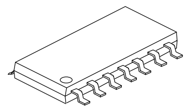
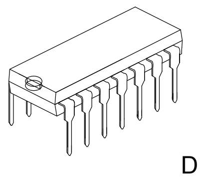
LOW VOLTAGE VERSATILE TELEPHONE TRANSMISSION CIRCUIT WITH DIALLER INTERFACE



SOP-14



DIP-14

■ 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

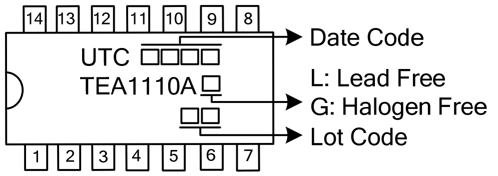
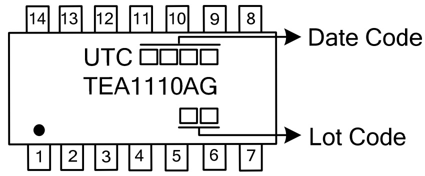
* Low DC line voltage; operates down to 1.6V (excluding voltage drop over external polarity guard)
* Voltage regulator with adjustable DC voltage
* Provides a supply for external circuits
* Symmetrical high impedance inputs (64kΩ) for dynamic, magnetic or piezo-electric microphones
* Asymmetrical high impedance input (32kΩ) for electric microphones
* DTMF input with confidence tone
* $\overline{MUTE}$ 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

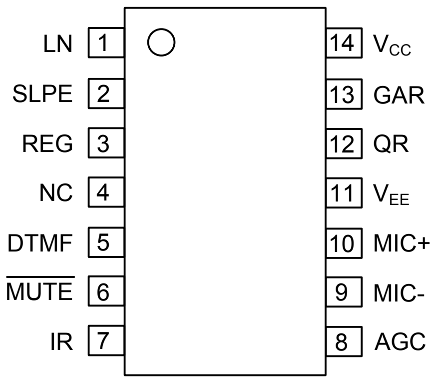
Ordering Number		Package	Packing
Lead Free	Halogen Free		
TEA1110AL-D14-T	TEA1110AG-D14-T	DIP-14	Tube
-	TEA1110AG-S14-R	SOP-14	Tape Reel

TEA1110AL-D14-T	
(1)Packing Type	(1) T: Tube, R: Tape Reel
(2)Package Type	(2) D14: DIP-14, S14: SOP-14
(3)Green Package	(3) L: Lead Free, G: Halogen Free and Lead Free

■ MARKING

DIP-14	SOP-14
	

■ 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	$\overline{\text{MUTE}}$	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_{EE}	Negative line terminal
12	12	QR	Earpiece amplifier output
13	13	GAR	Earpiece amplifier gain adjustment
14	14	V_{CC}	Supply voltage for internal circuit

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNIT
Positive Continuous Line Voltage		V_{LN}	V_{EE}-0.4 ~ 12	V
Repetitive Line Voltage During Switch-on or Line Interruption			V_{EE}-0.4 ~ 13.2	V
Maximum Voltage On All Pins		$V_{N(MAX)}$	V_{EE} -0.4 ~V_{CC}+0.4	V
Maximum Line Current (R_{SLPE}=20Ω)		I_{LINE}	140	mA
Power Dissipation (Ta=75°C)	DIP-14	P_D	588	mW
	SOP-14		384	mW
Junction Temperature		T_J	125	°C
Ambient Temperature		T_{OPR}	-25~+75	°C
Storage Temperature		T_{STG}	-40~+125	°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	DIP-14	θ_{JA}	85	°C/W
	SOP-14		130	°C/W

Note: Mounted on epoxy board

■ ELECTRIC CHARACTERISTICS (Ta=25°C, unless otherwise specified)

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

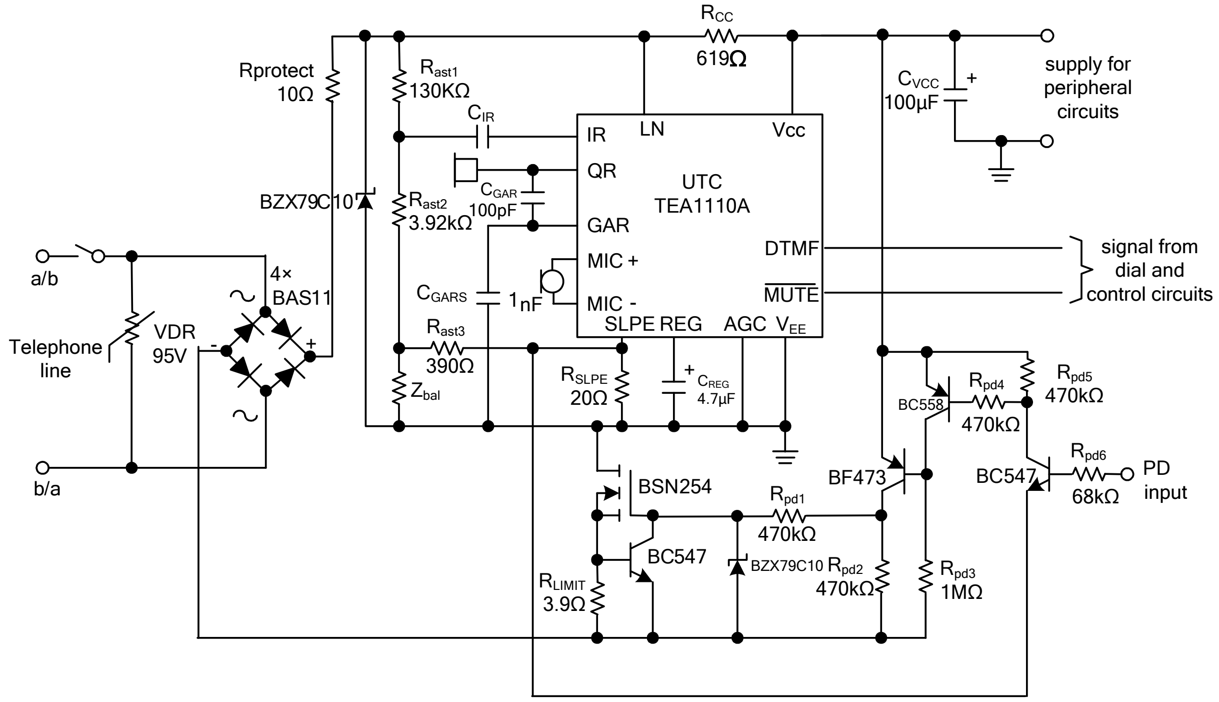
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Supplies (pins VLN, V_{CC}, SLPE and REG)						
Stabilized Voltage Between LN and SLPE	V_{REF}		3.1	3.35	3.6	V
DC Line Voltage	V_{LN}	I_{LINE} =1mA		1.6		V
		I_{LINE} =4mA		2.3		V
		I_{LINE} =15mA	3.35	3.65	3.95	V
		I_{LINE} =140mA			6.9	V
DC line voltage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

■ ELECTRIC CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Receiving amplifier (pins IR, QR and GAR)						
Voltage gain from IR to QR	G_{VRX}	V_{IR} = 4mV (RMS)	32	33	34	dB
Gain variation with frequency referred to 1kHz	$G_{VRX(F)}$	f = 300~3400 Hz		±0.2		dB
Gain variation with temperature referred to 25°C	$G_{VRX(T)}$	Ta = -25 ~ +75 °C		±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 =0mA sine wave drive R_L = 50Ω, THD =2%		0.25		V
		I_P = 0mA sine wave drive R_L =450 Ω, THD =2%		0.35		
Noise output voltage at pin R (RMS value)	$V_{NORX(rms)}$	G_{VRX} =33dB, IR open-circuit, R_L =150Ω		-87		dBVp
Automatic gain control (pin AGC)						
Gain control range for microphone and receiving amplifiers with respect to I_{LINE}=15mA	G_{VTRX}	I_{LINE} = 85mA		5.9		dB
Highest line current for maximum gain	I_{START}			23		mA
Lowest line current for minimum gain	I_{STOP}			56		mA
DTMF amplifier (pin DTMF)						
Voltage gain from DTMF to LN	G_{VDTMF}	V_{DTMF} = 20mV (RMS) $\overline{MUTE}$ = LOW	24.1	25.3	26.5	dB
Gain variation with frequency referred to 1kHz	$G_{VDTMF(F)}$	f = 300~3400Hz		±0.2		dB
Gain variation with temperature referred to25°C	$G_{VDTMF(T)}$	Ta = -25 ~ +75 °C		±0.4		dB
Voltage gain from DTMF to QR (confidence tone)	G_{VCT}	V_{DTMF} = 20mV (RMS) R_L = 150 Ω		-15		dB
Mute function (pin $\overline{MUTE}$)						
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	$I_{\overline{MUTE}}$			1.5		μA
Gain reduction for microphone and receiving amplifiers	G_{VTRXM}	$\overline{MUTE}$ = 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, V_{CC} 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 RVA between pins REG and SLPE (see Fig.2) and be decreased by connecting RVA 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 Ω. The changing of RSLPE 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}.

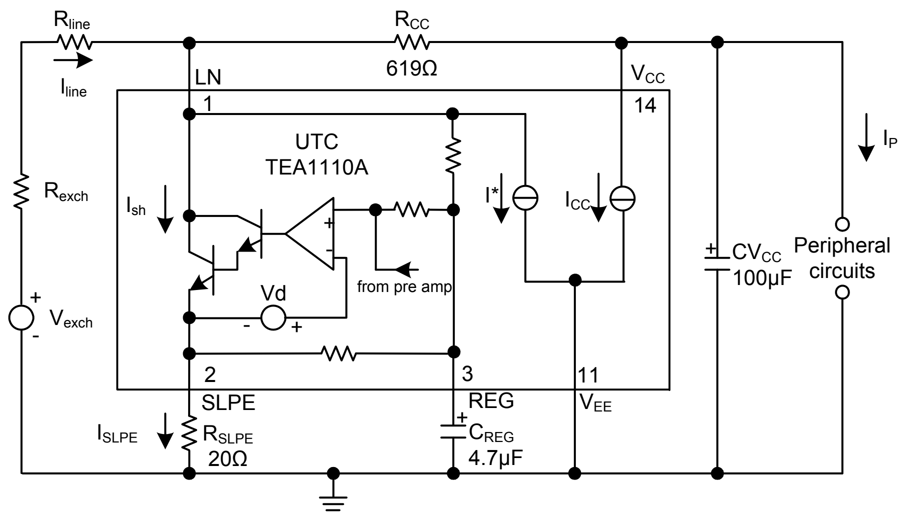
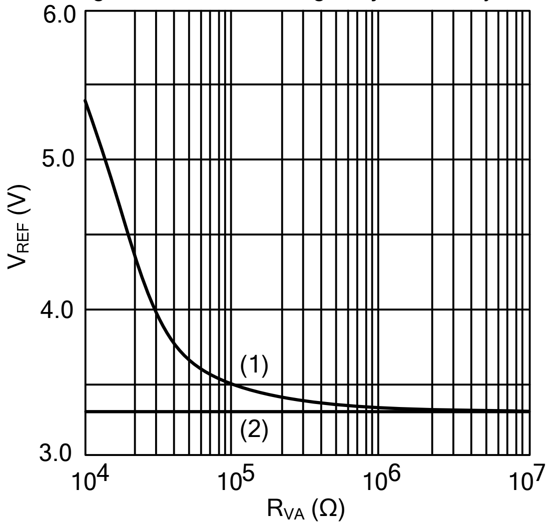


Fig 1. Supply configuration.

■ FUNCTIONAL DESCRIPTION(Cont.)

Fig.2 Reference voltage adjustment by R_{VA}



(1) Influence of RVA on V_{REF}
(2) V_{REF} without influence of RVA

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 CV_{CC}. The V_{CC} voltage depends on the current consumed by the IC and the peripheral circuits as shown by the formula :(R_{CC}int is the internal equivalent resistance of the voltage supply, and Irec is the current consumed by the output stage of the earpiece amplifier))

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

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

The DC line current flowing into the set is determined by the exchange supply voltage (Vexch), the feeding bridge resistance (Rexch), the DC resistance of the telephone line (Rline) 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.

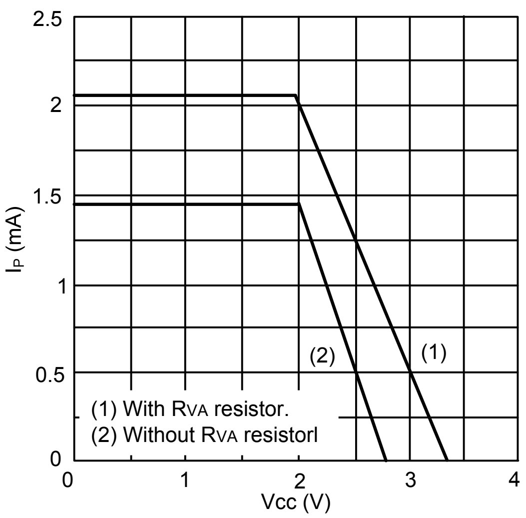


Fig.3 Typical current I_P available from V_{CC} for peripheral circuits at I_{LINE}=15mA.

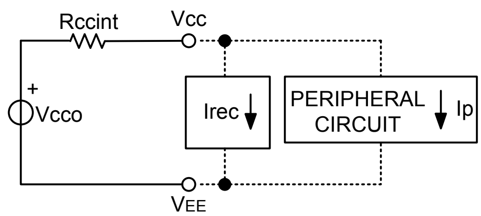


Fig.4 V_{CC} supply voltage for peripherals

■ 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.

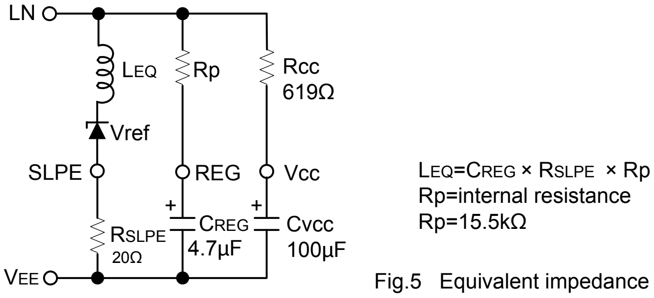


Fig.5 Equivalent impedance between LN and V_{EE}

Microphone amplifier (pins MIC+ and MIC-)

The UTC **TEA1110**A 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 V_{EE} 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 V_{EE}) ensure stability, the CGAR capacitor provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant CGAR × (R_{GARint} // R_{GAR}). And the R_{GARint} is the internal resistor connected between pins GAR and QR which sets a 125 kW typ gain. The condition C_{GARS} = 10 ×C_{GAR} 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 R_{CC} resistor, the I_{CC} 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 V_{EE}. The line currents I_{START} and I_{STOP} can be increased by this resistor (the ratio between I_{START} and I_{STOP} is not affected by the resistor). When pin AGC is in the open-circuit condition, the AGC function is inactive.

Mute function (pin $\overline{\text{MUTE}}$ MUTE)

The mute function performs the switching between the speech mode and the dialling mode. When the $\overline{\text{MUTE}}$ 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 V_{EE} 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}//Zline, Rast1, Rast2, Rast3, R_{SLPE} and Zbal (see Fig.6) suppresses the transmitted signal in the earpiece. Maximum compensation is obtained under the following conditions:

$R_{SLPE} \times Rast1 = R_{CC} \times (Rast2 + Rast3)$

$$K = \frac{(Rast2 \times (Rast3 + R_{SLPE}))}{(Rast1 \times R_{SLPE})}$$

Zbal= k×Zline

The scale factor k is mainly for the compatibility with a standard capacitor from the E6 or E12 range for Zbal.

Zline varies considerably with the line type and the line length in practice. Therefore, the Zbal 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 Zbaland 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.

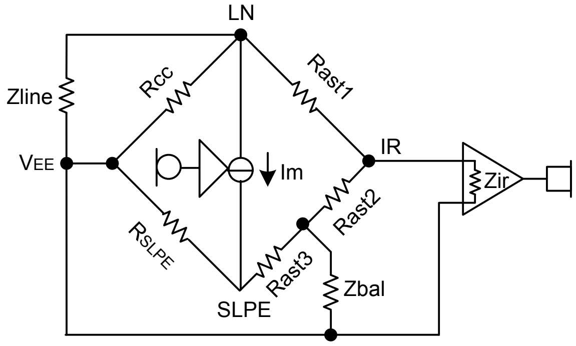


Fig.6 Equivalent circuit of UTC TEA1110A anti-sidetone bridge