from TX+/TX– to LN	V_{TX} = 200 mV (RMS)	10.1	11.3	12.5	dB
ΔG_{vtxf}	gain variation with frequency referred to 1 kHz	f = 300 to 3400 Hz	–	±0.2	–	dB
$\Delta G_{vtx}T$	gain variation with temperature referred to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
CMRR	common mode rejection ratio		–	60	–	dB
ΔG_{vtxr}	gain voltage reduction range (TEA1118 only)	external resistor connected between GAT and REG	–	–	6	dB
$V_{LN(max)}$	maximum sending signal (RMS value)	I_{line} = 15 mA; THD = 2%	1.4	1.7	–	V
		I_{line} = 4 mA; THD = 10%	–	0.8	–	V
$V_{TX(max)}$	maximum transmit input voltage (RMS value)	I_{line} = 15 mA; THD = 2%	–	0.45	–	V
		I_{line} = 75 mA; THD = 2%	–	0.9	–	V
V_{notx}	noise output voltage at pin LN; pins TX+/TX– shorted through 200 Ω	psophometrically weighted (P53 curve)	–	–84	–	dBmp
Transmit mute (pin TMUTE; TEA1118A only)						
ΔG_{vtxm}	gain reduction	TMUTE = HIGH	–	80	–	dB
V_{IL}	LOW level input voltage		V_{EE} – 0.4	–	V_{EE} + 0.3	V
V_{IH}	HIGH level input voltage		V_{EE} + 1.5	–	V_{CC} + 0.4	V
I_{TMUTE}	input current	input level = HIGH	–	1.25	3	μA
Receive amplifier (pins IR, QR and GAR)						
$\|Z_i\|$	input impedance		–	20	–	kΩ
G_{vrx}	voltage gain from IR to QR	V_{IR} = 4 mV (RMS)	29.8	31	32.2	dB
ΔG_{vrxf}	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.2	–	dB
$\Delta G_{vrx}T$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
ΔG_{vrxr}	gain voltage reduction range	external resistor connected between GAR and QR	–	–	12	dB
$V_{o(rms)}$	maximum receive signal (RMS value)	I_P = 0 mA sine wave drive; R_L = 150 Ω; THD = 2%	–	0.25	–	V
		I_P = 0 mA sine wave drive; R_L = 450 Ω; THD = 2%	–	0.35	–	V
$V_{norx(rms)}$	noise output voltage at pin QR (RMS value)	IR open-circuit; R_L = 150 Ω; psophometrically weighted (P53 curve)	–	–86	–	dBVp

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Automatic gain control (pin AGC)						
ΔG_{vtrx}	gain control range for transmit and receive amplifiers with respect to I_{line} = 15 mA	I_{line} = 75 mA;	–	5.8	–	dB
I_{start}	highest line current for maximum gain		–	26	–	mA
I_{stop}	lowest line current for minimum gain		–	61	–	mA
DTMF amplifier (pin DTMF; TEA1118A only)						
$\|Z_i\|$	input impedance		–	20	–	kΩ
G_{vtx}	voltage gain from DTMF to LN	V_{DTMF} = 100 mV (RMS); MUTE or TMUTE = HIGH	16.2	17.4	18.6	dB
ΔG_{vtxf}	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.2	–	dB
$\Delta G_{vtx}T$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to + 75 °C	–	±0.4	–	dB
G_{vrx}	voltage gain from DTMF to QR (confidence tone)	V_{DTMF} = 100 mV (RMS); R_L = 150 Ω	–	–18	–	dB
Mute function (pin MUTE; TEA1118A only)						
V_{IL}	LOW level input voltage		V_{EE} – 0.4	–	V_{EE} + 0.3	V
V_{IH}	HIGH level input voltage		V_{EE} + 1.5	–	V_{CC} + 0.4	V
I_{MUTE}	input current	input level = HIGH	–	1.25	3	μA
ΔG_{trxm}	gain reduction for transmit and receive amplifiers	MUTE = HIGH	–	80	–	dB

APPLICATION INFORMATION



(1) TEA1118 only.
(2) TEA1118A only.

Fig.16 Typical application of the TEA1118 and TEA1118A in sets with pulse dialling or flash facilities.