Operation and Service Manual

JFET Preamp

SIM910

SRS Stanford Research Systems

Certification

Stanford Research Systems certifies that this product met its published specifications at the time of shipment.

Warranty

This Stanford Research Systems product is warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment.

Service

For warranty service or repair, this product must be returned to a Stanford Research Systems authorized service facility. Contact Stanford Research Systems or an authorized representative before returning this product for repair.

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Contents

General Information

The SIM910 JFET Preamp, part of Stanford Research Sysetems' Small Instrumentation Modules family, is a low noise general purpose voltage preamplifier with bandwidth from DC to 1 MHz.

Safety and Preparation for Use

Biomedical Applications

Under certain conditions, the SIM910 may prove to be unsafe for applications involving human subjects. Incorrect grounding, component failure, and excessive common-mode input voltages are examples of conditions in which the instrument may expose the subject to large input currents. Therefore, Stanford Research Systems does not recommend the SIM910 for such applications.

Warning Regarding Use with Photomultipliers

The front-end amplifier of this instrument is easily damaged if a photomultiplier is used improperly with the amplifier. When left completely unterminated, a cable connected to a PMT can charge to several hundred volts in a relatively short time. If this cable is connected to the inputs of the SIM910, the stored charge may damage the front-end JFETs. To avoid this problem, provide a leakage path of about $100\,\mathrm{k\Omega}$ to ground inside the base of the PMT to prevent charge accumulation.

Service

Do not install substitute parts or perform any unauthorized modifications to this instrument.

The SIM910 is a single-wide module designed to be used inside the SIM900 Mainframe. Do not turn on the power until the module is completely inserted into the mainframe and locked in place.

Symbols you may Find on SRS Products

Symbol	Description
$\sim$	Alternating current
⚡	Caution - risk of electric shock
⏚	Frame or chassis terminal
⚠	Caution - refer to accompanying documents
⏚	Earth (ground) terminal
—⊣⊢—	Battery
⌒⌓	Fuse
|	On (supply)
◯	Off (supply)

Notation

The following notation will be used throughout this manual:

- Front-panel buttons are set as [Button];
  [Adjust ▲▼] is shorthand for "[Adjust ▲] & [Adjust ▼]".

- Front-panel indicators are set as *OVLD*.

- Remote command names are set as *IDN?.

- Literal text other than command names is set as OFF.

Specifications

Performance Characteristics

Frequency range	DC to 1 MHz; −3 dB @ 1.9 MHz, typ.
Gain	1, 2, 5, 10, 20, 50, 100
Gain accuracy	± 0.5 % DC to 100 kHz
	± 5 % @ 1 MHz, typ.
Gain stability	200 ppm/°C
Input voltage noise (RTI, gain ≥ 10)	$4\,\mathrm{nV}/\sqrt{\mathrm{Hz}}$@ 1 kHz, typ.
gain 1	$12\,\mathrm{nV}/\sqrt{\mathrm{Hz}}$@ 1 kHz, typ.
Input current noise	$<10\,\mathrm{fA}/\sqrt{\mathrm{Hz}}$, typ.
Input impedance	100 MΩ // 35 pF
Input Bias Current (DC)	0.5 pA, typ.
Output impedance	50 Ω
AC coupling frequency	16 mHz −3dB
Input selection	A, A−B, GND
Input coupling	AC or DC
Input shields	Floating or ground
Maximum input, differential	±1 V before overload
Maximum input, common-mode	±5 V
	clamped at ±6 V
Maximum output voltage	±10 V before overload
Maximum output current	±100 mA before overload
CMRR	85 dB @ 1 kHz
Offset stability	±10 ppm/°C max
Operating temperature	0 °C to 40 °C, non-condensing
Power	+5 V (50 mA typ., 100 mA max.)
	±15 V (50 mA typ., 300 mA max.)

General Characteristics

Interface	Serial (RS-232) through SIM interface
Connectors	BNC (3 front, 1 rear)
	DB–15 (male) SIM interface
Weight	1.5 lbs
Dimensions	1.5″ W × 3.6″ H × 7.0″ D

1   Operation

The SIM910 JFET Preamp is a flexible low noise voltage preamplifier for general use from DC to 1 MHz. This chapter gives the necessary information to get started quickly with the SIM910.

In This Chapter

1.1 Instrument Overview

The SIM910 is a voltage preamplifier with low input and output noise. It provides selectable gain from 1 to 100 of a single ended or true differential signal. The amplifier runs from DC to 1 MHz, or can be AC coupled with 16 mHz −3dB frequency. In addition, the input BNC shields can be grounded or floated allowing the signal ground to be referenced to a local or remote ground. An overload light indicates when the input or output maximum voltage, or maximum output current has been reached.

The amplifier settings can be controlled either by the front panel buttons or the remote serial interface. Digital noise is eliminated by only clocking the microprocessor when settings are being changed. The complete amplifier configuration (i.e., gain settings, coupling, etc.) is saved in non-volatile memory.

The front end amplifier of this instrument is protected with a pair of 100 Ω resistors (R103 & R104). Note that the internal-grounding input configuration grounds the amplifier inputs *after* these protection resistors.

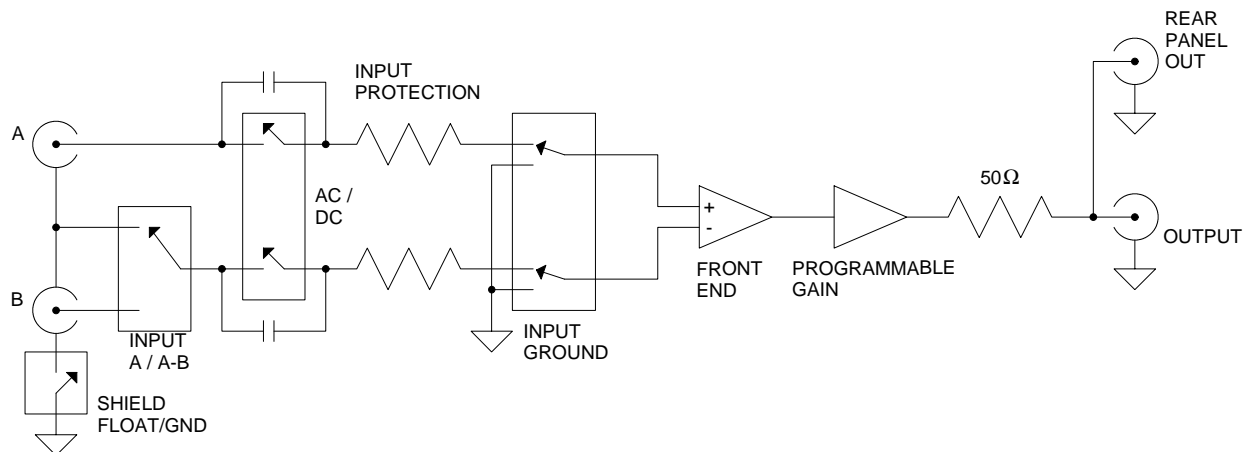A block diagram of the amplifier is shown below in Figure 1.1.

Figure 1.1: The SIM910 block diagram.

1.2 Front Panel Operation

All SIM910 configurations can be specified either from the front panel, or by commanding through the remote serial interface. The front panel is shown below (Figure 1.2). The front panel contains the

gain settings, the overload light, the input settings, the coupling and the shield states, and the buttons to control them.

Figure 1.2: The SIM910 front and rear panel.

1.2.1   Gain

The gain is selectable from 1 to 100. Gain settings are 1, 2, 5, 10, 20, 50, and 100 and are displayed as a product of 1, 2, or 5 and a multiplier of 10 or 100. Gain is raised or lowered by pressing [Gain ▲] or [Gain ▼] in the GAIN block on the upper right of the module. The change is reflected in the LEDs to the left of the buttons. Pushing [Gain ▲] when on gain 100 produces no effect. Pushing [Gain ▼] when on gain 1 produces no effect.

1.2.2   Offset

The offset is adjustable through a hole in the GAIN block of the front panel with a small flat head screwdriver. See Section 3.1 for a description of the offset trimming procedure.

1.2.3   Overload

There is an overload light in the gain section of the front panel. *OVLD* is lit when the input common mode is outside ±5 V, the input signal is

greater than ±1 V, or the output is outside ±10 V. The overload signal can also be asserted on the status pin. See section 2.4.4.

1.2.4   Inputs

The two input connectors, labeled A and B, are in the INPUT block of the front panel. [Input] selects between A, A−B, and Ground. A & B are voltage inputs with input impedance of 100 MΩ in parallel with ~35 pF. The connector shields are tied to each other, and can be either floated or grounded to Signal Ground using [Shield]. Input A is the non-inverting input. When input A−B is selected, B is the inverting input.

When input A is selected, the connector shield is used as the inverting input, and acts as the reference for the A signal. Thus by selecting Shield Float, a remote ground reference can be brought to the unit using a single BNC. As long as the common-mode voltage limit is satisfied, this configuration can be useful in breaking ground loops.

overload limits   If the common-mode limits are exceeded, the inputs will be (separately) clamped to ~ ±6 V through a series input resistor of 100 Ω. The maximum signal voltage is ±1 V, while the maximum common mode voltage is ±5 V. Exceeding these limits will cause *OVLD* to light up.

When the Ground input is selected, the user inputs A & B are left floating and the amplifier is internally grounded at the front-end, after the series resistors. The Input grounded noise is the limit of the amplifier's noise.

Pressing [Couple] selects AC (16 mHz −3dB) or DC coupling.

1.2.5   Output

The output of the instrument is located in the OUTPUT block of the front panel. The output is referred to Signal Ground, which is tied to the outside of the BNC connector.

Note about grounds   The chassis of the SIM910 is tied to the power supply return, and *not* Signal Ground. When operating in the SIM900, the chassis and Signal Ground are tied together in the SIM900 Mainframe. If the amplifier is operated with an independent supply, the output will be referenced to Signal Ground (pin 1 on DB–15 J401). The Signal Ground and the chassis are tied through back to back protection schottky diodes, so they can't be more than ~ ±0.35 V apart.

The instrument's output impedance is 50 Ω, and can drive load impedances from ∞ down to 50 Ω. Note: when driving a 50 Ω load the gain will be half that displayed on the LEDs.

1.3   Rear Panel Output

The rear panel contains a BNC connected to the output, and the SIM interface connector (see Figure 1.2).

The rear panel output is wired in parallel to the front panel output. The output is not designed to drive 2 simultaneous $50\,\Omega$ loads. If one output is driving a $50\,\Omega$ load, the other should be connected to a high impedance load.

1.4   SIM Interface

The primary connection to the SIM910 JFET Preamp is the rear-panel DB–15 SIM interface connector. Typically, the SIM910 is mated to a SIM900 Mainframe via this connection, either through one of the internal mainframe slots, or the remote cable interface.

It is also possible to operate the SIM910 directly, without using the SIM900 Mainframe. This section provides details on the interface.

1.4.1   SIM interface connector

The DB–15 SIM interface connector carries all the power and communications lines to the instrument. The connector signals are specified in Table 1.1

Pin	Signal	Direction Src ⇒ Dest	Description
1	SIGNAL_GND	MF ⇒ SIM	Ground reference for signal
2	−STATUS	SIM ⇒ MF	Status/service request (GND=asserted, +5V=idle)
3	RTS	MF ⇒ SIM	HW Handshake (+5 V=talk; GND=stop)
4	CTS	SIM ⇒ MF	HW Handshake (+5 V=talk, GND=stop)
5	−REF_10MHZ	MF ⇒ SIM	10 MHz reference (No connection in SIM910)
6	−5V	MF ⇒ SIM	Power supply (No connection in SIM910)
7	−15V	MF ⇒ SIM	Power supply (analog circuitry)
8	PS_RTN	MF ⇒ SIM	Power supply return
9	CHASSIS_GND		Chassis ground
10	TXD	MF ⇒ SIM	Async data (start bit="0"=+5 V; "1"=GND)
11	RXD	SIM ⇒ MF	Async data (start bit="0"=+5 V; "1"=GND)
12	+REF_10MHz	MF ⇒ SIM	10 MHz reference (No connection in SIM910)
13	+5V	MF ⇒ SIM	Power supply (digital circuitry)
14	+15V	MF ⇒ SIM	Power supply (analog circuitry)
15	+24V	MF ⇒ SIM	Power supply (No connection in SIM910)

Table 1.1: SIM Interface Connector Pin Assignments, DB-15

1.4.2   Direct interfacing

The SIM910 is intended for operation in the SIM900 Mainframe, but users may wish to directly interface the module to their own systems without the use of additional hardware.

The mating connector needed is a standard DB–15 receptacle, such as Amp part # 747909-2 (or equivalent). Clean, well-regulated supply voltages of +5, ±15 VDC must be provided, following the pin-out specified in Table 1.1. Ground must be provided on pins 1 and 8, with chassis ground on pin 9. The −STATUS signal may be monitored

on pin 2 for a low-going TTL-compatible output indicating a status message.

The SIM910 has no internal protection against reverse polarity, missing supply, or overvoltage on the power supply pins.

1.4.2.1 Direct interface cabling

If the user intends to directly wire the SIM910 independent of the SIM900 Mainframe, communication is usually possible by directly connecting the appropriate interface lines from the SIM910 DB–15 plug to the RS-232 serial port of a personal computer.[1] Connect RXD from the SIM910 directly to RD on the PC, TXD directly to TD, and similarly RTS→RTS and CTS→CTS. In other words, a null-modem style cable is *not* needed.

To interface directly to the DB–9 male (DTE) RS-232 port typically found on contemporary personal computers, a cable must be made with a female DB–15 socket to mate with the SIM910, and a female DB–9 socket to mate with the PC's serial port. Separate leads from the DB–15 need to go to the power supply, making what is sometimes know as a "hydra" cable. The pin-connections are given in Table 1.2.

DB–15/F to SIM910		Name
	DB–9/F	
3 ⟷	7	RTS
4 ⟷	8	CTS
10 ⟷	3	TxD
11 ⟷	2	RxD
	5	Computer Ground
	to P/S	
7 ⟷	−15 VDC	
14 ⟷	+15 VDC	
13 ⟷	+5 VDC	
8,9 ⟷	Ground (P/S return current)	
1 ⟷	Signal Ground (separate wire to Ground)	

Table 1.2: SIM910 Direct Interface Cable Pin Assignments

more about grounding   The Chassis Ground and Power Ground are tied together in the instrument. The +5 V sections use the Power Ground, and the signal

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[1] Although the serial interface lines on the DB-15 do not satisfy the minimum voltage levels of the RS-232 standard, they are typically compatible with desktop personal computers

sections of the instrument use the ±15 V and Signal Ground. The Signal Ground and Power Ground are tied through protection schottky diodes, and can therefore not be more than ~ ±0.35 V apart. These two ground lines should be separately wired back to a single, low-impedance ground source at the power supply.

1.4.2.2 Serial settings

The serial port settings at power-on are: 9600 baud, 8–bits, no parity, 1 stop bit, and hardware flow control (see Section 2.3.1). The serial settings cannot be changed on the SIM910.

2   Remote Operation

This chapter describes operating the module over the serial interface.

In This Chapter

2.1   Index of Common Commands

symbol	definition
i	Integers
(*?*)	Required for queries; illegal for set commands
{*var*}	Required parameter for set commands; illegal for queries

Amplifier

*RST	2 – 6	Reset
GAIN(?) {*i*}	2 – 6	Gain
COUP(?) {*i*}	2 – 6	Coupling
INPT(?) {*i*}	2 – 6	Input
SHLD(?) {*i*}	2 – 6	Shield

Status

*STB?	2 – 7	Status Byte
*SRE(?) {*i*}	2 – 7	Service Request Enable
STOL(?) {*i*}	2 – 7	Status Monitors Overload
OVLD?	2 – 7	Overload

Interface

*IDN?	2 – 7	Identify
*TST?	2 – 8	Self Test
CONS(?) {*i*}	2 – 8	Console Mode

2.2   Alphabetic List of Commands

★

*IDN?	2 – 7	Identify
*RST	2 – 6	Reset
*SRE(?) {*i*}	2 – 7	Service Request Enable
*STB?	2 – 7	Status Byte
*TST?	2 – 8	Self Test

C

CONS(?) {*i*}	2 – 8	Console Mode
COUP(?) {*i*}	2 – 6	Coupling

G

GAIN(?) {*i*}	2 – 6	Gain

I

INPT(?) {*i*}	2 – 6	Input

O

OVLD?	2 – 7	Overload

S

SHLD(?) {*i*}	2 – 6	Shield
STOL(?) {*i*}	2 – 7	Status Monitors Overload

2.3   Introduction

Remote operation of the SIM910 is through a simple command language documented in this chapter. Both set and query forms of most commands are supported, allowing the user complete control of the amplifier from a remote computer, either through the SIM900 Mainframe or directly via RS-232 (see Section 1.4.2.1).

See Table 1.1 for specification of the DB–15 SIM interface connector.

2.3.1   Power-on configuration

The settings for the remote interface are 9600 baud with no parity, hardware flow control, and local echo disabled (CONS OFF).

Most of the SIM910 instrument settings are stored in non-volatile memory, and at power-on the instrument returns to the state it was last in when power was removed. Exceptions are noted in the command descriptions.

Reset values of parameters are shown in **boldface**.

2.3.2   Buffers

Incoming data from the host interface is stored in a 32-byte input buffer. Characters accumulate in the input buffer until a command terminator (either ⟨CR⟩ or ⟨LF⟩) is received, at which point the message is parsed and executed. Query responses from the SIM910 are buffered in a 64-byte output queue.

If the input buffer overflows, then all data in *both* the input buffer and the output queue are discarded, and an error is recorded in the CESR and ESR status registers.

2.3.3   Device Clear

The SIM910 host interface can be asynchronously reset to its power-on configuration by sending an RS-232-style ⟨break⟩ signal. From the SIM900 Mainframe, this is accomplished with the SRST command; if directly interfacing via RS-232, then use a serial break signal. After receiving the Device Clear, the interface is reset to 9600 baud and CONS mode is turned OFF. Note that this *only* resets the communication interface; the basic function of the SIM910 is left unchanged; to reset the instrument, see *RST.

2.4   Commands

This section provides syntax and operational descriptions for remote commands.

2.4.1   Command syntax

The four letter mnemonic (shown in CAPS) in each command sequence specifies the command. The rest of the sequence consists of parameters.

Commands may take either *set* or *query* form, depending on whether the "?" character follows the mnemonic. *Set only* commands are listed without the "?", *query only* commands show the "?" after the mnemonic, and *optionally query* commands are marked with a "(?)".

Parameters shown in { } are not always required. Parameters in { } are required to set a value, and are omitted for queries. Parameters listed without any surrounding characters are always required.

Do *not* send ( ) or { } as part of the command.

Multiple parameters are separated by commas. Commands are terminated by either ⟨CR⟩ or ⟨LF⟩ characters. Null commands and whitespace are ignored. Execution of command(s) does not begin until the command terminator is received.

2.4.2   Notation

The following table summarizes the notation used in the command descriptions:

symbol	definition
i	Integers
(*?*)	Required for queries; illegal for set commands
{*var*}	required parameter for set commands; illegal for queries

2.4.3   Amplifier commands

These commands provide control over the settings of the amplifier circuitry. All of these commands are persistent, in the sense that the module will restore the last amplifier configuration upon power-on reset.

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*RST   Reset

Reset the amplifier to default configuration.

In response to *RST, the amplifier settings become: unity gain, AC coupling, input grounded, shield floated.

GAIN(?) {*i*}   Gain

Set (query) the amplifier gain {to *i*=(1, 2, 5, 10, 20, 50, 100)}.

COUP(?) {*i*}   Coupling

Set (query) the amplifier input coupling.

COUP 1 sets AC coupling, while COUP 2 sets DC coupling.

INPT(?) {*i*}   Input

Set (query) the amplifier input.

INPT 1 sets the amplifier input to A, INPT 2 selects A−B, and INPT 3 grounds the amplifier front-end.

SHLD(?) {*i*}   Shield

Set (query) the amplifier input BNC shield configuration.

SHLD 1 floats the A & B input shields, while SHLD 2 ties the input shields to amplifier ground.

2.4.4   Status commands

The Status commands query and configure registers associated with status reporting of the SIM910.

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*STB?	Status Byte

Reads the Status Byte register.

Execution of the *STB? query clears all flag bits set in the Status Byte register (see the Register Model section 2.5 for more about the Status Byte register).

*STB also causes the −STATUS signal to be deasserted, as long as the module is not in Status-Monitors-Overload mode (see STOL).

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*SRE(?) {*i* }	Service Request Enable

Set (query) the Service Request Enable register {to *i*} See section 2.5.

STOL(?) {*i* }	Status Monitors Overload

Set (query) the Status-Monitors-Overload mode {to *i*=(0, 1)}.

STOL 1 causes the −STATUS signal (pin 2 on J401 Dsub-15 connector) to become a real-time monitor of the amplifier overload detect circuit. STOL 0 restores −STATUS to reflect the overall service request message from the Status Byte register. In applications where prompt flagging of an amplifier overload is required, STOL 1 mode provides a single interface line for this signal.

The state of STOL is stored in non-volatile memory and restored upon power-on reset. Neither *RST nor device-clear affects the state of STOL.

OVLD?	Overload

Reports the current overload condition. Query returns 0 for normal operation, or 1 if the amplifier is presently in overload.

2.4.5   Interface commands

The interface commands provide information and control over the communication link between the SIM910 and the host computer. None of these commands have any effect on the amplifier function itself.

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*IDN?	Identify

Query the device identification string.

The identification string is formatted as:
`Stanford_Research_Systems,SIM 910,S/N******,VER#.##`
where `******` is the 6-digit serial number, and `#.##` is the firmware revision level.

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*TST?	Self Test
	Query the device self test.
	The SIM910 does not perform any self tests, and will always return the message **0** to this query.

CONS(?) {*i* }	Console Mode
	Set (query) the Console mode {to *i*=(**0**, 1)}.
	CONS 1 causes each character received at the Input Buffer to be echoed to the Output Queue. This mode can be useful when typing interactively to the SIM910.
	On device clear, **CONS** is set to **0** (off).

2.5 Register Model

The SIM910 monitors and reports errors and other conditions using a single 8-bit register, the Status Byte register. Each bit in the register is mapped to a particular event category, and if that event occurs the corresponding bit is set to 1. Bits in the Status Byte are "sticky," in the sense that once set to 1, the bit will *not* revert to the 0 (zero) value even after the condition that caused the event has completed. Bits are only cleared by querying the register.

A companion register, the Service Request Enable, acts as a bitwise mask to the Status Byte for generating the –STATUS signal.

2.5.1 Status Byte (SB)

This is an 8-bit wide register. It can be read through the *STB? command which also causes it to be cleared.

Weight	Bit	Flag
1	0	EXE
2	1	CMD
4	2	QRE
8	3	OVR
16	4	SERR
32	5	URQ
64	6	DCAS
128	7	OVLD

EXE : Execution Error. Indicates an error in a command that was successfully parsed. Out-of-range parameters are an example.

CMD : Command Error. Indicates a parser-detected error.

QRE : Query Error. Indicates data in the Output Queue has been lost.

OVR : Input Buffer Overrun Error. Indicates data to the Input Buffer has been lost.

SERR : Serial Communications Error. This can be either (1) an Overrun Error (indicating received data has been lost), (2) a Noise Error (indicating noise is present on the receive bits), or (3) a Framing Error (indicating the stop bit is not detected). Note: A break signal will not set the SERR bit.

URQ : User Request. Indicates that a button has been pushed.

DCAS : Device Clear. Indicates that a break signal has been received on the serial interface.

OVLD : Overload. Indicates an overload condition has occurred.

2.5.2   Service Request Enable (SRE)

The SRE is used to control the status line when Status-Monitors-Overload Mode is disabled (See STOL).

This is an 8-bit wide register. Each bit in the SRE corresponds one-to-one with a bit in the SB register, and acts as a bitwise AND of the SB flags. If any bits are simultaneously set in both the SB and the SRE, then a service request is indicated and the –STATUS signal (pin 2 on the Dsub-15 SIM Interface Connector) is asserted low.

This register is set and queried with the *SRE(?) command. On Power-On, this register is cleared.

3   Performance Tests

This chapter describes how to adjust the module to meet it's speci-
fications. The module should be warmed up for at least 15 minutes
before making any adjustments.

In This Chapter

3.1   Offset

The SIM910 front-panel offset adjustment provides an easy way for the user to null the amplifier's DC offset. The module should be running for at least 15 minutes before setting the offset. To do this, set the input to GND. Set the gain to 100. Insert a small flat screwdriver through the front-panel OFFSET hole and adjust the offset potentiometer until the output of the amplifier is less than 1 mV. Return to the desired input, A or A−B. Note: the offset will be affected by CMRR adjustments. Thus the offset should be trimmed after any CMRR adjustments.

3.2   Calibration

In addition to the offset trimpot, there are 3 internal trimmers that are calibrated at the factory. They are "CMRR Adjust" (R120), "Gain Adjust" (R215), and "Freq Adjust" (C402). These are located on the inside of the box and can easily be adjusted once the right side panel of the SIM910 has been removed. Adjustments are most easily done when the instrument is powered externally, or on the SIM900 Mainframe remote cable. The module should be running for at least 15 minutes before doing any adjustments

3.2.1   Adjusting the CMRR

The common mode adjustment minimizes the common mode response of the amplifier by balancing the two sides of the front-end JFET. Locate R120, the "CMRR Adjust" trimpot, on the inside of the SIM910. Set the module's gain to 100, input mode to A−B, coupling to DC, and shield to grounded. Generate a ±1 V amplitude sine wave at 1 kHz. Carefully tee equal lengths of BNC cable to the module's A and B inputs from the signal source. Adjust the "CMRR Adjust" trimpot to minimize the output signal at 1 kHz; it should be below ±5 mV.

3.2.2   Adjusting the gain

The relative gains in the amplifier are set by 0.1% resistors; however, the overall gain is adjusted with a "Gain Adjust" trimpot (R215). Locate R215, the "Gain Adjust" trimpot, on the inside of the SIM910. Set the module's gain to 100, input mode to A, coupling to DC, and shield to grounded. Generate a ±10 mV amplitude sine wave at 1 kHz, or a swept sine wave of the same amplitude. Connect the signal source to the module A input. Measure the transfer function of the module output relative to the signal input. Adjust the "Gain Adjust" trimpot to make the transfer function equal 100 at 1 kHz.

3.2.3   Adjusting the freq adjust

The clocking of the microprocessor is done by an RC oscillator, which must be adjusted to 1% of 2.5 MHz in order to insure the serial baud rate is 9600 baud. This is done with the "Freq Adjust" trimcap (C402). Locate C402, the "Freq Adjust" trimcap, on the inside of the SIM910. Locate the Frequency Test Point, TP401, and connect a probe to monitor the clock signal. To override the clock-stopping circuitry, depress and hold down one of the front-panel buttons. Adjust the "Freq Adjust" trimcap to make the frequency at the test point 2.5 MHz.

3.3   Performance Tests

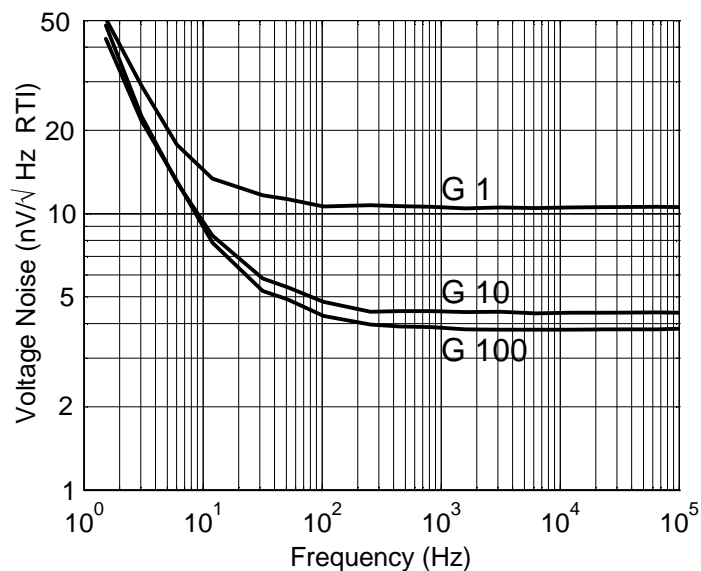The following curves are typical noise density vs. frequency for the SIM910.

Figure 3.1: The SIM910 noise density versus frequency.

These are noise plots with the input grounded internally.

If you are amplifying a small signal far from the SIM900 Mainframe it could be preferable to run the SIM910 on an external supply, i.e. the one which is powering your other electronics. To do this, simply supply ±15 V and a signal ground to power the signal electronics and +5V and Power ground to power the microprocessor. Use the shield floated option on the module to use the external ground for

your signal reference. See table 1.1 for the power and communication connector pin specifications.

3.4 SIM910 Performance Test Record

Description	Measured Value
Serial Number	
Clock Frequency at TP401	
Gain 1	
Gain 2	
Gain 5	
Gain 10	
Gain 20	
Gain 50	
Gain 100	
CMRR	
Offset	
Noise @ gain 100 @ 1 kHz	

Table 3.1: Performance Record

4 Parts Lists and Schematics

This chapter presents a brief description of the SIM910 circuit design. A complete parts list and circuit schematics are included.

In This Chapter

4.1   Circuit Discussion

4.1.1   Input amplifier and protection circuitry

The front-end amplifier Q101 is a matched JFET pair biased with 5.5 mA per side. Closed-loop feedback is provided by U105 for an overall first-stage gain of 10.

The JFET inputs are protected by TVS101. A pair of bootstrapped diodes, D101 and D102, isolate the amplifier from this device. Series input resistors R103 and R104 (100 Ω each) provide some passive input protection as well, and limit the input current when TVS101 turns on. For excessive input overvoltages, one or both of these resistors may be damaged or destroyed.

4.1.2   Programmable gain stages

To preserve pulse shapes while changing amplifier gain, a "fixed-gains with attenuators" topology was chosen for the SIM910. Low impedance precision divider ladders (R201 − R204, and R207 − R211) provide programmable gain steps without introducing excessive noise at lower gains. Gain allocations are noted on the schematic, indicating which switches within U201 and U203 are closed based on gain.

The overall gain of the SIM910 is trimmed at U204, the gain of which is adjustable by ± 10 %. The final output stage rolls the gain off slowly above 1 MHz, and includes a high-current output buffer (U207) capable of driving long coaxial cables and other reactive loads. Note that the 50 Ω output resistor R225 is common to both the front- and rear-panel output connectors. Because of this, at most one of the outputs may be terminated with an external 50 Ω load.

4.1.3   Digital control

The SIM910 is controlled by microcontroller U405. Amplifier configuration is set by shift registers U301 and U302, while the front panel LED indicators are driven directly by processor port pins. U406 is a serial EEPROM providing non-volatile memory for amplifier configurations.

A critical aspect of the design is the clock-stop circuitry implemented by U403 and U404. A simple RC-oscillator is enabled or disabled at pin 1 of U403, which is driven by synchronizing flip-flop U403B to ensure that no "runt" clock pulses are produced that would violate U405's minimum clock periods. Four separate clock-starting signals are combined by U402:

- Power-on reset

- Amplifier overload

- Incoming serial data

- Front-panel button press

The fast start-time of the RC-oscillator ensures that incoming serial data will be correctly decoded by the microcontroller's UART, even when the clock is started by the serial start bit of the incoming data. When the microcontroller has completed all pending activity, it drives the STOP signal high (pin 24 of U405), effectively halting its own processor clock. In this way, the SIM910 guarantees no digital clock artifacts can be generated during quiescent operation.

4.2 Parts List

Reference	SRS P/N	Part Value		Reference	SRS P/N	Part Value
C102,C101	5-00069	0.1U-P		R126,R127,R205,R206,R212,	4-01431	10
C103,C109,C111,C113,C202,	5-00319	10U-35V		R213,R221,R222,R223,R224		
C204,C206,C208,C213,C215,				R128,R129	4-00306	100M
C217,C219,C404,C406,C408				R130,R131,R412,R414	4-01455	100
C104,C106,C108,C110,C112,	5-00299	0.1U		R132,R302,R303,R304,R305,	4-01471	470
C116,C117,C201,C203,C205,				R306,R307,R308,R309,R310,		
C207,C212,C214,C216,C218,				R311,R315		
C403,C405,C407,C411,C412,				R201,R207	4-00528	499.0
C413,C414,C415,C416				R202,R208	4-01656	301.0
C107,C114	5-00369	33P		R203,R204,R211	4-00685	100.0
C115	5-00361	6.8P		R209	4-01657	48.70
C209,C220	5-00363	10P		R210	4-01658	52.30
C211,C210	5-00375	100P		R214	4-00987	44.2
C301	5-00298	0.01U		R215	4-00353	100.
C401	5-00381	330P		R216	4-01084	453
C402	5-00106	9.0-50P		R219	4-01041	162
C409,C410	5-00387	1000P		R225	4-00913	49.9-2W
D102,D101	3-01400	BAV199W		R232,R235,R236	4-01274	43.2K
D401	3-00945	BAT54S		R233,R234,R237	4-01318	124K
D501,D502,D503,D504,D507,	3-00424	LED		R240	4-01018	93.1
D509,D510,D511,D512,D513,				R241	4-00988	45.3
D515				R301,R316,R402,R405,R407,	4-01527	100K
D508	3-00425	LEDRED		R409,R410,R415		
D514	3-00426	YELLOW		R314,R401,R406,R408,R417	4-01503	10K
J101,J102,J201,J202	1-00003	BNC		R403	4-01479	1.0K
J301	1-00609	HEADER 22		R404	4-01083	442
J401	1-00367	DB15		R413,R411	4-01465	270
J501	1-00610	HEADER 22		S501,S502,S503,S504,S505	2-00053	SW
K101,K102,K103,K104	3-01401	DS2E-ML-DC5V		TVS101	3-01402	LCDA05
L401,L402,L403	6-00174	BEAD		U101	3-00542	AD587JR
Q101	3-00545	2N5564		U103	3-01398	OPA2131
Q301	3-00580	MMBT3906		U105,U202,U204	3-01360	OPA228UA
R101,R102,R108	4-01213	10.0K		U106	3-01403	OPA2130UA
R103,R104,R238	4-01021	100		U107,U208	3-00727	LM339
R105	4-01251	24.9K		U201,U203	3-01358	DG444
R106,R226,R227,R228,R229,	4-01280	49.9K		U206	3-00996	OPA227UA
R230,R231				U207	3-00279	LT1010CN8
R107	4-01687	2.0K		U209	3-00728	LM393
R109,R217,R218,R220	4-01096	604		U302,U301	3-00787	74HC595
R110,R111	4-01079	402		U401	3-00903	MAX6348UR44
R112,R113	4-01367	402K		U402	3-00663	74HC08
R117,R114	4-01121	1.10K		U403	3-00742	74HC74
R116,R115	4-01027	115		U404	3-01405	74AC00
R118,R119	4-01611	8.25		U405	3-01406	68HC705C8A
R120	4-00486	50.0		U406	3-01407	93AA56
R122,R121	4-01355	301K		U407	3-00662	74HC14
R125	4-01134	1.50K				

4.3 Schematic Diagrams

Schematic diagrams follow this page.