SHELDON INSTRUMENTS

SI-BRIDGE User's Guide

May, 1998

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1.0 Introduction

The SI-BRIDGE is a bridge completion module for use with the SI-100's Octal Analog card. It has circuitry for shunt calibration, bridge balancing, as well as open sockets for placing discrete resistors for bridge completion. Resistive bridge sensors are more commonly known as strain gauges, which can be directly mounted onto a test specimen or be mounted onto a diaphragm to form other sensor types such as accelerometers, pressure gauges, deflectometers, and load cells.

The figure below illustrates a simple diagram of a strain gauge circuit, with a typical configuration linking the excitation source as well as amplification. By their nature, the difference between the two signal terminals of strain gauge circuits can be relatively negligible when compared to nominal levels of most electronic circuitry. Hence the need for a differential amplifier to elevate the signal's dynamic range to a level that can be easily quantized by a data converter. Additionally, the bridge balance potentiometer serves to nullify any irrelevant DC biases that result from inaccuracies and mismatches within the strain gauge's resistive elements and the amplifier itself.

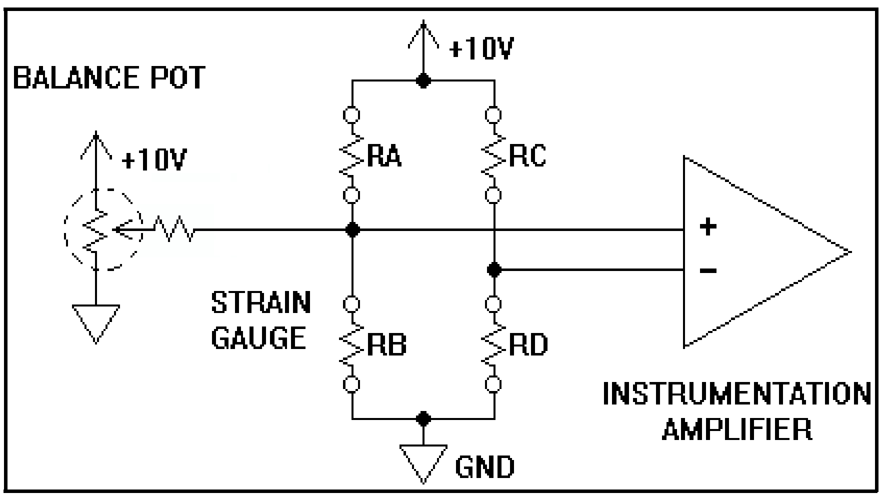

Figure 1. Strain gauge circuit block diagram.

Note: Strain gauges are classified as balanced or differential sensors. Unlike single ended or unbalanced sensors that reference a single signal output with respect to a system ground, both signal terminals of differential sensors emit currents and voltages through both terminals that are not necessarily referenced to a common system ground. Therefore, special care must be taken to avoid connecting either signal terminal to the excitation return path, shield, or system ground.

Depending upon the nature of the measurement in question, not all resistive elements of a strain gauge need to be mounted onto the test specimen. However, all four resistive elements need to be present in order for the bridge to be completed and hence minimize the effect of unwanted DC signal biases. Each of the four resistive elements has its own socket allowing for a very flexible bridge arrangement, with the most popular configurations being quarter bridges, half bridges, three quarter bridges, and full bridges.

2.0 Quarter Bridge Configurations and Mounting Details.

Quarter bridge strain gauges refer to a configuration in which only a single (1) resistive element is mounted onto the test specimen. In this case, three (3) of the four (4) absent resistors need to be mounted into their sockets in order to complete the bridge. Please refer to figures 2 through 5 for further details.

*Note: The discrete resistors used to complete the bridge circuit must be of the <u>**same**</u> nominal impedance value (ohms = Ω) as the resistive element of the strain gauge, which is typically in the range of **150Ω** to **1000Ω**. It is also imperative that these discrete resistors have a tolerance no worse than **1%**, and be capable of dissipating at least **1/4Watt** of power.*

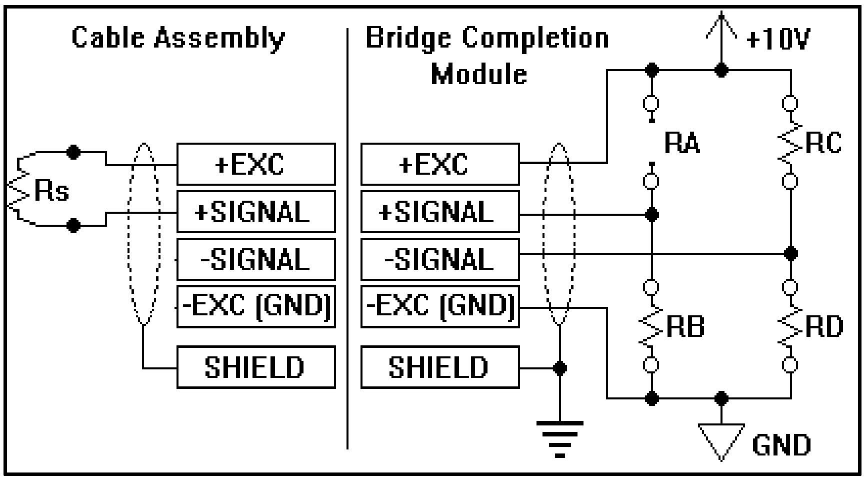

Figure 2. Quarter bridge with resistive element placed between the +EXCITATION and the +SIGNAL terminals, RA is removed.

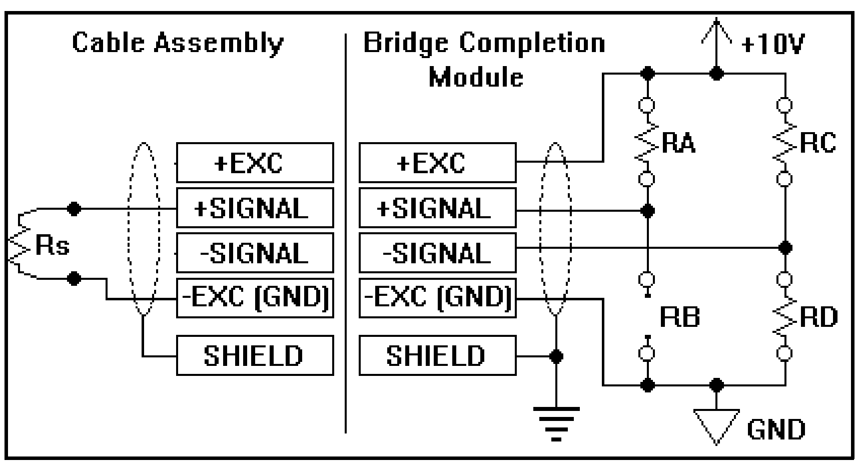

Figure 3. Quarter bridge with resistive element placed between the +SIGNAL and the -EXCITATION (GND) terminals, RB is removed.

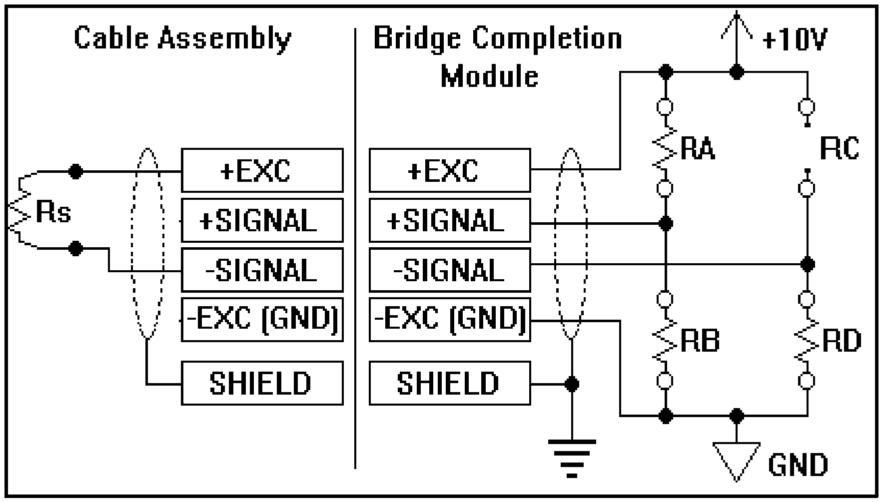

Figure 5. Quarter bridge with resistive element placed between the +EXCITATION and the -SIGNAL terminals, RC is removed.

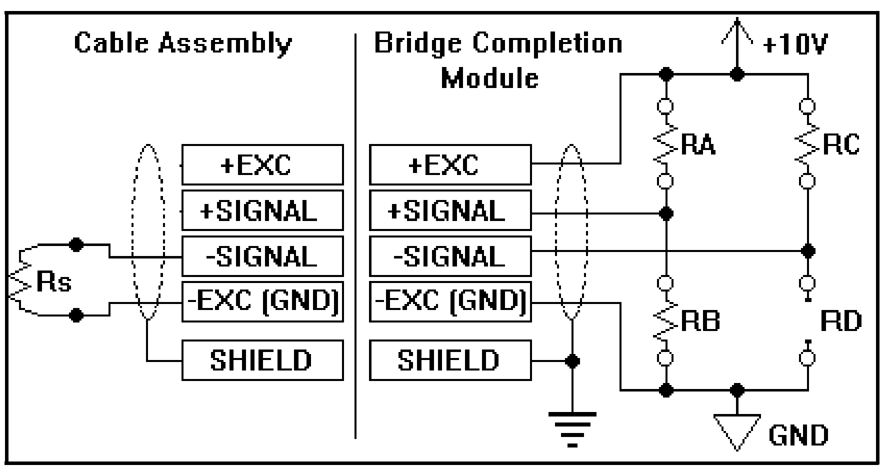

Figure 4. Quarter bridge with resistive element placed between the -SIGNAL and the -EXCITATION (GND) terminals, RD is removed.

3.0 Half Bridge Configurations and Mounting Details.

Half bridge strain gauges refer to a configuration in which two (2) resistive elements are mounted onto the test specimen. In this case, two (2) of the four (4) absent resistors need to be mounted into their sockets in order to complete the bridge. Please refer to figures 6 through 11 for further details.

*Note: The discrete resistors used to complete the bridge circuit must be of the **same** nominal impedance value (ohms = Ω) as the resistive elements of the strain gauge, which is typically in the range of **150Ω** to **1000Ω**. It is also imperative that these discrete resistors have a tolerance no worse than **1%**, and be capable of dissipating at least **1/4Watt** of power.*

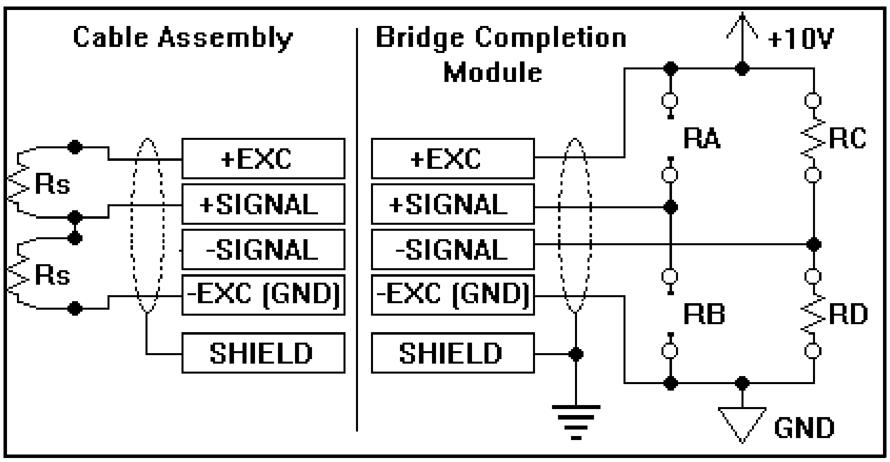

Figure 6. Half bridge with two resistive elements, one placed between the +EXCITATION and the +SIGNAL terminals, and the other placed between the +SIGNAL and the −EXCITATION (GND) terminals. RA and RB are removed.

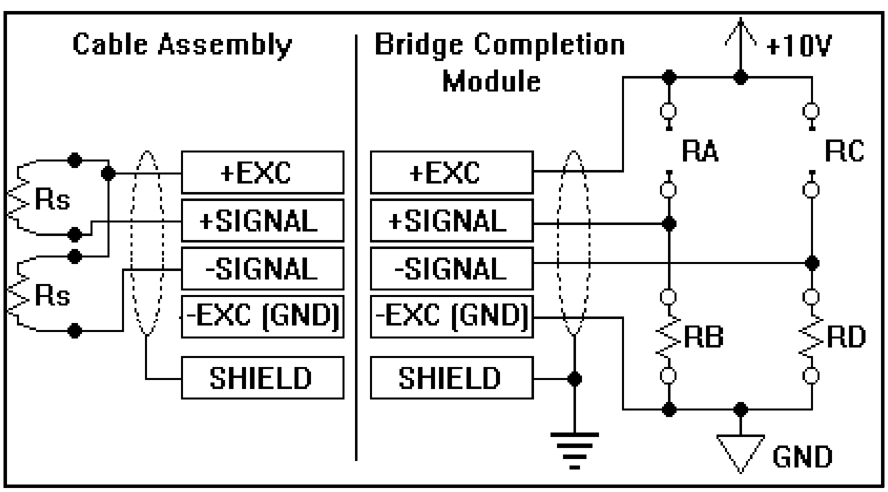

Figure 7. Half bridge with two resistive elements, one placed between the +EXCITATION and the +SIGNAL terminals, and the other placed between the +EXCITATION and the +SIGNAL terminals. RA and RC are removed.

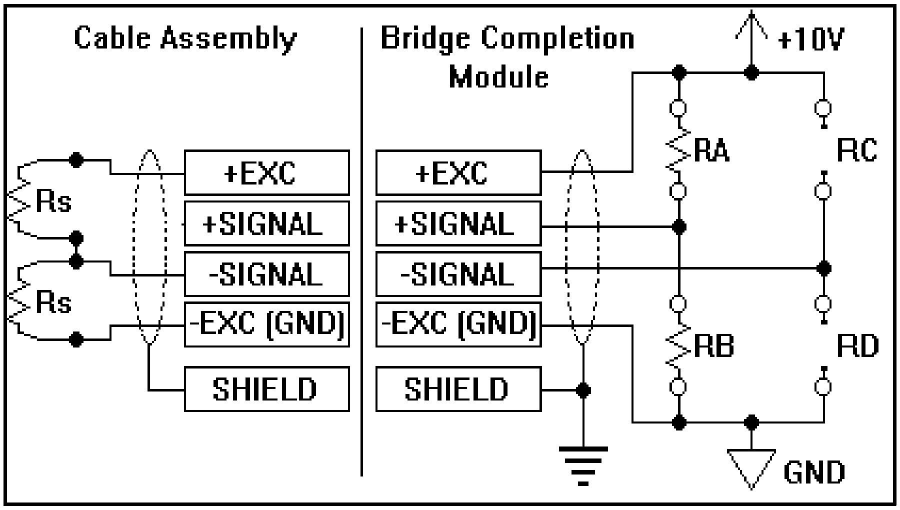

Figure 8. Half bridge with two resistive elements, one placed between the +EXCITATION and the +SIGNAL terminals, and the other placed between the +SIGNAL and the −EXCITATION (GND) terminals. RC and RD are removed.

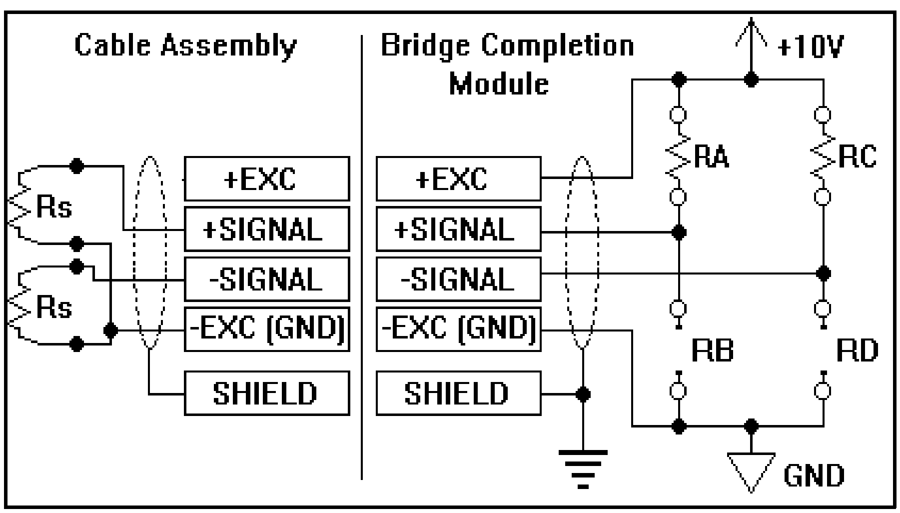

Figure 9. Half bridge with two resistive elements, one placed between the +SIGNAL and the −EXCITATION (GND) terminals, and the other placed between the −SIGNAL and the −EXCITATION (GND) terminals. RB and RD are removed.

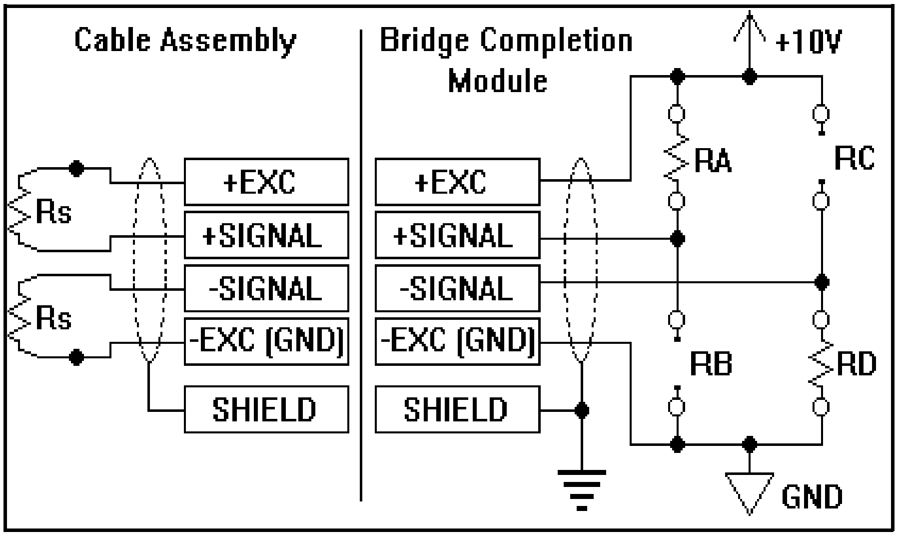

Figure 10. Half bridge with two resistive elements, one placed between the +EXCITATION and the −SIGNAL terminals, and the other placed between the +SIGNAL and the −EXCITATION (GND) terminals. RC and RB are removed.

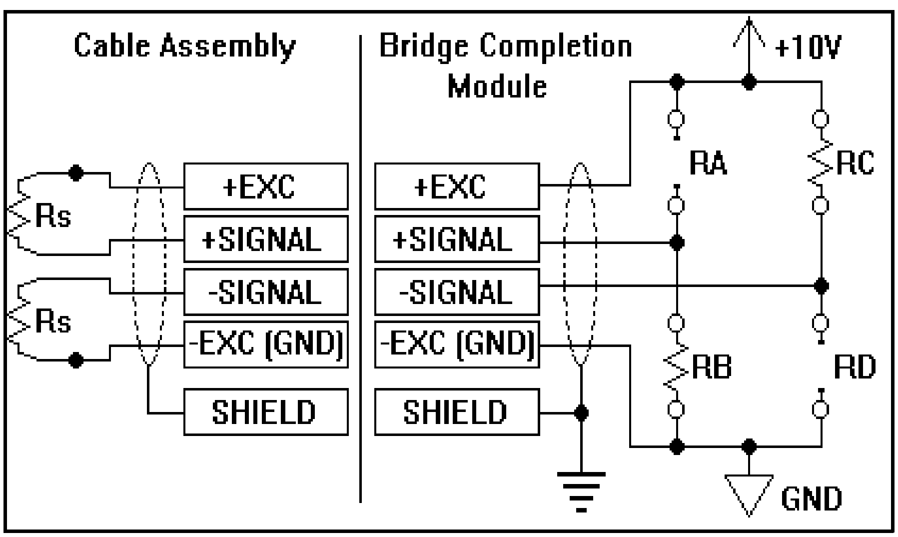

Figure 11. Half bridge with two resistive elements, one placed between the +EXCITATION and the +SIGNAL terminals, and the other placed between the −SIGNAL and the −EXCITATION (GND) terminals. RA and RD are removed.

4.0 Three-Quarter Bridge Configurations and Mounting Details.

Three-Quarter bridge strain gauges refer to a configuration in which three (3) resistive elements are mounted onto the test specimen. In this case, one (1) of the four (4) absent resistors needs to be mounted into its socket in order to complete the bridge. Please refer to figures x through y for further details.

*Note: The discrete resistors used to complete the bridge circuit must be of the **same** nominal impedance value (ohms = Ω) as the resistive elements of the strain gauge, which is typically in the range of **150Ω** to **1000Ω**. It is also imperative that these discrete resistors have a tolerance no worse than **1%**, and be capable of dissipating at least **1/4Watt** of power.*

5.0 Full Bridge Configurations and Mounting Details.

Full bridge strain gauges refer to a configuration in which all four (4) resistive elements are mounted onto the test specimen. In this case, no discrete resistors are needed since the bridge circuit is already complete. Please refer to figure 12 for further details.

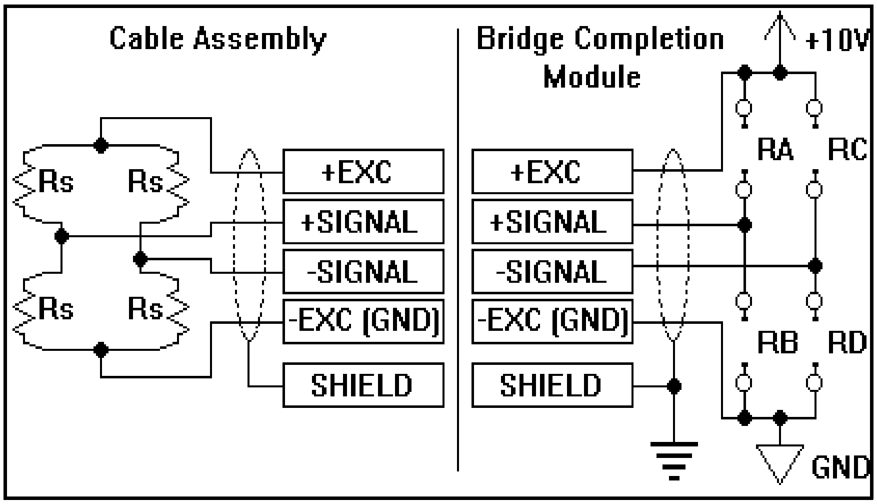

Figure 12. Full bridge configuration.

6.0 Procedure for Verifying Proper Strain Gauge Operation.

Note: Before mounting strain gauges or inserting completion resistors, be sure that all power is turned ***OFF*** *from the SI–100. Extreme caution must be observed in order to prevent damage to either the SI–100 or the strain gauges.*

Once the strain gauges are mounted and the completion resistors are inserted, several steps can be taken in order to ensure proper operation:

1) With all power OFF and the SI–100 disconnected from the bridge module, measure the impedance across both strain gauge terminals pairs.

If properly inserted, the nominal impedance value of the bridge must be read across both strain gauge terminal pairs. The terminal pairs refer to the measurement taken across the following points:

a) +SIGNAL and –SIGNAL
b) +EXCITATION and –EXCITATION (GND)

For example, if the nominal bridge impedance (ohms = Ω) is **350Ω**, then **350Ω** must be measured across +SIGNAL and –SIGNAL. Likewise, the exact same **350Ω** must be measured across +EXCITATION and –EXCITATION (GND).

2) Once completed, reconnect the SI–100 to the bridge module and it is now safe to turn all power back ON.

3) Using any real time data display VI (i.e. Calibration.vi or Oscilloscope.vi) and with a desired gain value uploaded to the SI–100's internal amplifiers, balance the bridge by turning the corresponding potentiometer until the signal is static at **0Vdc**.

When turning the pot, notice the higher sensitivity relative to the higher gain value uploaded to the SI–100's internal amplifiers.

6.1 Troubleshooting.

If the gauges do not balance out, more steps can be taken:

1) With all power ON, and the SI–100 connected to the bridge module, measure the voltages across **all** resistive elements.

The nominal excitation voltage sourced from the SI-100 is **+10Vdc** with respect to system ground. With this in mind, notice that a nominal **+5Vdc** voltage drop must be present across any one of the four resistive elements, irrespective of whether the resistor is a part of the bridge or a discrete resistor inside of the module. A voltage drop is measured by establishing contact between the two (2) floating probes of a digital multimeter (DMM), and both terminals of a resistor. When speaking of a voltage drop, we are referring to a floating voltage across a resistive load, and not necessarily referencing this voltage to a system ground.

If there is either a voltage of **0Vdc**, **3.3Vdc**, or **6.6Vdc** present across resistor terminals, it is most likely because two (2) resistors are redundant, and erroneously placed in parallel or not in place at all.

2) Check for proper connector contacts and cable continuity.

7.0 Connector Pinouts.

The pinouts below correspond to the 37 pin DSUB on the module that mates directly to the SI-100 connector labeled as "Differential."

		19	GND0
-IN0	37		
		18	+IN0
+10VREF0	36		
		17	GND1
-IN1	35		
		16	+IN1
+10VREF1	34		
		15	GND2
-IN2	33		
		14	+IN2
+10VREF2	32		
		13	GND3
-IN3	31		
		12	+IN3
+10VREF3	30		
		11	GND4
-IN4	29		
		10	+IN4
+10VREF4	28		
		9	GND5
-IN5	27		
		8	+IN5
+10VREF5	26		
		7	GND6
-IN6	25		
		6	+IN6
+10VREF6	24		
		5	GND7
-IN7	23		
		4	+IN7
+10VREF7	22		
		3	none
none	21		
		2	none
none	20		
		1	none

The pinouts below correspond to the 9 pin DSUB on the module that includes shunt calibration circuitry.

	5 SHIELD
+EXC 9	
	4 -EXC
none 8	
	3 none
+SHUNT	
	2 none
+SIGNAL 6	
	1 -SIGNAL