# MITEL

## SEMICONDUCTOR

# MH88612BV-K

## Subscriber Line Interface Circuit (SLIC)

### Advance Information

## Features

- Transformerless 2-wire to 4-wire conversion
- Battery and ringing feed to line.
- Off-hook and dial pulse detection.
- Ring ground over-current protection.
- Constant current feed with constant voltage foldover.
- Relay driver.
- Power Denial.
- Wide Operating Range.
- Pin for pin compatible 600R and 900R variants.

## Applications

Line interface for:

- PABX
- Intercoms
- Key Telephone Systems
- Control Systems

### Ordering Information

| | |
|---|---|
| MH88612BV-K | 20 Pin SIL Package (600R) |
| MH88612BV-4K | 20 Pin SIL Package (900R) |

**0°C to 70°C**

## Description

The SLIC provides a complete interface between a switching system and a subscriber loop. Functions provided include battery feed and ringing feed to the subscriber line, 2-Wire to 4-Wire hybrid interfacing, constant current feed with constant voltage foldback, and dial pulse detection. The device is fabricated using thick film hybrid technology in a 20-pin single in-line package.
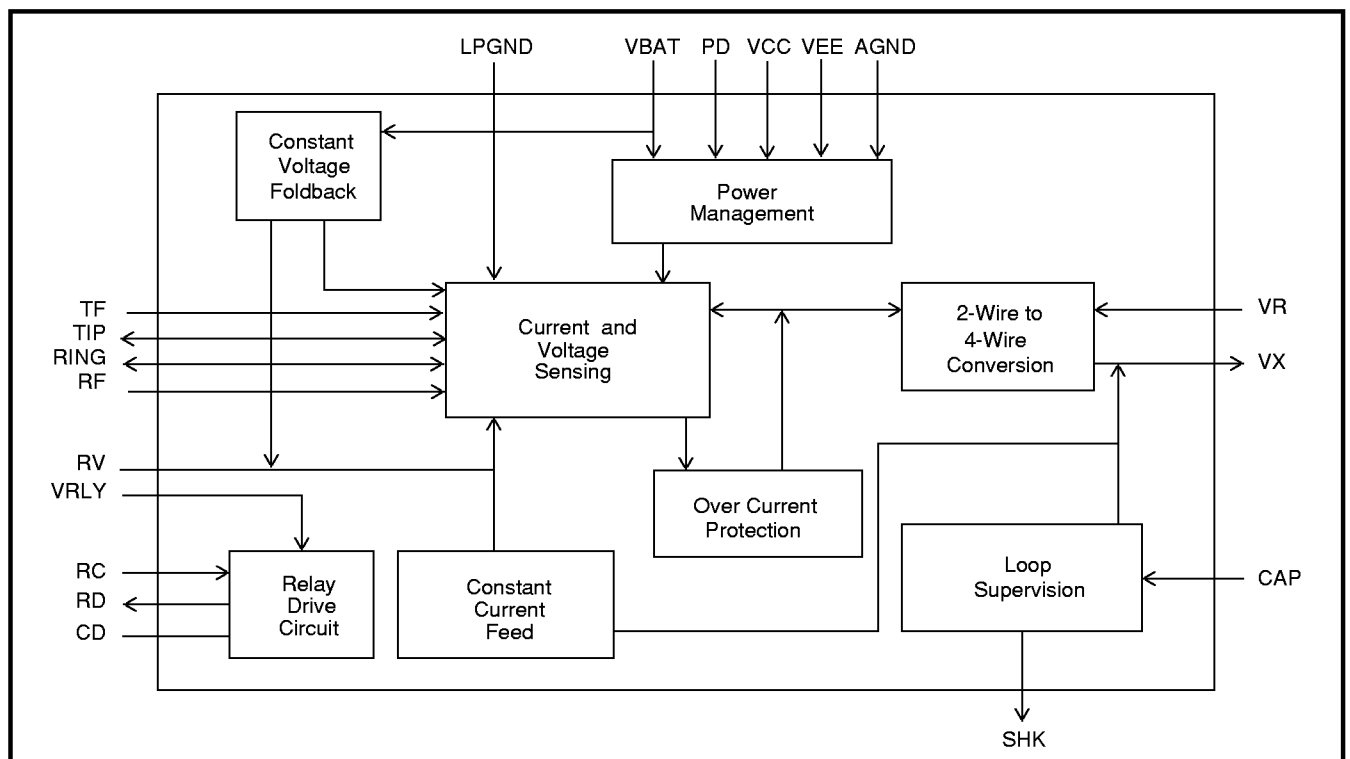


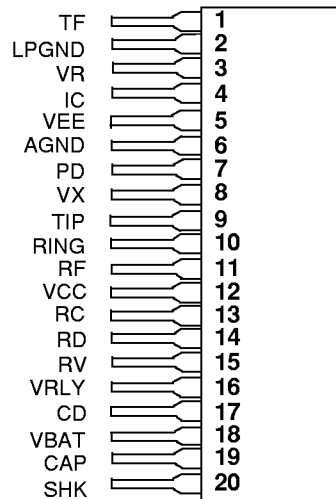Figure 1 - Functional Block Diagram

1

```
                        TF  ═══╗ 1
                     LPGND  ═══╣ 2
                        VR  ═══╣ 3
                        IC  ═══╣ 4
                       VEE  ═══╣ 5
                      AGND  ═══╣ 6
                        PD  ═══╣ 7
                        VX  ═══╣ 8
                       TIP  ═══╣ 9
                      RING  ═══╣ 10
                        RF  ═══╣ 11
                       VCC  ═══╣ 12
                        RC  ═══╣ 13
                        RD  ═══╣ 14
                        RV  ═══╣ 15
                      VRLY  ═══╣ 16
                        CD  ═══╣ 17
                      VBAT  ═══╣ 18
                       CAP  ═══╣ 19
                       SHK  ═══╣ 20
```

**Figure 2 - Pin Connections**

## Pin Description

| Pin # | Name | Description |
|---|---|---|
| 1 | TF | **Tip Feed.** Connects to external diode for protection |
| 2 | LPGND | **Loop Ground.** Is the system ground reference with respect to VBAT. Normally connected to AGND. |
| 3 | VR | **Voice Receive (Input).** The 4 wire analog signal to the device. |
| 4 | IC | **Internal Connection.** No connection should be made to this pin |
| 5 | VEE | **Negative Power Supply Voltage (-5V).** |
| 6 | AGND | **Analog Ground.** Connects to System Ground (Earth). |
| 7 | PD | **Power Denial (Input).** A logic high will isolate the battery voltage to Tip/Ring. |
| 8 | VX | **Voice Transmit (Output).** The 4-wire analog signal from the device. |
| 9 | TIP | **Tip Lead.** Connects to the "Tip" lead of the telephone line. |
| 10 | RING | **Ring Lead.** Connects to the "Ring" lead of the telephone line. |
| 11 | RF | **Ring Feed (Input).** Normally connected to Ring relay for negative battery feed voltage and ringing voltage input. |
| 12 | VCC | **Positive Power Supply Voltage (+5V).** |
| 13 | RC | **Relay Control (Input).** Active high. |
| 14 | RD | **Relay Drive.** Open collector sinks current when RC is at logic high. |
| 15 | RV | **Ring Feed Voltage.** Normally connected to pin 11 (RF) through a normally closed relay and to external diode protection. |
| 16 | VRLY | **Relay voltage Supply (+5V).** |
| 17 | CD | **Clamping Diode.** Normally connected to AGND. |
| 18 | VBAT | **Negative Battery Feed Supply Voltage  (-48V).** Battery supply for the Subscriber Line. Typically -48VDC is applied to this pin. |
| 19 | CAP | **Ring Trip Filter Capacitor.** Normally connected via an external capacitor to ground to prevent false ring trip. Must be open circuit to allow dial pulse detection. |
| 20 | SHK | **Switch Hook Detect (Output).** A logic level 1 will indicate that the Subscriber Line is in the 'Off-Hook' state. |

Note 1:  C4 in Figure 3 can be added permanently to this pin for certain dial pulse applications.

## Functional Description

The SLIC performs a transformerless 2-wire to 4-wire conversion of the analog signal. The 2-wire circuit is the balanced line going to the subscriber loop, while the 4-wire circuit is the audio signal going to and from devices such as the voice codec or switching circuit. The SLIC also provides a switch hook (SHK) status output which goes high when the telephone is set off-hook.

## Constant Current Feed

The MH88612BV-K family employs complex feedback circuits to supply a constant current feed or, if necessary, constant voltage feed to the line. With a nominal -48V battery the device will supply a constant current of typically 25mA to a line up to 1100Ω. For longer lines there is insufficient battery voltage so the device automatically switches to constant voltage mode where Tip and Ring will stay at their minimum and maximum voltage levels and the supplied current will be reduced accordingly. The maximum line resistance supported is 2000Ω including the telephone set.

## Switch Hook Detection

The SHK pin will go to logic 1 to indicate that a telephone connected to the line has gone off-hook (on-line). Off-hook will not be indicated if the loop resistance (including the telephone set) is too high for the device to support.

The SHK output will toggle to indicate dial pulses on the line. If the capacitor on CAP (Pin 19) has not been switched out of circuit the dial pulses will be distorted.

## Ringing And Ring Trip Detection

In Figure 3 a ringing signal (e.g.90 Vrms and -48Vdc) is applied to the line by disconnecting pin 15 (RV) from pin 11(RF), and connecting the ringing voltage at pin 11 (RF) by use of the relay K1.

The SLIC can detect an off-hook condition during ringing but there is a large AC component which must be filtered out to give a true off-hook condition at SHK.

A 1.0μF capacitor connected from pin 19 (CAP) to ground will provide adequate attenuation when ringing is applied. Once an off-hook condition has been detected a logic low should be applied to pin 13 (RC) which will deactivate the relay (K1) to

disconnect the ringing voltage from pin 11 and reconnect to pin 15. At that time the SLIC will revert to constant current feed operation.

For applications requiring Dial Pulse Detection the Capacitor connection to ground C1 should be controlled such that the capacitor is disconnected during Pulse Dialling.

If the signalling method is unknown, a capacitor of approximately 56nf should be permanently fitted between CAP (pin 19) and ground. This should be in addition to the capacitor mentioned in the above paragraph.

During off-hook conditions (on-line), the capacitor (C1) should not have a low impedance path to ground. This can be achieved using a transistor (Q1) and resistor (R2) as shown in Figure 3, with R2 providing a high impedance path for C1. When ringing is applied (RC = 5V) the transistor will short circuit R2 which will give C1 a low impedance path to ground and provide the required filtering.

Other methods can be used to switch out C1, such as a relay or a codec system drive output (with a similar configuration as above).

For applications using DTMF signalling, C1 can be permanently connected to ground.

## Current Limit

The Tip or Ring of the telephone line may accidentally be shorted to ground. In such a case, current will only flow through the feed resistor. This high current will be sensed and reduced by the current limit circuit to a lower value to protect the internal circuitry.

### Power Denial

The power denial function is a feature of the MH88612 which allows for powering down of the subscriber loop. A logic high voltage applied to the power denial input effectively removes the battery voltage from the loop driver circuitry. The resulting $I_{LOOP}$ is negligible and power consumption is minimised. The power denial function is useful for disabling a loop which may have a ground fault.
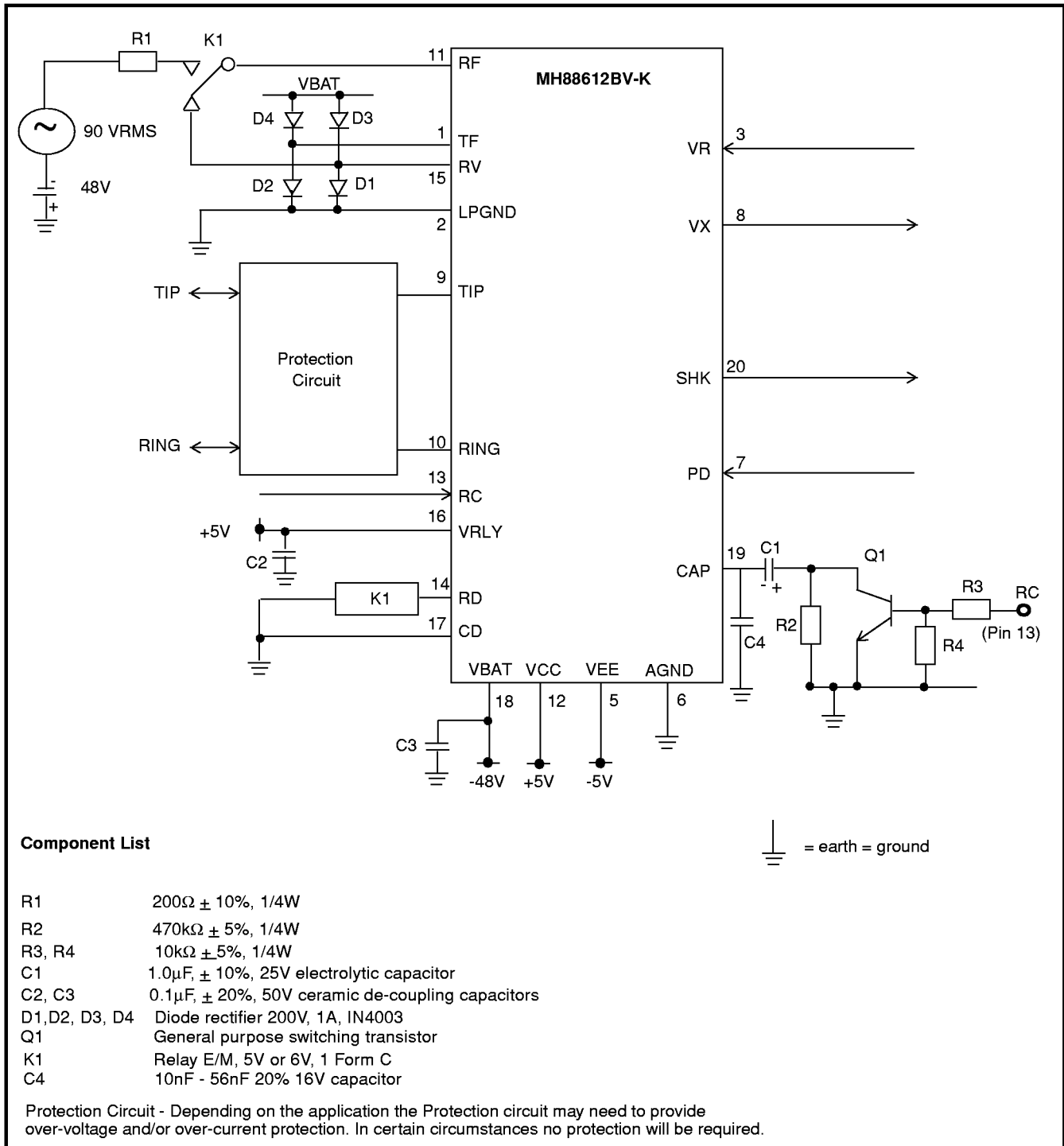
**Figure 3 - Typical Application Circuit**

**Component List**

| R1 | 200Ω ± 10%, 1/4W |
|---|---|
| R2 | 470kΩ ± 5%, 1/4W |
| R3, R4 | 10kΩ ± 5%, 1/4W |
| C1 | 1.0μF, ± 10%, 25V electrolytic capacitor |
| C2, C3 | 0.1μF, ± 20%, 50V ceramic de-coupling capacitors |
| D1,D2, D3, D4 | Diode rectifier 200V, 1A, IN4003 |
| Q1 | General purpose switching transistor |
| K1 | Relay E/M, 5V or 6V, 1 Form C |
| C4 | 10nF - 56nF 20% 16V capacitor |

Protection Circuit - Depending on the application the Protection circuit may need to provide over-voltage and/or over-current protection. In certain circumstances no protection will be required.

# MH88612BV-K

## Absolute Maximum Ratings*

| | Parameter | Symbol | Min | Max | Units |
|---|---|---|---|---|---|
| 1 | DC Supply Voltage<br>LPGND = AGND | $V_{CC}$<br>$V_{EE}$<br>$V_{BAT}$<br>$V_{RLY}$ | -0.3<br>-9<br>-60<br>-0.3 | 9<br>0.3<br>0.3<br>40 | V<br>V<br>V<br>V |
| 2 | Storage Temperature | $T_S$ | -40 | 100 | °C |
| 3 | Package Power Dissipation | PD | | 2 | W |

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

## Recommended Operating Conditions

| | Characteristics | Sym | Min | Typ‡ | Max | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| 1 | Operating Supply Voltage | $V_{CC}$<br>$V_{EE}$<br>$V_{BAT}$<br>$V_{RLY}$ | 4.75<br>-5.25<br>-54 | 5.0<br>-5.0<br>-48<br>5 | 5.25<br>-4.75<br>-42 | V<br>V<br>V<br>V | |
| 2 | Relay Driver Current | $I_{RLY}$ | | | 100 | mA | |
| 3 | | $T_o$ | 0 | | 70 | °C | |

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

## DC Electrical Characteristics† - Voltages are with respect to GNDA unless otherwise stated.

| | Characteristics | | Sym | Min | Typ‡ | Max | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|
| 1 | Supply Current | $V_{CC}$<br>$V_{EE}$<br>$V_{BAT}$ | $I_{CC}$<br>$I_{EE}$<br>$I_{BAT}$ | | 7.5<br>-5.1<br><br>3 | <br><br>800 | mA<br>mA<br>μA<br>mA | PD = Logic High<br>PD = Logic Low, Idle |
| 2 | Power Consumption | | $P_C$ | | 160<br>1600 | | mW<br>mW | Standby $V_{BAT}$ = -48V<br>Active (Off Hook) |
| 3 | Constant Current Line Feed | | $I_{Loop}$ | 23<br>15 | 25<br>16.5 | 27<br>19 | mA<br>mA | $R_{Loop}$ <1100Ω<br>$R_{Loop}$ ≤2000Ω<br>$V_{BAT}$ = -48V |
| 4 | Operating Loop Resistance | | $R_{Loop}$ | | | 2000 | Ω | $V_{BAT}$ = -48V @ $I_{Loop}$ = 16mA, $R_{Loop}$ includes telephone set |
| 5 | Ring Ground Over-Current protection | | | | | 45 | mA | $V_{BAT}$ = 48V |
| 6 | Off-Hook Detect<br>Output Low Voltage (On-hook)<br>Output High Voltage (Off-hook) | | $V_{OL}$<br>$V_{OH}$ | <br>2.7 | | 0.4 | V<br>V | Active high logic<br>$I_{OL}$ = 8mA<br>$I_{OL}$ = -100mA |
| 7 | RC, PD Control Input<br>Input Low Volt (no activation)<br>Input High Volt (activation) | | $V_{IL}$<br>$V_{IH}$ | <br>2.0 | | 0.7 | V<br>V | Active high logic<br><br>LSTTL compatible |
| 8 | RC, PD control Input<br>Input Low Current (no activation)<br>Input high current (activation) | | $I_{IL}$<br>$I_{IH}$ | | | 50<br>0.5 | μA<br>mA | |
| 9 | PD Control Input<br>Input Low Current<br>Input High Current | | $I_{IL}$<br>$I_{IH}$ | | | 0.5<br>0.3 | mA<br>mA | |

† DC Electrical Characteristics are over recommended operating supply voltages.
‡Typical figures are at 25°C with nominal 5V supplies and are for design aid only.

## AC Electrical Characteristics

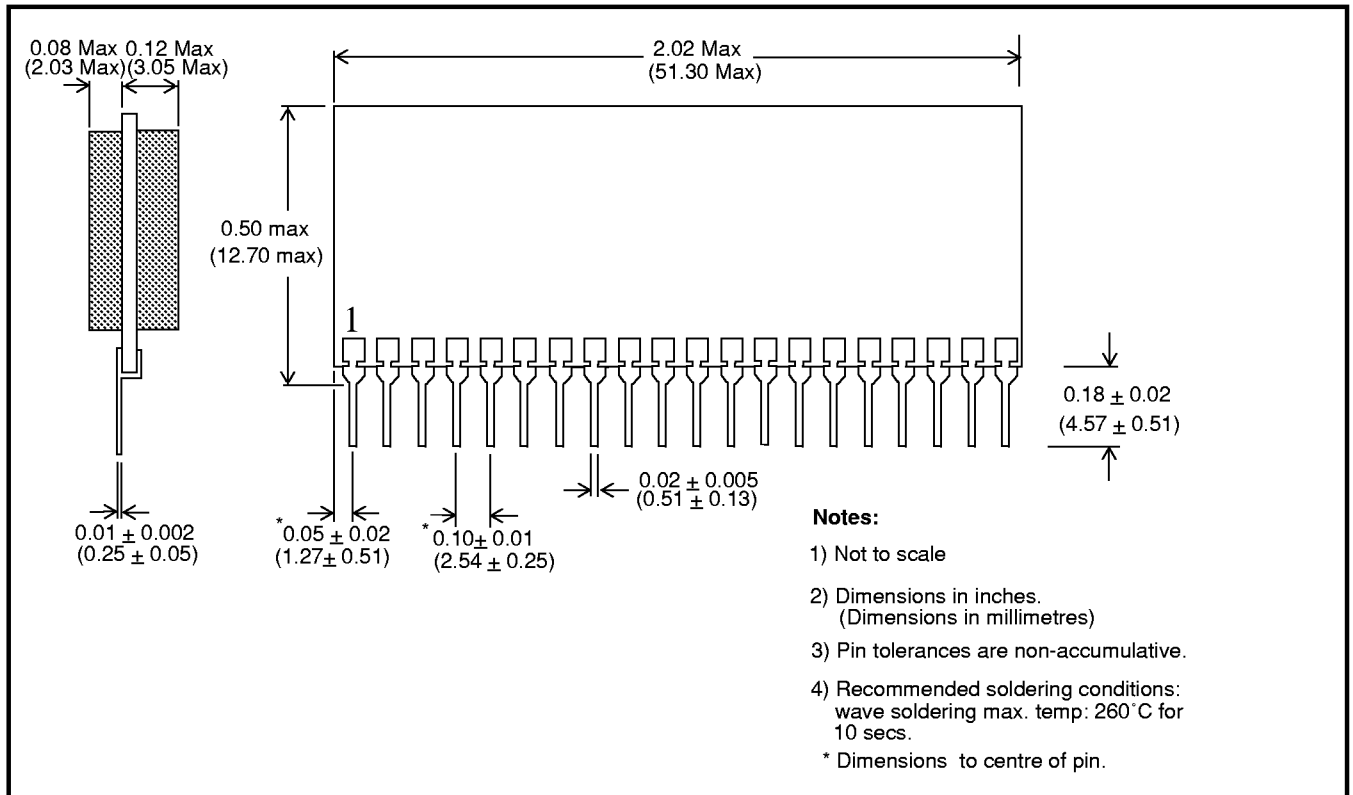| | Characteristics | Sym | Min | Typ‡ | Max | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| 1 | Ringing Voltage<br>Frequency | $V_{RING}$<br>$F_{RING}$ | <br>17 | | 90<br>25 | $V_{rms}$<br>Hz | Superimposed on $V_{BAT}$ = -48V |
| 2 | Ringer Equivalence Number | REN | | | 2 | | |
| 3 | Ring Trip Detect time | | | 200 | 300 | ms | |
| 4 | Input AC Impedance 2-wire | Zin | | 600<br>900 | | $\Omega$<br>$\Omega$ | MH88612BV-K<br>MH88612BV-4K |
| 5 | Input Impedance at VR | | | 100 | | $k\Omega$ | |
| 6 | Output Impedance at VX | | | 10 | | $\Omega$ | |
| 7 | Gain 2-wire to VX<br><br>Gain relative to Gain @ 1kHz | | -1.3<br><br>-0.3 | -1.0 | -0.7<br><br>+0.3 | dB | Input + 3dBm,<br>1kHz across Tip and Ring<br>300-3400 Hz |
| 8 | Gain VR to 2-wire<br><br><br>Gain relative to Gain @ 1kHz | | -1.3<br><br><br>-0.3 | -1.0 | -0.7<br><br><br>+0.3 | dB<br><br><br>dB | Input 0.5Vrms 1kHz at VR<br>$Z_{Load}$ = 600$\Omega$<br>300 - 3400 Hz |
| 9 | 2-wire Return Loss over 300-3400Hz | | 20 | 30 | | dB | Input 0.5Vrms,<br>1kHz across Tip and Ring<br>$Z_{Load}$= 600$\Omega$ |
| 10 | Transhybrid Loss | THL | 20 | 30 | | dB | 300-3400 Hz<br>$Z_{Load}$= 600$\Omega$ |
| 11 | Longitudinal to Metallic<br>Balance | | 40<br>46 | 55<br>55 | | dB<br>dB | 300-600Hz<br>600-3400Hz |
| 12 | Total Harmonic Distortion<br>at VX<br><br>at Tip and Ring | THD | | <br>0.1<br><br>0.1 | <br>1.0<br><br>1.0 | <br>%<br><br>% | Input + 3dBm,<br>1kHz across Tip and Ring<br>Input 1.0Vrms 1kHz at VR |
| 13 | Common Mode Rejection Ratio<br>2-wire to VX | CMRR | <br>40 | <br>50 | | dB | Input 0.5Vrms, 1kHz |
| 14 | Idle channel Noise | Nc | | | +14 | dBrnC | @ 2 Wire and VX<br>C- Message weighted |
| 15 | Power supply rejection ratio<br>$V_{CC}$<br>$V_{EE}$<br>$V_{BAT}$ | PSRR | <br>26<br>26<br>26 | | | <br>dB<br>dB<br>dB | 100 m$V_{PP}$ ripple, 1kHz on $V_{CC}$/$V_{EE}$/$V_{BAT}$, measure at VX and across Tip and Ring |

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

0.08 Max 0.12 Max
(2.03 Max)(3.05 Max)

2.02 Max
(51.30 Max)

0.50 max
(12.70 max)

1

0.02 ± 0.005
(0.51 ± 0.13)

0.18 ± 0.02
(4.57 ± 0.51)

0.01 ± 0.002
(0.25 ± 0.05)

*0.05 ± 0.02
(1.27± 0.51)

*0.10± 0.01
(2.54 ± 0.25)

**Notes:**

1) Not to scale

2) Dimensions in inches.
   (Dimensions in millimetres)

3) Pin tolerances are non-accumulative.

4) Recommended soldering conditions:
   wave soldering max. temp: 260˚C for
   10 secs.
   * Dimensions to centre of pin.

**Figure 4 - Mechanical Data**

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