



Transmation

INSTRUCTION MANUAL

Model 1045 DIGITAL CALIBRATOR/SIGNAL INDICATOR

“The Personal Calibrator”

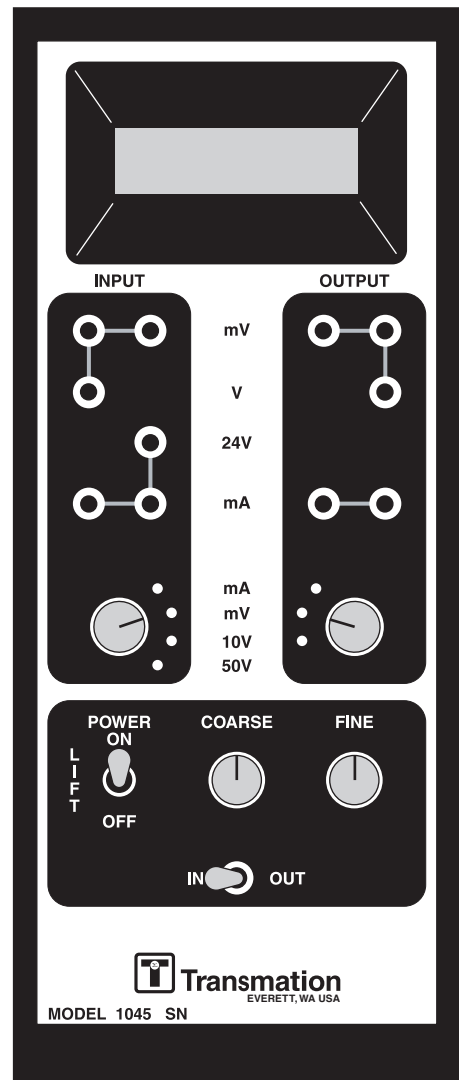


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Safety Information

- Do not operate the Calibrator around explosive gas, vapor, or dust.
- Do not connect to AC line power, open case or charge batteries in a hazardous location.

1. GENERAL INFORMATION

1.1 DESCRIPTION

This manual describes the Transmation Model 1045 Digital Calibrator and Signal Indicator. The Model 1045 is a field-portable, battery-powered precision test instrument designed to simultaneously simulate and measure DC process signals.

The Model 1045 can simulate and/or measure current or voltage signals that fall within the millivolt, volt and milliamp ranges indicated in Specification 1.2.1. Input and output signal values are displayed on a four-digit liquid crystal display located on the Model 1045's front panel. The display mode (input or output) is selected via a toggle switch situated near the bottom of the front panel. In addition to displaying input or output signals, the display automatically indicates the display mode, the signal range in use, polarity and error conditions (low battery or overrange).

Each signal type has a separate set of terminals for input and output connections, permitting simultaneous input and output operation. For instance, the Model 1045 can be used to apply a mV test signal to a transmitter and simultaneously measure the transmitter's mA output signal. Range selection is done independently for the input and output sections via two rotary switches on the front panel.

The Model 1045 is an extremely versatile instrument. In addition to simultaneous process signal simulation/measurement, the Model 1045 can simulate a two-wire transmitter. The Model 1045 can be inserted into a loop with an existing loop power supply (50 VDC maximum). The Model 1045 can also measure the mA output of a two-wire transmitter while simultaneously powering the transmitter from the Model 1045's own 24 VDC supply.

The Model 1045 is powered by nickel-cadmium batteries in a shrink-wrap package. By using a calculator-type charger transformer (supplied with the unit), the Model 1045's batteries can be recharged from a suitable AC line outlet. When the transformer is connected to an AC outlet, a built-in constant-charging circuit provides a constant 50 mA current to recharge the depleted batteries. This constant supply permits the Model 1045 to be operated in any mode while simultaneously recharging the batteries and still maintain peak recharging rates. The AC charger transformer assemblies can be specified for operation with either 90-130 VAC @ 50/60 Hz or 230 VAC at 50/60 Hz. See the Recommended Spare Parts List in Section 1.4 for details.

1.2 SPECIFICATIONS

Unless otherwise indicated, all specifications are referred to an ambient temperature of 25 °C ± 1 °C (77 °F ± 2 °F).

- 1.2.1 INPUT AND OUTPUT RANGE, RESOLUTION AND ACCURACY: See Table 1-1 below
- 1.2.2 INPUT IMPEDANCE
mV: 10 megohms minimum
V: 1 megohm minimum
mA: 10 ohms ± 5%
- 1.2.3 OUTPUT IMPEDANCE:
mV: 0.5 ohms maximum
V: 2 ohms maximum
mA: True current source up to 500 ohm load
- 1.2.4 STABILITY: Short Term (24 hrs.): ±1 LSD
Long Term (30 days): ±2 LSD
- 1.2.5 OUTPUT NOISE: Less than ±1 LSD
- 1.2.6 COMMON MODE REJECTION (INPUT-TO-CASE): 120 dB minimum @ 50/60 Hz
- 1.2.7 MAXIMUM COMMON MODE VOLTAGE: 250 VDC or 250V peak AC
- 1.2.8 NORMAL MODE REJECTION: 60 dB minimum @ 50/60 Hz
- 1.2.9 INPUT PROTECTION: Protected against misconnections and overvoltages to 125 VAC on mV and V
- 1.2.10 OUTPUT PROTECTION: Protected against short circuit
- 1.2.11 INPUT/OUTPUT ISOLATION: 250 VDC or 250V peak AC
- 1.2.12 STORAGE TEMPERATURE: -30 °C to 60 °C (-22 °F to 140 °F)
- 1.2.13 OPERATING TEMPERATURE: 0 °C to 50 °C (32 °F to 122 °F)
- 1.2.14 AMBIENT TEMPERATURE EFFECT: 0.01 % of span/ °C
- 1.2.15 POWER: Rechargeable nickel-cadmium battery pack
- 1.2.16 CHARGE LIFE: 4 hours typical for 20 mA continuous output; 12 hours typical for 4 mA continuous output; 16 hours typical for all other modes
- 1.2.17 BATTERY CHARGE: Built-in constant-current charging circuit powered by external transformer; 14 hours typical to full charge

- 1.2.18 LOW BATTERY INDICATION: "LO BAT" message indicated on display when battery voltage approaches the end of its charge life
- 1.2.19 DISPLAY: 4-digit LCD with status annunciators for signal type, input, output, polarity, low battery and overrange
- 1.2.20 INPUT/OUTPUT CONNECTIONS: Miniature banana jacks
- 1.2.21 HOUSING: Interlocking anodized aluminum extrusions
- 1.2.22 DIMENSIONS (HWD): 217 mm x 86 mm x 42 mm (8.55" x 3.38" x 1.65")
- 1.2.23 WEIGHT: 0.8 kg (1.75 lbs.)

1.3 UNPACKING

It is recommended that all packing materials be retained in the event that the instrument must be returned to the factory. The Model 1045 is shipped in its vinyl carrying case with a nickel-cadmium battery pack installed. Verify that the shipping carton contains:

- A Model 1045 Digital Calibrator and Signal Indicator
- An AC charger transformer
- 2 sets of test leads
- Thermocouple Conversion Tables

1.4 RECOMMENDED SPARE PARTS LIST

ITEM

Liquid Crystal Display
Power Switch
Display Mode Switch
Output Function (Range) Switch
Input Function (Range) Switch
Range Switch Knob
Output Adjust Control Pot
Output Adjust Control Knob
Nickel-Cadmium Battery Pack
7.5 Ohm Resistor (Fuse)
90-130 VAC Charger Transformer
230 VAC Charger Transformer
AC Power Jack
Test Leads (pair)
Thermocouple Conversion Tables
Vinyl Carrying Case
Model 1045 Instruction Manual

Table 1-1. Input/Output Range, Resolution and Accuracy

	TYPE	RANGE	RESOLUTION	ACCURACY
I N P U T	mV IN	-99.99 to +99.99 mV	0.01 mV	± (0.01 % FS + 0.01 % ROG ± 1 LSD)
	50V IN	-50.00 to +50.00 V	0.01 V	± (0.02 % FS + 0.01 % RDG ± 1 LSD)
	10V IN	-9.999 to +9.999 V	0.001 V	± (0.01 % FS + 0.01% ROG ± 1 LSD)
	mA IN	-99.99 to +99.99 mA	0.01 mA	± (0.02 % FS + 0.01 % ROG ± 1 LSD)
O U T P U T	mA OUT	0 to 99.99 mV	0.01 mV	± (0.01 % FS + 0.01 % RDG ± 1 LSD)
	V OUT	0 to 9.999 V	0.001 V	± (0.01 % FS + 0.01 % RDG ± 1 LSD)
	mA OUT	0 to 22 mA into 500 ohms	0.01 mA	± (0.045 % FS + 0.01 % RDG ± 1 LSD)

KEY: FS = Full scale
LSD = Least significant digit
RDG = Reading

2. OPERATION

2.1 OVERVIEW

This section contains instructions concerning the operation of the Model 1045 Digital Calibrator and Signal Indicator. Section 2.2 briefly describes the use of the front panel controls, terminals and display. Section 2.3 contains step-by-step application instructions. Each set of instructions is accompanied by a connection diagram that shows the correct test circuit configuration.

2.2 CONTROLS, INDICATORS, AND TERMINALS

All control and adjustment switches, indicators and terminals are located on the front panel as illustrated in Figure 2-1 below.

2.2.1 POWER SWITCH

To turn the power on, pull out the two-position locking toggle switch labeled POWER, then move it up to the ON position. To turn the power off, pull out the toggle switch and move it down to the OFF position.

2.2.2 INPUT/OUTPUT TERMINALS

All input and output terminals are of the miniature banana plug variety. Those used for measurement (input) applications are located on the left side of the front panel, while those used for signal simulation (output) applications are located on the right side. The input side is isolated from the output side to permit simultaneous connection of test equipment to the input and output terminals. The positive (+) and negative (-) terminals are color-coded: RED = (+) and BLACK = (-). To conserve space on the front panel, certain signal ranges share a common negative terminal. Connecting lines drawn between the positive and negative terminals are used to indicate a shared negative terminal where applicable.

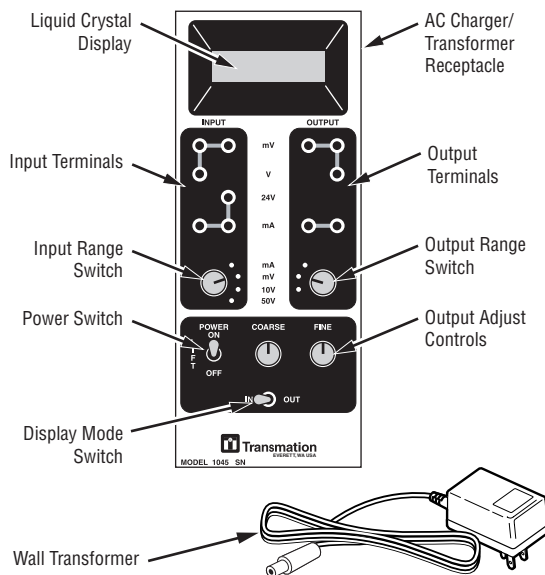


Figure 2-1. Front Panel Controls

The terminal labeled 24V provides an unregulated +24 volts with respect to the (+) mA IN terminal. When a two-wire transmitter is connected to the 24V and (+) mA IN terminals as shown in Figure 2-7 on page 7, the Model 1045 can measure the two-wire transmitter's mA output and simultaneously power the loop.

2.2.3 INPUT/OUTPUT RANGE SWITCHES

Range selection is done independently for the input and output sides of the Model 1045. A four-position and a three-position rotary switch are provided for that purpose. The mA output mode doubles as the two-wire transmitter simulate mode. When mA output is selected, the Model 1045 can be connected to an existing loop power supply (50 VDC maximum) or it can drive the current loop from its internal circuitry.

2.2.4 OUTPUT ADJUST CONTROLS

Output signal amplitude is controlled by the Coarse and Fine Output Adjust Controls on the front panel. The table below indicates the adjustment ranges of the Coarse and Fine knobs for each output range.

OUTPUT RANGE	COARSE	FINE
mV OUT	0 to +99.99 mV	1.25 mV
V OUT	0 to 9.999 VDC	0.15 V
mA OUT	0 to 22 mA	0.4 mA

2.2.5 DISPLAY MODE SWITCH

One 4-digit liquid crystal display services both the input and output sides of the Model 1045. The display mode is switch-selectable via the two-position toggle switch located near the bottom of the Model 1045's front panel. The selected display mode (input or output) is indicated on the display. The display also shows the signal range in use and error conditions as they occur. If the Model 1045's working range is exceeded, the display will automatically blank and the "OVRNG" legend will be displayed. When the battery needs recharging, "LO BAT" will be indicated.

2.3 APPLICATION INSTRUCTIONS

Step-by-step operating instructions and connection diagrams for using the Model 1045 in various test applications are provided in the following sections.

2.3.1 USING THE MODEL 1045 TO MEASURE MILLIVOLTS, VOLTS OR MILLIAMPS

1. Connect the negative lead of the signal source under test to either the black (-) mV/V IN terminal or the black (-) mA IN terminal (as required) on the Model 1045.
2. Connect the positive lead of the signal source under test to the red (+) mV IN, V IN or mA IN terminal (as required) on the Model 1045.
3. Set the Display Mode Switch to IN.
4. Set the Input Range Switch to the range that matches the signal source's output.
5. Lift the Power Switch to ON.
6. Monitor the input signal on the Model 1045.

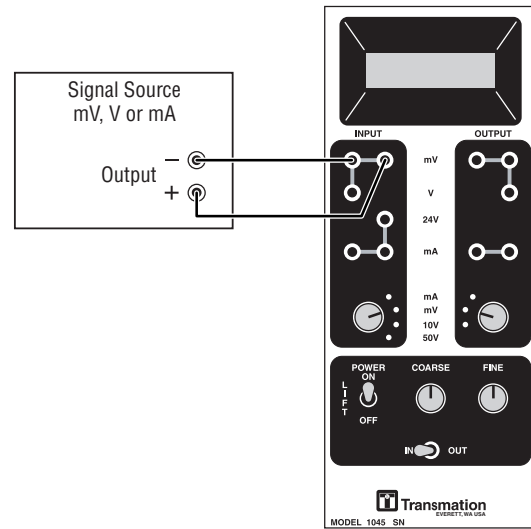


Figure 2-2. Measuring Millivolts, Volts or Millamps (mV connection illustrated)

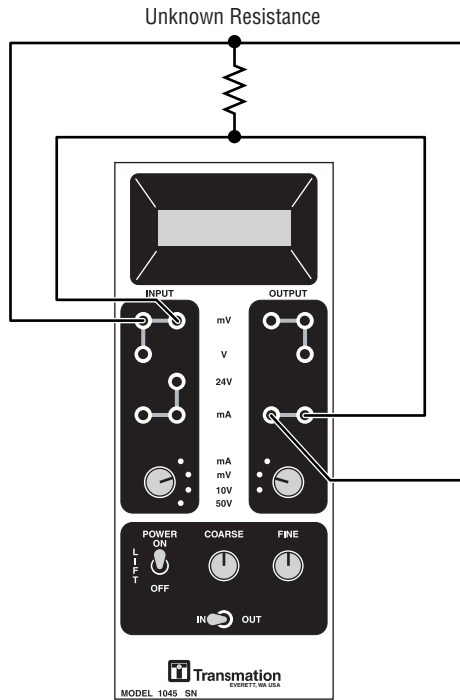


Figure 2-3. Measuring Resistance

2.3.2 USING THE MODEL 1045 TO MEASURE RESISTANCE

By making use of the Model 1045's ability to measure an unknown signal and output a test signal simultaneously, it is possible to measure an unknown resistance. Measuring an unknown resistance with the Model 1045 involves driving a known current through the unknown resistance and measuring the voltage generated across the resistance. The unknown resistance can then be calculated using the formula $R = V/I$.

To minimize the required arithmetic, use one of the following values for the known current signal: 0.01 mA, 0.1 mA, 1 mA or 10 mA.

In some cases, the voltage value read on the Model 1045's display can be translated directly into ohms. For instance, assume that the current output is 1 mA and the mV input range is being used. A reading of 10 mV = 10 ohms and a reading of 25 mV = 25 ohms. In other cases, the voltage value read on the Model 1045's display must be multiplied by the proper factor (see the table below) to obtain the unknown resistance value in ohms. For instance, assume that the current output is 1 mA. A reading of 1V = 1000 ohms and a reading of 0.5V = 500 ohms.

KNOWN CURRENT SIGNAL	MULTIPLICATION FACTOR
0.01 mA	100,000
0.1 mA	10,000
1 mA	1,000
10 mA	100

To measure resistance with the Model 1045, follow the instructions listed below.

1. Connect a test lead from the black (-) mA OUT terminal on the Model 1045 to the resistance.
2. Connect a test lead from the red (+) mA OUT terminal on the Model 1045 to the resistance.
3. Connect a test lead from the black (-) mV/V IN terminal on the Model 1045 to the resistance.
4. Connect a test lead from the red (+) mV IN or V IN terminal (as required) on the Model 1045 to the resistance.
5. Set the Display Mode Switch to OUT.
6. Set the Output Range Switch to mA.
7. Turn the Output Adjust Controls counterclockwise three full turns.
8. Lift the Power Switch to ON.
9. Adjust the Coarse and Fine Output Adjust Controls until the Model 1045 displays the desired signal input to the resistance.
10. To monitor the voltage drop across the resistance, set the Display Mode Switch to IN and the Input Range Switch to V. Alternate the display mode using the Display Mode Switch as required.
11. Perform the necessary calculations to obtain the resistance in ohms.

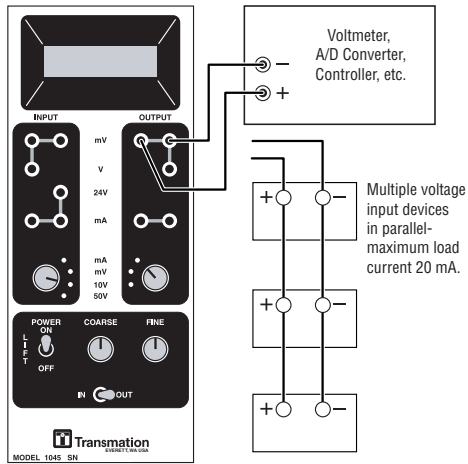


Figure 2-4. Using the Model 1045 as a Millivolt or Voltage Source

2.3.3 USING THE MODEL 1045 AS A MILLIVOLT OR VOLTAGE SOURCE

1. Connect the negative lead from the device under test to the black (-) mV/V OUT terminal on the Model 1045.
2. Connect the positive lead from the device under test to either the red (+) mV OUT or V OUT terminal (as required) on the Model 1045.
3. Set the Display Mode Switch to OUT.
4. Set the Output Range Switch to either mV or V, as required.
5. Turn the Output Adjust Controls counterclockwise three full turns.
6. Lift the Power Switch to ON.
7. Adjust the Coarse and Fine Output Adjust Controls until the Model 1045 displays the desired output voltage.

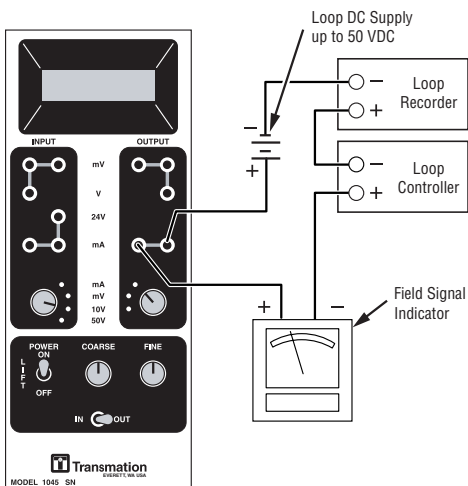


FIGURE 2-5a. Using the Model 1045 as a Two-Wire Transmitter Simulator

2.3.4 USING THE MODEL 1045 AS A CURRENT SOURCE OR TWO-WIRE TRANSMITTER SIMULATOR

1. Connect the negative lead of the current input device under test to the black (-) mA OUT terminal on the Model 1045.
2. Connect the positive lead of the current input device under test to the red (+) mA OUT terminal on the Model 1045.
3. Set the Display Mode Switch to OUT.
4. Set the Output Range Switch to mA.
5. Turn the Output Adjust Controls counterclockwise three full turns.
6. Lift the Power Switch to ON.
7. Adjust the Coarse and Fine Output Adjust Controls until the Model 1045 displays the desired output current.

NOTE:

A typical two-wire transmitter simulator configuration is shown in Figure 2-5a. If an existing DC power supply is not available, use the configuration shown in Figure 2-5b.

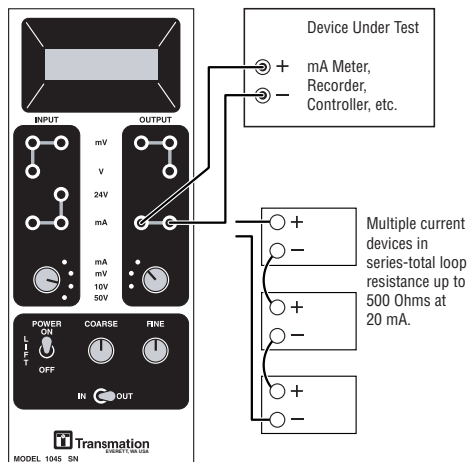


FIGURE 2-5b. Using the Model 1045 as a Current Source

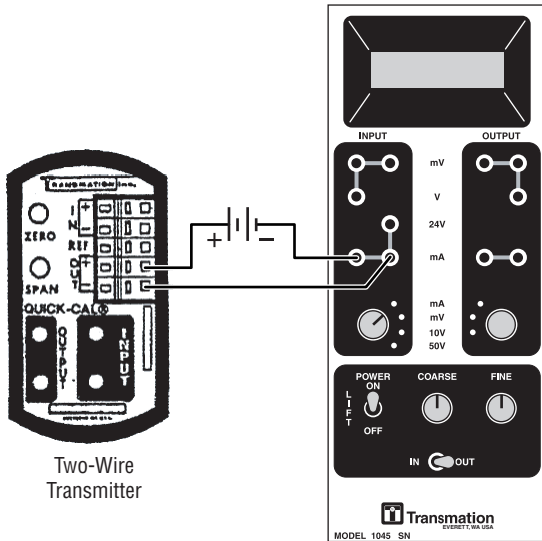


Figure 2-6. Measuring the Output of a Powered Two-Wire Transmitter

2.3.5 USING THE MODEL 1045 TO MEASURE THE OUTPUT OF A POWERED TWO-WIRE TRANSMITTER

1. Connect the negative side of the loop to the black (-) mA IN terminal on the Model 1045.
2. Connect the positive side of the loop to the red (+) mA IN terminal on the Model 1045.
3. Set the Display Mode Switch to IN.
4. Set the Input Range Switch to mA.
5. Lift the Power Switch to ON.
6. Monitor the output signal of the transmitter on the Model 1045.

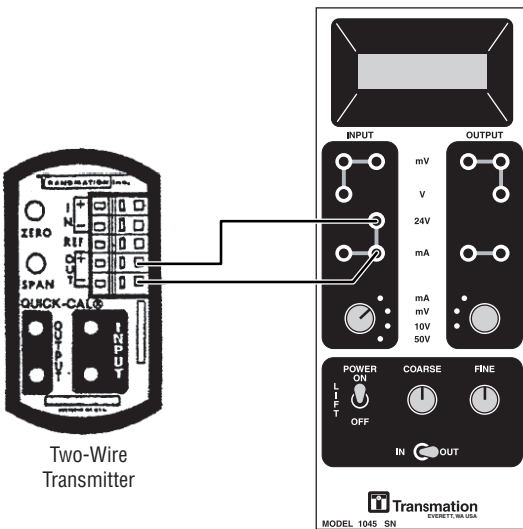


Figure 2-7. Powering a Two-Wire Transmitter While Measuring its Output

2.3.6 USING THE MODEL 1045 TO POWER A TWO-WIRE TRANSMITTER WHILE MEASURING ITS OUTPUT

1. Connect the negative output lead of the two-wire transmitter to the red mA IN terminal on the Model 1045.
2. Connect the positive output lead of the two-wire transmitter to the red (+) 24V terminal on the Model 1045.
3. Set the Display Mode Switch to IN.
4. Set the Input Range Switch to mA.
5. Lift the Power Switch to ON.
6. Monitor the output signal of the transmitter on the Model 1045.

NOTE:

The 24V is a nominal value. Exact voltage is a function of the battery charge level.

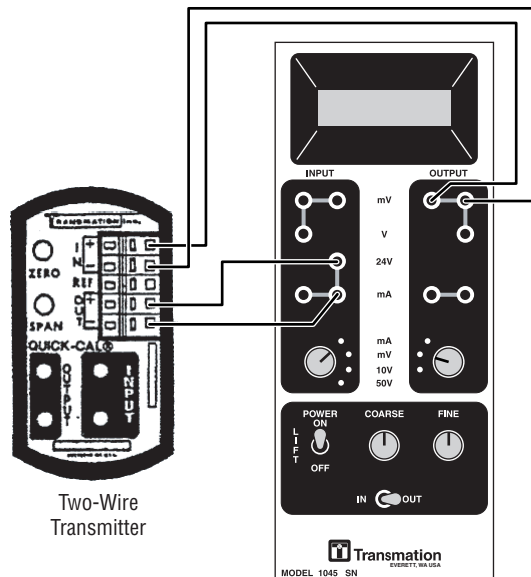


Figure 2-8. Calibrating a Two-Wire Transmitter – Simultaneous Input and Output (mA connection illustrated)

2.3.7 USING THE MODEL 1045 TO CALIBRATE A TWO-WIRE TRANSMITTER – SIMULTANEOUS INPUT AND OUTPUT

1. Connect the negative input lead of the two-wire transmitter to either the black (-) mV/V UUT or mA OUT terminal (as required) on the Model 1045.
2. Connect the positive input lead of the two-wire transmitter to either the red (+) mV OUT, V OUT or mA OUT terminal (as required) on the Model 1045.
3. Connect the negative output lead of the two-wire transmitter to the red (acting negative) mA IN terminal on the Model
4. Connect the positive output lead of the two-wire transmitter to the red (+) 24 V terminal on the Model 1045.
5. Set the Display Mode Switch to OUT.
6. Set the Input Range Switch to mA.
7. Set the Output Range Switch to either mV, V or mA, as required.
8. Turn the Output Adjust Controls counterclockwise three full turns.
9. Lift the Power Switch to ON.
10. Adjust the Coarse and Fine Output Adjust Controls until the Model 1045 displays the desired signal input to the transmitter.
11. To monitor the output of the transmitter, set the Display Mode Switch to IN. Alternate the display mode using the Display Mode Switch as required.
12. Follow the transmitter manufacturer's recommended calibration procedure.

2.3.8 USING THE MODEL 1045 TO CALIBRATE A FOUR-WIRE TRANSMITTER – SIMULTANEOUS INPUT AND OUTPUT

Use the procedure outlined above with the following exceptions:

- In Step 3, connect the transmitter's negative output lead to the black (-) mV/V IN or mA IN terminal, as required.
- In Step 4, connect the transmitter's positive output lead to the red (+) mV IN, V IN or mA IN terminal, as required.

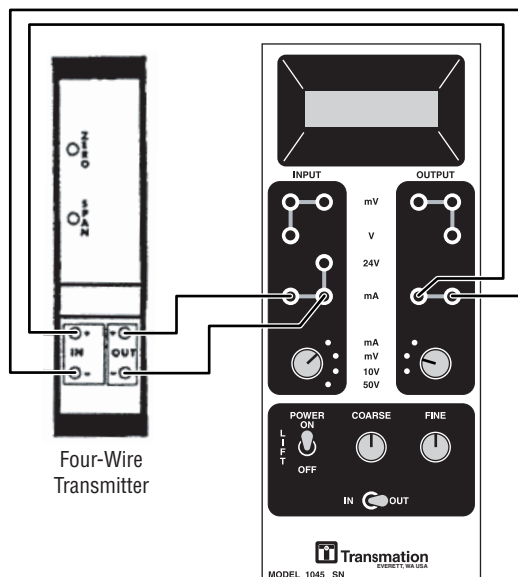


Figure 2-9. Calibrating a Four-Wire Transmitter – Simultaneous Input and Output (mA connection illustrated)

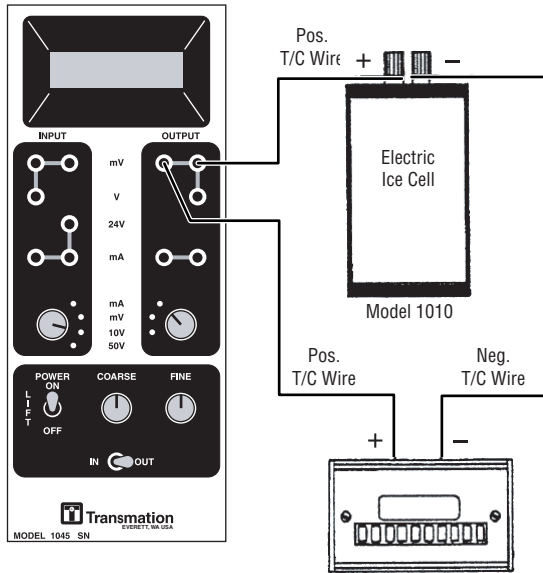


Figure 2-10a. Using the Model 1045 as a Temperature Compensated mV Source to Calibrate a T/C Indicator

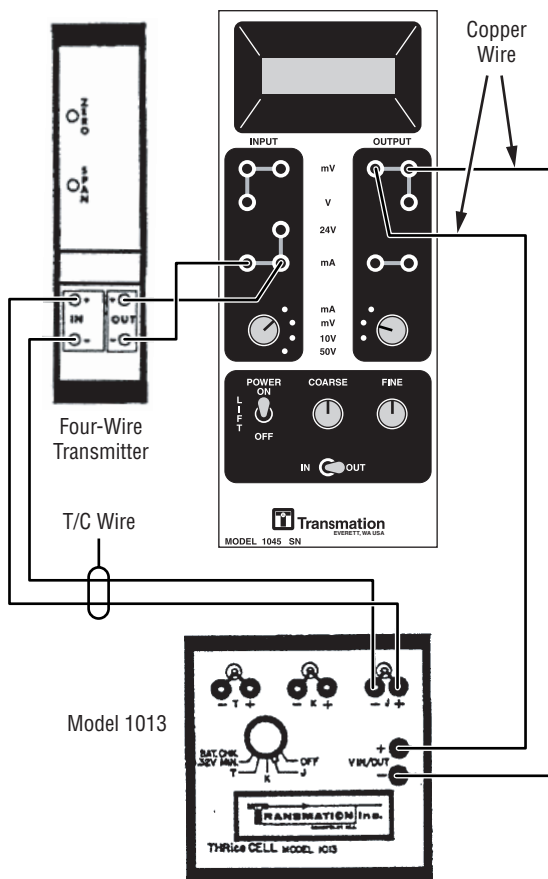


Figure 2-10b. Using the Model 1045 to Calibrate a T/C Transmitter

2.3.9 USING THE MODEL 1045 AS A THERMOCOUPLE SOURCE OR THERMOCOUPLE INDICATOR

The Model 1045 can be used to calibrate thermocouple (T/C) devices or measure T/C signals. When thermocouple-to-copper connections are made at any temperature other than 0 °C (32 °F), error is introduced into the measurement and/or signal. Therefore, it is recommended that an ice point reference cell, such as the Transmation Model 1010 or 1013, be used to compensate for the ambient temperature at the Model 1045's input and/or output terminals. When an ice point reference cell is not available, the amount of compensation required can then be calculated. The measured and/or simulated signal can then be modified accordingly. This section describes how to use an ice cell with the Model 1045, and alternately, how to calculate the required compensation.

2.3.9.1 USING THE MODEL 1045 AS A THERMOCOUPLE SOURCE WITH AN ICE CELL

1. Use Thermocouple Conversion Tables to determine the mV equivalent of the temperature signal to be simulated.
2. Make the necessary connections between the Model 1045, the ice cell and the T/C device. Figure 2-10a shows the connections between the Model 1045, a Transmation Model 1010 Ice Point Reference Cell and a T/C indicator. Figure 2-10b shows the connections between the Model 1045, a Transmation Model 1013 Ice Point Reference Cell and a T/C transmitter. In Figure 2-10b, the Model 1045 is being used to provide a T/C signal (type J) to the transmitter and measure the transmitter's resulting mA output. The Model 1013 is recommended for applications with type J, K and T thermocouples. The Model 1010 is recommended for all other types of thermocouples. Consult the appropriate instruction manual for detailed information (I.S. #100720-900 for the Model 1010 or I.S. #100726-900 for the Model 1013). Note that the red T/C lead is negative and the color-coded T/C lead is positive.
3. Set the Model 1045's Output Range Switch to mV, and, if monitoring an input as well (as shown in Figure 2-10b), set the Input Range Switch for the appropriate range.
4. Use the Model 1045's Output Adjust Controls to adjust the output to the mV equivalent of the temperature value determined in Step 1.
5. Monitor the mV output on the Model 1045. If calibrating a thermocouple indicator such as the one shown in Figure 2-10a, a display is generally provided for monitoring the temperature. If calibrating a transmitter, the transmitter output (normally mA) can be monitored on the Model 1045.

2.3.9.2 USING THE MODEL 1045 AS A THERMOCOUPLE INDICATOR WITH AN ICE CELL

1. Make the necessary connections between the Model 1045, the ice cell and the thermocouple (see Figures 2-11a and 2-11b below). Note that the red T/C lead is negative and the color-coded T/C lead is positive.
2. Set the Model 1045's Input Range Switch to mV.
3. Monitor the mV input signal on the Model 1045.
4. Use the Thermocouple Conversion Tables to convert the mV value to its temperature equivalent per T/C type.

2.3.9.3 USING THE MODEL 1045 TO SIMULATE A THERMOCOUPLE WITHOUT AN ICE CELL

1. Connect the Model 1045's mV output terminals to the T/C device under test, using the appropriate type of T/C leads (see Figure 2-12a below). Connect the red T/C lead between the negative (-) terminals and the color-coded lead between the positive (+) terminals.
2. Use the Thermocouple Conversion Table to determine the mV equivalent of the temperature signal to be simulated per T/C type being used.
3. Use an instrument thermometer to measure the ambient temperature at the mV output terminals and convert the temperature to its mV equivalent per T/C type.
4. Subtract the mV value obtained in Step 3 from the mV value in Step 2.
5. Set the Output Range Switch to mV.
6. Turn the Output Adjust Controls counterclockwise three full turns.
7. Adjust the Output Adjust Controls until the Model 1045 displays the mV output value obtained in Step 4.

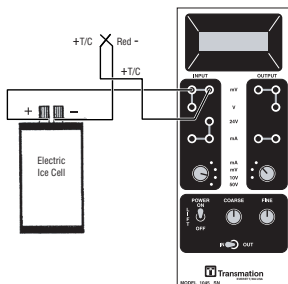


Figure 2-11a

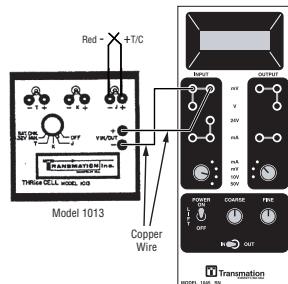


Figure 2-11b

Using the Model 1045 as a Temperature Compensated T/C Indicator

EXAMPLE: Simulate a type J thermocouple signal of 337 °F with an ambient temperature of 70 °F.

STEP 2	STEP 3	STEP 4
T/C SIGNAL IN mV	AMBIENT TEMP. IN mV	COMPENSATED mV SIGNAL
9.083 mV	- 1.076 mV	= 8.01 mV

2.3.9.4 USING THE MODEL 1045 TO MEASURE A THERMOCOUPLE SIGNAL WITHOUT AN ICE CELL

1. Connect the T/C leads to the Model 1045's mV input terminals (see Figure 2-12b below). Connect the red T/C lead to the black (-) terminal and the color-coded T/C lead to the red (+) terminal.
2. Set the Input Range Switch to mV.
3. Monitor the mV input signal on the Model 1045.
4. Use an instrument thermometer to measure the ambient temperature at the Model 1045's mV IN terminals.
5. Use the Thermocouple Conversion Tables to convert the temperature value from Step 4 to its mV equivalent per T/C type.
6. Add the mV value in Step 5 to the mV value in Step 3.
7. Use the Thermocouple Conversion Tables to convert the resulting mV value in Step 6 to its temperature equivalent per T/C type.

EXAMPLE: Measure a type J thermocouple signal with an ambient temperature of 70 °F.

STEP 3	STEP 5	STEP 6	STEP 7
VALUE DISPLAYED	AMBIENT TEMP. IN mV	COMPENSATED VALUE	ACTUAL T/C SIGNAL
8.01 mV	+ 1.076 mV	= 9.086 mV	= 337°F

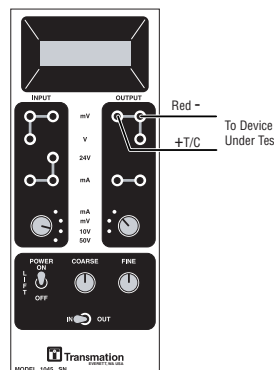


Figure 2-12a

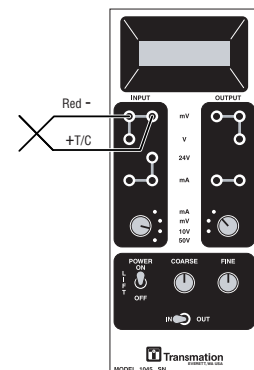


Figure 2-12b

Using the Model 1045 in a Direct T/C Connection

3. THEORY OF Operation

3.1 OVERVIEW

The Model 1045's circuitry is assembled on two PC boards: the display board and the power supply/DVM board. As the name implies, the power supply/DVM board contains the instrument's power supply and DVM sections. The display board contains the input, output and display sections. These boards are connected via three flat jumper strips: JA (14 lines), JB (8 lines) and JC (2 lines). Brief descriptions of the various circuits on the boards are provided below.

3.2 INPUT SECTION

The input section conditions each analog input signal for compatibility with the instrument's DVM. Voltage and mA signals are scaled to 0-100 mV. Millivolt signals require no scaling.

Switch S1-A is controlled by the Input Range Switch on the front panel. It connects one set of input terminals at a time to the DVM section via pins 7 and 8 of JB.

Voltage signals are attenuated by the resistor network of R5, R6, R7, R44 and R45. R6 and R44 are adjusted to provide the precise attenuation factor needed to scale the voltage down to 0-100 mV. Milliamp signals are scaled by resistors R1-R4 such that 1 mA at the mA input terminals represents 1 mV at the DVM.

3.3 OUTPUT SECTION

The output section generates a signal within one of the specified signal ranges depending on the position of S2-A. S2-A is controlled by the Output Range Select Switch on the front panel. It connects the appropriate resistor to the output amplifier's (A1) feedback loop. For instance, when mV OUT is selected, R24 is used; when V OUT is selected, R20 is used; and when mA OUT is selected, R15 is used.

R13 and R11 are both 3 3/4-turn potentiometers. They serve as the Coarse and Fine Output Adjust Controls, respectively. Q2 and R27 limit the current through Q1 to approximately 27 mA.

Switch S2-B is also controlled by the Output Range Switch. It makes the output signal available for display when switch S3 is appropriately positioned. S3 is controlled by the Display Mode Switch on the front panel. Voltage and mA output signals must be properly scaled for compatibility with the DVM in much the same manner as the voltage and mA input signals. R21, R22 and R23 scale the voltage output signals while R16-R19 scale the mA output signals.

3.4 DVM SECTION

Analog signals (0-100 mV) from the input and output sections are converted to BCD digits and are transmitted to the display section by the DVM (A1). The DVM provides four BCD digits that are multiplexed so that only one digit appears on the DVM output lines at one time. The BCD code and various display control signals are transmitted to the display section via jumper strip JA.

Millivolt level signals from the input and output sections are buffered and amplified by a CMOS buffer amplifier (A2). A2 has a gain of 10 and amplifies the millivolt signals to 0-1V. In addition, A2 has a very low susceptibility to zero drift. Therefore, no zero reference circuitry is required. Overvoltage protection is provided by CR6, CR7, CR9 and CR10. A6 is used to detect overrange conditions and transmits the appropriate control signal to the display section. The DVM's A/D converter runs on a 100 KHz clock signal.

3.5 DISPLAY SECTION

The display section includes a 4-digit liquid crystal display, four BCD-to-seven segment decoders, a low battery detection circuit and a display legend driver circuit. The BCD code from the DVM is applied to all four decoders (A5-A8) simultaneously. Only one decoder is enabled at a time as determined by the digit drive lines from the DVM (D1-04).

The display also has provision for displaying certain messages and/or symbols that indicate mode of operation, signal range, polarity and error conditions. Two separate circuits are used to drive those portions of the display. The low battery detection circuit compares the battery voltage (V_D) with a precision reference voltage (V_R). When V_D drops below 4.75V, the "LO BAT" message is displayed. The display legend driver comprises numerous logic gates (A2 and A3) that detect mode of operation (IN or OUT), range (mV, V or mA), polarity and overrange (OVRNG).

3.6 POWER SUPPLY SECTION

Power for the input, output, DVM and display sections is provided by four AA nickel-cadmium cells. Transformer 1 is used to provide isolation between the input, output and power sections. The input and output sections tap the primary coil of T1 to obtain their required operating voltage using separate secondary coils. The digital circuitry in the DVM and display sections obtain their required voltage directly from the batteries.

The battery charging circuit is comprised of op-amp A7, transistor Q3 and their associated components. When the transformer is connected to a suitable AC line outlet, the circuit provides a constant 50 mA current to recharge the depleted batteries. This constant supply permits the Model 1045 to be operated in any mode while simultaneously recharging the batteries without affecting the recharge time.

4. MAINTENANCE

4.1 OVERVIEW

⚠️ WARNING

DO NOT connect to AC line power, open case or charge batteries in a hazardous location.

Field service procedures for the Model 1045 include replacing damaged external components, recharging and/or replacing the batteries and periodically recalibrating the instrument.

It is strongly recommended that units requiring service beyond the scope of the procedures listed above, especially instruments used in hazardous locations, be returned to the factory for service. Refer to the Factory Service and Warranty Statement on the back cover for additional information.

For a nominal fee, experienced electronic technicians who elect to perform post-warranty repairs may obtain a complete schematic set by contacting Transmation. Include model number, serial number and date of purchase of the affected unit when requesting service literature.

4.2 CHECKING THE BATTERY CHARGE LEVEL

In certain situations, it may be advantageous to determine the approximate charge state of the Model 1045's batteries.

1. Connect the test leads to the black (-) and red (+) V IN terminals, observing polarity.
2. Set the Display Mode Switch to IN.
3. Set the Input Range Switch to 50 V.
4. Lift the Power Switch to ON.
5. Insert the nose of the red alligator clip into the red (+) 24V terminal.
6. Monitor the voltage value indicated on the Model 1045's display.

A reading of 29-30 volts typically indicates fully charged batteries, while a reading of 25-26 volts typically indicates that a charge session may be required shortly (see Section 4.3). The "LO BAT" legend normally appears when the voltage approaches the 25 volt range.

4.3 RECHARGING THE BATTERIES

The legend "LO BAT" will be indicated on the Model 1045's display when the batteries need recharging. For optimum battery life, the batteries should be recharged immediately upon the indication of a low battery condition. For this purpose, the Model 1045 is equipped with an AC charger transformer (90-130 VAC @ 50/60 Hz or 230 VAC @ 50/60 Hz compatible). To recharge the batteries:

1. Verify that the AC power source on hand is compatible with the AC charger transformer provided with the Model 1045.
2. Plug the miniature power jack on the charger transformer's cord into the receptacle on the side of the Model 1045.
3. Plug the charger transformer into a suitable AC line outlet.

NOTE:

The recharge rate of the Model 1045 is independent of the unit's ON/OFF state or the mode of operation. The circuitry is designed to permit operation in any mode without affecting the recharge time.

4.4 REPLACING THE BATTERIES

⚠️ CAUTION

Do not remove the battery pack while the charger is in use. Failure to observe this precaution will result in damage to the 1045. When handling the battery pack, exercise caution that the battery terminals are not shorted. When shorted, the battery pack can output approximately 40 amps.

The Model 1045's battery pack is rated for 1000 discharge/recharge cycles. Therefore, the batteries should not have to be replaced more often than once every two or three years, depending on usage. Use only Transmation Battery Pack as a replacement part.

1. Remove the four screws that secure the top and bottom plates of the instrument case (see Figure 4-1 below).
2. Slide the rear panel up to expose the battery compartment.
3. Lift the shrink-wrapped battery pack out of its compartment and unsolder the red (+) and black (-) leads to the battery pack.
4. Replace the old battery pack with a new one (consult Section 1.4 for the Transmation part number). Solder the red and black leads to the new battery pack and place it in the battery compartment.
5. Reassemble the instrument case.

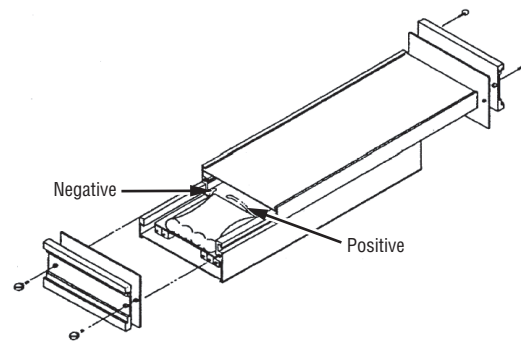


Figure 4-1. Instrument Case Disassembly

4.5 CALIBRATION

The Model 1045 is calibrated at the factory prior to shipment. The stability of the Model 1045's internal components enables it to maintain its rated accuracy for an extended period. Therefore, calibration should be checked annually and the instrument recalibrated as required.

To calibrate the Model 1045, consult Figures 4-2 and 4-3 and follow the instructions outlined below.

4.5.1 EQUIPMENT

- Precision signal source(s): Capable of providing mV, volt and mA signals within the input ranges specified for the Model 1045
- Precision Signal Indicator(s): Capable of measuring mV, volt and mA signals within the ranges specified for the Model 1045

The accuracy of the test equipment must be approximately 10 times better than that specified for each input and output range on the Model 1045 (see Section 1.2).

4.5.2 ADJUSTING THE CALIBRATION POTS

The Model 1045 is equipped with six calibration pots. A single pot (R16) is used to calibrate both the millivolt input and output ranges simultaneously. Thus, calibrating the millivolt input range automatically calibrates the millivolt output range. This adjustment also sets the basic accuracy of the DVM chip and therefore affects all input and output functions. Pot R16 is located beneath the top plate of the instrument case (see Figure 4-2 below). The voltage and milliamp signal ranges each have a separate input and output pot. These pots are located beneath the bottom plate of the instrument case. The locations of all five pots are shown in Figure 4-3 below. To gain access to the pots, it is necessary to disassemble the instrument case (see Section 4.4).

4.5.3 INPUT RANGE CALIBRATION

The millivolt input range should be adjusted before the other ranges (see Section 4.5.2).

1. Connect a precision signal source of the appropriate type to the input terminals of the input range being calibrated on the Model 1045.

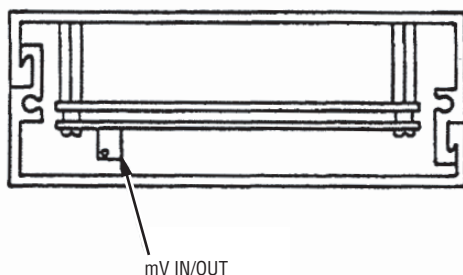


Figure 4-2. mV Calibration Pot

2. Set the Input Range Switch for the corresponding input range.
3. Lift the Power Switch to ON.
4. Adjust the signal source until the Model 1045 displays a signal that is near the top end of the Model 1045's input range (i.e. 99.99 mV, 9.999 V or 99.99 mA).
5. Set the Display Mode Switch to IN.
6. Monitor the test signal on the Model 1045. If the reading is not within the Model 1045's specified accuracy, adjust the appropriate calibration pot until the Model 1045 displays the correct reading.
7. Repeat Steps 1-6 for each of the remaining input ranges.

4.5.4 OUTPUT RANGE CALIBRATION

The millivolt output range should be adjusted before the other ranges (see Section 4.5.2).

1. Connect a precision signal indicator of the appropriate type to the output terminals of the output range being calibrated on the Model 1045.
2. Set the Output Range Switch for the corresponding output range.
3. Set the Display Mode Switch to OUT.
4. Turn the Output Adjust Controls counterclockwise three full turns.
5. Lift the Power Switch to ON.
6. Turn the Output Adjust Controls until the Model 1045 displays a signal that is near the top end of the Model 1045's output range (i.e. 99.99 mV, 9.999 V or 22 mA).
7. Monitor the output signal on both the Model 1045 and the signal indicator. If the reading on the Model 1045 does not match that of the signal indicator, adjust the appropriate calibration pot until the Model 1045 displays the correct reading.
8. Repeat Steps 1-7 for each of the remaining output ranges.

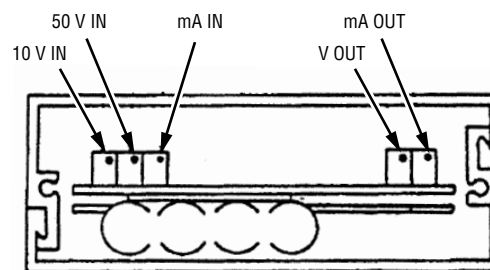


Figure 4-3. V/mV Calibration Pots

Warranty

Transmation products are warranted to be free from defects in material and workmanship (excluding fuses, batteries and leads) for a period of one year from the date of shipment. Warranty repairs can be obtained by returning the equipment prepaid to our factory. Products will be replaced, repaired, or adjusted at our option. *Transmation gives no other warranties, including any implied warranty of fitness for a particular purpose.* Also, Transmation shall not be liable for any special, indirect, incidental or consequential damages or losses arising from the sale or use of its products.

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