

**Instruction Manual
AVTM 72-360J**

For the
**Versa-Cal/Loop
Calibrator**

Catalog No. 720360 Series

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**BIDDLE**
INSTRUMENTS

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72-360J

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INSTRUCTION MANUAL FOR
VERSA-CAL/LOOP™ CALIBRATOR
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Section A SAFETY PRECAUTIONS

-SAFETY IS THE RESPONSIBILITY OF THE USER-

-LA SEGURIDAD ES EL CARGO DEL OPERADOR-



Figure 1: View of the Biddle Cat. No. 720360-2 Versa-Cal/Loop Calibrator.

Biddle Versa-Cal/Loop calibrators have been designed and manufactured to meet the requirements of ANSI C39.5-1974 "Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation." The calibrators themselves do not present any unusual shock hazard during operation. Neither do the circuits on which the calibrators are usually used. However, in case of electrical fault or even without fault in systems of unusual design, the circuit being calibrated may be at a voltage capable of causing electrical shock. Therefore, users must take all necessary precautions to prevent contact with hazardous live circuits.

The loop unit terminals are rated only for DC voltage up to 60 volts; this rating should not be exceeded.

Internal maintenance must be performed only by persons familiar with the construction and operation of the calibrator and the shock hazard involved. Use caution when handling the test set when it is removed from its case. The circuits having hazardous voltages are:

- a. The high voltage output of the DC/DC Converter which powers the gas discharge display. This is nominally 175V dc and can deliver up to 35 mA. This can be hazardous and could cause injury due to involuntary reaction.
- b. The line cord and primary of the power transformer. The test set should be battery operated when performing maintenance to avoid the shock hazard from the ac supply line.

Do not use this instrument or its accessories for any purpose not described in this manual.

Section B
INTRODUCTION & DESCRIPTION

1. GENERAL

The Versa-Cal/Loop™ is a complete Versa-Cal thermocouple-millivolt calibrator with a "loop module" addition which is entirely enclosed in a special lid assembly. The instrument provides measurement and calibrated output capabilities for use in testing DC process control systems and components.

This instruction manual applies only to the loop module and its use. Please read the Instruction Manual 72-350J for information on the main unit.

2. PHYSICAL

External connections to the loop module are made by banana jacks, using a pair of mating test leads which have 3-way tips. A pair of short jumpers with stackable banana plugs at both ends are also supplied. The leads and instruction manuals are stored in a compartment above the loop panel.

Connections to the main Versa-Cal unit are made by an umbilical cable. This cable supplies power from the battery in the main unit to the loop module. It also carries signals from the loop module to the digital display of the main unit.

3. FUNCTIONAL

The loop module measures and generates both current and voltage signals. For measurements, all signals are scaled to 0-100 millivolts. They are displayed digitally on the main instrument panel using the millivolt "Measure" function.

The loop module has two signal channels, designated MEASURE and OUTPUT respectively, which are isolated from each other.

INTRODUCTION & DESCRIPTION (cont'd)

The MEASURE channel has a pair of input terminals marked "DC IN" and a two-wire output which is wired to the A channel on the main unit. A "FUNCTION" switch selects Volts or Milliampere or OFF. In the OFF position, the FUNCTION switch opens both of the DC IN terminals and both output connections to the main unit.

The "OUTPUT" channel generates signals, either DC Volts or Milliampere, at a second pair of terminals marked "DC OUT". The generated signal is accurately measured and can be displayed through the B channel of the main unit.

The OUTPUT channel has six manual controls. The three on the left are for the initial setup. Their functions are as follows:

FUNCTION switch: selects VOLTS or MILLIAMPS to be generated, or OFF. In OFF position, the switch opens the DC OUT terminals and both connections to the B channel of the main unit.

VOLTS RANGE switch: selects nominal range, 1-5 volts or 2-10 volts.

mA SOURCE & RANGE switch: further defines the milliampere output when selected by the FUNCTION switch. Includes four positions as follows:

1. INT, 4-20: permits instrument to act as a constant current source with a 30-volt internal power supply over a 4-20 mA nominal range.
2. INT, 10-50: same as preceding except nominal current range is 10-50 mA.

INTRODUCTION & DESCRIPTION (cont'd)

3. EXT, 4-20: same as (1.) except uses external power supply; thus the instrument simulates a typical process control transmitter, regulating current in a loop which has a separate supply.
4. EXT, 10-50: same as preceding except nominal current range is 10-50 mA.

The other three output controls are in a group labelled "OUTPUT SET". These establish the value of the output signals. Their functions are as follows:

PERCENT OF RANGE switch: selects one of five fixed output values or a continuously variable control. The fixed outputs are at 0, 25, 50, 75, and 100 percent of the selected nominal range (1-5, 2-10, 4-20, 10-50). These values are accurate if the FINE TRIM control is set at its index mark.

Setting the switch to "VARIABLE" activates the VARIABLE control.

VARIABLE (-25 to 110%) control: controls output over the full selected nominal range, with overrange of at least 10% at the upper end and near -25% at the lower end.

FINE TRIM control: controls output over about 1% of selected nominal range. Has a single turn, with one index mark at center of its travel. This control is always in the circuit, regardless of the position of the PERCENT OF RANGE switch.

Section C SPECIFICATIONS

SPECIFICATIONS FOR LOOP CALIBRATION FEATURES

FUNCTIONS

- MEASURE DC volts or milliamperes.
- OUTPUT and measure DC volts or milliamps; mA with either internal or external power source.

MEASUREMENT DISPLAY

Digital, 20,000 counts with correct decimal point and automatic range change between 19.950 and 20.00. Shows input to MEASURE channel or output from OUTPUT channel.

RANGES, RESOLUTION AND ACCURACY - MEASURE CHANNEL

UNITS OF MEASURE	RANGE (+ OR -) (AUTO CHANGE AT 19.95)	RESOLUTION	LIMIT OF ERROR 25±10°C, ONE YEAR
mA or Volts	0.000-19.950	0.001	0.05% rdg + 0.005
volts	19.95-60	0.01	0.05% rdg + 0.02
mA	19.95-101.10	0.01	0.05% rdg + 0.02

RANGES, RESOLUTION AND ACCURACY - OUTPUT CHANNEL

NOMINAL CONTROL LOOP RANGE	FULL OUTPUT RANGE ¹	RANGE, RESOLUTION AND LIMIT OF ERROR OF DISPLAY ²	LIMIT OF ERROR OF OUTPUT SETTING AT FIVE FIXED POINTS (FINE TRIM AT DOT)
4-20mA	0-22mA	Same as in MEASURE channel	0.024mA (0.15% range)
10-50mA	0-55mA		0.10mA (0.25% range)
1-5V	0-5.5V		0.01V (0.25% range)
2-10V	0-11V		0.02V (0.25% range)

¹ Using VARIABLE control.

² All settings can be trimmed to the full resolution of the display, using ±1/2% FINE TRIM control.

SPECIFICATIONS (cont'd)

WARMUP TIME to specified performance: 1 minute.

MEASURE CHANNEL INPUT RESISTANCE

Volts: 1.0 megohm $\pm 0.1\%$

mA: 60 ohms max.

OUTPUT REGULATION AND STABILITY

Maximum output change is 0.1% of nominal range as a result of any of the following changes:

- Full range load change.
- A 10°C change in ambient temperature.
- First minute of warmup.
- Eight hours after warmup, at constant ambient.

OUTPUT RATINGS, mA RANGES

- Internal source voltage: 30V. $\pm 5\%$.
- External voltage: 60V. maximum allowable.
- Loop resistance: maximum depends on current setting and total loop voltage as shown in Figure 2.

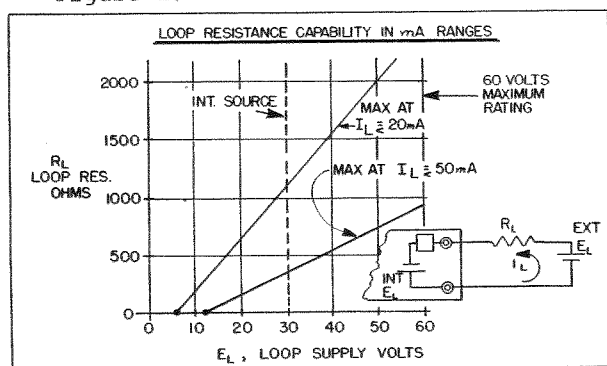


Figure 2: Loop Resistance Capability in mA Output Ranges

SPECIFICATIONS (cont'd)

OUTPUT RATINGS, VOLTS RANGES

Rated Load Current: 20 mA.

Short Circuit Protection: Current limits at about 45 mA, no damage. Thermal limiter requires up to 5 minutes to reset.

OVERSTRESS PROTECTION

Loop panel terminals withstand 120 volts RMS sine wave or DC across any two terminals in either polarity in any switch position for short time without harm.

PROTECTION FROM ACCIDENTAL CONNECTIONS

No interconnection is made between any pair of terminals and any other pair (of the four pairs) regardless of switch settings. Also, both terminals of either loop channel are disconnected when the corresponding FUNCTION switch is OFF.

POWER SUPPLY

DC-to-DC converter in loop module draws power from battery in main unit for OUTPUT circuits only. Battery drain is negligible when using EXT source for mA, or when using VOLTS output to a high-resistance load. The battery drain depends on the output current as shown in the following table:

OUTPUT CURRENT (IN VOLTS MODE OR mA MODE WITH INTERNAL SOURCE)	CONTINUOUS OPERATION ON ONE FULL BATTERY CHARGE	
	DISPLAY ON	DISPLAY OFF
0	10 hours	6 days
10 mA	8 hours	32 hours
20 mA	7 hours	15 hours
50 mA	4 hours	6 hours

Operation may continue with charger on.

SPECIFICATIONS (cont'd)

SAFETY

Design meets ANSI C39.5-1974, and IEC-348-1978.

AMBIENT TEMPERATURE RANGE

Operating: -10° to +45°C (14° to 113°F)
Storage: -40° to +70°C (-40° to +158°F)

ACCESSORIES

- . Pair of 3-ft. long test leads with banana plug at instrument end, test probe with a slip-on clip and banana plug at outboard end.
- . Pair of 1-foot stackable banana plug jumpers.
- . Instruction Manuals.

ENCLOSURE

- . Aluminum housing fastened in impact-resistant ABS polymer lid. Captive hinge prevents accidental dropping of lid assembly.
- . Bail holds lid open at convenient position for use.
- . Lid also contains compartment for instruction manuals, accessory leads and charger cord.
- . Brief instructions printed on accessory compartment lid.

Section D OPERATION

CAUTION!

Before handling any electrical installation, or connecting it to the Versa-Cal/Loop, make sure it is not hazardous to you or is above the 60-volts DC rating of the Versa-Cal/Loop.

Even a supposed low-voltage system may carry line voltage in the event of an electrical fault.

Always follow established safety practices in exposing and connecting to any electrical circuit!

1. PREPARATION

Open the lid and rest it in a convenient position. For a horizontal panel arrangement, use the snap-out wire bail to support the lid. For a vertical panel arrangement, rest the instrument on its handle.

Open the accessory compartment to remove the probe leads and Instruction Manuals. Use the following procedure to operate the latch:

To Open - Hold the cover in place and pull out on the black knob. It snaps free in a travel of about 1/4".

To Close -First pull out the black knob as far as it will go. With hands off the knob, push the panel to the closed position, then push in the knob to latch. It's simple when you remember to not press on the knob first.

OPERATION (cont'd)

2. TURNING ON AND OFF

Before attempting to operate the loop unit, you should become familiar with the main unit operation. Read the Instruction Manual 72-350J for the Versa-Cal instrument, and practice using the various controls on the main-unit.

Note: For normal use of the binding posts on the main unit, the FUNCTION switches on the loop panel must be set to OFF.

Whenever starting up, switch on the main unit briefly to test the display, battery, etc. The mV CHECK mode is convenient.

The loop module is ready to operate as soon as connected and turned on; it draws its power direct from the battery in the main unit, whether the main unit is turned on or not.

Always remember to keep both of the FUNCTION switches set to OFF when the loop unit is not in use. This will prevent damage should there be accidental high voltage connection to the loop terminals. It will also prevent unexpected effects of the instrument on any system connected to the loop terminals. It will also conserve battery charge.

3. SETTING MAIN UNIT FOR LOOP OPERATION

You may turn on the main instrument at any time, but to conserve battery, wait until you are ready to read the display. Then set the main unit controls as follows:

Range knob to "mV".

Function knob to MEASURE.

CHANNEL SELECT switch as follows:

To read loop MEASURE channel, set to "A".

To read loop OUTPUT channel, set to "B".

OPERATION (cont'd)

4. USING THE MEASURE CHANNEL

4.1 Measuring VOLTS.

1. Make sure the circuit under test is safe.
2. Connect the probes to the DC IN terminals.
3. Connect the probes to the circuit under test.
4. Set the main panel switches to MEASURE/mV/A. (The display reads "OPEN".)
5. Set the loop module MEASURE FUNCTION switch to VOLTS.
6. Read the display in volts. A negative (-) sign means that the negative side of the measured voltage is connected to the positive (+) terminal.

A display of "Error" means that the voltage being measured is greater than 101.1 volts.

A display which continually jumps from one reading to another indicates a large amount of AC in the voltage. This may indicate a dangerous fault, or excessive ripple in the measured circuit.

4.2 Measuring mA

- 1-4. Follow steps 1-4 of the "Measuring VOLTS" procedure above.
5. Set the loop module MEASURE FUNCTION switch to mA.
6. Read the display in milliamperes. A negative sign means that the direction of current flow is opposite to that shown by the arrow marked at the terminals.

Interpret "Error" or continually changing display as in the VOLTS procedure.

OPERATION (cont'd)

5. USING THE OUTPUT CHANNEL

5.1 Basic Output Operations

There are six different modes and ranges of OUTPUT operation. They all have the following steps:

- . Leave the FUNCTION switch at OFF until everything else is ready.
- . Make sure the circuit under test is safe, and that its loop power supply voltage (if any) is less than 60 volts DC.
- . Connect the test leads to the DC OUT terminals.
- . Connect the probes to the circuit under test. Match the polarity of the circuit under test to the arrow at the DC OUT terminals. The arrow shows the direction of current flow inside the calibrator. It also can be interpreted as a polarity sign which depends on the output mode as follows:

For VOLTS and for mA INT, arrowhead is (+).
For mA EXT, arrow head is (-).

- . Set the main panel switches to MEASURE/mV/B. (The display reads "OPEN".)

OPERATION (cont'd)

5.2 Milliampere Output

Set the "SOURCE AND RANGE" switch to the desired conditions as follows:

Select "EXT." if the loop is powered by an external source.

Select "INT." if there is no external power source.

Select "4-20" or "10-50" depending on the milliamp range of the system under test.

Select a desired output level on the OUTPUT SET controls. For example, set the PERCENT OF RANGE switch to the first current value desired, say "0". (This will produce 4 mA on the 4-20 range or 10 mA on the 10-50 range.)

Move the output FUNCTION switch to mA. The programmed current now flows if the loop has a low enough resistance. The display shows the exact value of this current in mA.

To obtain any of the five fixed-step current values, set the FINE TRIM control to its index mark, and select a fixed-step value on the PERCENT OF RANGE switch. The preset values of current and the range of the FINE TRIM control are given in the table below.

OPERATION (cont'd)

SETTING OF "PERCENT OF RANGE" SWITCH	"FIXED STEP" OUTPUT CURRENT VALUES, mA			
	IN 4-20 RANGE		IN 10-50 RANGE	
	WITH FINE TRIM AT CENTER	RANGE OF FINE TRIM	WITH FINE TRIM AT CENTER	RANGE OF FINE TRIM
0	4.0 ± 0.02	±0.1	10.0 ± 0.1	±0.25
25	8.0 ± 0.02	±0.1	20.0 ± 0.1	±0.25
50	12.0 ± 0.02	±0.1	30.0 ± 0.1	±0.25
75	16.0 ± 0.02	±0.1	40.0 ± 0.1	±0.25
100	20.0 ± 0.02	±0.1	50.0 ± 0.1	±0.25

The fixed-step values give a very quick and quite accurate calibrated output at five cardinal points. For full accuracy at these points, adjust the FINE TRIM control, reading the display.

To set the output to values between the fixed-step values, move the PERCENT OF RANGE switch to the VARIABLE setting. This activates the VARIABLE control which covers the range from -25% to +110% in three turns. Use the FINE TRIM control for close adjustment.

OPERATION (cont'd)

5.3 Volts Output

Proceed as for milliamperes output, except as follows:

Select the desired range (1-5 or 2-10) on the VOLTS RANGE switch; (the mA SOURCE AND RANGE switch has no effect.)

When ready to energize, set the output FUNCTION switch to VOLTS. The Loop module now delivers the programmed output voltage if the load circuit has a high enough resistance. The display shows the exact value of this voltage in volts.

Operate the OUTPUT SET controls just as for milliamps. The preset fixed-step voltage values are as follows:

SETTING OF "PERCENT OF RANGE" SWITCH	"FIXED STEP" OUTPUT VOLTAGE VALUES, VOLTS			
	1-5 VOLTS RANGE		2-10 VOLTS RANGE	
	FINE TRIM AT CENTER	RANGE OF FINE TRIM	FINE TRIM AT CENTER	RANGE OF FINE TRIM
0	1.0 ± 0.01	±0.025	2.0 ± 0.02	±0.05
25	2.0 ± 0.01	±0.025	4.0 ± 0.02	±0.05
50	3.0 ± 0.01	±0.025	6.0 ± 0.02	±0.05
75	4.0 ± 0.01	±0.025	8.0 ± 0.02	±0.05
100	5.0 ± 0.01	±0.025	10.0 ± 0.02	±0.05

OPERATION (cont'd)

6. USING THE LOOP MODULE AS A LOOP POWER SUPPLY

The loop module can perform very well as a current-limited constant-voltage power supply. It can deliver about 18 volts at 50 mA or 24 volts at 20 mA. It will limit the current at whatever output value you set on the controls (55 mA in the procedure outlined below.) To power a loop with the module:

1. Set up as for mA output.
2. Set the PERCENT OF RANGE switch to VARIABLE and turn the VARIABLE control full clockwise.
3. A transmitter in the loop will now control the current as long as it asks for less than 55 mA and more than 0.1 mA. The display will measure the current in the loop. If the display is not needed, set the main panel switch to OFF; this will conserve the battery.

REMEMBER - TURN BOTH SWITCHES OFF WHEN LOOP PANEL IS NOT IN USE.

7. USING BOTH MEASURE AND OUTPUT CHANNELS AT ONCE

7.1 General

The following paragraphs describe some specific illustrations of simultaneous input/output operations. We suggest you practice on a resistor as in Figure 3 and become familiar with this useful feature of the Versa-Cal/Loop.

OPERATION (cont'd)

Other applications in calibration and troubleshooting will occur to you as you become familiar with the instrument. For easy reference, the following table lists all the possible combinations of input and output available from the complete instrument. You can set up and operate any output from column A with any input from column B.

COLUMN A OUTPUTS FROM LOOP PANEL	COLUMN B, INPUTS	
	TO LOOP PANEL	TO MAIN PANEL
mA	±0-100 mA	±0-100 mV
VOLTS	±0-60 V.	Any of 7 TC's

7.2 Measuring Resistance in a Loop (or Any Resistance)

Three hookups are shown in Figures 3-5 to illustrate the possibilities. To use any of them, simply connect as shown and proceed as follows:

- a. Set current, reading on B in mA.
- b. Read voltage in volts or millivolts on A.
- c. Calculate resistance:

$$\text{Volts/mA} = K \text{ ohms}$$

$$\text{mV/mA} = \text{ohms}$$

Notice that setting the current to 1.000 mA eliminates the calculation (step c); the resistance is the same as the voltage.

OPERATION (cont'd)

Low resistances can be read to an accuracy of 0.1 milliohm. High values can be read to 0.2% accuracy at 10,000 ohms and 1% at 50,000 ohms, with useful indication up to a megohm or so.

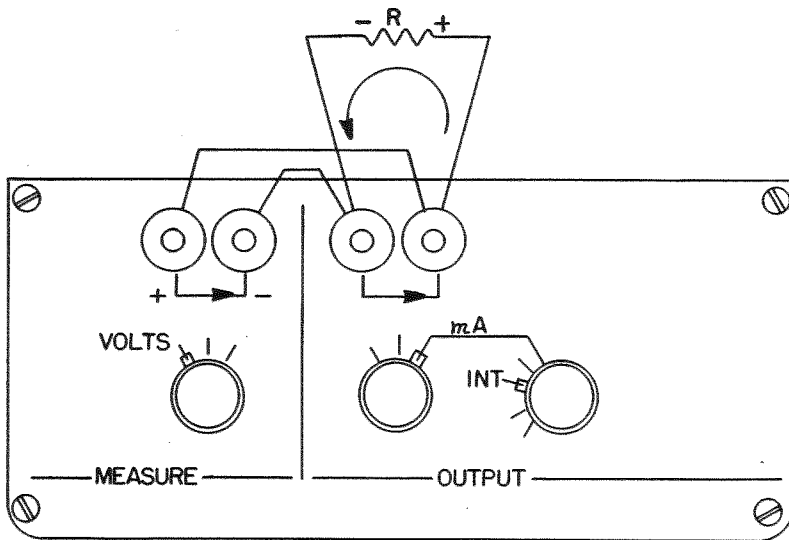


Figure 3: Hookup for Measuring Total Loop Resistance.

OPERATION (cont'd)

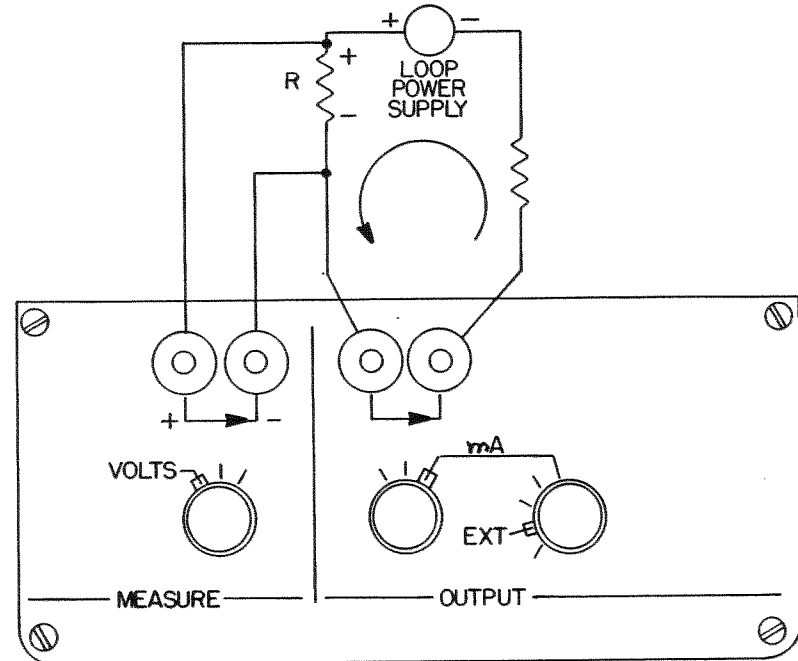


Figure 4: Measuring resistance of one part of a loop. Shown using EXT. voltage source. (30-Volt INT. source may also be used.)

OPERATION (cont'd)

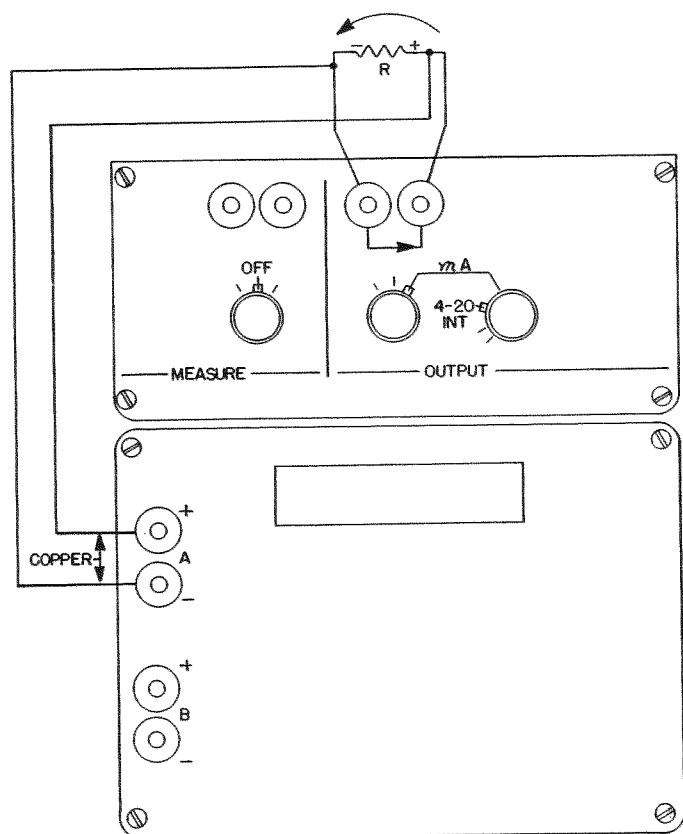


Figure 5: Measuring resistance thermometer or other low resistance with better precision. Set current to 1.000 mA for up to 100 ohms; 0.500 mA for up to 200 ohms. Potential leads made entirely of copper will avoid thermal emf errors. A low current will avoid self-heating when testing resistance thermometers.

OPERATION (cont'd)

7.3 Calibrating a Current-to-Current Transducer

This procedure applies to all devices which operate with current in and current out. One example is a controller, as shown in Figure 6. For analog relays, such as I/ I, the same setup is used. A suggested procedure is as follows:

1. Connect as shown.
2. Set output for EXT or INT source, as applicable.
3. Set output currents to cardinal points, reading display on B. Read transducer output on A. Alternately, adjust for desired input (transducer output) and read resulting output.

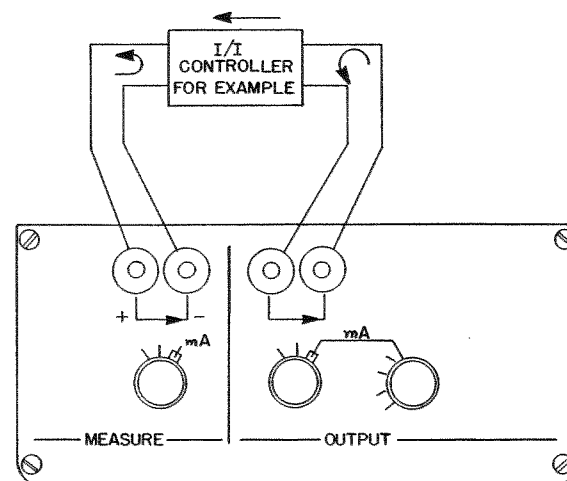


Figure 6: Calibrating an I/I Device.

Section E
OPERATION NOTES

Answers to some typical questions:

- Q1. OOPS -I'm in a powered loop but by mistake I switched to INT SOURCE.
- A. No harm is done as long as the total loop voltage is not excessive. The 30 volts of the Versa-Cal/Loop source adds to the voltage of the loop supply. As long as the total is less than the 60-volt rating, the Versa-Cal/Loop operates normally. (If the polarity is also wrong, the two supplies will buck, with a good chance that the system will not work.)
- Q2. OOPS - I'm in a powered loop but by mistake I switched to VOLTS output instead of mA.
- A. Usually no problem. If connection is in the wrong polarity (for loop) the instrument will simply read the loop supply voltage. If in the right polarity, a thermal limiter (RT2) may activate if loop supply current rises above around 200 mA. It will take a few minutes to reset. In fact, this feature can be used to quickly test the loop as follows:

Connection polarity incorrect (for mA):
Display reads loop voltage.

Connection polarity correct:
Display reads (-), about 1 volt.

Loop Open:
Display accurately follows the output voltage settings.

OPERATION NOTES (cont'd)

No loop voltage, and resistance greater than 1200 ohms:

Display follows output settings.

No loop voltage, and resistance less than 800 ohms:

Display won't reach 5V at 100% setting.
For a complete short, the display will read zero volts regardless of setting.

Section F WARRANTY & REPAIR

All products supplied by Biddle Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps, or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

REPAIRS

Biddle Instruments maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend that it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, marked for the attention of the Instrument Service Manager.