Model SC21

Bridge Signal Conditioner w/Gain & Filter

INSTRUCTION MANUAL

March 23, 2005

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FIGURES

Bridge Signal Conditioner with Gain and Filtering

Adds bridge signal conditioning with gain to ADC modules

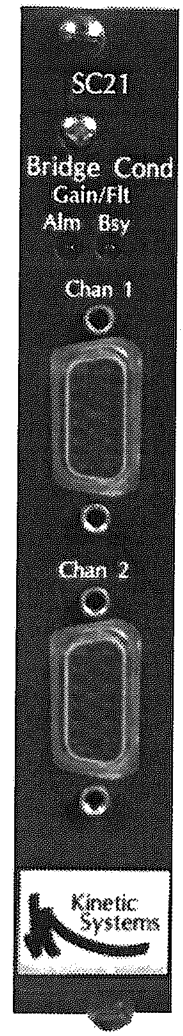
SC21

Features

- Two-channel-per-card packaging for maximum versatility
- Up to 16 SC21 Conditioners can be inserted in a V710 Active Termination Panel
- Used with the V213 or other ADC modules
- Accommodates 1, 2 or 4 active bridge arms
- Programmable gain from 1 to 2000
- Programmable 2-pole active filters with cutoff frequencies of 10, 50 and 500 Hz
- Programmable shunt calibration and bridge balance
- Programmable excitation with 0, 2.5, 5 or 10 V selection with excitation alarm
- Excitation regulation and sensing per channel for maximum stability
- 10-wire transducer hookups can be accommodated
- Optional trifilar-wound transformer for excellent high-frequency CMRR

Typical Applications

- Acoustic and vibration measurements
- Rocket motor tests
- Automotive testing
- Tests using bridge-type sensors



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General Description *(Product specifications and descriptions subject to change without notice.)*

The SC21 is a two-channel bridge signal conditioner with programmable gain and filtering. It is packaged in a 3U (5.25") high, 220 mm (8.7") deep, module. It accommodates transducers that represent 1, 2 or 4 active arms of a bridge circuit. Up to 16 SC21 modules (32 channels) can be installed in a single V710 termination panel. Therefore, a V213 module can be used with a single chassis of SC21 bridge conditioners. Strain gages, RTDs and other bridge-type sensors can be accommodated.

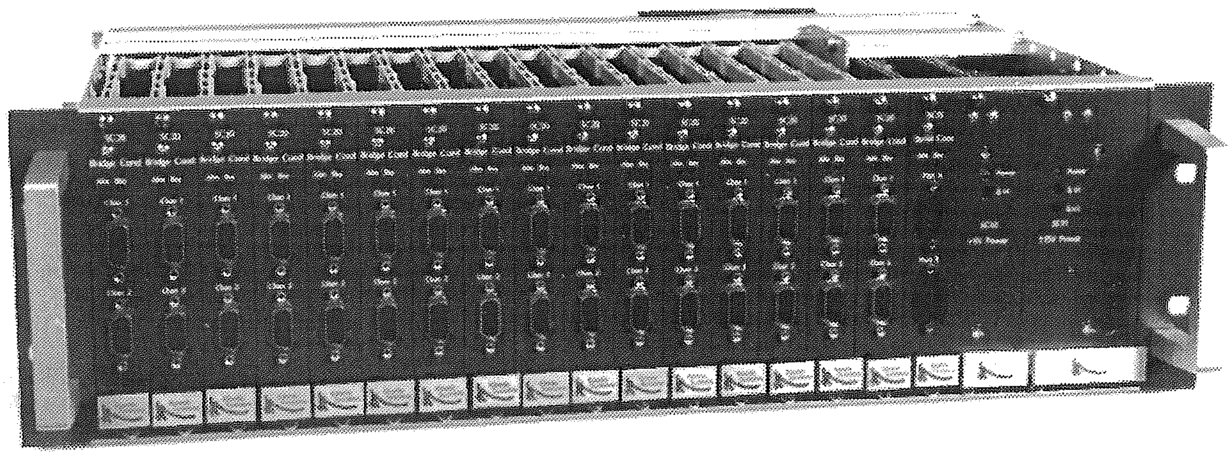
Each SC21 channel includes programmable gain from 1 to 2000 with prefilter gains of 1, 10, 100 and 1000 as well as post filter gains of 1, 2, 5 and 10. Each channel also includes a programmable Butterworth filter with cutoff frequencies of 10, 50 and 500 Hz. Each filter can also be bypassed. End-to-end channel calibration is accomplished by software configuring the input multiplexer on an SC21 channel to receive a reference voltage from the SC15 Serial Controller via the V710 backplane. Note that an SC15-AB11 Controller with Calibrator is required.

Sockets are provided for on-board bridge completion. High-precision 120 Ω, 350 Ω and 1000 Ω resistors are available. Shunt calibration is activated under program control. Shunt calibration resistors can be plugged into the module to accommodate various bridge requirements. Bridge excitation is programmable, with 0, 2.5, 5 and 10 V selection. The bridge excitation is non-isolated and balanced to ground (e.g. 10 V excitation is supplied to the legs of the bridge as +5 V and -5 V with respect to ground). Each SC21 channel contains a regulator for excitation, and individual remote sensing is provided for high excitation stability.

For applications that exhibit high electrical noise, an option is available that includes a trifilar-wound input transformer. This transformer provides excellent high-frequency common-mode rejection.

Connections are available to provide a full 10-wire bridge hookup. Each of the bridge channels is connected via a 15-contact "D" connector on the associated SC21 front panel. Setup and control of the SC21 are accomplished via a standard serial port on the SC15 Serial Controller module.

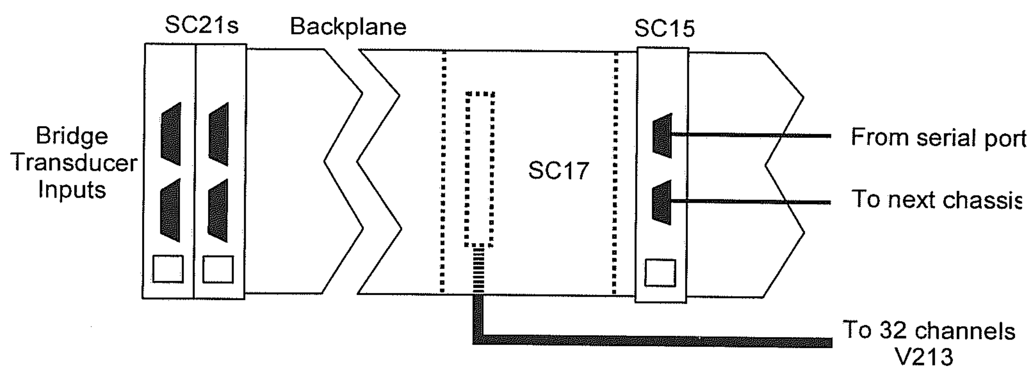
V710 Active Termination Panel (shown with 16 bridge conditioning modules)



Item	Specification
Inputs Number of channels	 2
Filter 3 dB Cutoff Frequency Selection	10, 50, 500 Hz and Bypass
Excitation	Independent excitation for each channel. Each channel provides +/- excitation and sense leads. Excitation voltages of 0 V, 2.5 V, 5 V and 10 V are available. Open sense lines or an over-current condition will shut down the supply automatically and signal the error condition. Excitation calibration is also provided.
Line regulation	0.003 %V
Load regulation	0.0025 %V/mA
Temperature Coefficient	2 ppm/°C
Bridge Completion	Two channels of bridge completion are provided. ¼-, ½- and full-bridge configurations are supported. The completion resistors plug into the SC21 PC card. 120, 350 and 1000 ohm resistor kits are available.
Shunt Calibration	+/- shunt calibration is performed on each channel. The customer-supplied resistors are installed on the SC21 PC card. Switching is performed under software control.
Gain Selection	Prefilter fain: 1, 10, 100, 1000; postfilter gain: 1, 2, 5, 10; Maximum overall gain: 2000
Gain/Offset Accuracy Referred to input (RTI) after automatic calibration, using a V213 at 2 kHz ADC sample rate.	**Gain** **Accuracy** 1 ± (1.2 mV + 0.025% of reading) 2 ± (600 µV + 0.025% of reading) 5 ± (250 µV + 0.025% of reading) 10 ± (120 µV + 0.025% of reading) 20 ± (60 µV + 0.025% of reading) 50 ± (25 µV + 0.025% of reading) 100 ± (13 µV + 0.025% of reading) 200 ± (8 µV + 0.025% of reading) 500 ± (5 µV + 0.025% of reading) 1000 ± (5 µV + 0.025% of reading) 2000 ± (5 µV + 0.025% of reading)

Item	Specification
Gain Stability	20 ppm/°C
Offset Voltage Stability, RTI	4 µV/°C, gain $\geq$ 1000
CMRR	-80 dB minimum, optional trifilar-wound inputs provide excellent RF rejection to 100 MHz
Bridge Balance	A 12-bit DAC provides the ability to remove bridge offsets of up to ±70 mV with a 350 ohm bridge.
Input Connector Type	15-contact DSUB socket-type connector (3-row type with the same shell size as a DE9S connector)

Connections Between A V710 Termination Panel and a V213 ADC



Note: The SC15-AB11 Serial Controller with Calibrator and the SC17-AA21 Connector Adapter should be used with SC21 Bridge Signal Conditioners.

Ordering Information

Model SC21-AA11	Bridge Signal Conditioner with Gain, Filtering and Trifilar Transformers
Model SC21-AB11	Bridge Signal Conditioner with Gain and Filtering
Model SC20-0002	120 Ohm Bridge Completion Resistor Kit (Three resistors per kit)
Model SC20-0003	350 Ohm Bridge Completion Resistor Kit (Three resistors per kit)
Model SC20-0004	1000 Ohm Bridge Completion Resistor Kit (Three resistors per kit)

Related Products

Model V710-AA11	Active Termination Panel
Model 5938-Z1A	Connector - 15 Contact "DSUB" (3-row), Pins
Model SC10-AA11	+5 V Power Supply
Model SC11-AA11	±15 V Power Supply
Model SC15-AB11	Serial Controller with Calibrator and Reference
Model SC17-AA21	Connector Adapter with Calibration Connector
Model SC26-AA11	V710 Load Module (Required to maintain power supply regulation whenever eight or less SC-series signal conditioning modules are installed in the V710 Active Termination Panel.)

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UNPACKING AND INSTALLATION

At KineticSystems, static precautions are observed during production, test, and packaging of the modules. This includes using static proof mats and wrist straps. Please observe these same precautions whenever possible when unpacking and installing the modules.

The SC21 is shipped in an anti-static bag within a foam packing container. Carefully remove the module from its static-proof bag. Bridge completion and shunt calibration resistors should be installed at this time (if required). Refer to Module Insertion for information on installing these components.

Module Insertion

The SC21 is packaged in a 3U (5.25") high, 220mm (8.7") deep, module. Up to 16 SC21 conditioners can be inserted into a single KineticSystems Model V710 active termination panel. The V710 has sixteen positions for 220mm deep KineticSystems SC-series signal conditioning cards, one 220mm deep position reserved for the SC15 Serial Controller and two 160mm deep positions for Model SC10 and SC11 power supplies. In addition, analog output signals from the SC21 modules are routed via the V710 backplane to an analog interface card that is mounted to the rear of the V710 termination panel.

SC21 modules may be installed in the left most sixteen slots of the V710 active termination panel. The seventeenth slot from the left, adjacent to the SC10 and SC11 power supplies, is reserved for an SC15 serial controller as stated above. All of the modules should be secured into the V710 with the top and bottom front panel screws to ensure a good front panel to chassis ground connection.

When mounting the V710 active termination panel into a nineteen-inch rack, it is advisable to leave two or more inches of open space above and below the V710 to maintain proper cooling.

NOTE: A SC26 load module must be installed in the V710 active termination panel whenever there are eight or less SC-series signal conditioning cards installed. The load module is required to maintain power supply output regulation.

FRONT PANEL INFORMATION

LEDs

The "Bsy" (Busy) LED is illuminated when the registers are being accessed.

The "Alm" (Alarm) LED is illuminated when an Excitation Alarm has occurred due to an overcurrent condition or an open sense lead. The Channel Alarm register (at address 0x0) may be read to determine which channel(s) caused the alarm condition.

Connectors

There are two 15-contact "D" connectors (AMP # 748390-6) mounted on the front panel. For a definition of the pins on these connectors refer to Figure 3.

SC21 INTRODUCTION

Transducer connections are made to the SC21 card via the two front-panel connectors. It accommodates transducers that represent 1, 2 or 4 active arms of a bridge circuit. Connections are available to provide a full 10-wire bridge hookup.

Setup and control of the SC21 are accomplished via a standard serial port connected to the Model SC15 Serial Controller.

The SC21 contains two (2) channels of bridge signal conditioning (Refer to Figure 1) with each channel supplying bridge completion circuitry and independent bridge excitation circuitry. In addition, the SC21 provides programmable gain per channel and 2-pole, active, low-pass Butterworth filters on each channel. Filter cutoff frequencies of 10, 50 and 500 Hz plus bypass are software-selectable. Software-selectable pre-filter gains of 1, 10, 100, 1000 and post-filter gains of 1, 2, 5, 10 are provided. The maximum overall gain setting is 2000. Optional trifilar transformers are available for noisy environments or where long input cabling is required. These transformers reduce RF and common mode voltages to the input of the SC21.

Bridge completion (if installed) can be inserted automatically by programming the low thermal EMF latching relays. Either 1/4, 1/2 or full bridge configurations can be selected. Bridge completion resistor option kits are available in 120 Ohm, 350 Ohm, and 1000 Ohm sets. Each channel also provides bridge balancing. A 12-bit Digital-to-Analog (D/A) converter is used to inject current into the bridge to remove initial offset voltages or preloads of up to 70 mV.

Shunt calibration may be performed across two arms of the bridge, providing +/- shunt calibration capability. The switching is performed using programmable solid state switches.

Excitation functionality provides programmable excitation voltages of 0, ±1.25 V, ±2.5 V and ±5.0 V at currents of up to 50 mA. Bandwidth of the control loop exceeds 2 kHz. Overcurrent conditions or an open sense lead will cause the supply to shut down with an Excitation Alarm being generated when this occurs. Excitation is controlled on a per channel basis, so that different excitation voltages may be set for each channel.

End-to-end channel calibration is accomplished in software by configuring the input multiplexer on the SC21 to receive a reference voltage from a programmable calibrator on the SC15 via the V710 backplane.

Analog output signals from the SC21 modules are routed via the V710 termination panel backplane to an analog interface card that is mounted on the rear of the V710. Several types of analog interface cards are available that adapt the output signals to a pinout configuration that matches the type of ADC to be used. Versions of these cards are also available with a parallel connector that provides output buffering of the analog signals for driving an analog recorder. Consult the factory for additional information on these analog interface cards.

Bridge Channel Input Amplifiers

The SC21 bridge signal conditioner input channels utilize programmable gain amplifiers that provide excellent accuracy, high input impedance and low input bias currents. For the programmable gain amplifiers to work properly, an input bias current return path must be provided. Without an input bias current return path, the inputs will float to a potential that exceeds the common-mode range of the amplifier. When these channels are configured as bridge inputs, a bias current return path is inherently provided by the source. However, configurations with floating signal sources must provide an input bias current return path. A pair of resistors tied between the channel inputs and the input ground pin can be used to provide this path (refer to Figure A.11 in the Appendix). Resistors in the 100kΩ to 1 MΩ ohm range are sufficient for most source impedances. Do not use these resistors if the signal source is ground referenced, as a ground loop may occur. Also, if the source has high leakage to ground, use of the resistors may produce DC offsets.

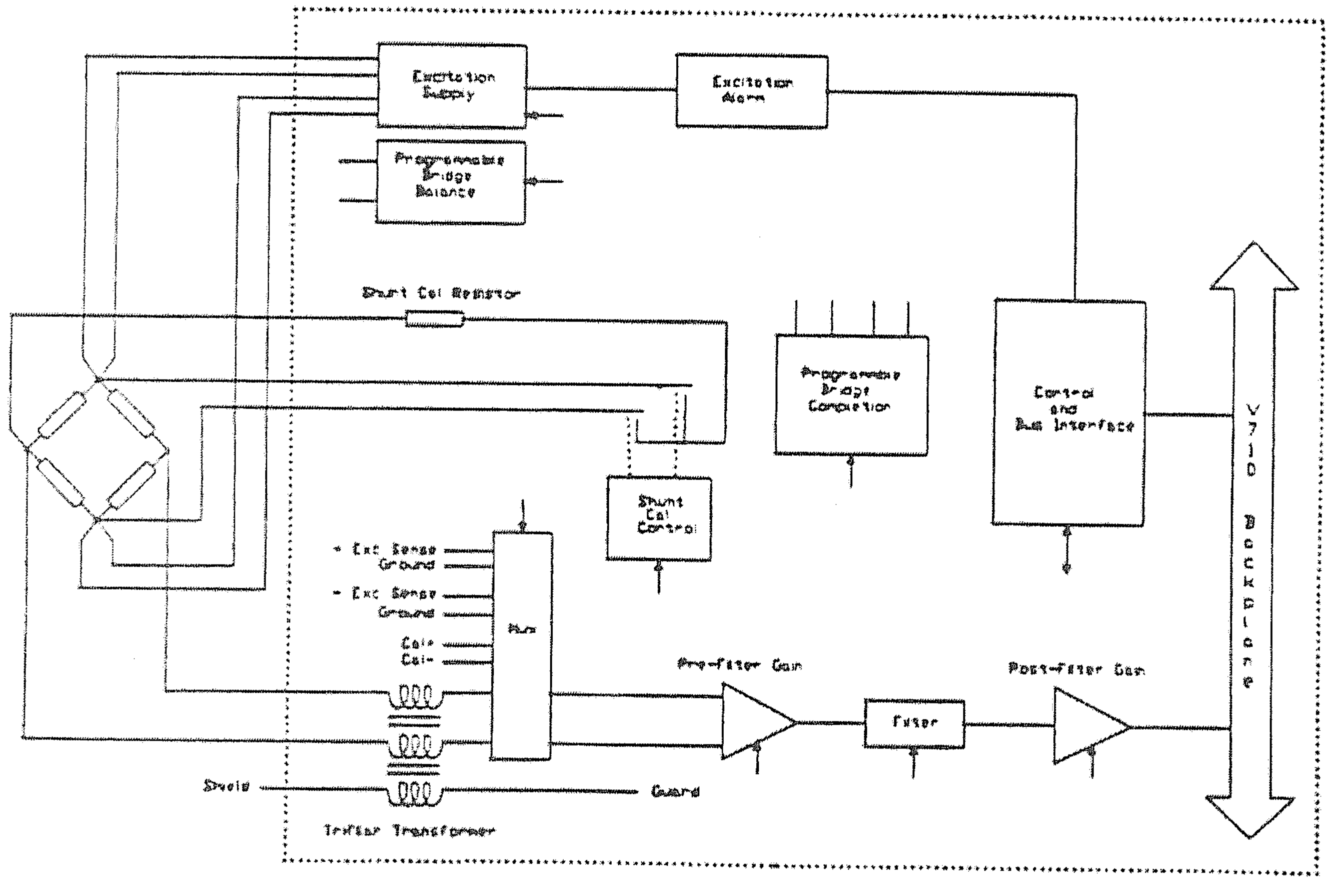

FIGURE 1 - SC21 2-Channel Bridge Signal Conditioner

Configuring Bridge Completion and Shunt Calibration

The SC21 can serve as the input interface for six basic configurations: 1/4 bridge, 1/2 bridge, full bridge, RTD, potentiometer, or voltage inputs. Typical input configurations and connections for a channel are shown in Appendix A.

Sockets are provided for on-board bridge completion. High-precision 120Ω, 350Ω, and 1000Ω resistor kits are available. The SC20-0002 (120Ω bridge completion resistor kit), the SC20-0003 (350Ω bridge completion resistor kit), and the SC20-0004 (1000Ω bridge completion resistor kit) each provides one (1) channel of bridge completion. Bridge completion is activated under program control.

Sockets are also provided so a customer supplied shunt resistor may be placed in opposing arms of the bridge to provide +/- shunt calibration. This resistor can be installed onboard the SC21 module or on the customer's transducer. Shunt calibration is activated under program control. Refer to Figure 2 below for the location of bridge completion and shunt calibration resistor sockets on the SC21.

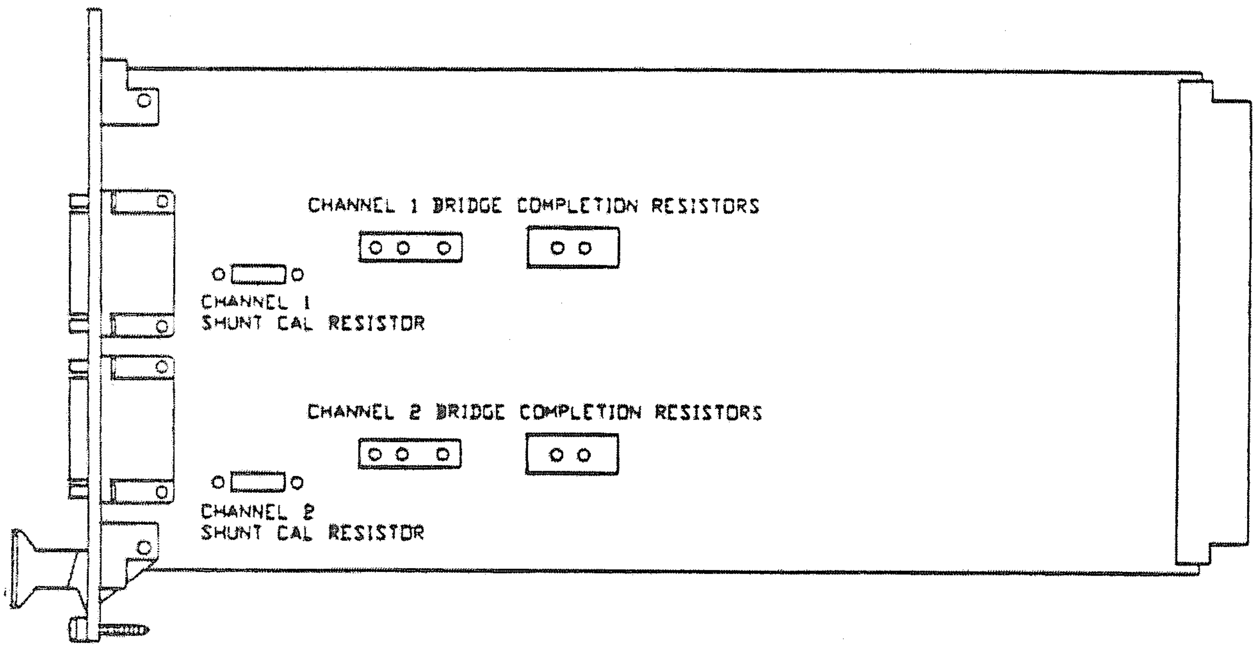

FIGURE 2 - Bridge Completion and Shunt Calibration Resistor Locations

System Calibration/Diagnostics

In any system, particularly with larger data acquisition systems, verifying the proper functioning of the system and the calibration of analog I/O is essential. Generally, it is possible to check out some digital system components through exercising the hardware under software control.

To audit analog channels to any degree requires that a series of known analog signals be injected into each channel of the system. This can be accomplished either by operator intervention or by providing the capability to switch known calibration signals into the input under software control. Switching of calibration signals by hand can be very time consuming and is subject to errors.

For these reasons, KineticSystems has chosen an implementation with full end-to-end calibration features. To accomplish this goal with the architecture described, a known calibration signal must be injected at the input to the signal conditioning at a voltage level appropriate for the chosen gain setting. This is accomplished by a calibration source consisting of a precision voltage reference followed by a programmable active attenuator which is located on the SC15 serial controller. The output of this calibrator is bussed via the V710 termination panels backplane to a multiplexer at the input of each signal conditioning channel. The multiplexer can be configured under software control to receive either the bridge signal or the calibration reference.

Calibrator Calibration for the SC21/SC15/V213 Module Set

When the SC21 is used in conjunction with the KineticSystems model V213 32 or 64 channel scanning ADC, a high degree of accuracy can be achieved by storing calibrator error coefficients for both offset and gain in software. The output of the calibration source on the SC15 serial controller can be connected to a GPIB digital voltmeter. A 2-pin LEMO connector on the SC17 analog interface card is provided for this purpose. The actual calibrator output voltage can then be read and calibration coefficients stored for each calibrator setting to compensate for any gain error. These coefficients are applied in software during channel calibration to compute the true voltage applied to a channel during gain calibration.

Coefficients are also stored to compensate for channel-to-channel offset errors. These coefficients are applied in software during channel offset calibration. The coefficients are generated by grounding each SC21 channels input at the front panel and measuring the front panel offset voltage using the V213 (consult the factory for the availability of shorting connectors for this purpose). The input muxes on the SC21 module are then switched to receive Cal ground from the calibrator on the SC15 and the Cal offset voltage is measured with the V213. Offset coefficients are then derived from the front panel and Cal offset measurements.

Although this calibration procedure is performed at the factory for specific SC21/SC15/V213 module sets prior to shipment, it is recommended that the procedure be performed approximately every six months. The calibration date is also stored in software to help track the last calibration date. If a module within the SC21/SC15/V213 set is replaced, this procedure should be repeated as error coefficients may no longer be valid.

Model SC21

The following is a list of steps to follow in performing calibration of the calibration source for the SC21/SC15/V213 module set :

1. The SC21/SC15/V213 module set should be allowed at least a 30 minute warm-up period.

2. Connect the 2-pin LEMO connector on the SC17 analog interface card to a precision voltage meter. All SC21 channel input pins (front panel connectors J1 and J2 pins 5 and 10) must be connected to ground. Pin 14 at each input connector is analog ground. Consult the factory for availability of shorting connectors to provide this function.

3. In software for each SC21 channel, set the input mux to "line" and set for "full bridge", "0 volts excitation", "pre-filter gain = 100", "post-filter gain = 10", "filter bypass".

4. Gain Calibration – repeat steps 4a to 4c for all 12 differential calibrator voltages. In the following equation of step 4c, these expected calibrator voltages are referred to as "CALIBRATOR", ranging from 10 volts to 2 millivolts. The calibrator voltages are set by the Write Calibrator command at the SC15 serial controller (consult the SC15 manual for the table of calibrator commands). Make sure to wait for the calibrator voltage to settle before any measurements are taken.

4a. Use a precision meter to measure the positive calibration voltage (average 100 points). The measured positive calibration voltage is referred to as PCAL in the equation of step 4c.

4b. Use a precision meter to measure the negative calibration voltage (average 100 points). The measured negative calibration voltage is referred to as NCAL in the equation of step 4c.

4c. Store the gain error coefficient in software as a 16-bit signed integer according to the following equation.

$$\text{GAIN COEFFICIENT} = \left(\frac{PCAL - NCAL}{CALIBRATORx2} - 1\right)x10^{6}$$

5. If offset calibration is not needed, then skip to step 7.

6. Offset calibration – for each channel repeat steps 6a through 6f.

6a. The SC21/SC15/V213 module set must remain intact for the gain and offset coefficients to be valid. Make sure a shorting connector is connected to all channels.

6b. In software, for each channel of the SC21, set input Mux to "line", "full bridge", "0 volts excitation", "pre-filter gain=100", "post-filter gain=10", "filter bypass". Set the V213 for internal continuous scan, set mux rate to 2 kHz for highest accuracy, and a gain of 1 for all channels. Create a scan list for all channels to be calibrated. The scan rate is not critical, but it should be set to a valid rate (30 Hz is recommended).

6c. Measure the front panel offset voltage (RTO) using the V213 (average 100 points). Use this equation to convert the COUNTS read from the V213 into RTO voltage.

$$VOLTAGE(RTO) = \frac{1}{100}\sum_{1}^{100} COUNTS \; x \; 319.8242188 \mu Volts$$

This front panel ground measurement is referred to as FP OFFSET in the equation of step 6f.

6d. In software for each SC21, connect all channels input Mux to "Cal" (all other settings are the same as step 3). Set the calibrator output on the SC15 Serial Controller to "zero" (ground).

6e. Measure the zero offset voltage (RTO) using the equation in step 6c (average 100 points). The zero ground measurement is referred to as CAL OFFSET in the equation of step 6f.

6f. Store the zero error coefficient in software as a 16-bit signed integer according to the following equation:

$$OFFSET\ COEFFICIENT = \frac{(FP\ OFFSET - CAL\ OFFSET)}{1000} x\ 10^9$$

7. Store the calibration date in software.

8. End of calibration.

Software Channel Calibration

Once the gain and offset coefficients for the calibrator have been stored in software, each channel on the SC21 can be calibrated under software control using the calibrator on the SC15 Serial Controller. Offset and gain error coefficients for each channel must be stored in software and applied to any voltage readings from those channels. It is important not to confuse these channel error coefficients with the calibrator gain and offset error coefficients. The calibrator error coefficients are used during the channel calibration. The following is a list of steps to follow in performing the SC21 channel calibration:

1. The SC21/SC15/V213 module set should be allowed at least a 30 minute warm-up period.

2. Set the SC21 channels to the desired gain and filter selection. The chosen gain is referred to as GAIN SETTING in the equation to follow for uncalibrated voltage.

3. Gain calibration – for every channel, repeat steps 3a through 3f.

   a. Set the channels input Mux to "Cal".

   b. Set the calibration voltage (calibrator output at the SC15) to that channels positive full scale voltage. The full scale voltage is dependent on the gain setting for that channel. The expected positive calibration voltage will be referred to as $POSCAL_{EXPECTED}$ in the equation in step 3f. Be sure to wait for the voltage to settle to 16-bit accuracy once the calibration voltage is set.

   c. Measure the positive full scale voltage (average 100 points recommended). Use the following equation to convert the COUNTS read from the V213 into voltage RTO.

$$VOLTAGE(RTO) = \frac{1}{100}\sum_{1}^{100} COUNTS\, x\, 319.8242188\, \mu Volts$$

   The measured positive full scale calibration voltage is referred to as $POSCAL_{MEASURED}$ in the equation of step 3f.

   d. Set the calibration voltage (calibrator output at the SC15) to that channel's negative full scale voltage. The full scale voltage is dependent on the gain setting for that channel. The expected negative full scale calibration voltage will be referred to as $NEGCAL_{EXPECTED}$ in the equation in step 3f. Be sure to wait for the voltage to settle to 16-bit accuracy once the calibration voltage is set.

e. Measure the negative full scale voltage (average100 points). Use the equation in 3c. The measured negative full scale calibration voltage is referred to as $NEGCAL_{EXPECTED}$ in the equation in step 3f.

f. Read the gain error for the calibrator voltage from software. The gain correction term is referred to as GAINCOEF in the following equation:

$$GAIN = \frac{POSCAL_{MEASURED} - NEGCAL_{MEASURED}}{(POSCAL_{EXPECTED} - NEGCAL_{EXPECTED}) \bullet (1 + GAINCOEF \bullet 10^{-6})}$$

g. Record the "true" gain for the channel as calculated above.

4. Offset Calibration – for every channel.

a. Set the calibration voltage to ground (Write calibrator command to the SC15). Wait for the filter to settle to 16-bit accuracy.

b. Measure the offset in counts (average 100 points). Use the equation in Step 3c to convert counts to voltage RTs. For each channel, read the offset coefficient from software. The offset correction is referred to as OFFCOEF in the following equation:

$$OFFSET = \left(\frac{OFFSET_{MEASURED}}{GAIN}\right) + (OFFSETCOEF \bullet 10^{-9})$$

c. Record the "true" offset for the channel as calculated above.

Applying the Software Coefficients

Once the software gain and offset coefficients for each channel have been calculated, they may be applied when taking data. Measure the counts from the V213. The V213 represents voltage in a two's complement format. In the following two equations, this variable will be referred to as COUNTS.

When calibration is unnecessary, the gain is derived simply from the pre-filter and post-filter gain settings in the SC21 channel gain register. Convert counts to uncalibrated voltage using the following equation:

$$UNCALIBRATEDVOLTAGE = \frac{COUNTS \bullet 319.8242188\mu Volts}{GAINSETTING}$$

For best accuracy, the calibration coefficients may be used to calculate the calibrated voltage. Convert counts to calibrated voltage using the following equation:

$$CALIBRATEDVOLTAGE = \frac{(COUNTS \bullet 319.8242188\mu Volts)}{GAIN} - OFFSET$$

Where GAIN is the "true" channel gain as calculated in step 3f above and OFFSET is the "true" channel offset as calculated in step 4b above.

Excitation Voltage Reference Calibration

The excitation voltage circuit on the SC21 consists of a precision +10 volt reference and precision resistor dividers that provide excitation voltages of 0V, ±1.25V, ±2.5V and ±5.0V. It is recommended that calibration of the +10 volt reference be performed every 12 months. Listed below are the steps required to calibrate the +10 volt excitation reference.

1. Access to the reference potentiometer on the SC21 requires placing the module on a 3U high extender (DIN41612 connector C96 test adapter Schroff part no. 23021-654). Allow the SC21 a 15-minute warm-up period prior to proceeding to Step 2.

2. The 10 volt reference potentiometer PT1 is located at the upper left-hand corner of the module directly behind the module front panel. Using a precision meter such as the HP3458A to monitor test points TP1 (+) and TP2 (-), adjust potentiometer PT1 to +10.0000 volts, ±0.0005 volts.

SC21 TROUBLE SHOOTING GUIDE

Problem	Possible Cause
Output at + or - 12 Volts	Input MUX open or no input connection. Input signal saturating amplifier; gain set too high.
Output always at zero	Input MUX set to zero. Gain set too low for input signal. Filter set to wrong bandedge.
Signal is clipped	Gain set too high.
Output not changing with input signal	Input MUX set to other than "Line", possibly to "Cal" or "± excitation". Gain set too low.
Input signal not changing	No excitation voltage.
ADC module not receiving data from SC21	Wrong connector adapter card installed on back of V710 active termination panel. V710 power is turned off. Cable connection between V710 and ADC module is bad or missing.
Excitation alarm	Excitation sense lines open. Shorted excitation. Current excitation overload. Excitation voltage too high for transducer.
No shunt calibration	Shunt calibration resistors not installed.

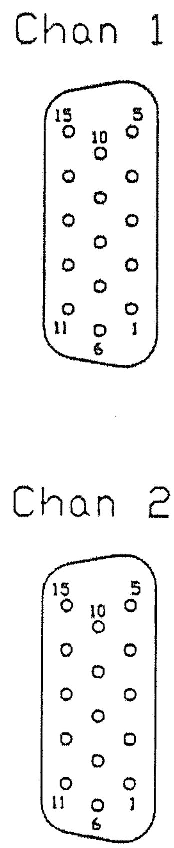

FIGURE 3 - SC21 Front panel connectors

Front Panel connectors J1 and J2

Pin #	J1 Description	Pin #	J2 Description
1	Ch 1 Pos Monitor	1	Ch 2 Pos Monitor
2	Ch 1 Pos Sense	2	Ch 2 Pos Sense
3	Ch 1 Pos Excitation	3	Ch 2 Pos Excitation
4	Ch 1 Cal Resistor	4	Ch 2 Cal Resistor
5	Ch 1 Pos Input	5	Ch 2 Pos Input
6	Ch 1 Neg Excitation	6	Ch 2 Neg Excitation
7	Ch 1 Neg Sense	7	Ch 2 Neg Sense
8	Ch 1 Neg Monitor	8	Ch 2 Neg Monitor
9	Ch 1 Quarter Bridge	9	Ch 2 Quarter Bridge
10	Ch 1 Neg Input	10	Ch 2 Neg Input
11	No Connection	11	No Connection
12	No Connection	12	No Connection
13	No Connection	13	No Connection
14	Analog Ground	14	Analog Ground
15	Ch 1 Shield	15	Ch 2 Shield

PROGRAMMING INFORMATION

SC21 Operational Registers

00h - Channel Alarm Register

07	06	05	04	03	02	01	00
						Ch 2 Alarm	Ch 1 Alarm
1= Alarm Condition							

Bits 0-1 contain information about channel excitation alarms. A read of this register will clear the alarm bits.

01h - Channel 1 Excitation/Bridge Configuration Register

07	06	05	04	03	02	01	00
Not Used	Monitor	Local Sense	Bridge Config.		2.5	10	5
	1 = Enable	1 = Enable	00=Full 01=1/2 10=1/4		Excitation (Note: none=0 Volt)		

Bits 0-2 select the excitation voltage. Select only one of the bits for the excitation voltage ("1" = selected). If the excitation has shut down as a result of an Excitation Alarm, the excitation must be reset to 0 before selecting the appropriate excitation voltage.

Bits 3-4 allow selection of the bridge configuration. Bit 5 selects local sense. Bit 6 shorts the monitor lines to the excitation lines.

02h - Channel 2 Excitation/Bridge Configuration Register

07	06	05	04	03	02	01	00
Not Used	Monitor	Local Sense	Bridge Config.		2.5	10	5
	1 = Enable	1 = Enable	00=Full 01=1/2 10=1/4		Excitation (Note: none=0 Volt)		

Bits 0-2 select the excitation voltage. Select only one of the bits for the excitation voltage ("1" = selected). If the excitation has shut down as a result of an Excitation Alarm, the excitation must be reset to 0 before selecting the appropriate excitation voltage.

Bits 3-4 allow selection of the bridge configuration. Bit 5 selects local sense. Bit 6 shorts the monitor lines to the excitation lines.

03h - Channel 1 Bridge Balance Register 1

07	06	05	04	03	02	01	00
DAC 7	DAC 6	DAC 5	DAC 4	DAC 3	DAC 2	DAC 1	DAC 0
Bridge Balance DAC Value							

04h - Channel 1 Bridge Balance Register 2

07	06	05	04	03	02	01	00
+	-	+	-	DAC 11	DAC 10	DAC 9	DAC 8
Shunt Calibration		Bridge Balance Polarity		Bridge Balance DAC Value			

The Bridge Balance DAC value is programmed via bits 0-7 of Bridge Balance Register 1 and bits 0-3 of Bridge Balance Register 2 (The SC21 utilizes a 12-bit DAC for balance). The polarity of this offset is programmed by selecting one of the bits 4 or 5 of Bridge Balance Register 2. If neither is selected then Bridge Balance is disabled.

Bits 6 and 7 control Shunt Calibration. When neither bit is asserted then the bridge is unshunted. Selecting + or - shunt calibration ("1" = selected) causes the Shunt Cal resistor (if installed) to be switched into the appropriate arm of the bridge.

05h - Channel 2 Bridge Balance Register 1

07	06	05	04	03	02	01	00
DAC 7	DAC 6	DAC 5	DAC 4	DAC 3	DAC 2	DAC 1	DAC 0
Bridge Balance DAC Value							

06h - Channel 2 Bridge Balance Register 2

07	06	05	04	03	02	01	00
+	-	+	-	DAC 11	DAC 10	DAC 9	DAC 8
Shunt Calibration		Bridge Balance Polarity		Bridge Balance DAC Value			

The Bridge Balance DAC value is programmed via bits 0-7 of Bridge Balance Register 1 and bits 0-3 of Bridge Balance Register 2 (The SC21 utilizes a 12 bit DAC for balance). The polarity of this offset is programmed by selecting one of the bits 4 or 5 of Bridge Balance Register 2. If neither is selected then Bridge Balance is disabled.

Bits 6 and 7 control Shunt Calibration. When neither bit is asserted then the bridge is unshunted. Selecting + or - shunt calibration ("1" = selected) causes the Shunt Cal resistor (if installed) to be switched into the appropriate arm of the bridge.

07h - Input Mux Register

07	06	05	04	03	02	01	00
Not Used							
				Channel 2 Input MUX 00=LINE 01=EXC + 10=EXC - 11=CAL		Channel 1 Input MUX 00=LINE 01=EXC + 10=EXC - 11=CAL	

Bits 0-3 are used to program the input multiplexer. They select either the channel (line), +/- Excitation sense voltage or Cal source. This input MUX selection is provided to allow software end-to-end calibration and measurement of the excitation voltage via the sense lines. The SC21 uses a zero balanced Excitation supply, so for a 10 volt excitation setting the Excitation + sense line will read +5 volts and the Excitation - sense line will read -5 volts, etc.

<u>08h</u> - <u>Channel 1 Gain Register</u>

07 06 05 04 03 02 01 00

Not Used		
	Channel 1 pre-filter gain 00 GAIN=1 01 GAIN=10 10 GAIN=100 11 GAIN=1000	Channel 1 post-filter gain 00 GAIN=1 01 GAIN=2 10 GAIN=5 11 GAIN=10

<u>09h</u> - <u>Channel 2 Gain Register</u>

07 06 05 04 03 02 01 00

Not Used		
	Channel 2 pre-filter gain 00 GAIN=1 01 GAIN=10 10 GAIN=100 11 GAIN=1000	Channel 2 post-filter gain 00 GAIN=1 01 GAIN=2 10 GAIN=5 11 GAIN=10

Bits 0-1 select the channel post-filter gain setting. Bits 2-3 select the channel pre-filter gain setting. In general, it is best to apply the most possible gain in the first stage. For example, a gain of 10 can be accomplished by applying the gain of 10 in the first or second stage. In this case, a gain of 10 should be applied in the first stage for best noise immunity. However, a gain of 1000 should be accomplished by applying a gain of 100 in the pre-filter stage and a gain of 10 in the post-filter stage, etc., if bandwidth needs to be maintained. **See the specification table on page 2 for bandwidth limitations at various gain settings.**

NOTE: Overall gain is limited to 2000 when using the calibrator on the SC15 serial controller to perform channel calibration.

0Ah - Channel 1 Filter Register

07	06	05	04	03	02	01	00
Not Used							
						Channel 1 filter selection 00 10 Hz 01 50 Hz 10 500 Hz 11 Bypass	

0Bh - Channel 2 Filter Register

07	06	05	04	03	02	01	00
Not Used							
						Channel 2 filter selection 00 10 Hz 01 50 Hz 10 500 Hz 11 Bypass	

Bits 0-1 select the filter cut-off or the bypass (wideband) path.

APPENDIX

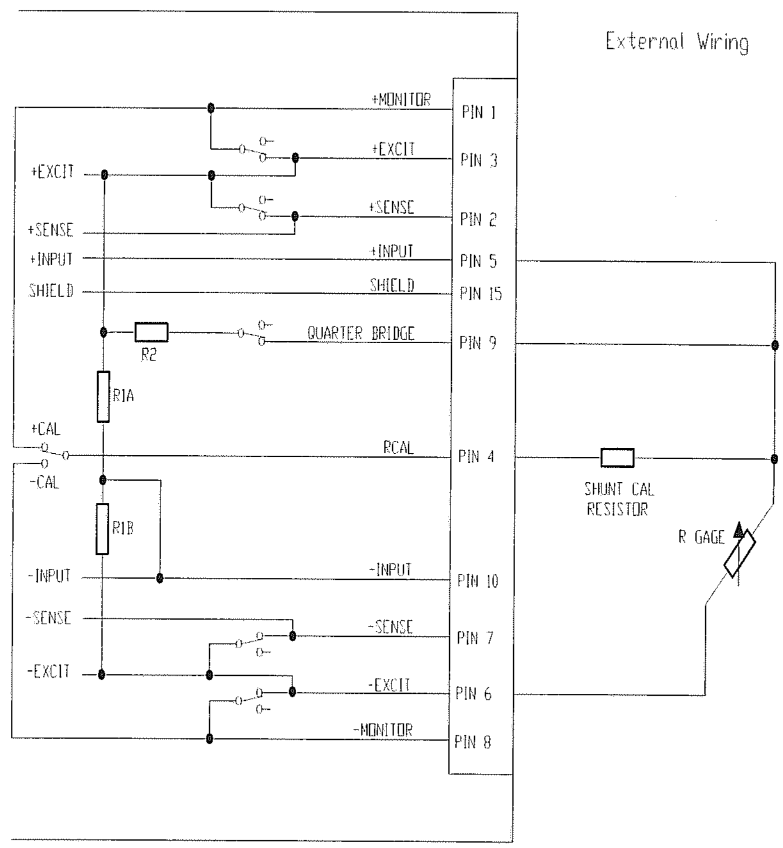

FIGURE A.1

1/4 BRIDGE - INTERNAL SENSING AND EXTERNAL CAL RESISTOR

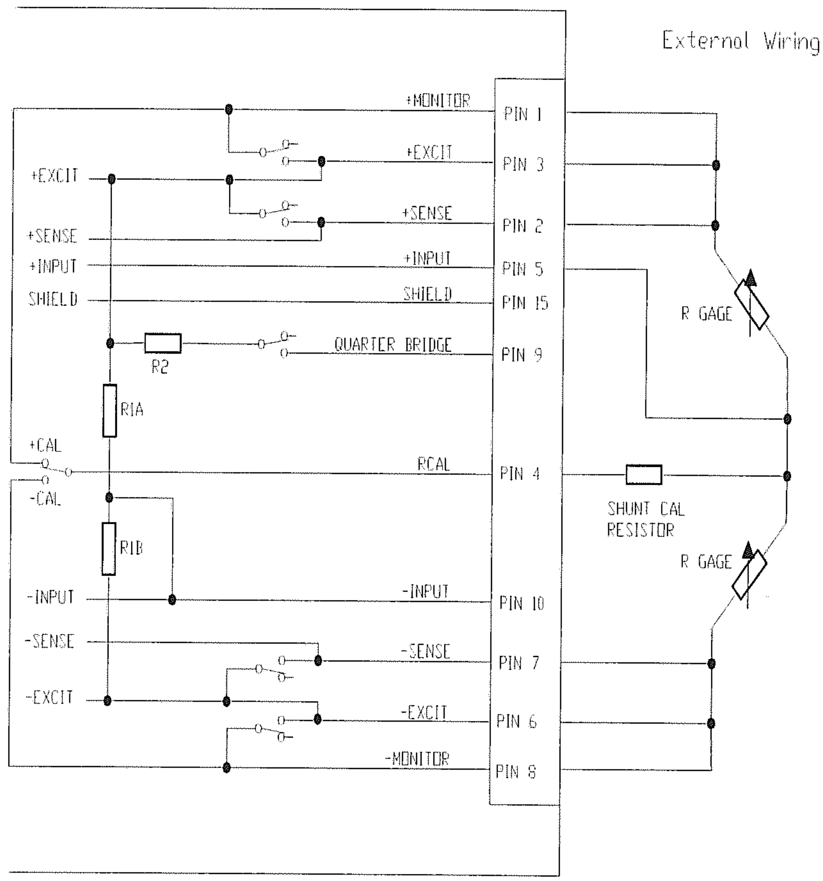

FIGURE A.2

1/2 BRIDGE - EXTERNAL SENSING AND EXTERNAL CAL RESISTOR

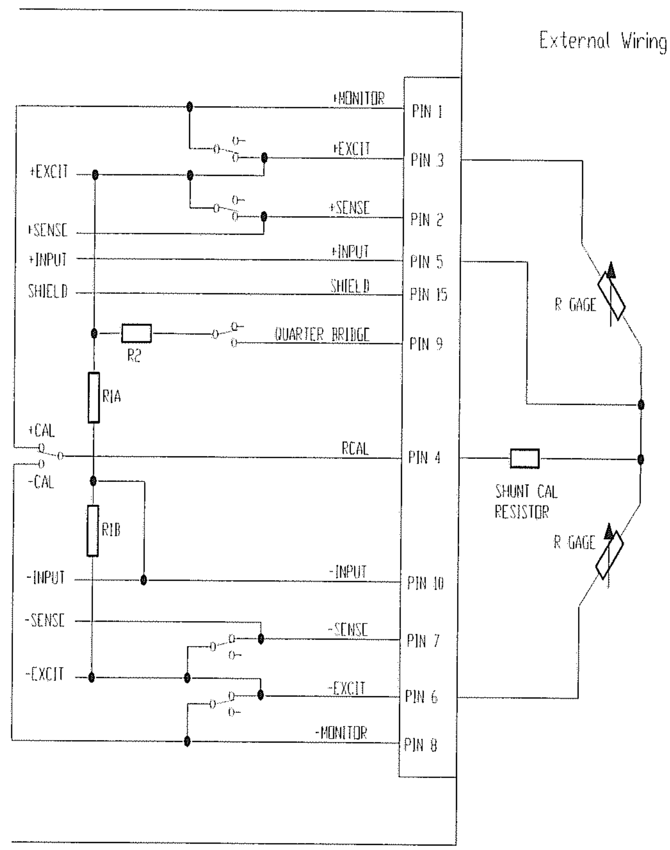

FIGURE A.3

1/2 BRIDGE - INTERNAL SENSING AND EXTERNAL CAL RESISTOR

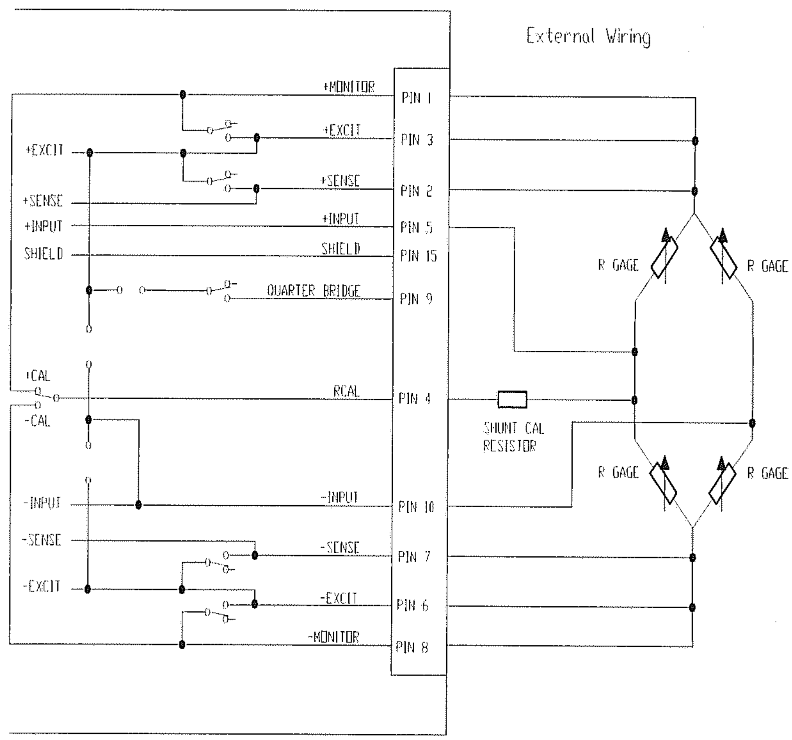

FIGURE A.4

FULL BRIDGE - EXTERNAL SENSING AND EXTERNAL CAL RESISTOR

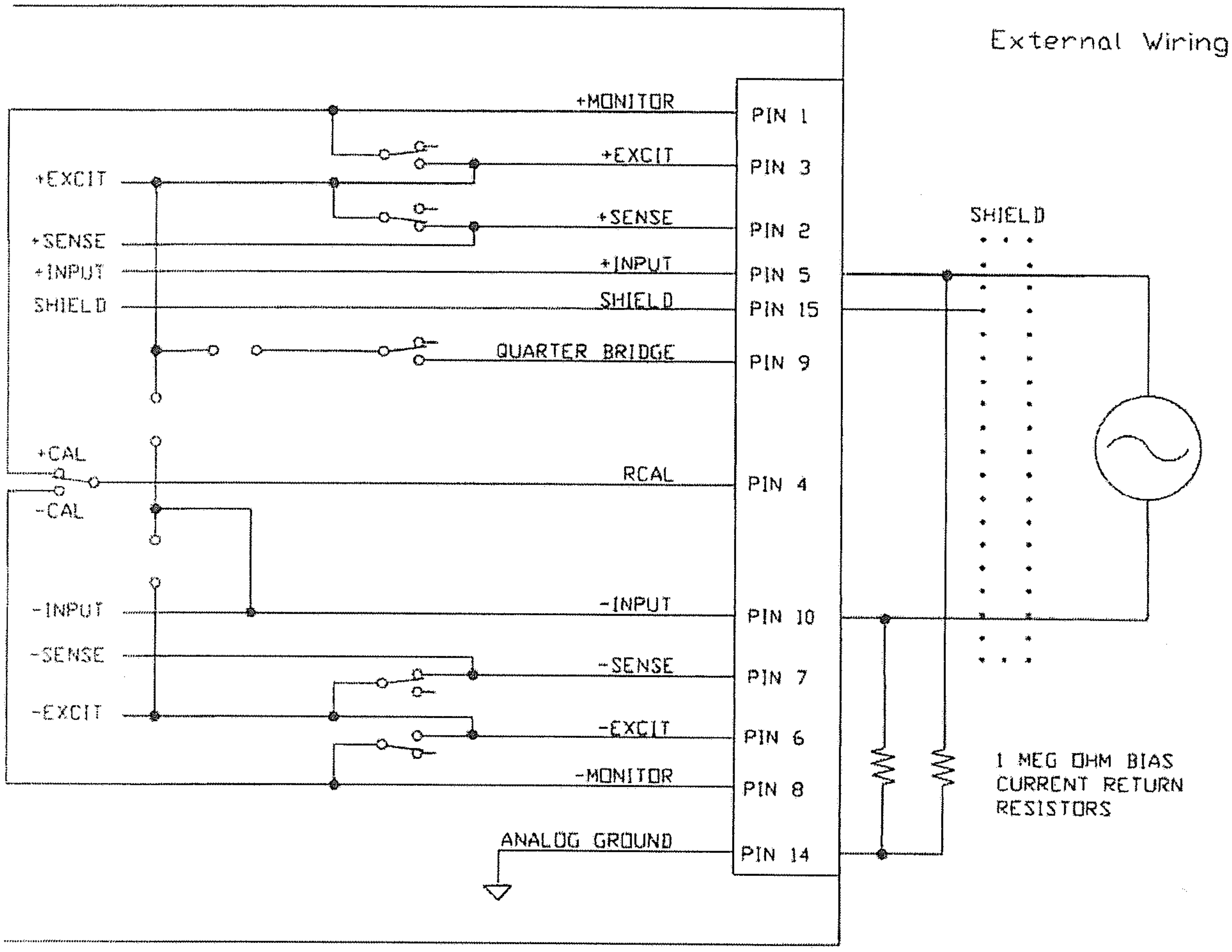

FIGURE A.5

VOLTAGE INPUT

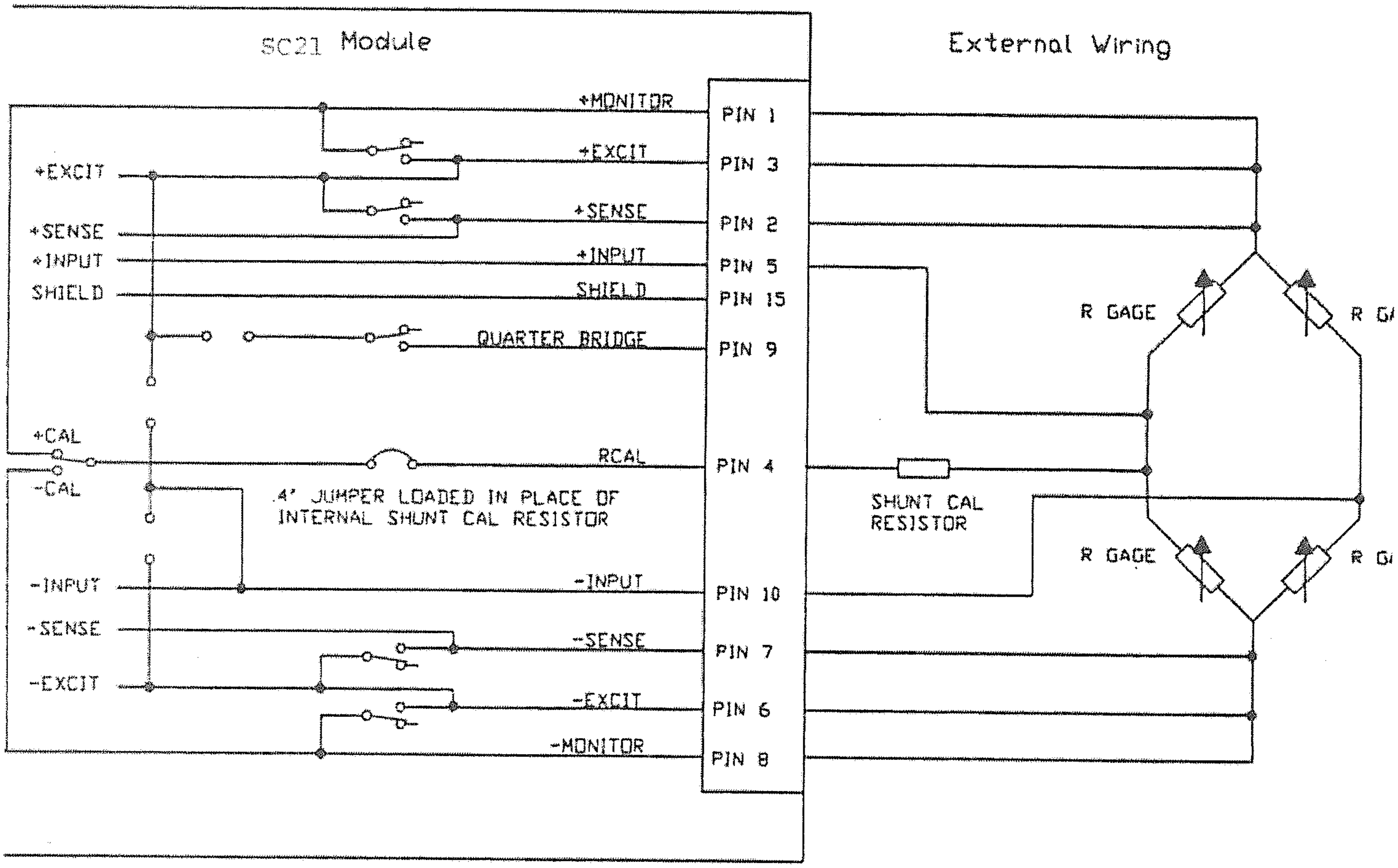

FIGURE A.6
FULL BRIDGE - EXTERNAL SENSING AND EXTERNAL CAL RESISTOR

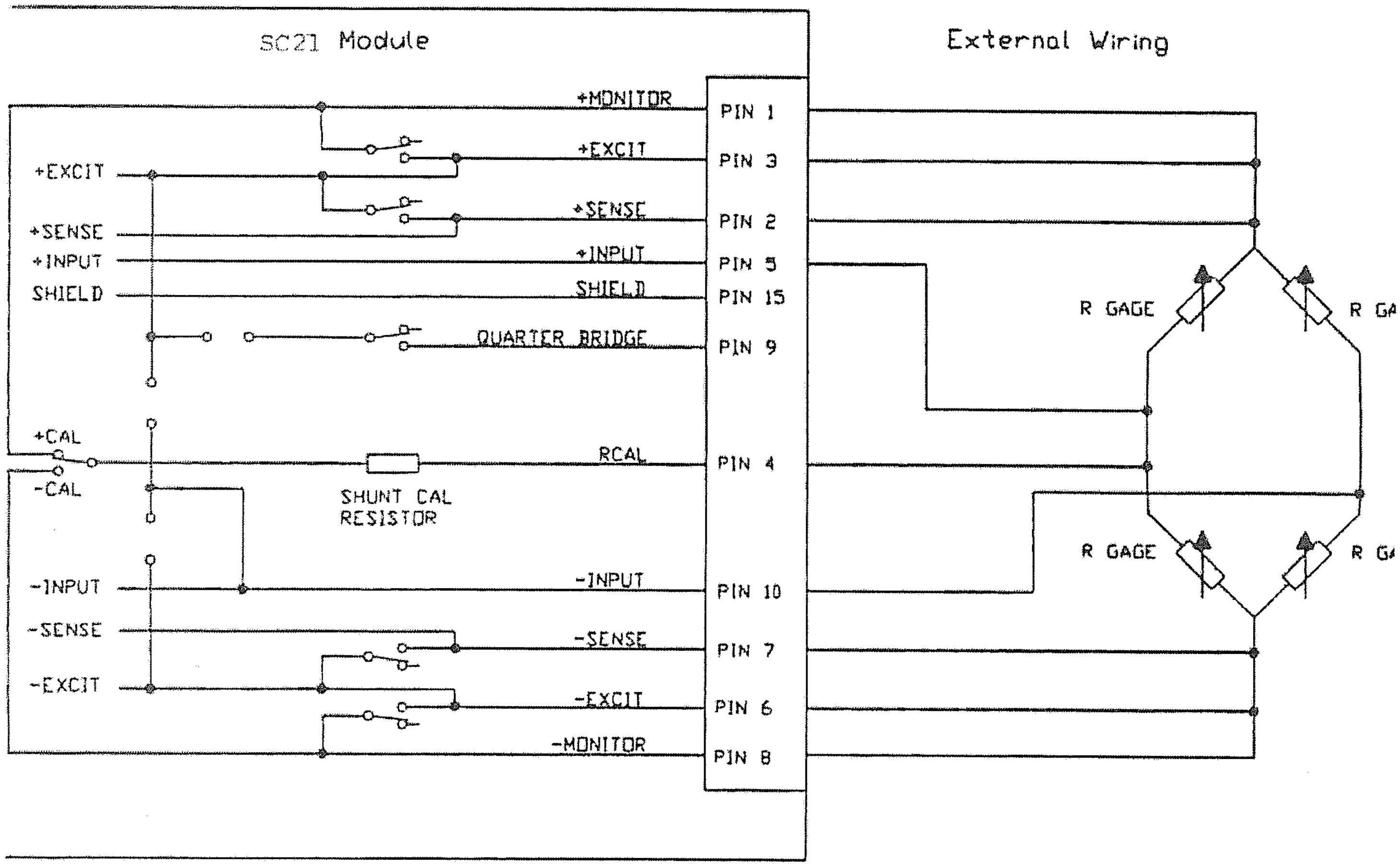

FIGURE A.7
FULL BRIDGE - EXTERNAL SENSING AND INTERNAL CAL RESISTOR

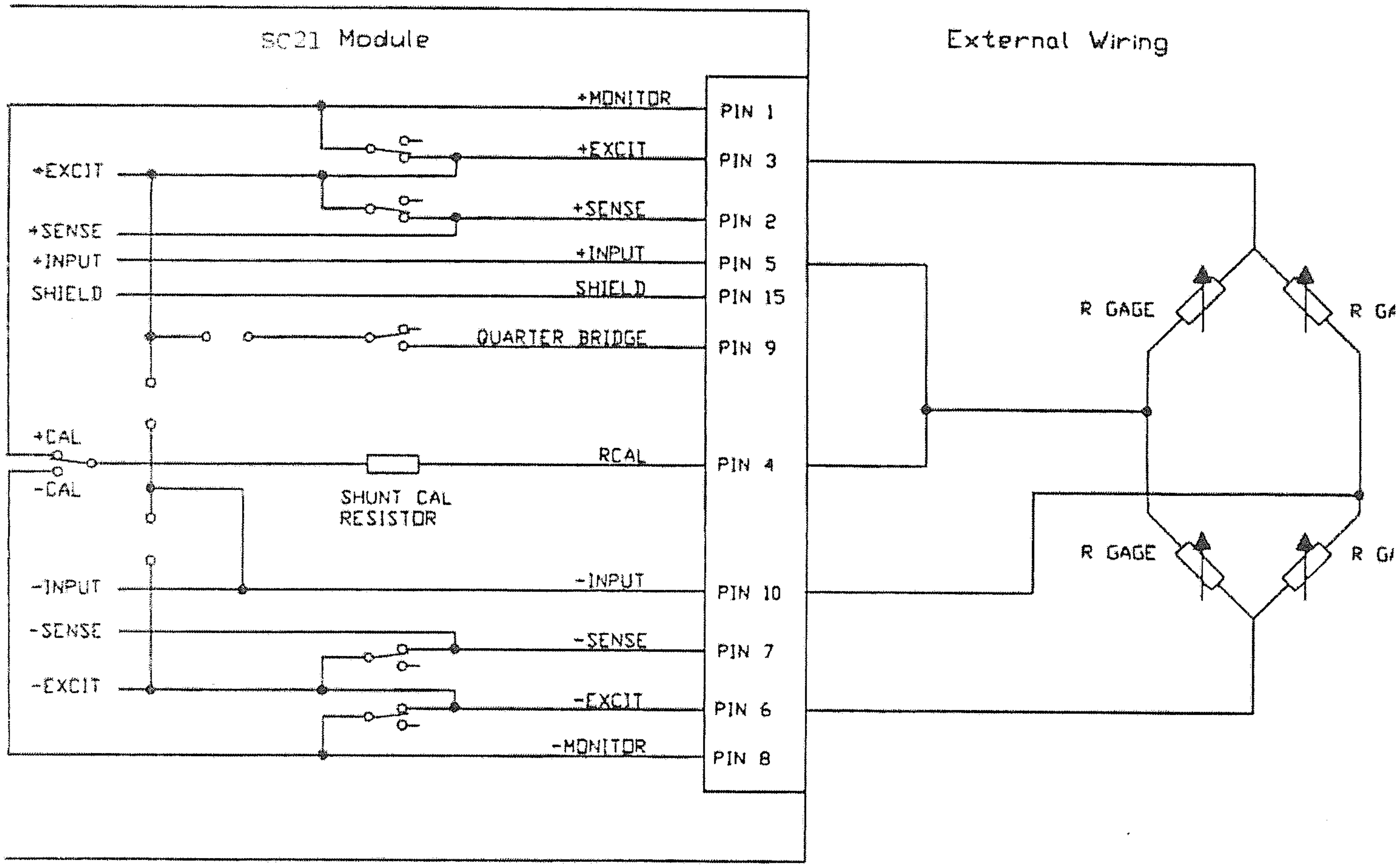

FIGURE A.8
FULL BRIDGE - INTERNAL SENSING AND INTERNAL CAL RESISTOR

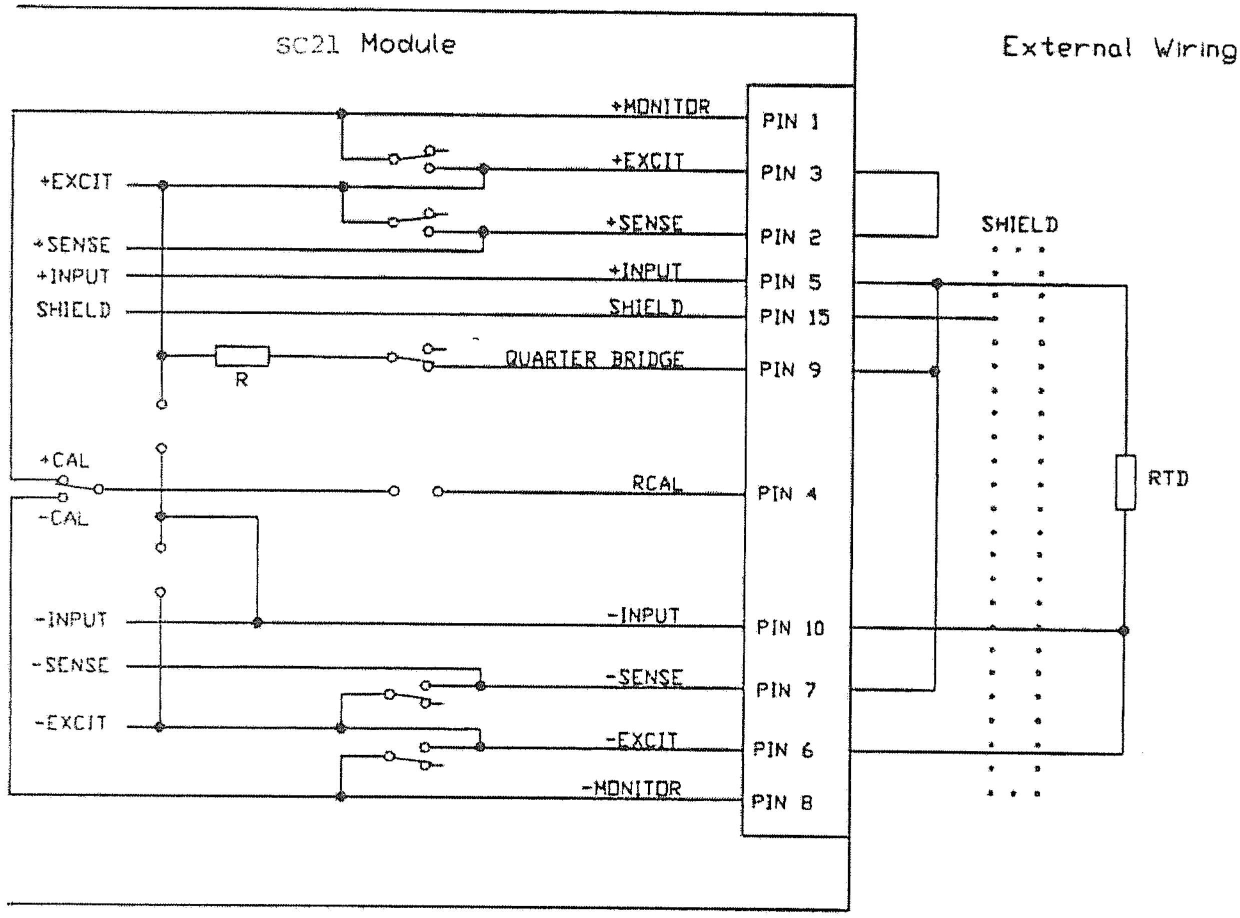

FIGURE A.9
RTD CONNECTION

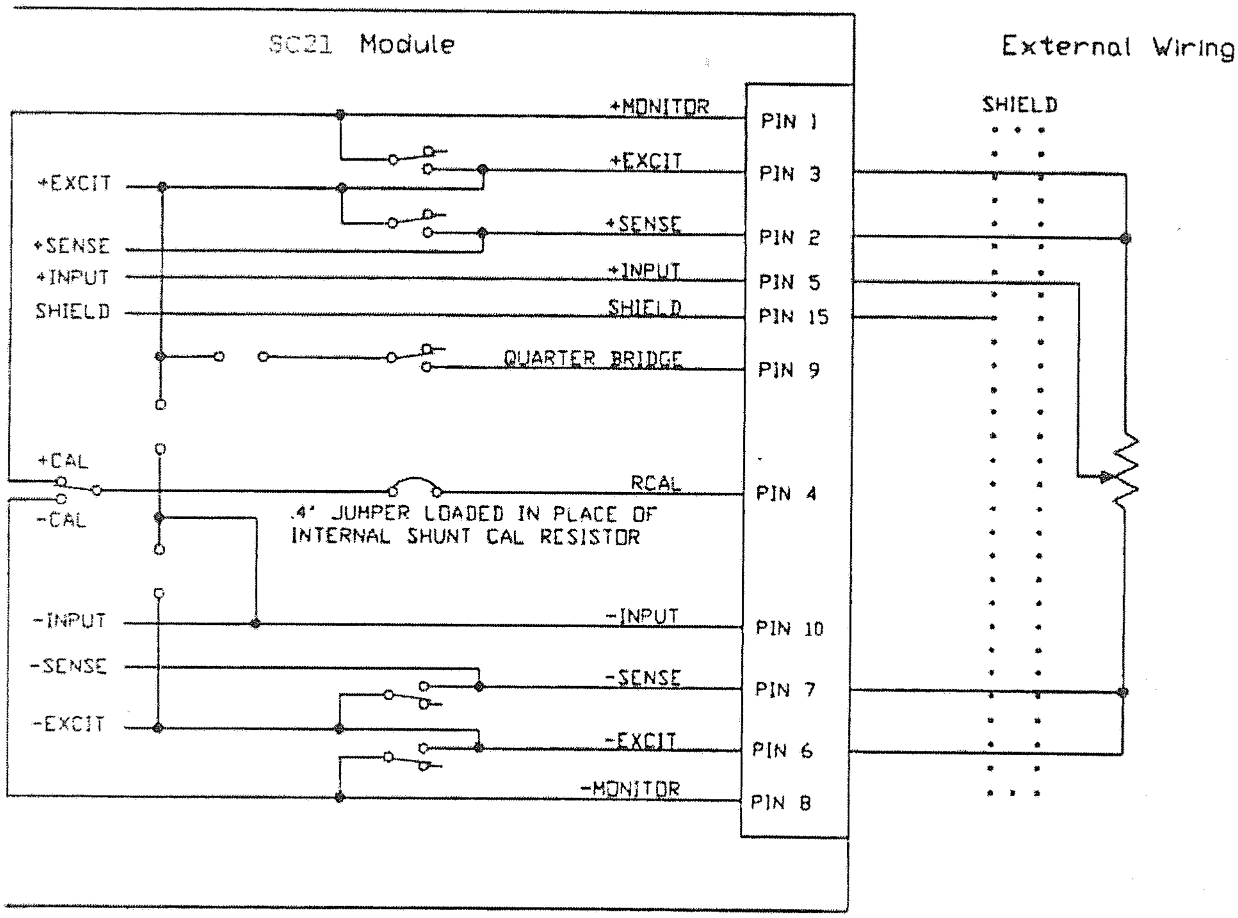

FIGURE A.10
POTENTIOMETER CONNECTION

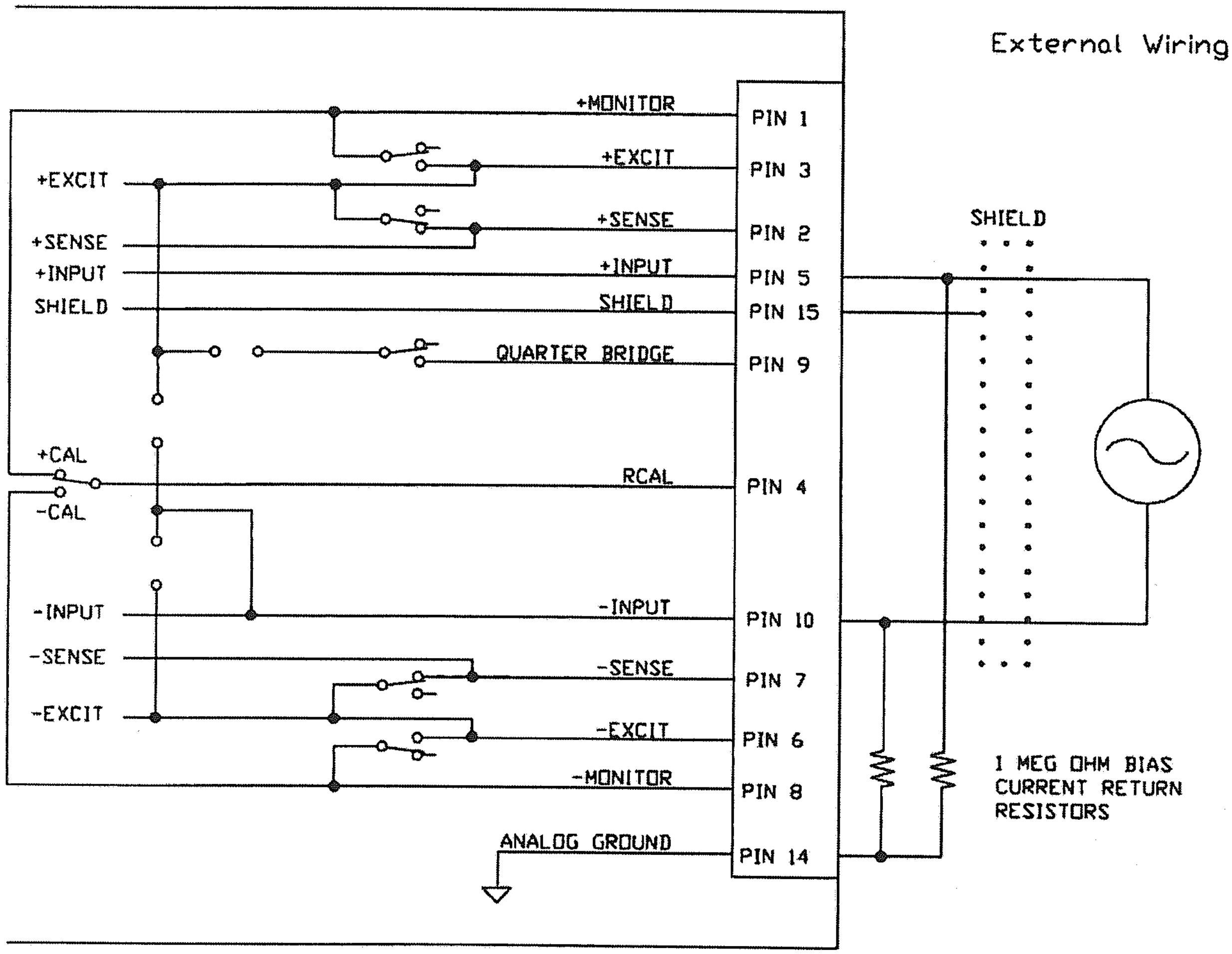

FIGURE A.11

VOLTAGE INPUT