MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

T-75-11-37

TCA 3383 A/B

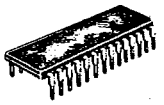
TELEPHONE SET TRANSMISSION CIRCUIT

The TCA3383A and TCA3383B telephone set transmission circuits replace the hybrid transformer in a telephone set, include transmit and receive amplifiers and provide line matching and sidetone cancellation. Automatic gain control is available for line length compensation. Together with companion TCA3381 and TCA3382, plus a CMOS microcomputer, a fully electronic telephone set with loudspeaker amplified reception can be built.

- Nominal transmit and receive gains accurate to ±1 dB
- Automatic preset sidetone network adjustment, compensates for line length variations
- Optional microphone and earphone amplifier automatic gain control to compensate variations in line length
- Regulated D.C. output to power external circuitry
- Multifrequency or Loop Disconnect Dialling Inputs
- Mute facility for transmit and receive amplifiers
- Low noise
- Low current consumption.

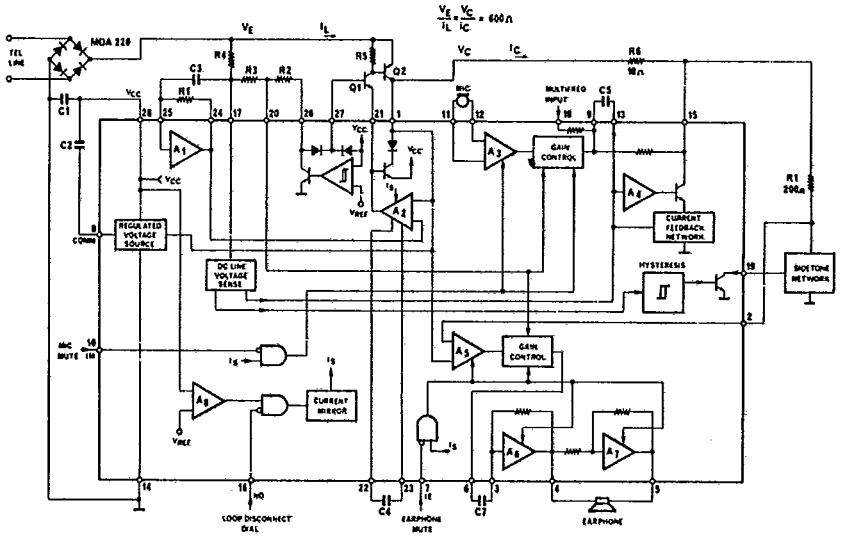
TELEPHONE SET TRANSMISSION CIRCUIT

BIPOLAR INTEGRATED CIRCUIT



28 PIN DIL PACKAGE
Ordering Information:
TCA3383A-DP/TCA3383B-DP

TCA 3383 BLOCK DIAGRAM



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ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Operating Ambient Temperature	T_A	−20 to +60	°C
Storage Temperature	T_S	−65 to +150	°C
Operating Junction Temperature	T_J	150	°C
Thermal Resistance: Plastic Package	R_T	80 to 110	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Start-up Characteristics (I_{CH} = 1mA max)	2					
Line current (V_E >10V)		I_{LD}	28	120	150	mA
Q_2 Emitter voltage (I_{LD} <28 mA)		V_{ED}	–	4.6	6.6	V
Start-up delay time (C_1 = 220 µF, C_5 = 2,2 µF)	13	t_D	150	–	350	ms
Power Supply Characteristics	2					
(−25°C ≤ T_A ≤ 70°C, I_{CH} = 1 mA)						
Line current (V_E > 11 V)		I_L	27.5		57.5	mA
Q2 Emitter voltage		V_E				
I_L = 15 mA			–	6.3	6.9	V
I_L = 25 mA			–	7.8	10.9	V
Regulated supply:						
Voltage (V_{AL} = V_{CC} − V_{COM})		V_{AL}	3.8	4	4.2	V
Regulation (0 < I_{CH} < 3 mA)		ΔV_{AL}	–	10	80	mV
Internal supply:						
Voltage (I_{CH} = 0)		V_{CC}	4.8	5.2	5.6	V
Regulation (0 < I_{CH} < 5 mA)		ΔV_{CC}	–	500	–	mV
Output impedance (0 < I_{CH} < 5 mA)		Z_{out}	–	150	300	Ω
Transmit Gain (300-3400 Hz)						dB
TCA3383A	3					
Nominal gain, DC Resist. = 1280 Ω, 0 dBm on line		G_{EN}	45.5	46.5	47.5	
Short line gain, DC Resist. = 300 Ω, 0 dBm on line		G_{EC}	39	41	43	
TCA3383B						
Nominal Gain, DC Resist. = 1280 Ω, 0 dBm on line		G_{EN}	51.5	52.5	53.5	
Short line gain, DC Resist. = 300 Ω, 0 dBm on line		G_{EC}	45	47	49	
Receive Gain (300-3400 Hz)	4					dB
Nominal gain, DC Resist. = 1280 Ω − 10 dBV receive level		G_{RN}	3	4	5	
Short line gain, DC Resist. = 300 Ω, − 10 dBV receive level		G_{RC}	−4.5	−2.5	−0.5	
Line Terminating Impedance (I_L ≥ 18 mA)	4					
300 – 500 Hz		Z_P	360	600	1000	Ω
500 – 3400 Hz		Z_P	450	600	750	
Microphone Amplifier Input Impedance	3					
300 – 3400 Hz TCA 3383 A		Z_E	350	400	450	Ω
TCA 3383 B			9000	14000		
Earphone Amplifier Output Impedance	4					
300 – 3400 Hz		Z_R	–	3	10	Ω
Common Mode Rejection						
Receive amplifier	5	R_{RCM}	–	65	–	dB
Microphone Muting	3					
Gain reduction (300-3400 Hz, I_L ≥ 18 mA, 0dBm, V_{IM} ≥ V_{IMH} min.)		A_{HM}	−60	−71	–	dB
Mute level "High" (COMM = Reference)		V_{IMH}	V_{AL} −0.8	–	–	V
Mute level "Low" (COMM = Reference)		V_{IMB}		–	0.8	V

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ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Earphone Muting						
Gain reduction	4	A_{HR}	−60	−69	–	dB
(300-3400 Hz, I_L > 18 mA, −10 dBV, V_{IE} > V_{IEH})						
Mute level "High" (COMM = Reference)		V_{IEH}	V_{AL} −0.8	–	–	V
Mute level "Low" (COMM = Reference)		V_{IEB}	–	–	1.5	V
Logic Ports Input Current						
IM, IE, ND	3,4	I	–	1	50	µA
Dialling Input Characteristics	3,4					
Input "High"		V_{NDH}	V_{AL} −0.8	–	–	V
Input "Low"		V_{NDB}	–	–	0.8	V
Open loop line current (V_E = 46.5V)		I_{LD}	–	45	150	µA
Switching of Sidetone Network Resistors	6					
Q_2 Emitter voltage, β off		V_{EIOFF}	10.5	11.2	–	V
Q_2 Emitter voltage, β on		V_{EION}	–	11.2	13	V
"ON" Resistance β (300-3400 Hz)		R_{ONR}	–	–	2	KΩ
"OFF" Resistance β (300-3400 Hz)		R_{OFFR}	100	–	–	KΩ
Transmit Harmonic Distortion RBC < 1280 Ω	3	d_E				
Line level +3 dBm (F = 1kHz)			–	0.4	3	%
Line level +6 dBm (F = 1kHz)			–	–	10	%
Receive Harmonic Distortion	4	d_R				
RBC < 1280 Ω, Rphone = 200 Ω)						
Receive level −11.5 dBV (F = 1 kHz)			–	1.5	3	%
Receive level −10 dBV (F = 1 kHz)			–	–	10	%
Receive Noise	2	B_R	–	–	500	µV
Transmit Noise (e = 0V, DCR = 300 Ω)	3	B_E	–	–	−84	dBmp
MF Input Gain						
Pin 18 to line (600 Ω)	7	G_{MF}	4.0	5.0	6.0	dB
MF Input Impedance	7	Z_{MF}	50	80	110	KΩ
Side Tone Cancellation	3					
F = 300 − 3400 Hz	3					
DCR = 1280 Ω						
− 10 dBV (316 mV_{RMS}) on line		G_{ST}	–	−38	−32	dBV

Note: The line voltage is equal to the voltage on the emitter of Q_2 (V_E) plus the forward voltage drop across the diode bridge (max. 1.5 V).

TCA3383A/B TELEPHONE SET TRANSMISSION CIRCUITS

CIRCUIT DESCRIPTION (See block diagram)

The TCA3383 A/B bipolar integrated circuits interface the microphone and earphone of a telephone set to the two-wire circuit of the telephone line. Controlled gain amplifiers are included for the microphone signal output to the line and the incoming line signal to the earphone. Automatic switching between two preset sidetone networks* is available and inputs are available for either multifrequency (DTMF) or loop disconnect dialling.

DC SUPPLY (See block diagram)

Power for the IC is derived from the line via external transistor Q_2 and pin 1, which supply current to the V_{CC} rail internally.

C_1 is a smoothing capacitor for the unstabilised 5V supply voltage V_{CC} (pin 28 − pin 14). The 4V stabilised supply between COMM and V_{CC} (pin 28 − pin 8) is smoothed by C_2. Power is available for external circuitry such as DTMF generator, MCU, etc.

In the start-up condition immediately after connection to the line C_1 (V_{CC}) is charged rapidly by biasing Q_2 on via Q_4 which in turn is biassed on by the resistor network R_4, R_3, R_2 and the internal circuitry on pins 26, 27. Fig. 8 shows the typical line current vs line voltage characteristic of the circuit and fig. 9 shows the typical regulation of the supply voltages (pins 28,8) as a function of external load current.

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CONTROLLED GAIN

The gain of the microphone amplifier and earphone amplifier can be automatically controlled by the D.C. level on the line by the divider R_3/R_2 on pin 20. Additionally, the DC line voltage sensed at pin 17 is used to switch in or out additional resistors in the sidetone network to obtain preset levels of sidetone cancellation as a function of line length.

Fig. 11 shows how to suppress, with two diodes, the AGC for microphone and earphone if the compensation in line length is not needed.

The variation in amplifier gains between different units under given conditions is tightly controlled in manufacture – nominal gain variation in transmission is ±1 dB max, so that the performance in a given system is well defined.

MUTE FUNCTIONS

Separate microphone and earphone muting is provided through pins 10 and 7 respectively if they are logic level "high".

Muting is also provided during the start-up delay time.

DIALLING

Loop disconnect dialling pulses can be applied at pin 16 ("High" to disconnect). In order to avoid dial clicks, the earphone and the microphone amplifiers ought to be muted externally by applying a logic "1" on pin 7 and 10.

The line current is interrupted by switching of the transistor Q_1 which obtains emitter drive from amplifier A_2, which in turn derives its supply current from the current mirror controlled by the AND gate at pin 16.

Multifrequency dialling tones can be transmitted to the line via pin 18, which is linked internally to pin 9 via a 80k resistor.

*See application circuit: R8 serial + R9, C6 parallel to ground when beta OFF or R8 serial + R9, C6, R11 parallel to ground when beta ON (short line)

PIN DESCRIPTION

Pin 1: V_C	Low voltage line image
Pin 2: V'_C	Speech signal to earphone
Pin 3: V_{EAR}	Negative input of earphone amplifier
Pin 4, 5: E1, E2	Earphone connections
Pin 6: E_{CONT}	Speech signal to earphone, controlled in function of line length
Pin 7: IE	Inhibit earphone (Active "High")
Pin 8: COMM	Internal reference. External available ground.
Pin 9: I_{AC}	Input of AC line current amplifier
Pin 10: IM	Inhibit microphone (Active "High")
Pin 11, 12: M1, M2	Differential input for 2-wires microphone
Pin 13: I_{COR}	Input of DC line current controller
Pin 14: GROUND	Most negative voltage
Pin 15: V'_C	Analog signal output to line. Line terminating impedance matching
Pin 16: ND	Loop disconnect dial pulses input ("High" to disconnect)
Pin 17: AV_E	DC line voltage sense input
Pin 18: MF	DTMF input
Pin 19: Beta	Open collector output to switch sidetone network with regard to line length
Pin 20: V_{CONT}	Part of DC line voltage for gain control of microphone and earphone amplifiers with regard to line length and Controlling DC part
Pin 21: I_{REG}	Current line regulation control
Pin 22, 23: C1, C2	Connection of an external capacity (typ. 470 pF) for internal stability
Pin 24: V_{AC}	Op-amp output for AC impedance transfer
Pin 25: V'_R	Op-amp negative input for AC impedance transfer
Pin 26: V_{DEM}	Internally input connected to ground, except during start-up phase, providing then the control on external transistor Q1
Pin 27: V'_{DEM}	Output to be connected to the base of external transistor Q1 start-up characteristic
Pin 28: V_{CC}	Positive supply, regulated to 4.0 V between V_{CC} and COMM

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FIGURE 1 – BASIC TEST CIRCUIT

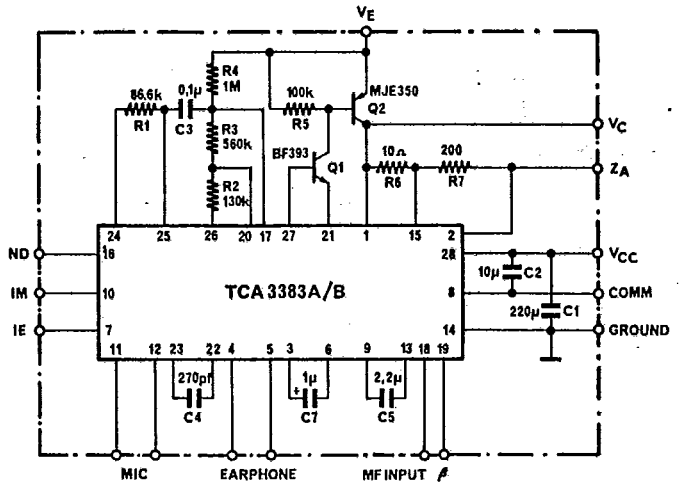

FIGURE 2 – I_{LD}, V_{ED}, t_D, I_L, V_E, V_{AL}, V_{CC}, BR TESTS

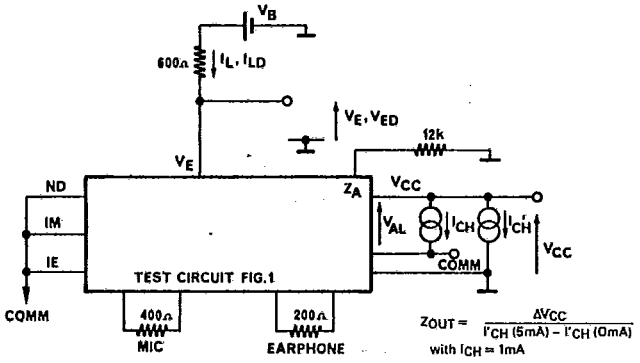

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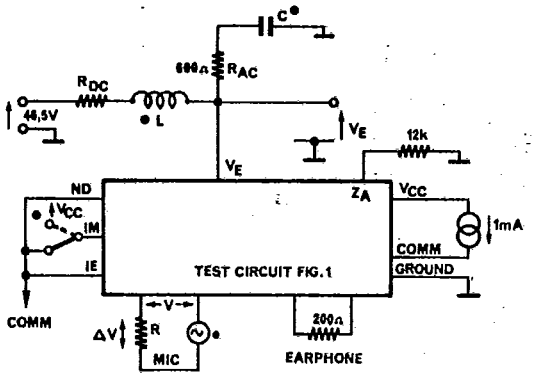
FIGURE 3 – G_{EN}, G_{EC}, Z_E, A_{HM}, V_{IMH}, V_{IMB}, B_E TESTS

$G_{EN} = G_E$ for nominal lines
$G_{EC} = G_E$ for short lines



- $L\omega >> 600\ \Omega$

$1/C\omega << 600\ \Omega$

$$A_{HM} = 20 \log \frac{U_E\ (I_M = 0)}{U_E\ (I_M = 1)}$$

$$G_E = 20 \log \frac{U_E}{e}$$

$$Z_E = \frac{V_{MIC} \cdot R^*}{\Delta V}$$

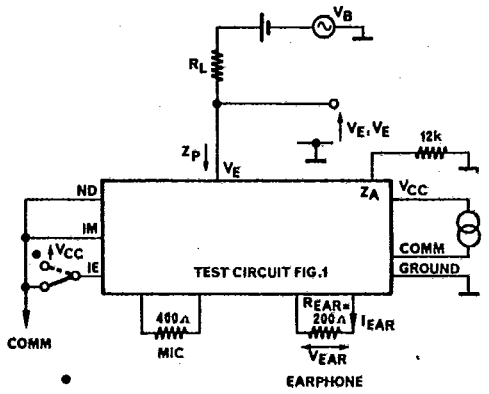
* R = 400 Ω for TCA 3383 A
R = 1400Ω for TCA 3383 B

$$G_{ST} = 20 \log \frac{U_{EAR}}{1\ V}$$

(Note: A_{HM}, G_E, B_E, G_{ST} with R = 400 Ω)

FIGURE 4 – G_{RN}, G_{RC}, Z_P, Z_R, A_{HR} TESTS

$G_{RN} = G_R$ for nominal lines
$G_{RC} = G_R$ for short lines



$$A_{HR} = 20 \log \frac{U_{EAR}\ (I = 0)}{U_{EAR}\ (I = 1)}$$

$$G_R = 20 \log \frac{U_{EAR}}{U_E}$$

$$Z_P = \frac{R_L\ U_E}{V_B - U_E}$$

$$Z_R = \frac{400\ (U_{EAR}\ (400) - U_{EAR}\ (200)}{2\ U_{EAR}\ (200) - U_{EAR}\ (400)}$$

(R_{EAR} = 400 Ω or 200 Ω for Z_R calculation)

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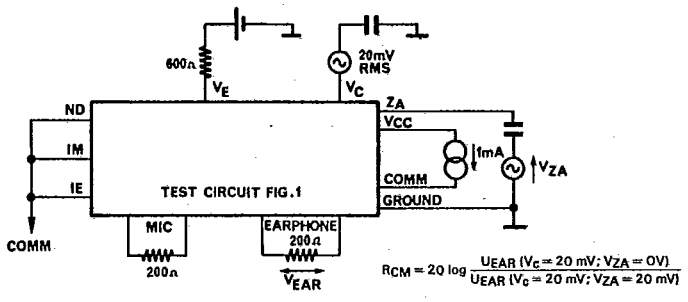
FIGURE 5 – COMMON MODE REJECTION – RECEIVE AMPLIFIER TEST CIRCUIT



$$R_{CM} = 20 \log \frac{U_{EAR}\,(V_C = 20\ mV;\ V_{ZA} = 0V)}{U_{EAR}\,(V_C = 20\ mV;\ V_{ZA} = 20\ mV)}$$

FIGURE 6 – $V_{E|}$ $R_{ON|}$ $R_{OFF|}$ TEST CIRCUIT

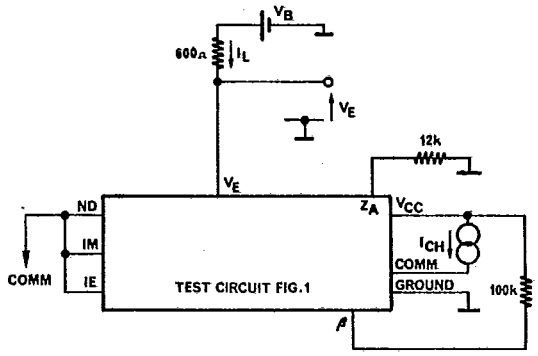


FIGURE 7 – MF TRANSMISSION

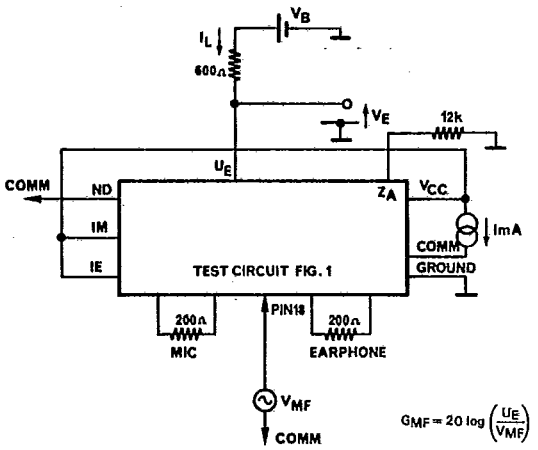


FIGURE 8 – DC SUPPLY MASK
(Including dioμ Bridge)

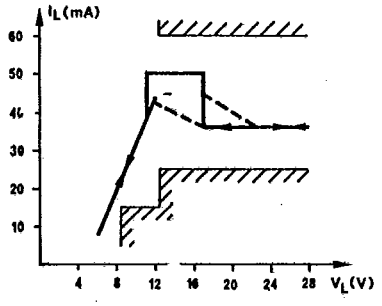


FIGURE 9 – TYPICAL REGULATION CHARACTERISTICS OF SUPPLY VOLTAGES

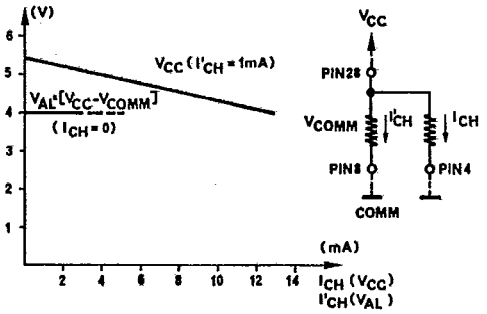


FIGURE 10 – TYPICAL VARIATION OF TRANSMIT AND RECEIVE GAINS WITH LINE VOLTAGE

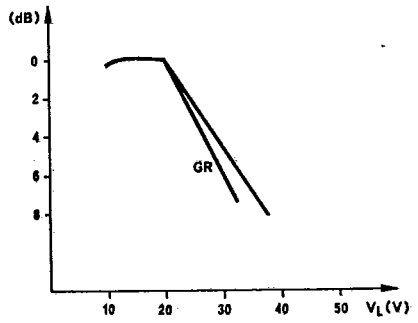
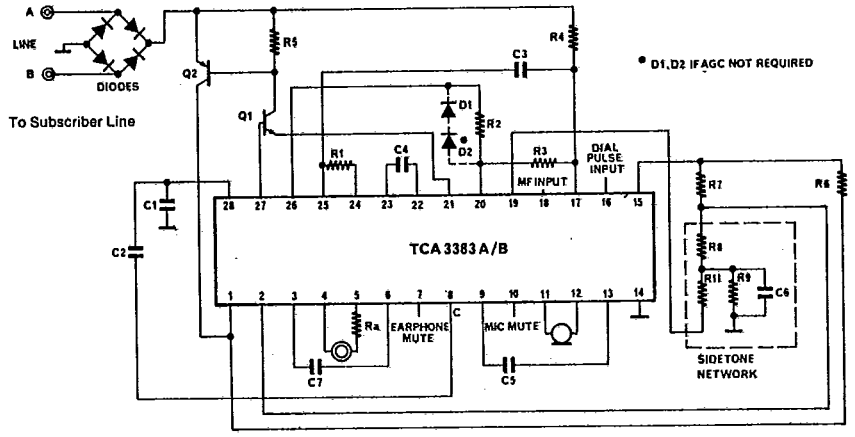


FIGURE 11 – TCA 3383A/B BASIC APPLICATION CIRCUIT
ND, IM, IE tied to COM if not used.

Typical Application



COMPONENT LIST – APPLICATION FIGURE 11

1. Transistors

Type	Nr	V_{CEOmin}	β_{min} (I_C = 10 mA)	I_{Cmax}(mA)	I_{Cpeak}(mA)	Location
PNP	MJE350	150V	30	60	150	Q2
NPN	BF393	150V	30	5	15	Q1

2. Diode bridge: MDA 204

V_{min} = 200 V

3. Resistors

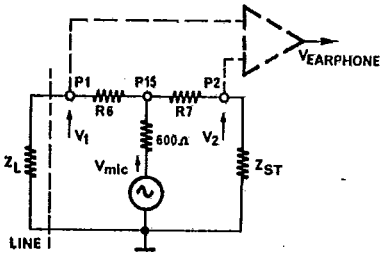
R_1 = 86.6 KΩ ±1%
R_2 = 130 KΩ ±1%
R_3 = 560 KΩ ±1%
R_4 = 1 MΩ ±1%
R_5 = 100 KΩ ±10%
R_6 = 10 Ω ±1%
R_7 = 200 Ω ±1%
$R_8 + R_9$ = 12 K for 600Ω line (modulus)

4. Capacitors

C_1 = 220 µF V= 6V
C_2 = 10 µF V= 5V
C_3 = 100 µF V= 20V
C_4 = 270 µF V= 6V
C_5 = 2.2 µF V= 5V
*C_6 = 3.3 nF V= 10V
C_7 = 1.0 µF V= 5V

*Indicative value

FIGURE 12 – CALCULATION OF SIDETONE NETWORK



In balance, $U_{earphone}$ resulting from U_{mic} = 0

ie $U_1 = U_2$

hence $\frac{Z_L}{Z_L + R_6} = \frac{Z_{ST}}{Z_{ST} + R_7}$

thus $Z_{ST} = Z_L \frac{R_7}{R_6}$

(For Z_L = 600 Ω, R_6 = 10 Ω, R_7 = 200 Ω : Z_{ST} = 12K)

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FIGURE 13 – START-UP PERIOD (See block diagram)