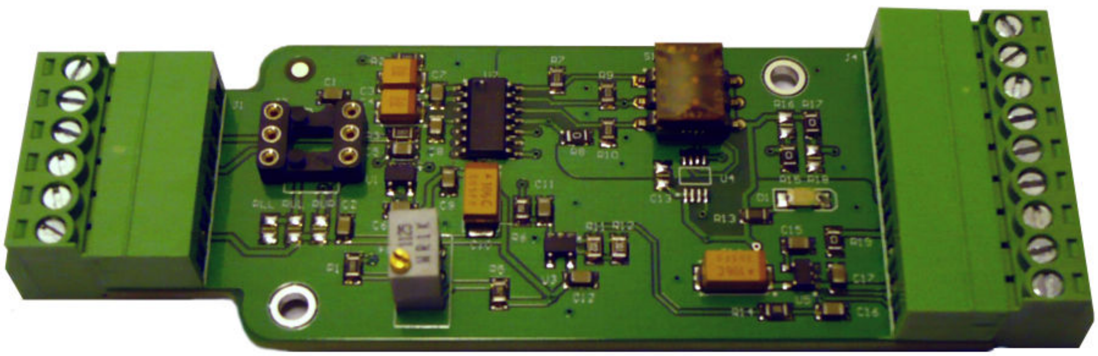
Embedded Strain Gauge and Load Cell Signal Conditioner/Amplifier v.2.5.1



1 DESCRIPTION

The EMBSGB200 v.2.5.1 embedded strain gauge signal conditioner is a versatile, low cost solution to your strain measurement needs. This amplifier, unlike most other indicators or amplifiers, comes with a ***factory gain calibration***. Additionally, the gain of the amplifier is configurable with discrete gain levels. **These features allow the end user to combine this amplifier with any load cell and begin measurement without calibrating the amplifier.** This miniaturized board accepts or completes a single Wheatstone bridge arranged in quarter, half, or full bridge configuration. In full bridge mode, it can also accept a standard analog load cell. Gain and offset adjustment can be controlled manually (M and C versions) or programmably via standard RS-232 protocol (X version). Easily interface with your PC, microprocessor, or ADC for reliable and low cost measurement of strain signals or any other application that requires a differential amplifier. Additionally, this board can be interfaced directly with any analog LabVIEW DAQ or other data acquisition system.

2 APPLICATIONS

- Strain gauge measurement
- Load cell measurement
- Bridge sensor amplifier
- Thermistor measurement
- General differential amplifier

3 FEATURES

- Factory calibration included - **field calibration not required**
- Optional 5V only, 6-16V, 8-24V power supply options
- 5V Bridge excitation
- Flexible on-board bridge completion resistor options (sold separately)
  - Through hole
  - Surface mount (0805 package)
  - Prototyping DIP socket (pluggable)
- Precision gain (<0.1% tolerance typical) - actual gain noted on back label
- Configurable gain: 110, 220, 550, 1100, 2200, 5500, 11000
- Manual or programmable gain
  - Manual: DIP switch controlled (M and C versions)
  - RS-232 controlled (X version)
- Gain can be customized at time of order 1/11 to 2 times gain range above
- Manual or programmable output offset
  - Manual: Potentiometer controlled (M and C versions)
  - RS-232 controlled (X version)
- Variety of outputs available
  - 0-5V (M version)
  - 0-5V and 4-20mA (C version)
  - RS-232 12bit Digitized ADC
- Noise elimination filter
  - Factory default low-pass: -3 dB at ∼60 Hz with 350 bridge
  - Factory adjustable, per request
  - User configurable with modification
- Small profile (1.3” x 3.3”)

4 AVAILABLE MODELS

The EMBSGB200 v.2.3 can be ordered as several versions including manual or RS-232 serial control, 0-5V/4-20mA output, as well as different style terminal blocks for the input and output signal headers. Please refer to the information below to determine the available models.

4.1 EMBSGB200-M

EMBSGB200-M is the stable of the EMBSGB200 family. This version has been offered for years and has been used in hundreds of load measurement applications from prosthetics to Arctic building installations. This version features:

- Manual gain (DIP switch) and offset (potentiometer) adjustments
- Input voltage range 6-16VDC
- Output 0-5V analog voltage

4.2 EMBSGB200-C

EMBSGB200-C is the industrial version of the above. It is similar to the EMBSGB200-M with an expanded input voltage range and additional current loop. This version features:

- Manual gain (DIP switch) and offset (potentiometer) adjustments
- Input voltage range 8-24VDC
- Output 0-5V analog voltage
- Output 4-20mA analog current

4.3 EMBSGB200-X

EMBSGB200-X is the "smart" version of the EMBSGB200-M with an expanded input voltage range and RS-232 interface. This version features:

- Programmable gain and offset via RS-232 interface
- Input voltage range 8-24VDC
- Output 0-5V analog voltage
- Output digitized with on board 12bit ADC
- Configurable with automatic gain/offset commands
- Simple load cell sensitivity input for no calibration operation
- Easy to use dead load calibration
- Streaming data period from 10ms-1min per sample

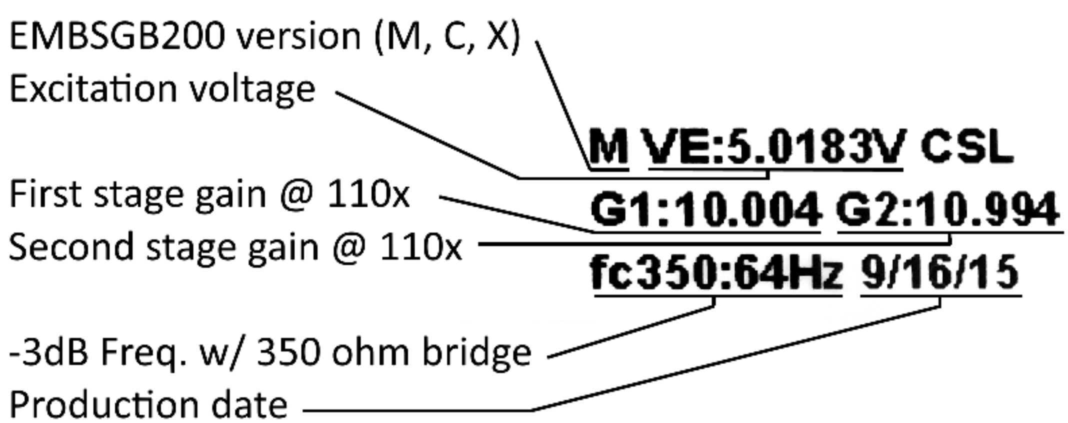
4.4 ADDITIONAL OPTIONS

- Standard versions feature pluggable terminal blocks on both ends of the amplifier. This version is shown above.
- Optional OEM versions feature unsoldered header pins to be used in a breadboard or soldered directly to another PCB with 100mil spacing.
- Overall amplifier gain can be modified to users specifications (contact Tacuna Systems). Gain can be scaled 1/11 (0.0909) to 2 times the gain specified in the description or in Section 12.1.

4.5 CALIBRATION LABEL

Each EMBSGB200 unit is tested and marked with calibration information via a permanent label on the bottom side of the board. The label states the model variety (M, C, X, as above), excitation voltage, stage one gain, stage two gain, -3dB frequency using a 350Ω bridge, and production date.

The amplifiers are tested using 110x gain, thus the first stage and second stage values should equal 110 when multiplied. The first stage amplifier will change gain from 10x to 20x when the first DIP switch is on. In this configuration, the total amplification in the example below would then be $2 * 10.004 * 10.994 = 219.968$x.



5 ELECTRICAL SPECIFICATIONS

The input and output electrical specifications for the EMBSGB are listed in the tables below.

Table 1: Electrical Specifications EMBSGB200-M

Parameter	Min	Typ	Max	Unit	Comments
Supply Voltage	6	9	16	VDC	
Supply Current	-	52	100	mA	With 120Ω bridge
Analog Out	0.030	-	4.85	VDC	
Gain Error	-	0.03	0.1	%	Each amplifier is supplied with calibration showing actual gain
Gain Drift	-	-	16	ppm/°C	
CMRR	110	-	-	dB	
Corner Freq.	60	70	85	Hz	With 350Ω bridge

Table 2: Electrical Specifications EMBSGB200-C

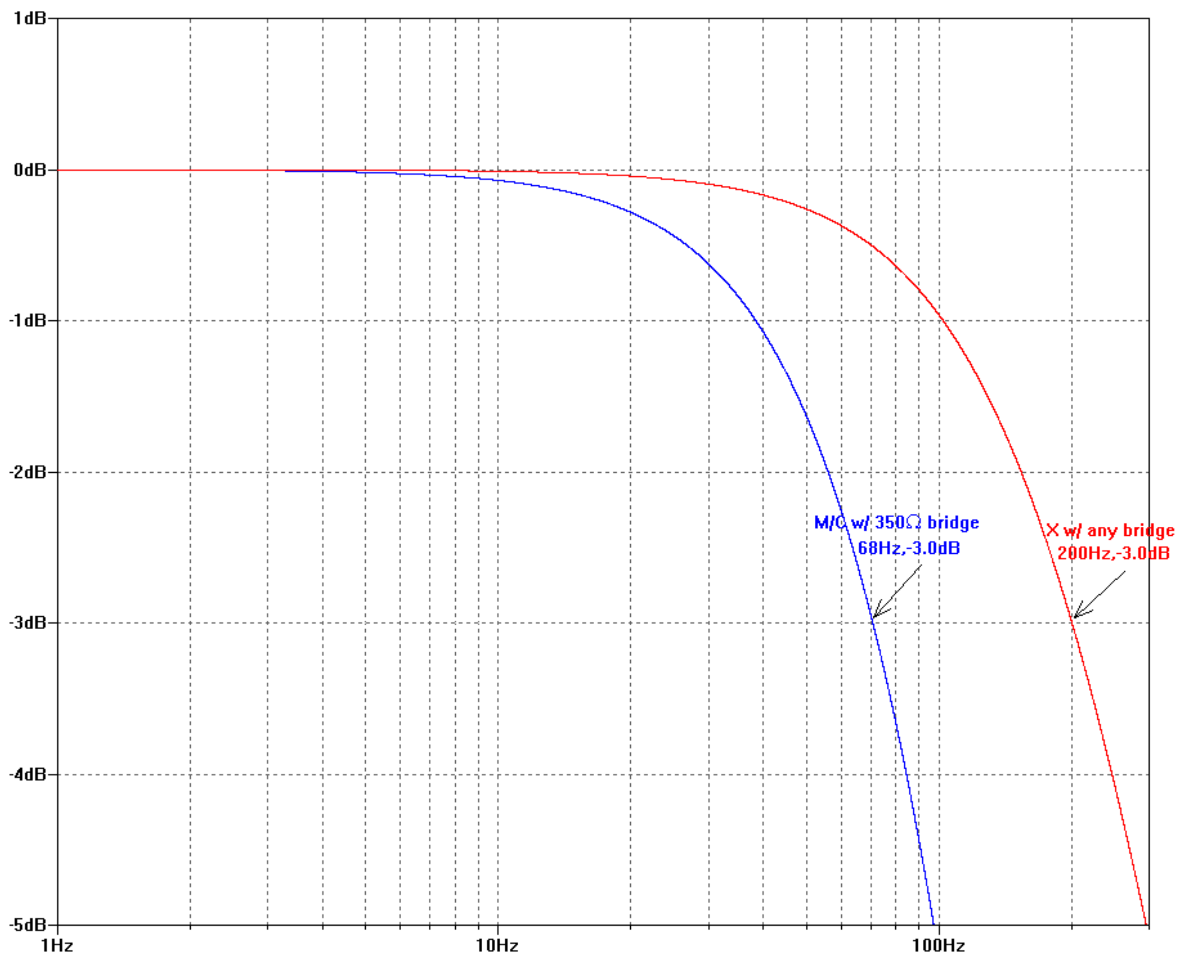
Parameter	Min	Typ	Max	Unit	Comments
Supply Voltage	8	-	24	VDC	
Supply Current	-	52	100	mA	With 120Ω bridge
Analog Out V	0.030	-	4.85	VDC	
Analog Out A	2.5	-	25	mA	
Gain Error	-	0.03	0.1	%	Each amplifier is supplied with calibration showing actual gain
Gain Drift	-	-	16	ppm/°C	
CMRR	110	-	-	dB	
Corner Freq.	60	70	85	Hz	With 350Ω bridge

Table 3: Electrical Specifications EMBSGB200-X

Parameter	Min	Typ	Max	Unit	Comments
Supply Voltage	8	-	24	VDC	
Supply Current	-	52	100	mA	With 120Ω bridge
Analog Out	0.030	-	4.85	VDC	
Gain Error	-	0.03	0.1	%	Each amplifier is supplied with calibration showing actual gain
Gain Drift	-	-	16	ppm/°C	
CMRR	110	-	-	dB	
Corner Freq.	190	210	225	Hz	With 350Ω bridge
Baud Rate	9600	115200	115200	bps	Only 9600 and 115200 bps are available.
RS-232 Level	-	±9	-	VDC	TTL levels available with modification.
Sample Period	0.010	-	60	s	
ADC Resolution	-	12	-	bits	

6 FREQUENCY RESPONSE

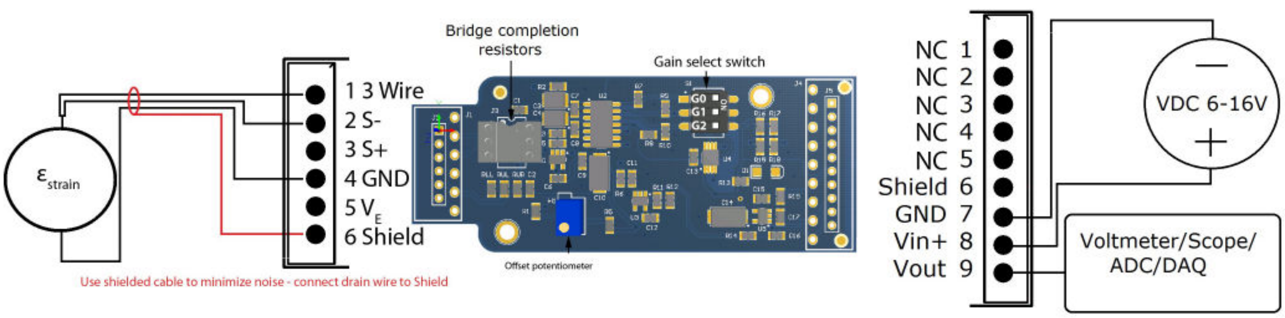
The EMBSGB200-M and C are equipped with two low pass filters while the EMBSGB200-X is equipped with only the second low pass filter. These effectively filter noise from most load measurements and serve as an anti-aliasing filter in the case of the EMBSGB200-X. The resultant frequency response can be seen in the chart below.
The first filter uses the bridge resistance and one 4.7μF capacitor (C7). This, in turn, feeds the first stage amplifier. The second filter follows and consists of a simple RC LPF composed of one 590Ω resistor (R6) and one 2.2μF capacitor (C11). Combined, these filters have a corner frequency of ∼68Hz with a 350Ω bridge and ∼104Hz with a 120Ω bridge. The EMBSGB200-X is only fitted with the first filter with one 4.7μF capacitor (C7). This results in a corner frequency of ∼200Hz. NOTE: Due to the manufacturing tolerances in ceramic capacitors, the real world corner frequencies are generally 15% higher than the calculated values. These values can be customized by Tacuna Systems or by the end-user. If changing the filter component values, it is recommended to keep the capacitor value below 4.7μF and resistor value above 590Ω to ensure amplifier stability.



7 QUICKSTART

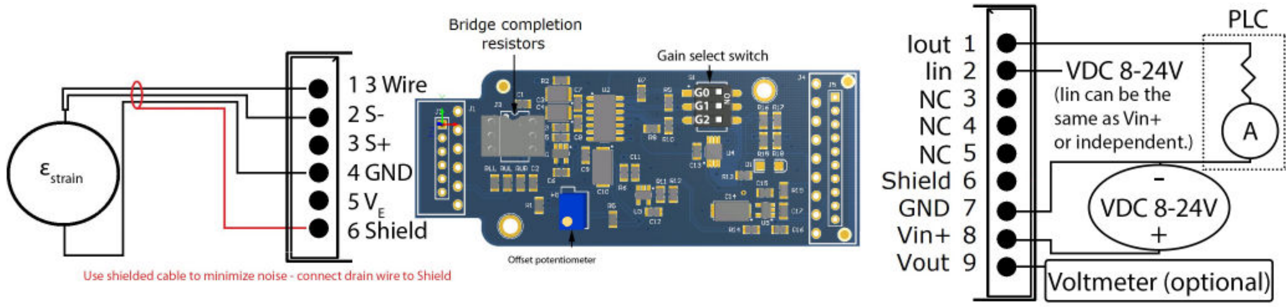
7.1 EMBSGB200-M

1. Using ESD precautions, unpack and connect strain gauge(s) or a load cell to the inputs of the EMBSGB200 according to Section 14.
2. Place correct value bridge completion resistors (if needed for non-quarter bridge).
3. Apply a 6V to 16V DC power across pins 7 and 8 (note the polarity). The green LED will indicate correct power to the system.
4. Set the desired gain with the gain select switch as shown in Section 12.1.
5. Connect a voltmeter, DAC, ADC, or other measurement device to the analog output pin 9.
6. While reading the analog output with the system unloaded, adjust the potentiometer (could take up to 20 turns) until the voltage reaches approximately 2.5V if measuring tension and compression. If only measuring one direction, the offset might be better suited to be set closer to 0.5V or 4.5V depending on the polarity of the gauge wiring. Simple experimentation can determine proper unloaded offset adjustment.
7. Now the EMBSGB200 is properly set up and adjusted, you can now calculate strain from the output of the amplifier - see Section 14 for more information.



7.2 EMBSGB200-C

Follow the steps from 7.1 above. Note, that the C version has a different Vin+ range. The positive current-loop supply should be connected to Iin (pin 2). This can be the same source as Vin+ (generally +24V) or an independent source. Iout should connect to the PLC current-loop input. Iout will generate a current that flows through some resistance (usually internal to the PLC) to GND. $Iout = \frac{Vout}{2490}$



7.3 EMBSGB200-X With Load Cell or Scale and Known Sensitivity

This method is best used when the sensitivity for the load cell is known and accurate. It requires no external calibrated weight and can automatically calculate gain.

1. Using ESD precautions, unpack and connect a load cell to the inputs of the EMB-SGB200 according to Section 14.
2. Apply 8-24V DC power across pins 7 and 8 (note the polarity). The green LED will indicate correct power to the system.
3. Be sure system is in the nominal/unloaded state.
4. Connect RS-232 cable to PC (see Section 9) and establish software communication via RS-232 terminal like PuTTY.
5. Send command: CONFigure:ADC:AutoOffset 0
6. The amplifier should return a value close to 0.5V.
7. For a sensitivity of 2.9994mV/V, send command: CONFigure:LOAD:GF 2.9994
8. For a capacity of 1000, send command: CONFigure:LOAD:Cap 1000
9. Calculate the highest allowable sample period in ms. Assuming 1000ms, send command CONFigure:ADC:Period 1000
10. Choose between manual and automatic gain setting.

    Manual gain:
    Using the formula, Max Gain = 4000mV/(5V*Sensitivity (V/V)), calculate the value for maximum gain. For example, if the sensitivity of a particular cell is 2.9994mV/V, Max Gain = 4000mV/(2.9994mV/V*5V) = 266.72V/V. To properly set the gain, choose the next lower gain setting of 220X. Send command: CONFigure:ADC:Gain 1

    Automatic gain:
    Send command: CONFigure:ADC:AutoGain

11. To store these settings, send command: CONFigure:SYSTem:STOREconfig
12. To tare the load measurement, send command: CONFigure:LOAD:Tare
13. To make a measurement with the system loaded, send command: MEASure:LOAD? 0

7.4 EMBSGB200-X System With Known Capacity and Unknown Sensitivity

This method will calculate the sensitivity of the system and will return the value upon successful calibration. This value can be saved for future use or analysis.

1. Using ESD precautions, unpack and connect strain gauge(s), load cell, or scale to the inputs of the EMBSGB200 according to Section 14.
2. Apply 8-24V DC power across pins 7 and 8 (note the polarity). The green LED will indicate correct power to the system.
3. Be sure system is in the nominal/unloaded state.
4. Connect RS-232 cable to PC (see Section 9) and establish software communication via RS-232 terminal like PuTTY.
5. Send command: CONFigure:ADC:AutoOffset 0, the amplifier should return a value close to 0.5V.
6. For a capacity of 1000, send command: CONFigure:LOAD:Cap 1000
7. Calculate the highest allowable sample period in ms. Assuming 1000ms, send command CONFigure:ADC:Period 1000
8. Choose between manual and automatic gain setting.

   Manual gain:
   Using the formula, Max Gain = 4000mV/(5V*Sensitivity (V/V)), calculate the value for maximum gain. For example, if the sensitivity of a particular cell is 2.9994mV/V, Max Gain = 4000mV/(2.9994mV/V*5V) = 266.72V/V. To properly set the gain, choose the next lower gain setting of 220X. Send command: CONFigure:ADC:Gain 1

   Automatic gain:
   Assuming calibrated weight of 10Lb, send command: CONFigure:ADC:AutoGain 10
   Follow onscreen instructions.

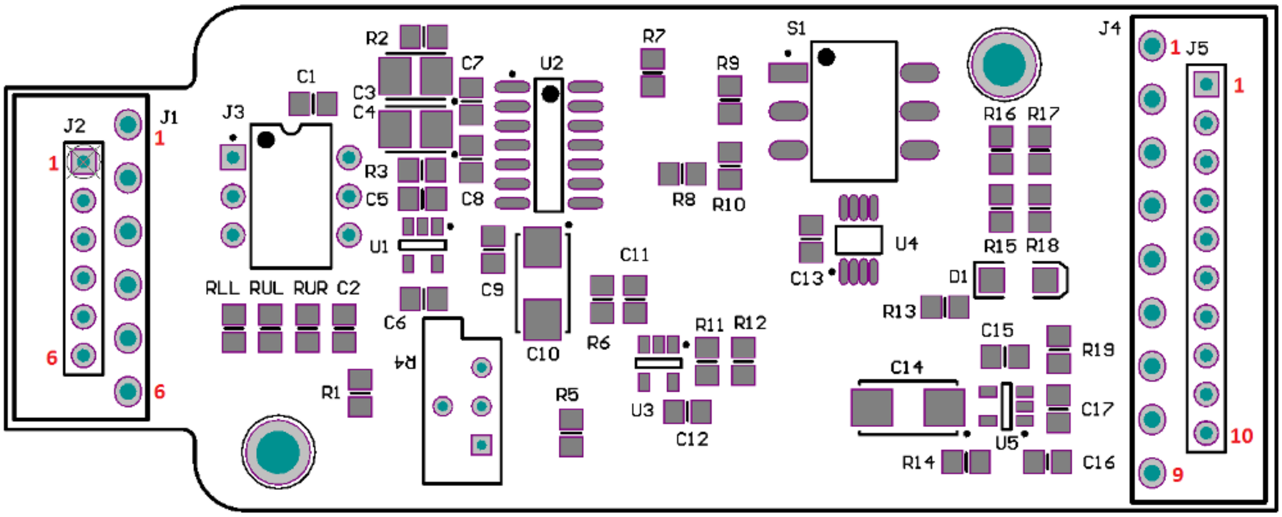
9. Assuming calibrated weight of 10Lb, send command: CONFigure:Load:CALIbrate 10
10. Follow onscreen instructions.
11. To store these settings, send command: CONFigure:SYSTem:STOREconfig
12. Be sure system is in the nominal/unloaded state.
13. To tare the load measurement, send command: CONFigure:LOAD:Tare
14. To make a measurement with the system loaded, send command: MEASure:LOAD? 0
15. The measured load should be very close to 0.0.
16. Load the system with the calibrated weight from steps 9 & 10. and send command: MEASure:LOAD? 0
17. The measured load should be very close to the calibrated weight value.

7.5 EMBSGB200-X System With Unknown Capacity and Unknown Sensitivity

The final configuration method is the traditional calibration method with no known capacity or sensitivity. This often occurs with strain gauges applied to equipment or other in-situ measurements.

1. Using ESD precautions, unpack and connect strain gauge(s), load cell, or scale to the inputs of the EMBSGB200 according to Section 14.
2. Apply 8-24V DC power across pins 7 and 8 (note the polarity). The green LED will indicate correct power to the system.
3. Be sure system is in the nominal/unloaded state.
4. Connect RS-232 cable to PC (see Section 9) and establish software communication via RS-232 terminal like PuTTY.
5. Auto gain setting is not valid for this configuration. Gain will need to be set as low as possible and increased iteratively, testing for amplifier saturation. Begin with lowest gain. Send command: CONFigure:ADC:Gain 0
6. Send command: CONFigure:ADC:AutoOffset 0, the amplifier should return a value close to 0.5V.
7. For an unknown system capacity, send command: CONFigure:LOAD:Cap 0
8. Calculate the highest allowable sample period in ms. Assuming 1000ms, send command CONFigure:ADC:Period 1000
9. Assuming calibrated weight of 10Lb, send command: CONFigure:Load:CALIbrate 10
10. Follow onscreen instructions.
11. To store these settings, send command: CONFigure:SYSTem:STOREconfig
12. Be sure system is in the nominal/unloaded state.
13. To tare the load measurement, send command: CONFigure:LOAD:Tare
14. To make a measurement with the system loaded, send command: MEASure:LOAD? 0
15. The measured load should be very close to 0.0.
16. Load the system with the calibrated weight from steps 9 & 10 and send command: MEASure:LOAD? 0
17. The measured load should be very close to the calibrated weight value.

8 PINOUT



Input Signal Header

Headers J1 and J2 are used to connect the strain gauge or load cell

Table 4: Pinout - Input Signal Header

Pin		Name	Details
J1:1	J2:1	3Wire	Third wire for quarter bridge config
J1:2	J2:2	S-	Negative sense
J1:3	J2:3	S+	Positive sense
J1:4	J2:4	GND	Ground
J1:5	J2:5	V_E	+5V Excitation voltage out or +5V supply in (if supplying +5V here, do not connect V+ below)
J1:6	J2:6	Shield	Connection for shielded cable drain

Output Signal Header

Headers J4 & J5 contain the output and control signals for the amplifier board

Table 5: Pinout - Output Signal Header

Pin		Name	Details		
			M Ver.	C Ver.	X Ver.
J4:1	J5:1	Iout	NC	Current loop out $\left(Iout = \frac{Vout}{2490}\right)$	NC
J4:2	J5:2	Iin	NC	Current loop in (+8-24V)	NC
J4:3	J5:3	SP	NC	NC	Set point out
J4:4	J5:4	RX	NC	NC	RS-232 Receive
J4:5	J5:5	TX	NC	NC	RS-232 Transmit
J4:6	J5:6	Shld	Connection for shielded wire drain		
J4:7	J5:7	GND	Ground		
J4:8	J5:8	V+	+6-16V In	+8-24V In	
J4:9	J5:9	Vout	Analog voltage output		
–:–	J5:10	+5V	Optional +5V input - Use with regulated +5V supply (use only when not supplying V+)		

9 RS-232 Connections and Common Pinouts

Many RS-232 cables have common colors and common pinouts. Below is the most common color/pinout scheme for RS-232 cables. If unsure about any cable's pinout, it recommended to check the wire to pin continuity with a multimeter to ensure correct pinout scheme.

Table 6: Common Cable RS-232 Pinout and Connection to EMBSGB200X

RS-232 Pin Number	Color	Details	EMBSGB200 Pin
1	Brown	DCD	NC
2	Red	RX	J4:5 (TX)
3	Orange	TX	J4:4 (RX)
4	Yellow	DTR	NC
5	Green	GND	J4:7 (GND) or J4:6 (SHLD)
6	Blue	DSR	NC
7	Purple	RTS	NC
8	Grey	CTS	NC
9	Black	RI	NC

10 BLOCK DIAGRAM

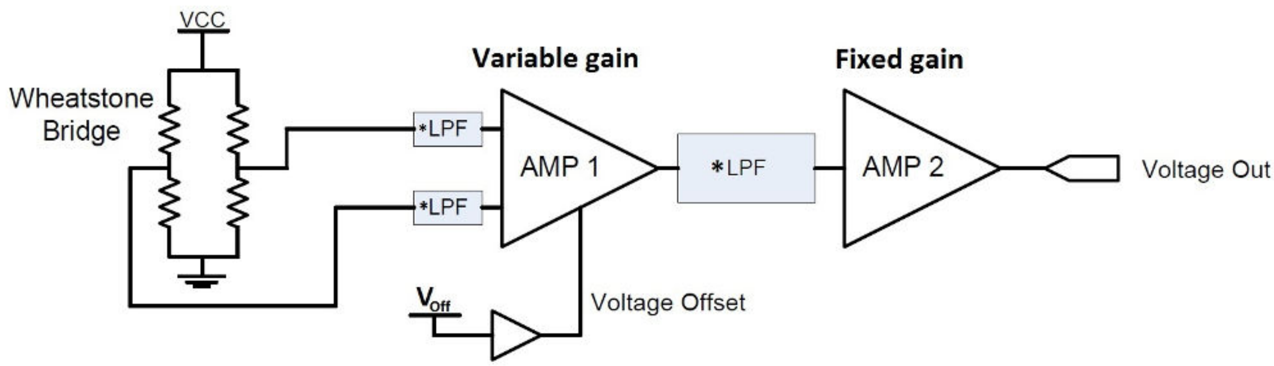


Figure 10.1: Amplification Stages

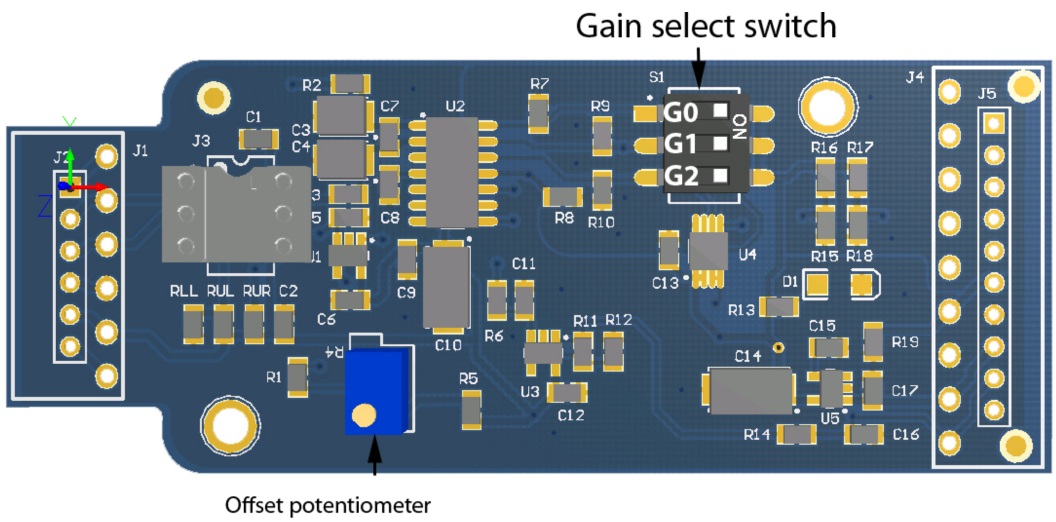
The EMBSGB200 is built using a two-stage amplification system. The first stage is an instrumentation amplifier with excellent common mode characteristics. This, coupled with the first-stage low-pass filter (LPF) allows for a very high signal-to-noise ratio. Additionally, the first stage amplifier has a variable gain range of 10-1000x to achieve flexibility when amplifying bridges with very different sensitivities. The output of the first-stage amplifier is fed through a second LPF and into a fixed gain (11x) second-stage amplifier. The resultant gain range is therefore 110-11000x.

11 FILTERING

Low pass filter default is ∼68-75 Hz with 350Ω bridge but can be customized to the desired corner frequency. More information is available in Section 6.

12 MANUAL OPERATION AND CONTROL

In the manual version, gain is controlled by the three gain control switches and the offset is controlled through the offset adjustment potentiometer.



12.1 MANUAL GAIN CONTROL

The gain of the second stage amplifier is fixed at 11. However, the gain of the primary stage amplifier can be controlled by the three gain control DIP switches. The total gain of the amplifier board is calculated by multiplying the gain of the two amplifiers together. The *total gain* of the amplifier board is listed in the following table.

G2 (MSB)	G1	G0 (LSB)	Total Gain (G_{AMP1}*G_{AMP2})
OFF	OFF	OFF	110
OFF	OFF	ON	220
OFF	ON	OFF	550
OFF	ON	ON	1100
ON	OFF	OFF	2200*
ON	OFF	ON	5500*
ON	ON	OFF	11000*
ON	ON	ON	DO NOT USE

*Gains above 1000 are not recommended without careful consideration of noise and might require additional shunt resistors to prevent the first-stage amplifier from saturating.

12.2 MANUAL OFFSET CONTROL

The offset potentiometer is intended to not only negate imbalances within the Wheatstone bridge but to center the output voltage at a desired nominal voltage. This potentiometer is a multi-turn unit. In order to affect a change on the output, the operator might need to turn this potentiometer many times (in either direction). This potentiometer can be turned in excess of 12-20 times to cover the entire adjustment range and has a clutch such that it cannot be damaged from exceeding the adjustment range. Note: its response is not linear throughout the entire range.

For most applications, use the offset potentiometer to adjust the output voltage to near the middle of the range for V_{out} (approximately 2.5 V). Adjusting the output voltage to 2.5 V allows for maximum range of both positive and negative strain. If your strain gauge is known to only flex in one direction, you may find it more useful to adjust the output voltage closer to the top or bottom of the V_{out} range so you can get maximum resolution from your ADC. It is generally best to keep the offset at least 0.5 V from each rail to avoid output saturation. For example, the lowest offset should be 0.5 V and the highest offset should be 4.5 V.

NOTE

The offset potentiometer will need to be readjusted for each gain alteration and/or bridge reconfiguration.

13 SERIAL OPERATION AND CONTROL

The EMBSGB200-X is equipped with the dual-stage amplifier section discussed thus far with the addition of on-board microcontroller, analog to digital converter (ADC), and RS-232 level converter. These combine to form a complete load measurement solution, ready to be processed/logged with a PC, PLC, microcontroller, etc. The RS-232 serial interface uses SCPI formatted commands to accomplish all tasks associated with gain, offset, load calculation, and data communication. These commands are listed in the next section.

13.1 RS-232 SERIAL INTERFACE COMMAND LIST

The commands listed in the following table are used to configure and communicate with the EMBSGB200-X.

Table 7: RS-232 Serial Interface Command List

Command Format	Description
MEASure:VOLTage:DC? 0	Reads voltage on Vout in Volts.

Continued on next page

Table 7 – *Continued from previous page*

Command Format	Description
MEASure:LOAD? 0	Reads system load in capacity/calibrated unit. Units are optional and are configured with CONFigure:SYSTem:UNITConfig.
CONFigure:SYSTem:UNITConfig I	Sets system unit handling and conversion (if different from CALUnits). I=0 sets units to lb, I=1 sets units to kg, I=2 sets units to lb (printing), I=3 sets units to kg (printing). Options 0 and 1 will convert the numeric output if necessary, but won't append the actual unit label to the numeric value. Options 2 and 3 will also convert the numeric value and will append the lb/kg characters to the numeric output.
CONFigure:SYSTem:CALUnits I	Sets system calibration units. I=0 sets units to lb, I=1 sets units to kg.
CONFigure:SYSTem:POLarity I	Sets polarity of the amplifier. I=0 normal polarity, I=1 inverted polarity.
CONFigure:Load:CALIbrate F	Calibrates system with known calibration weight (F). Follow on screen cues. Returns sensitivity value.
CONFigure:LOAD:GF F	Sets system calibration in mV/V. Ex. If load cell sensitivity = 2.9994mV/V, CONFigure:LOAD:GF 2.9994 would properly set this value.
CONFigure:LOAD:Cap F	Sets system capacity. The amplifier assumes units are consistent between capacity, calibration, etc. Therefore no units are required. Ex. If load cell capacity is 50lbs, CONFigure:LOAD:Cap 50 would properly set this value.
CONFigure:LOAD:Tare	Subtracts nominal value from system load. This function only affects MEASure:LOAD? reading.
CONFigure:ADC:Gain I	Sets system gain. I=0 110x, I=1 220x, I=3 550x, I=4 1100x, I=5 2200x, I=6 5500x, I=7 11000x. Be sure not to set gain too high as to saturate output. Output saturates >4.7V.
CONFigure:ADC:AutoGain	Sets system gain automatically using capacity and sensitivity values. This command assumes both of those values have been properly set using CONFigure:LOAD:GF and CONFigure:LOAD:Cap. Additionally, this command assumes the user has properly set the offset (above 0V).

Continued on next page

Table 7 – *Continued from previous page*

Command Format	Description
CONFigure:ADC:AutoGain F	Sets system gain automatically using capacity and calibrated weight. This command assumes capacity has been properly set using CONFigure:LOAD:Cap and the user has a calibrated weight available. Additionally, this command assumes the user has properly set the offset (above 0V). The value passed using this command is the value of the calibrated weight.
CONFigure:ADC:Period I	Sets system sample/transmit period in ms. Valid range based on baud rate: 115200bps: 10-60000ms, 9600bps: 20-60000ms. The amplifier will average the resulting value period(ms)/2 times. If the board is configured with a period of 50ms, the output value will be averaged 25 times.
CONFigure:Load:Stream I	Begins streaming of system load. I=0 disables streaming. I=1 enables streaming.
CONFigure:Voltage:Stream I	Begins streaming of output voltage. I=0 disables streaming. I=1 enables streaming.
CONFigure:ADC:AutoOffset I	Sets the output offset automatically according to I. This command assumes system is unloaded and will attempt to set the unloaded offset to 0.5V, 2.5V, or 4.5V. I=0 output offset ∼0.5V, I=1 output offset ∼2.5V, I=3 output offset ∼4.5V. If the board is unable to achieve the requested value, an error is returned. Otherwise Vout is returned.
CONFigure:ADC:Offset F	Sets the first stage amplifier offset voltage which is then multiplied by the second stage gain. Ex. CONFigure:ADC:Offset 0.010 would set the offset voltage of the first stage amplifier by 10mV. If the second stage gain is 11, that would translate to a Vout increase of 110mV.
CONFigure:SYSTem:SETPVoltage F	Sets the trip voltage for the SPOUT transistor. NOTE: The setpoint is not enabled until issuing CONFigure:SYSTem:SETPConfig.
CONFigure:SYSTem:SETPLoad F	Sets the trip load for the SPOUT transistor. NOTE: The setpoint is not enabled until issuing CONFigure:SYSTem:SETPConfig.

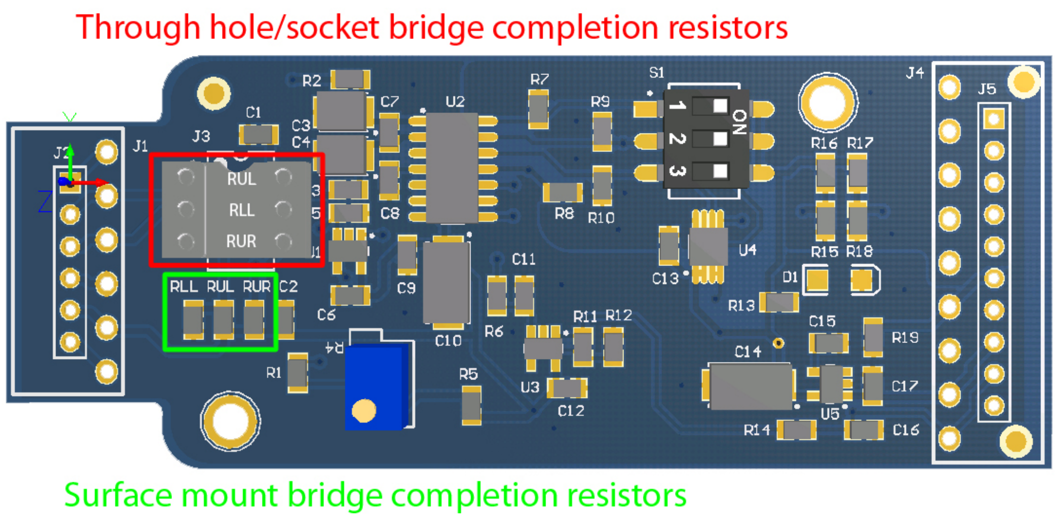
Continued on next page

Table 7 – *Continued from previous page*

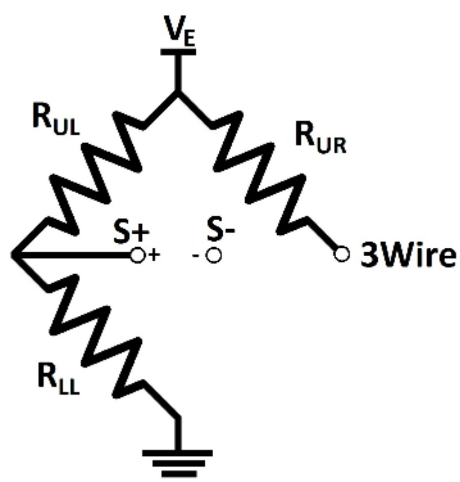
Command Format	Description
CONFigure:SYSTem:SETPConfig I	Configures the SPOUT transistor and on-board LED to enable based on the value passed. I=0 disable SPOUT and set on-board LED to default blink status, I=1 set SPOUT when voltage passes CONFigure:SYSTem:SETPVoltage setting, I=2 set SPOUT when load reaches CONFigure:SYSTem:SETPLoad setting, I=3 same as I=1 and set on-board LED, I=4 same as I=2 and set on-board LED.
CONFigure:SYSTem:BAUDrate I	Configures the board's baud rate. Valid values are 9600 and 115200. After setting this value, it must be stored in EEPROM with CONFigure:SYSTem:STOREconfig and the amplifier restarted with CONFigure:SYSTem:RESET to take effect.
CONFigure:SYSTem:STOREconfig	Stores the system configuration parameters into EEPROM: capacity, GF, tare, streaming state, period, gain, and offset. CONFigure:SYSTem:RESET restarts the board.
CONFigure:SYSTem:FACTreset	Restores factory EEPROM values above and restarts board.
CONFigure:SYSTem:READParams?	Returns each configurable parameter being used by the board.
CONFigure:SYSTem:ECHO I	Sets the command echo setting. I=1 sends each character received back to the sender via the RS-232 interface. I=0 turns off this feature.

14 BRIDGE CONFIGURATION

The bridge can be configured in many ways and can be completed by onboard bridge completion resistors. To complete the bridge, you can use 0805 surface mount resistors or standard through-hole resistors placed in the DIP socket shown in the board diagram.



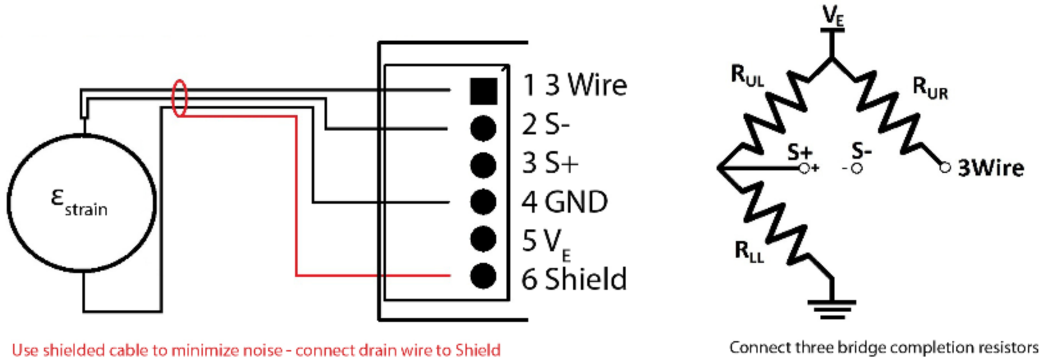
The simplified schematic of the bridge completion circuit is shown below, the two types of resistors (surface mount and through-hole are wired in parallel).



Shielded wire should be used to minimize EM noise.

14.1 Quarter Bridge

Quarter bridge utilizes the three-wire configuration to minimize the effect of wire resistance. In addition, all three bridge completion resistors are required.



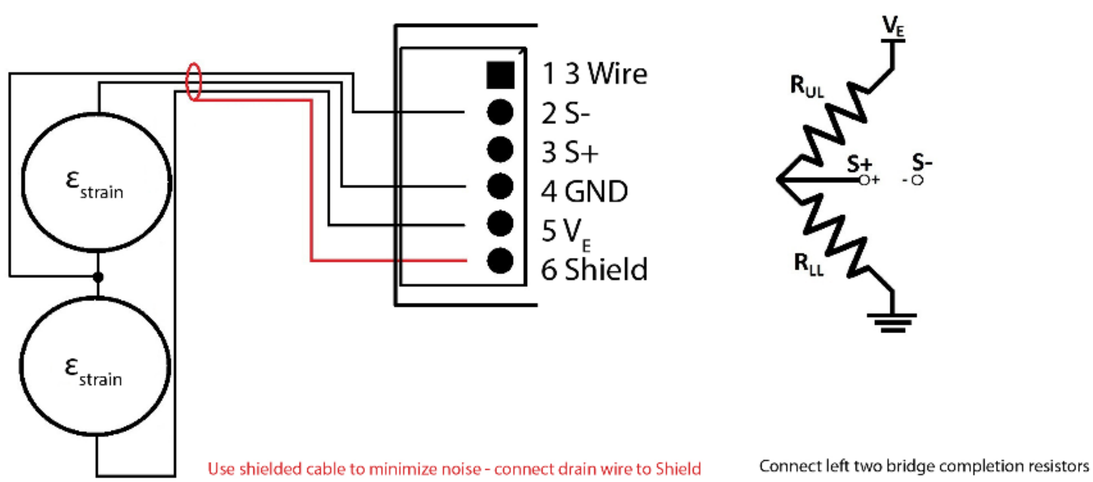
The output strain voltage Vs in this case can be expressed as:

$$V_{\text{S, quarter}} \approx \frac{V_E GF\epsilon}{4} \tag{1}$$

where V_E is the excitation voltage, GF is the gauge factor or sensitivity of the gauge, and ϵ is the change in length (strain).

14.2 Half Bridge

Half bridge only uses the two left-side bridge completion resistors.



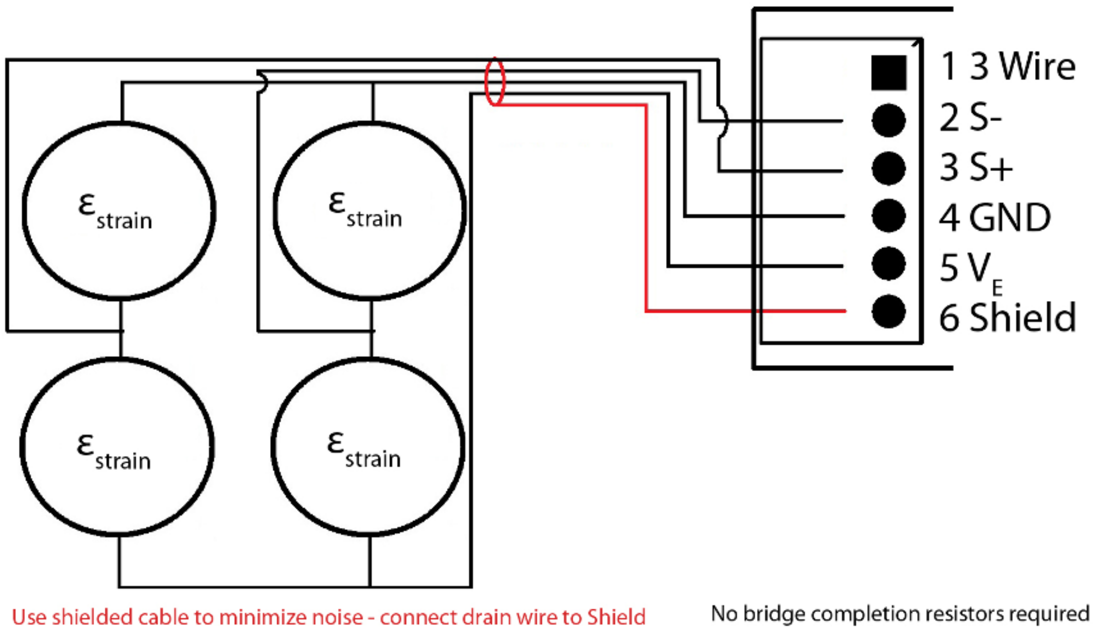
The output strain voltage Vs in this case can be expressed as:

$$V_{\text{S, half}} \approx \frac{V_E GF\epsilon}{2} \tag{2}$$

where V_E is the excitation voltage, GF is the gauge factor or sensitivity of the gauge, and ϵ is the change in length (strain).

14.3 Full Bridge

A load cell or a full bridge requires no completion resistors.



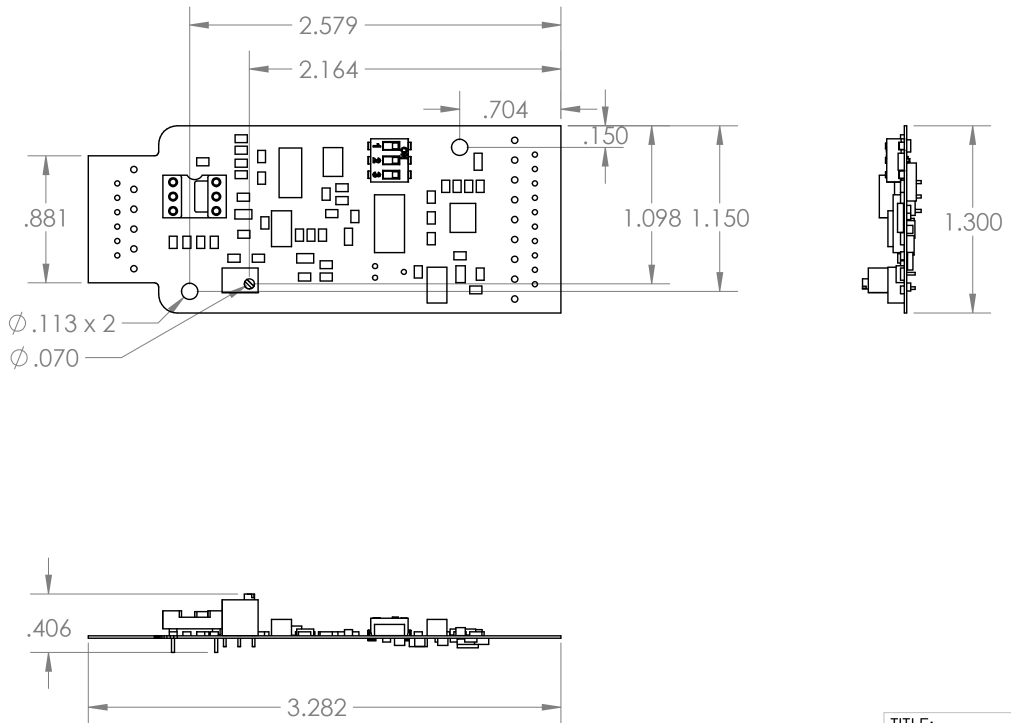
The output strain voltage Vs in this case can be expressed as:

$$V_{\text{S, full}} \approx V_E GF \epsilon \tag{3}$$

where V_E is the excitation voltage, GF is the gauge factor or sensitivity of the gauge, and ϵ is the change in length (strain).

15 MECHANICAL DRAWINGS

3D CAD drawings are available at www.tacunasystems.com. The following pages contain the 2D drawings for the PCB and the EMBSGB200 with enclosure and pluggable connectors.

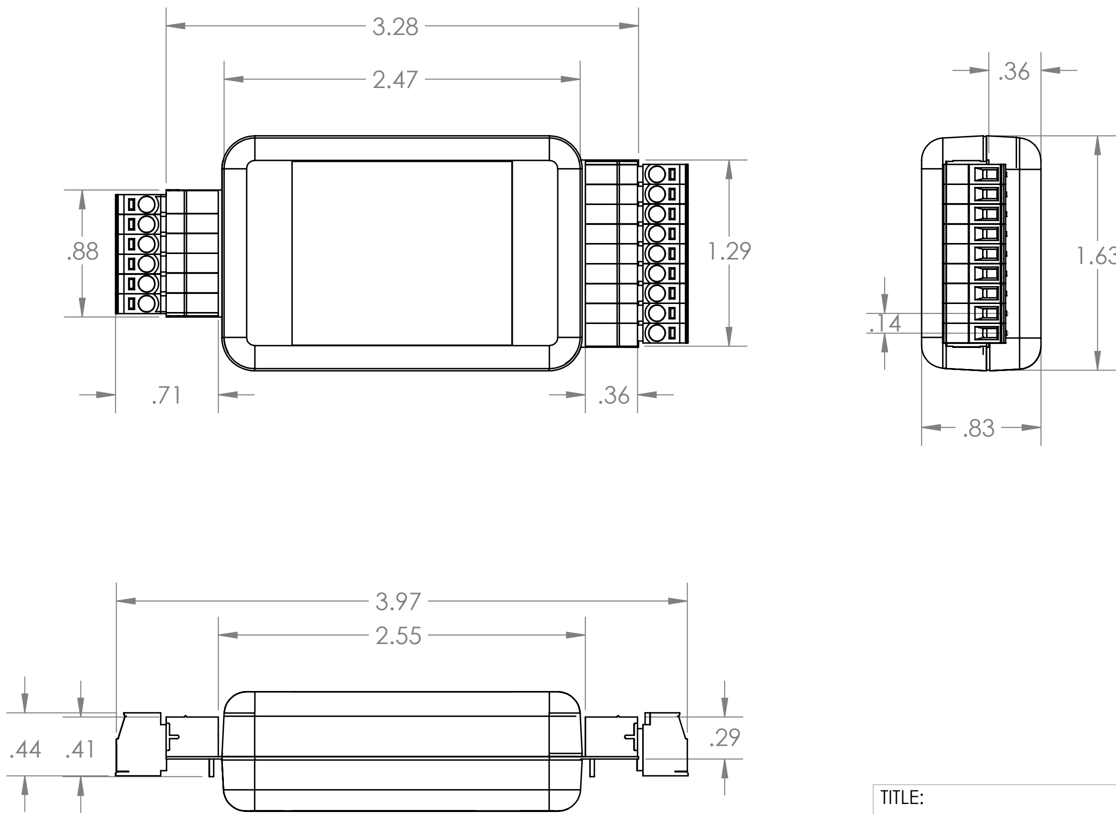


TITLE:

EMBSGB200

SIZE A | DWG. NO. EMBSGB200_PCB | REV 1

SCALE: 1:1 | DIMS IN INCHES | SHEET 1 OF 1



TITLE:		
EMBSGB200&Enc		
SIZE A	DWG. NO. EMBSGB200_PCB_w/Enc	REV 1
SCALE: 1:1	DIMS IN INCHES	SHEET 1 OF 1

16 TROUBLSHOOTING

No LED power indication

Check connections, the power plug is the large connector. With the large connector on the right and the small connector on the left (component side up) the pins count increasingly from top to bottom.
Check power requirements, the supply voltage requires a minimum voltage of 6 V and a maximum of 16V along with a maximum of 100 mA of current.

Saturated low or high output signal

Saturated high

Check that wheatstone bridge is well balanced, if not use shunting resistors to correct any errors.
Check if amplification gain is too high, using correct MSB to LSB orientation.
Progressively high gain requires a further balanced wheatstone to prevent saturation.

Check if potentiometer (Manual mode) or DAC (SPI) reference voltage is too high.

Check connections, the gauge input/load connects to the small connector. With the large connector on the right and the small connector on the left (component side up) the pins count increasingly from top to bottom.

Saturated low

Check that wheatstone bridge is well balanced, if not use shunting resistors to correct any errors.
Check if amplification gain is correct, using correct MSB to LSB orientation.
Progressively high gain requires a further balanced wheatstone to prevent saturation at low or high rails.

Check if potentiometer (Manual mode) or DAC (SPI) reference voltage is too low.

Check connections, the gauge input/load connects to the small connector. With the large connector on the right and the small connector on the left (component side up) the pins count increasingly from top to bottom.

17 NOTES