MITEL

SEMICONDUCTOR

MT91610

Analog Ringing SLIC

Preliminary Information

Features

- Transformerless 2W to 4W conversion
- Controls battery feed to line
- Programmable line impedance
- Programmable network balance impedance
- Off-hook and dial pulse detection
- Protects against GND short circuit
- Programmable gain
- Programmable constant current mode with constant voltage fold over
- Transformerless balanced ringing with automatic ring trip circuit. No mechanical relay
- Supports low voltage ringing
- Line polarity reversal
- On-hook transmission
- Power down and wake up capability
- Meter pulse injection
- Ground Key detection

Applications

Line interface for:
- PABX
- Intercoms
- Key Telephone Systems
- Control Systems

Package Information

MT91610AQ   36 Pin QSOP Package

-40°C to +85°C

Description

The Mitel MT91610, with an external bipolar driver (Figure 4), provides an interface between a switching system and a subscriber loop. The functions provided by the MT91610 include battery feed, programmable constant current with constant voltage fold over for long loop, 2W to 4W conversion, off-hook and dial pulse detection, direct balance ringing with built in ring tripping, unbalance detection, user definable line and network balance impedance's and gain, and power down and wake up. The device is fabricated as a CMOS circuit in a 36 pin QSOP package.
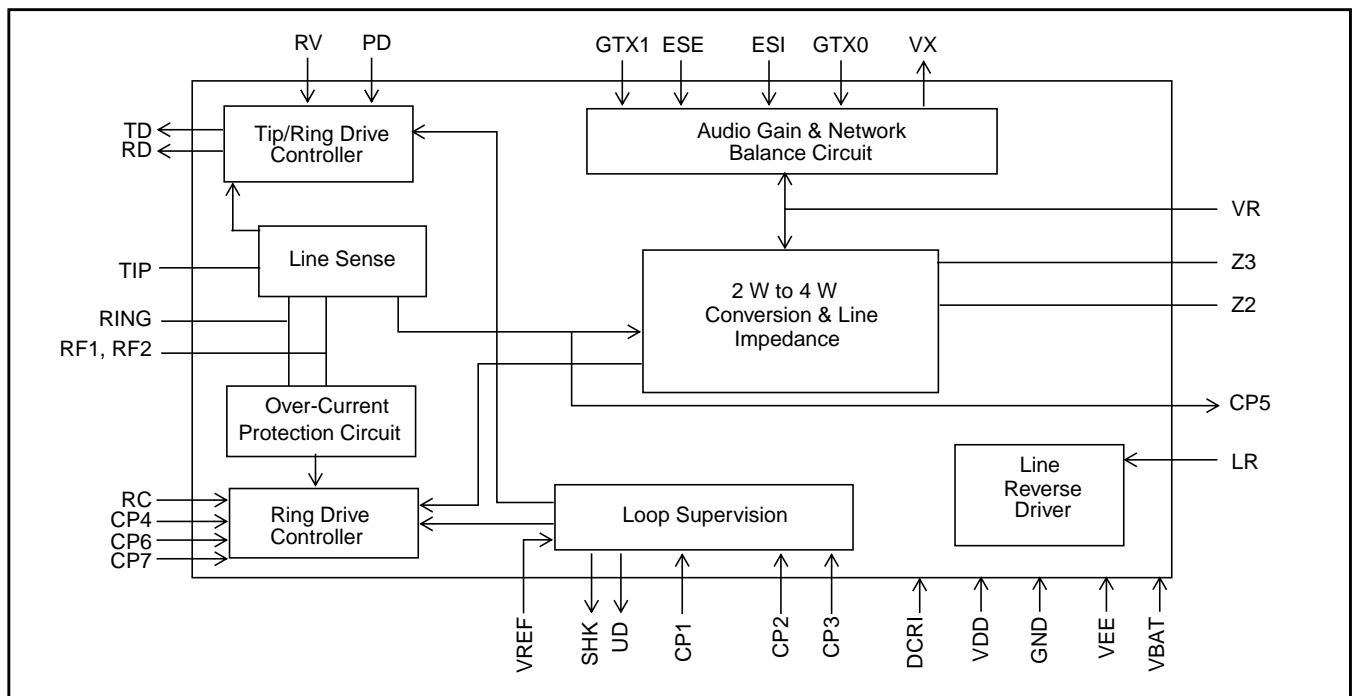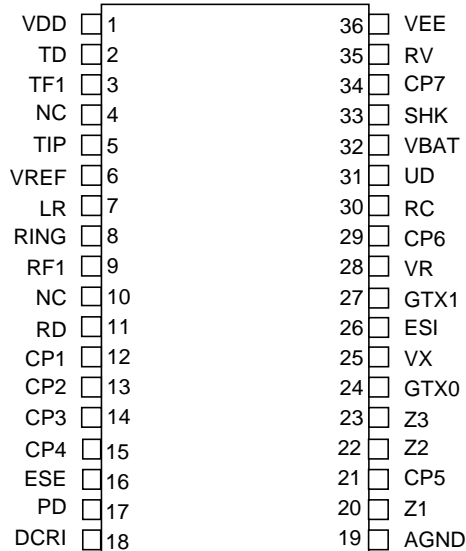

Figure 1 - Functional Block Diagram

Figure 2 - Pin Connections

Pin Description

Pin #	Name	Description
1	VDD	Positive supply rail, +5V.
2	TD	**Tip Drive (Output).** Controls the Tip transistor. Connects 150nF cap to GND.
3	TF1	**Tip Feed 1 (Output).** Connects to the Tip transistor and to TIP via the Tip feed resistor.
4	NC	**No Connection** Left open
5	Tip	**Tip.** Connects to the TIP lead of the telephone line.
6	VREF	**Reference Voltage (Input).** Used to set the subscribers loop constant current. A 0.1uF cap should be connected between this pin and GND for noise decoupling.
7	LR	**Line Reverse (Input).** This pin should be set to 0V for NORMAL polarity. Setting the pin to +5V reverses the polarity of Tip and Ring
8	Ring	**Ring.** Connects to the RING lead of the telephone line
9	RF1	**Ring Feed 1 (Output).** Connects to the RING lead via the Ring feed resistor
10	NC	**No Connection** Left open
11	RD	**Ring Drive (Output).** Controls the Ring transistor. Connects 150nF cap to GND.
12	CP1	**CP1.** A 220nF capacitor should be connected between this pin and pin 13
13	CP2	**CP2.** A 330nF capacitor for loop stability is connected between this pin and pin 14
14	CP3	**CP3.** A 330nF capacitor for loop stability is connected between this pin and pin 13
15	CP4	**CP4.** A 100nF cap should be connected between this pin and GND
16	ESE	**External Signal Enable (Input).** A logic '1' enable the MPI (Meter Pulse Input) to Tip / Ring. This pin should be set to logic '0' when not used.
17	PD	**Power Down (Input).** A logic '1' power down the device. This pin should be set to logic '0' for normal operation.
18	DCRI	**DC voltage for Ringing Input (Input)** The positive voltage supply for balance ringing. The input DC voltage range is from 0V to +72V.
19	AGND	**Analog Ground.** 4 Wire Ground, normally connected to system ground.

Pin Description (continued)

Pin #	Name	Description
20	Z1	**Line Impedance Node 1**. A resistor of scaled value "k" is connected between Z1 and Z2. This connection can not be left open circuit.
21	CP5	**Line Impedance AC couple.** A 0.1uF cap must be connected between this pin and Z1 (pin 16)
22	Z2	**Line Impedance Node 2**. This is the common connection node between Z1 and Z3.
23	Z3	**Line Impedance Node 3**. A network either resistive or complex of scaled value "k" is connected between Z3 and Z2. This connection can not be left open circuit.
24	GTX0	**Gain Node 0**. This is the common node between Z3 and VX where resistors are connected to set the 2W to 4W gain.
25	VX	**Transmit Audio**. 4W analog signal from the SLIC.
26	ESI	**External Signal Input**. 12 / 16 KHz signal input
27	GTX1	**Gain Node 1**. The common node between VR and the audio input from the CODEC or switching network where resistors are fitted to sets the 4W to 2W gain
28	VR	**Receive Audio**. 4W analog signal to the SLIC.
29	CP6	**Ringing Cap.** A 0.47uF cap should be connected between this pin and GND for ringing voltage filtering.
30	RC	**Ringing Control.** An active high (+5V) on this pin will set up the DC feed and gain of the SLIC to apply 20 Hz ringing. When low (0V) set the SLIC in normal constant current mode of operation.
31	UD	**UnBalance Detect.** To indicate an offset current between Tip and Ring
32	VBAT	**VBAT.** The negative battery supply, typically at -48V
33	SHK	**Switch Hook.** This pin indicates the line state of the subscribers telephone. The output can also be used for dial pulse monitoring. This pin is active high
34	CP7	**Deglitching Cap.** A 33nF should be connected between this pin and GND
35	RV	**Ringing Voltage.** 20 Hz sinusoidal or square wave AC in for balance ringing
36	VEE	Negative supply rail, -5V.

Functional Description

Refer to Figure 4 for MT91610 components designation.

The MT91610, with external bipolar transistors, functions as an Analog Line SLIC for use in a 4 Wire switched system. The SLIC performs all of the BORSH functions whilst interfacing to a CODEC or switching system.

2 Wire to 4 Wire conversion

The SLIC performs 2 wire to 4 wire conversion by taking the 4 wire signal from an analog switch or voice CODEC, and converting it to a 2 wire differential signal at Tip and Ring. The 2 wire signal applied to tip and ring by the phone is converted to a 4 wire signal, which is the output from the SLIC to the analog switch or voice CODEC.

Gain Control

It is possible to set the Transmit and Receive gains by the selection of the appropriate external components.

The gains can be calculated by the following formulae:

2W to 4W gain
Gain 2 - 4 = 20 Log [R8 / R7]

4W to 2W gain

Gain 4 - 2 = 20 Log [0.891 * [R10 / R9]]

Impedance Programming

The MT91610 allows the designer to set the device's impedance across TIP and RING, (Z_{TR}), and network balance impedance, (Z_{NB}), separately with external low cost components.

The impedance (Z_{TR}) is set by R4, R5, whilst the network balance, (Z_{NB}), is set by R6, R8, (see Figure 4.)

The network balance impedance should be calculated once the 2W - 4W gain has been set.

Line Impedance

For optimum performance, the characteristic impedance of the line, (Z_0), and the device's impedance across TIP and RING, (Z_{TR}), should match. Therefore:

$$Z_0 = Z_{TR}$$

The relationship between Z_0 and the components that set Z_{TR} is given by the formula:

$$Z_0 / (Ra+Rb) = kZ_0 / R4$$
where $kZ_0 = R5$
        $Ra = Rb$

The value of k can be set by the designer to be any value between 20 and 250. R4 and R5 should be greater than 50kΩ.

Network Balance Impedance

The network balance impedance, (Z_{NB}), will set the transhybrid loss performance for the circuit. The transhybrid loss of the circuit depends on both the 4 - 2 Wire gain and the 2 - 4 Wire gain.

The method of setting the values for R6 (or Z6... it can be a complex impedance) is given as below:

$$R6 = R7 * (R9 / R10) * 2.2446689 * (Z_{NB} / Z_{NB} + Z_0)$$

Please note that in the case of Z_0 not equal to Z_{NB} (the THL compromized case) R6 is a complex impedance. In the general case of Z_0 matches to Z_{NB} (the THL optimized case) R6 is just a single resistor.

Loop Supervision

The Loop Supervision circuit monitors the state of the phone line and when the phone goes "Off Hook" the SHK pin goes high to indicate this state. This pin reverts to a low state when the phone goes back "On Hook" or if the loop resistance is too high (>2.3KΩ)

When loop disconnect dialing is being used, SHK pulses to logic 0 indicate the digits being dialled. This output should be debounced.

## Constant Current Control & Voltage Fold Over Mode

The SLIC employs a feedback circuit to supply a constant feed current to the line. This design is accomplished by sensing the sum of the voltages across the feed resistors, Ra and Rb, and comparing it to the input reference voltage, Vref, that determines the constant current feed current.

By using a resistive divider network, (Figure 3), it is possible to generate the required voltage to set the I_{LOOP}. This voltage can be calculated by the formula:

$$I_{LOOP} = \frac{[G * 5] * 3}{(Ra + Rb)}$$

where, $G = R2 / (R1 + R2)$
        I_{LOOP} is in Ampere.
        $R1 = 200K\Omega$

From Figure 3 with Ra = Rb = 100 Ω
For I_{LOOP} = 20mA, R2 = 72.73 KΩ
For I_{LOOP} = 25mA, R2 = 100 KΩ
For I_{LOOP} = 30mA, R2 = 133.33 KΩ
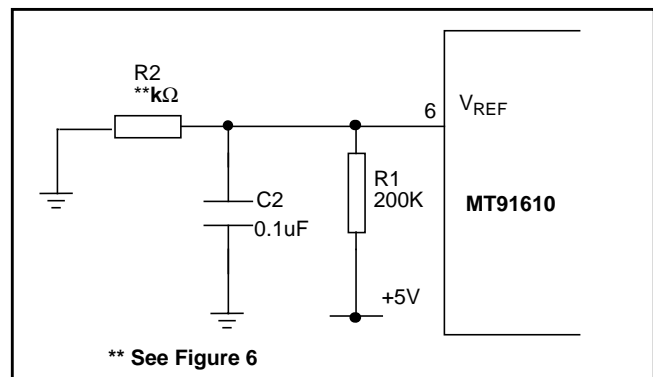
Figure 3 - Loop Setting

For convenience, a graph which plots the value of R2 (KΩ) versus the expected loop current is shown in Figure 6.

As +5V is used as the reference voltage to generate the loop current, any noise on the +5V rail will deteriorate the PSR (Power Supply Rejection) parameter of the SLIC. It is therefore important to decouple +5V to GND. A 0.1uF cap at Vref pin (pin6) is recommended.

The MT91610 operating current mode is recommended to be between 20mA and 30mA. The device will automatically switch to voltage hold over mode should an unexpected long loop situation occur for a given programmed loop current. The lowest operational current should be 16mA with VBAT set at -48V. A typical Operating Current versus Loop Resistance with VBAT at -48V is shown in Figure 7.

UD & Line Drivers Overcurrent Protection

The Line Drivers control the external Battery Feed circuit which provide power to the line and allows bi-directional audio transmission.

The loop supervision circuitry provides bias to the line drivers to feed a constant current. Overcurrent protection is done by the following steps:

(A) External bipolar transistors to limit the current of the NPN drivers to 50mA (Figure 5).

(B) The local controller should monitor the Unbalance Detection output (UD) for any extended period of assertion (>5 seconds). In such case the controller should power down the device by asserting the PD pin, and polls the device every 5 seconds.

The UD output can be used to support GND START LOOP in a PaBX operation.

Please note that this UD output should be disregarded and masked out if RC pin is active (ie set to +5V).

Powering Up / Down Sequence

AGND is always connected
Powering Up: +5V, -5V, VBAT
　　　　　　　PD to +5V for 100ms; PD to 0V
Powering Down: VBAT, -5V, +5V

Balanced Ringing & Automatic Ring Tripping

Balanced Ringing is applied to the line by setting the RC to +5V (pin 25) and connecting ringing signal (20Hz) to RV (pin 35) as shown in Figure 4. A 1.2Vrms input will give approximately about 60Vrms output across Tip and Ring, sufficient for short loop SLIC application. The SLIC is capable of detecting an Off Hook condition during ringing by filtering out the large A.C. component. A 0.47uF cap should be connected to pin CP6 (pin 29) to form such filter. This filter allows a true Off Hook condition to be monitored at pin SHK (pin 33). When an Off Hook condition is detected by the SLIC, it will remove the 20Hz AC ringing voltage and revert to constant current mode. The local controller will, however, still need to deselect RC (set it to 0V).

The MT91610 supports short burst of ringing cadence. A deglitching input (CP7) is provided to ensure that the SHK pin is glitch free during the assertion and de-assertion of RC. A 33nF cap should be connected at this pin to GND.

A positive voltage source is required to be connected to the pin DCRI (Figure 5) for normal Ringing generation. The SLIC can perform ringing even with the DCRI input connected to 0V. However, it does require the VBAT to be lower than -48V (ie at -53V or lower) and the 20Hz AC input should be a square wave at 2Vrms.

Line Reversal

The MT91610 can deliver Line Reversal, which is required in operation such as ANI, by simply setting LR (pin 7) to +5V. The device transmission parameters will cease during the reversal. The LR (pin 7) should be set to 0V for all normal loop operations.

Power Down And Wake Up

The MT91610 should normally be powered down to conserve energy by setting the PD pin to +5V. The SHK pin will be asserted if the equipment side (2 wire) goes off hook. The local controller should then restore power to the SLIC for normal operations by setting the PD pin to 0V.

Please note that there will be a short break (about 80ms) in the assertion time of SHK due to the time required for the loop to power up and loop current to flow. The local controller should be able to mask out this time fairly easily.

Meter Pulse Injection

The MT91610 provides a gain path input (ESI) for meter pulse injection and an independent control logic input (ESE) for turning the meter pulse signal on and off.

Additional circuit can be used to ensure good cancellation of meter pulse signal (Figure 4) should it becomes audible at the 4 wire side. Usually, the optional circuit is not required.

Gain (meter pulse) = 20 Log [0.891 * (R10 / R11)]

Components Selection

Feed Resistors

The selection of feed resistors, Ra and Rb, can significantly affect the performance of the MT91610. The value of 100 Ω is used for both Ra and Rb.

The resistors should have a tolerance of 1% (0.1% matched) and a power rating of 0.5 Watt.

Calculating Components Value

There are five parameters a designer should know before starting the component calculations. These five parameters are:

1) characteristic impedance of the line Z_o
2) network balance impedance Z_{NB}
3) value of the feed resistors (Ra and Rb)
4) 2W to 4W transmit gain
5) 4W to 2W receive gain

The following example will outline a step by step procedure for calculating component values. Given:

$$Z_o = 600\Omega, \quad Z_{NB} = 600\Omega, \quad Ra=Rb= 100\Omega$$
$$\text{Gain 2 - 4 = -6dB}, \quad \text{Gain 4 - 2 = -1 dB}$$

Step 1: Gain Setting (R7, R8, R9, R10)

Gain 2 - 4 = 20 Log [R8 / R7]
  -6 dB = 20 Log [R8 / R7]
$\therefore$ choose R7 = 300kΩ, R8 = 150kΩ.

Gain 4 - 2 = 20 Log [0.891 * [R10 / R9]]
  -1 dB = 20 Log [0.891 * [R10/ R9)]
$\therefore$ choose R9 = 200kΩ, R10 = 200kΩ.

Step 2: Impedance Matching (R4, R5)

Z_o / (Ra+Rb) = kZ_o / R4 where kZ_o = R5
R5 / R4 = 3
 $\therefore$ choose R4 = 100kΩ => R5 = 300kΩ

Step 3: Network Balance Impedance (R6)

Optimized Case $Z_o = Z_{NB}$
R6 = R7 * (R9 / R10) * 2.2446689 * (Z_{NB} / Z_{NB} + Z_o)
R6 = 300kΩ * (1) * 1.1223344
   = 336.7kΩ

Step 4: The Loop Current (R2)

In order to remain in constant current mode during normal operation, it is necessary that the following equation holds:

 {| I * Zt |} V < { | VBAT | - 6*VREF - 2} V
where,
I = Desirable Loop Current
Zt = Ra + Rb + maximum loop impedance
VBAT = Battery voltage
VREF= DC voltage at VREF pin

Given the parameters as follows:
Ra = Rb = 100 Ω
Expected maximum loop impedance = 1.6kΩ (including Ra and Rb)
Desirable Loop Current = 20mA
6*Vref=8V
Then | VBAT | (min) = 1600 * 0.020 +10 = 42V

Assume that the VBAT of 42V is available, then read the value of R2 from Figure 6, which is 50kΩ.

Step 5: Calculation Of Non-Clipping Sinusoidal Ringing Voltage At Tip Ring (VTR)

Assume the Ringing Current is less than 40mA, the ringing voltage (20Hz) at Tip and Ring is given as:

VTR (rms) = 0.707 * {| VBAT | + VDCRI - (15.6 * VREF)}

VDCRI= Positive DC voltage at DCRI pin
VBAT = Negative Battery voltage
VREF= Positive DC voltage at VREF pin

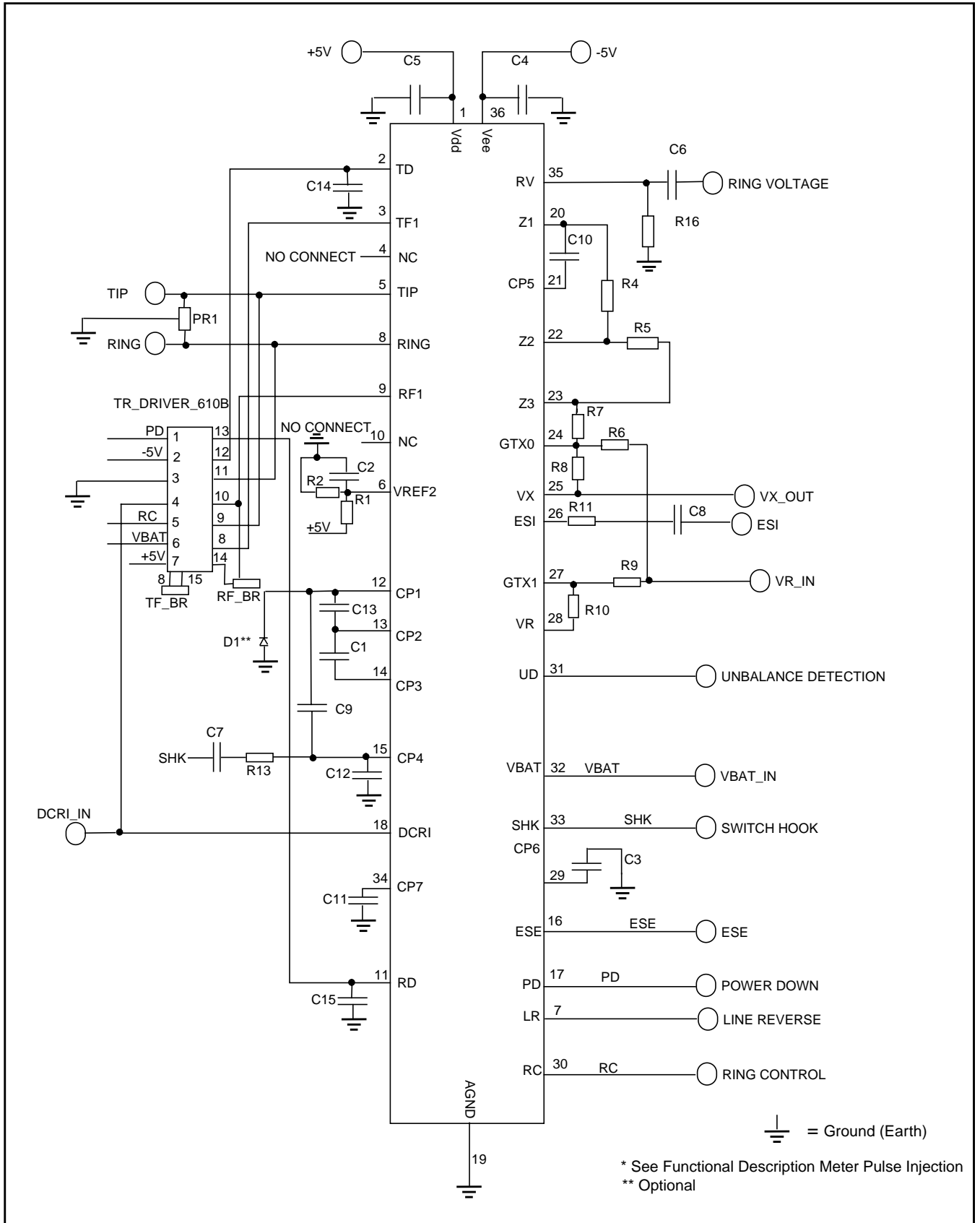AC voltage at the RV input pin is therefore
RV (rms)~= VTR (rms) / 50

Figure 4 - Typical Application with a Resistive 600 ohm Line Impedance

Component List

R11 = 100kΩ
R2 = See Figure 6
R1,9,10 = 200kΩ
R4 = 100kΩ
R5,7,16 = 300kΩ
R6 = 336k7Ω
R8 = 150kΩ
R13 = 51kΩ

C1,10 = 330nF, 5%
C2,4,5,7,8 = 100nF, 5%
C3 = 470nF, 5%
C6 = 4.7uF, 5%
C9 = 10nF, 5%
C11 = 33nF, 5%
C12 = 100nF, 5%
C13 = 220nF, 5%
C14,15 = 150nF, 5%

D1 = 1N5819 Schottky Diode (Optional)

All resistors are 1/4W, 1% unless otherwise indicated.

PR1 = This device must always be fitted to ensure damages does not occur from inductive loads.
For simple applications PR1 can be replaced by a single TVS, such as 1.5KE220C, across tip and ring.
For applications requiring lightning and mains cross protection further circuitry will be required and the following protection devices are suggested:
P2353AA, P2353AB (Teccor), THBT20011, THBT20012, THBT200S (SGS-Thomson), TISP2290, TSSP8290L (T.I.)
TF_BR,RF_BR= Circuit Breaker
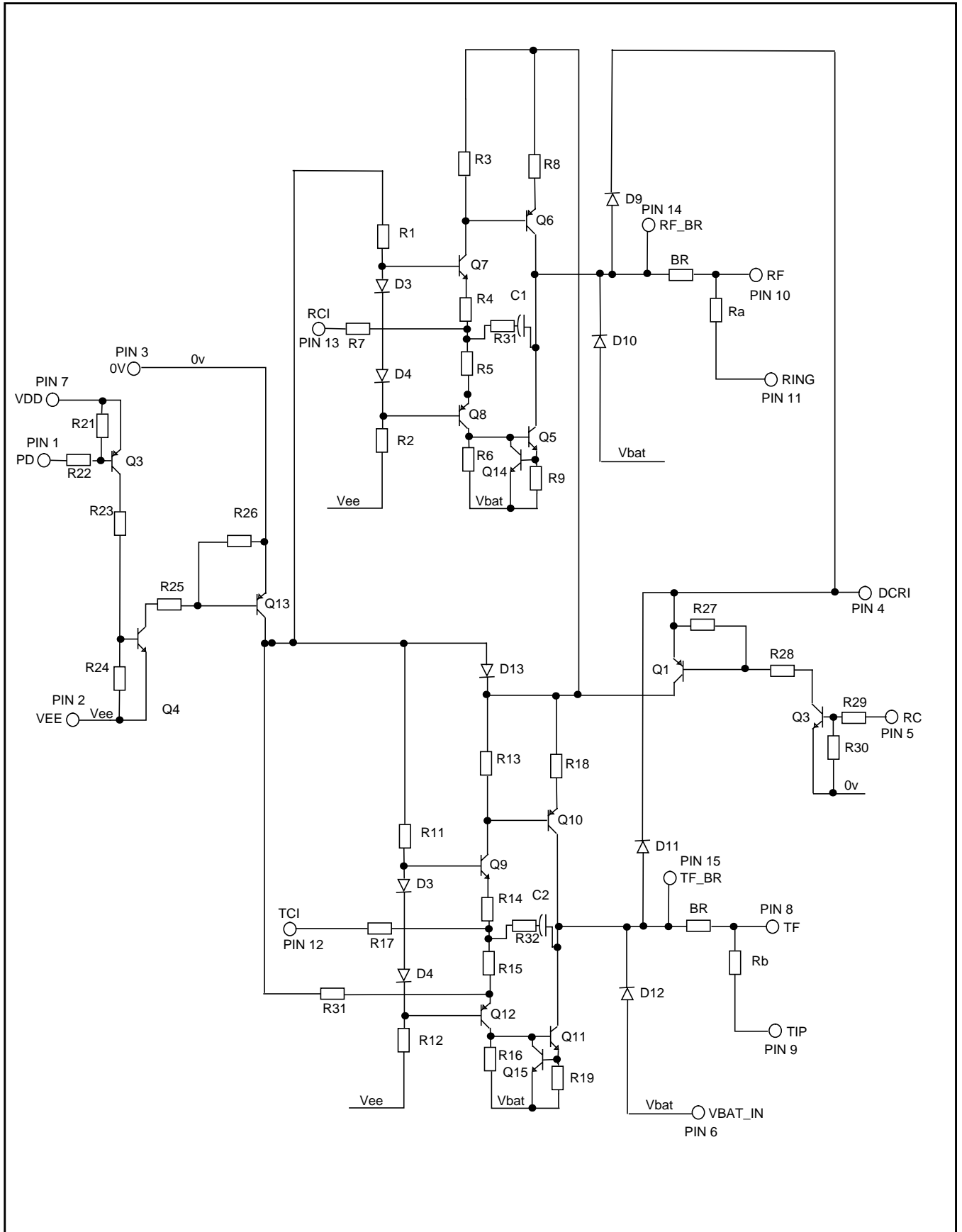
Figure 5 - Line Driver Stage

Component List

R1,3,6,11,13,16 = 2.5kΩ
R2,12   =   3.6kΩ
R4,5,14,15 = 470 Ω
R7,17,31,32 = 360 Ω
R8,9,18,19 = 12 Ω
Ra, Rb   =   100 Ω 1%, 0.15% matched 1W
R21,26,27,30 = 30kΩ
R22,25,28,29 = 3kΩ
R23,24   =   20kΩ
R21,26,27,30 = 3 kΩ
R31 =   5.1 kΩ

C1,2   =   10nF, 5%

D1-8,13   =   1N4148 or equivalent
D9,10,11,12 = 1N4005 or equivalent

Q1,3   =   2N2907
Q2,4,14,15=   2N2222
Q3   =   BCP56
Q5,7,9,11 =   MPSA42
Q6,8,10,12,13   = MPSA92

BR   =Circuit Breaker

All resistors are 1/4W, 1% unless otherwise indicated.

R2 (Kohm) vs Loop Current (mA)

R2 (Kohm)
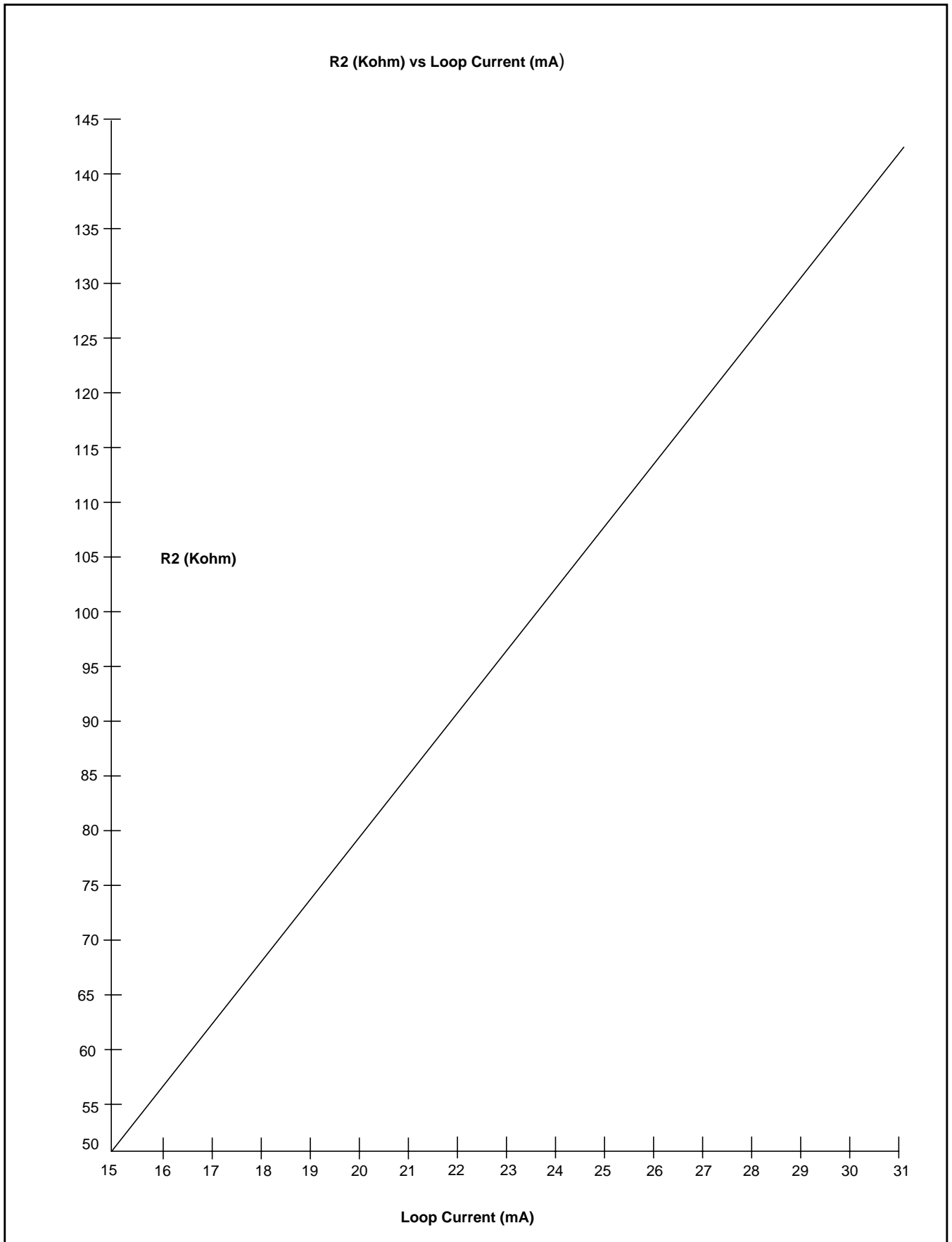
Loop Current (mA)

Figure 6 - Approximated R2 (Kohm) Versus Programmed Loop Current (mA)

Loop Current (mA) versus Loop Resistance (Ohm)
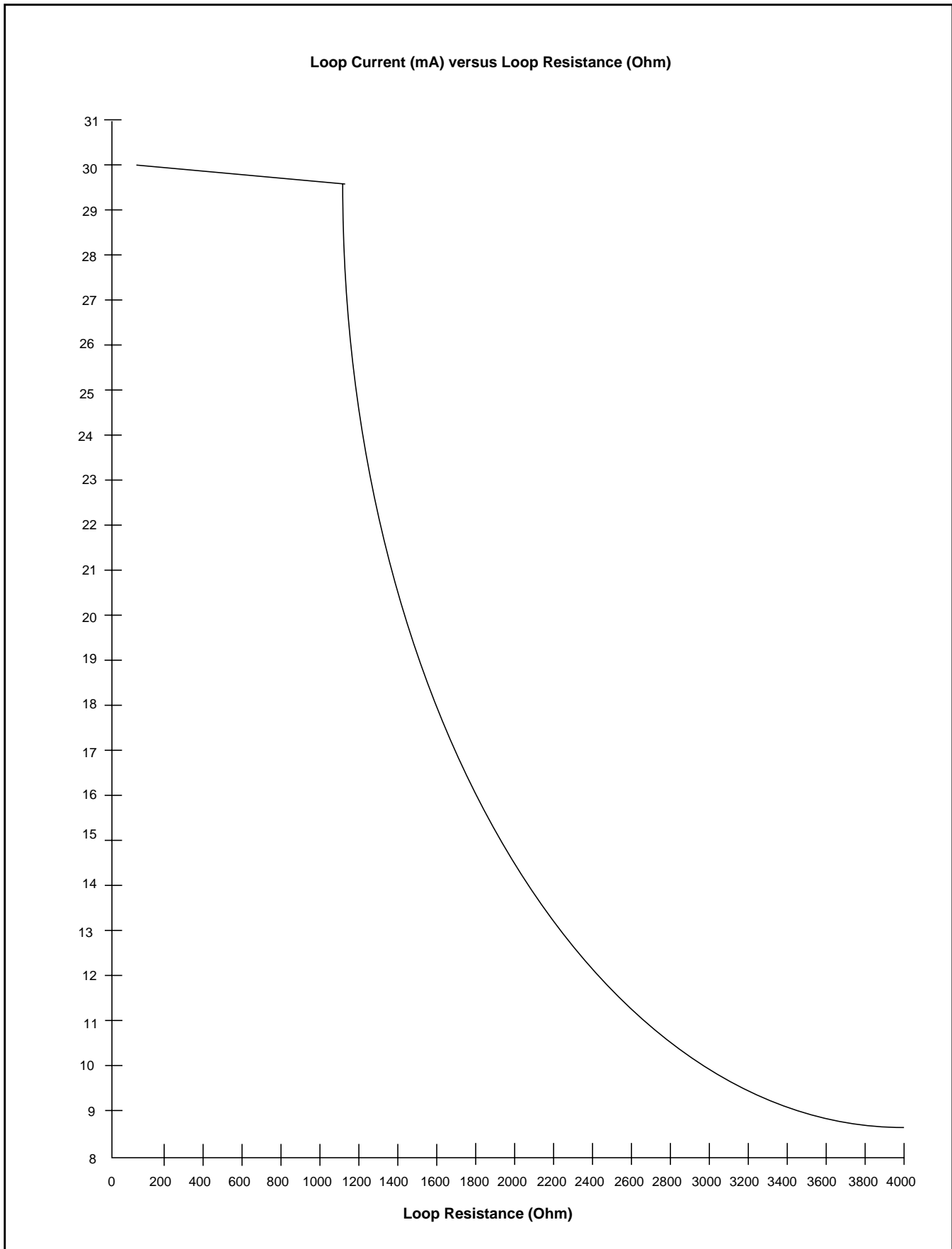
Figure 7 - Loop Current (mA) Versus Loop Resistance (ohm)

Absolute Maximum Ratings*

	Parameter	Sym	Min	Max	Units	Comments
1	DC Supply Voltages	V_{DD} V_{EE} V_{BAT}	-0.3 +0.3 +0.3	+6.5 -6.5 -72	V V V	
2	Ringing Voltages	V_{RING}		70	V_{RMS}	Differentially across Tip & Ring for a 1.5Vrms input at RV (Figure 4)
3	Voltage setting for Loop Current	V_{REF}	0	5	V	Note 1
4	Overvoltage Tip/GND Ring/GND, Tip/Ring	E_E		200	V	MAX 1ms (with power on)
5	Ringing Current	I_{RING}		35	mA	
6	Tip / Ring Ground over-current			50	mA	Note 2
7	Storage Temp	T_{STG}	-65	+150	˚C	
8	Package Power Dissipation	P_{DISS}		0.10	W	+85˚C max, V_{BAT} = -48V
9	ESD maximum rating			500	V	

*Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied.

Note 1: Refer to Figure 3 & 6 for appropriate biasing values
Note 2: Tip and Ring drivers to be limited to about 50mA externally (Figure 5). If the UD pin is asserted for longer than 5 seconds, then PD should be asserted to power down the device. The device should then be checked (by de-asserting PD) every 5 seconds.

Recommended Operating Conditions

	Parameter	Sym	Min	Typ‡	Max	Units	Test Conditions
1	Operating Supply Voltages	V_{DD} V_{EE} V_{BAT} DCRI	4.75 -5.25 -72 5	5.00 -5.00 -48	5.25 -4.75 -22 72	V V V V	50mA current capability
2	Ringing Voltage	V_{RING}	0	60		V_{RMS}	Note 3
3	Voltage setting for Loop Current	V_{REF}		1.67		V	I_{LOOP} = 25mA, VBAT = -48V Note 4
4	Operating Temperature	T_O	-40	+25	+85	˚C	

‡ Typical Figures are at 25˚C with nominal supply voltages and are for design aid only

Note 3: For a 1.2Vrms 20Hz input at RV terminal (Figure 4) and with RC pin set to +5V.
Note 4: Refer to Figure 3 & 6 for biasing values

DC Electrical Characteristics †

	Characteristics	Sym	Min	Typ‡	Max	Units	Test Conditions
1	Supply Current	I_{DD} I_{EE} I_{BAT}		8 6 28		mA mA mA	PD= 0V V_{BAT}= -48V $I_{BAT} \sim I_{LOOP}$ + 3 mA
2	Supply Current	I_{DD} I_{EE} I_{BAT}		300 300 1.8		uA uA mA	PD = 5V V_{BAT} = -48V
3	Constant Current Line Feed	I_{LOOP}		25		mA	V_{REF}=1.67V
4	Operating Loop Constant Current Mode (including the DC resistance of the Telephone Set)	R_{LOOP}		1600 700		Ω Ω	I_{LOOP} = 20mA V_{BAT} = -48V I_{LOOP} = 20mA V_{BAT} = -22V
5	Off Hook Detection Threshold	S_{HK}		14		mA	
6	RC, LR Input Low Voltage Input High Voltage	V_{IL} V_{IH}	 4.5		0.5	V V	L_{IL} = -1µA L_{IH} = 1µA
7	PD, ESE Input Low Voltage Input High Voltage	V_{IL} V_{IH}	 4.5		0.5	V V	L_{IL}= -1µA L_{IH} = 1µA
8	SHK Output Low Voltage Output High Voltage	V_{OL} V_{OH}	 2.7		0.4	V V	L_{OL} = 8mA L_{OH} = -1mA
9	UnBalance Detection Threshold	I_{UD}		12		mA	
10	UD Output Low Voltage Output High Voltage	V_{OL} V_{OH}	 2.7		0.4		L_{OL} = 0.3mA L_{OH} = -0.3mA
11	DialPulseDistortion			1		ms	

†Electrical Characteristics are over Recommended Operating Conditions unless otherwise stated.

‡Typical Figures are at 25°C with nominal ±5V and are for design aid only.

AC Electrical Characteristics [†]

	Characteristics	Sym	Min	Typ[‡]	Max	Units	Test Conditions
1	Ring Trip Detect Time	Tt		90	200	mS	
2	Impedance (2W)	Z_O		600		Ω	
3	Return Loss (2W)	RL	20	30		dB	300Hz to 3k4Hz
4	Transhybrid Loss	THL	20	25		dB	Note 5
5	Output Impedance at VX			10		Ω	AC small signal
6	Gain 4 to 2 Wire @ 1kHz		-1.5	-1	-0.5	dB	Note 5
7	Gain Relative to 1kHz			±0.15		dB	300 - 3400Hz
8	Gain 2W to VX @ 1kHz		-0.5	0	0.5	dB	Note 5
9	Gain Relative to 1kHz			±0.15		dB	300Hz to 3.4KHz
10	Longitudinal to Metallic Balance at 2W	LCL		55		dB	300Hz to 3.4KHz
11	Total Harmonic Distortion @2W @VX	THD		 0.3 0.3	 1.0 1.0	 % %	 1Vrms, 1kHz @ 2W 1Vrms, 1KHz @ VR
12	Common Mode Rejection 2 Wire to Vx	CMR	45	50		dB	Input 0.5Vrms, 1KHz
13	Idle Channel Noise @2W @VX	NC		 12 12		 dBrnC dBrnC	 Cmessage Filter Fig. 4 Cmessage Filter Fig. 4
14	Power Supply Rejection Ratio at 2W and VX Vdd Vee	PSR		 23 23		 dB dB	0.1Vp-p @ 1kHz
15	Line Reversal Recovery Timing	TLRR		30	50	ms	Note 6

[†]Electrical Characteristics are over Recommended Operating Conditions unless otherwise stated.

[‡]Typical Figures are at 25°C with nominal ±5V and are for design aid only.

Note 5: Refer to Figure 4 & 5 for set up and components value.
Note 6: TLRR is measured from the time when the LR pin is set to 0V (de-selected), to the time when the loop current is within 10% of its programmed steady state value.

Notes:

1. Lead Coplanitary should be 0 to 0.10mm (.004") max
2. Package surface finishing
   (2.1) Top Matte: (Charmilles #18-30)
   (2.2) All Sides: (Charmilles #18-30)
   (2.3) Bottom Matte: (Charmilles #18-30)
3. All dimensions excluding mold flashes
4. Max. deviation of center of package and center of leadrame to be 0.10mm (.004")
5. Max. misalignment between top and bottom center of package to 0.10mm (.004")
6. End flash from the package body shall not exceed 0.152 (.006") per side (D)
7. Dimension B shall not include dambar protrusion/intrusion and solder coverage.
8. Not to scale
9. Dimension in inches
10. Dimensions in (millimeters)

QSOP - Quad Shrink Outline Package

Dim	36-Pin		Dim	36-Pin	
	Min	Max		Min	Max
A	.096 (2.44)	.104 (2.64)	e	.0315 inches (ref) 0.80mm	
A$_1$	.004 (0.10)	.012 (0.30)	H	.398 (10.11)	.414 (10.51)
B	.011 (0.26)	.020 (0.51)	L	0.16 (0.40)	.050 (1.27)
C	.0091 (0.23)	.0125 (0.32)	Q	0	8
D	.598 (15.20)	.606 (15.40)	R	.025 (0.63)	.035 (0.89)
E	.291 (7.40)	.299 (7.60)	ZD	.0335 inches (ref) 0.85	

Notes:

Notes:

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