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Bulletin No. APLI/V-K
Drawing No. LP0123
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MODEL APLI - APOLLO CURRENT METER & MODEL APLV - APOLLO VOLTMETER

- *TWO MULTI-RANGE UNITS COVER:*
  199.9 µA to 1.999 A, 199.9 mV (DC)
  1.999 V to 300 V (DC)
- *3 1/2-DIGIT, 0.56" (14.2 mm) HIGH LED DISPLAY W/POLARITY*
- *BUILT-IN SCALING PROVISIONS*
- *SELECTABLE DECIMAL POINT LOCATION*
- *AUTO ZEROING CIRCUITS*
- *FRONT PANEL CALIBRATION ADJUSTMENT*
- *OVER-RANGE INDICATION*
- *NEMA 4/IP65 SEALED FRONT METAL BEZEL*

DESCRIPTION

Apollo Volt and Current Meters are premium quality instruments designed for tough industrial applications. With multi-range capability, built-in provision for scaling, and DIP switch selectable decimal points, these units offer the ultimate in application flexibility.

The die-cast metal bezel of the Apollo not only enhances the appearance of any panel, it can also be sealed in the front panel for use in wash-down areas and tough, dirty industrial environments. The 3 1/2-digit bi-polar display (minus sign displayed when current or voltage is negative) features 0.56" (14.2 mm) high, 7-segment LED's for easy reading. Also featured are removable terminal blocks on the rear that facilitate installation wiring and change-outs.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

CAUTION: Risk of Danger. Read complete instructions prior to installation and operation of the unit.	**CAUTION: Risk of electric shock.**

SPECIFICATIONS

1. **DISPLAY**: 3 1/2-digit, 0.56" (14.2 mm) high, 7-segment LED, (-) minus sign displayed when current or voltage is negative. Decimal points inserted before 1st, 2nd, or 3rd least significant digits by DIP switch selection.
2. **POWER**: 115 VAC ±10%, 50/60 Hz, 6 VA.
   Isolation: 2300 Vrms for 1 min. between input and supply.
3. **INPUT RANGES**: (Selectable by input and jumper connections.)

DC Voltmeter	DC Current Meter
±1.999 Volts (basic range)	±199.9 µA
±19.99 Volts	±1.999 mA
±199.9 Volts	±19.99 mA
±300 Volts	±199.9 mA
	±1.999 amps
	±199.9 mV (basic range)

Input Impedance:

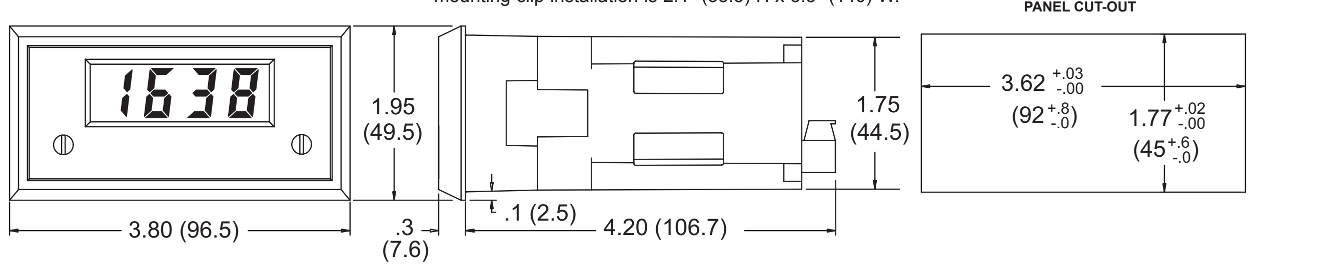
Voltage: All ranges1MΩ

Current:	
199.9 µA	1.111 KΩ
1.999 mA	111 Ω
19.99 mA	11 Ω
199.9 mA	1 Ω
1.999 A	0.1 Ω

4. **ACCURACY**:
   DC Volts - ±(0.1% of Reading + 1 digit)
   DC Current
   199.9 µA, 1.999 mA, 19.99 mA: ±(0.1% of Reading + 1 digit)
   199.9 mA: ±(0.15% of Reading + 1 digit)
   1.999 A: ±(0.5% of Reading + 1 digit)
5. **OVER-RANGE INDICATION**: on all modes is indicated by blanking 3 least significant digits.
6. **MAX. VOLTAGE ON BASIC RANGE INPUTS**: 75 VDC (Term. 8 to 3 on voltmeter, Term. 9 to 3 on current meter).
7. **MAX. VOLTAGE ON TERMINAL BLOCK**: 300 VDC (Both voltmeter and current meter).

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.3) H x 5.5" (140) W.



8. **MAX. SHUNT CURRENTS (ON CURRENT METER)**:
199.9 µA through 19.99 mA: 10 x max. range current
199.9 mA: 1 amp
1.999 amp: 3 amps
Caution: In circuits where fault currents can exceed the maximum shunt current, a fast-blow fuse should be installed in series with the input signal. Otherwise, a slow blow 10 amp fuse is recommended that will allow for start-up over current situations, while still protecting the instrument.
9. **TEMPERATURE COEFFICIENTS:**

Current meter	Voltmeter
DC: ±100 PPM/°C	DC: ±75 PPM/°C

10. **ENVIRONMENTAL CONDITIONS**:
Operating Temperature : 0° to 60°C
Storage Temperature : -40° to 80°C
Operating and Storage Humidity: 85% max. relative humidity (non-condensing) from 0°C to 50°C.
Altitude: Up to 2000 meters
11. **RESPONSE TIME TO STEP CHANGE INPUT**: 1 sec. nominal
12. **READING RATE**: 2.5 readings/sec., nominal
13. **NORMAL MODE REJECTION**: 50 dB 50/60 Hz
14. **COMMON MODE REJECTION**: 110 dB DC or 50/60 Hz
15. **COMMON MODE VOLTAGE (COMM. TO EARTH)**: 350 volt peak
16. **CERTIFICATIONS AND COMPLIANCES**:
CE Approved
EN 61326-1 Immunity to Industrial Locations
Emission CISPR 11 Class A
Safety requirements for electrical equipment for measurement, control, and laboratory use:
EN 61010-1: General Requirements
Type 4 Enclosure rating (Face only)
IP65 Enclosure rating (Face only)
Refer to the EMC Installation Guidelines section of this bulletin for additional information.
17. **CONSTRUCTION**: Metal die-cast front bezel with black, high impact plastic case. This unit is rated for NEMA 4/IP65 indoor use when properly installed (panel gasket and mounting clips included). Installation Category II, Pollution Degree 2.
18. **WEIGHT**: 1.2 lbs. (0.54 Kg)

EMC INSTALLATION GUIDELINES

Although Red Lion Controls Products are designed with a high degree of immunity to Electromagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into a unit may be different for various installations. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed are some EMI guidelines for a successful installation in an industrial environment.

1. A unit should be mounted in a metal enclosure, which is properly connected to protective earth.
2. Use shielded cables for all Signal and Control inputs. The shield connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield to earth ground (protective earth) at one end where the unit is mounted.
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is over 1 MHz.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors, feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run through metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter. Also, Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
4. Long cable runs are more susceptible to EMI pickup than short cable runs.
5. In extremely high EMI environments, the use of external EMI suppression devices such as Ferrite Suppression Cores for signal and control cables is effective. The following EMI suppression devices (or equivalent) are recommended:
   Fair-Rite part number 0443167251 (RLC part number FCOR0000)
   Line Filters for input power cables:
   Schaffner # FN2010-1/07 (Red Lion Controls # LFIL0000)
6. To protect relay contacts that control inductive loads and to minimize radiated and conducted noise (EMI), some type of contact protection network is normally installed across the load, the contacts or both. The most effective location is across the load.
   a. Using a snubber, which is a resistor-capacitor (RC) network or metal oxide varistor (MOV) across an AC inductive load is very effective at reducing EMI and increasing relay contact life.
   b. If a DC inductive load (such as a DC relay coil) is controlled by a transistor switch, care must be taken not to exceed the breakdown voltage of the transistor when the load is switched. One of the most effective ways is to place a diode across the inductive load. Most RLC products with solid state outputs have internal zener diode protection. However external diode protection at the load is always a good design practice to limit EMI. Although the use of a snubber or varistor could be used.
   RLC part numbers: Snubber: SNUB0000
   Varistor: ILS11500 or ILS23000
7. Care should be taken when connecting input and output devices to the instrument. When a separate input and output common is provided, they should not be mixed. Therefore a sensor common should NOT be connected to an output common. This would cause EMI on the sensitive input common, which could affect the instrument's operation.

Visit RLC's web site at http://www.redlion.net/Support/InstallationConsiderations.html for more information on EMI guidelines, Safety and CE issues as they relate to Red Lion Controls products.

WIRING CONNECTIONS

All connections are made to a removable terminal block for ease of installation. Conductors should meet voltage and current ratings for each terminal. Also cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the unit be protected by a fuse or circuit breaker.

To remove the block, pull from the back of the block until it slides clear of the terminal block shroud. ***Caution****: Terminal block should* ***NOT*** *be removed with power applied to the unit.*

POWER WIRING

Primary AC power is connected to Terminals 1 and 2 *(Marked A.C. Power, located on the left-hand side of the terminal block)*. For best results, the AC power should be relatively *"Clean"* and within the specified ±10% variation limit. Drawing power from heavily loaded circuits or from circuits that also power loads that cycle on and off, should be avoided.

SIGNAL WIRING

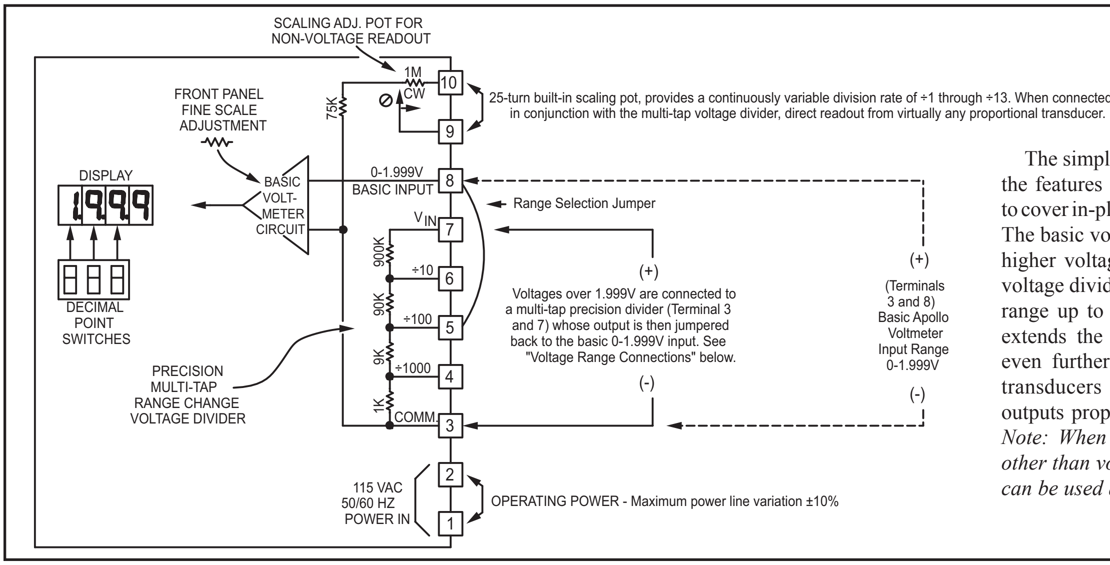
Input connections and range configuration jumpers are made on Terminals 3 through 10 or 11.

(For detailed information, see "Inputs and Configurations".)

DECIMAL POINT SELECTION

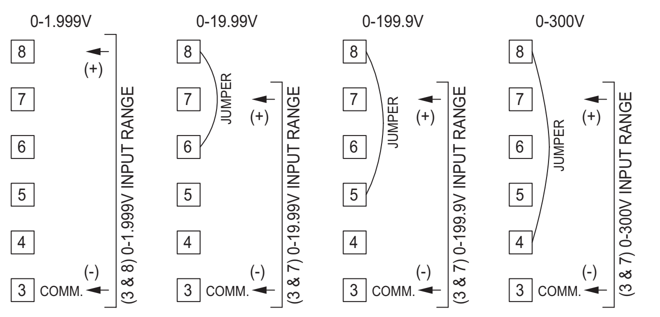
The Apollo Volt and Current meters have DIP switches located on the side of the unit for the selection of 1 of 3 decimal points for display.

APOLLO VOLTMETER INPUTS & CONFIGURATIONS



The simplified schematic (left) shows all of the features that permit the Apollo Voltmeter to cover in-plant voltage related measurements. The basic voltmeter range is 0 to 1.999 V. For higher voltage readout, a multi-tap precision voltage divider can be connected to extend the range up to 300 V. A built-in scale adj. pot. extends the capability of Apollo Voltmeters even further to provide direct readout from transducers that generate signal voltage outputs proportional to RPM, PSI, FPM, etc. *Note: When used to readout in scaled units other than voltage, the front panel adjustment can be used as a fine trim scaling adjustment.*

VOLTMETER RANGE CHANGE CONNECTIONS

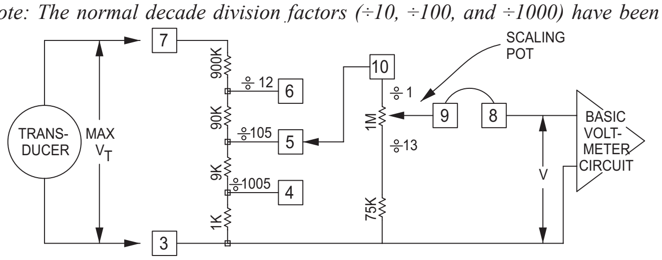


SCALING FOR DIRECT READOUT OF OTHER VARIABLES

In many industrial applications, a voltage sensing instrument is required to display a reading in terms of PSI, RPM, or some other variable. The signal voltage being measured is normally generated by a transducer which senses the variable and delivers a linearly proportional output voltage.

The multi-tap divider and the scale adj. pot. of the Apollo Voltmeters can be connected in tandem *(series)* to scale *(divide)* virtually any signal voltage up to 300 V max. down to the basic 0 to 1.999 V input range to get the desired reading. The multi-tap voltage divider provides coarse ranges of division and the scaling pot. provides continuous selection of division factors between the taps.

Note: The normal decade division factors (÷10, ÷100, and ÷1000) have been



adjusted in this schematic to account for parallel connection of the scale pot. resistance which increases these factors as shown.

In order to determine the jumper wiring configuration of the Apollo for a scaled application, we must first determine the division factor required to provide the desired display.

USING THE FORMULA:

$$\frac{VT \times D.D.P.}{D.R.} = D.F.$$

WHERE:

VT	=	Maximum Transducer Output
D.D.P	=	Display Decimal Point
D.R.	=	Desired Reading
D.F.	=	Division Factor

D.D.P.			
0.000	=	1	The Display Decimal Point
00.00	=	10	(D.D.P.) is determined by
000.0	=	100	the desired decimal point
0000	=	1000	placement in the readout.

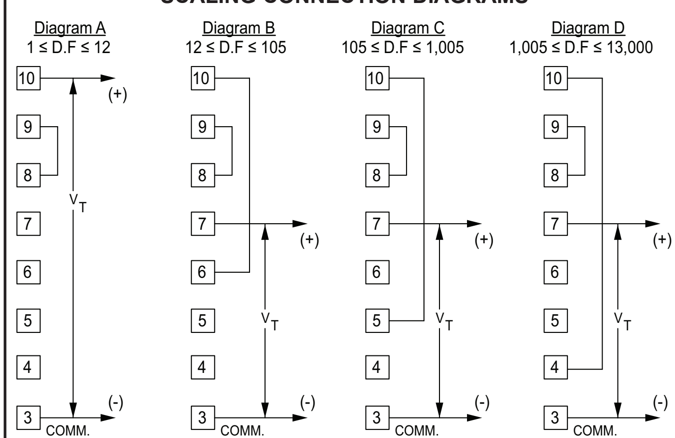
Then we connect the divider and pot. to obtain the adjustable division range we need to bracket the proper division factor *(See "Scaling Connection Diagrams" below)*.

EXAMPLE 1: A pressure transducer delivers a 5.5 V signal @ 120.0 PSI maximum.

$$\frac{VT \times D.D.P.}{D.R.} = \frac{5.5 \times 100}{120.0} = 4.58 \text{ D.F.}$$

This division factor falls between 1 and 12, so connect per *"Diagram A"* below. Calibrate by adjusting the scaling pot. to get the proper readout at a known pressure.

SCALING CONNECTION DIAGRAMS

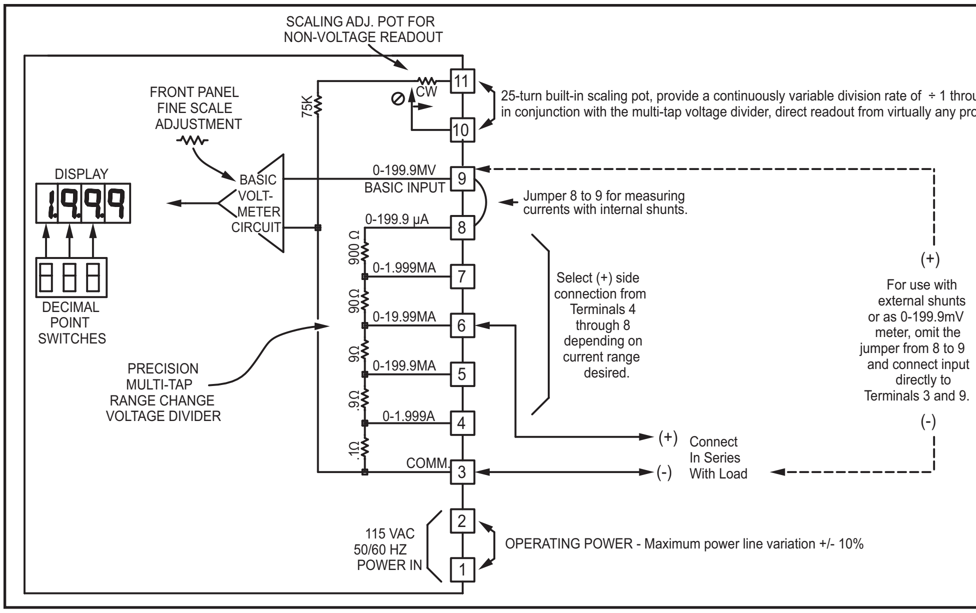


EXAMPLE 2: A tachometer generator delivers 210 VDC at maximum machine speed which is to be indicated as 575 FPM on an Apollo Voltmeter.

$$\frac{210 \text{ V (Max. from tach. gen.)} \times 1000 \text{ (D.P.P.)}}{575 \text{ (Desired Readout)}} = 365 \text{ (D.F.)}$$

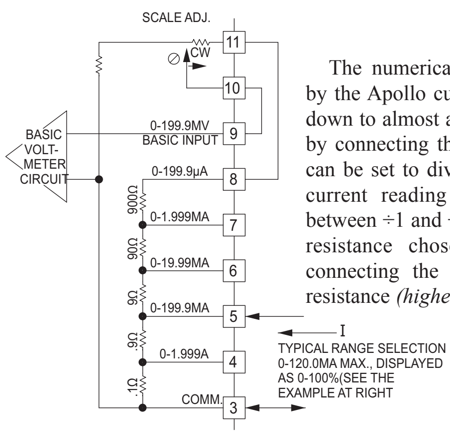
This division factor falls between 105 and 1005, so connect per *"Diagram C"* above. Calibrate by adjusting the scaling pot. to get the proper readout at a known speed.

APOLLO CURRENT METER INPUTS & CONFIGURATIONS



Apollo Current Meters incorporate a basic 0 to 199.9 mV voltmeter circuit together with a string of built-in current shunts that can be connected to provide current measuring ranges from 0 to 199.9 µA to 1.999 amps in 5 decade steps. A built-in scaling pot. also allows the unit to be used as a scaleable millivoltmeter and provides for arbitrary current scaling. *Note: When used to readout in scaled units other than voltage or current, the front panel adjustment can be used as a fine trim scaling adjustment.*

CURRENT METER SCALING



The numerical current value displayed by the Apollo current meter can be scaled down to almost any lower numerical value by connecting the scale adj. pot. This pot can be set to divide the normal numerical current reading by any division factor between ÷1 and ÷13. In addition, the shunt resistance chosen can be reduced by connecting the current lead to a lower resistance *(higher range tap)*.

EXAMPLE

In the diagram *(left)*, the Apollo Current Meter has been connected to measure a circuit current to 120.0 mA maximum. However, in this application, the readout is to be in percent of load current, with 120.0 mA being equivalent to 100.0% readout. The scale adj. pot. connected as shown can be adjusted to reduce the normal 120.0 mA display to the 100.0% display desired. The input current leads could also be connected to 4 and 3 instead of 5 and 3 as shown, and this would yield a readout to 100% and allow the decimal point and least significant digit *(0.1%)* to be dropped.

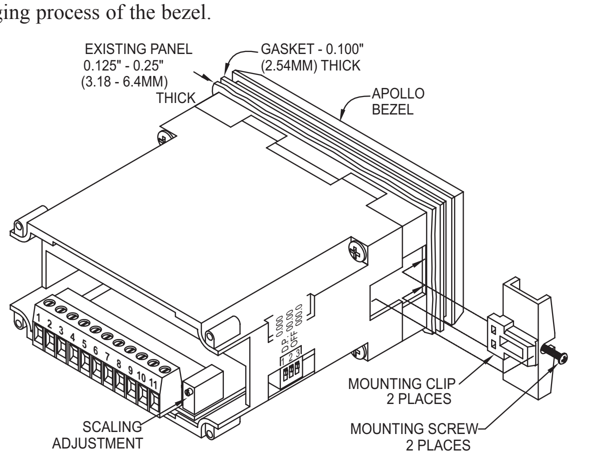
Scaling to obtain a numerical readout higher than the numerical value of the current can also be done in most cases by simply feeding the current input into a lower range. However, at the higher current range *(1.999 A)* and with external shunts, care should be taken to avoid exceeding maximum shunt current.

For example, if the unit is measuring a maximum current of 1.3 amps *(current flowing between terminals 3 and 4)*, the numerical current value will be 1.300 displayed. Here, it is impossible to increase the numerical scaled value to say 1.500 by connecting to the next sensitivity *(199.9 mA)* since the 1.3 amp actual current exceeds the maximum current rating of this range *(See "Specifications" for maximum current.)*

INSTALLATION ENVIRONMENT

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.



Installation

The unit meets NEMA 4/IP65 requirements for indoor use when properly installed. The units are intended to be mounted into an enclosed panel

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".)*

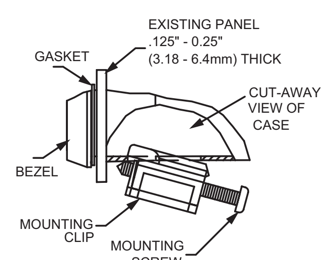
After the panel cut-out has been completed and deburred, carefully slide the gasket over the rear of the unit to the panel. Insert the unit into the panel.

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.

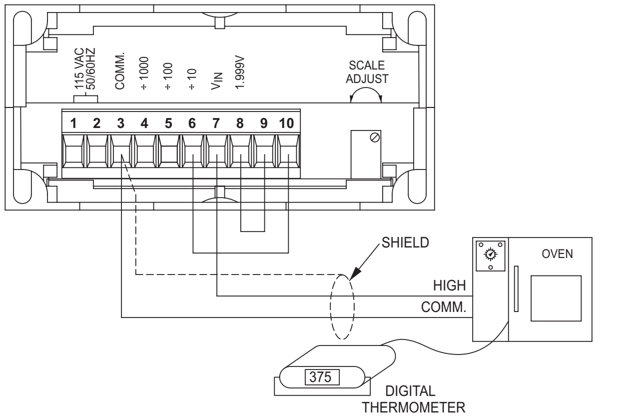
Tighten the screws evenly to apply uniform compression, thus providing a water-tight seal.

Caution: *Only minimum pressure is required to seal panel. Do* ***NOT*** *overtighten screws.*



TYPICAL VOLTAGE & CURRENT MEASUREMENT APPLICATIONS

TEMPERATURE MONITORING IN A BISCUIT BAKING OPERATION



A biscuit baker has temperature controllers on his ovens that have a dial for setting the temperature of his ovens. He would like to have a digital display of his temperature for ease of monitoring. He has determined, by talking to the temperature controller manufacturer, there is a 0 to 10 VDC voltage available from the controller, that represents a temperature of approximately 0 to 600°F.

An Apollo DC voltage indicator is ideally suited to this application. It is apparent that a standard range will not satisfy this requirement; therefore, field scaling is required. The first thing that must be done is to determine what division factor is required. Use the equation discussed in the text.

$$\text{Division Factor} = \frac{\text{(Maximum Output) x D.P.P.}}{\text{(Desired Display)}} = \frac{(10) \text{ x } 1000}{(600)} = 16.7 \text{ (D.F.)}$$

It can be seen that the division factor falls between 12 and 105 *(See "Scaling Connection Diagrams")*. This is accomplished by connecting a jumper between "÷10" *(Terminal 6)* and Terminal 10 *(the 1.999 V basic input)*, and a jumper between Terminal 9 and Terminal 8. Then, using 2 conductor shielded wire to minimize noise pickup, the common of the temperature controller output is connected to *"COMM." (Terminal 3)* and the *"HIGH"* side of the output of the temperature controller is connected to "V_{IN}" *(Terminal 7)*. The shield is also connected to *"COMM." (Terminal 3)*.

The Apollo is now ready to be calibrated. The baker has access to a portable digital thermometer. So in this case, calibration will be accomplished by causing the Apollo indicator to agree with the portable digital thermometer. The baker sets his oven to his normal baking temperature of 375°F. He installs the temperature probe in the oven and waits for it to reach equilibrium. After the oven has stabilized, at its operating temperature, the baker simply adjusts the *"coarse"* scaling adjustment, located at the rear of the unit, until the display is close in value to that indicated on the digital thermometer. He then removes the *"fine"* scaling access plug and adjusts the *"fine"* scaling adjustment until the display agrees with the digital thermometer. He replaces the access plug to keep dust out of the Apollo. The Apollo voltmeter now indicates the oven temperature and the baker can monitor his temperature precisely.

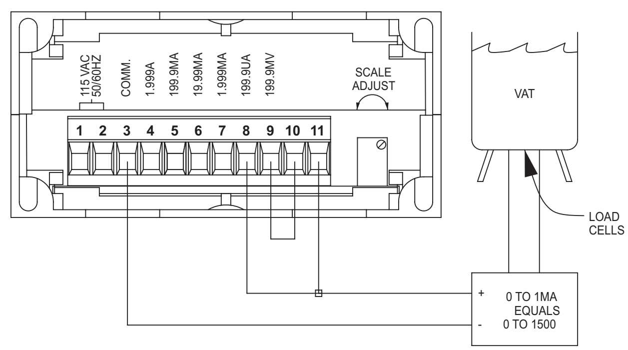
VOLUME INDICATION

A manufacturer who uses vats of chemicals in his process has been using the output of load cells, connected to a circuit that in turn drives a 1 mA DC analog meter movement to display how full the vat is. The meter dial is calibrated 0 to 1500 gallons.

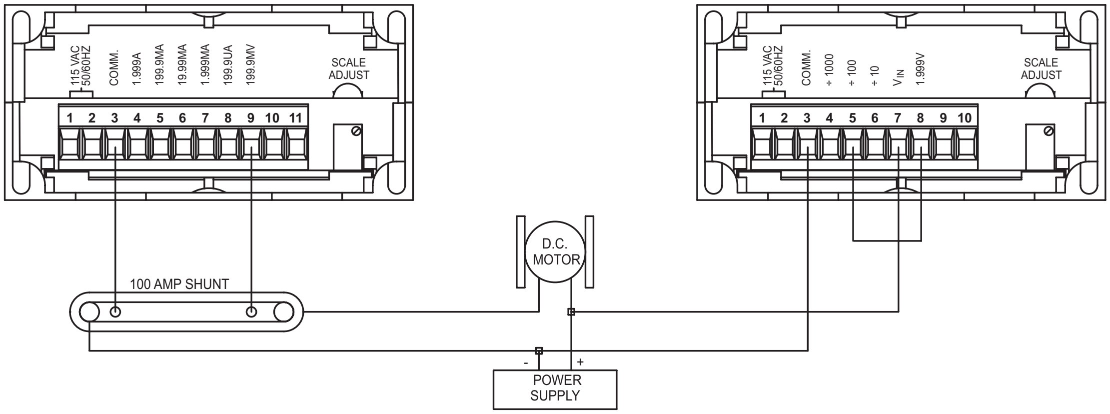
An Apollo DC current indicator is ideally suited to this application. It is apparent that a standard range will not satisfy this requirement and field scaling is required.

It can be seen that the 1 mA for 1500 gallons can not be accomplished using the 1.999 mA range; however, the maximum input of 1mA does not exceed the maximum input on the 199.9 µA range, so this range is selected. This is accomplished by connecting the jumpers as described in the "Scaling" section *[e.g. from "199.9 µA" (Terminal 8) to Terminal 11 and a jumper between Terminal 10 and the "199.9 mV" basic input (Terminal 9)]*. Then, the Apollo is connected in the circuit to replace the analog meter by connecting the *"199.9 µA"* (Terminal 8) where the "+" terminal of the analog meter was connected, and connecting the *"COMM."* (Terminal 3) where the "-" terminal of the analog meter was connected.

The Apollo is now ready to be calibrated. The operator fills the vat until it is completely full and he knows he has 1500 gallons. He then adjusts the coarse scaling adjustment on the rear of the Apollo indicator until the display reads approximately 1500. He then removes the *"fine"* scaling adjustment access plug and adjusts the *"fine"* scaling adjustment until the display reads exactly 1500. He replaces the access plug to keep dust and water out of the Apollo. The Apollo current meter now indicates the exact number of gallons in the vat. No decimal point is selected because the resolution is 1 gallon.



VOLTAGE & CURRENT MONITORING OF A DC MOTOR



It is desired to monitor the power supply voltage and load current of a 120 volt DC motor. The maximum load current is 100 amps.

The Apollo DC Voltmeter, Model APLVD, is configured for the 199.9 V calibrated range by connecting the " ÷100" (Terminal 5) to the 1.999 V basic input (Terminal 8). The "COMM." (Terminal 3) is connected to the negative terminal of the power supply and the " V_{IN}" input (Terminal 7) is connected to the positive terminal of the power supply. The resolution of the display is 0.1 V, therefore "D.P.1" is selected.

The Apollo DC Current Meter, Model APLID, is configured by simply connecting the "COMM." (Terminal 3) and the "199.9 mV" basic input (Terminal 9) to the sense terminals of the external 100 amp current shunt (AP-SCM-100). The external shunt is then connected in series with the negative terminal of the power supply. The resolution of the display is 0.1 amp, therefore "D.P.1" is selected.

The Apollo volt and current meters will now indicate the power supply voltage and load current of the DC motor precisely.

TROUBLESHOOTING

For further technical assistance, contact technical support at the appropriate company numbers listed.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
**APLVD	Apollo DC Voltmeter, 115 VAC	APLVD400
**APLID	Apollo DC Current Meter, 115 VAC	APLID400
–	*10 amp Current Shunt	APSCM010
–	*100 amp Current Shunt	APSCM100

* *Voltage drop at full current = 100.0 mV maximum. Continuous current should not exceed 115% of rating.*

** *Units are shipped calibrated to the following readings:*

MODEL NO.	DISPLAY @ INPUT
APLVD	1999 @ 1.999 VDC
APLID	1999 @ 199.9 mVDC

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LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

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