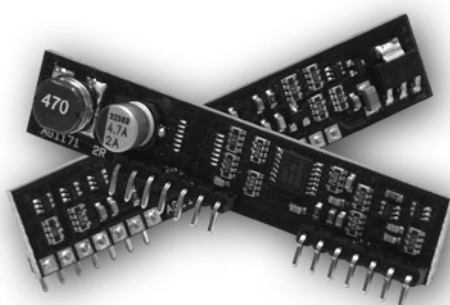




# Ag1171

+3.3V / +5.0V Low Power Ringing SLIC



## Features

- A highly featured low power SLIC in a 14 pin SIL format.
- Integral high efficiency DC/DC converter. Single supply voltage: +3.3V to +5.0V.
- Highly integrated with an on-board ringing generator.
- Tip/Ring polarity reversal. On-Hook Transmission for caller line ID.
- Suitable for FCT applications.
- Easy to use, with a minimum number of external components.
- Simplified protection in "on-premise" applications.
- Silvertel "design-in" assistance

## Description

The Silvertel Ag1171 is a single Subscriber Line Interface Circuit (SLIC) in a 14 pin single in line (SIL) format. The combination of features and packaging offers extremely efficient use of board area, saving significant system size and cost, minimising time to market for Telephony Systems developers.

The Ag1171 has been designed to work with loop lengths of typically 1.0km (470R including telephone).

The Ag1171 has integral dc/dc converter and ringing generation thus providing all the line powering requirements from a single supply. The Ag1171 requires a minimum of external components, making it ideal for low line count, short loop length applications, such as WLL Terminal (WLL), Fixed Cellular Terminals (FCT), Fixed Wireless Terminals (FWT) and Internet Telephony (VoIP).

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## 1. Ag1171 Product Selector

| Part Number | Impedance | Package | Supply Voltage  | Marking |
|-------------|-----------|---------|-----------------|---------|
| Ag1171      | 600 ohm   | SIL     | 3.3 to 5.0 Volt |         |

Table 1: Ordering Information

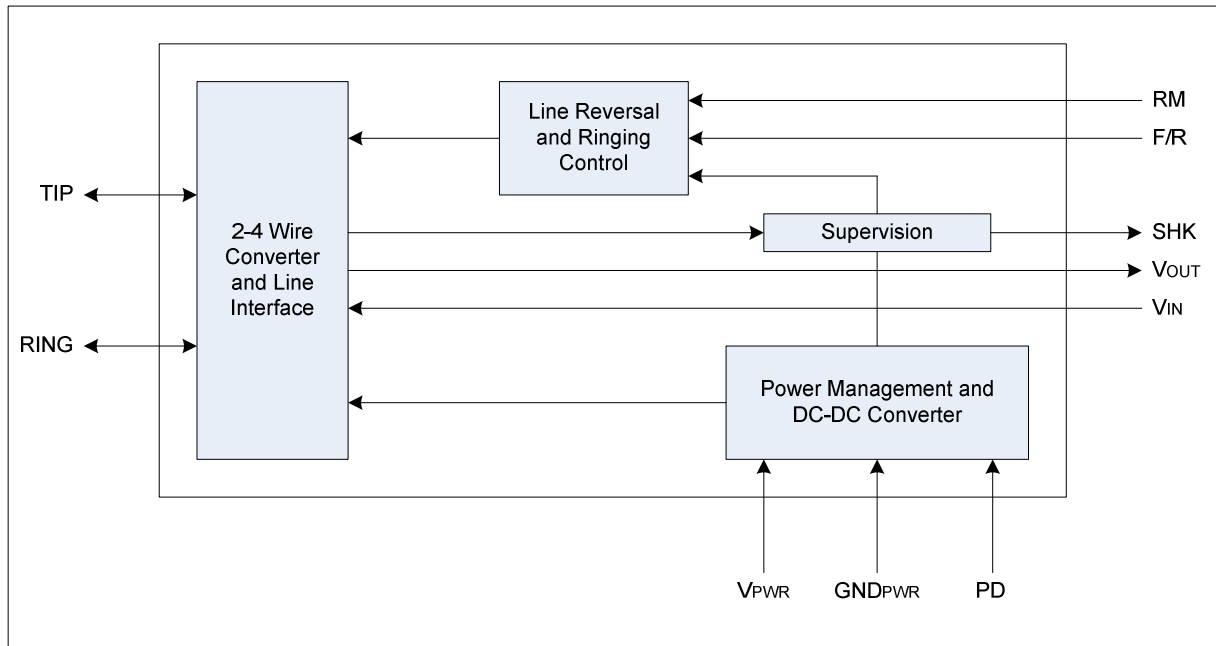
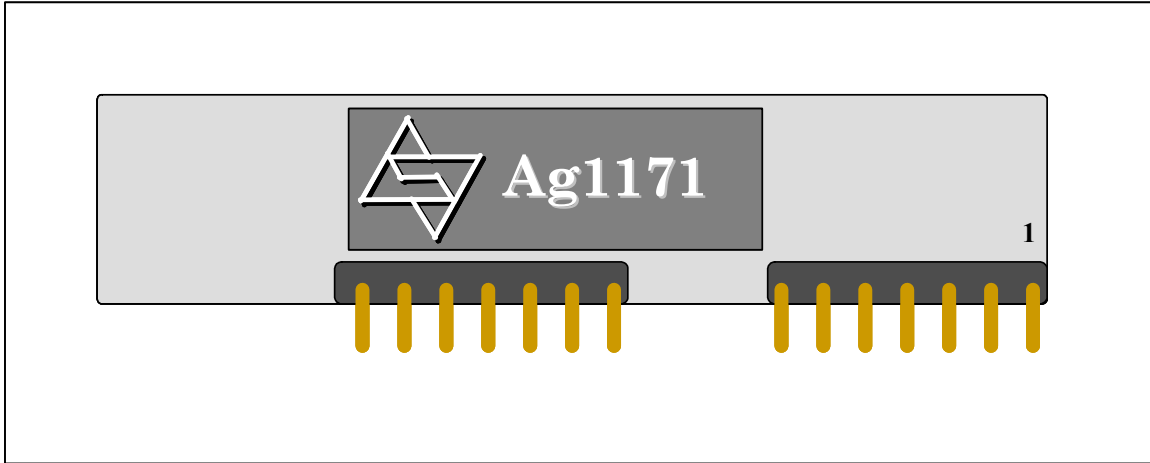


Figure 1: Block Diagram



**Figure 2: Ag1171 Package Format**

## 2. Pin Description

| Pin # | Name               | Description   |
|-------|--------------------|---|
| 1     | RING (B)           | <b>Ring.</b> Connects to the subscriber line Ring.  |
| 2     | TIP (A)            | <b>Tip.</b> Connects to the subscriber line Tip.  |
| 3     | F/R                | <b>Forward/Reverse.</b> A logic (L) will reverse the Tip and Ring voltage polarities. F/R is toggled to produce the ringing output. |
| 4     | RM                 | <b>Ringing Mode.</b> Sets bias conditions during ringing. Must be set to logic (H) during ringing. Logic (L) for other modes.       |
| 5     | SHK                | <b>Switch Hook.</b> Indicates an off-hook condition when at logic (H).  |
| 6     | NC                 | <b>No Connection.</b> Do not connect to this pin.   |
| 7     | NC                 | <b>No Connection.</b> Do not connect to this pin.   |
| 8     | NC                 | <b>No Connection.</b> Do not connect to this pin.   |
| 9     | V <sub>IN</sub>    | <b>Audio In.</b> Analog input signal from the Codec (which is output on Tip and Ring). Connect via a 10nF capacitor                 |
| 10    | V <sub>OUT</sub>   | <b>Audio Out.</b> This is the analog output signal (from Tip and Ring) to the Codec. Connect via a 100nF capacitor.                 |
| 11    | NC                 | <b>No Connection.</b> Do not connect to this pin.   |
| 12    | GND <sub>PWR</sub> | <b>DC/DC Ground.</b> Ground input for the DC/DC converter.  |
| 13    | +V <sub>PWR</sub>  | <b>DC/DC Supply.</b> +5.0V or +3.3V input for the DC/DC converter.  |
| 14    | PD                 | <b>Power Down DC/DC Converter.</b> A logic (L) on this pin powers down the Ag1171. DO NOT put logic (H) on this pin.                |

## 3. Functional Description

### 3.1. Line Interfacing

As well as being used in an electrically demanding environment, the needs of different applications and regulatory standards means that the SLIC must be flexible, and have facilities to ensure robust performance. The Ag1171 SLIC provides a complete and flexible interface to the telephone.

### 3.2. Battery Feed

The Ag1171 has an integral DC/DC converter, which generates the battery voltage in the device. This means that only a single supply of between +3.3V to +5.0V is needed, unlike conventional SLICs which will also need a battery voltage of anything between 20V and 60V ( 75V for ringing). This confers a significant cost, space and time to market benefit on the equipment designer.

The battery feed to the telephone line is generated from the positive supply rail. This provides a 48V battery feed to the line driver, which is adjusted automatically to match line conditions. In Forward mode the Ring voltage is negative with respect to the Tip voltage.

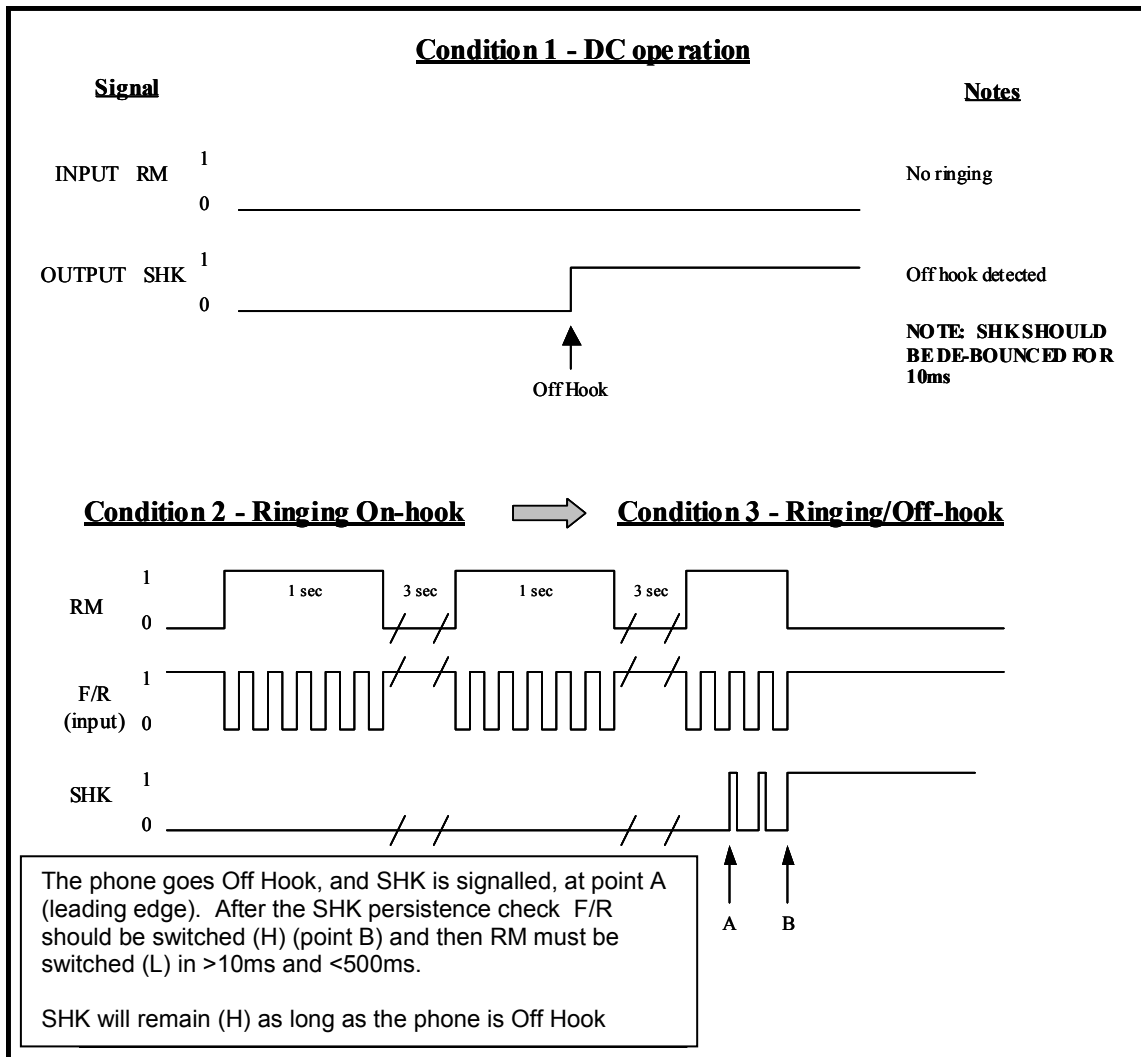
Power efficiency is good, because the line is supplied with only as much power as is needed. Little excess heat is generated, even on short lines. The loop current is pre-set to a constant 30mA, under the conditions shown in Section 10.3 of this datasheet, which specifies the 'DC Electrical Characteristics' for the Ag1171.

### 3.3. Ringing

The ringing signal is generated by switching the SLIC into ringing mode, by setting the RM pin high, and then toggling the F/R pin at the required frequency and cadence. The toggling of the F/R pin produces a balanced signal at Tip and Ring. These signal waveforms are shown in Figure 3. Ringing voltage of approximately 60Vrms is applied to a single telephone set. To limit power consumption RM should only be set (H) during ringing and set (L) at all other times.

During ringing the integral DC/DC converter is switched by RM (H) to produce a battery voltage of 72V. This will produce greater than 40Vrms into 3 telephones (with tone ringers). The slope of the edges on the ringing waveform is set internally to give the correct waveform with 20Hz to 25Hz ringing frequency.

When an "Off Hook" condition occurs during ringing, the Ag1171 detects the loop current and signals "Ring Trip" with pulses on the SHK output. The SHK signal must be "de-bounced" (persistence check) for 10ms to remove any spurious pulses. RM must not be switched (L) until >10ms after F/R is switched permanently (H). This allows any transient over voltages time to decay. The DC/DC controller limits the power so the Ag1171 can ring continuously with a ring-trip load. It is recommended to switch ringing Off with RM (L) in <500ms to limit the power dissipation. The ring-trip function will operate up to a loop resistance of typically 470R (equivalent to 1km of line with 300R telephone).



**Figure 3: Ringing Signal Waveforms**

### 3.4. Power Down and Synchronisation

The DC/DC converter can be switched off by applying a logic (L) level to the PD input. The SLIC takes 50ms to power up from this state. Logic outputs are not valid during this time. When using the power down function, it is recommended that the SLIC is polled (powered up periodically) to check for SHK (the subscriber has gone off-hook). If Power Down mode is not required, the PD pin should be left open circuit. The PD input should not be taken to a logic (H) as this may damage the SLIC. Connecting to PD via a diode will ensure it is never taken (H). NOTE: This is a sensitive node, keep connections very short.

The DC/DC has an internal oscillator. If desired for EMC reasons, the oscillator frequency may be synchronised with an external clock. To do this, a 64kHz square wave (with 50:50 mark space) should be input to the PD pin. See Applications Note: AN1171-1, for further details.



### **3.5. The 2-4 Wire (hybrid) Conversion**

The Ag1171 SLIC transmits and receives balanced 2 wire analog signals at the Tip and Ring connections. These are converted to a ground referenced output at VOUT and from a ground referenced input at VIN.

The VOUT and VIN pins are normally connected to a Codec or telephony DSP for conversion of audio to and from a digital format.

### **3.6. Transmit and Receive Gain**

The gain in both the transmit direction (Tip/Ring to VOUT) and the receive direction (VIN to Tip/Ring) is set to 0dB. Normally any gain adjustments required by the user can be made by programming the Codec or telephony DSP.

### **3.7. The 2 Wire Impedance**

The Ag1171 2 Wire impedance at Tip/Ring is set internally to 600R. It requires no external programming resistors.

### **3.8. Network Balance Impedance**

The Ag1171 network balance impedance, ZB, is set internally to 600R. It requires no external programming resistors.

### **3.9. Tip & Ring Polarity Reversal**

The Ag1171 can reverse the battery voltage polarity at Tip and Ring via the F/R pin.

If F/R is held at logic (H) (Forward) the d.c. voltage at Ring is negative with respect to Tip. If F/R is taken to logic (L) (Reverse) the voltage at Ring is positive with respect to Tip.

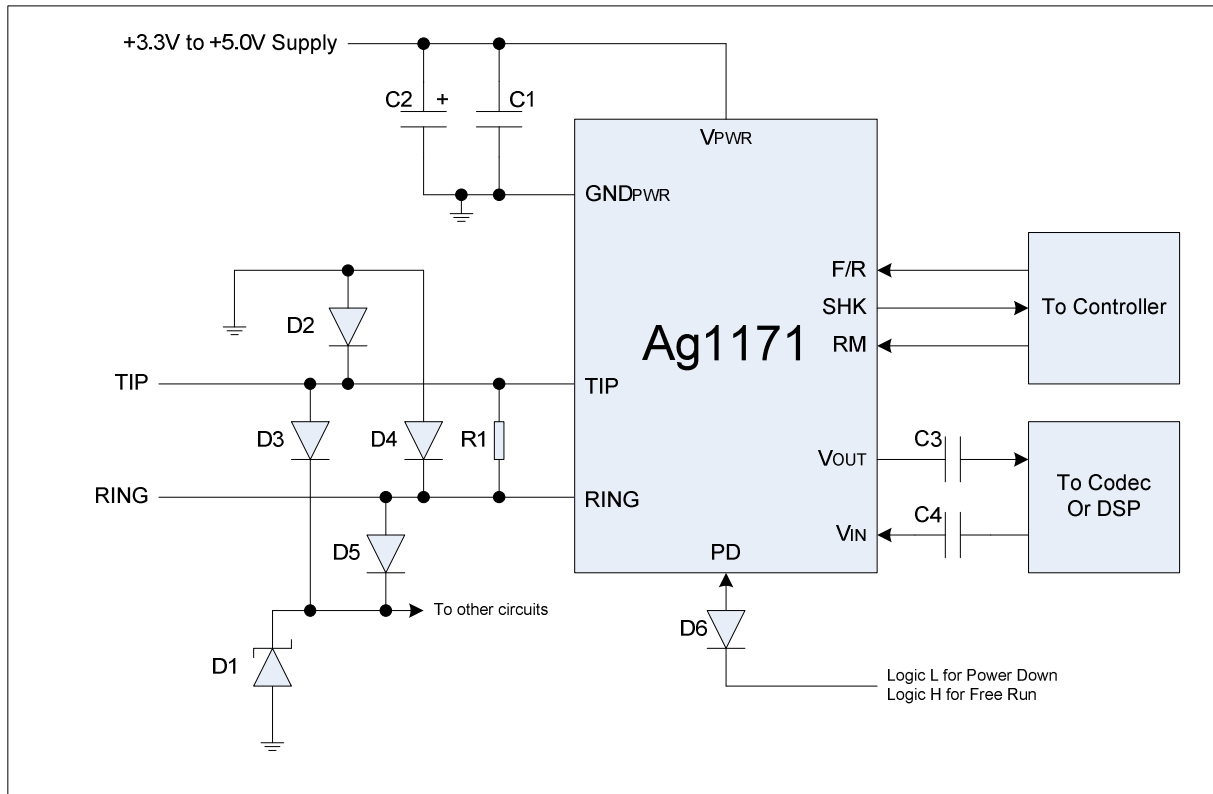
### **3.10. On Hook Transmission**

The Ag1171 is capable of on-hook transmission if an external resistor is fitted between pins 1 (Ring) and 2 (Tip).

This means analog signals can be transmitted from VIN through Tip and Ring and onto the line even when no external loop current is flowing. This can be used when sending Caller Line Identification (CLI) information or for other “no ring” calls.

The Ag1171 will provide on hook transmission of audio signals up to 0dBm (0.775V) with a high impedance on Tip/Ring or with AC loads down to 600R. To achieve this the external bias resistor should have a value of 20Kohms. This will increase the VPWR idle current by 35ma. A larger value of resistor will reduce the idle current but the maximum audio signal which can be transmitted will be reduced in proportion e.g. a 39Kohm bias resistor will allow audio signals up to -6dBm (0.387V) with an increase in idle current of 18mA.





**Components**

- C1, C3 = 100nF
- C4 = 10nF
- C2 = 470uF, 16V Aluminium Electrolytic (standard type)
- R1 = External DC bias resistor (required for CLI) typically 20K to 39K
- D1 = BZT03C82 or P6KE82 (only one needed per line card)
- D2 – 5 = 1N4004 or MB4S bridge
- D6 = 1N4148 or BAS16

**Figure 4: Typical Connection Diagram**

**3.11. Switch Hook Detection**

When the subscriber goes “off-hook” loop current will begin to flow. If this current is above the detection threshold the switch hook output, SHK, will switch to a logic (H). It is recommended that software or hardware de-bouncing of the switch hook signal is used. This is to avoid short pulses which can cause a false switch hook output, triggering the incorrect system response.

During loop disconnect dialling, SHK will pulse between logic (H) and logic (L) to indicate the digits being dialled. Again it is recommended that software de-bouncing of the pulse edges is used to avoid false detection of digits

## **4. Protection of the Ag1171 SLIC**

### **4.1. Thermal Protection**

Should the SLIC be operated incorrectly, for example by accidentally shorting Tip and Ring to each other or to ground, the power dissipation is automatically limited by the DC/DC converter

This feature means that the SLIC will always operate within its power limits, without overheating. When operating on very short lines the battery voltage is regulated to a low value. This limits the power dissipation and ensures the Ag1171 operates with a minimum temperature rise.

### **4.2. Overvoltage Protection**

The Ag1171 is designed for use short loop “on-premise” applications, such as FCT, FWT, WLL and VoIP. In this case power cross and lightning protection is not required. The only protection which should be required is for ESD (Electro Static Discharge) caused by handling during installation.

The Ag1171 has been designed to be able to use low cost ESD protection components. A typical circuit is shown in Figure 4. This circuit is suitable for most “on-premise” applications.

This circuit is the minimum overvoltage protection that should be used with the Ag1171. Operation with no overvoltage protection or with incorrect components (e.g. Varistors or Gas Discharge tubes) is strongly discouraged and will not be supported by Silvertel.

In ‘off-premise’ applications, a subscriber circuit will be required to withstand over voltage conditions which could be caused by lightning or overhead power cables striking the telephone cables. It is therefore normal in “off-premise” applications to provide additional primary and secondary protection circuits to prevent damage to the SLIC. For further information see application note ANX-Overvolt1. This is available on our website [www.silvertel.com](http://www.silvertel.com).

## **5. Typical Application**

The Ag1171 has been designed to interface to telephony Codecs or DSPs. Applications drawings for many codecs and DSP chips are available. Please contact Silvertel or visit our website [www.silvertel.com](http://www.silvertel.com). An example is shown in figure 4.

The status outputs from the SLIC are passed to the micro-controller. These signals can then be processed as necessary by the system software.

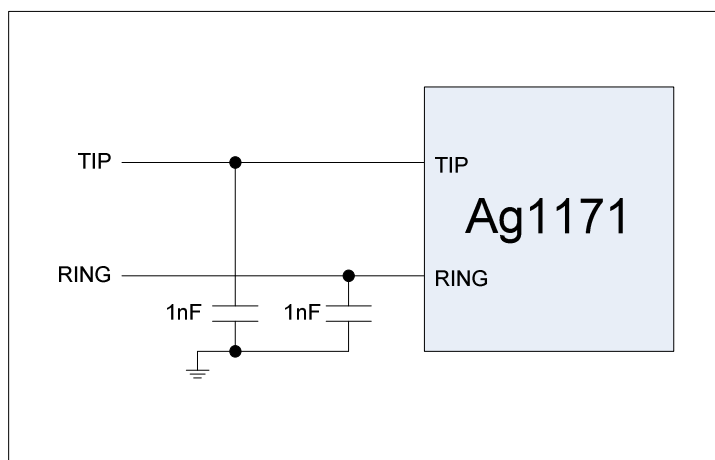
The audio signals which are on the 4 wire side of the connection are coupled by capacitors to avoid d.c. level problems between the two devices.

## 6. DC Supply Voltage

During operation the DC Supply Voltage MUST be regulated within the limits shown in the Electrical Characteristics – Section 10.0 of this datasheet. Use of a “clean” power supply is extremely important. Should the VCC supply rail go above the Absolute Maximum Rating of 7.0V, for even a short time, then permanent damage to the Ag1171 is likely to result.

We also advise that the designer performs a full system evaluation, under all possible performance conditions, to ensure that the VCC Maximum rating is not exceeded.

In some applications, additional EMI suppression may be needed. In this instance capacitors can be added to filter out the higher frequencies of the DC-DC converter. See figure 5 for details. Values between 1nF and 10nF are suitable.



**Figure 5: Optional EMI Suppression**

## 7. Layout Considerations

### 7.1. Power and Ground

Tracks to the +VPWR and GNDPWR should be made as thick as possible. To maximise the performance of the device, signal tracks should be kept as short as possible. To reduce DC/DC noise capacitors up to 10nF may be connected to ground at Tip and Ring.

## 8. Electrical Characteristics

### 8.1. Absolute Maximum Ratings\*

|   | Parameter                                  | Symbol     | Min  | Max  | Units |
|---|--|------------|------|------|-------|
| 1 | DC Supply Voltage                          | $V_{CC}$   | -0.3 | 7.0  | V     |
| 2 | Maximum Power Dissipation, Off Hook @ 25°C | $P_{SLIC}$ |      | 1.2  | W     |
| 3 | Storage Temperature                        | $T_S$      | -40  | +100 | °C    |
| 4 | Duty Cycle for RM(H)                       |            |      | 33   | %     |

\*Exceeding the above ratings may cause permanent damage to the product. Functional operation under these conditions is not implied. Maximum ratings assume free airflow.

### 8.2. Recommended Operating Conditions\*

All Voltages are with respect to ground unless otherwise stated.

|   | Parameter             | Symbol   | Min | Typ | Max | Units |
|---|-----------------------|----------|-----|-----|-----|-------|
| 1 | DC Supply Voltage     | $V_{CC}$ | 3.1 |     | 5.5 | V     |
| 2 | Operating Temperature | $T_{OP}$ | 0   | 25  | 70  | °C    |

\*Typical figures are at 25°C with nominal +5.0V/+3.3V supplies and are for design use only. They are not guaranteed. It is important that the user performs a full system evaluation, under all possible performance conditions, to ensure that the VCC Maximum rating is not exceeded.

**8.3. DC Electrical Characteristics\***

|    | DC Characteristic   | Sym                  | Min  | Typ*       | Max        | Units    | Test Comments  |
|----|---|----------------------|------|------------|------------|----------|--|
| 1  | Supply Current, on-hook<br>@ 5.0V<br>@ 3.3V                         | $I_{VPWR}$           |      | 60<br>70   | 90<br>105  | mA<br>mA | CLI bias resistor<br>not fitted                              |
| 2  | Supply current ringing 1 REN<br>@ 5.0V<br>@ 3.3V                    | $I_{RINGING}$        |      | 330<br>350 | 480<br>500 | mA<br>mA | $R_{LOOP} = 0R$<br>Load = 1 REN                              |
| 3  | Supply current, off-hook<br>@ 5.0V<br>@ 3.3V                        | $I_{ACTIVE}$         |      | 290<br>360 | 400<br>450 | mA<br>mA | $R_{LOOP} = 0R$<br>Load = 300R                               |
| 4  | Supply current during ring trip<br>(<1 sec max)<br>@ 5.0V<br>@ 3.3V |                      |      | 330<br>350 |            | mA<br>mA | $R_{LOOP} = 0R$<br>Load = 300R                               |
| 5  | Supply current in power down  | $I_{PD}$             |      | 7<br>5     |            | mA<br>mA | @ 5.0V<br>@ 3.3V   |
| 6  | Wake-up time  |                      |      | 50         |            | ms       | Logic outputs not<br>valid for this time                     |
| 7  | SHK debounce time   |                      |      | 10         |            | ms       |  |
| 8  | RM (H) persistence time   |                      | 10   |            |            |          | After ring trip  |
| 9  | Constant current feed to line<br>@ 5.0V<br>@ 3.3V                   | $I_{LOOP}$           |      | 30<br>26   |            | mA<br>mA | Load = 300R  |
| 10 | Tip/Gnd or Ring/Gnd or<br>Tip&Ring/Gnd overcurrent                  |                      |      | 45<br>50   |            | mA<br>mA | RM = L<br>RM = H   |
| 11 | Off-Hook detect @5.0V<br>Output Low Voltage<br>Output High Voltage  | $V_{OL}$<br>$V_{OH}$ | 4.5  |            | 0.5        | V<br>V   | 100uA max output<br>(with 3.3k internal<br>pull-up resistor) |
| 12 | Off-Hook detect @3.3V<br>Output Low Voltage<br>Output High Voltage  | $V_{OL}$<br>$V_{OH}$ | 2.8  |            | 0.5        | V<br>V   |  |
| 13 | Control Inputs, F/R, RM<br>Input Low Voltage<br>Input High Voltage  | $V_{IL}$<br>$V_{IH}$ | 3.5  |            | 0.5        | V<br>V   | @ 5.0V   |
|    |   | $V_{IL}$<br>$V_{IH}$ | 2.0  |            | 0.5        | V<br>V   | @ 3.3V   |
| 14 | Control Inputs, F/R, RM<br>Input low current<br>Input high current  | $I_{IL}$             | -0.5 |            | 0.5        | mA       |  |
|    |   | $I_{IH}$             | -0.5 |            | 0.5        | mA       |  |
| 15 | Control Inputs, PD<br>Input Low Voltage<br>Input High Voltage       | $V_{IL}$<br>$V_{IH}$ | 2.0  |            | 0.5        | V<br>V   | @ 5.0V   |
|    |   | $V_{IL}$<br>$V_{IH}$ | 2.0  |            | 0.5        | V<br>V   | @ 3.3V   |

|    | DC Characteristic   | Sym                  | Min          | Typ* | Max        | Units    | Test Comments |
|----|---|----------------------|--------------|------|------------|----------|---------------|
| 15 | Control Inputs, PD<br>Input low current<br>Input high current | $I_{IL}$<br>$I_{IH}$ | -0.5<br>-0.5 |      | 0.5<br>0.5 | mA<br>mA |               |

1) All DC Electrical Characteristics are over the Recommended Operating Conditions with  $V_{CC}$  at +5.0V  $\pm$ 1%, or +3.3V  $\pm$ 1%, unless otherwise stated.

2) Operating currents are dependent on the users application.

\*Typical figures are at 25°C and are for design aid only. Not Guaranteed

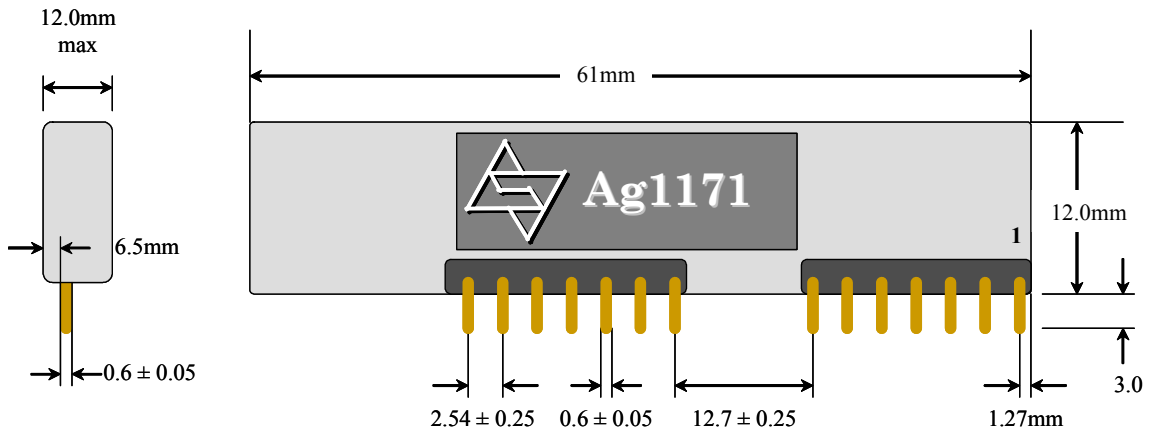
#### 8.4. AC Electrical Characteristics\*

|    | AC Characteristic   | Sym   | Min            | Typ*     | Max  | Units            | Test Comments                          |
|----|---|-------|----------------|----------|------|------------------|--|
| 1  | SHK Detect Time   |       |                | 5        |      | ms               | No Ringing                             |
| 2  | Ring Trip Capability  |       |                |          | 470  | ohm              | Includes telephone set                 |
| 3  | Input Impedance at $V_{IN}$   |       |                | 60       |      | kohm             |  |
| 4  | Output impedance at $V_{OUT}$   |       |                |          | 10   | ohm              |  |
| 5  | Ringing Capability at 40V <sub>rms</sub>                                |       |                | 3        |      | phone            | note 3                                 |
| 6  | Ringing voltage   |       |                | 65       |      | V <sub>rms</sub> | No load @ 20Hz                         |
| 7  | Absolute Voltage Gain, 2 Wire to $V_{OUT}$                              |       | -0.75          | 0        | 0.75 | dB               | Off-Hook                               |
| 8  | Absolute Voltage Gain $V_{IN}$ to 2Wire                                 |       | -0.75          | 0        | 0.75 | dB               | Off-Hook                               |
| 9  | Relative Gain. Referenced to 1kHz. 2Wire - $V_{OUT}$ , $V_{IN}$ - 2Wire |       | -0.5           |          | 0.5  | dB               | Over frequency range 300 to 3400 Hz    |
| 10 | Overload Distortion @2 Wire and $V_{OUT}$                               | OD    |                | 0.5<br>5 | 1    | %<br>%           | @+3dBm, 1kHz<br>@+6dBm, 1kHz           |
| 11 | Idle Channel Noise  | $N_c$ |                | 5        | 18   | dBrnC            | @2 Wire & $V_{OUT}$                    |
| 13 | Return Loss   | RL    | 16<br>18       |          |      | dB               | 300 - 500 Hz<br>500Hz - 3400Hz         |
| 14 | Transhybrid Loss  | THL   | 12<br>21<br>16 |          |      | dB<br>dB<br>dB   | 300-500Hz<br>500-2500Hz<br>2500-3400Hz |
| 15 | Load on $V_{OUT}$   |       |                | 10       |      | kohm             | Coupling capacitor = 100nF             |
| 16 | Tip-Ring Reversal Settling Time   |       |                |          | 50   | ms               | To within +20% of set $I_{LOOP}$       |

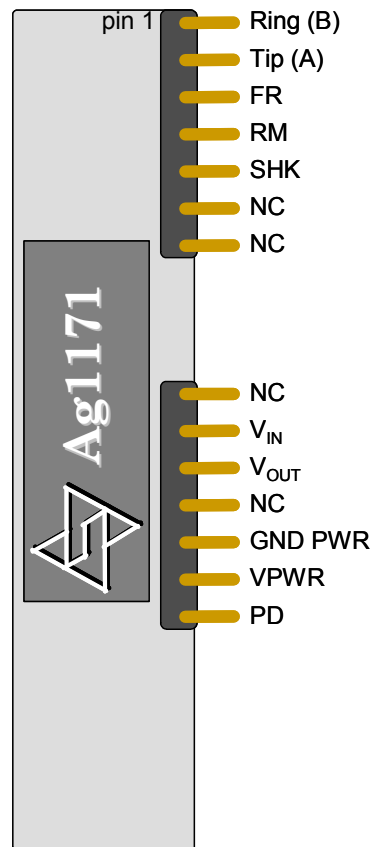
3) This applies to 3 phones with tone ringers or 2 phones with mechanical bells.

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

## 9. Package



Dimensions are nominal unless otherwise stated



Silvertel recommends the use of 2.54mm sockets, especially on prototype and pre production boards.

Recommended PCB hole diameter =  $1.1 \pm 0.05$  mm

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