



## TEA1110A

### LINEAR INTEGRATED CIRCUIT

## LOW VOLTAGE VERSATILE TELEPHONE TRANSMISSION CIRCUIT WITH DIALLER INTERFACE

### DESCRIPTION

The UTC **TEA1110A** is a versatile telephone transmission circuit providing full speech and line interface functions in electronic telephone sets. This device works at a line voltage which can be as low as 1.6V DC (with reduced performance) to enable parallel connection of telephone sets. It also realizes electronic switching between speeches and dialling.

The UTC **TEA1110A** is ideal for applications, such as line powered telephone sets, cordless telephones, and fax machines, answering machines.

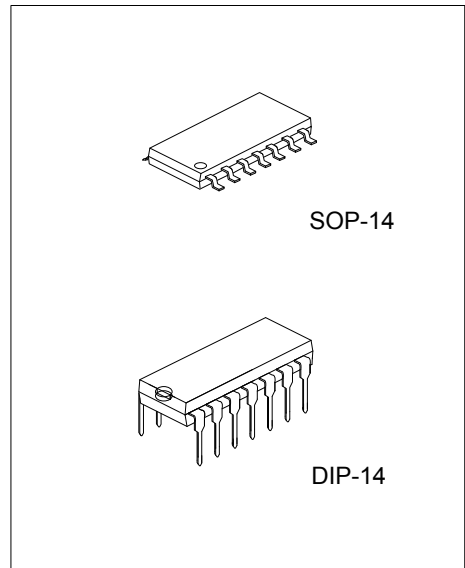
### FEATURES

- \* Low DC line voltage; operates down to 1.6V (excluding voltage drop over external polarity guard)
- \* Voltage regulator with adjustable DC voltage
- \* Provides a supply for external circuits
- \* Symmetrical high impedance inputs (64kΩ) for dynamic, magnetic or piezo-electric microphones
- \* Asymmetrical high impedance input (32kΩ) for electric microphones
- \* DTMF input with confidence tone
- \*  $\overline{\text{MUTE}}$  input for pulse or DTMF dialling
- \* Receiving amplifier for dynamic, magnetic or piezo-electric earpieces
- \* AGC line loss compensation for microphone and earpiece amplifiers.

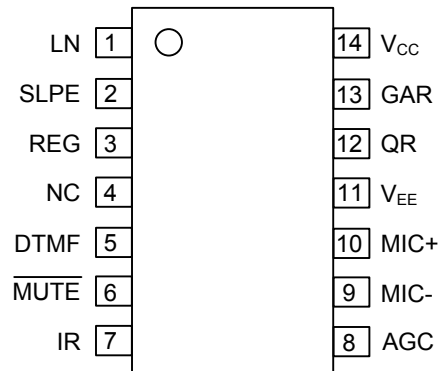
### ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
TEA1110AL-D14-T	TEA1110AG-D14-T	DIP-14	Tube
TEA1110AL-S14-R	TEA1110AG-S14-R	SOP-14	Tape Reel

<p>TEA1110AL-D14-T</p> <p>(1)Packing Type (2)Package Type (3)Lead Free</p>	<p>(1) T: Tube, R: Tape Reel (2) D14: DIP-14, S14: SOP-14 (3) G: Halogen Free, L: Lead Free</p>
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### ■ PIN CONFIGURATION



### ■ PIN DESCRIPTION

PIN NO.	PAD NO.	SYMBOL	DESCRIPTION
1	1	LN	Positive line terminal
2	2	SLPE	Slope (DC resistance) adjustment
3	3	REG	Line voltage regulator decoupling
4	4	NC	Not connected
5	5	DTMF	Dual-tone multi-frequency input
6	6	MUTE	Mute input to select speech or dialing mode (active LOW)
7	7	IR	Receiving amplifier input
8	8	AGC	Automatic gain control/line loss compensation
9	9	MIC-	Inverting microphone amplifier input
10	10	MIC+	Non-inverting microphone amplifier input
11	11	V <sub>EE</sub>	Negative line terminal
12	12	QR	Earpiece amplifier output
13	13	GAR	Earpiece amplifier gain adjustment
14	14	V <sub>CC</sub>	Supply voltage for internal circuit

### ■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Positive Continuous Line Voltage	$V_{LN}$	$V_{EE}-0.4 \sim 12$	V
Repetitive Line Voltage During Switch-on or Line Interruption		$V_{EE}-0.4 \sim 13.2$	V
Maximum Voltage On All Pins	$V_{N(MAX)}$	$V_{EE}-0.4 \sim V_{CC}+0.4$	V
Maximum Line Current ( $R_{SLPE}=20\Omega$ )	$I_{LINE}$	140	mA
Power Dissipation ( $T_a=75^\circ\text{C}$ )	DIP-14	$P_D$	588
	SOP-14		384
Junction Temperature	$T_J$	125	$^\circ\text{C}$
Ambient Temperature	$T_{OPR}$	$-25 \sim +75$	$^\circ\text{C}$
Storage Temperature	$T_{STG}$	$-40 \sim +125$	$^\circ\text{C}$

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

### ■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	$\theta_{JA}$	85	$^\circ\text{C}/\text{W}$
		130	$^\circ\text{C}/\text{W}$

Note: Mounted on epoxy board

### ■ ELECTRIC CHARACTERISTICS ( $T_a=25^\circ\text{C}$ , unless otherwise specified)

( $I_{LINE}=15\text{mA}$ ,  $V_{EE}=0\text{V}$ ,  $R_{SLPE}=20\Omega$ , AGC pin connected to  $V_{EE}$ ,  $Z_{LINE}=600\Omega$ ,  $f=1\text{kHz}$ )

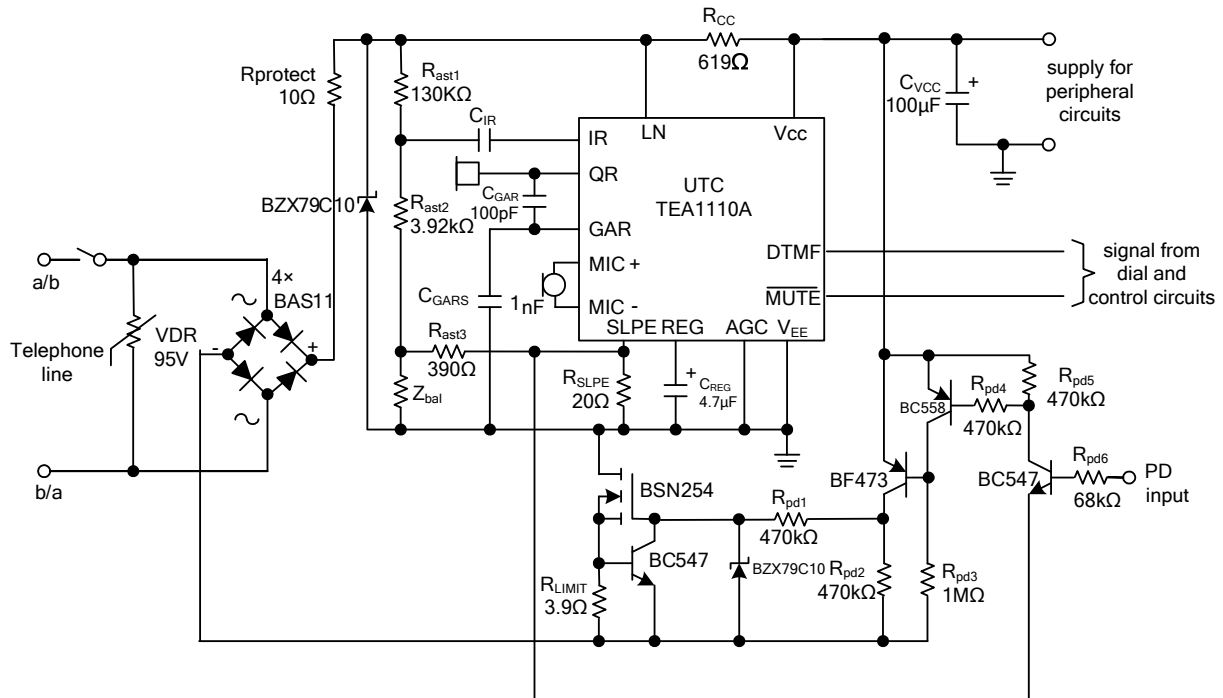
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
<b>Supplies (pins VLN, VCC, SLPE and REG)</b>						
Stabilized Voltage Between LN and SLPE	$V_{REF}$		3.1	3.35	3.6	V
DC Line Voltage	$V_{LN}$	$I_{LINE}=1\text{mA}$		1.6		V
		$I_{LINE}=4\text{mA}$		2.3		V
		$I_{LINE}=15\text{mA}$	3.35	3.65	3.95	V
		$I_{LINE}=140\text{mA}$			6.9	V
DC line voltage with an external resistor RVA	$V_{LN(exR)}$	$R_{VA(SLPE-REG)} = 27\text{k}\Omega$		4.4		V
DC line voltage variation with temperature referred to $25^\circ\text{C}$	$V_{LN(T)}$	$T_a = -25 \sim +75^\circ\text{C}$		$\pm 30$		mV
internal current consumption	$I_{CC}$	$V_{CC} = 2.9\text{V}$		1.3	1.48	mA
Supply voltage for peripherals	$V_{CC}$	$I_P=0\text{mA}$		2.9		V
Equivalent supply voltage resistance	$R_{CCint}$	$I_P=0.5\text{mA}$		550	620	$\Omega$
<b>Microphone amplifier (pins MIC+ and MIC-)</b>						
Voltage gain from MIC+/MIC- to LN	$G_{VTX}$	$V_{MIC}=4\text{mV (RMS)}$	42.7	43.7	44.7	dB
Gain variation with frequency referred to 1kHz	$G_{VTX(F)}$	$f=300\sim 3400\text{Hz}$		$\pm 0.2$		dB
Gain variation with temperature referred to $25^\circ\text{C}$	$G_{VTX(T)}$	$T_a = -25 \sim +75^\circ\text{C}$		$\pm 0.3$		dB
Common mode rejection ratio	CMRR			80		dB
Maximum sending signal (RMS value)	$V_{LN(MAX)}$ (rms)	$I_{LINE}=15\text{mA}$ ; THD=2%	1.4	1.7		V
		$I_{LINE}=4\text{mA}$ ; THD=10%		0.8		V
Noise output voltage at pin LN, pins MIC+/MIC- shorted through $200\Omega$	$V_{NOTX}$			-78.5		dBmp

■ ELECTRIC CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
<b>Receiving amplifier (pins IR, QR and GAR)</b>						
Voltage gain from IR to QR	$G_{VRX}$	$V_{IR} = 4\text{mV (RMS)}$	32	33	34	dB
Gain variation with frequency referred to 1kHz	$G_{VRX(F)}$	$f = 300\sim 3400\text{ Hz}$		$\pm 0.2$		dB
Gain variation with temperature referred to 25°C	$G_{VRX(T)}$	$T_a = -25 \sim +75\text{ }^\circ\text{C}$		$\pm 0.3$		dB
Gain voltage reduction range	$G_{VRXR}$	external resistor connected between GAR and QR			14	dB
Maximum receiving signal (RMS value)	$V_{O(rms)}$	$I_P = 0\text{mA sine wave drive}$ $R_L = 50\Omega, \text{THD} = 2\%$		0.25		V
		$I_P = 0\text{mA sine wave drive}$ $R_L = 450\Omega, \text{THD} = 2\%$		0.35		
Noise output voltage at pin R (RMS value)	$V_{NORX(rms)}$	$G_{VRX} = 33\text{dB}$ , IR open-circuit, $R_L = 150\Omega$		-87		dBVp
<b>Automatic gain control (pin AGC)</b>						
Gain control range for microphone and receiving amplifiers with respect to $I_{LINE} = 15\text{mA}$	$G_{VTRX}$	$I_{LINE} = 85\text{mA}$		5.9		dB
Highest line current for maximum gain	$I_{START}$			23		mA
Lowest line current for minimum gain	$I_{STOP}$			56		mA
<b>DTMF amplifier (pin DTMF)</b>						
Voltage gain from DTMF to LN	$G_{VDTMF}$	$V_{DTMF} = 20\text{mV (RMS)}$ $\overline{\text{MUTE}} = \text{LOW}$	24.1	25.3	26.5	dB
Gain variation with frequency referred to 1kHz	$G_{VDTMF(F)}$	$f = 300\sim 3400\text{Hz}$		$\pm 0.2$		dB
Gain variation with temperature referred to 25°C	$G_{VDTMF(T)}$	$T_a = -25 \sim +75\text{ }^\circ\text{C}$		$\pm 0.4$		dB
Voltage gain from DTMF to QR (confidence tone)	$G_{VCT}$	$V_{DTMF} = 20\text{mV (RMS)}$ $R_L = 150\Omega$		-15		dB
<b>Mute function (pin MUTE)</b>						
LOW level input voltage	$V_{IL}$		$V_{EE}$ -0.4		$V_{EE}$ +0.3	V
HIGH level input voltage	$V_{IH}$		$V_{EE}$ +1.5		$V_{CC}$ +0.4	V
Input current	$I_{\overline{\text{MUTE}}}$			1.5		$\mu\text{A}$
Gain reduction for microphone and receiving amplifiers	$G_{VTRXM}$	$\overline{\text{MUTE}} = \text{LOW}$		80		dB

### APPLICATION INFORMATION CIRCUIT

Typical application of the UTC **TEA1110A** in sets with Pulse Dialling or Flash facilities



## FUNCTIONAL DESCRIPTION

### Supply (pins LN, SLPE, VCC and REG)

The UTC **TEA1110A** and its peripheral circuit derive the power supply from telephone line (see Fig.1). The IC generates a stabilized reference voltage ( $V_{REF}$ ) between pins LN and SLPE. The voltage at pin SLPE is proportional to the line current.  $V_{REF}$  is temperature compensated and can be adjusted by means of an external resistor ( $R_{VA}$ ).  $V_{REF}$  is set to 3.35 V, which can be increased by connecting  $R_{VA}$  between pins REG and SLPE (see Fig.2) and be decreased by connecting  $R_{VA}$  between pins REG and LN. The voltage at pin REG is used by the internal regulator to generate  $V_{REF}$  and is decoupled by, which is connected to  $V_{EE}$ . This  $C_{REG}$  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).

In the following formula, the most appropriate value for  $R_{SLPE}$  is 20  $\Omega$ . The changing of  $R_{SLPE}$  will affect the DC characteristics; furthermore, it can influence the microphone and DTMF gains, the gain control characteristics, the side tone level and the maximum output swing on the line.

The voltage at pin LN is:

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

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

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  $V_{EE}$ .

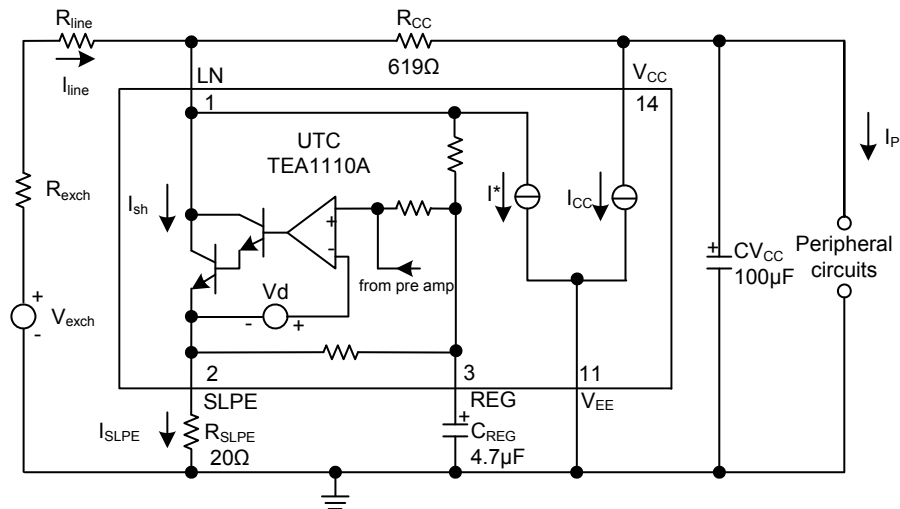
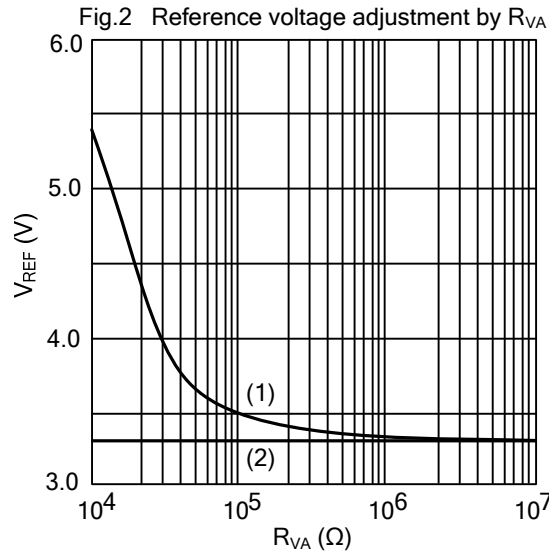


Fig 1. Supply configuration.

### FUNCTIONAL DESCRIPTION(Cont.)



(1) Influence of  $R_{VA}$  on  $V_{REF}$   
 (2)  $V_{REF}$  without influence of  $R_{VA}$

The internal circuitry of the UTC **TEA1110A** is supplied from pin  $V_{CC}$  which can be used to supply peripheral circuits such as dialling or control circuits. This voltage supply is derived from the line voltage by means of a resistor ( $R_{CC}$ ) and it must be decoupled by a capacitor  $C_{VCC}$ . The  $V_{CC}$  voltage depends on the current consumed by the IC and the peripheral circuits as shown by the formula :( $R_{CCint}$  is the internal equivalent resistance of the voltage supply, and  $I_{rec}$  is the current consumed by the output stage of the earpiece amplifier)

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

$$V_{CC0} = V_{LN} - R_{CC} \times I_{CC} \text{ (see also Figs 3 and 4).}$$

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 ( $V_{REF}$ ). The internal reference voltage (generating  $V_{REF}$ ) would be automatically adjusted to a lower value when the line currents drop below 7.5mA. Therefore, more sets can work in parallel with DC line voltages (excluding the polarity guard) down to 1.6V (absolute minimum voltage). At currents below 7.5mA, the circuit has limited sending and receiving levels. This is called the low voltage area.

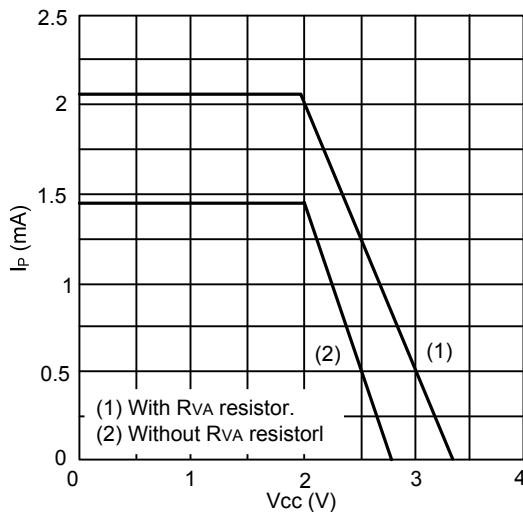


Fig.3 Typical current  $I_P$  available from  $V_{CC}$  for peripheral circuits at  $I_{LINE}=15mA$ .

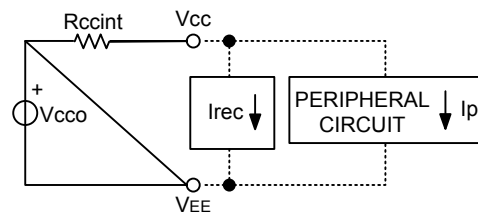
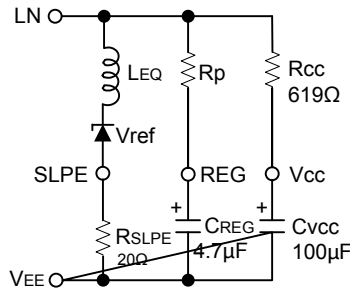


Fig.4  $V_{CC}$  supply voltage for peripherals

## FUNCTIONAL DESCRIPTION(Cont.)

### Set impedance

The dynamic impedance is mainly determined by the RCC resistor within the audio frequency range. The equivalent impedance of the circuit is shown in Fig.5.



$$\begin{aligned} LEQ &= CREG \times RSLPE \times Rp \\ Rp &= \text{internal resistance} \\ Rp &= 15.5k\Omega \end{aligned}$$

Fig.5 Equivalent impedance between LN and VEE

### Microphone amplifier (pins MIC+ and MIC-)

The UTC **TEA1110A** has symmetrical microphone inputs. The input impedance between pin MIC+ and pin MIC- is 64kΩ (2 × 32kΩ). On this microphone amplifier, automatic gain control is used for line loss compensation.

### 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 VEE is 20kΩ. Connecting an external resistor RGAR between pins GAR and QR can decrease the voltage gain within 14dB from pin IR to pin QR. The two external capacitors CGAR (connected between pins GAR and QR) and CGARS (connected between GAR and VEE) ensure stability, the CGAR capacitor provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant CGAR × (RGARint // RGAR). And the RGARint is the internal resistor connected between pins GAR and QR which sets a 125 kW typ gain. The condition CGARS = 10 × CGAR is required to ensure stability.

The output voltage of the receiving amplifier is for continuous wave drive specially. The maximum output swing depends on the DC line voltage, the RCC resistor, the ICC current consumption of the circuit, the IP current consumption of the peripheral circuits and the load impedance.

On this receiving amplifier automatic gain control is used for line loss compensation.

### Automatic gain control (pin AGC)

The UTC **TEA1110A** performs automatic line loss compensation. The automatic gain control varies both the gain of the microphone amplifier and receiving amplifier in accordance with the DC line current within 5.9 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 176Ω/km and an average attenuation of 1.2dB/km).

The IC can be used with different configurations of feeding bridge (supply voltage and bridge resistance) by the means of connecting an external resistor RAGC between pins AGC and VEE. The line currents ISTART and ISTOP can be increased by this resistor (the ratio between ISTART and ISTOP is not affected by the resistor). When pin AGC is in the open-circuit condition, the AGC function is inactive.

### Mute function (pin MUTE MUTE)

The mute function performs the switching between the speech mode and the dialling mode. When the MUTE is in a low level, the DTMF input is active and the microphone and receiving amplifiers inputs are inactive. When the MUTE is in a high level, the microphone and receiving amplifiers inputs are active while the DTMF input is inactive. The input includes a pull-up resistor.

### DTMF amplifier (pin DTMF)

When the DTMF amplifier is inactive, dialling tones that can be heard in the earpiece at a low level may be sent on line. The UTC **TEA1110A** has an asymmetrical DTMF input. The input impedance between DTMF and VEE is 20kΩ. The automatic gain control has no effect on the DTMF amplifier.



### FUNCTIONAL DESCRIPTION(Cont.)

#### SIDETONE SUPPRESSION

The UTC **TEA1110A** anti-side tone network consisting of  $R_{CC}$ / $Z_{line}$ ,  $R_{ast1}$ ,  $R_{ast2}$ ,  $R_{ast3}$ ,  $R_{SLPE}$  and  $Z_{bal}$  (see Fig.6) suppresses the transmitted signal in the earpiece. Maximum compensation is obtained under the following conditions:

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

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

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

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

$Z_{line}$  varies considerably with the line type and the line length in practice. Therefore, the  $Z_{bal}$  value should be set to be an average line length which gives appropriate side tone 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 receiving signal is to be attenuated 32dB by the anti-side tone network from the line before it enters the receiving amplifier, and the attenuation is almost constant over the whole audio frequency range.

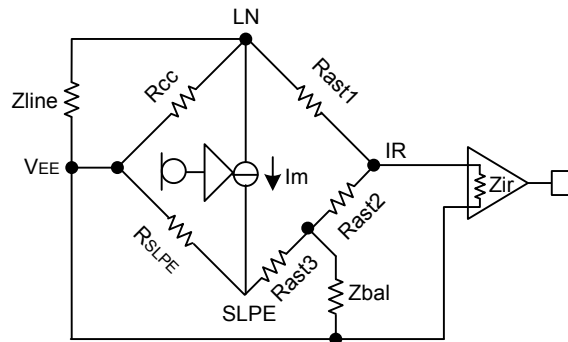


Fig.6 Equivalent circuit of UTC TEA1110A anti-sidetone bridge

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