

# Low voltage versatile telephone transmission circuit with dialler interface

TEA1113

## 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 inputs (64 k $\Omega$ ) for dynamic, magnetic or piezo-electric microphones
- Asymmetrical high impedance input (32 k $\Omega$ ) for electret microphones
- DTMF input with confidence tone
- MUTE input for pulse or DTMF dialling
- Receiving amplifier for dynamic, magnetic or piezo-electric earpieces
- Dynamic limitation in the transmit direction to prevent distortion of the transmit line and sidetone signals
- AGC line loss compensation for microphone and earpiece amplifiers
- LED on-hook/off-hook status indication
- Microphone mute function available with switch.

## GENERAL DESCRIPTION

The TEA1113 is a bipolar integrated circuit that performs all speech and line interface functions required in fully electronic telephone sets. It performs electronic switching between speech and dialling. The IC operates at a line voltage down to 1.6 V DC (with reduced performance) to facilitate the use of telephone sets connected in parallel.

A current (proportional to the line current and internally limited to 19.5 mA) is available to drive an LED which indicates the on-hook/off-hook status.

The transmit signal on the line is dynamically limited to prevent distortion at high transmit levels for both the sending line and sidetone signals. The microphone amplifier can be disabled during speech condition by means of a microphone mute function.

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

## APPLICATION

- Line powered telephone sets, cordless telephones, fax machines and answering machines.

## QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{line}$	line current operating range	normal operation	11	—	140	mA
		with reduced performance	1	—	11	mA
$I_{LED(max)}$	maximum supply current available	$I_{line} < 18 \text{ mA}$	—	0.6	—	mA
		$I_{line} > 76 \text{ mA}$	—	19.5	—	mA
$V_{LN}$	DC line voltage	$I_{line} = 15 \text{ mA}$	3.7	4.0	4.3	V
$V_{LN(max, p-p)}$	maximum output voltage swing (peak-to-peak value)	$I_{line} = 15 \text{ mA}$	3.8	4.65	—	V
$I_{CC}$	internal current consumption	$V_{CC} = 3.2 \text{ V}$	—	1.3	1.6	mA
$V_{CC}$	supply voltage for peripherals	$I_{line} = 15 \text{ mA}; I_p = 0 \text{ mA}$	2.8	3.2	—	V
$G_{vtx}$	typical voltage gain range microphone amplifier receiving amplifier	$V_{MIC} = 2 \text{ mV (RMS)}$	38.8	—	51.8	dB
		$V_{IR} = 4 \text{ mV (RMS)}$	19.3	—	31.3	dB
$\Delta G_{vtx}$	gain control range for microphone and receiving amplifiers with respect to $I_{line} = 15 \text{ mA}$	$I_{line} = 85 \text{ mA}; \text{AGC pin connected to } V_{EE}$	—	5.8	—	dB
$\Delta G_{vtxm}$	microphone amplifier gain reduction		—	80	—	dB

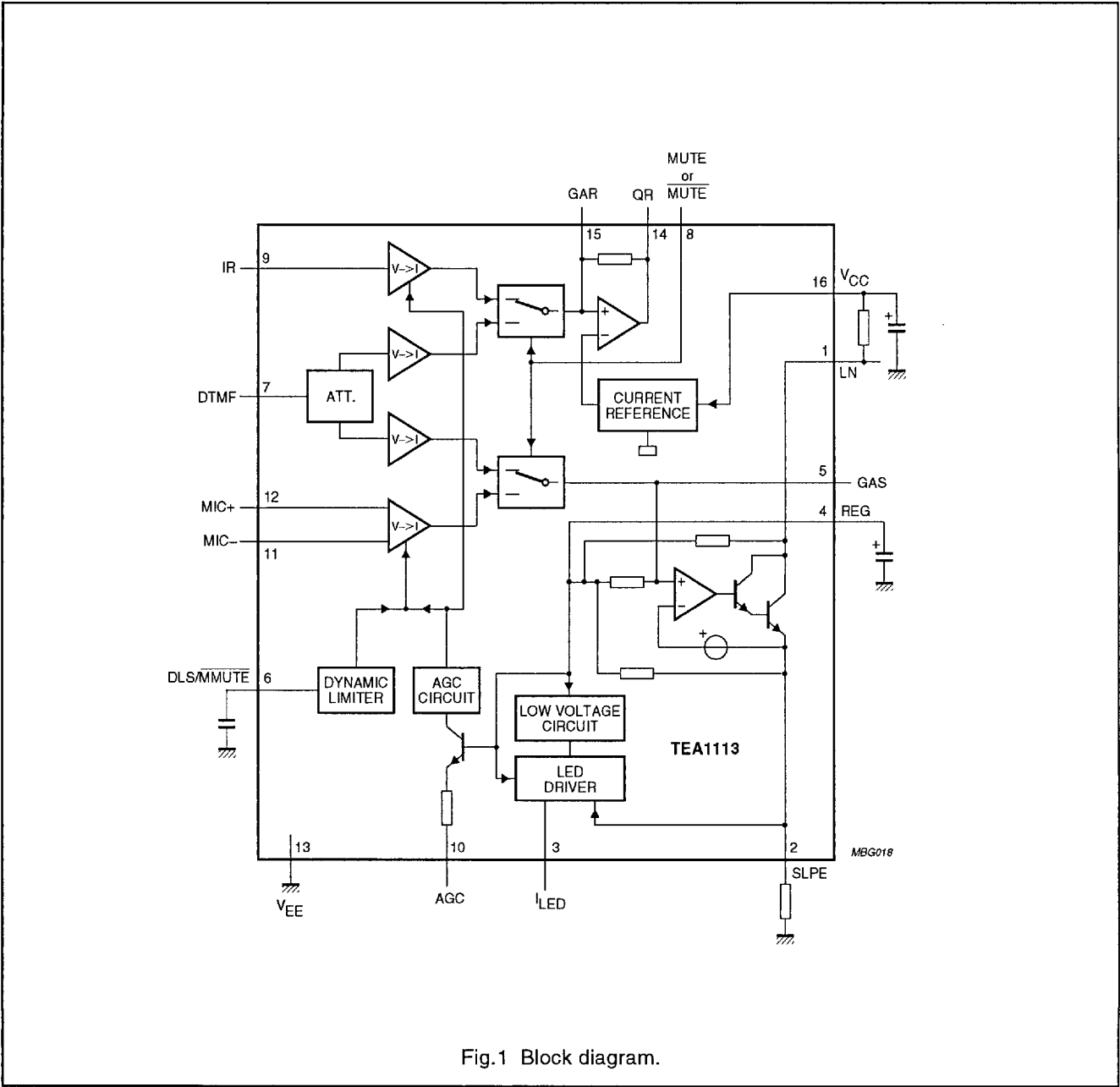
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ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1113	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
TEA1113T	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

BLOCK DIAGRAM



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## PINNING

SYMBOL	PIN	DESCRIPTION
LN	1	positive line terminal
SLPE	2	slope (DC resistance) adjustment
I <sub>LED</sub>	3	available output current to drive an LED
REG	4	line voltage regulator decoupling
GAS	5	sending gain adjustment
DLS/MMUTE	6	dynamic limiter timing adjustment and microphone mute input
DTMF	7	dual-tone multi-frequency input
MUTE	8	mute input to select speech or dialling mode (active LOW)
IR	9	receiving amplifier input
AGC	10	automatic gain control - line loss compensation
MIC-	11	inverting microphone amplifier input
MIC+	12	non-inverting microphone amplifier input
V <sub>EE</sub>	13	negative line terminal
QR	14	receiving amplifier output
GAR	15	receive gain adjustment
V <sub>CC</sub>	16	supply voltage for speech circuit and peripherals

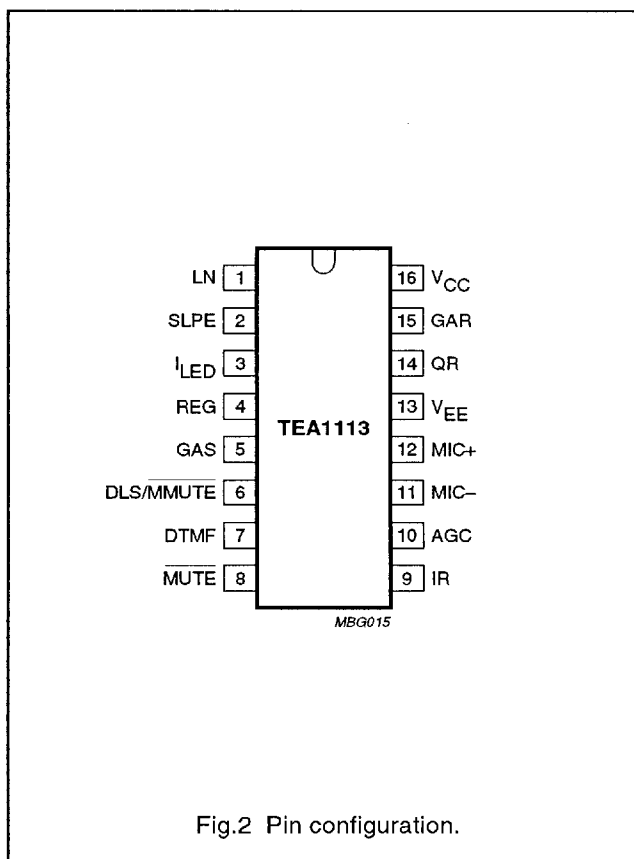


Fig.2 Pin configuration.

## FUNCTIONAL DESCRIPTION

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

### Supply (pins LN, SLPE, V<sub>CC</sub> and REG)

The supply for the TEA1113 and its 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 3.7 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, 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 3 illustrates the supply configuration.

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

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

$$I_{SLPE} = I_{line} - I_{CC} - I_p - I^* = I_{LED} + I_{sh}$$

$I_{line}$ : line current

$I_{CC}$ : current consumption of the IC

$I_p$ : supply current for peripheral circuits

$I^*$ : current consumed between LN and  $V_{EE}$

$I_{LED}$ : supply current for the LED component

$I_{sh}$ : the excess line current shunted to SLPE (and  $V_{EE}$ ) via LN.

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The preferred value for  $R_{SLPE}$  is 20  $\Omega$ . Changing  $R_{SLPE}$  will affect more than the DC characteristics; it also influences the microphone and DTMF gains, the LED supply current characteristic, the gain control characteristics, the sidetone level and the maximum output swing on the line.

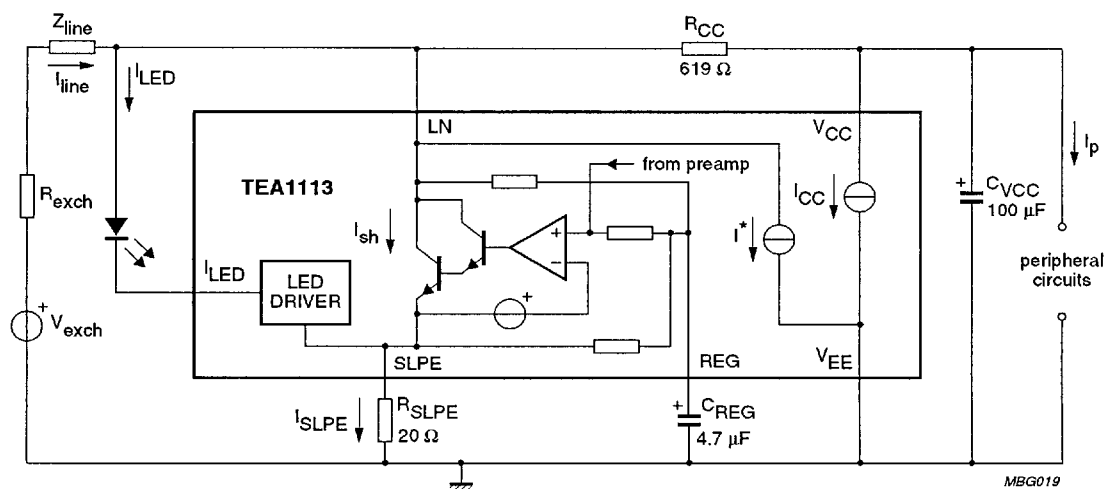
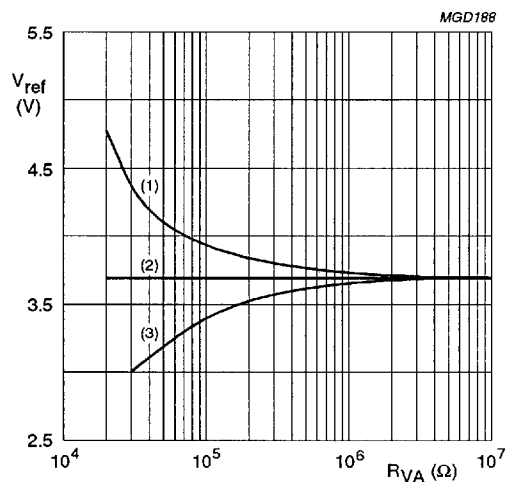


Fig.3 Supply configuration.



- (1)  $R_{VA}$  between REG and SLPE.
- (2) No  $R_{VA}$ .
- (3)  $R_{VA}$  between REG and LN.

Fig.4 Reference voltage adjustment by a  $R_{VA}$  resistor.

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The internal circuitry of the TEA1113 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 5 and 6).  $R_{CCint}$  is the internal impedance of the voltage supply point, and  $I_{rec}$  is the current consumed by the output stage of the earpiece amplifier.

$$V_{CC} = V_{CCO} - R_{CCint} \times (I_p - I_{rec})$$

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

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 8 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 8 mA, the circuit has limited sending and receiving levels. This is called the low voltage area.

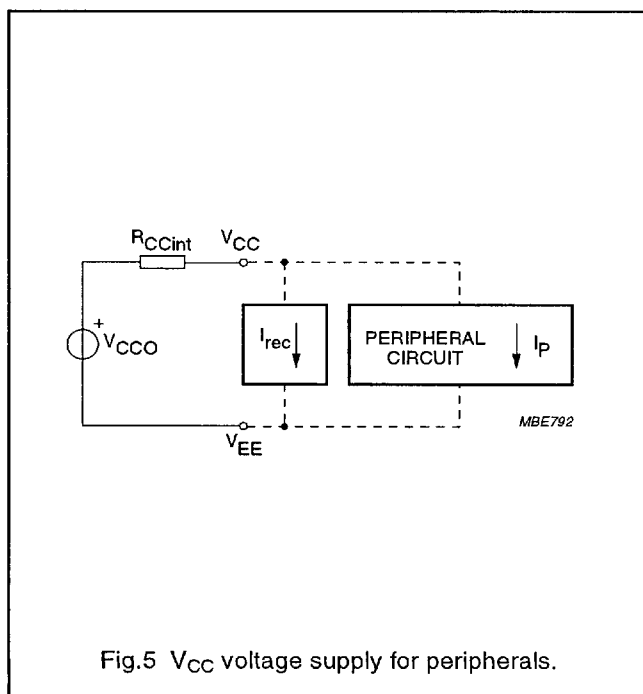


Fig.5  $V_{CC}$  voltage supply for peripherals.

### 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.7.

### LED supply (pin $I_{LED}$ )

The TEA1113 gives an on-hook/off-hook status indication. This is achieved by a current made available to drive an LED connected between pins  $I_{LED}$  and LN. In the low voltage area, which corresponds to low line current conditions, no current is available for this LED. For line currents higher than a threshold current, the  $I_{LED}$  current increases proportionally to the line current (with a ratio of one third). The  $I_{LED}$  current is internally limited to 19.5 mA (see Fig.8).

This LED driver is referenced to SLPE. Consequently, all the  $I_{LED}$  supply current will flow through the  $R_{SLPE}$  resistor. The AGC characteristics are not disturbed (see Fig.3 for the supply configuration).

### Microphone amplifier (pins MIC+, MIC– and GAS)

The TEA1113 has symmetrical microphone inputs. The input impedance between pins MIC+ and MIC– is 64 k $\Omega$  ( $2 \times 32$  k $\Omega$ ). The voltage gain from pins MIC+/MIC– to pin LN is set to 51.8 dB (typ). The gain can be decreased by connecting an external resistor between pins GAS and REG. The adjustment range is 13 dB. A capacitor  $C_{GAS}$  connected between pins GAS and REG can be used to provide a first-order low-pass filter. The cut-off frequency corresponds to the time constant  $C_{GAS} \times R_{GASint}$ .  $R_{GASint}$  is the internal resistor which sets the gain with a typical value of 69 k $\Omega$ .

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

### Dynamic limiter and microphone mute (pin DLS/MMUTE)

The dynamic limiter only acts on the microphone channel, this is to prevent clipping of the line signal. To prevent distortion, the microphone gain is rapidly reduced when peaks on the line signal exceed an internally determined threshold level or when the current in the transmit output stage is insufficient. The time in which the gain reduction is realized is very short (attack time). The microphone channel stays in the reduced gain condition until the peaks on the line signal remain below the threshold level. The microphone gain then returns to its nominal value after a time determined by the capacitor  $C_{DLS}$  (release time).

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The maximum output swing on the line depends on the DC voltage setting ( $V_{ref}$ ). The internal threshold level is automatically adapted.

A LOW level on pin DLS/MMUTE inhibits the microphone inputs MIC+ and MIC- without affecting the DTMF and receiving inputs. Removing the LOW level from pin DLS/MMUTE provides the normal function of the microphone amplifier after a short time which is determined by capacitor  $C_{DLS}$ . With the value of the capacitor at 470 nF, the release time is in the order of a few tenths of a millisecond. The microphone mute function can be realized by a simple switch as illustrated in Fig.9.

### Receiving amplifier (pins IR, GAR and QR)

The receiving amplifier has one input (IR) and one output (QR). The input impedance between pin IR and pin  $V_{EE}$  is 20 k $\Omega$ . The voltage gain from pin IR to pin QR is fixed to 31.3 dB (typ). The gain can be decreased by connecting an external resistor 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  $C_{GAR} \times R_{GARint}$ .  $R_{GARint}$  is the internal resistor which sets the gain with a typical value of 100 k $\Omega$ . The relationship  $C_{GARS} \geq 20 \times C_{GAR}$  must be fulfilled to ensure stability.

The output voltage of the receiving amplifier is specified for continuous wave drive. The maximum output swing depends on the DC line voltage, the  $R_{CC}$  resistor, the  $I_{CC}$  current consumption of the circuit, the  $I_p$  current consumption of the peripheral circuits and the load impedance.

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

### Automatic gain control (pin AGC)

The TEA1113 performs automatic line loss compensation. The automatic gain control varies the gain of the microphone amplifier and the gain of the receiving amplifier in accordance with the DC line current. The control range is 5.8 dB (which corresponds to a line length of 5 km for a 0.5 mm diameter twisted-pair copper cable with a DC resistance of 176  $\Omega$ /km and an average attenuation of 1.2 dB/km). The ICs have been optimized for an exchange supply voltage of 48 V and a feeding bridge resistance of 600  $\Omega$ . In this case, the AGC pin must be connected to pin  $V_{EE}$ . An external resistor  $R_{AGC}$  can be connected between pins AGC and  $V_{EE}$  to comply with other configurations of exchange supply voltage and

feeding bridge resistance. 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.

### Mute function (pin MUTE)

The mute function performs the switching between the speech mode and the dialling mode. When MUTE is LOW or open-circuit, the DTMF input is enabled and the microphone and receiving amplifiers inputs are disabled. When MUTE is HIGH, the microphone and receiving amplifiers inputs are enabled while the DTMF input is disabled.

### DTMF amplifier (pin DTMF)

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 TEA1113 has an asymmetrical DTMF input. The input impedance between DTMF and  $V_{EE}$  is 20 k $\Omega$ . The voltage gain from pin DTMF to pin LN is 25.4 dB. When the resistor  $R_{GAS}$  is connected, to decrease the microphone gain, the DTMF gain varies in the same way (the DTMF gain is 26.4 dB lower than the microphone gain with no AGC control).

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

### Sidetone suppression

The anti-sidetone network comprising  $R_{CC}/Z_{line}$ ,  $R_{ast1}$ ,  $R_{ast2}$ ,  $R_{ast3}$ ,  $R_{SLPE}$  and  $Z_{bal}$  (see Figs.10 and 11) 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  $Z_{bal}$ .

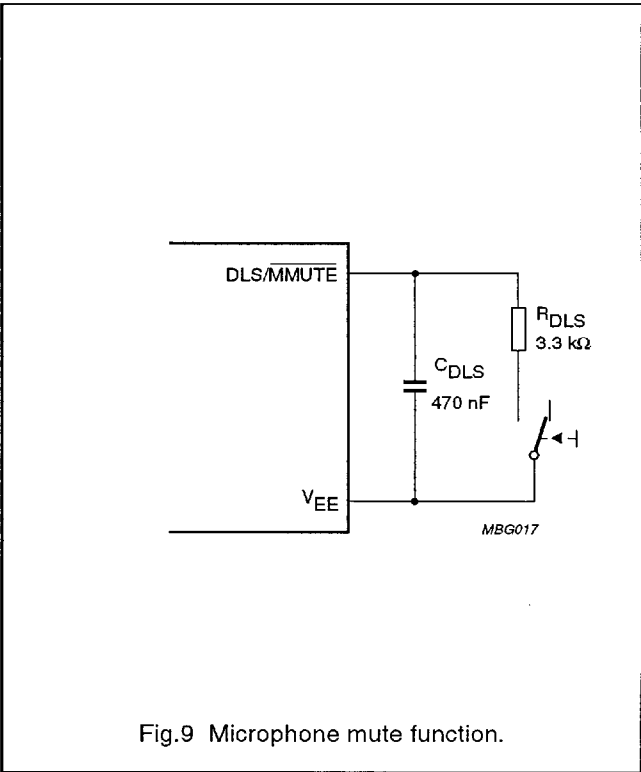
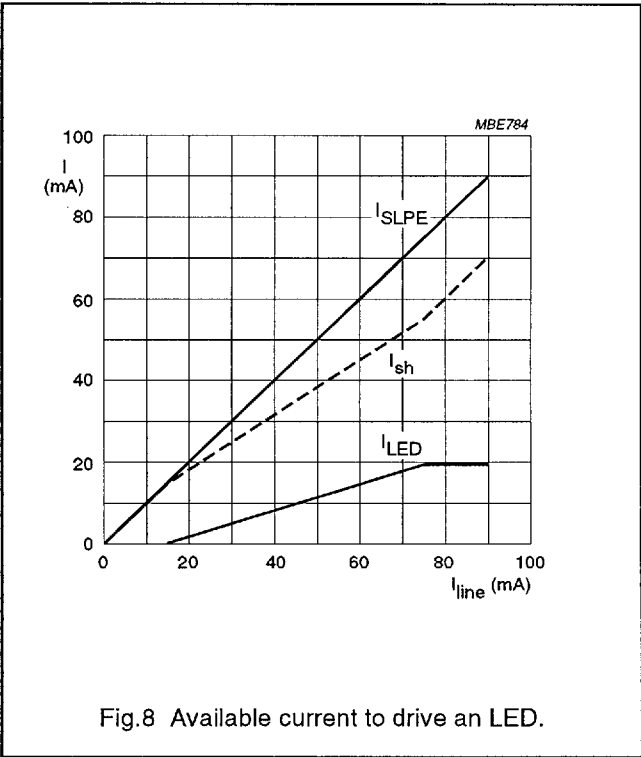
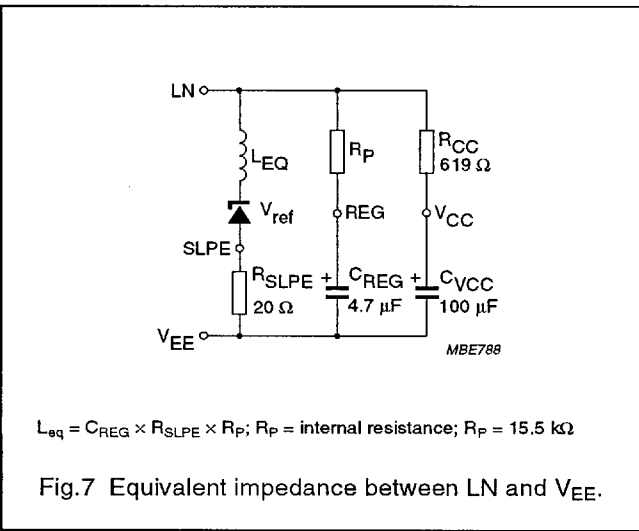
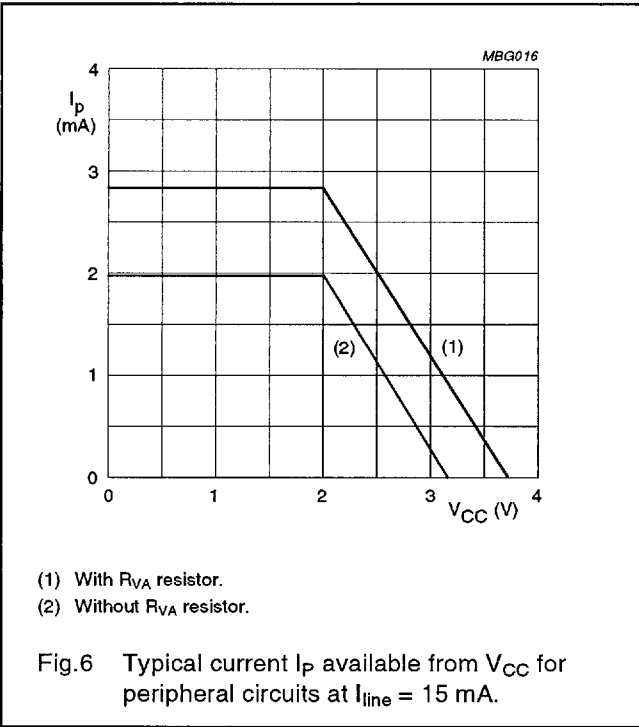
In practice,  $Z_{line}$  varies considerably with the line type and the line length. Therefore, the value chosen for  $Z_{bal}$  should be for an average line length which gives satisfactory sidetone suppression with short and long lines. The suppression also depends on the accuracy of the match between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

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The anti-sidetone network for the TEA1113 (see Fig.10) attenuates the receiving signal from the line by 32 dB before it enters the receiving amplifier. The attenuation is almost constant over the whole audio frequency range.

More information on the balancing of an anti-sidetone bridge can be obtained in our publication "Wirebound Telecom Applications Handbook 1995", order number 9398 706 72011 .



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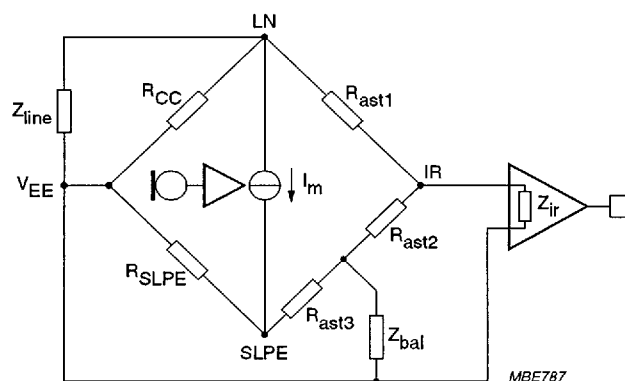


Fig.10 Equivalent circuit of TEA1113 family anti-sidetone bridge.

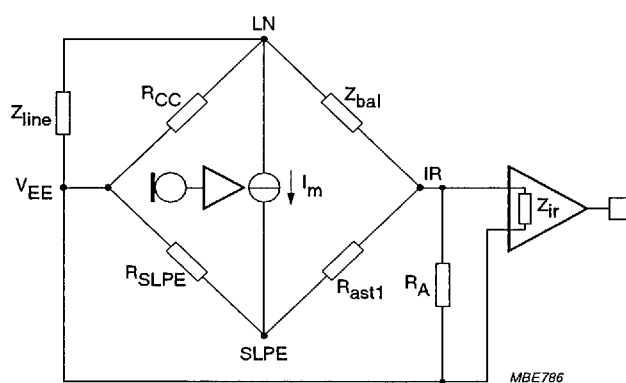


Fig.11 Equivalent circuit of an anti-sidetone network in a Wheatstone bridge configuration.

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## LIMITING VALUES

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

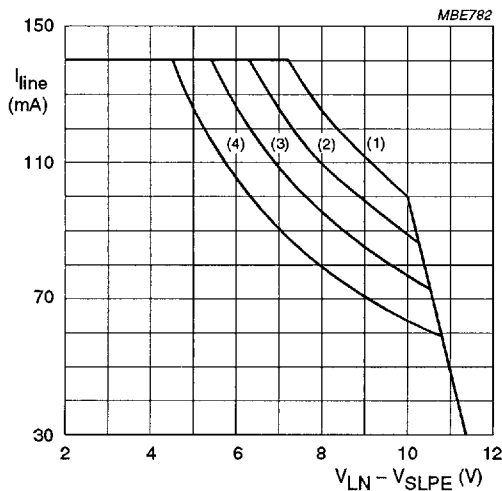
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{LN}$	positive continuous line voltage		$V_{EE} - 0.4$	12.0	V
	repetitive line voltage during switch-on or line interruption		$V_{EE} - 0.4$	13.2	V
$V_{n(max)}$	maximum voltage on pins $I_{LED}$ , SLPE		$V_{EE} - 0.4$	$V_{LN} + 0.4$	V
	maximum voltage on all other pins		$V_{EE} - 0.4$	$V_{CC} + 0.4$	V
$I_{line}$	line current	$R_{SLPE} = 20 \Omega$ ; see Figs 12 and 13	—	140	mA
$P_{tot}$	total power dissipation	$T_{amb} = 75^\circ\text{C}$ ; see Figs 12 and 13			
	TEA1113		—	625	mW
	TEA1113T		—	416	mW
$T_{stg}$	IC storage temperature		-40	+125	$^\circ\text{C}$
$T_{amb}$	operating ambient temperature		-25	+75	$^\circ\text{C}$

## THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient in free air (TEA1113)	80	K/W
	thermal resistance from junction to ambient in free air mounted on epoxy board $40.1 \times 19.1 \times 1.5$ mm (TEA1113T)	120	K/W

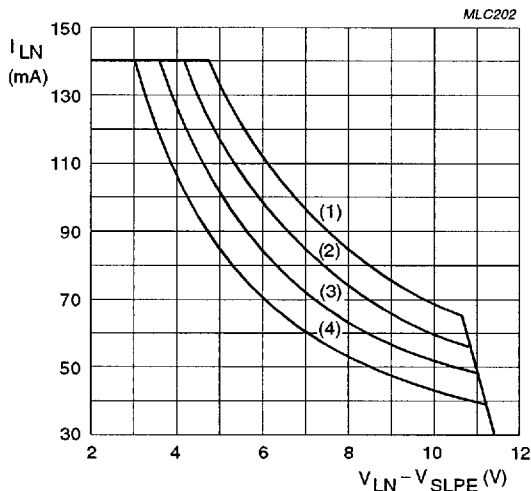
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LINE	T <sub>amb</sub> (°C)	P <sub>tot</sub> (mW)
(1)	45	1000
(2)	55	875
(3)	65	750
(4)	75	625

Fig.12 Safe operating area (TEA1113).



LINE	T <sub>amb</sub> (°C)	P <sub>tot</sub> (mW)
(1)	45	666
(2)	55	583
(3)	65	500
(4)	75	416

Fig.13 Safe operating area (TEA1113T).

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## CHARACTERISTICS

$I_{line} = 15 \text{ mA}$ ;  $V_{EE} = 0 \text{ V}$ ;  $R_{SLPE} = 20 \text{ }\Omega$ ;  $C_{DLS} = 470 \text{ nF}$ ; AGC pin connected to  $V_{EE}$ ;  $Z_{line} = 600 \text{ }\Omega$ ;  $f = 1 \text{ kHz}$ ;  
 $T_{amb} = 25 \text{ }^{\circ}\text{C}$ ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply (pins <math>V_{LN}</math>, <math>V_{CC}</math>, SLPE and REG)</b>						
$V_{ref}$	stabilized voltage between LN and SLPE	$I_{line} = 15 \text{ mA}$	3.45	3.7	3.95	V
$V_{LN}$	DC line voltage	$I_{line} = 1 \text{ mA}$	–	1.6	–	V
		$I_{line} = 4 \text{ mA}$	–	2.5	–	V
		$I_{line} = 15 \text{ mA}$	3.7	4	4.3	V
		$I_{line} = 140 \text{ mA}$	–	–	7.0	V
$V_{LN(exR)}$	DC line voltage with an external resistor $R_{VA}$	$I_{line} = 15 \text{ mA}$ ; $R_{VA(LN-REG)} = 82 \text{ k}\Omega$	–	3.6	–	V
		$I_{line} = 15 \text{ mA}$ ; $R_{VA(SLPE-REG)} = 27 \text{ k}\Omega$	–	4.75	–	V
$\Delta V_{LN}/T$	DC line voltage variation with temperature referenced to $25 \text{ }^{\circ}\text{C}$	$I_{line} = 15 \text{ mA}$ $T_{amb} = -25 \text{ to } +75 \text{ }^{\circ}\text{C}$	–	$\pm 30$	–	mV
$I_{CC}$	internal current consumption	$V_{CC} = 3.2 \text{ V}$	–	1.3	1.6	mA
$V_{CC}$	supply voltage for peripherals	$I_{line} = 15 \text{ mA}$ ; $I_p = 0 \text{ mA}$	2.8	3.2	–	V
$R_{ccint}$	equivalent supply voltage impedance	$I_{line} = 15 \text{ mA}$ ; $I_p = 0.5 \text{ mA}$	–	550	620	$\Omega$
<b>LED supply (pin <math>I_{LED}</math>)</b>						
$I_{line(h)}$	highest line current for $I_{LED} < 0.6 \text{ mA}$		–	18	–	mA
$I_{line(l)}$	lowest line current for maximum $I_{LED}$		–	76	–	mA
$I_{LED(max)}$	maximum supply current available		–	19.5	–	mA
<b>Microphone amplifier (pins MIC+, MIC– and GAS)</b>						
$ Z_i $	input impedance differential between pins MIC+ and MIC–		–	64	–	k $\Omega$
	single-ended between pins MIC+/MIC– and $V_{EE}$		–	32	–	k $\Omega$
$G_{vtx}$	voltage gain from MIC+/MIC– to LN	$I_{line} = 15 \text{ mA}$ ; $V_{MIC} = 2 \text{ mV (RMS)}$	50.6	51.8	53	dB
$\Delta G_{vtxf}$	gain variation with frequency referenced to $1 \text{ kHz}$	$I_{line} = 15 \text{ mA}$ ; $f = 300 \text{ to } 3400 \text{ Hz}$	–	$\pm 0.2$	–	dB
$\Delta G_{vtxT}$	gain variation with temperature referenced to $25 \text{ }^{\circ}\text{C}$	$I_{line} = 15 \text{ mA}$ ; $T_{amb} = -25 \text{ to } +75 \text{ }^{\circ}\text{C}$	–	$\pm 0.3$	–	dB
CMRR	common mode rejection ratio		–	80	–	dB
$\Delta G_{vtxr}$	gain voltage reduction range	external resistor connected between GAS and REG	–	–	13	dB

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{notx}$	noise output voltage at pin LN; pins MIC+ / MIC- shorted through 200 $\Omega$	psophometrically weighted (P53 curve)	–	–70.5	–	dBmp
<b>Dynamic limiter and microphone mute (pin DLS/MMUTE)</b>						
DYNAMIC LIMITER BEHAVIOUR						
$V_{LN(max,p-p)}$	maximum output voltage swing on the line (peak-to-peak value)	$I_{line} = 15 \text{ mA}$ ; $V_{ref} = 3.7 \text{ V}$ $I_{line} = 4 \text{ mA}$	3.8 –	4.65 1.6	– –	V
THD	total harmonic distortion	$V_{MIC} = 4 \text{ mV (RMS)} + 10 \text{ dB}$	–	–	2	%
		$V_{MIC} = 4 \text{ mV (RMS)} + 15 \text{ dB}$	–	–	10	%
$t_{att}$	attack time, $V_{MIC}$ jumps from 2 mV up to 20 mV	$C_{DLS} = 470 \text{ nF}$	–	1.5	5	ms
$t_{rel}$	release time, $V_{MIC}$ jumps from 20 mV down to 2 mV	$C_{DLS} = 470 \text{ nF}$	50	150	–	ms
MICROPHONE MUTE INPUT						
$\Delta G_{vtxm}$	gain reduction	$DLS/MMUTE = LOW$	–	80	–	dB
$V_{IL}$	LOW level input voltage		$V_{EE} - 0.4$	–	$V_{EE} + 0.3$	V
$I_{IL}$	LOW level input current		40	60	–	$\mu\text{A}$
$t_{rel}$	release time after a LOW level on pin DLS/MMUTE	$C_{DLS} = 470 \text{ nF}$	–	30	–	ms
<b>Receiving amplifier (pins IR, QR and GAR)</b>						
$ Z_i $	input impedance		–	20	–	k $\Omega$
$G_{vrx}$	voltage gain from IR to QR	$I_{line} = 15 \text{ mA}$ ; $V_{IR} = 4 \text{ mV (RMS)}$	30.3	31.3	32.3	dB
$\Delta G_{vrxf}$	gain variation with frequency referenced to 1 kHz	$I_{line} = 15 \text{ mA}$ ; $f = 300 \text{ to } 3400 \text{ Hz}$	–	$\pm 0.2$	–	dB
$\Delta G_{vrxT}$	gain variation with temperature referenced to 25 $^{\circ}\text{C}$	$I_{line} = 15 \text{ mA}$ ; $T_{amb} = -25 \text{ to } 75 \text{ }^{\circ}\text{C}$	–	$\pm 0.3$	–	dB
$\Delta G_{vrxr}$	gain voltage reduction range	external resistor connected between GAR and QR	–	–	12	dB
$V_{o(rms)}$	Maximum output voltage (RMS value)	$I_{line} = 15 \text{ mA}$ ; $I_p = 0 \text{ mA}$ sine wave drive; $R_L = 150 \Omega$ ; THD = 2%	240	290	–	mV
		$I_{line} = 15 \text{ mA}$ ; $I_p = 0 \text{ mA}$ sine wave drive; $R_L = 450 \Omega$ ; THD = 2%	350	410	–	mV
$V_{nox(rms)}$	noise output voltage at pin QR (RMS value)	$I_{line} = 15 \text{ mA}$ ; $R_L = 150 \Omega$ ; IR open-circuit; psophometrically weighted (P53 curve)	–	50	–	$\mu\text{V}$
<b>Automatic gain control (pin AGC)</b>						
$\Delta G_{vtrx}$	gain control range for microphone and receiving amplifiers with respect to $I_{line} = 15 \text{ mA}$	$I_{line} = 85 \text{ mA}$ ; AGC pin connected to $V_{EE}$	–	5.8	–	dB

# Low voltage versatile telephone transmission circuit with dialler interface

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{\text{start}}$	highest line current for maximum gain	AGC pin connected to $V_{\text{EE}}$	–	25	–	mA
$I_{\text{stop}}$	lowest line current for minimum gain	AGC pin connected to $V_{\text{EE}}$	–	59	–	mA
<b>DTMF amplifier (pin DTMF)</b>						
$ Z_i $	input impedance		–	20	–	k $\Omega$
$G_{\text{vdtmf}}$	voltage gain from DTMF to LN	$I_{\text{line}} = 15 \text{ mA};$ $V_{\text{DTMF}} = 25 \text{ mV (RMS)};$ $\text{MUTE} = \text{HIGH}$	24.2	25.4	26.6	dB
$\Delta G_{\text{vdtmff}}$	gain variation with frequency referenced to 1 kHz	$I_{\text{line}} = 15 \text{ mA};$ $f = 300 \text{ to } 3400 \text{ Hz}$	–	$\pm 0.2$	–	dB
$\Delta G_{\text{vdtmfT}}$	gain variation with temperature referenced to 25 °C	$I_{\text{line}} = 15 \text{ mA};$ $T_{\text{amb}} = -25 \text{ to } +75 \text{ °C}$	–	$\pm 0.5$	–	dB
$G_{\text{vct}}$	voltage gain from DTMF to QR (confidence tone)	$I_{\text{line}} = 15 \text{ mA}; R_L = 150 \Omega;$ $V_{\text{DTMF}} = 25 \text{ mV (RMS)};$	–	–18	–	dB
<b>Mute function (pin MUTE)</b>						
$V_{\text{IL}}$	LOW level input voltage		$V_{\text{EE}} - 0.4$	–	$V_{\text{EE}} + 0.3$	V
$V_{\text{IH}}$	HIGH level input voltage		$V_{\text{EE}} + 1.5$	–	$V_{\text{CC}} + 0.4$	V
$I_{\text{MUTE}}$	input current	input level = HIGH	–	1.25	3	$\mu\text{A}$
$\Delta G_{\text{vtrxm}}$	gain reduction for microphone and receiving amplifiers	$\text{MUTE} = \text{LOW}$	–	80	–	dB

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APPLICATION INFORMATION

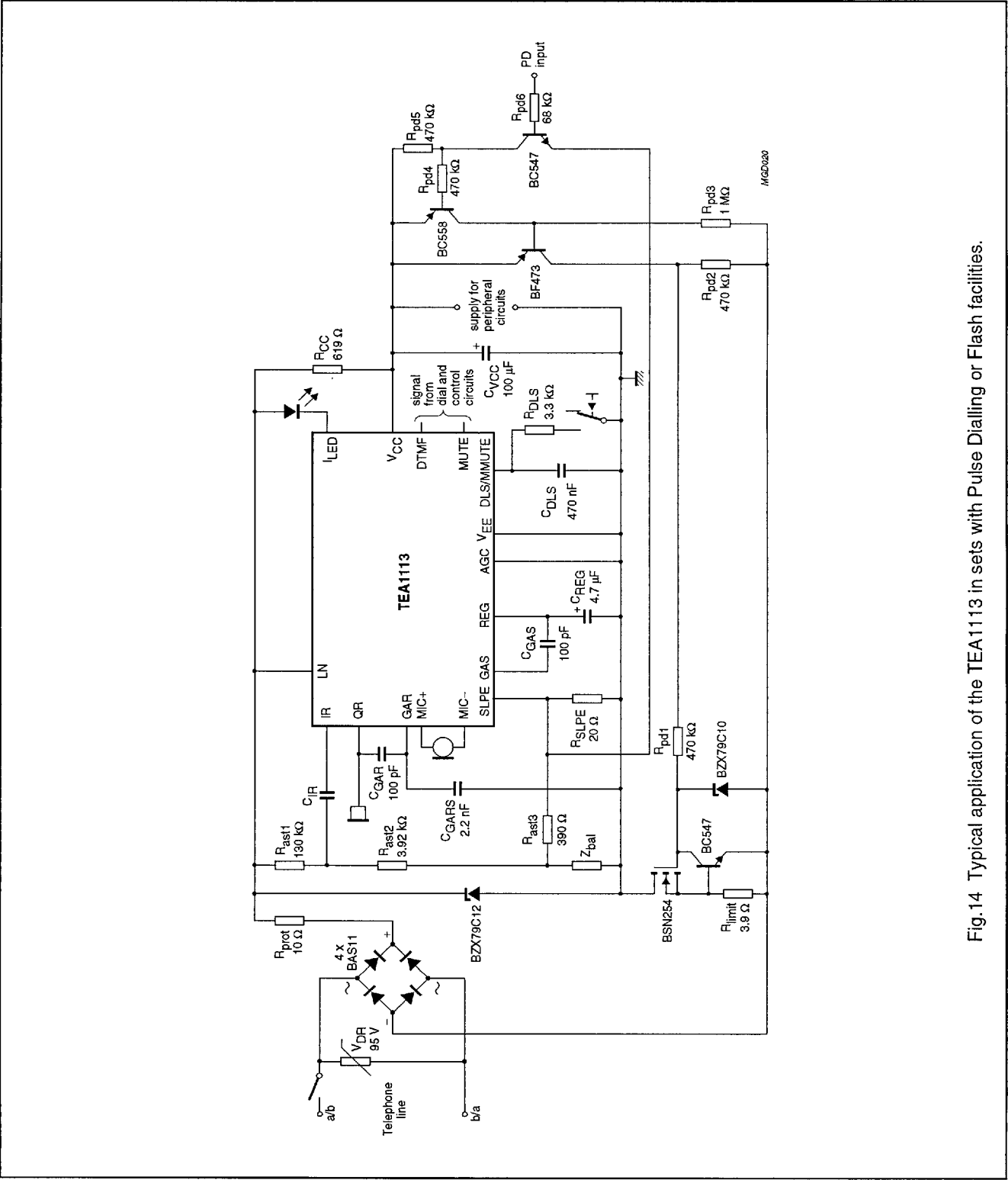


Fig.14 Typical application of the TEA1113 in sets with Pulse Dialling or Flash facilities.

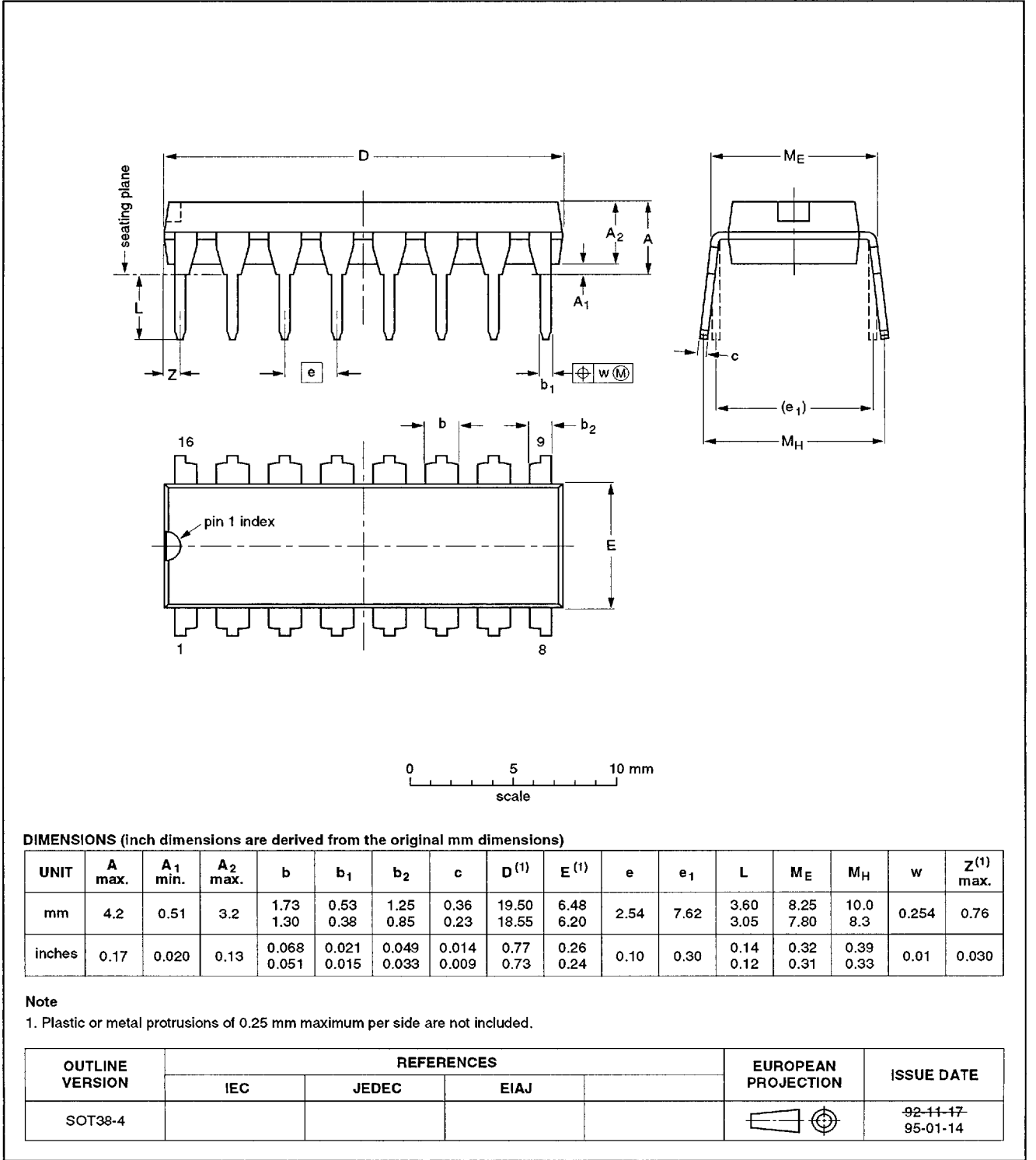
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PACKAGE OUTLINES

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

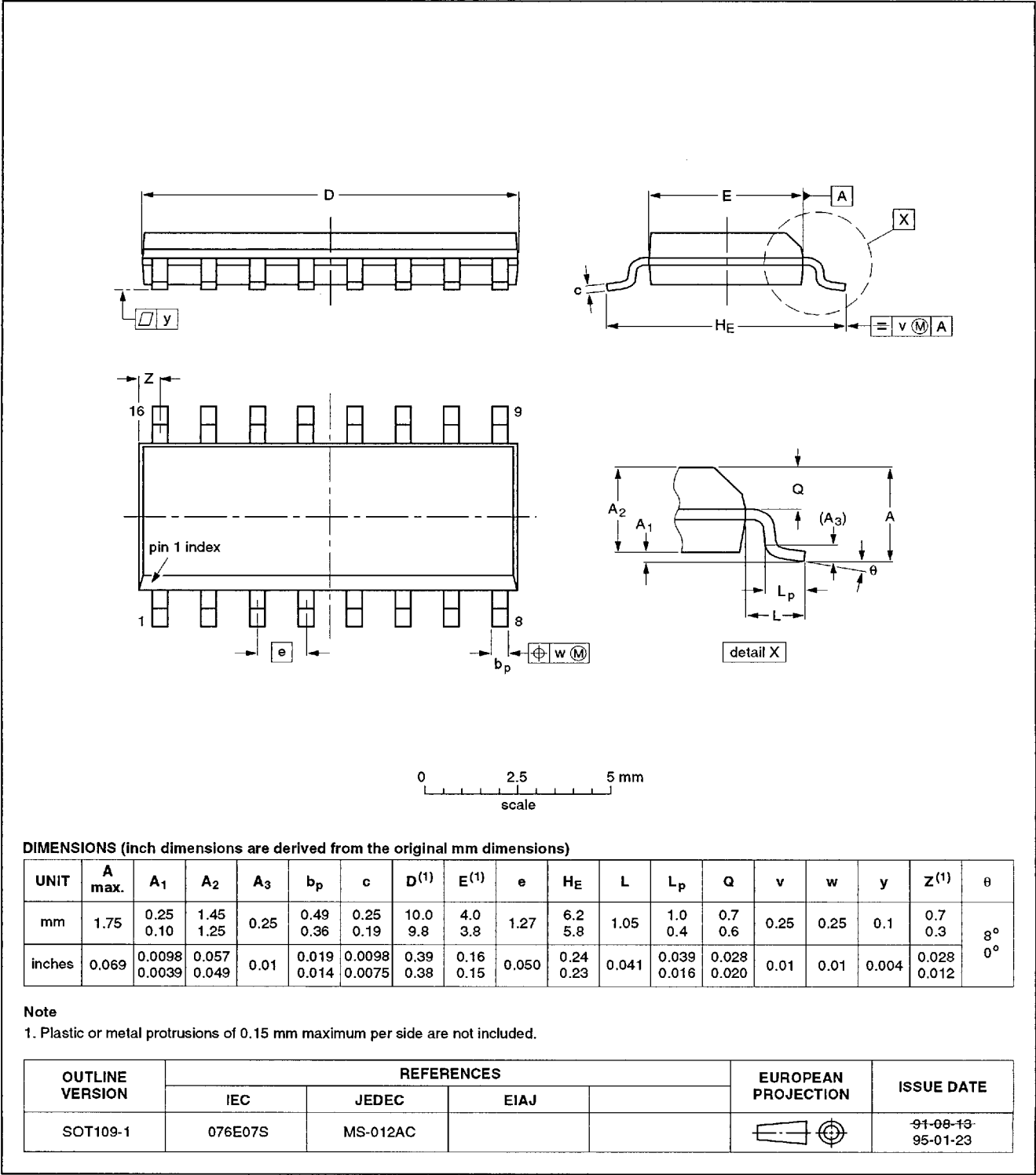


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SO16: plastic small outline package; 16 leads; body width 3.9 mm

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## 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

#### REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO packages.

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

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

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

#### WAVE SOLDERING

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

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

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

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

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

#### REPAIRING SOLDERED JOINTS

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