

### Features

- High Gain version MH88511
- Compatible with popular MH88500
- Operates with a wide range of battery voltages
- Constant current battery feed
- Dry line compatible
- Overvoltage and short circuit protection
- Ringing Feed
- Off-hook detection and LED indicator drive
- Dial pulse detection
- Ring trip filter with auto ring trip
- Relay driver
- Transformerless 2-2 wire conversion
- Low power consumption
- Mute of incoming audio
- Few external components

### Applications

- Line Interface for:
- PABX
- Intercoms
- Key Systems

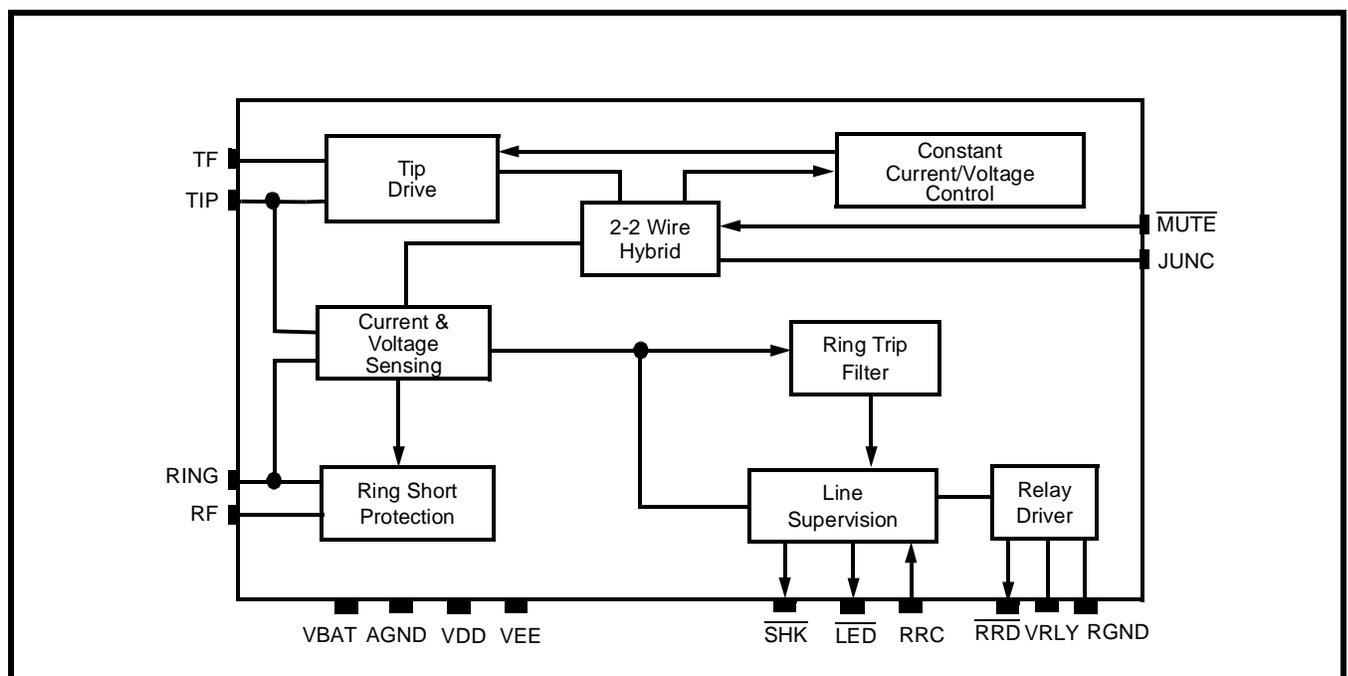
### Ordering Information

MH88510	20 Pin SIL Package
MH88511	20 Pin SIL Package

**0°C to 70°C**

### Description

The Mitel MH88510/11 Subscriber Line Interface Circuit provides a complete interface between the telephone line and a speech switch requiring only single bidirectional switch per crosspoint. The functions provided by the MH88510/11 include bidirectional differential to single ended conversion in the speech path, line battery feed, ringing feed and loop and dial pulse detection. The device is fabricated as a thick film hybrid which incorporates various technologies for optimum circuit board and very high reliability.



**Figure 1 - Functional Block Diagram**

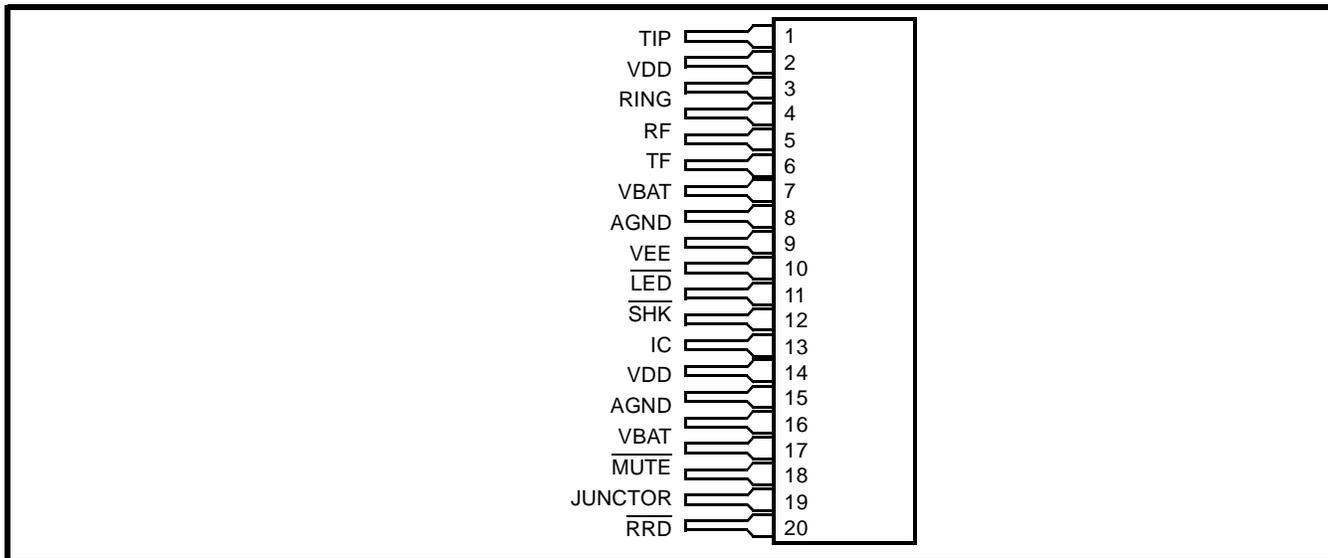


Figure 2 - Pin Connections

## Pin Description

Pin #	Name	Description
1	TIP	<b>Tip Lead.</b> Connects to the “Tip” lead (A-wire) of the telephone line.
2	VDD	<b>Positive Power Supply Voltage.</b> Normally +5V. This provides current for both internal circuitry as well as the loop. Not internally connected to pin 12.
3	RING	<b>Ring Lead.</b> Connects to the “Ring” lead (B-wire) of the telephone line.
4	RF	<b>Ring Feed.</b> Connect to the Ring Relay contact. See Figure 5.
5	TF	Leave open circuit
6	VBAT	<b>Battery Voltage Supply.</b> Normally -24V or -48V. Not internally connected to pin 14.
7	AGND	<b>Analog Ground.</b> Supply and battery ground. Internally connected to pin 13. For optimum performance connect pin 7 to pin 13.
8	$V_{EE}$	<b>Negative Power Supply Voltage.</b> Normally -5V.
9	$\overline{LED}$	<b>LED Drive (Output).</b> Drives an LED directly. A logic low indicates an off-hook condition.
10	$\overline{SHK}$	<b>Switch Hook Detect (Output).</b> A logic low indicates an off-hook condition.
11	IC	<b>Internal Connection.</b> This pin is connected internally
12	$V_{DD}$	<b>Positive Power Supply Voltage.</b> Normally +5V. This provides current for both internal circuitry as well as the loop.
13	AGND	<b>Analog Ground.</b> Supply and battery ground. Internally connected to pin 13. For optimum performance connect pin 13 to pin 7.
14	$V_{BAT}$	<b>Battery Voltage Supply.</b> Normally -24V or -48V. Not internally connected to pin 6.
15	$\overline{MUTE}$	<b>MUTE (Input).</b> A logic low will mute signals coming from Tip-Ring to the JUNC.
16	JUNC	<b>Receive/transmit audio speech path.</b> (Referenced to 0V GND).
17	$\overline{RRD}$	<b>Ring Relay Drive (Output).</b> Connects to the ring relay coil. A logic low activates the relay.
18	RGND	<b>Relay Ground.</b> Return path for relay supply voltage. Normally connected to AGND.
19	RRC	<b>Ring Relay Control (Input).</b> A logic high activates the Ring Relay Drive ( $\overline{RRD}$ ) outputs.
20	VRLY	<b>Relay Positive Supply Voltage.</b> Normally +5V. Connects to the relay coil and the relay supply voltage. An internal clamp diode from VRLY to RGND is provided.

## Functional Description

### The BORSH Functions

The MH88510/11 performs all of the Borsh functions of Battery Feed, Overvoltage Protection, Ringing, Supervision and Hybrid (2-2 Wire).

### Battery Feed

The MH88510/11 powers the telephone set with constant DC loop current for shortlines and automatically reverts to constant voltage for long lines. Since the Tip drive is powered down from the  $V_{DD}$  supply, loop current flows through both the  $V_{BAT}$  supply and the  $V_{DD}$  supply.

### Overvoltage Protection

The MH88510/11 is protected from short term (20ms) transients (+250V) between Tip and Ring, Tip and ground, and Ring and Ground. However additional protection circuitry may be needed depending on the requirements which must be met. Normally, simple external shunt protection as shown in Figures 5 and 6 is all that is required.

### Ringing

The ringing insertion circuitry has the capability to provide ringing voltage to the telephone set by simply adding an external relay, ring generator and a 200 $\Omega$  limiting resistor. The internal relay driver

switches ringing voltage on to the line via the external ring relay. The SLIC provides two internal 300W battery feed resistors through which the ringing current will flow. A clamp diode is included which suppresses voltage transients during relay switching caused by the relay coil. In addition, the circuit prevents connection of the ringing source during off-hook conditions. See figure 5 for typical application.

### Hybrid

The 2-2 Wire hybrid circuit converts the incoming balanced signal at Tip and Ring of the telephone line into a ground referenced output signal at JUNC of the SLIC, and converts the ground referenced input signal at JUNC of the SLIC into a non-balanced output signal at Tip and Ring of the telephone line.

### Line Impedance

The MH88510/11's Tip-Ring( $Z_{in}$ ) impedance is fixed at 600 $\Omega$ . For correct SLIC impedance, JUNC must be appropriately terminated. See **AC Electrical Characteristics**.

### Supervision

The loop detection circuit determines whether a low enough impedance is across Tip and Ring to be recognised as an Off-Hook condition. When an off-hook condition occurs, the  $\overline{SHK}$  and  $\overline{LED}$  outputs toggle to a logic low level. These outputs also toggle during incoming dial pulses.

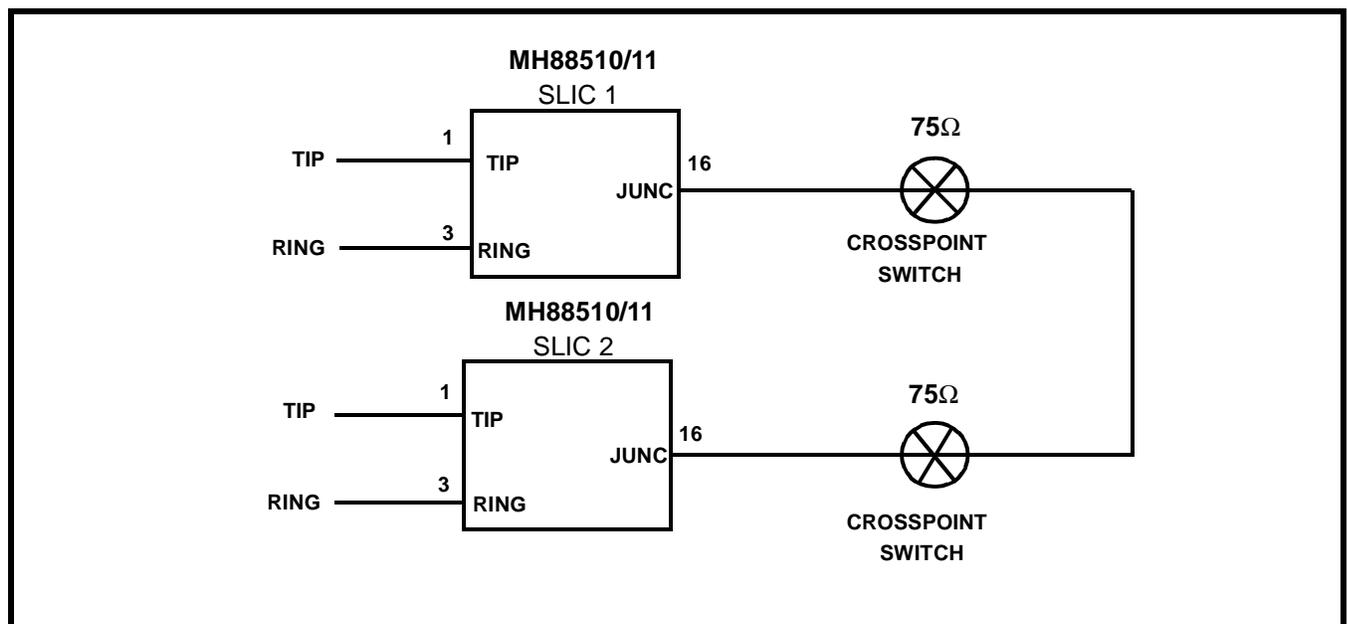


Figure 3 - SLIC Crosspoint Switch Connection

The  $\overline{\text{SHK}}$  output has low drive capability while the  $\overline{\text{LED}}$  output can drive an  $\overline{\text{LED}}$  directly. The detection circuit engages a ringing filter during applied ringing. The ringing filter ensures that the  $\overline{\text{SHK}}$  output toggles at the ringing cadence and not at the ringing frequency. The ring trip detection circuit also prevents false off-hook detection due to the current associated with the AC ringing voltage as well as current transients when the ringing voltage is switched in and out.

## Hybrid

The 2-wire hybrid circuit converts the incoming balanced signal at Tip and Ring of the telephone line into a ground referenced output signal at JUNC of the SLIC, and converts the ground referenced input signal at JUNC of the SLIC into a non-balanced output signal at Tip and Ring of the telephone line.

## Return Loss at Tip-Ring

To maximise return loss, the impedance at Tip-Ring should match the SLIC's impedance ( $600\Omega$ ). However, the SLIC's input impedance is dependent on the JUNC termination resistance. For a  $600\Omega$  SLIC input impedance, the JUNC must be terminated with  $754\Omega$ .

Figure 2 illustrates a typical connection between two SLICs through two crosspoint switches. Optimum return loss occurs when JUNC is terminated with  $754\Omega$ . Since the JUNC input/output is  $604\Omega$  and the crosspoint switches resistance are  $75\Omega + 75\Omega$ , this configuration gives optimum return loss as shown in Figure 3.

## MUTE

A logic low at the MUTE input results in, muted signals coming from Tip and Ring to the JUNC terminal while allowing signals from the JUNC terminal to Tip and Ring to be transmitted.

## Tip-Ring Drive Circuit

The audio input ground referenced signal at JUNC is converted to a differential output signal at Tip and Ring. The output signal consists of the audio signal superimposed on the DC battery feed current. The Tip-Ring drive circuit is optimised for good 2-Wire longitudinal balance.

In addition, the Tip-Ring Drive Circuit has the capability to drive a dry line (a line with no DC current flowing); the AC Electrical Characteristics apply (except for longitudinal balance), even when the loop current drops to zero. Therefore, the MH88510 has the capability to drive a line much longer than  $2000\Omega$  providing the user is not concerned with loop current, SHK detection or ringing generator current.

## Short Circuit Protection

The MH88510 is protected from long term (infinite) short circuit conditions occurring between Tip and Ring, Tip and AGND, and Ring and AGND.

## Line Impedance

The MH88510's Tip-Ring ( $Z_{in}$ ) impedance is fixed at  $600\Omega$ . For correct SLIC impedance, JUNC must be appropriately terminated. See **AC Electrical Characteristics**.

## Transmit and Receive Gain

Transmit Gain (JUNC to Tip-Ring) and Receive Gain (Tip-Ring to JUNC) are fixed. For correct gain, the SLIC input impedance must match the line impedance and JUNC must be appropriately terminated.

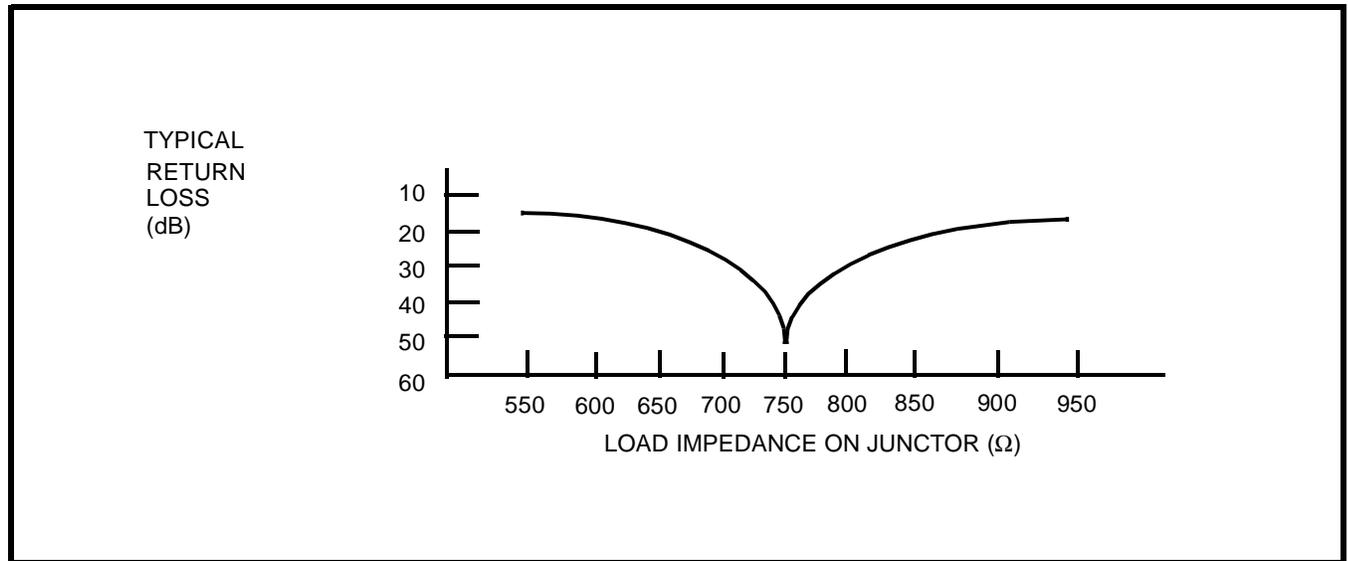


Figure 4 - Return Loss VS Junctor Load Impedance

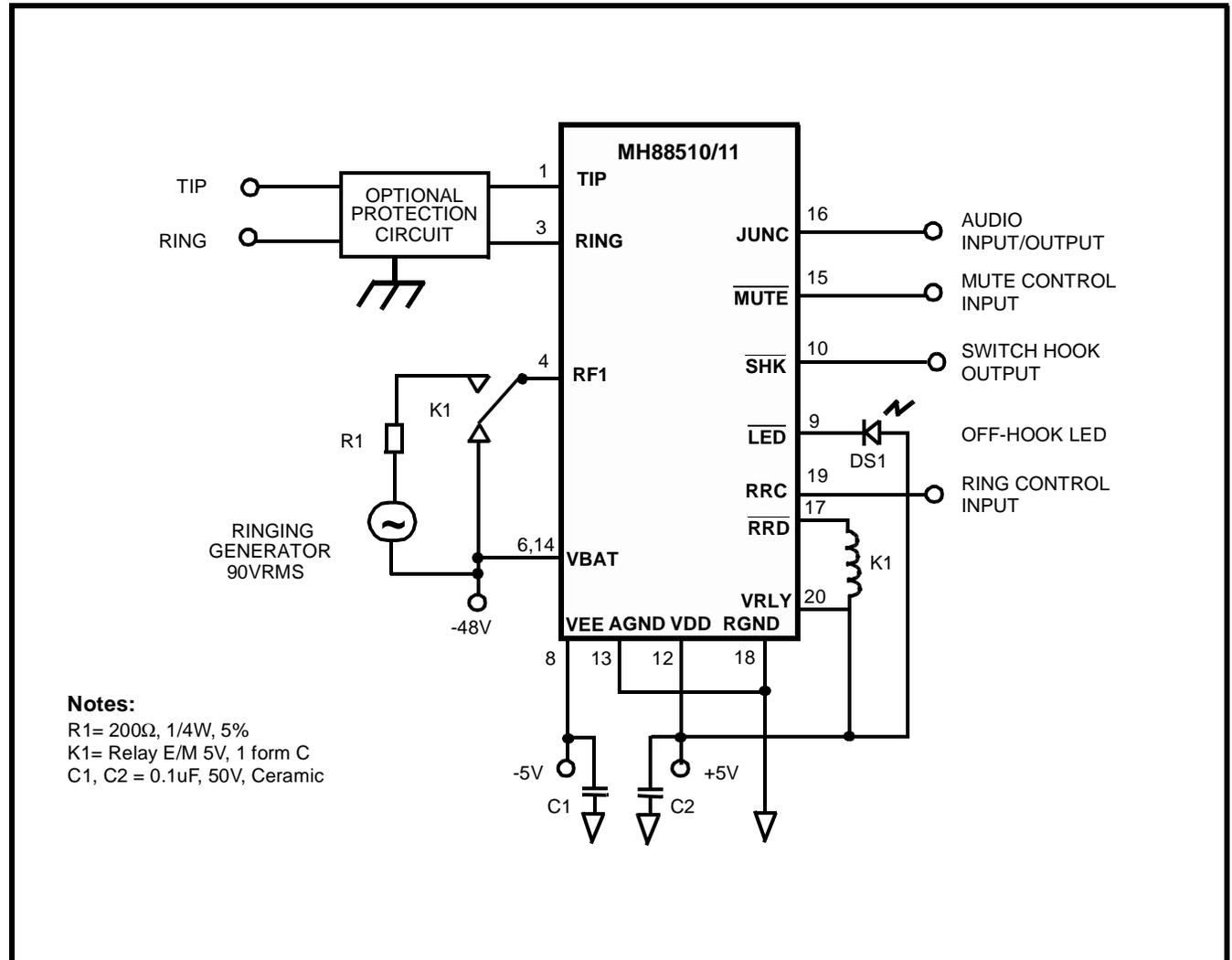


Figure 5 - Typical Application Circuit

Absolute Maximum Ratings<sup>†</sup>

	Parameter	Symbol	Min	Max	Units
1	DC Supply Voltage	$V_{DD}$ $V_{EE}$	-0.3 0.3	15 -15	V V
2	DC Battery Voltage	$V_{BAT}$	0.3	-60	V
3	DC Relay Voltage	$V_{RLY}$	-0.3	20	V
4	AC Ring Generator Voltage			150	$V_{RMS}$
5	Storage Temperature	$T_S$	-55	125	°C

<sup>†</sup> Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied.

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	DC Supply Voltage	$V_{DD}$ $V_{EE}$	4.75 -4.75	5.0 -5.0	7.35 -8.40	V V	
2	DC Battery Voltage	$V_{BAT}$	-23	-48	-56	V	
3	DC Relay Voltage	$V_{RLY}$		5.0	15	V	
4	AC Ring Generator Voltage Ringing Generator Frequency		17	90	105 33	$V_{RMS}$ Hz	
5	Operating Temperature	$T_{OP}$	0		70	°C	

<sup>‡</sup> Typical figures are at 25°C with nominal  $\pm 5V$  supplies and are for design aid only: not guaranteed and not subject to production testing.

DC Electrical Characteristics<sup>†</sup>

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Supply Current: Open Loop	$I_{DD}$ $I_{EE}$ $I_{BAT}$			15 15 15	mA mA mA	$R_{LOOP} = \text{Open}$
	Normal Loop	$I_{DD}$ $I_{EE}$ $I_{BAT}$			43 15 43	mA mA mA	$R_{LOOP} = 1000\Omega$
	Short Loop	$I_{DD}$ $I_{EE}$ $I_{BAT}$			43 15 43	mA mA mA	$R_{LOOP} = 0\Omega$
2	Power Consumption <sup>①</sup> : Open Loop	PC			880	mW	$R_{LOOP} = \text{Open}$
	Normal Loop	PC			2360	mW	$R_{LOOP} = 1000\Omega$
	Short Loop	PC			2360	mW	$R_{LOOP} = 0\Omega$
3	Low Level Output Voltage <sup>②</sup>	$V_{OL}$	-3.0			V	$I_{OL} = 2\mu A$
	High Level Output Voltage	$V_{OH}$	3.0			V	$I_{OH} = 2\mu A$
4	Sink Current, $\overline{\text{LED}}$ to AGND <sup>②</sup>	$I_{OL}$	0.6			mA	$V_{OL} = -1.5V$
	Sink Current, $\overline{\text{LED}}$ to VDD	$I_{OH}$	2.5			mA	$V_{OL} = 3.25V$
5	Sink Current, Relay to VDD	$I_{OL}$	100			mA	$V_{OL} = 0.35V$
	Clamp Diode Current	$I_{CD}$	150			mA	
6	High Level Input Voltage <sup>③</sup>	$V_{IH}$	3.5			V	$I_{IL} = 1.0mA$
7	Low Level Input Voltage <sup>④</sup>	$V_{IL}$			0.8	V	$I_{IL} = 0.5mA$

<sup>†</sup> DC Electrical Characteristics are over recommended operating conditions with  $V_{DD}$  at +5.0V and  $V_{EE}$  at -5V  $\pm 5\%$  unless otherwise stated.

<sup>‡</sup> Typical figures are at 25°C with nominal  $\pm 5V$  supplies and are for design aid only: not guaranteed and not subject to production testing.

<sup>①</sup> Supply Current and Power Consumption characteristics are over recommended operating conditions with  $V_{DD}$  at 5.0V,  $V_{EE}$  at -5.0V and  $V_{BAT}$  at -48V. Note that loop current flows through both the  $V_{BAT}$  and the  $V_{DD}$  supply.

<sup>②</sup>  $\overline{\text{SHK}}$  output consists of a 100k $\Omega$  resistor in series with an op-amp with a minimum output voltage swing of  $\pm 3.25V$ .

<sup>③</sup> LED outputs consists of a 2.5k $\Omega$  resistor in series with SHK op-amp output.

RRC input consists of a 5k $\Omega$  resistor in series with the base lead of the relay driver transistor (grounded emitter).

<sup>④</sup> The MUTE input is internally pulled up. With no input connection, the voltage level at the MUTE input is typically at 1.5V.

## AC and DC Loop Electrical Characteristics\*

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Maximum AC Ringing Current Rejection ①		44			mA	
2	Ring Trip Detect Time				125	ms	
3	Operating Loop Current $V_{BAT} = -48V$ $V_{BAT} = -23V$	$I_{IP}$	18 18	23 23	28 28	mA mA	$R_{Loop} < 2000\Omega$ $R_{Loop} < 600\Omega$
4	Maximum Operating Loop Resistance ② $V_{BAT} = -48V$ $V_{BAT} = -23V$	$R_{IP}$	2000 600			$\Omega$ $\Omega$	$I_{Loop} = 18mA$ $I_{Loop} = 18mA$
5	Loop Current at Off-Hook Detect Threshold	$I_{SH}$	8 9	10 11	12 13	$\mu A$ $\mu A$	$V_{DD} = 5.0V, V_{EE} = -5.0V$ $V_{DD} = 7.0V, V_{EE} = -8.0V$

\* AC and DC Loop Electrical Characteristics are over recommended operating conditions unless otherwise stated.

‡ Typical figures are at 25°C with nominal  $\pm 5V$  supplies and are for design aid only.

① The SLIC can be loaded with an AC impedance as low as  $2200\Omega$  without generating a false  $\overline{SHK}$  output. Since each REN represents  $8k\Omega$ , the SLIC can drive a REN of 3.6 without generating a false SHK output.

② See section on Tip-Ring Drive Circuit for driving longer lines.

## AC Electrical Characteristics

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Return Loss at 2-Wire		20	30		dB	Reference $600\Omega$ @ 1kHz
2	Impedance at Junctor			604		$\Omega$	
3	Longitudinal to Metallic Balance		50	60		dB	40Hz - 4kHz
4	Longitudinal to Junctor Balance		50	60		dB	40Hz - 4kHz
5	Signal Output Overload Level at 2-Wire at Junctor		3.5 3.5			dBm dBm	% THD $\leq 5\%$ Reference: $600\Omega$ Reference: $754\Omega$
6	Total Harmonic Distortion at 2-Wire at Junctor	THD			1.0 1.0	% %	Input 0.5V 1kHz
7	Idle Channel Noise at 2-Wire at Junctor	Nc			12 12	dBrcn dBrcn	Reference: $600\Omega$ Reference: $754\Omega$
8	Power Supply Rejection Ratio at 2-Wire and Junctor $V_{DD}$ $V_{EE}$ $V_{BAT}$	PSRR		25 25 25		dB dB dB	Ripple 0.1V 1kHz
9	Mute Attenuation		30			dB	Input 0.5V MUTE = 0.0V @1kHz

‡ Typical figures are at 25°C with nominal  $\pm 5V$  supplies and are for design aid only.

**AC Gains Table - MH88510**

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Gain 2-Wire to Junctor		1.05 0.42	1.12 0.98	1.19 1.51	V/V dBV	Input 0.5V 1kHz Input 0.5V 1kHz
2	Frequency Response Gain (relative to gain at 1kHz)		-0.3		0.3	dB	200Hz - 3400Hz
3	Gain Junctor to 2-Wire		0.96 -0.35	1.00 0.0	1.04 0.35	V/V dBV	Input 0.5V 1kHz Input 0.5V 1kHz
4	Frequency Response Gain (relative to gain at 1kHz)		-0.3		0.3	dB	200Hz - 3400Hz

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

**AC Gains Table - MH88511<sup>†</sup>**

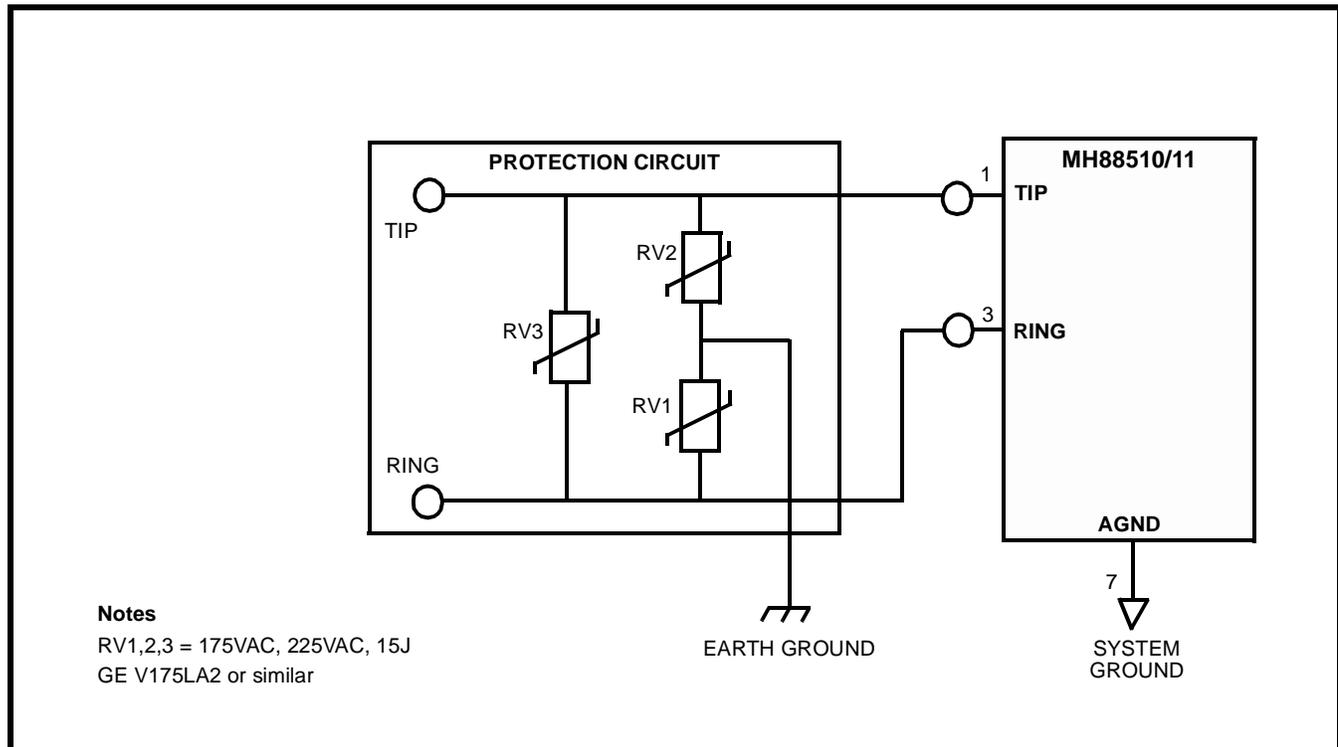
	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Gain 2-Wire to Junctor		1.15 0.21	1.19 1.50	1.22 1.72	V/V dBV	Input 0.5V 1kHz Input 0.5V 1kHz
2	Frequency Response Gain (relative to gain at 1kHz)		-0.3		0.3	dB	200Hz - 3400Hz
3	Gain Junctor to 2-Wire		1.04 0.34	1.08 0.67	1.11 0.91	V/V dBV	Input 0.5V 1kHz Input 0.5V 1kHz
4	Frequency Response Gain (relative to gain at 1kHz)		-0.3		0.3	dB	200Hz - 3400Hz

† AC Electrical Characteristics are over recommended operating conditions unless otherwise stated.

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

Note1: All of the above test conditions use 754Ω connected between JUNC and GRD, and 600W connected between Tip and Ring unless otherwise stated.

Note 2: All of the above test conditions use 200Hz to 6400Hz unless otherwise stated.



**Figure 6 - Typical Protection Circuit**

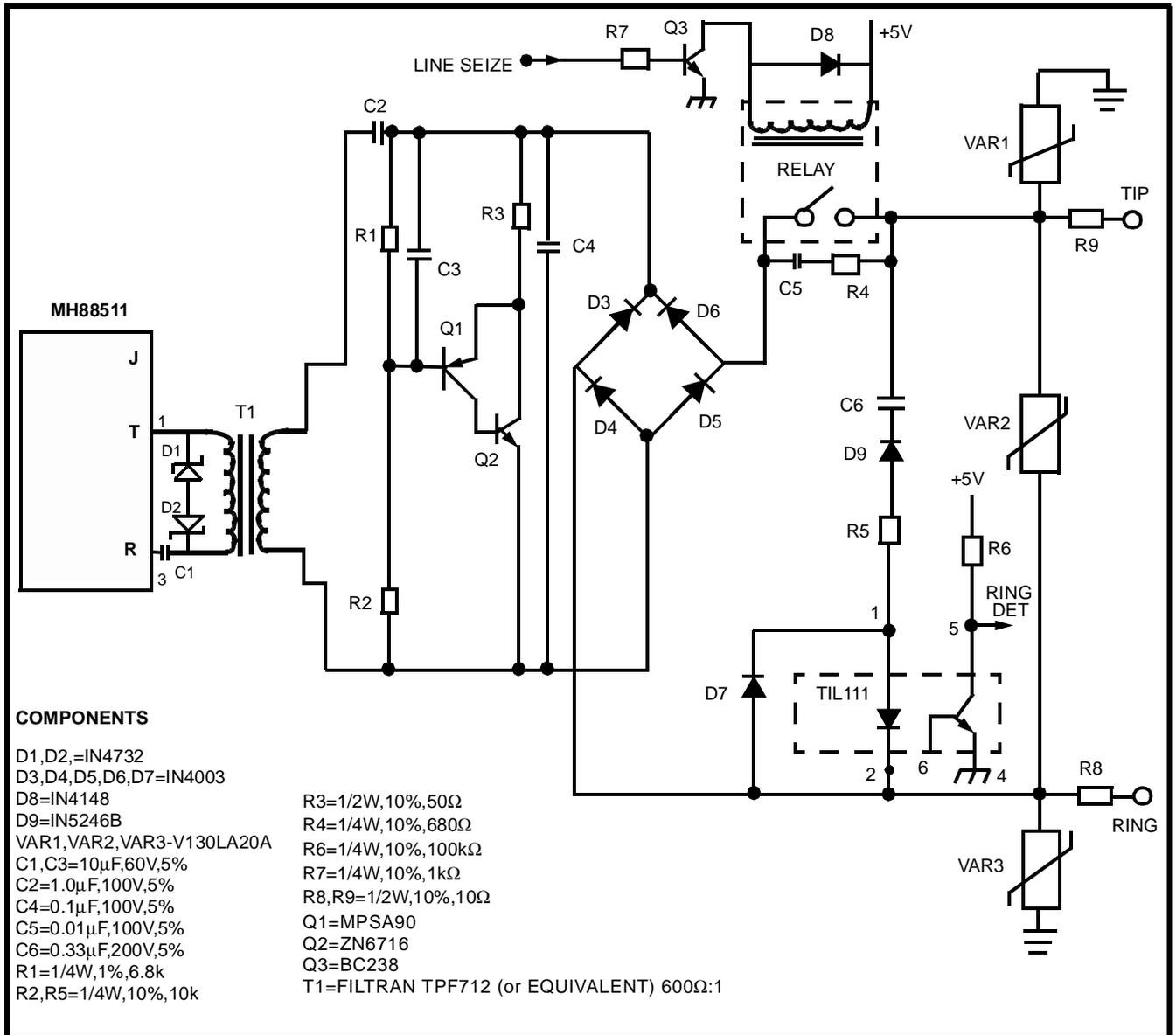


Figure 7 - MH88511 as a Trunk Interface Application

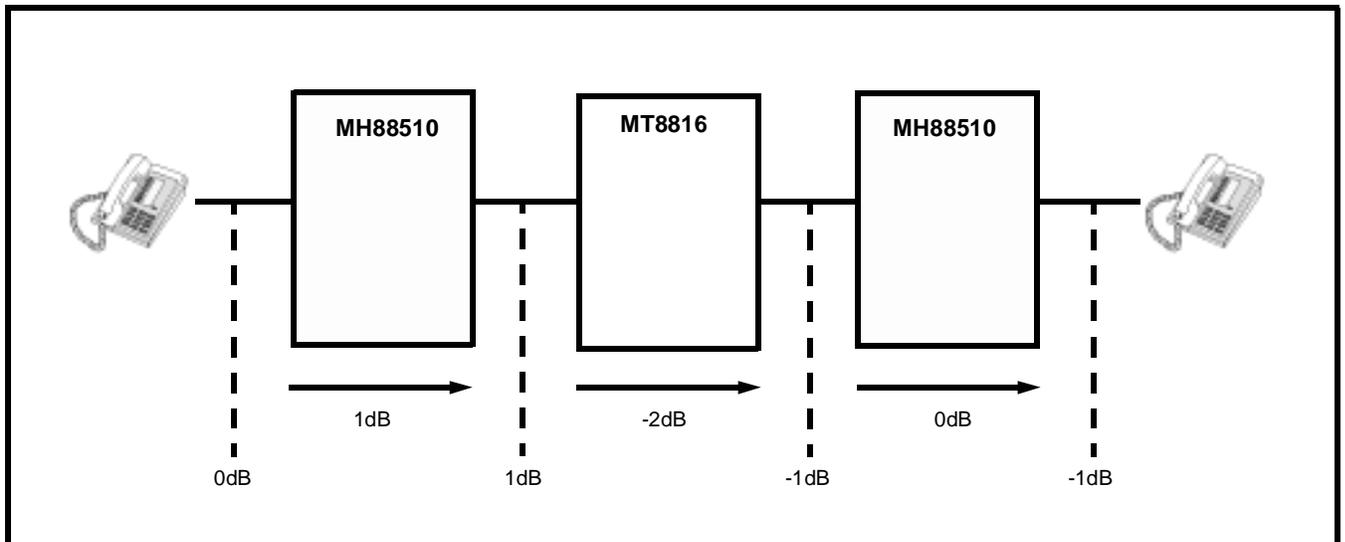


Figure 8a - Line to Line

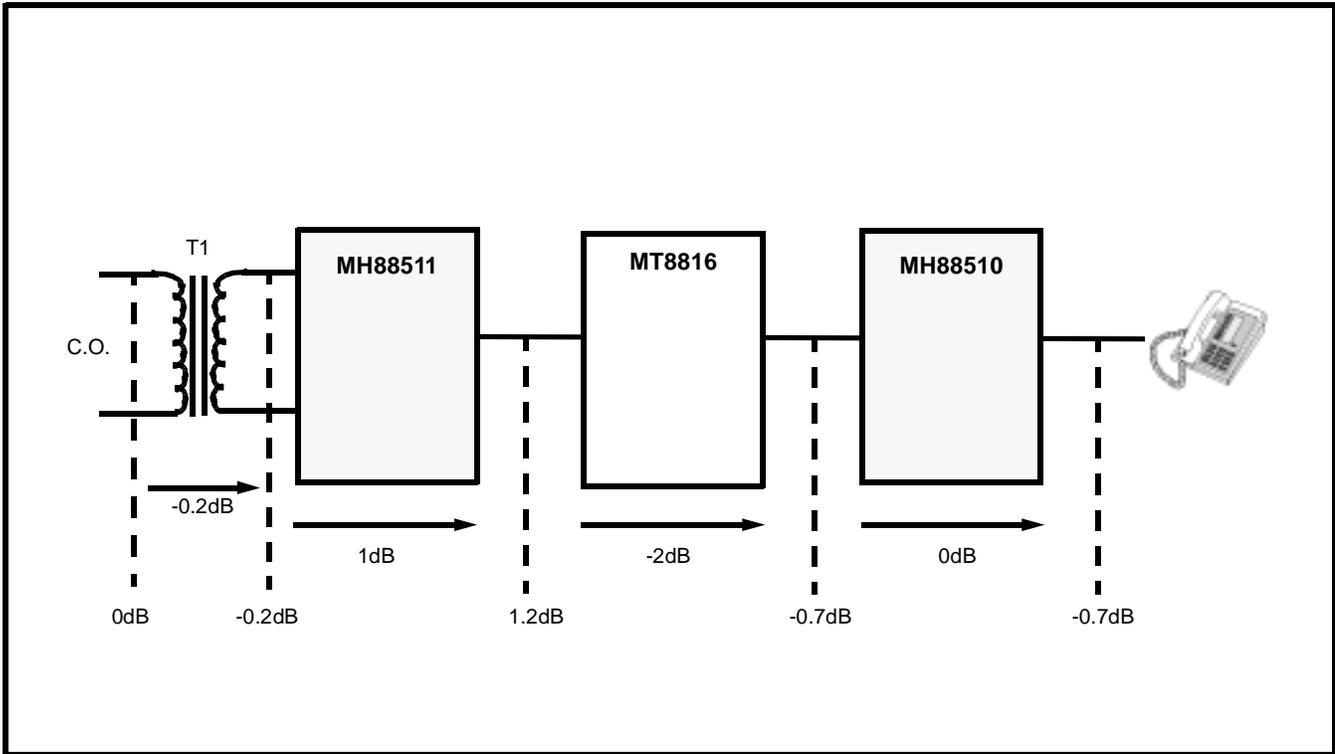


Figure 8b- Line to Line

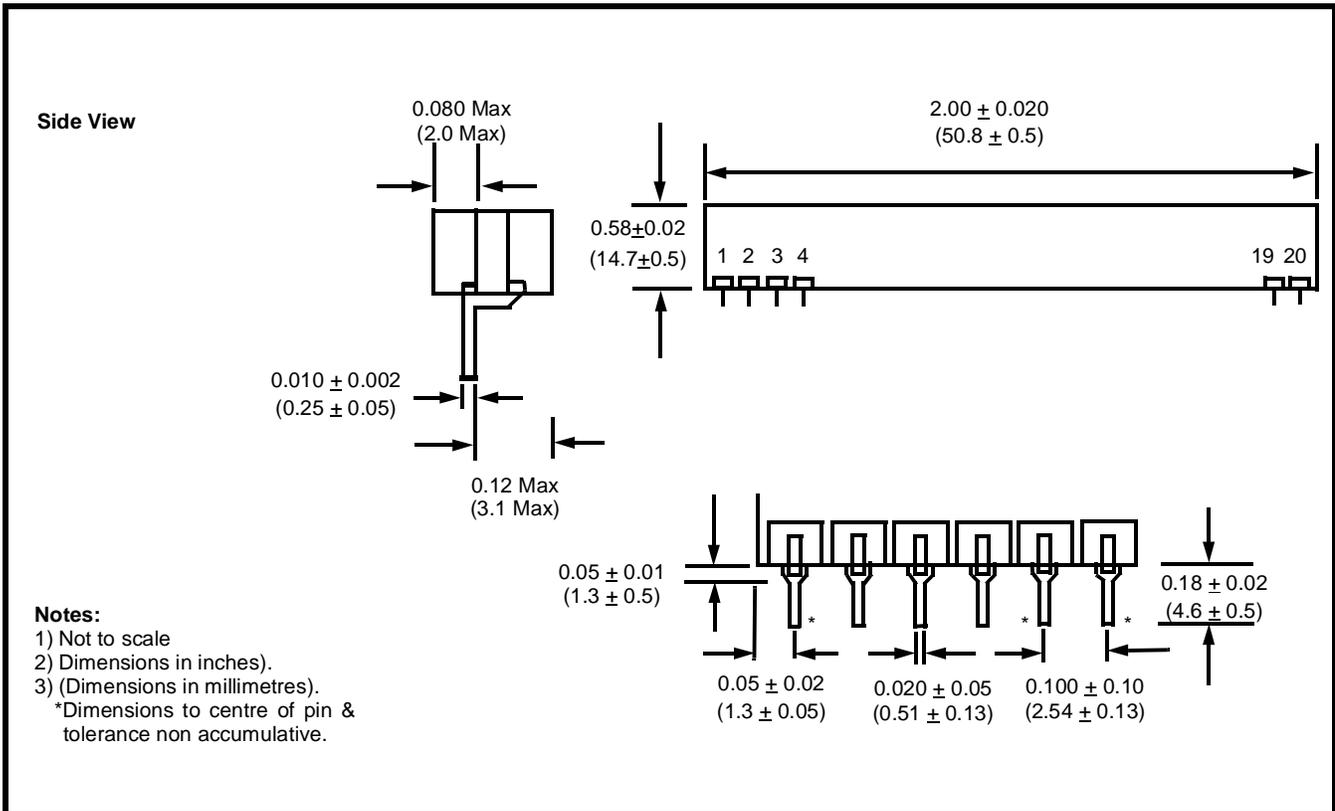


Figure 9 - Mechanical Data