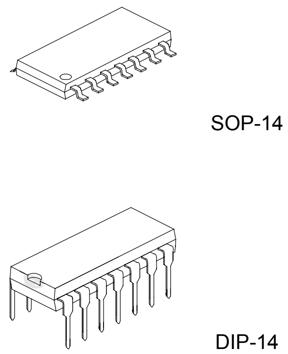
LOW VOLTAGE VERSATILE TELEPHONE TRANSMISSION CIRCUIT WITH DIALLER INTERFACE



DESCRIPTION

The UTC TEA1110A 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.

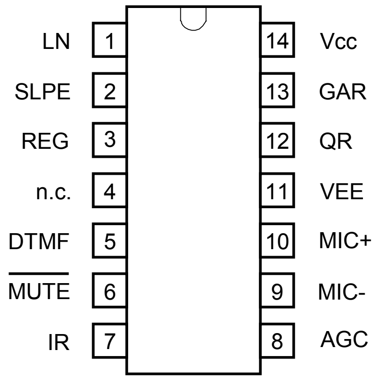
FEATURES

*Low DC line voltage; operates down to 1.6 V (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
*$\overline{\text{DTMF}}$ 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.

APPLICATIONS

*Line powered telephone sets, cordless telephones, fax machines, answering machines.

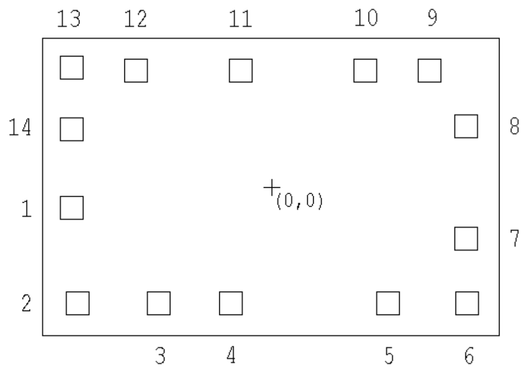
PIN CONFIGURATION



PIN DESCRIPTION

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

BONDING PAD LOCATIONS



SYMBOL	PAD No.	COORDINATES	
		x	y
LN	1	-791	-82
SLPE	2	-767.5	-460
RGE	3	-445	-460
n.c.	4	-157.5	-460
DTMF	5	467	-460
$\overline{\text{MUTE}}$	6	780.5	-459
IR	7	774.5	-205.5
AGC	8	774.5	241
MIC-	9	629.5	461
MIC+	10	375	461
V_{EE}	11	-121.5	461
QR	12	-536.5	461
GAR	13	-791	471
Vcc	14	-791	227.5

UNIT: μ m

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
Total power dissipation (Ta=75℃) DIP-14 SOP-14	Ptot	 588 384	mW
Storage temperature	Tstg	-40~+125	℃
Ambient temperature	Ta	-25~+75	℃
Maximum Junction temperature	Tj	125	℃

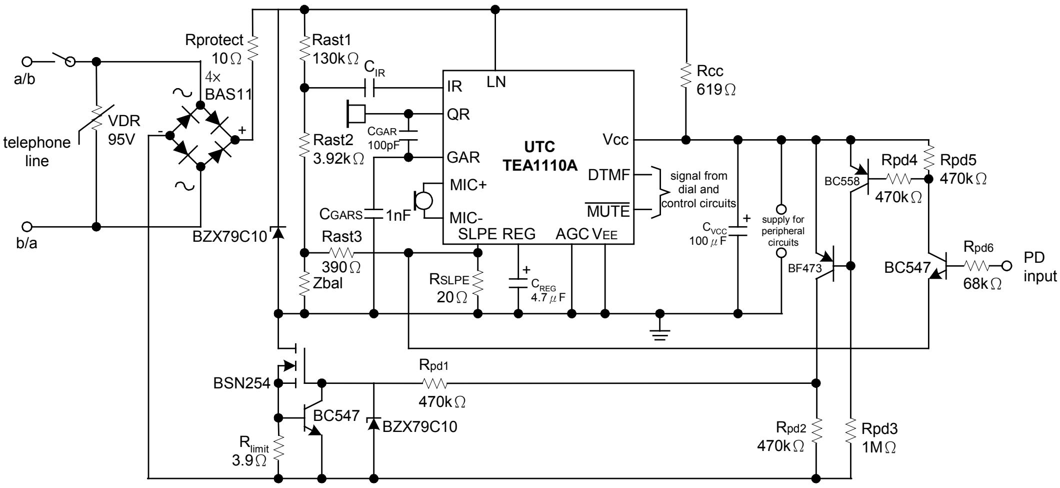
ELECTRIC CHARACTERISTICS

(I_{line}=15mA, V_{EE}=0V, R_{SLPE}=20Ω, AGC pin connected to VEE, Z_{line}=600Ω, f=1kHz, Ta=25℃, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Supplies (pins VLN, VCC, 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} = 1 mA		1.6		V
		I_{line} = 4 mA		2.3		V
		I_{line} = 15 mA	3.35	3.65	3.95	V
		I_{line} = 140 mA			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	$\Delta V_{LN(T)}$	Ta = -25 to +75 °C		±30		mV
internal current consumption	I_{CC}	V_{CC} = 2.9 V		1.1	1.4	mA
Supply voltage for peripherals	Vcc	Ip=0mA		2.9		V
Equivalent supply voltage resistance	Rccint	Ip=0.5mA		550	620	Ω
Microphone amplifier (pins MIC+ and MIC-)						
Voltage gain from MIC+/MIC- to LN	Gvtx	V_{MIC} = 4 mV (RMS)	42.7	43.7	44.7	dB
Gain variation with frequency referred to 1 kHz	$\Delta G_{vtx(f)}$	f = 300 to 3400 Hz		±0.2		dB
Gain variation with temperature referred to 25℃	$\Delta G_{vtx(T)}$	Ta = -25 to +75 °C		±0.3		dB
Common mode rejection ratio	CMRR			80		dB
Maximum sending signal(RMS value)	$V_{LN(max)\ (rms)}$	Iline = 15 mA; THD = 2%	1.4	1.7		V
		Iline = 4 mA, THD = 10%		0.8		V
Noise output voltage at pin LN, pins MIC+/MIC- shorted through 200Ω	V_{notx}			-78.5		dBmp
Receiving amplifier (pins IR, QR and GAR)						
Voltage gain from IR to QR	Gvrx	VIR = 4 mV (RMS)	32	33	34	dB

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Gain variation with frequency referred to kHz	$\Delta G_{vrx(f)}$	f = 300 to 3400 Hz		±0.2		dB
Gain variation with temperature referred to25°C	$\Delta G_{vrx(T)}$	Ta = -25 to +75 °C		±0.3		dB
Gain voltage reduction range	ΔG_{vrxr}	external resistor connected between GAR and QR			14	dB
Maximum receiving signal (RMS value)	$V_{o(rms)}$	I_P = 0 mA sine wave drive, R_L = 150Ω, THD = 2%		0.25		V
		I_P = 0 mA sine wave drive, R_L = 450 Ω, THD = 2%		0.35		
Noise output voltage at pin R (RMS value)	$V_{norx(rms)}$	Gvrx = 33 dB, IR open-circuit, RL = 150 Ω		-87		dBVp
Automatic gain control (pin AGC)						
Gain control range for microphone and receiving amplifiers with respect to Iline=15mA	ΔG_{vtrx}	I_{line} = 85 mA		5.9		dB
Highest line current for maximum gain	Istart			23		mA
Lowest line current for minimum gain	Istop			56		mA
DTMF amplifier (pin DTMF)						
Voltage gain from DTMF to LN	Gvdtmf	V_{DTMF} = 20 mV (RMS), $\overline{MUTE}$ = LOW	24.1	25.3	26.5	dB
Gain variation with frequency referred to 1kHz	$\Delta G_{vdtmf(f)}$	f = 300 to 3400 Hz		±0.2		dB
Gain variation with temperature referred to25°C	$\Delta G_{vdtmf(T)}$	T_a = -25 to +75 °C		±0.4		dB
Voltage gain from DTMF to QR (confidence tone)	Gvct	V_{DTMF} = 20 mV (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	ΔG_{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, VCC and REG)

The supply for the UTC TEA1110A and its peripherals is obtained from the telephone line (see Fig.1). The IC generates a stabilized reference voltage (Vref) between pins LN and SLPE. Vref is temperature compensated and can be adjusted by means of an external resistor (R_{VA}). Vref equals 3.35 V and can be increased by connecting R_{VA} between pins REG and SLPE (see Fig.2), or decreased by connecting RVA between pins REG and LN. The voltage at pin REG is used by the internal regulator to generate Vref and is decoupled by 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.

The voltage at pin LN is:

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

$I_{SLPE}=I_{line}-Icc-Ip-I^*$

Where:

Iline = line current

Icc = current consumption of the IC

I_P = supply current for peripheral circuits

I* = current consumed between LN and VEE.

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

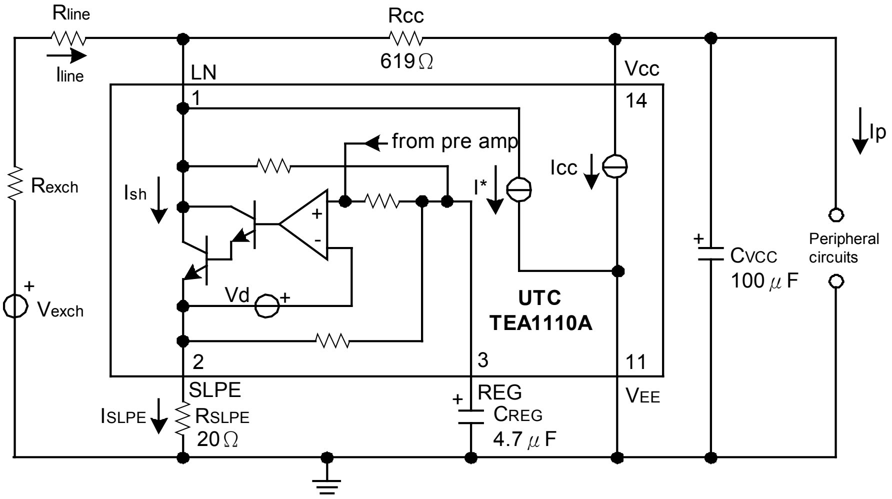


Fig. 1 Supply configuration.

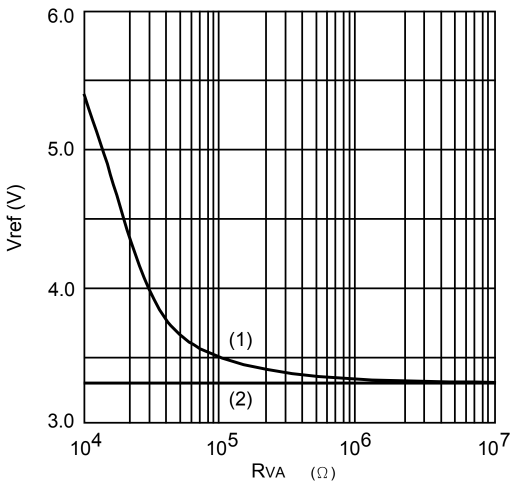


Fig.2 Reference voltage adjustment by R_{VA}

The internal circuitry of the UTC TEA1110A 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 CV_{CC}. 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:

$Vcc=V_{CC0}-Rccint\times(Ip-Irec)$

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

R_{CCint} is the internal equivalent resistance of the voltage supply, and Irec is the current consumed by the output stage of the earpiece amplifier.

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 (Vref). With line currents below 7.5 mA, the internal reference voltage (generating Vref) 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 sending and receiving levels. This is called the low voltage area.

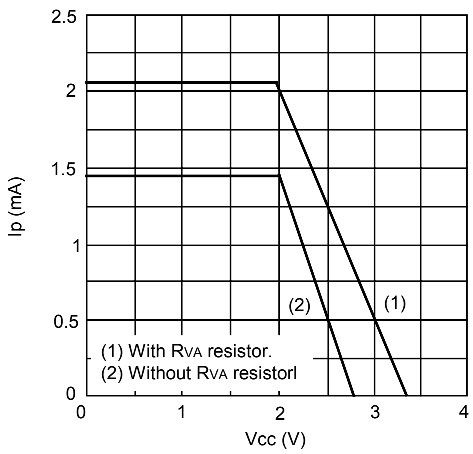


Fig.3 Typical current Ip available from Vcc for peripheral circuits at I_{line}=15mA.

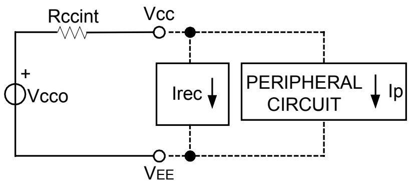
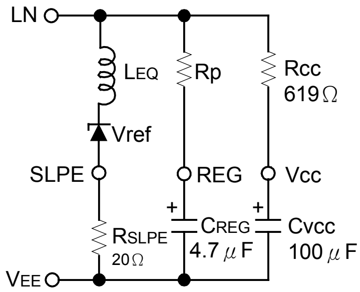


Fig.4 Vcc supply voltage for peripherals

Set impedance

In the audio frequency range, the dynamic impedance is mainly determined by the R_{CC} resistor. The equivalent impedance of the circuit is illustrated in Fig.5.



$L_{EQ}=C_{REG} \times R_{SLPE} \times Rp$
Rp=internal resistance
Rp=15.5kΩ

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

Microphone amplifier (pins MIC+ and MIC-)

The UTC TEA1110A has symmetrical microphone inputs. The input impedance between pins MIC+ and MIC- is 64 kΩ (2 × 32 kΩ). Automatic gain control is provided on this amplifier 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 20 kΩ. The voltage gain from pin IR to pin QR can be decreased by connecting an external resistor R_{GAR} between pins GAR and QR; the adjustment range is 14 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} ×(R_{GARint} // R_{GAR}). R_{GARint} is the internal resistor (connected between pins GAR and QR) which sets the gain with a typical value of 125 kW. The condition $C_{GARS} = 10 \times C_{GAR}$ 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 UTC TEA1110A 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 5.9 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 176 Ω/km and an average attenuation of 1.2 dB/km). The IC 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 Istart and Istop is not affected by the resistor). The AGC function is disabled when pin AGC is left open-circuit.

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

The mute function performs the switching between the speech mode and the dialling mode. When $\overline{\text{MUTE}}$ is LOW, the DTMF input is enabled and the microphone and receiving amplifiers inputs are disabled. When $\overline{\text{MUTE}}$ is HIGH, the microphone and receiving amplifiers inputs are enabled while the DTMF input is disabled. A pull-up resistor is included at the input.

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 UTC TEA1110A has an asymmetrical DTMF input. The input impedance between DTMF and V_{EE} is 20 kΩ. The automatic gain control has no effect on the DTMF amplifier.

SIDETONE SUPPRESSION

The UTC TEA1110A anti-sidetone network comprising RCC//Zline, Rast1, Rast2, Rast3, R_{SLPE} and Zbal (see Fig.6) suppresses the transmitted signal in the earpiece. Maximum compensation is obtained when the following conditions are fulfilled:

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

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

$$Zbal = k \times Zline$$

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

In practice, Zline varies considerably with the line type and the line length. Therefore, the value of Zbal 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 Zbaland the impedance of the average line.

The anti-sidetone network for the UTC TEA1110A (as shown in Application information circuit) 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.

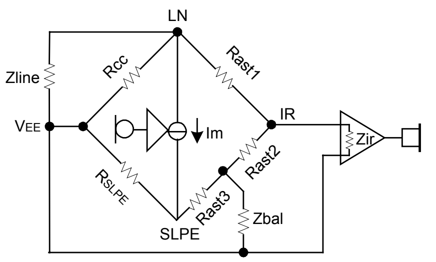


Fig.6 Equivalent circuit of UTC TEA1110A anti-sidetone bridge