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AMP-SG#-U2 MODULAR STRAIN GAGE AMPLIFIER OPERATOR'S MANUAL



**OBSERVE
PRECAUTIONS FOR
HANDLING
ELECTROSTATIC
SENSITIVE DEVICES**

Revision 8/23

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Introduction

The *Modular Strain Gage Amplifier* is designed to provide strain gage excitation and signal amplification. These amplifiers may be used in conjunction with Michigan Scientific slip rings. Although all Michigan Scientific slip ring assemblies are manufactured with instrumentation quality rings and brushes, superior data accuracy is achieved by locating the signal amplifier on the rotating side of the slip ring. This configuration greatly improves signal quality because the amplifier is located closer to the sensor, which reduces errors due to long lead wires, connector resistance variations, and electro-magnetic interference.

These *Modular Strain Gage Amplifiers* incorporate a precision low drift bridge excitation supply, a stable differential amplifier, and a remotely activated shunt calibration resistor for system span verification. Each amplifier module provides strain gage bridge excitation and amplification. For more channels, the amplifiers may be stacked or arrayed around an adapter plate.

Features

- Precision low drift bridge excitation supply of 5 or 10 Volts.
- Bridge excitation may be remotely turned on and off.
- Powers resistive bridges of 350 Ω and greater.
- Precision, low noise, differential amplifier.
- Externally adjustable gain, range of 100 V/V to 2000 V/V.
- Amplified signal is at high-level voltage (± 10 Volts full scale).
- Signal is greatly immune to external noise sources.
- Wide signal bandwidth (20kHz standard).
- Remote shunt calibration capabilities
- Externally adjustable shunt calibration resistance, range of 100k Ω to 1M Ω .
- Increases signal channel count with minimum number of slip ring connections. Six rings are recommended for first channel plus one for each additional. Up to 15 data channels with a twenty-connection slip ring assembly.

Operation

General Operation

AMP-SG#-U2 must be powered with ± 15 Volts and a common. These supplies should be connected to the proper terminals (see installation) for normal operation. If the supplies are reversed, -15 Volts to the +15 Volt pin and +15 Volts to the -15 Volt pin, the amplifier still operates, but the bridge's excitation is killed. This allows measurement of the amplifier's contribution to the signal's offset, the noise floor and magnetic contributions to the signals.

The signals from the strain gage bridges are amplified by 100 V/V to 2000 V/V. Instruction can be found for setting the gain in the Gain Formula section.

Applying +15 Volts to the calibration control pin invokes a shunt calibration resistor from positive bridge excitation to positive bridge signals. -15 Volts to the calibration control pin invokes the resistor from the positive bridge excitation to the negative bridge signals. This induces an offset in the bridge that simulates a known load on the transducer allowing the user to calibrate a data acquisition system without applying the actual load.

The shunt calibration resistances can be set from 100 k Ω to 1M Ω . Instructions for setting this can be found in the Shunt Calibration Resistance Formula section.

Operation with PS Series Power Supplies

Any Michigan Scientific power supplies will provide the ± 15 Volts and common. These power supplies reverse the polarity when the bridge excitation switch is off. Positive and negative shunt calibrations are also performed with a flip of the shunt calibration switch.

PS Series power supplies can power many spinning amplifiers depending on bridge excitation, bridge resistance, and power supply current capability.

Specifications

PARAMETER	SPECIFICATION
BRIDGE EXCITATION	
Type	DC Constant Voltage (Bipolar excitation)
Magnitude	AMP-SG#-U2-5 ±2.5 V (5 volts total) AMP-SG#-U2-10 ±5.0 V (10 volts total)
Accuracy	0.40%
Temperature Coefficient	0.0005 % / °C (0.00028 % / °F) Max
Current Limit	AMP-SG#-U2-5 42 mA AMP-SG#-U2-10 84 mA
REMOTE CALIBRATION	
Positive & negative shunt calibration	
Shunt Resistance internal value external value	100kΩ & 1MΩ 100kΩ through 1MΩ
Shunt Accuracy at 100kW at 1MW	0.01% 0.01%
GAIN	
Externally adjustable	
Range with jumper with external resistor	100 & 2000 V / V 100 through 2000 V / V
Accuracy @ 25°C, Gain=100 @ 25°C, Gain=1000	±0.05 % typ (±0.50 % max) ±0.50 % typ (±1.00 % max)
Temperature Coefficient	0.0025 % / °C (0.0014 % / °F)
OUTPUT	
Range	±10 V Max
Capacitive Load	1000 pF Max
VOLTAGE OFFSET	
Referred to input of amplifier	
Initial @ 25°C	±10 μV typ (±50 μV max)
Temperature Stability	±0.1 μV / °C typ (±0.25 μV / °C max)
Time Stability	±1.0 μV / Month
DC CMRR	160 dB
Noise rti 0.01 to 10 Hz	0.7 μV p-p
DYNAMIC RESPONSE	
Frequency Response -3dB @ Gain=1000 @ Gain=100	20 kHz 20 kHz
Slew rate	4 V / μS
Settling Time 0.01% @ Gain=100	9 μS
POWER REQUIREMENTS	
Voltage @ 25°C	±15 VDC
Current	±15 mA plus Bridge Load (+15 mA additional during shunt calibration)
ENVIRONMENT	
Specification	-25 to +85 °C (-13 to +185 °F)
Operation	-55 to +125 °C (-67 to +257 °F)
MECHANICAL	
Weight	
Overall Diameter	
Overall Height	

Installation

Electrostatic Sensitivity

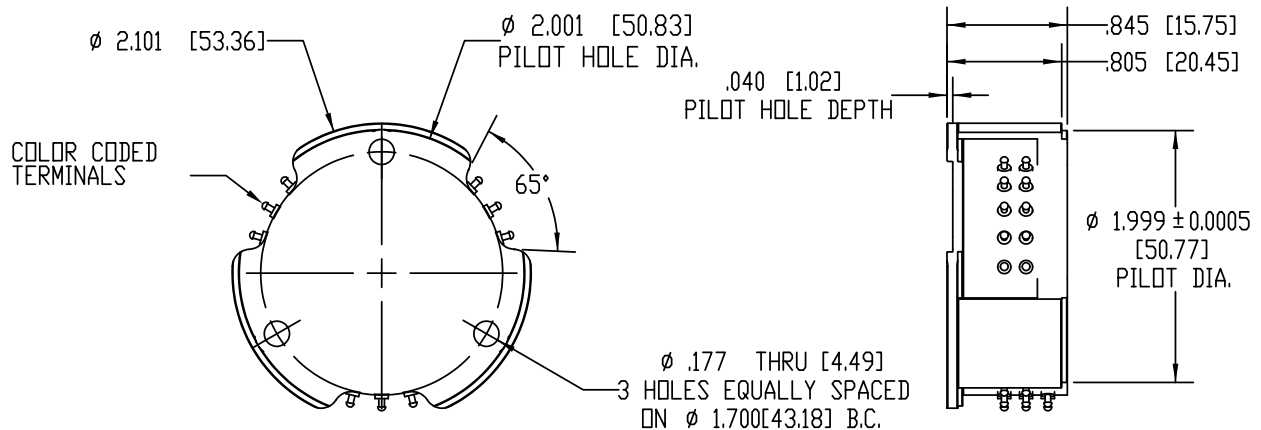


The AMP-SG#-U2 is an electrostatic sensitive device. The terminals should not be touched except during soldering. Soldering should be performed at electrostatic discharge protected workstations.

If an electrostatic discharge protected workstation is not available, use a grounded wrist-strap and ground the strain gage amplifier. Do not handle the device in areas where static charges are obviously present. Always store the AMP-SG#-U2 in an anti-static bag or container when not in use.

Mechanical Installation

SR Series Michigan Scientific slip rings pilot to AMP-SG#-U2 amplifiers. This allows the signal conditioning to be located on the rotating side of the slip ring. The shaft that the amplifier will mount to should be machined to allow the amplifier to pilot onto it. The pilot should have a minimum depth of 0.050 inch and be machined for flatness and concentricity with tolerances no greater than specified in the figure below.



DIMENSIONS ARE INCH [mm]

C627009S
AMP-SG3-U2
2/27/2013

Electrical Installation

The terminals on the AMP-SG#-U2 are color coded to help determine which supply, control or signal goes to which terminal.



Channel 1



Channel 2 & 3

<u>SIGNAL</u>	<u>TERMINALS</u>
BRIDGE CONNECTIONS:	
Positive Excitation	Red ●
Negative Excitation	Black ●
Bridge Signal High	Green ●
Bridge Signal Low	White ⊙
SLIP RING CONNECTIONS:	
Positive 15V	Blue ●
Negative 15V	Violet ●
Common	Gray ●
Calibration Control	Yellow ●
Output High	Orange ●
ADJUSTMENT TERMINALS:	
Gain Adjust	White ⊙ ⊙
Shunt Calibration Resistance Adjust	Brown ● ●

<u>SIGNAL</u>	<u>TERMINALS</u>
BRIDGE CONNECTIONS:	
Positive Excitation	Red ●
Negative Excitation	Black ●
Bridge Signal High	Green ●
Bridge Signal Low	White ⊙
SLIP RING CONNECTIONS:	
Output Low	Gray ●
Output High	Orange ●
ADJUSTMENT TERMINALS:	
Gain Adjust	White ⊙ ⊙
Shunt Calibration Resistance Adjust	Brown ● ●

The Output High is measured relative to the Output Low. Michigan Scientific recommends the Output Low be used and not the Common to reduce errors from voltage drops along the power common wire.

A full strain gage bridge is needed to allow the AMP-SG#-U2 to regulate the bridge excitation. Without the bridge, measurements of the excitation are not meaningful. Completion resistors can be added externally to the amplifier.

Gain and Shunt Settings

Gain Formula

The Gain of the AMP-SG#-U2 can be set to 2000 V/V by shorting the White gage terminals or to 100 V/V by leaving the terminals open. For intermediate gains a resistor can be soldered across the terminals. The following formula determines the resistor needed for a selected gain.

$$R_{ext} = \frac{24.014 \times 10^6 - 12007.24 \times Gain}{505.053 \times Gain - 50505.053}$$

Michigan Scientific can supply resistors, but if the user supplies their own Michigan Scientific suggests a 0.01% tolerance with a less than 25 ppm/°C temperature coefficient.

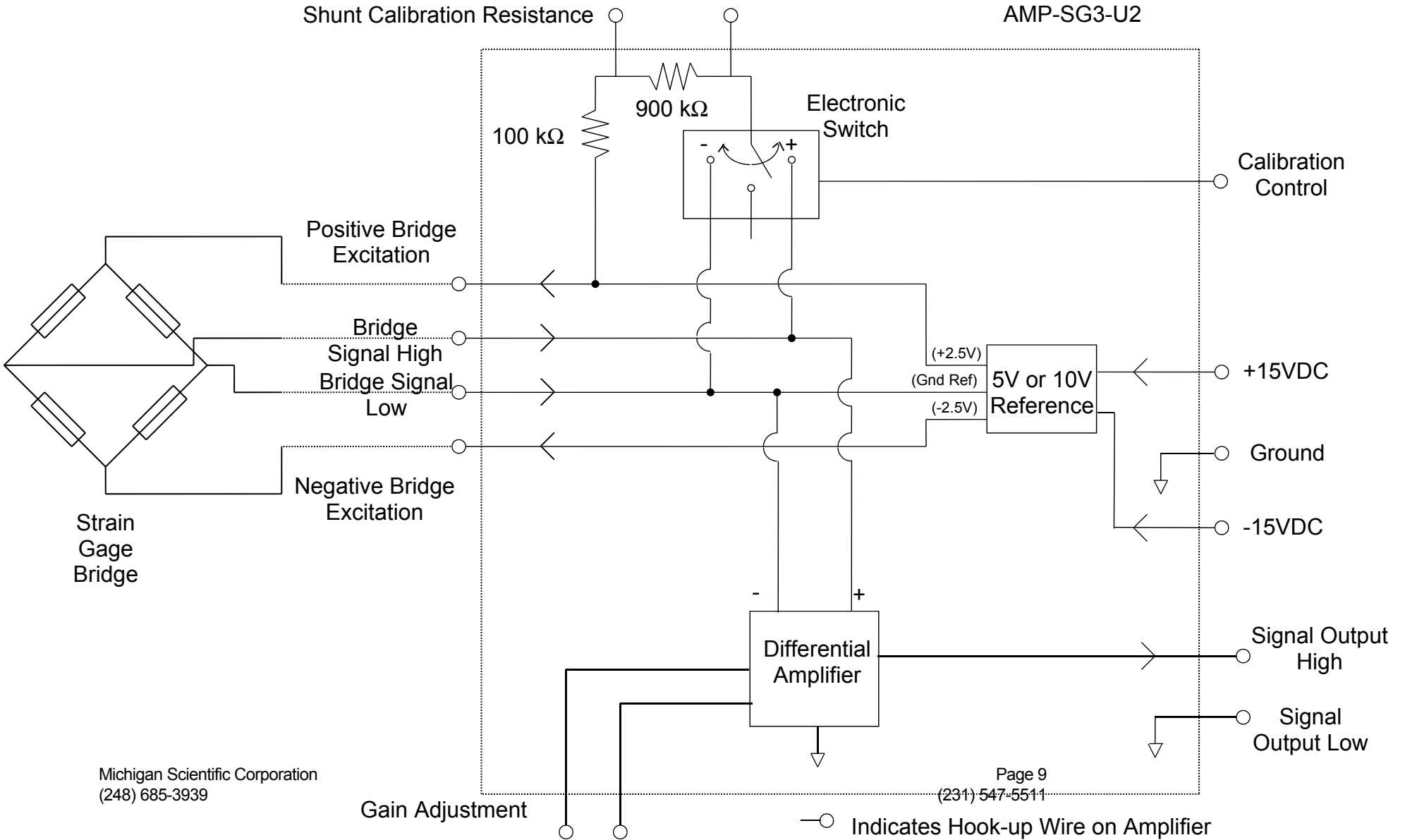
Shunt Calibration Resistance Formula

The resistance that is placed across the arm of the bridge is adjustable. When the Brown terminals are shorted the resistance is 100 kΩ. The resistance is 1 MΩ when the terminals are open. Placing a resistor on these terminals can make any resistance in-between. The following equation is used to determine the external resistance.

$$R_{ext} = \frac{9 \times 10^{10} - 9 \times 10^5 \times R_{cal}}{R_{cal} - 1 \times 10^6}$$

Michigan Scientific can supply resistors, but if the user supplies their own Michigan Scientific suggests a 0.01% tolerance with a less than 25 ppm/°C temperature coefficient.

Block Diagram



○ Indicates Hook-up Wire on Amplifier