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AMP-SG-U2
AMP-SG-U2-10

MODULAR STRAIN GAGE SPINNING AMPLIFIER

OPERATOR'S MANUAL

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Introduction

The *Modular Spinning Strain Gage Amplifier* is designed to mount on the rotor (spinning side) of all Michigan Scientific SR series 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 Spinning 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 one channel. For multiple channels, the amplifiers may be stacked or arrayed around an adapter plate.

Features

- Precision low drift bridge excitation supply, 5 Volts from the AMP-SG-U2,

  10 Volts from the AMP-SG-U2-10.
- Bridge excitation may be remotely turned on and off.
- Powers resistive bridges of 120 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 (gain-bandwidth product of 1 MHz).
- Remote shunt calibration capabilities
- Externally adjustable shunt calibration resistance, range of 100kΩ to 1MΩ.
- 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-circuit slip ring assembly.

Operation

General Operation

AMP-SG-U2 and AMP-SG-U2-10 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, a measure of the noise floor, and magnetic contributions to the signal.

The signal from the strain gage bridge is 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 signal. –15 Volts to the calibration control pin invokes the resistor from the positive bridge excitation to the negative bridge signal. 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 resistance can be set from 100 kΩ to 1MΩ. 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.

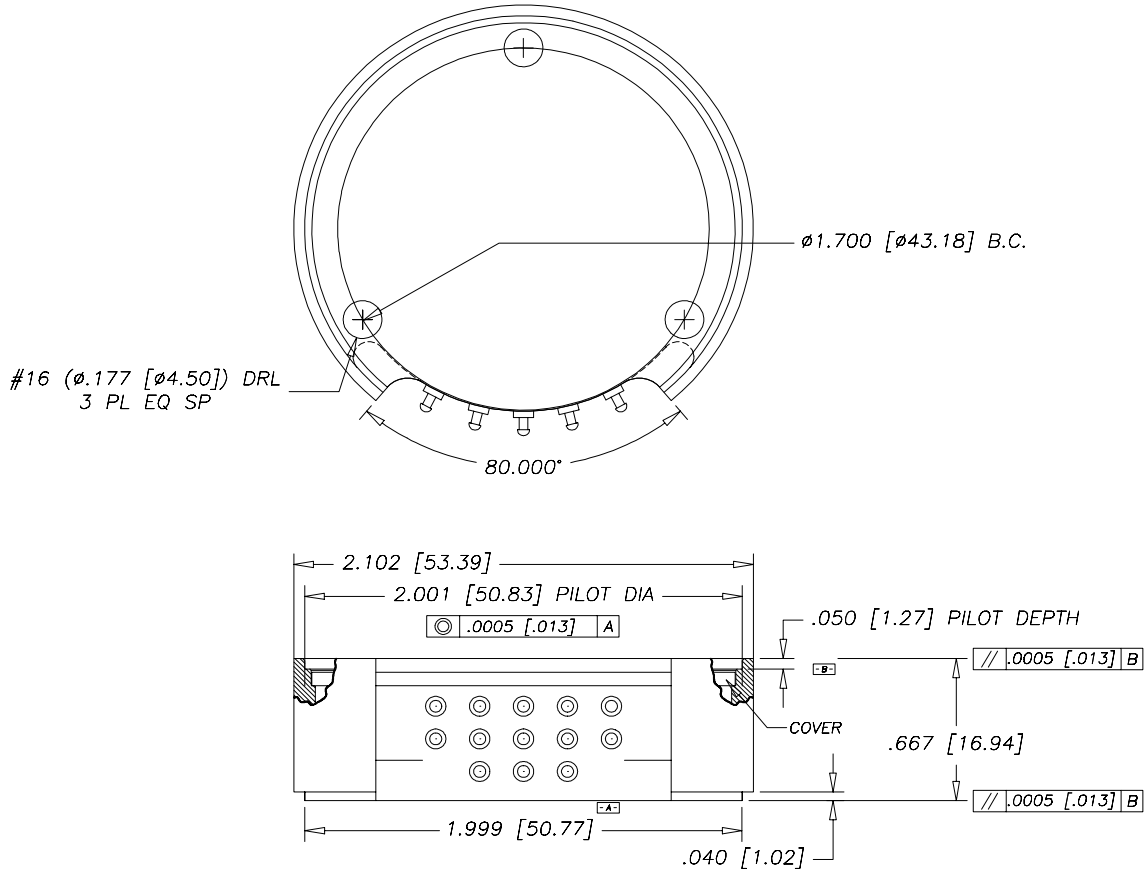
Specifications

PARAMETER		SPECIFICATION
BRIDGE EXCITATION		
Type		DC Constant Voltage (Bipolar excitation)
Magnitude		AMP-SG-U2 ±2.5 V Standard (5 volts total) AMP-SG-U2-10 ±5.0 V Available (10 volts total)
Accuracy		0.40%
Temperature Coefficient		0.0005 % / °C (0.00028 % / °F) Max
Current Limit		AMP-SG-U2 42 mA AMP-SG-U2-10 84 mA
REMOTE CALIBRATION		Positive & negative shunt calibration
Shunt Resistance	internal value	100kΩ & 1MΩ
	external value	100kΩ through 1MΩ
Shunt Accuracy	@ 100kW	0.01%
	@ 1MW	0.25%
GAIN		Externally adjustable
Range	with jumper	100 & 2000 V / V
	with external resistor	100 through 2000 V / V
Accuracy	@ 25°C, Gain=100	±0.05 % typ (±0.50 % max)
	@ 25°C', Gain=1000	±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	1 kHz
	@ Gain=100	10 kHz
Slew rate		0.5 V / μS
Settling Time	0.01% @ Gain=100	145 μS
POWER REQUIREMENTS		
Voltage	@ 25°C	±13 to ±17 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		64 G (2.25 Oz)
Overall Diameter		53.4 mm (2.102 in)
Overall Height		16.9 mm (0.667 in)

Installation

Mechanical Installation

SR Series Michigan Scientific slip rings pilot to AMP-SG-U2 and AMP-SG-U2-10 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.



Three #8 socket head cap screws should be tightened to no more than 45 inch-pounds to secure the amplifier.

The total indicated runout (t.i.r.) is <0.003 in. per module. Using a pilot will reduce runout better than bolts through the mounting holes alone.

The module is not waterproof. We do manufacture a slip ring / amplifier cover with a wheel adapter. Please contact factory for specifications.

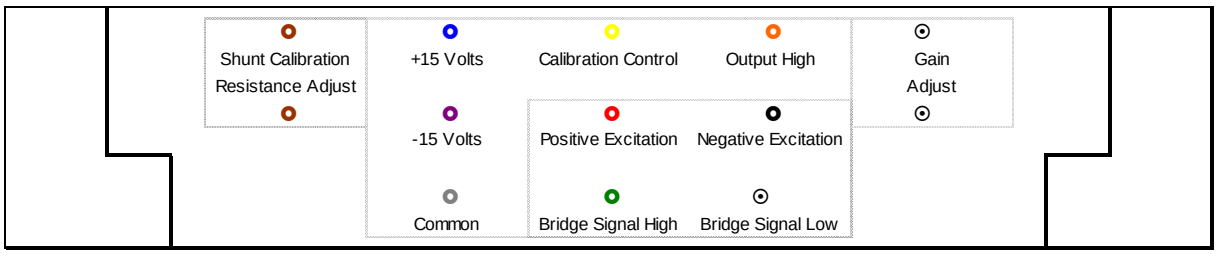
Electrical Installation

Solder terminals on the AMP-SG-U2 and the AMP-SG-U2-10 are color coded to help determine which supply, control, or signal goes to which terminal.

SIGNAL	TERMINALS
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

The output high is measured relative to the ground pin. Michigan Scientific recommends that a separate wire for signal common be added to the common pin to reduce errors from voltage drops along the power common wire. This wire can be added to the stator of a slip ring to decrease the amount of rings needed, but care should be given to physically place the amplifier and slip ring as close as possible to the bridge.

A full strain gage bridge is needed to allow the AMP-SG-U2 or AMP-SG-U2-10 to regulate the bridge excitation. Without the bridge, measurements of the excitation is not meaningful. Completion resistors can be added externally to the amplifier.



Formulae

Gain Formula

Gain of both AMP-SG-U2 and AMP-SG-U2-10 can be set to 2000 V/V by shorting the white terminals or 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 of Modular Strain Gage Amplifier