MITEL SEMICONDUCTOR

Application Note **MSAN-156**

Implementation Details for the MH88617 SLIC

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Contents

1.0 Overview

The MH88617 is a highly featured Subscriber Line Interface Circuit (SLIC). It provides a total analogue transmission and signalling link between a switching system and a subscriber loop.

Typical applications include PABX and Key Telephone Systems, Analog Terminal Adaptors, Pair-Gain, Fibre in the Loop and Wireless Local Loop systems.

This Application Note is intended to assist the user in implementing the MH88617 as an analogue line interface component in a communications system and should be read in conjunction with the data sheet for the MH88617.

2.0 Loop Current

The MH88617 employs a complex feedback network to provide a constant current feed to the line. The loop current can be programmed, via the ’LCA’ pin, between 14mA and 55mA.

2.1 Programming

The MH88617 is designed to provide 24mA of constant loop current by simply leaving the LCA pin open circuit.

The loop current can be programmed above 24mA by connecting a resistor between LCA and VCC.

Similarly, to program the loop current below 24mA a resistor needs to be connected between LCA and GND.

Internally, the MH88617 LCA pin can be depicted as shown in Figure 1.

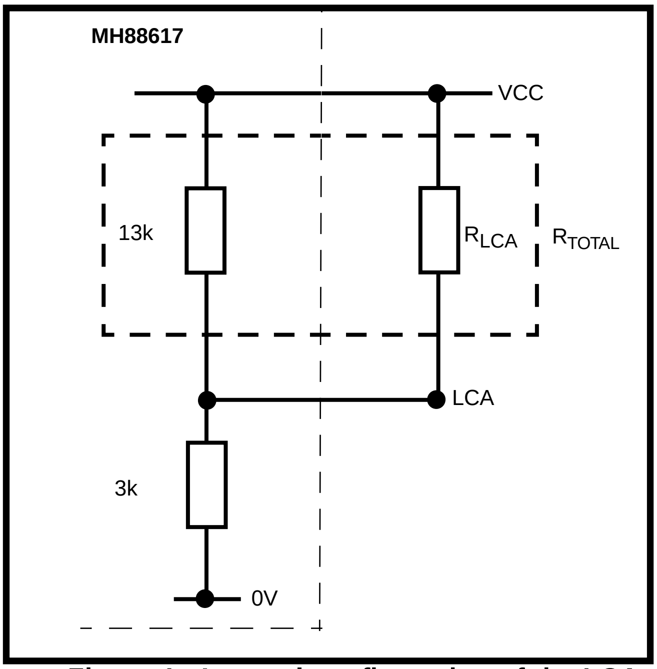

Figure 1 - Internal configuration of the LCA pin

From Figure 1 it can be seen that:

$$VLCA = \frac{(3) * VCC}{(13k + 3k)}$$

The resistor (R) connected between LCA and ground is given where I = Loop current

If 14mA > = ILoop <24mA, R is connected to AGND,

$$R\ (ohm) = \frac{(2438*I)}{(0.024038 - I)}$$

e.g. if ILoop = 14mA

$$R\ ohm = \frac{(2438 \times 14)}{0.024038 - 14mA}$$

= 3.4k

Alternatively:

If 24mA < ILoop ≤ 55mA, R is connected to +5V (VCC)

$$R(ohm) = \frac{(312.56 - 2438*I)}{(I - 0.024038)}$$

e.g. if ILoop = 30mA

$$R(ohm) = \frac{(312.56 - 2438 \times 30mA)}{(30mA - 0.024038)}$$

R(ohm) = 40.153K

Loop current mA	R (Kohm)
15	4.0
20	12.0
25	261.6
30	40.1
35	20.7
40	13.5

Table 1 - Value of R_{LCA} for Given Loop Current

It should be noted that if the loop current reaches 100mA, the device will shut down, due to its internal protection circuit. Also, if the loop current falls below 12mA, SHK will cease to function.

If the loop length is too long, the voltage drop across the combination of line and telephone can prevent the line drivers from supplying the desired loop current. Under these conditions the SLIC reverts to a constant voltage mode. This has the advantage of extending the operating loop length, but at the expense of loop current.

Table 1 shows a list of frequently used loop currents.

2.2 Power Down

A Power Down and Wake-Up feature is provided to allow the system to conserve power when the SLIC is not in use.

The SLIC enters the power down state when LCA is taken to GND.

Two circuits to achieve this are shown in Figure 2.

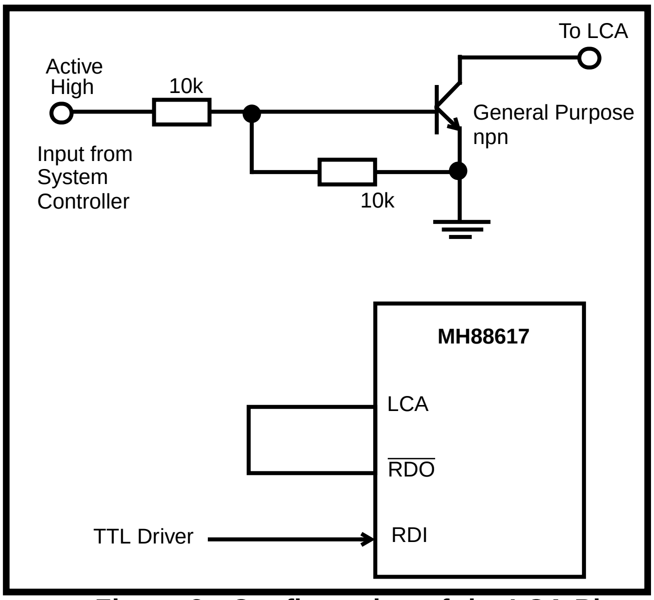

Figure 2 - Configuration of the LCA Pin

The SLIC will revert to a normal operating state within 150 milliseconds of the GND being removed from LCA.

In the Power Down mode, all internal circuitry, apart from the SHK detector, are disabled. The SLIC is able to detect the off-hook condition in the power down mode. Having detected the off-hook state the system has to remove the GND from the LCA pin, to cause the SLIC to 'Wake-Up'.

2.3 Overcurrent Fault Protection

The MH88617 has an internal protection circuit that becomes active if the current flowing between Tip and Ring to ground, or between either Tip to ground or Ring to ground, exceeds 100mA. When this level of current is detected the SLIC shuts itself down to prevent damage and save power. In this state, the SLIC periodically checks the fault current and when the fault has been removed, it reverts to an operational state.

With Tip and Ring shorted together, the resulting current flowing will equal the level programmed by the LCA pin.

The SLIC cannot be programmed above the 55mA current limit.

3.0 Ringing

The MH88617 has been designed to support Balanced Ringing by amplifying a low level AC input (RV) to appear as a differential output across Tip/ Ring.

The input at RV must be ground referenced with a low resistance path to ground. Any DC offset in the input signal will result in a corresponding shift in the

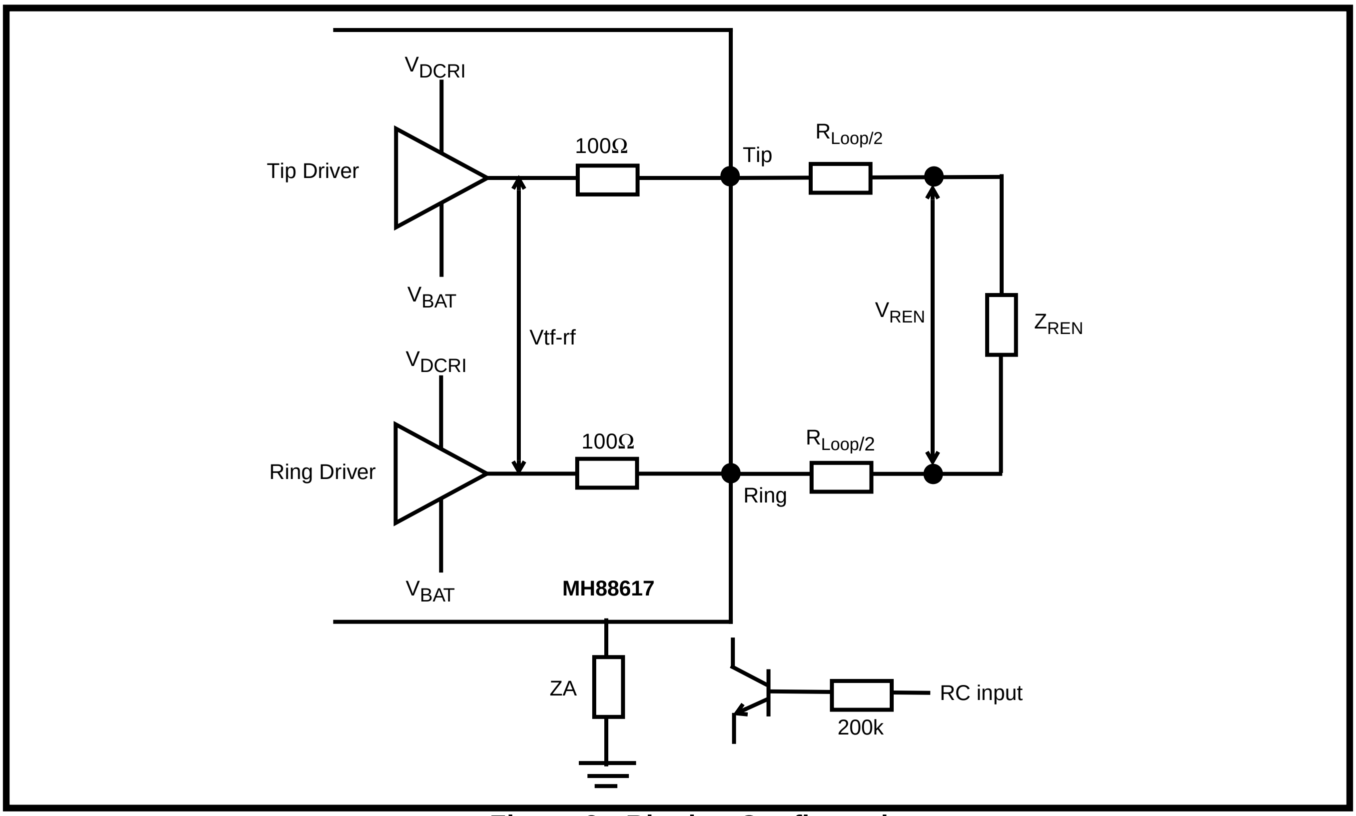

Figure 3 - Ringing Configuration

output voltage (multiplied by the RV_{GAIN}),and also possible delays in the ring tripping. This may result in clipping of the Ringing signal. However, this can be prevented by AC coupling the RV input with a series 1µF capacitor.

The input impedance at RV is approximately 5k when RC is at '1' and when RC is at '0' it is 100k.

The gain of the ringing amplifier is 50 when no load is connected across Tip/Ring. The actual gain will depend on the line impedance and load.

If a gain needs to be guaranteed fitting a transistor across ZA components will give an absolute gain of 42 as shown in Figure 3.

For a desired Ringing output (V_{REN}) across the Ringing Load (Z_{REN}) a corresponding voltage needs to be output from the Tip/Ring Drivers (Vtf-rf). Reference Figure 3.

To determine how to produce the desired level of Ringing at the load via a specific loop resistance, the following formulae are used:

$$V_{REN} = Vtf\text{-}rf * \left(\frac{Z_{REN}}{Z_{LOAD} + 200\Omega}\right)$$

where: $Z_{LOAD} = Z_{REN} + R_{LOOP}$
and also $Vtf\text{-}rf = (RV) * RV_{GAIN}$

For example, what level should be present at RV to provide 75VRMS into a REN of 1 over a 1900Ω loop resistance?

(Note: REN of 1 = 7000Ω @ 25Hz)

$$V_{REN} = Vtf\text{-}rf * \left(\frac{7000}{8900 + 200}\right)$$

75 = Vtf-rf * (0.769)

$\therefore Vtf\text{-}rf = 97.5V_{RMS}$

and also : Vtf-rf = RV * (42)

$$\frac{97.5}{42} = RV$$

$$2.32\ V_{RMS} = RV$$

3.1 Supply Voltages

The Ringing Voltage supplied to the line is not solely determined by the low level AC signal input at RV, but is also dependent on the voltages used to bias the line driver circuitry to the line, i.e. V_{BAT} and V_{DCRI}.

It is therefore important to ensure that these voltages are set correctly to ensure that the required level of Ringing can be obtained at the load.

The graph shown in Figure 4 gives an indication of the level of DCRI voltage required to provide a corresponding ringing voltage at the output of the Tip/Ring Driver circuitry (Vtf-rf).

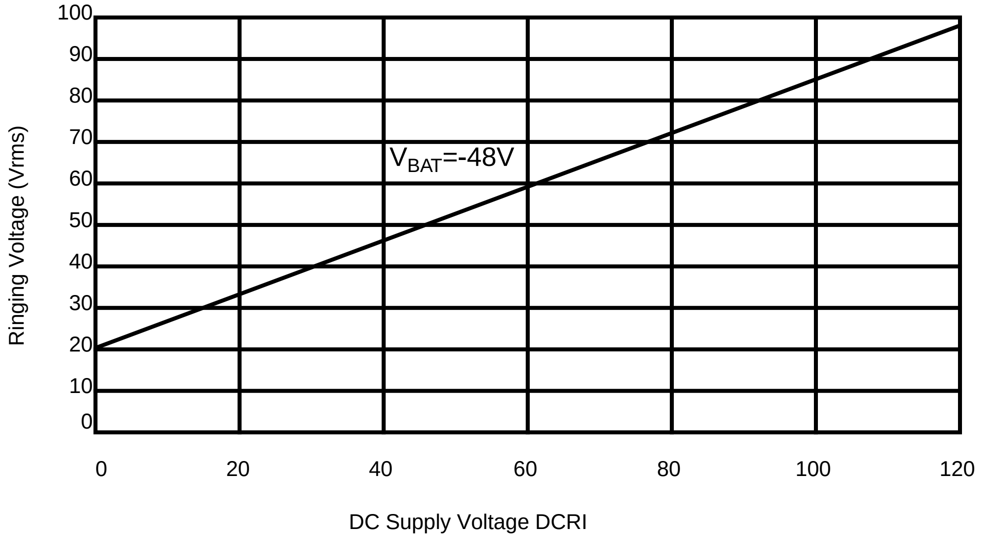

Figure 4 - Maximum Ringing Voltage Vtf-rf

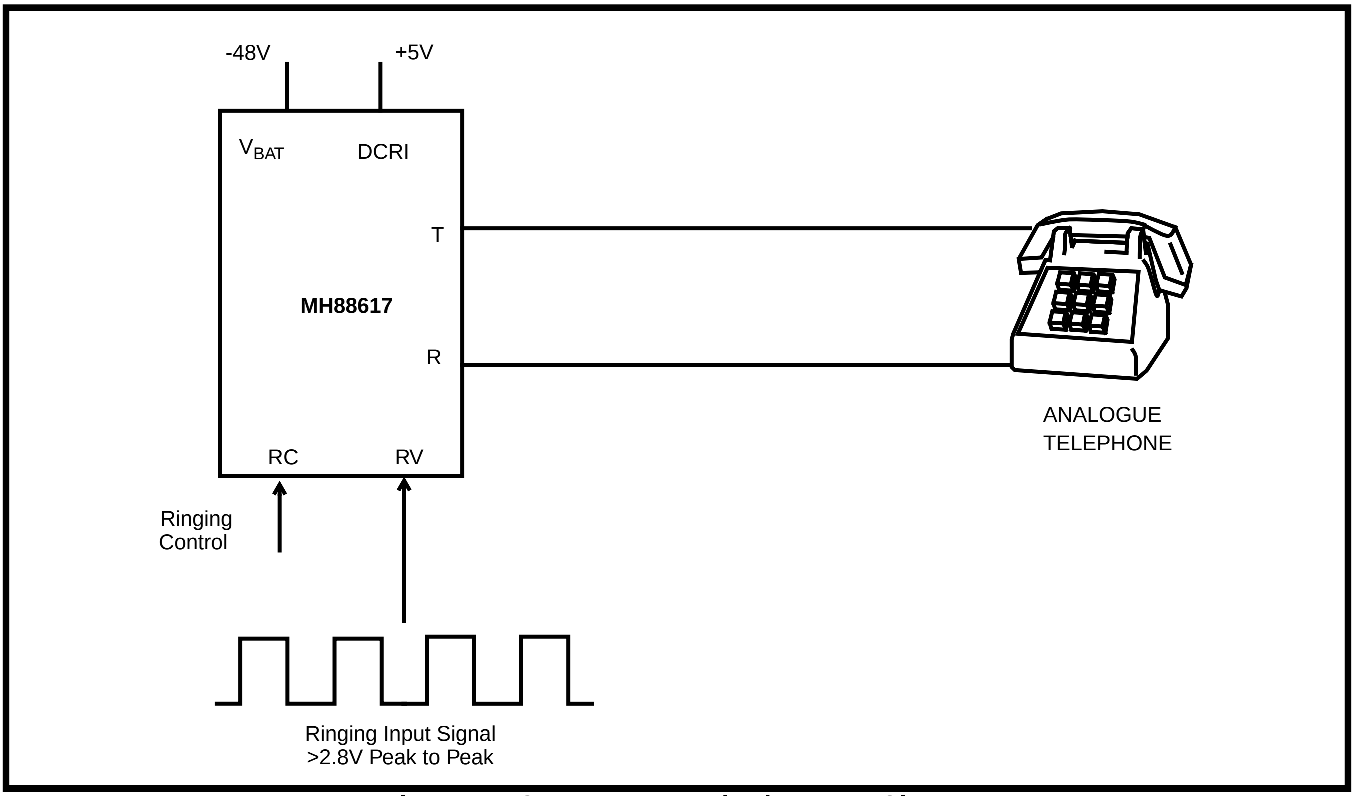

Figure 5 - Square Wave Ringing on a Short Loop

3.2 Square Wave Ringing

The MH88617 is capable of providing square wave ringing over a short loop (≤600 Ohms including the telephone set) using a low voltage DCRI supply and a square wave input at RV. Figure 5 illustrates how this can be achieved.

When using a square wave ringing input that has fast rising and falling edges, audible clicks may be heard on the line. To avoid this a filter can be used at the RV input to remove the fast edges which cause the problem. Figure 5 details how this can be performed.

The Square Wave input at RV can be a TTL square wave. Provided the TTL peak-to-peak amplitude can be guaranteed to be greater than +2.8V then the DCRI voltage can be as low as +5V. However, if the TTL input cannot be guaranteed to have an amplitude greater than +2.8V (peak-to-peak) the DCRI voltage needs to be +12V.

The TTL signal needs to be AC coupled to ensure that the ring tripping circuit functions correctly.

Provided either one of the two conditions above are satisfied the MH88617 will provide 40VRMS of Square Wave Ringing into a REN of 5, over a short loop.

SHK debouncing is recommended to accommodate 10 to 20mS glitches on the SHK pin.

4.0 Gain, Input and Balance Impedances

Due to the design architecture of the MH88617, the Gains and Input and Balance impedances are inter-related, e.g. a change in the programmed line impedance will affect the gains and network balance impedance.

Typical resistor configuration e.g.,

600R as shown in Figure 6 and
270R + 750R/150nF as shown in Figure 7

4.1 Programming

Table 2 gives programming components for different countries and gain. For countries not included, please call your regional applications group. It is recommended that the components are placed as close as possible to the SLIC for best results.

Figures 6 and 7 show the configuration of the resistor networks.

4.2 VX and VR Signals

The 4 wire ground referenced output VX is DC coupled internally. The output impedance at VX is typically 5 Ohms, AC impedance. The input impedance at the VR pin is typically 10k.

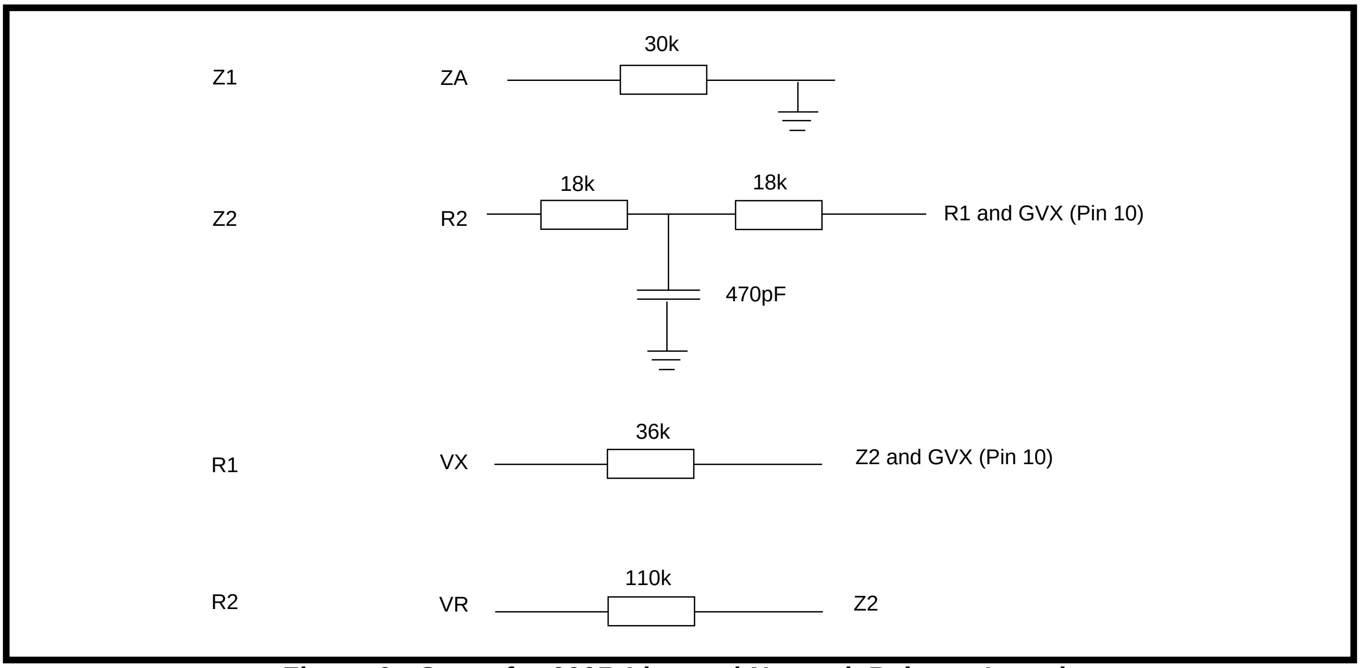

Figure 6 - Setup for 600R Line and Network Balance Impedance

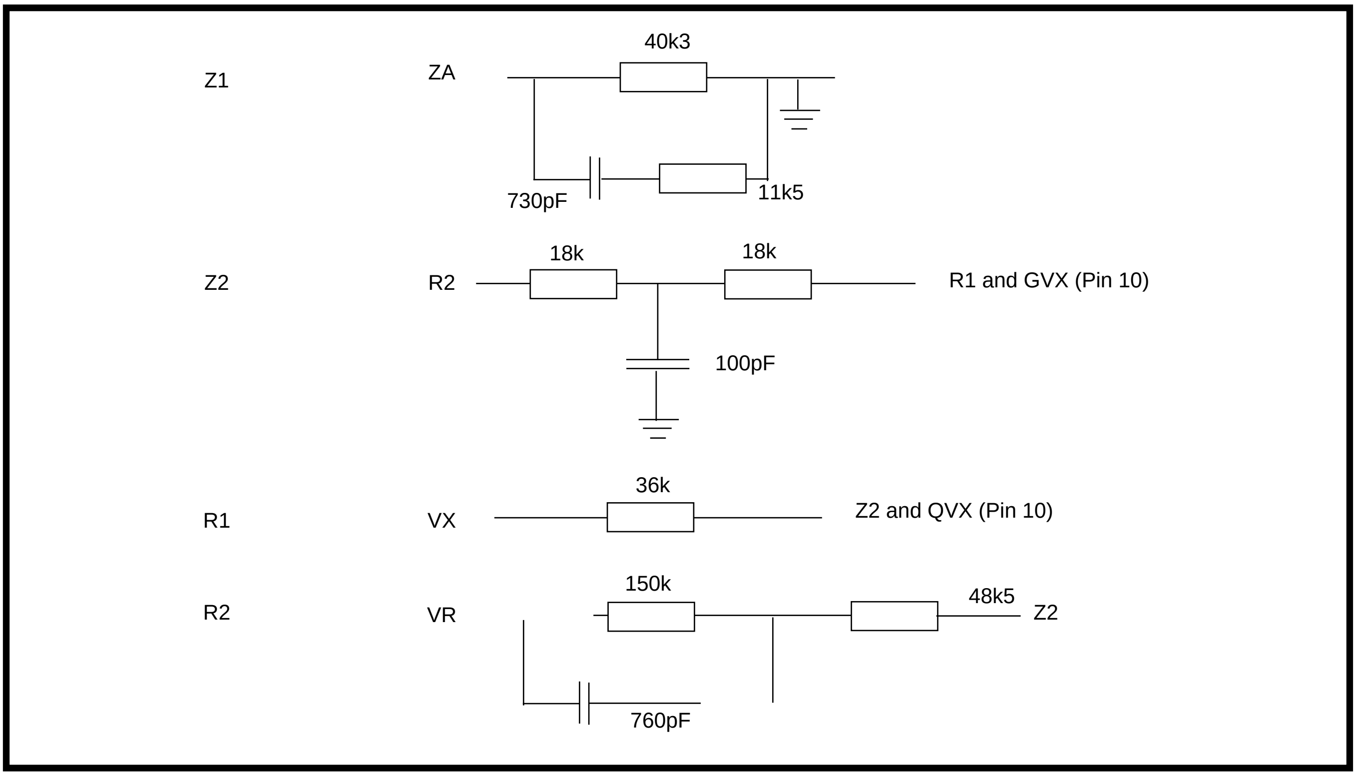

Figure 7 - Setup for Complex Line and Network Balance Impedance

Line Conditions				Programming Components			
Line Impedance	**Balance Impedance**	**VX gain**	**Vr gain**	**Z1**	**Z2**	**R1**	**R2**
600R	600R	0dB	0dB	30k	18K+18K T470pF	36k	110k
600R	600R	4dB	(-)4dB	30k	28K5+28K5T 330pF	57k	180k
600R	350R+ (1k//210nF)	0dB	0dB	30k	18k+18kT (10k3+5.3nF)	36k	110k
600R+2.16uF	600R+2.16uF	0dB	0dB	60K// (60K+14.4Nf)	18k+18kT330pF	36k	110k+10nF
300R+1k//220nF	370R +620R//310nF	0dB	0dB	44k//(12nF+16k5)	28k2+(6k84// 13,85nF)	36k	(200k//1.1nF) +50k
370R+620R//310nF	370R +620R//310nF	0dB	0dB	40K// (1.2Nf+32K5)	18K+18KT100pF	36k	(124k//1.5nF) +64k
220R+820R//115nF	220R +820R//115nF	0dB	0dB	41k//(630pF+3k)	36k	36k	(164k//550pF) +34k
900R+2.16=6uF	900R+2.16uF	0dB	0dB	60k//(105k+15nF)	18k+18kT150pF	36k	170k+10nF
900R	900R	0dB	0dB	38k9	18k+18kT330nF	36k	174k
150R+830R//72nF	150R+ 830R//72nF	0dB	0dB	40k//470pF	18k+18kT47pF	36k	(165k//360pF) +20k
180R+910//150nF	180R +910R//150nF	0dB	0dB	41k//910pF	36k	36k	(182k//760pF) +26k
200R+560R//0.1uF	200R +560R//0.1uF	0dB	0dB	35k//668pF	18k+18kT100pF	36k	(112k//530pF) +30k
270R+750R//150nF	270R +750R//150nF	0dB	0dB	40k3// (11k5+730pF)	18k+18kT100pF	36k	(150k//760pF) +48k5
150R+510R//47nF	150R +510R//47nF	0dB	0dB	32K//300pF	18k+18kT100pF	36k	(102K//238Pf) +20KpF
215R+1k//137nF	215R+1k// 137nF	0dB	0dB	43k// (2.3k+880pF)	36k	36k	(200k// 685pF+33k
1k2//(367R+112nF)	1k2// (367R+112nF)	0dB	0dB	42k8// (13k3+1.07nF)	18k+18kT100pF	36k	(184k8// 940pF) +47.4k
600R//30nF	600R//30nF	0dB	0dB	29k	18k+18KT330pF	36k	108k//100pF
300R+(360R// 660nF)	300R+(360R// 660nF)	0dB	0dB	32k//(19k+2.7nF)	18k+18KT330pF	36k	(72k// 3.3nF)+50k

Table 2 - Programming Components

5.0 Metering Injection

As mentioned in the MH88617 data sheet, the SLIC can be used to amplify a ground-referenced AC signal at "ESI", and output at Tip/Ring in the form of a differential signal.

The signal present at the ESI input is amplified and presented to the telephone line when the enable signal "ESE" is active high.

The gain from the ESI input to Tip/Ring is "2" and the maximum signal level output is $2.25V_{RMS}$. When the configuration is set for 600R line impedance. To reduce noise it is recommended that a 300k to 500k resistor is placed between the TTL driver and ESE pins.

6.0 Relay Driver

The MH88617 incorporates a relay driver, the function of which can be defined by the user. Examples of its use may be to drive a "test" relay application of power down or unbalanced ringing.

The input RDI is an active high input which forces the output $\overline{RDO}$ low.

The maximum relay voltage (V_{RELAY}) is +15V and a protection diode must be used to prevent damage to the relay driver output.

Figure 8 illustrates how the relay driver can be used in some of the examples given above.

The configuration showing how the Relay Driver can be used to power the SLIC down is shown in Figure 2. (reference section 2.2).

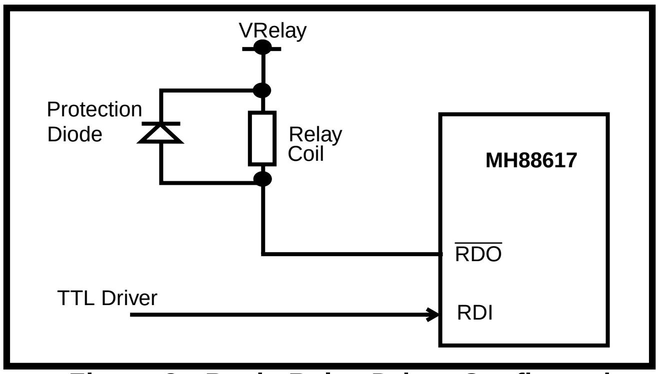

Figure 8 - Basic Relay Driver Configuration

7.0 Protection

It is necessary to protect the SLIC from voltage surges and lightning strikes.

PTC's or fuses can be used to protect from over current (PTC's have the advantage of being resettable). There are several devices available for over-voltage, either zeners, foldback diodes or devices designed specifically for this purpose from sidactor. If sidactors are used, two resistors in series with tip and ring are added to ensure that current is limited. See Figure 9.

8.0 Power Supply Considerations

The VDCRI needs to supply the current during ringing. The DCRI power supply should be capable of supplying 60mA minimum for a REN5. It should also be noted that loop current is drawn from the VCC supply during ringing, this supply must always be at a minimum of +5V, any decreases could cause the SLIC to malfunction.

If necessary current limiting circuitry can be added to the supply lines to ensure that supplies are not affected by current surges during ringing.

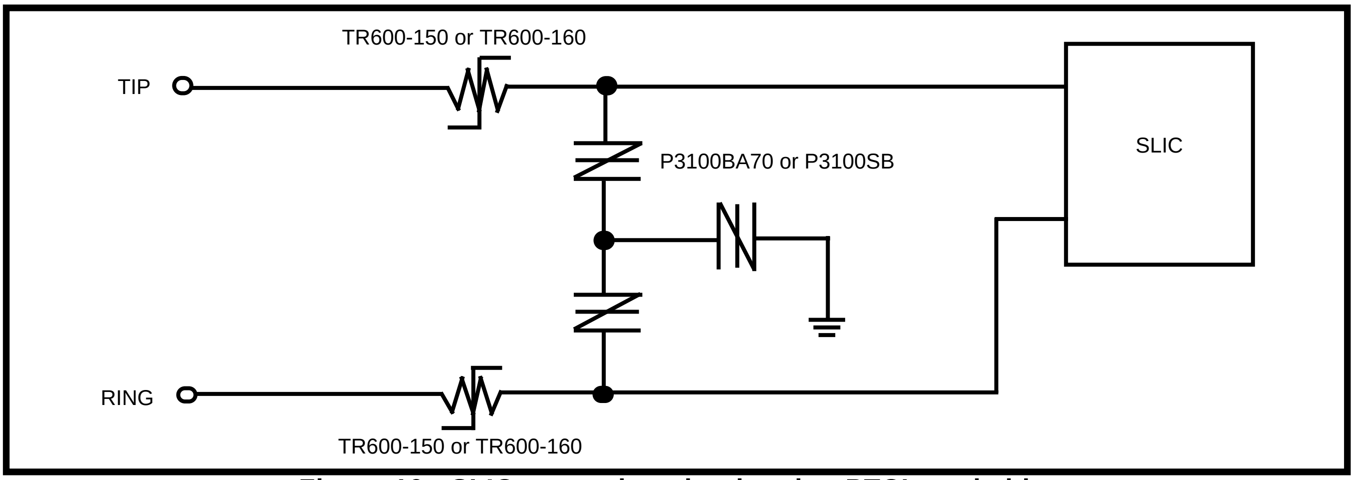

Figure 10 - SLIC protection circuit using PTC's and sidactors

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