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RED LION CONTROLS

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MODEL APLSG - APOLLO STRAIN-GAGE INDICATOR/MILLIVOLT INDICATOR

- 3½-DIGIT, 0.56" (14.2 mm) HIGH LED READOUT
- SEALED METAL FRONT BEZEL (NEMA 4/IP65)
- HIGH SENSITIVITY, 10 mV FULL SCALE
- WIDE RANGE GAIN AND OFFSET ADJUSTMENTS
- BUILT-IN EXCITATION (1.3 to 10 VDC @ 120 mA)
- APPLICABLE AS REGULAR MILLIVOLT INDICATOR (Single-ended or Differential Input)
- SELECTABLE DECIMAL POINTS
- PLUG-IN TERMINAL STRIPS
- OVER-RANGE INDICATION

DESCRIPTION

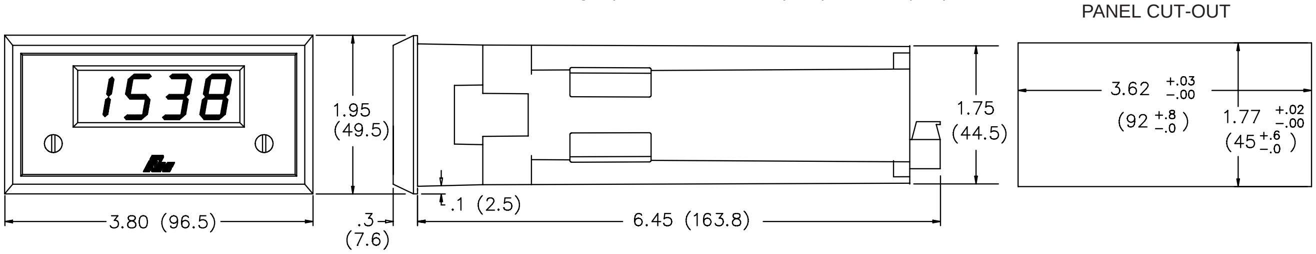
The Model APLSG expands the APOLLO capabilities into the indication of pressure, load, force, and other parameters measured with strain-gages. The unit features broad range scaling and can be used with a wide variety of strain-gage resistances and bridge configurations. A built-in excitation source is adjustable over a 1.3 to 10 VDC range @ 120 mA maximum, and can power up to four full 350 Ω bridges in load averaging applications. Although designed primarily for strain-gage indication, the APLSG is also ideal for single-ended or differential millivolt input applications with full-scale input ranges from 0 to 10 mV to 0 to 2 VDC, and where adjustable scaling and offset are required to give a direct readout in engineering units.

SPECIFICATIONS

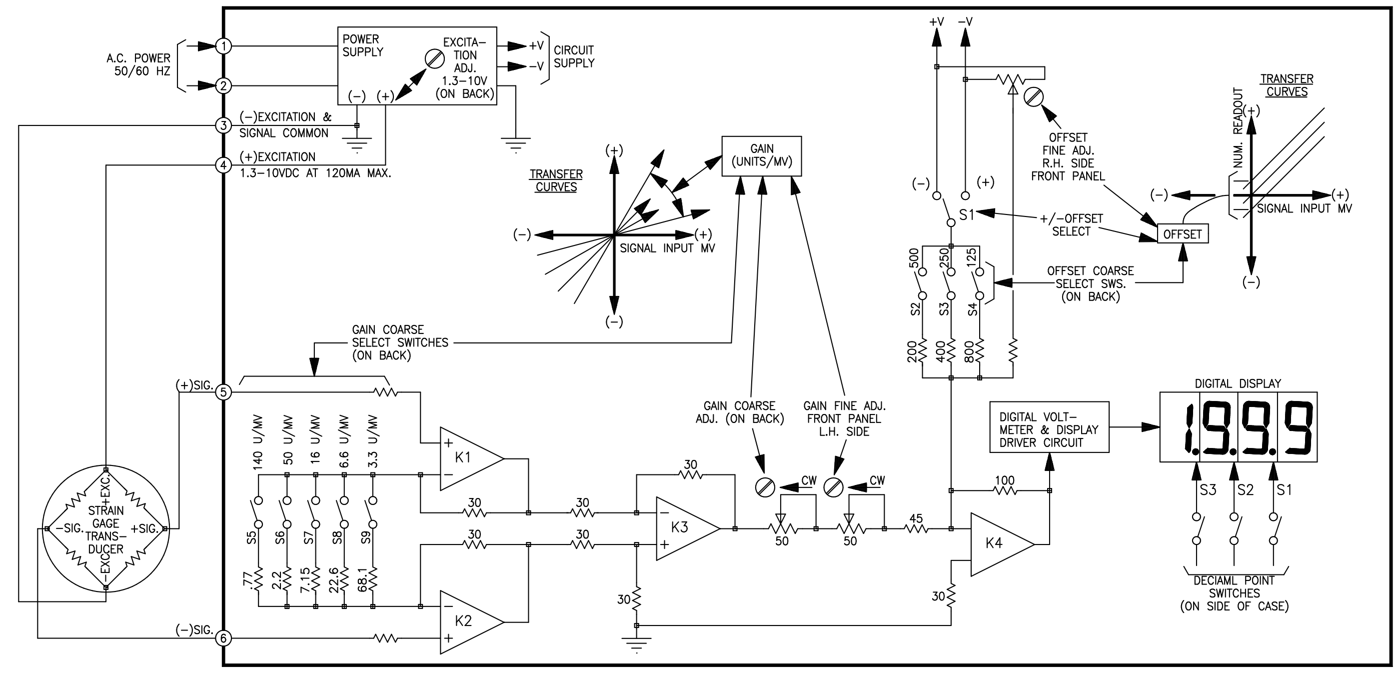
1. **DISPLAY:** 3½-digit, (1999), 0.56" (14.2 mm) LED, minus sign displayed for negative voltage indication. Decimal points inserted before 1st, 2nd, or 3rd least significant digits by DIP programming switches. Overrange blanks first 3 digits.
2. **POWER:** Available for 115 or 230 VAC ±10%, 50/60 Hz, 6 VA.
3. **INPUT SIGNAL:** Single-ended or differential input, ±2.0 V max. Gain (Sensitivity) is adjustable from 200 Units of Numerical Readout/millivolt input (gives full scale readout of 1999 at 10 mV input), to less than 1 Unit of Numerical Readout/mV (gives full scale readout of 1999 at 2.0 V input). Maximum common mode voltage swing with respect to signal ground, 0 to 7 V.
   Note: Absolute maximum voltage that can be applied between the two input terminals or between input and signal common is 75 VDC.
4. **INPUT IMPEDANCE:** 100 Megohms minimum.
5. **LINEARITY:** ±(0.05% of Reading, +1 digit)
6. **TEMPERATURE COEFFICIENTS:** 100 ppm/°C
   (Applies to Gain, Offset, and Excitation Voltage)
7. **NOISE REJECTION:** (@ 50/60 Hz) Normal Mode, -84 dB Common mode, -50 dB with respect to excitation common -110 dB with respect to earth ground.
8. **RESPONSE TIME:** 2.0 seconds to settle from step input.
9. **READING UPDATE TIME:** Displays updated every 0.4 seconds.
10. **EXCITATION SUPPLY:** Adjustable from 1.3-10 VDC. Max. output current 120 mA. Excitation supply is regulated.
11. **MAXIMUM TEMPERATURES:**
    Operating Range: -0° to +60°C
    Storage Temperature: -40° to +80°C
12. **CONNECTIONS:** Plug-in, compression type barrier terminal strip.
13. **CONSTRUCTION:** Die-cast metal front bezel with black, high impact plastic insert. Front panel meets NEMA 4/IP65 requirements for wash-down and dusty environments when properly installed. (Panel gasket and mounting clips included.)
14. **WEIGHT:** 1.2 lbs (0.54 Kg).

DIMENSIONS "In inches (mm)"

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.5" (140) W.



MODEL APLSG - SIMPLIFIED SCHEMATIC DIAGRAM



DESCRIPTION OF OPERATION

The Apollo Strain-Gage Indicator *(APLSG)* consists of a digital voltmeter combined with a high-gain, differential input amplifier that has provision for wide range scaling adjustment *(shown above)*. The unit also incorporates an excitation power supply that can be adjusted over a 1.3 to 10 VDC range, and delivers up to 120 mA.

In the simplified schematic above, K1, K2, and K3 form a high-gain, high-stability, differential input preamplifier with a single ended output. The gain of this preamplifier is set up by coarse gain select switches S5 through S9. These switches can be turned on in combination to provide discrete steps of gain-range adjustment. The output of the preamplifier *(K3 output)* is applied to summing amplifier, K4, through coarse and fine adjustable summing resistors. These adjustable resistors provide final vernier gain adjustment over a range of slightly more than 2:1. An adjustable offset voltage signal is also added-in at the input of K4, for zero-balance or for applications where the transfer curve must be offset from zero.

GAIN ADJUSTMENTS

Gain is defined as the Units of Numerical change seen on the display per mV *(millivolt)* of input signal change *(disregarding display decimal points)*. In effect, gain determines the slope of the transfer curve *(as shown above)* and is expressed in Units/mV.

$$\text{GAIN} = \frac{\text{(Max. Num. Readout) - (Min. Num. Readout)}}{\text{(Max. mV Input Sig.) - (Min. mV Input Sig.)}}$$

(Disregarded Decimal Points in Readout)

For example, if an APLSG is to display 50.0 @ 2 mV (min.) and 169.0 @ 19 mV (max.), the required gain will be:

$$\text{GAIN} = \frac{\text{1690 Units - 500 Units}}{\text{19 mV - 2 mV}} = \text{70 Units/mV}$$

(Remember, display decimal points are disregarded)

To establish this gain, the settings of the coarse gain select switches must first be determined. These switches establish the maximum end of the 2:1 adjustment range of the coarse and fine vernier gain adjustments.

COARSE GAIN SELECT SWITCHES: Each of the coarse gain select switches is marked with the amount of maximum gain it will contribute when turned on. They are turned on singly or in combination *(adding up each of their gain contributions)*, to arrive at a maximum gain value that is just above the desired gain value.

To achieve the desired gain of 70 Units/mV in the example just given, the following switches would be turned on:

S6 (Gain 50) + S7 (Gain 16) + S8 (Gain 6.6) = 72.6 Units/mV

With these switches ON, the coarse and fine vernier adjustments cover a gain range from about 36 Units/mV (½ *of max.*) to 72.6 Units/mV. The required gain of 70 Units/mV falls within this adjustable range.

COARSE AND FINE GAIN ADJUSTMENTS: Once the gain select switches have been set, the final gain calibration is made with the Coarse and Fine Gain adjustments. Both of these adjustments are 15-Turn, screwdriver adjust resistors that increase gain with clockwise rotation. The Coarse adjustment has a 2:1 range and is located on the rear of the unit. The Fine adjustment has a range of 5-10% *(depending on the setting of the Coarse adjustment)*, and is located behind the sealing screw on the L.H. side of the front panel.

OFFSET ADJUSTMENTS

Offset adjustments move the transfer curve up-and-down, along the vertical axis without changing the slope *(Gain)*, as shown above. They are used to *"balance"* the output of transducers or to intentionally introduce an offset, such as tare-load compensation.

The **FINE OFFSET ADJUSTMENT** is a 15-turn, screwdriver adjust potentiometer, located behind the sealing screw on the R.H. side of the front panel. It has a range of ±125 Numerical Units of offset which is sufficient for balancing the output of most transducers.

The **COARSE OFFSET SWITCHES** *(S2, 3, and 4)* can be used to add additional steps of offset. Like the coarse gain select switches, the offset switches are marked with the approximate value of offset contributed by each switch, and they can be turned on in combinations with each switch contributing its value to the total. Switch S1 selects the polarity of the offset signal and can be set to either add or subtract the offset contribution of the switches. The maximum offset that can be obtained with all switches ON and the Fine Offset at its maximum is ±1000, which is one half of the full scale readout.

SET-UP AND CALIBRATION

There are three different methods that can be used to calibrate the APLSG, and the method chosen depends largely on the nature of the application. The three methods are:

VOLTAGE CALIBRATION:

In this method, the transducer signal is simply replaced with an accurately measured input voltage that can be varied through the range normally delivered by the transducer *(See Voltage Calibration Circuit, below)*. The APLSG is then adjusted to provide the proper readout.

SYSTEM CALIBRATION:

In this method, the transducer is connected to the input of the APLSG in the final installation, or in a bench set-up simulating the actual installation. Accurately known inputs are then applied to the transducer *(i.e. load, pressure, force, etc.)*, and the APLSG adjustments are made to provide the desired indication. This method is usually preferable to the Voltage Calibration method since it calibrates both the transducer and the APLSG as a combination, and reduces the inherent risk of inaccuracy or errors accumulated by separate calibration. However, it can only be used in applications where the parameter to be indicated can be easily varied and accurately measured or established. It is also very awkward to use if an offset or transducer unbalance must be dealt with, because of Offset/Gain adjustment interaction.

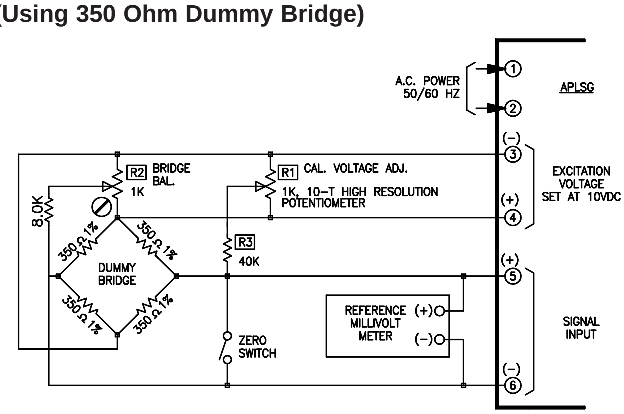
COMBINATION VOLTAGE/SYSTEM CALIBRATION:

In applications where tare-load, offset, or substantial transducer unbalance exists, and where high accuracy is required in the final indication, it may be desirable to voltage calibrate the unit first to get it very close to its final settings. Then after final installation the unit can be *"tweaked"* to its final settings while using accurately known inputs to the system.

These various factors make it impossible to set up one calibration procedure to cover all applications. However, using the following information on Voltage Calibration together with the examples given, should provide a good basis for handling virtually any calibration problem.

VOLTAGE CALIBRATION CIRCUIT

(Using 350 Ohm Dummy Bridge)



This 350 Ohms *"Dummy Bridge"* circuit delivers calibration voltages in ranges of 0 to ±22 mV, 0 to +44 mV, or 0 to -44 mV, depending on the setting of R2. The range can be increased or decreased by adjusting the value of R3 *(shown as 40 K)*. An accurate reference millivoltmeter is used to set up the calibration voltage, and a *"Zero Switch"* facilitates balancing without readjusting the calibration voltage. High-stability metalized resistors *(1% tol.)* should be used. The use of a dummy bridge insures a common-mode voltage during calibration that is very similar to that of the actual transducer.

VOLTAGE CALIBRATION

"Voltage Calibration" can be easily performed for any application, using the calibration circuit *(shown lower left)* together with the following procedure. However, before starting the procedure, the Input Swing Voltage (V_S), the Readout Span (R_S) and the required GAIN must be determined.

R_S = (Max. Numerical Display) - (Min. Numerical Display)

<u>(Disregard Decimal Points)</u>

V_S = (mV in @ Max. Display) - (mV in @ Min. Display)

GAIN = R_S/V_S = Units/mV

EXAMPLE: Readout is to be 5.00 Units @ 2 mV minimum, and 15.00 Units @ 18 mV maximum. The transducer is a 350 Ω strain-gage bridge requiring 10 VDC excitation.

R_S = 1500 - 500 = 1000 Units V_S = 18 mV - 2 mV = 16 mV

GAIN = 1000/16 = 62.5 Units/mV

Note: While most strain-gage readout applications are zero-based (i.e. zero readout @ zero input) this example was intentionally chosen because it included an offset reading at zero input. It will be used in the Calibration Procedure below to illustrate the most convenient way to handle offset situations without excessive interaction of gain and offset adjustments. If a zero-based example had been given, the minimum readout and input voltage would have both been zero. R_S and V_S would then simply be the maximum values of readout and input voltage respectively, gain would just be the ratio of (Max. Readout/Max. Input mV), and Steps 7 and 8 of the procedure below could be eliminated.

CALIBRATION PROCEDURE

1. Connect the unit to the Calibration Circuit as shown.
2. Set the Coarse Gain Select Switches, S5 through S9 to establish a maximum gain range just exceeding the required gain. Referring to the example given, the required gain was calculated to be 62.5 Units/mV. Setting switches S6 and S7 ON gives 50 + 16 = 66 Units/mV, which is just above the required amount.
3. Turn power on to the unit and allow 10 minutes of warm-up time for stabilization. Then set the excitation voltage accurately to the required level. *(10VDC in the example given.)*
4. Close the *"Zero Switch"* of the calibration circuit to obtain zero input voltage. Adjust the fine offset control *(R.H. side, Front Panel)* to get a zero readout. All offset switches, S2, 3, and 4, should be off.
5. Open the *"Zero Switch"* of the calibrating circuit and set the input voltage to the caluclated swing voltage, V_S. *(V_S is 16 mV in the example given.)* Now, adjust the Coarse Gain Control *(on the back)* and the Fine Control *(L.H. side, Front Panel)* to get a readout equal to the Readout Span. *(R_S = 1000 Units in the example given.)*
6. Repeat Step 4 and readjust zero if required. If zero readjustment was needed, repeat Step 5, then back to Step 4, etc., until Zero and RS readings are acceptable.

*7. Set the calibration voltage to the minimum input level and set the Coarse Offset Select Switches and the Fine Offset adjustment *(R.H. side, Front Panel)* to get the corresponding minimum readout. In the example given, the minimum readout was 500 units @ 2 mV.

*8. Vary the input from the minimum to maximum levels and check the corresponding readouts. Fine-tune if necessary by readjusting the fine gain adjustment at the maximum end and the fine offset adjustment at the minimum end. *(In the example, readout is 500 @ 2 mV min. and 1500 @ 18 mV max.)* Alternate between minimum and maximum inputs as required until readout is within desired tolerance at the extremes.

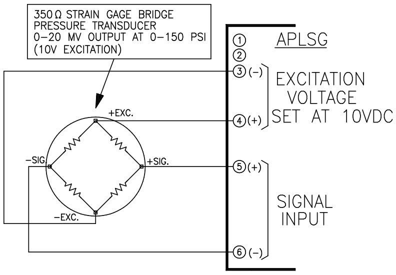
9. Set appropriate decimal point switch *(S2 for the example given)*. Replace sealing screws covering the fine gain and offset adjustments on the front panel.

   ***Caution**: Do **NOT** over-torque. The unit is now ready for installation.*

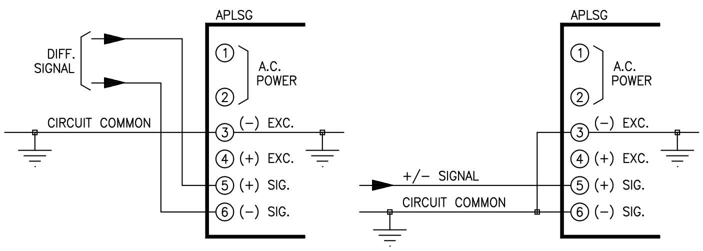
* - *Steps 7 and 8 are not required in zero-based applications.*

EXAMPLE #1 PRESSURE READOUT & SYSTEM CALIBRATION

This illustration depicts a common application using an APLSG with a strain-gage pressure transducer for pressure indication. The gain required to display 150 Units @ 20 mV is 150/20, or 7.5 Units/mV. Setting the Coarse Gain Select Switches S8 and S9 ON, gives a gain range of 6.6 + 3.3, or 9.9 Units/mV maximum, which brackets the required gain. The transducer curve is zero-based *(i.e. zero readout at zero input)*, and can be easily System Calibrated. A variable pressure input is applied to the transducer with a *"Dead-Weight Tester"* and the Fine Offset is adjusted to give a readout of zero with no pressure applied. Then 150 PSI is applied, the Coarse and Fine Gain controls are adjusted for a readout of 150. Pressure is removed, zero is checked and readjusted with the Fine Offset control if needed. Pressure is varied between zero and maximum, with the Fine Gain and Offset adjustments retrimmed as needed until the readout is within tolerance

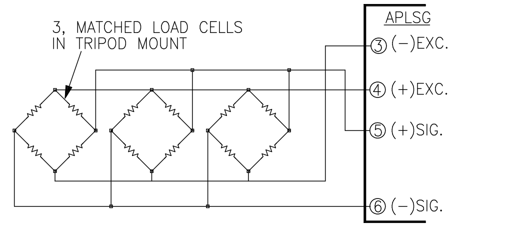


EXAMPLE #2 THE MODEL APLSG AS A MILLIVOLT INDICATOR



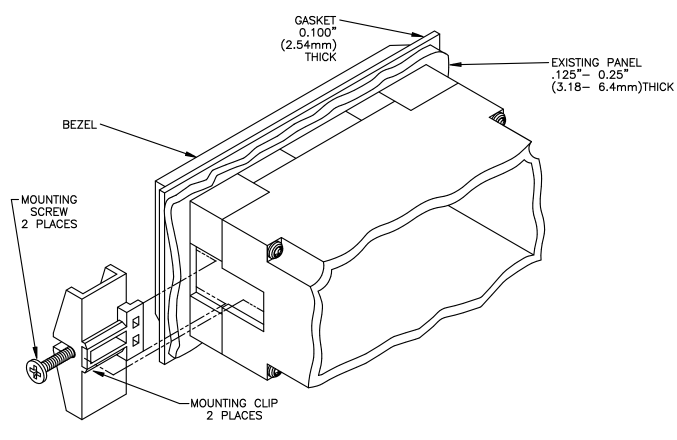
The APLSG can be used as a scaleable millivolt indicator and will accept either single-ended or differential inputs when connected as shown. Input signals are referenced to the negative (common) side of the excitation supply (Terminal 3). Maximum common-mode voltage (for differential input) is 0 to +7 VDC.

EXAMPLE #3 MULTIPLE LOAD-CELL INPUT, AVERAGE READING



The 120 mA excitation output capability of the APLSG allows it to operate multiple strain-gage bridges. In this example, it is used to indicate the quantity of granular material held in a hopper that is supported by three load cells in a tripod mounting arrangement. The tare-weight of the empty hopper is about 30% of the full weight, requiring a significant offset for a zero readout when empty. The APLSG is first Voltage-Calibrated *(using the known output of the load cells at the empty and full conditions)*. Then the unit is installed and fine trimmed (System Calibration) using known loads.

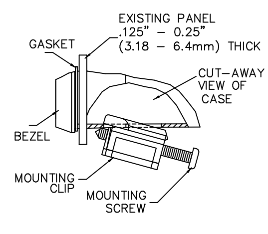
INSTALLATION



The Apollo Strain-Gage Indicator is designed to be panel-mounted with a gasket to provide a water-tight seal. Two mounting clips and screws are provided for easy installation. Consideration should be given to the thickness of the panel. A panel which is too thin may distort and not provide a water-tight seal. (Recommended minimum panel thickness is 1/8".)

After the panel cut-out has been completed and deburred, carefully apply the gasket to the panel. DO **NOT** APPLY THE ADHESIVE SIDE OF THE GASKET TO THE BEZEL. Insert the unit into the panel. As depicted in the drawing, install the screws into the narrow end of the mounting clips. Thread the screws into the clips until the pointed end just protrudes through the other side.

Install each of the mounting clips by inserting the wide lip of the clips into the wide end of the hole, located on either side of the case. Then snap the clip onto the case. Tighten the screws evenly to apply uniform compression, thus providing a water-tight seal. ***Caution****: Only minimum pressure is required to seal panel. Do* ***NOT*** *overtighten screws.*



ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBERS FOR AVAILABLE SUPPLY VOLTAGES 230 VAC	115 VAC
APLSG	Apollo Strain-Gage Indicator	APLSG410	APLSG400
For information on Pricing, Enclosures, & Panel Mount Kits refer to the RLC Catalog or contact your local RLC distributor.			

NOTES:

1. *Units are shipped calibrated to read 000.0 to 100.0 with 0 to 20 mV input, and with excitation set at 10 VDC.*
2. *The APLSG may be used for process weighing applications, however it does not meet the applicable specifications for commercial weighing.*

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