

### Features

- FAX and Modem interface
- Suitable for V.29 FAX & V.22 bis Data
- Allows caller identification
- Variants match German, UK, 600Ω & 900Ω network impedances
- Isolation circuitry conforms to international PTT requirements
- Transformerless 2-4 Wire conversion
- Loop start operation
- Pulse and DTMF operation
- Accommodates external monitor phone
- Line state detection outputs:
  - loop current/ringing outputs
  - monitor phone switch hook
- Single +5V operation

### Applications

Interface to Central Office for:

- DAA
- Modem
- FAX
- Answering Machine
- Terminal Equipment

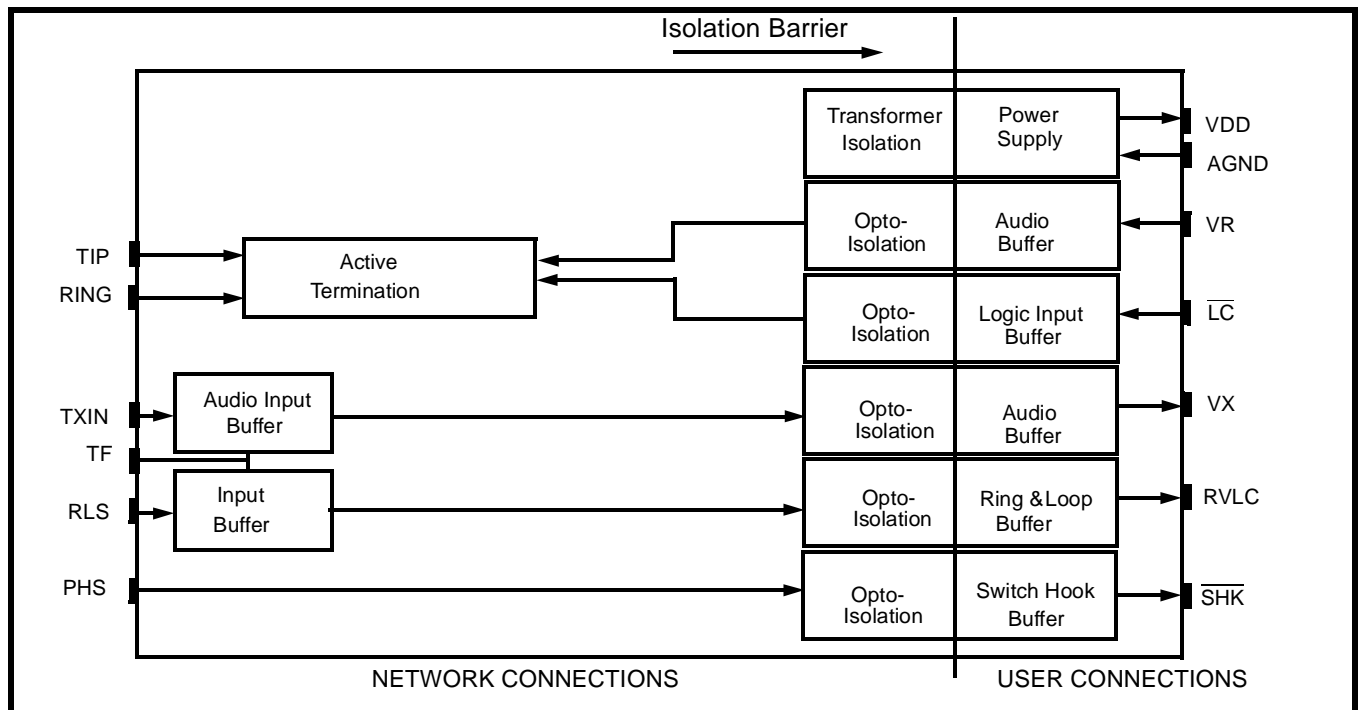
### Ordering Information

MH88400-1 14 Pin DIL Package  
 MH88400-2 14 Pin DIL Package  
 MH88400-3 14 Pin DIL Package  
**0°C to 70°C**

### Description

The Mitel MH88400 Line Interface Circuit provides a complete audio and signalling link between audio equipment and central office. The functions provided by the MH88400 include 2-4 Wire conversion, loop seizure, external monitor phone switch hook status and ringing voltage and loop current detection. The device is fabricated as a thick film hybrid which incorporates various technologies for optimum circuit design, high voltage isolation and very high reliability.

Variants are provided to meet German (-1) and UK (-3) and general 600Ω (-2) line impedance (see section on Line Impedances).



**Figure 1 - Functional Block Diagram**

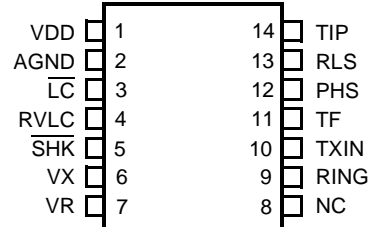


Figure 2 - Pin Connections

## Pin Description

Pin #	Name	Description
1	VDD	<b>Positive Power Supply Voltage.</b> +5V.
2	AGND	<b>Analog Ground.</b> 4-Wire Ground. Normally connected to System Ground,
3	$\overline{\text{LC}}$	<b>Loop Control (Input).</b> A logic low activates internal circuitry which provides a dc termination across Tip and Ring. Used for seizing the line and dial pulsing
4	RVLC	<b>Ring Voltage and Current Detect (Output).</b> A logic low indicates that loop current is detected. The loop current can be due to the external monitor phone or the MH88400 in the off-hook mode. The RVLC outputs pulses when the external monitor phone is dial pulsing or when the MH88400 is dial pulses via the LC input. In addition, when the MH88400 is in the on-hook mode, a pulsing output indicates that ringing voltage is across the Tip and Ring leads; the pulsing outputs frequency is twice the ringing frequency.
5	$\overline{\text{SHK}}$	<b>Switch Hook Detect (Output).</b> This is an optional output which can be used with the PHS input and an external phone. When loop current flows from PHS to TIP, $\overline{\text{SHK}}$ goes to logic low.
6	VX	<b>Transmit (Output).</b> 4-Wire ground(AGND) referenced audio output, biased at 2.5V. Outputs for both off-hook and on-hook.
7	VR	<b>Receive (Input).</b> 4-Wire ground (AGND) referenced audio input, biased at 2.5V. $\overline{\text{LC}}$ must be activated low and loop current must be flowing.
8	NC	<b>No Connection.</b> This pin is not connected internally
9	RING	<b>Ring Lead.</b> Connects to the "Ring" lead of the central office through a relay contact. The central office "Tip" and "Ring" leads may be interchanged
10	TXIN	<b>Transmit (Input).</b> Connects to the "Ring" lead of the central office through a coupling capacitor.
11	TF	<b>Tip Feed.</b> Connects to the "Tip" lead of the central office through an internal resistor and an optional external resistor.
12	PHS	<b>Monitor Phone Sense (Input).</b> This is an optional input which can be used with the $\overline{\text{SHK}}$ output and an external phone. When loop current flows from PHS to TIP, $\overline{\text{SHK}}$ goes to logic low.
13	RLS	<b>Ring Loop Sense (Input).</b> Sense node for ringing voltage detector and the loop current detector.
14	TIP	<b>Tip Lead.</b> Connects to the "Tip" lead of the central office through an optional relay contact. The central office "Tip" and "Ring" leads may be interchanged.

## Functional Description

The MH88400 Line Interface Circuit is a COIC (Central Office Interface Circuit) used to interface FAX's Modems or user defined equipment to Central Office 2-Wire Analog Trunks.

## Opto-Isolation

The isolation barrier is designed to meet regulatory requirements for a reinforced barrier of 3kVac. It provides full isolation of mains voltages up to 250V RMS and all telecom voltages. In order that this barrier is not bypassed a creepage/clearance distance of 6.4mm minimum must be maintained between wiring, pcb tracking, etc., connected to external circuitry on either side of the barrier. To make this requirement simpler, pins on the MH88400 connected to opposite sides of the barrier are on opposite sides of the package.

## External Protection Circuit

To meet regulatory high voltage requirement, an external protection circuit is required. The protection circuit shown in Figure 3 (Clamp Diode D1) is recommended.

## DC Loop Termination

The DC loop termination circuitry provides the loop with an active DC load termination when a logic low is applied to the  $\overline{LC}$  (Loop Control) input. The termination is simpler to a resistance of approximately  $300\Omega$  (loop current dependant). Internal optically isolated circuitry is used to switch the termination in and out the loop. This is used for both seizing the line as well as generating dial pulses.

## Supervision Features

The supervision circuitry is capable of detecting ringing voltage and loop current as well as the status of an optional external monitor phone. The RVLC (Ring Voltage Loop Current Detect) output provides a logic low when loop current due to the external monitor phone or due to the MH88400 being in the off-hook mode is detected.

The RVLC outputs pulses when the external monitor phone is dial pulsing or when the MH88400 is dial pulsing via the LC mode.

In addition, when the MH88400 is in the on-hook mode, a pulsing output indicates that ringing voltage is across the tip and ring leads; the pulsing output frequency is twice the ringing frequency. See Figure 3.

Ringing frequency may require external validation. An RC monostable is usually satisfactory for this purpose or this may also be achieved using software applications.

## 2-4 Wire Conversion

The 2-4 Wire conversion circuit converts the balanced full duplex signal at Tip and Ring of the central office line into a transmit ground referenced signal at VX (Transmit) of the MH88400. It also converts the receive ground referenced signal at VR (Receive) of the MH88400 into a balanced transmit signal at Tip and Ring of the central office line.

In full duplex transmission, the Tip-Ring signal consists of an audio signal from the central office as well as an audio signal due to the VR input. Consequently, both of these signals will appear at the VX output. The degree to which the 2-4 wire conversion circuit minimizes the contribution of the VR signal at the VX output is specified as transhybrid loss (THL).

A simple THL cancellation circuit as shown in figure 7 can be used for certain applications to give the required VX/VR signal separation. The MH88400 is then suitable to drive a COMBO 2 CODEC or a VLSI MODEM device.

## Line Impedance

The MH88400 is suitable to drive a COMBO 2 CODEC or a VLSI modem device. The MH88400 provides a fixed Tip-Ring impedance which conforms to the following PTT requirements.

MH88400-1	$Z_{in} = 200 + 820 // 115nF$ Germany FTZ
MH88400-2	$600\Omega$
MH88400-3	$Z_{in} = 370 + 620 // 310nF$ UK BSI

**Absolute Maximum Ratings\*** - All voltages are with respect to AGND unless otherwise specified.

	Parameter	Symbol	Min	Max	Units
1	DC Supply Voltage	$V_{DD}$	-0.3	6	V
2	Storage Temperature	$T_S$	-55	+80	°C
3	DC Loop Voltage	$V_{BAT}$	-100	+100	V
4	Ringing Voltage	$V_R$	-	120	$V_{RMS}$
5	Loop Current	$I_{Loop}$	-	90	mA

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

**Recommended Operating Conditions**

	Parameters	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	DC Supply Voltages	$V_{DD}$	4.5	5.0	5.5	V	
2	Operating Temperature	$T_{OP}$	0		70	°C	
3	Ringing Voltage	$V_R$		75		$V_{RMS}$	$V_{BAT}=-48V$

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

**Loop Electrical Characteristics\***

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Ringing Voltage No Detect Detect	$V_R$	27		20	$V_{RMS}$ $V_{RMS}$	
2	Ringing Frequency		15		68	Hz	
3	On-Hook 2-wire Impedance			40k		$\Omega$	1kHz
4	Operating Loop Current		10		80	mA	
5	Operating Loop Resistance				4000	$\Omega$	$V_{BAT}=-48V, I_{Loop}=10mA$
6	Off-Hook DC Resistance -1 & -2 Variants -3 Variant		310 160	350 300 250 400	480 480 300 450	$\Omega$ $\Omega$ $\Omega$ $\Omega$	$I_{Loop}=20mA$ $I_{Loop}=40mA$ $I_{Loop}=40mA$ $I_{Loop}=20mA$
7	Leakage Current (2-Wire to AGND)				10	$\mu A$	$100V_{DC}$
8	Leakage Current on Hook (Tip to Ring)			9	10	$\mu A$	$V_{BAT}=50V$
9	DC Resistance during dialling -1 variant			200	220	$\Omega$	$I_{Loop}=20-40mA$
10	Dial Pulse Distortion ON Off		0	+4 0	+8 +2	ms ms	

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

‡ Typical figures are at 25°C and are for design aid only.

Note: All of the above characteristics use a test circuit as per Figure 3.

## DC Electrical Characteristics †

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Supply Current	I <sub>DD</sub>		15		mA	V <sub>DD</sub> = 5.0V, I <sub>Loop</sub> =40mA
2	Power Consumption	PC		75		mW	V <sub>DD</sub> = -5.0V, I <sub>Loop</sub> =40mA
3	Low Level Output Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 1.0mA
	High level Output Voltage	V <sub>OH</sub>	3.8			V	I <sub>OH</sub> = 1.0mA
4	Low Level Input Voltage	V <sub>IL</sub>			0.9	V	V <sub>IH</sub> = 5.0V V <sub>IL</sub> = 0.0V
	High level Input Voltage	V <sub>IH</sub>	3.5			V	
5	High Level Input Current	I <sub>IH</sub>			0.6	mA	
	Low Level Input Current	I <sub>IL</sub>			1	μA	

† DC 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.

Note: See figure 3a and 3b.

AC Electrical Characteristics<sup>†</sup> - MH88400 All Variants

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	Input Impedance VR			47		kΩ	
2	Output Impedance at VX			5		Ω	
3	Transmit Gain (2-Wire to VX)			-0.4		dB	Input 0.5V at 1kHz off-hook
4	Frequency Response Gain (relative to Gain @ 1kHz)			-2.4 -3.0		dB dB	300 Hz 3400 Hz
5	Receive Gain (VR to 2-wire)			3.5		dB	Input 0.5V at 1kHz
6	Frequency Response Gain (relative to Gain @ 1kHz)			0 0		dB dB	300 Hz 3400 Hz
7	Signal Output Overload Level						THD ≤5% @ 1kHz I <sub>Loop</sub> =10-40mA
	at 2-Wire			-3.0 0.0 +2.0		dBm dBm dBm	V <sub>DD</sub> =4.5V V <sub>DD</sub> =5.0V V <sub>DD</sub> =5.5V
	at Vx			-3.0 0.0 +2.0		dBm dBm dBm	V <sub>DD</sub> =4.5V V <sub>DD</sub> =5.0V V <sub>DD</sub> =5.5V
8	Total Harmonic Distortion at 2-wire at VX	THD		0.9 1.2		% %	Input 0.5V at 1kHz DC loop = 1000Ω V <sub>DD</sub> =5.0V
9	Power Supply Reject Ratio at 2-wire at VX	PSRR		35 10		dB dB	Ripple 0.1V, 1kHz on V <sub>DD</sub>

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

‡ Typical figures are at 25°C and are for design aid only.

Note 1: All of the above characteristics use a test circuit as per Figure 3.

Note 2: All of the above test conditions use a test source impedance which matches the device's impedance.

Note 3: dBm is referenced to 600Ω unless otherwise stated.

Note 4: THD is measured with a "Weight" filter.

**AC Electrical Characteristics<sup>†</sup> - MH88400-1**

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	2-Wire input Impedance (200Ω + 820Ω //115nF)	Zin		900		Ω	@ 1kHz
2	Return Loss at 2-Wire (200Ω + 820Ω //115nF)	RL	20	22		dB	300-500Hz
			20	24		dB	500-2500Hz
			20	26		dB	2500-3400Hz
3	Longitudinal to Metallic Balance		40	65		dB	50-300Hz
			55	60		dB	300-1000Hz
			53	60		dB	1000-4000Hz
4	Idle Channel Noise at 2-Wire At VX	Nc		-84	-78	dBmp	
				-81		dBmp	

<sup>†</sup> AC Electrical Characteristics are over Recommended Operating Conditions unless otherwise stated.

<sup>‡</sup> Typical figures are at 25°C and are for design aid only.

Note 1: All of the above characteristics use a test circuit as per Figure 3.

Note 2: All of the above test conditions use a test source impedance which matches the device's impedance.

Note 3: dBm is referenced to 600Ω unless otherwise stated.

Note 4: THD is measured with "Weight" filter.

**AC Electrical Characteristics<sup>†</sup> - MH88400-2**

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	2-Wire Input Impedance -2 (600Ω)	Zin		600		Ω	@ 1kHz
2	Return Loss at 2-Wire (Reference -2 =600Ω)	RL	20	24		dB	300-3400Hz
3	Longitudinal to Metallic Balance		50	60		dB	300-3400Hz
4	Idle Channel Noise at 2-Wire at VX	Nc		-84	-78	dBmnp	
				-81		dBmnp	

<sup>†</sup> AC Electrical Characteristics are over Recommended Operating Conditions unless otherwise stated.

<sup>‡</sup> Typical figures are at 25°C and are for design aid only.

**AC Electrical Characteristics<sup>†</sup> - MH88400-3**

	Characteristics	Sym	Min	Typ <sup>‡</sup>	Max	Units	Test Conditions
1	2-Wire Input Impedance (370Ω + 620Ω // 310nF)	Zin		700		Ω	@ 1kHz
2	Return Loss at 2-Wire (370Ω + 620Ω // 310nF)	RL	18	20		dB	200-2400Hz
3	Longitudinal to Metallic Balance		50	60		dB	300-3400Hz
4	Idle Channel Noise at 2-Wire at VX	Nc		-80	-70	dBmp	
				-80	-70	dBmp	

<sup>†</sup> AC Electrical Characteristics are over Recommended Operating Conditions unless otherwise stated.

<sup>‡</sup> Typical figures are at 25°C and are for design aid only.

Note 1: All of the above characteristics use a test circuit as per Figure 3.

Note 2: All of the above test conditions use a test source impedance which matches the device's impedance.

Note 3: dBm is referenced to 600Ω unless otherwise stated.

Note 4: THD is measured with "weight" filter.

However, by adding external resistors to the VX output, the Transmit Gain can be reduced as shown in Figure 5. To limit the output current drawn, the minimum recommended resistance to ground is 2kΩ.

### TIP-RING Drive Circuit

The audio input ground (AGND) referenced signal at VR, biased at 2.5V, is converted to a balanced output signal at Tip-Ring. 2-4 wire isolation is achieved through optical isolation. The LC input is activated, low, and loop current must be flowing.

### TIP-RING Receive Circuit

The differential audio signal at Tip-Ring is converted to a ground (AGND) referenced signal, biased at 2.5V, at the VX output. 2-4 Wire isolation is achieved through a combination of optical isolation and transformerler isolation. The receive circuit operated with or without loop current and LC can be either high or low. Signal reception with no loop current can be used for on-hook reception of, for example, caller identification signals.

### Transmit Gain

Transmit Gain (Tip-Ring to VX) is fixed as indicated in “AC Electrical Characteristics”.

Overall Transmit Gain =

$$-0.4 \text{ dB} + 20\log (R4 / (R4 + R3))$$

The output impedance of the VX output is about 5Ω, therefore, with two external 1kΩ resistors configured as per Figure 5, this will result in 6dB of attenuation for a total gain of -6.4dB. For correct gain, the MH88400 input impedance must match the line impedance.

### Receive Gain

Receive Gain (VR to Tip-Ring) is fixed as indicated in “AC Electrical Characteristics”. However, by adding a single external resistor in series with the VR input, the Receive Gain can be reduced.

Overall Receive Gain =

$$3.5\text{dB} + 20\log (47\text{k}\Omega / (47\text{k}\Omega + R_{ext})),$$

The input impedance of the VR input is 47kΩ, therefore, an external 100kΩ resistor in series with this input will result in 9.9dB of attenuation for a total gain of -6.4dB.

For correct gain, the MH88400 input impedance must match the line impedance.

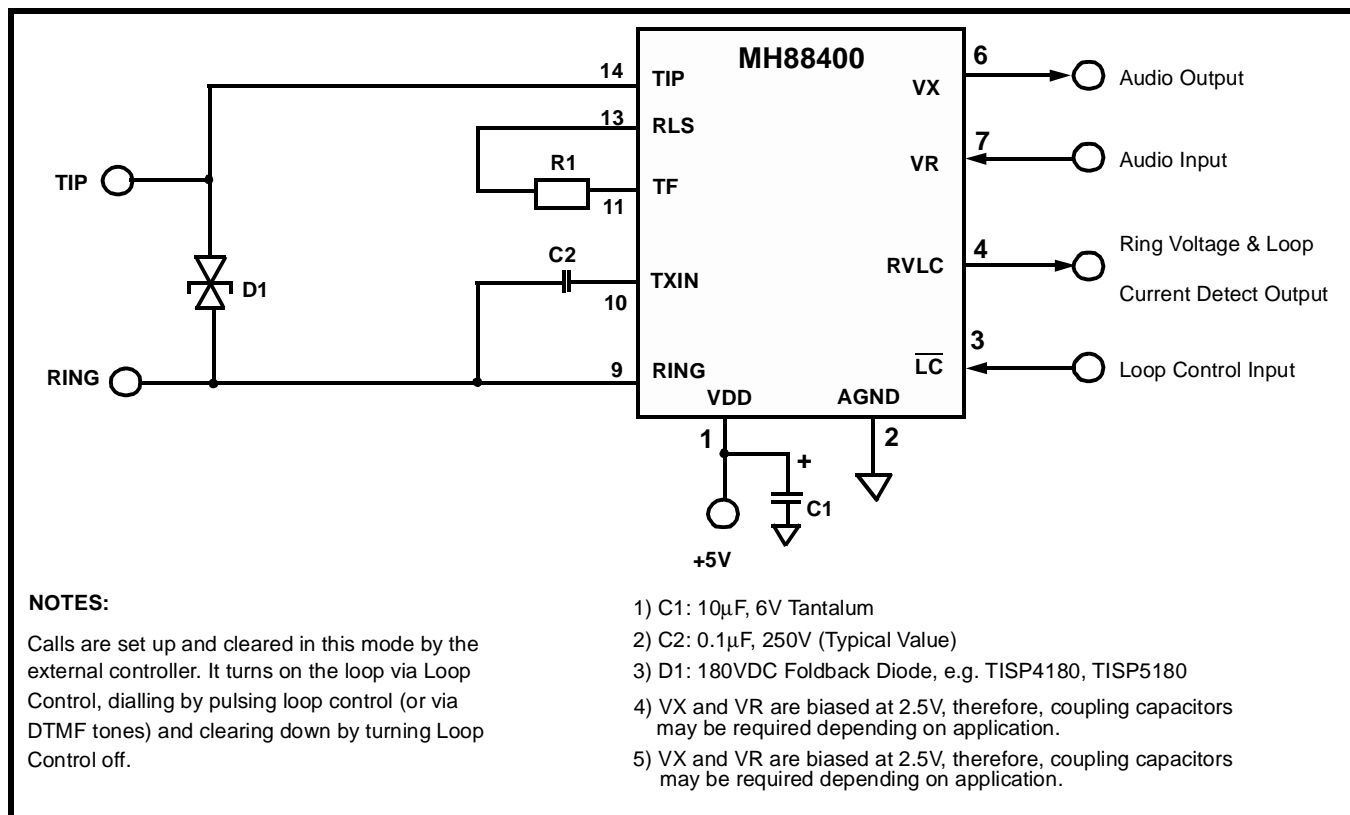


Figure 3 - Typical Application Circuit

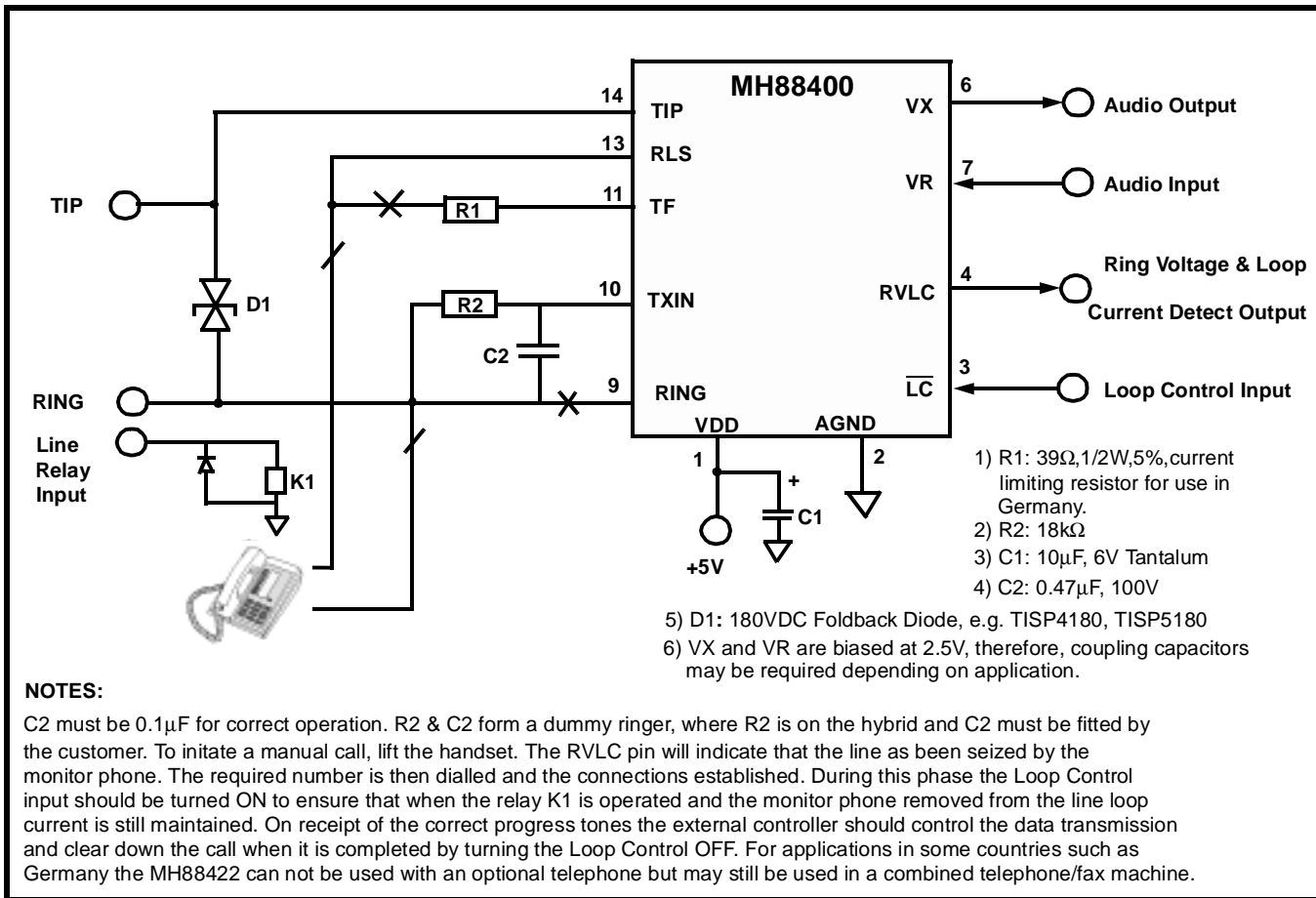


Figure 4 - Typical Application Circuit with Dummy Ringer and Monitor Phone

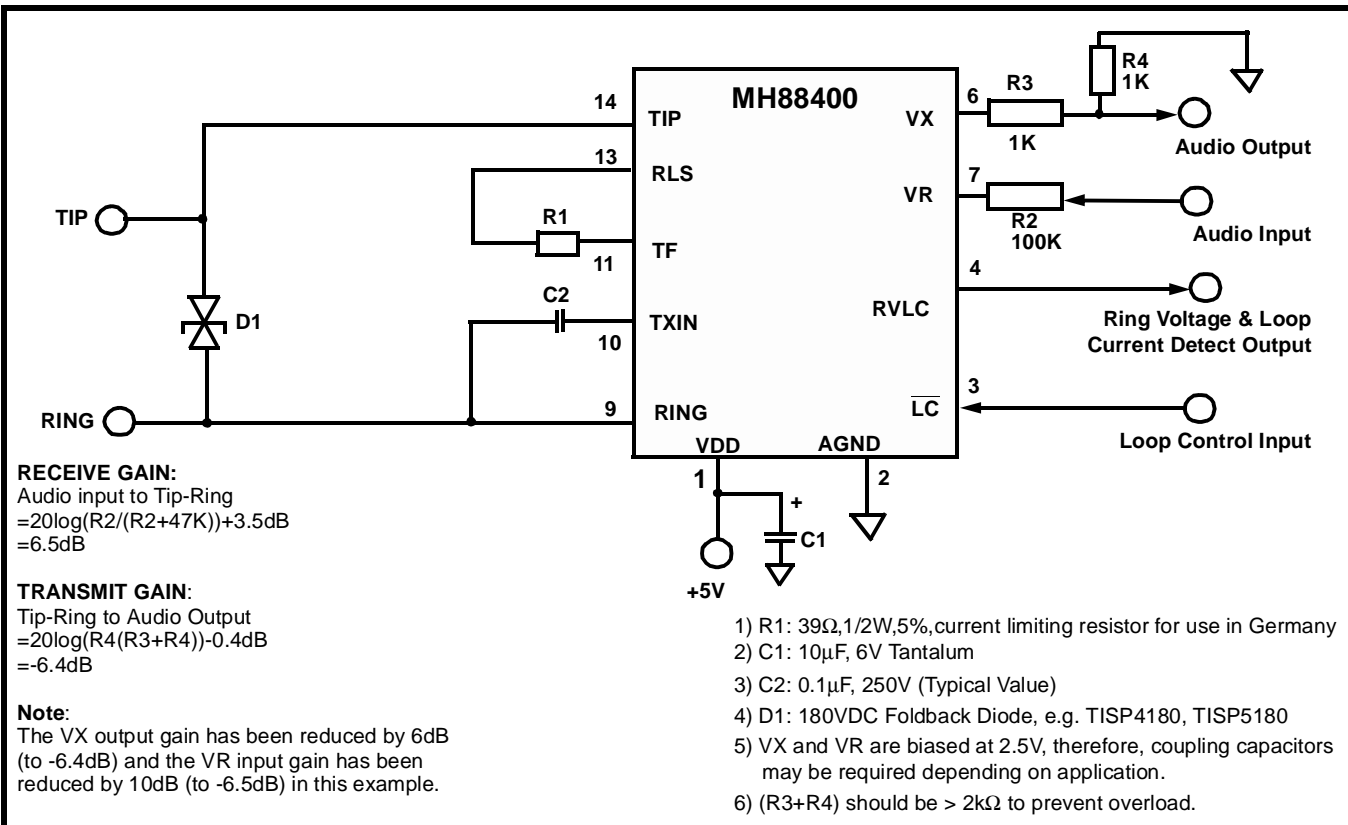


Figure 5 - Typical Application Circuit for Gain Adjustment



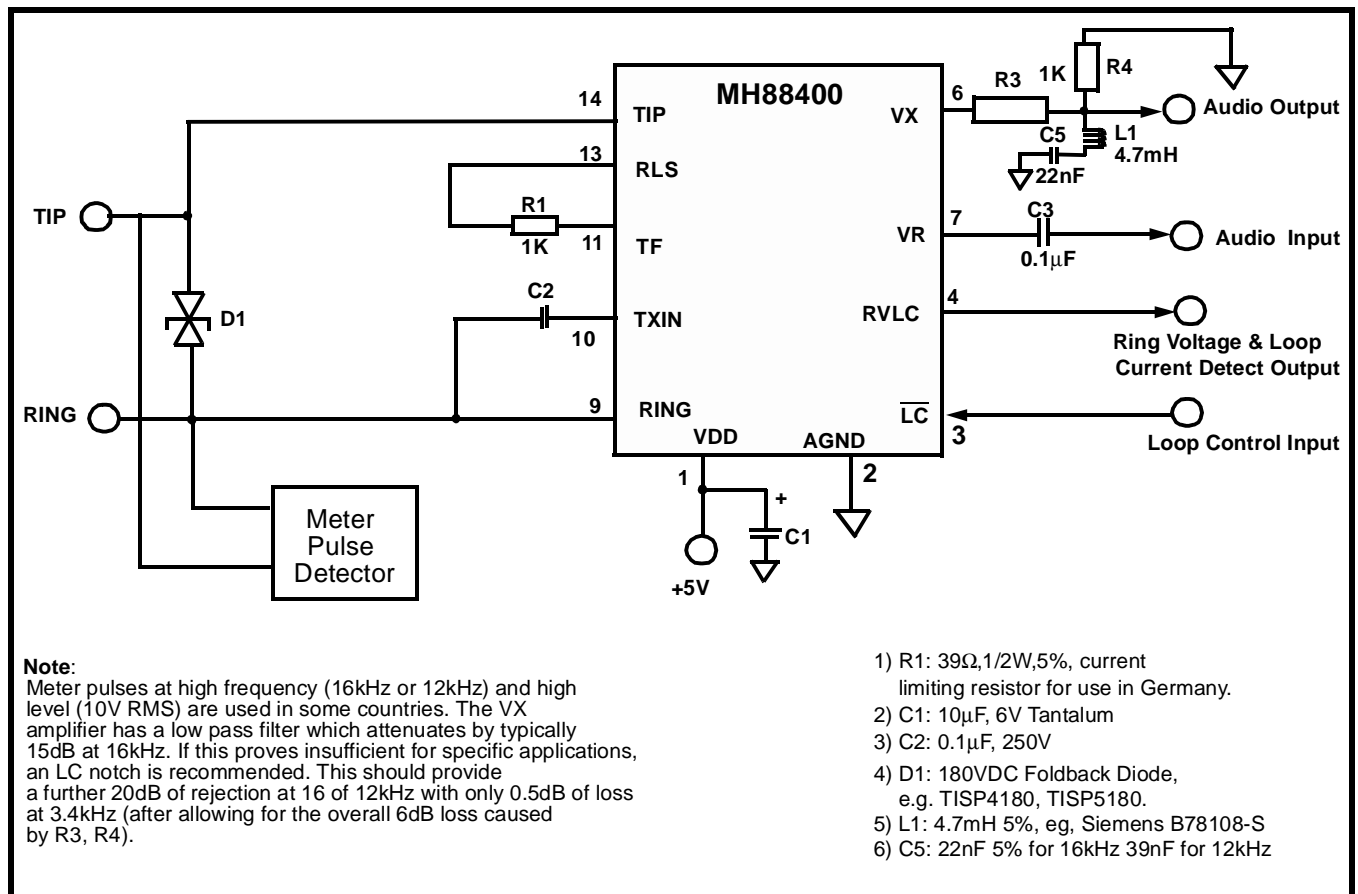


Figure 6 - Typical Application Circuit with Meter Pulse Filter and Coupling Capacitors

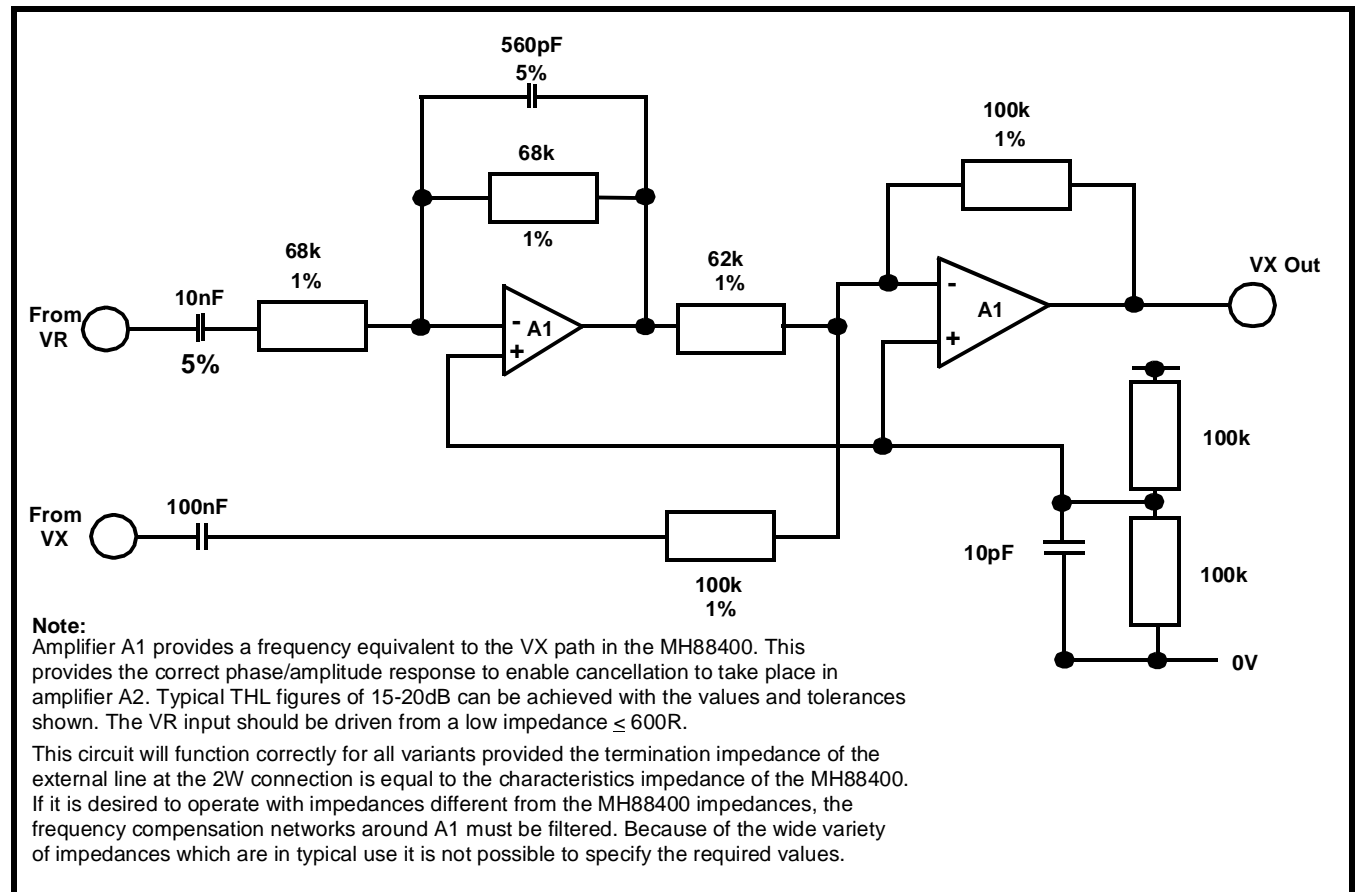


Figure 7 - Transhybrid Loss (THL) Cancellation Circuit

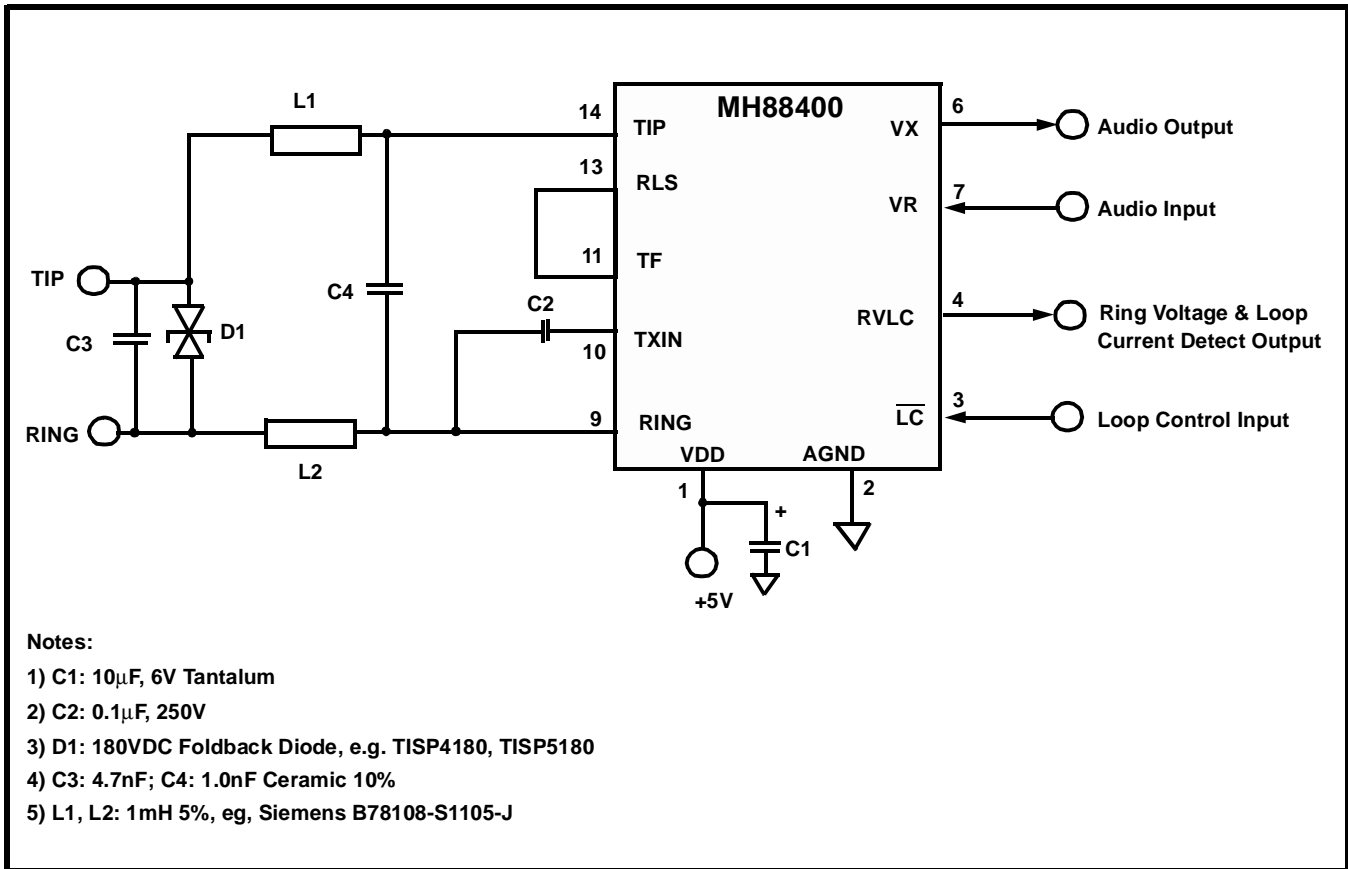


Figure 8 - Typical Application Circuit showing Noise Filter Network for Outband noise reduction

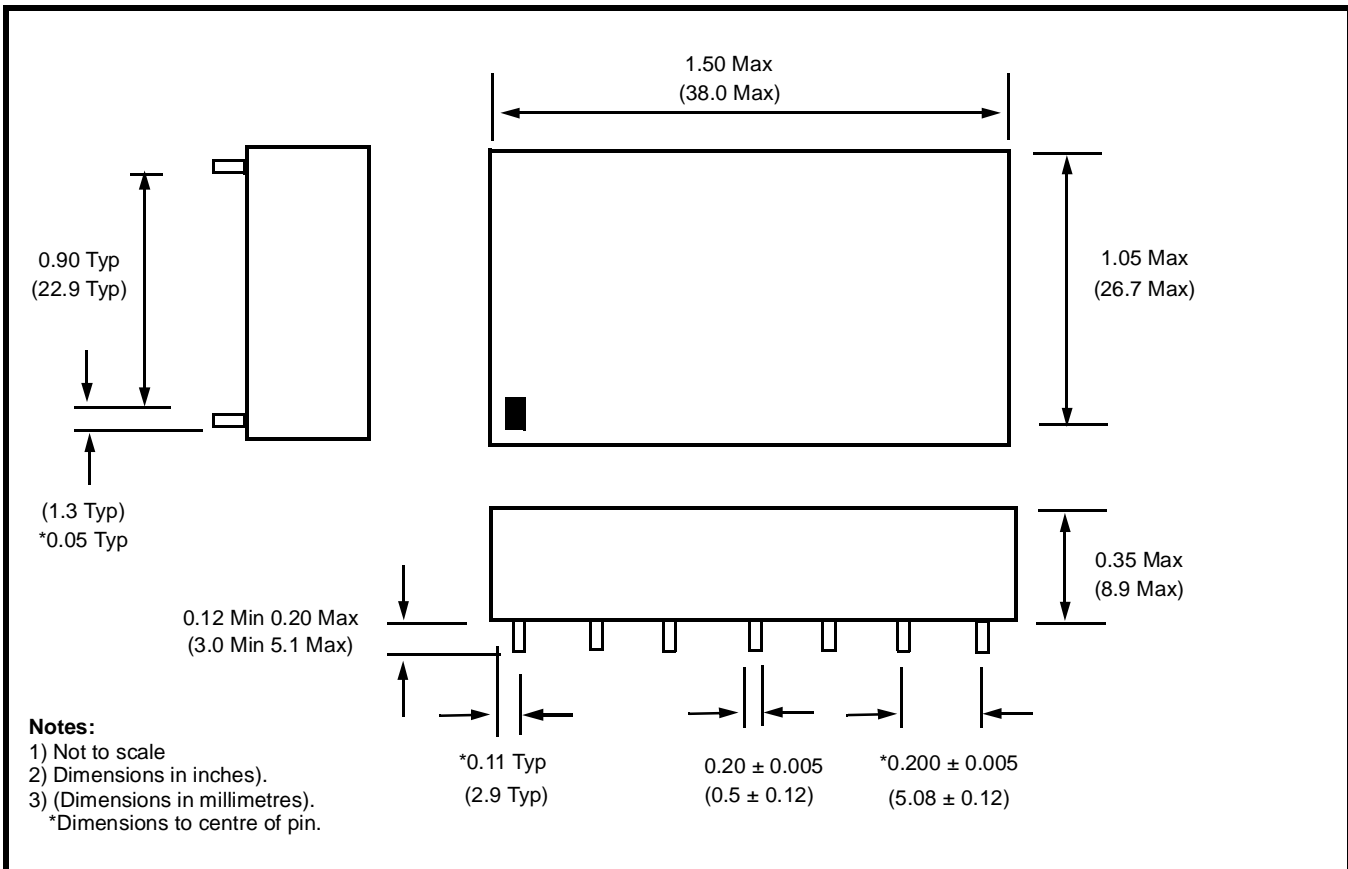


Figure 9 - Mechanical Data for 14 Pin DIL Hybrid