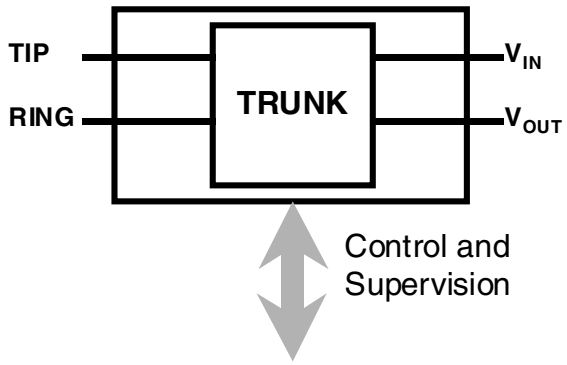
Silver TELECOM

Ag2120

FULLY FEATURED PSTN INTERFACE



FEATURES

- A highly featured PSTN Interface (COIC, FXO, DAA, Trunk Interface) in a single DIL or 12mm high SIL device.
- +5V or +3.3V supply.
- Transformer isolation providing high common mode rejection (CMRR) for use in un-grounded systems.
- Highly integrated with on board loop switch and integral diode bridge.
- Loop start circuit, ringing detect and loop current detection. Parallel phone detect.
- Tip-ring polarity reversal detect (for Caller Line ID and remote metering) and on-hook reception.
- Meets requirements of EN60950/UL1950, and FCC Pt68. Low cost power cross protection.
- Programmable d.c. mask, line and network impedances.
- Silver Telecom “design-in” assistance.

DESCRIPTION

The Ag2120 is a self-contained highly integrated PSTN Interface Circuit in a single SIL or DIL Module.

In addition to the features listed, the Ag2120 allows flexible programming of many functions, including the dc voltage mask and impedances. The Ag2120 meets international safety and regulatory requirements.

The device requires a minimum of external components and has been specified for ease of use, to reduce time to market.

The Ag2120 is designed for all applications, including those where there is a high level of common mode interference, such as PABX, long loop applications and systems without a ground.

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Ordering Information

Ag2120D Fully featured Trunk in DIL package
Ag2120S Fully featured Trunk in SIL package



Figure 1: Ag2120D - DIL Packaging Format

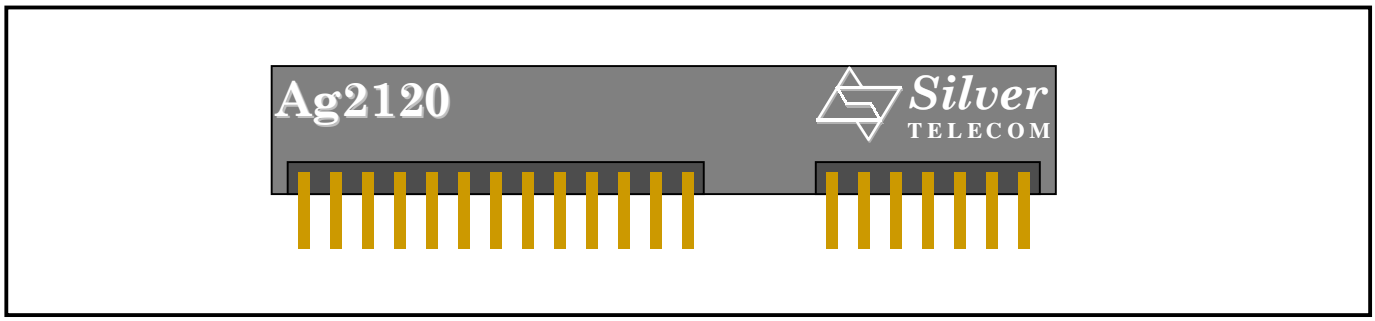


Figure 2: Ag2120S - SIL Packaging Format

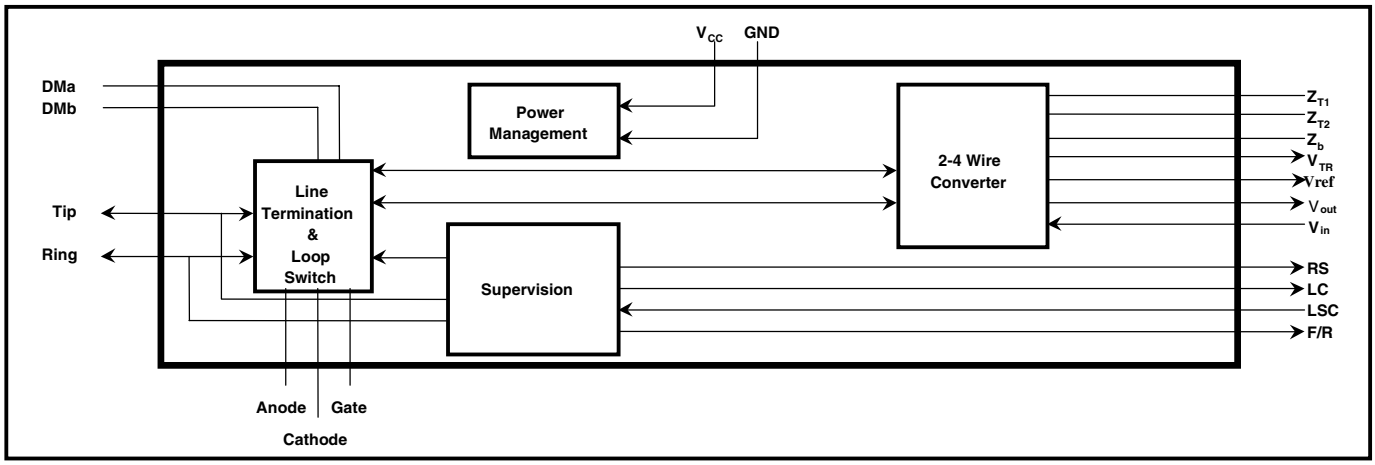


Figure 3: Functional Block Diagram

1.0 Pin Description

1.1 DIL Pin-Out

Pin #	Name	Description
1	**TIP (A)**	**Tip.** Connects to the subscriber line Tip.
2	**RING (B)**	**Ring.** Connects to the subscriber line Ring.
3	**CATHODE**	**Cathode.** For power cross protection connect to protection device cathode.
4	**ANODE**	**Anode.** For power cross protection connect to protection device anode.
5	**DMa**	**DC Mask a.** A resistor is connected between this pin and DMb to adjust the d.c. characteristics of the termination.
6	**DMb**	**DC Mask b.** A resistor is connected between this pin and DMa to adjust the d.c. characteristics of the termination.
7	**GATE**	**Gate.** For power cross protection connect to protection device gate.
8	**GND**	**Analog ground.** Normally connected to system ground.
9	**V_{CC}**	**Positive supply.** Must be connected to +5V or +3.3V.
10	**Z_{T2}**	**2 Wire matching network 2.** The 2 wire impedance matching network is connected between this pin and Z_{T1}. The compensation impedance Zc is connected between this pin and Zb.
11	**Z_{T1}**	**2 Wire matching network 1.** The 2 wire impedance matching network is connected between this pin and Z_{T2}.
12	**Z_b**	**Balance network.** The network balance matching components are connected between this pin, V_{IN} and GND.
13	**V_{IN}**	**Audio In.** This is the analog input signal from the Codec (which is output on Tip and Ring). Connected via a 100nF capacitor.
14	**nc**	**No connect.** This pin is not used and can be left open circuit.
15	**V_{OUT}**	**Audio Out.** This is the analog output signal (from Tip and Ring) to the Codec. Connected via a 100nF capacitor.
16	**F/R**	**Forward/reverse.** A logic 1 indicates that the Tip and Ring polarities are reversed. i.e. Tip is negative with respect to Ring.
17	**LC**	**Loop current.** A logic 1 Indicates that loop current is flowing.
18	**LSC**	**Loop switch control.** Applying a logic 1 closes the integral loop switch.
19	**RS**	**Ringing signal.** A logic 0 indicates the presence of ringing voltage on the telephone line. Toggles at ringing frequency.
20	**V_{REF}**	**Reference voltage.** Used with V_{TR} to detect off-hook parallel phone. Normally left open circuit. Approx. +1.9V
21	**V_{TR}**	**Tip/Ring voltage.** Indicates the voltage at Tip/Ring. Divided by 50 and relative to Vref.

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1.2 SIL Pin-Out

Pin #	Name	Description
1	**RING (B)**	**Ring.** Connects to the subscriber line Ring.
2	**TIP (A)**	**Tip.** Connects to the subscriber line Tip.
3	**CATHODE**	**Cathode.** For power cross protection connect to protection device cathode.
4	**ANODE**	**Anode.** For power cross protection connect to protection device anode.
5	**GATE**	**Gate.** For power cross protection connect to protection device gate.
6	**DMb**	**DC Mask b.** A resistor is connected between this pin and DMa to adjust the d.c. characteristics of the termination.
7	**DMa**	**DC Mask a.** A resistor is connected between this pin and DMb to adjust the d.c. characteristics of the termination.
8	**LC**	**Loop current.** A logic 1 Indicates that loop current is flowing.
9	V_{IN}	**Audio In.** This is the analog input signal from the Codec (which is output on Tip and Ring). Connected via a 100nF capacitor.
10	V_{OUT}	**Audio Out.** This is the analog output signal (from Tip and Ring) to the Codec. Connected via a 100nF capacitor.
11	**LSC**	**Loop switch control.** Applying a logic 1 closes the integral loop switch.
12	**GND**	**Analog ground.** Normally connected to system ground.
13	V_{CC}	**Positive supply.** Must be connected to +5V or +3.3V.
14	**F/R**	**Forward/reverse.** A logic 1 indicates that the Tip and Ring polarities are reversed. i.e. Tip is negative with respect to Ring.
15	Z_b	**Balance network.** The network balance matching components are connected between this pin, V_{IN} and GND.
16	Z_{T2}	**2 Wire matching network 2.** The 2 wire impedance matching network is connected between this pin and Z_{T1}. The compensation impedance Zc is connected between this pin and Zb.
17	Z_{T1}	**2 Wire matching network 1.** The 2 wire impedance matching network is connected between this pin and Z_{T2}.
18	**RS**	**Ringing signal.** A logic 0 indicates the presence of ringing voltage on the telephone line. Toggles at ringing frequency.
19	V_{REF}	**Reference voltage.** Used with V_{TR} to detect off-hook parallel phone. Normally left open circuit. Approx. +1.9V
20	V_{TR}	**Tip/Ring voltage.** Indicates the voltage at Tip/Ring. Divided by 50 and relative to Vref.

2.0 Line Interfacing

The Ag2120 line interface provides a flexible and robust interface to the telephone line. It has been designed to meet regulatory standards whilst providing a space and power efficient solution.

2.1 D.C. Termination.

Any equipment terminating a telephone line must present the correct d.c. resistance to the line. This ensures that the correct current flows to be able to detect the off hook condition, avoids excessive power dissipation in the Subscriber Line Interface (SLIC) and the Subscriber's equipment, and minimises the size of power supply needed to drive the SLIC.

The Ag2120 has been designed to meet the requirements of many network operators. This is done by making the d.c. characteristic adjustable. These are controlled by connecting the DM pins on the line side of the circuit. Table 1 shows how these are connected.

Table 1 Set Up of the DM Pins

Market	DMa	DMb
North America (EIA 464, Resistive)	Connect together through 390K resistor	
Europe (CTR21)	Connect together through 390K resistor	
Far East	Connect together through 390K resistor	

2.2 Signalling and Loop Status.

The Ag2120 provides facilities to monitor and control the telephone line. This allows the device to be used with a variety of loop signalling schemes and minimises the number of external components needed to implement a complete line interface.

In order to implement ground start applications please contact Silver Telecom or our local representative.

2.2.1 The On-Board Loop Switch

The Ag2120 implements the loop start protocol when initiating and answering a call. This means that a switch must be closed to allow loop current to flow, signalling to the SLIC that the terminating equipment has gone "off-hook". This has been done historically by a relay. The Ag2120 uses an integral optically isolated switch to do this, eliminating the need for an external relay, so space and cost is saved for the user.

The on-board Loop Switch is controlled by the LSC pin. A logic 1 applied to the pin closes the loop switch. This is done when the terminating equipment wishes to begin a call or in response to the reception of the ringing signal. The LSC pin can be controlled by the output drive pins of a Codec or from a micro controller device.

Once the Loop Switch has been closed confirmation that loop current is flowing is provided by the LC pin. This can be used for fault detection and for call clear detection.

2.2.2 Ringing Detection and Sensitivity.

The terminal equipment must be capable of detecting and responding to an incoming call in the same way as a telephone set. The termination circuitry must, therefore, detect the presence of the ringing signal.

The Ag2120 provides an output, RS, which indicates the presence of ringing by switching from a logic 1 to logic 0. The RS output will toggle at the ringing frequency. A capacitor to ground can also be added if ringing cadence is needed rather than the ringing frequency.

The sensitivity to ringing is set internally to $22V_{RMS}$ when V_{CC} is +5V, or $14V_{RMS}$ when V_{CC} is +3.3V.

2.2.3 Reversal Detect

The reversal of the battery polarity is used as a signalling technique. The Ag2120 can detect this condition and provides an output on the F/R pin, whether in the on-hook or off-hook state.

One example of this type of signalling is in Caller Line ID in the United Kingdom, where a battery polarity reversal precedes the transmission of data before the ringing signal is applied to the line. Another example is in some systems in the US where a reversal is used to indicate far end answer.

3.0 The 2-4 Wire (Hybrid) Conversion.

The Ag2120 transmits and receives balanced 2-wire analog signals at the Tip and Ring connections. These are converted to a ground referenced output at V_{OUT} and from a ground referenced signal at V_{IN}.

V_{OUT} and V_{IN} are normally connected to a Codec (via d.c. blocking capacitors) for conversion to and from a Pulse Code Modulated (PCM) stream.

3.1 Transmit and Receive Gain.

The gain in both the transmit and receive directions is set at 0dB. Any gain adjustments can be made using the Codec functionality. This is either by hardware or software depending upon the Codec used.

eg.	2-wire Impedance	Z_T	Z_C	Network Balance Impedance	Z_{b1}	Z_{b2}	Z_{b3}	C3	Notes
1	600Ω	300Ω	47K	600Ω	100K	0R	---	---	USA Short Line, Far East, Middle East
2	CTR21	TBA	TBA	CTR21	TBA	TBA	TBA	TBA	Europe
3	600Ω	300Ω	TBA	AT&T compromise	TBA	TBA	TBA	TBA	USA Long Line

Table 2: Line and Network Balance Impedance Examples

3.2 The 2 Wire Impedance

The input impedance, Z_{IN}, of the Ag2120 can be programmed. This is achieved by connecting an impedance matching network between Z_{T1} and Z_{T2}. This network is the line impedance to be matched minus 300Ω. For example to match 600Ω, fit a 300Ω resistor. Other common line impedances, and the corresponding programming components are listed in Table 2.

In addition to the programming network, an impedance, Z_{FC}, must be fitted between ZT2 and Zb to provide frequency compensation.

An alternative method of programming the 2 wire impedance is to choose a codec where the internal filter characteristics can be programmed to provide the correct matching. In order to generate the filter coefficients a model of the Ag2120 must be used. This file, in .CIR format is available on request from Silver Telecom or one of our representatives.

Full details on how the Codec is programmed must be obtained from the Codec manufacturer.

3.3 Network Balance Impedance

The setting of the network balance impedance is very similar to that of the 2 wire impedance. Again this can be done by programming of the Codec, using the .CIR file, or it can be done by hardware components.

3.4 On-Hook Reception

The need to provide the facility for data exchange On-Hook is becoming increasingly common, whether for Caller Line I.D. or for telemetry purposes. The

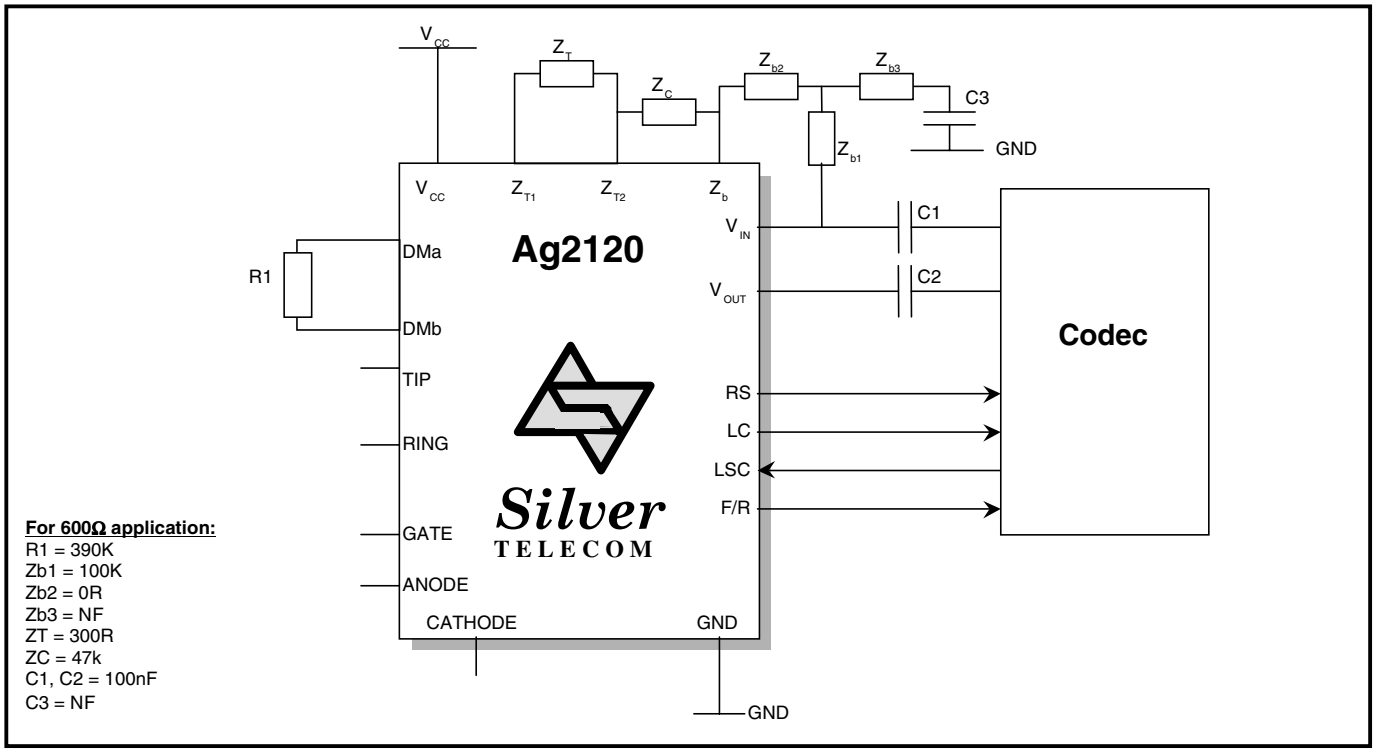


Figure 4: Line Impedance and Network Balance Components

Ag2120 can receive signals On-Hook, presenting a high impedance to the line, i.e. while drawing a very small current (5μA approx) from the line.

3.5 Ringer Load Networks

The "dummy ringer" is usually a capacitive/resistive load which is connected across TIP/RING. During a call it is of sufficiently high impedance not to affect the operation of the interface. The Ag2120 meets the dummy ringer requirements for CTR21 (Europe), USA and Asia.

4.0 Device Protection.

As with many of the requirements which must be met by the Ag2120 the device protection is dependent upon regulatory standards in the market in which the equipment is deployed. Some examples are given below, but these are not exhaustive.

For a more comprehensive overview of protection refer to the Silver Telecom protection applications note, which is available directly form Silver Telecom, via our web-site (www.silvertel.com), or through our local representative.

4.1 FCC Pt 68 Requirements.

To withstand the FCC Pt68 longitudinal voltage surge of 1500V no protection is required as the barrier will withstand 1500V peak voltage to GND.

To withstand the FCC Pt68 metallic surges at 800V requires a 130V AC varistor (which clamps at 300V which is the rating of the loop switch transistor). A 14mm device should be used to withstand the two 100A 10/560us surges.

Examples of suitable devices are:-
Joyin JVR-14N201K;
Walsin VZ14D201KBS

Note: If varistors to ground are used for added protection (e.g. more than 1500V) customers should be aware that the FCC test generator for longitudinal tests is rated at up to 1000A. 10Ω 2W wire wound surge limiting resistors will also be needed.

4.2 UL1459 and UL1950 Protection.

To meet the UL1459 and UL1950 mains cross test 22Ω 2W wire wound surge resistors and 0.35A special fuses (Bussman C515 or Littelfuse 220003) in a balanced configuration are required. Alternatively a Teccor F1250T fuse may be used without surge limiting resistors.

It is also possible to use PTC thermistors to meet these tests. The Raychem TR600-150 is designed for this application. See Raychem application notes for further details.

A typical application is shown in figure 6a.

4.3 Other Standards.

The Ag2120 has provision for low cost mains cross protection (CCITT K21): a 47Ω 2W wire wound surge resistor and a PTC thermistor are sufficient to meet regulatory approvals. A suitable device is the Walsin PTD3A350H26. (Metallic protection with a single device is all that is required as the Ag2120 will withstand longitudinal voltages up to 1000Vrms to ground without additional protection).

As an option, for improved off-hook power cross

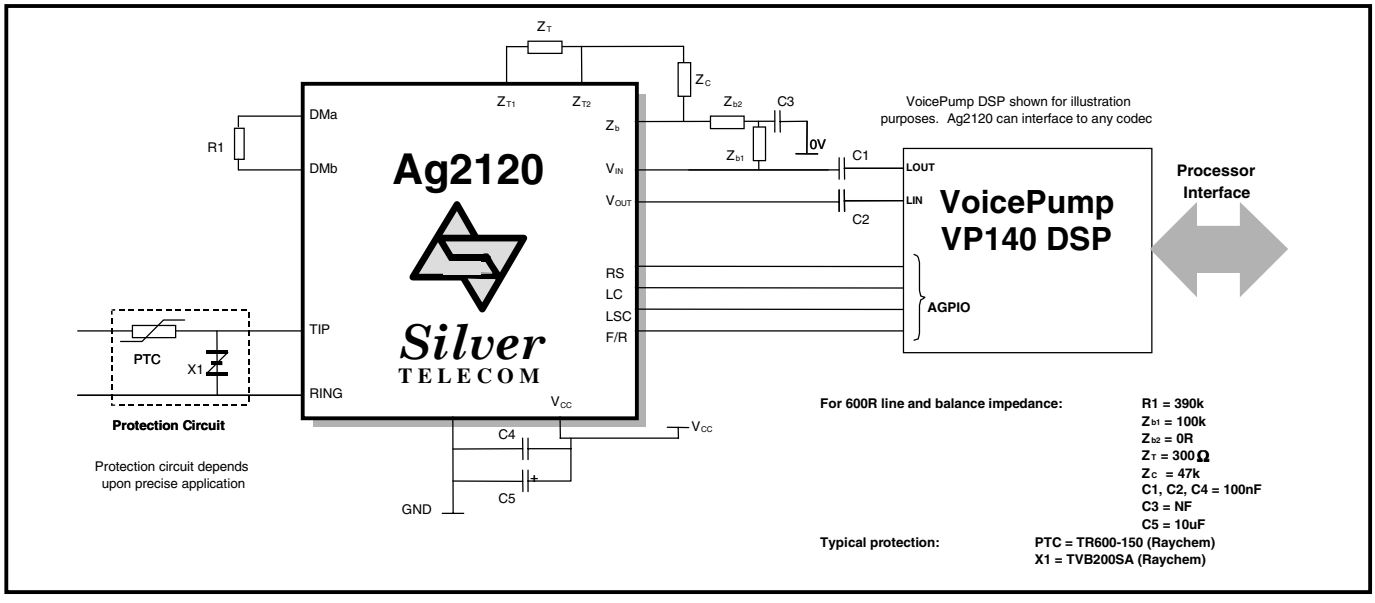


Figure 5: Typical Application

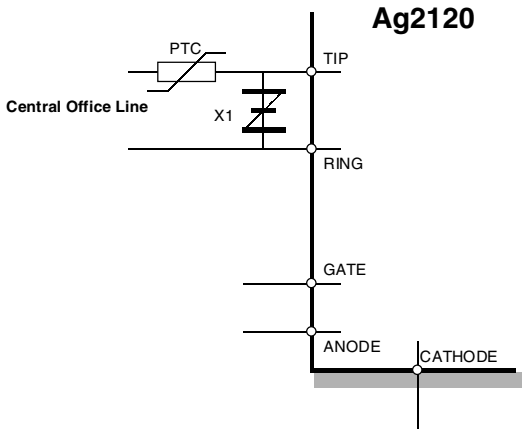


Fig 6a: Standard Protection

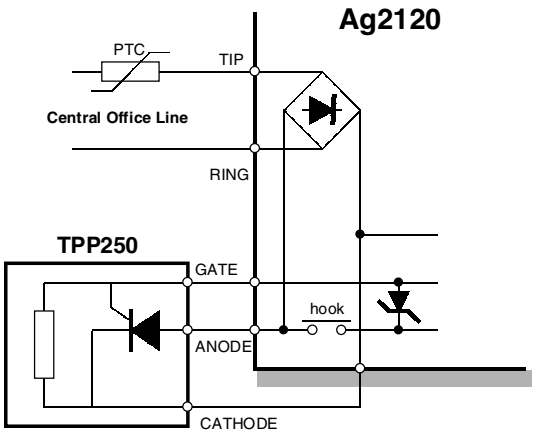


Fig 6b: Protection for Off-hook

Figure 6: Protection Options

protection, the Ag2120 has been designed to interface directly to the STM TPP25011.

This protection arrangement is shown in figure 6b.

5.0 Regulatory Standards

There are some aspects of international standards which are not fully met by the Ag2120. These are shown below. It is Silver Telecom's policy to bring to the attention of customers all known exceptions.

The Ag2120 meets the requirements of EN60950 (1992) paragraph 6.2.1.2 for all countries except Norway and Sweden. Please contact Silver Telecom if the product is needed for Norway or Sweden.

User/Network safety from mains power voltage (UL1950/EN60950 paragraphs 2.1.1 and 6.2.1.4) must be provided externally by a power supply with reinforced or double insulation.

6.0 Layout

Signal tracks should be kept as short as possible. Special attention should be paid to DMa and DMb, as these are sensitive nodes.

7.0 Absolute Maximum Ratings*

All Voltages are with respect to ground unless otherwise stated.

	Parameter	Sym	Min	Max	Units
1	DC supply voltage	V_{CC}	-0.3	6.0	V
2	DC battery voltage present between Tip and Ring (on-hook)	V_{TR}		300	V
3	Maximum voltage on programmable pin, LSC		-0.3	6.0	V
4	Maximum power dissipation per trunk @ 25°C	P_{TRUNK}		0.75	W
5	Maximum power dissipation per module @ 25°C	P_{TOT}		3.0	W
6	Maximum loop current	I_{LOOP}		90	mA
7	Maximum ringing current (for 0.5 second)	I_{RING}		185	mA
8	Storage Temperature	T_S	-40	+100	^{O}C

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

8.0 Recommended Operating Conditions*

All Voltages are with respect to ground unless otherwise stated.

	Parameter	Symbol	Min	Typ	Max	Units
1	DC supply voltage (+5V operation)	V_{CC}	4.75	5.0	5.25	V
2	DC supply voltage (+3.3V operation)	V_{CC}	3.0	3.3	3.6	V
3	DC battery voltage on Tip and Ring (on-hook)	V_{TIP} V_{RING}	0 0	0 -48	-120 -120	V V
4	DC loop current	I_{LOOP}	0	25	85	mA
5	Operating Temperature	T_{OP}	0	25	70	^{O}C

*Typical figures are at 25^{O}C with nominal +5V supplies and are for design use only.

9.0 DC Electrical Characteristics.

	Characteristic	Sym	Min	Typ[2]	Max	Units	Test Comments[1]
1	Supply current (per trunk), on-hook[3]	I_{CC}		2.5	4.0	mA	
2	Loop current range	I_{LOOP}	14.0		85.0	mA	
3	Status outputs, RS, F/R Output low voltage Output high voltage	 V_{OL} V_{OH}	 4.5		 0.4	 V V	+5V operation @ 50µA @ -50µA
4	Status outputs, RS, F/R Output low voltage Output high voltage	 V_{OL} V_{OH}	 2.8		 0.4	 V V	+3.3V operation @ 50µA @ -50µA
5	Control input, LSC Input low voltage Input high voltage	 V_{IL} V_{IH}	 4.5		 0.3	 V V	+5V operation
6	Control input, LSC Input low current Input high current	 I_{IL} I_{IH}			 500 100	 µA µA	+5V operation
7	Control input, LSC Input low voltage Input high voltage	 V_{IL} V_{IH}	 2.8		 0.3	 V V	+3.3V operation
8	Control input, LSC Input low current Input high current	 I_{IL} I_{IH}			 500 100	 µA mA	+3.3V operation
3	Status output LC Output low voltage Output high voltage	 V_{OL} V_{OH}	 4.5		 0.5	 V V	+5V operation @ 50µA @ -50µA
4	Status outputs LC Output low voltage Output high voltage	 V_{OL} V_{OH}	 2.8		 0.5	 V V	+3.3V operation @ 50µA @ -50µA
9	Off-hook DC voltage			5.7		V	I_{LOOP} = 20mA DMa-DMb = TBA
10	Leakage current, Tip and Ring to analog ground	I_{LA}			35	µA	$100V_{DC}$
11	Leakage current on-hook, Tip to Ring	I_{LTR}			35	µA	

All DC Electrical Characteristics are over the Recommended Operating Conditions with V_{cc} at +5.0V $\pm$5%, unless otherwise stated.
1 For test circuit details please contact Silver Telecom
2 Typical figures are at 25°C with nominal +5V supply and 25mA loop current, unless otherwise stated. These figures are for design aid only.
3 Operating currents are dependant on the users application.

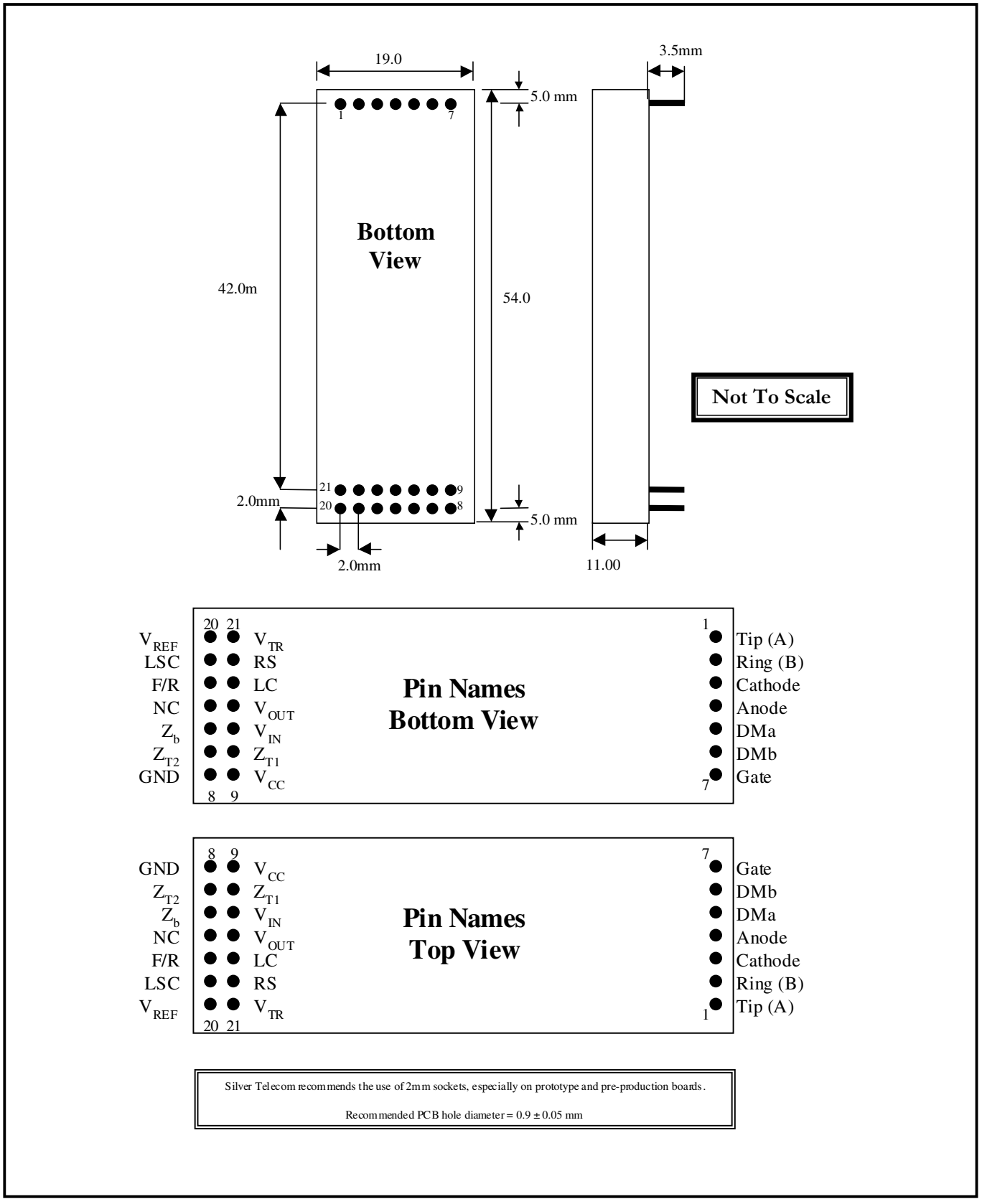
10.0 AC Electrical Characteristics.

	Characteristic	Sym	Min	Typ*	Max	Units	Test Comments[1]
1	Ringing voltage: detect Ringing voltage: no detect	V_{RD}	26	22 22	18	V_{RMS}	+5V operation
2	Ringing voltage: detect Ringing voltage: no detect	V_{RD}	18	14 14	10	V_{RMS}	+3.3V operation
3	Ringing frequency	F_R	15		68	Hz	
4	Input Impedance at V_{IN}			100		kΩ	
5	Output impedance at V_{out}				10	Ω	
6	Absolute voltage gain, 2 Wire to V_{OUT}		-0.5		+0.5	dB	Off-hook
7	Absolute voltage gain, V_{IN} to 2 Wire		-0.5		+0.5	dB	Off-Hook
8	On-hook gain, 2 Wire to V_{OUT}		-0.5		+0.5	dB	
9	Relative gain, referenced to 1kHz. 2Wire - V_{out}, V_{in} - 2Wire		-0.5		+0.5	dB	200 - 3400 Hz
10	Total harmonic distortion @ 2Wire and V_{out}	THD		0.1	1.0	%	@0dBm, 1kHz
11	Overload distortion @2 Wire and V_{out}[2]	OD		0.5	5.0	%	@+3dBm, 1kHz
12	Common mode rejection ratio	CMRR	70	75		dB	50 – 500Hz V_{CM} = 60V_{RMS}
13	Common mode overload level	CMOL		250	300	V_{RMS}	50 – 60Hz
14	Idle channel noise[3]	N_C		12.0		dBrnC	@2 Wire & V_{OUT}
15	Power supply rejection ratio at 2 Wire and V_{out}	PSRR	25			dB	Ripple 0.1V, 1kHz on V_{CC}
16	Return loss[4]	RL	18			dB	300-3400Hz
17	Transhybrid loss[4]	THL	18 21			dB dB	300-3400Hz 500-2500Hz
18	Metallic to longitudinal balance		60 40	70 70		dB	200-1000Hz 1000-4000Hz
19	Leakage current, Tip or Ring to analog ground	I_{LA}			5	mA_{RMS}	1000V ac

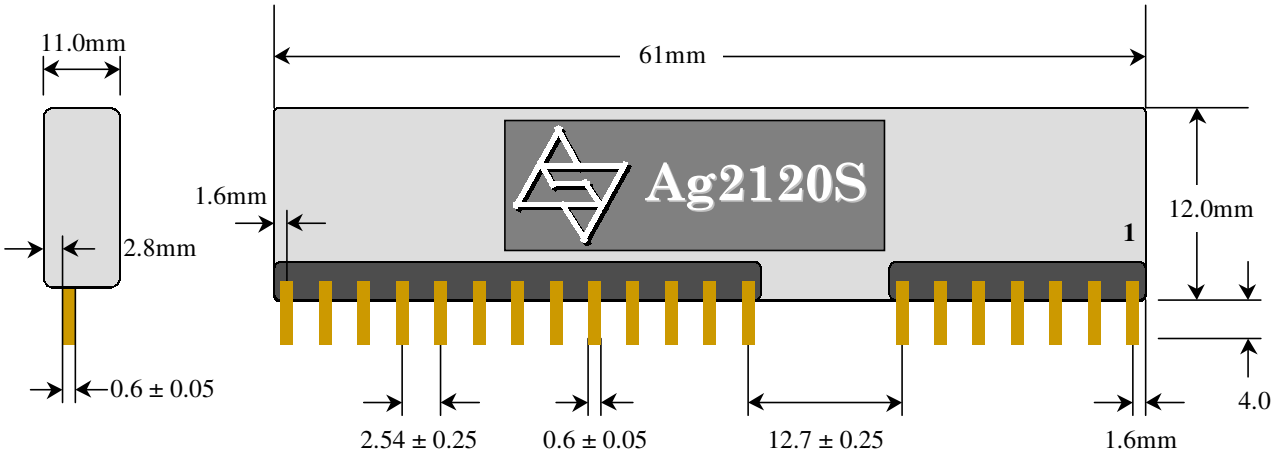
All AC Electrical Characteristics are over the Recommended Operating Conditions with V_{CC} at +5.0V ±5%, unless otherwise stated.
*Typical figures are at 25°C with nominal 5V supply and 25mA loop current unless otherwise stated. These figures are for design aid only.
1 For test circuit details please contact Silver Telecom.
2 These figures fpr+5V operation. For +3.3V operation, OD is typically 5% at +3dBm.
3 In the off-hook condition
4 Into a 600Ω impedance

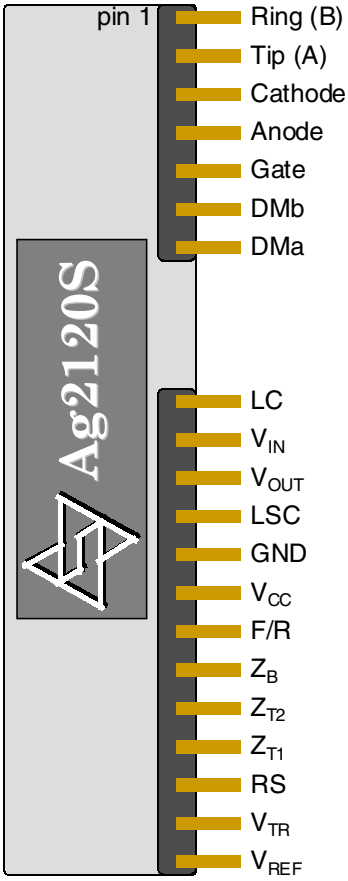
11.0 Mechanical Specification and Pin Assignation

11.1 Ag2120D – DIL Package



11.1 Ag2120S – SIL Package





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

Recommended PCB hole diameter = 1.1 ± 0.05 mm

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12.0 Change Sheet

Date of Change	Version Number	Description of Change	Change implemented
8 Aug 2002	V1.0	First issue.	CB
27 Sept 02	V1.1	Include V_{REF} on DIL, and V_{REF} and V_{TR} on SIL	CB
7 Oct 2002	V2.0	Fill in various TBA's	SE