# T.O. 33K8-4-310-1

TECHNICAL MANUAL

# CALIBRATION PROCEDURE

# FOR

# DC CALIBRATION STANDARD

# 4000/4000A

(DATRON)



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# DC CALIBRATION STANDARD

## 4000 / 4000A

## (DATRON)

## 1 CALIBRATION DESCRIPTION:

*Table 1.*

| Test Instrument (TI) Characteristics | Performance Specifications | Test Method |
|---|---|---|
| DC Voltage | Range: 0 to 1000 VDC | Compared to a DC Voltage Standard |
| (4000A) | Accuracy:<br>100 µV thru 100 mV Rngs,<br>±(11 ppm + 0.5 µV); all other Rngs,<br>±10 ppm | |
| (4000) | 100 µV thru 100 mV Rngs,<br>±(15 ppm + 1.0 µV); 1 thru<br>100 V Rngs, ±10 ppm; 1000 V<br>Rng, ±15 ppm | |
| Resistance | Range: 1 Ω to 10 MΩ<br><br>Accuracy: TI Displayed Value<br>± ppm, (4-WIRE)<br>1 Ω ±54 ppm;<br>10 Ω ±33 ppm;<br>100 Ω ±19 ppm;<br>1 kΩ ±14 ppm;<br>10 kΩ ±14 ppm;<br>100 kΩ ±16 ppm;<br>1 MΩ ±30 ppm;<br>10 MΩ ±54 ppm<br><br>Accuracy: TI Displayed Value<br>± ppm, (2-WIRE)<br>1 Ω ±5.0%;<br>10 Ω ±0.5%;<br>100 Ω ±508 ppm;<br>1 kΩ ±58 ppm;<br>10 kΩ ±14 ppm;<br>100 kΩ ±16 ppm;<br>1 MΩ ±30 ppm;<br>10 MΩ ±54 ppm<br><br>ZERO RESISTANCE (2-WIRE)<br>0.9 Ω or less on all Ranges | Compared to a Standard Resistance |

*Table 1. (Cont.)*

| Test Instrument (TI) Characteristics | Performance Specifications | Test Method |
|---|---|---|
| DC Current | Range: 0 to 1 ADC<br><br>Accuracy: ±55 ppm all ranges except 1 A which is ±105 ppm | Measure voltage drop across a Standard Resistance |

## 2 EQUIPMENT REQUIREMENTS:

| | Noun | Minimum Use Specifications | Calibration Equipment | Sub-Item |
|---|---|---|---|---|
| 2.1 | DC REFERENCE STANDARD | Range: 10 VDC<br><br>Accuracy: ±5 ppm | Fluke 732A | |
| 2.2 | REFERENCE DIVIDER | Range: 10:1 & 100:1<br><br>Accuracy: Self-Cal Before Use | Fluke 752A | |
| 2.3 | KELVIN VOLTAGE DIVIDER | Range: 0.01 to 1.0 Ratio<br><br>Accuracy: ±0.5 ppm Terminal Linearity | Fluke 720A | |
| 2.4 | NULL DETECTOR | Sensitivity: 1 µV<br><br>Accuracy: ±3% FS | Fluke 845AB | |
| 2.5 | DECADE RESISTOR | Range: 400 Ω<br><br>Accuracy: ±10% | Clarostat 240C | |
| 2.6 | SPST SWITCH | Range: N/A<br><br>Accuracy: N/A | As Available | |
| 2.7 | AC VOLTMETER | Range: 105 to 125 VAC<br><br>Accuracy: ±3% | Weston 433 | |
| 2.8 | VARIAC | Range: 105 to 125 VAC<br><br>Accuracy: N/A | As Available | |

| | Noun | Minimum Use Specifications | Calibration Equipment | Sub-Item |
|---|---|---|---|---|
| 2.9 | RESISTANCE STANDARD | Range: 1 Ω to 100 kΩ<br>Accuracy: Certified value | ESI SR1010-10/1K/10K | |
| 2.10 | RESISTANCE STANDARD | Range: 1 MΩ to 10 MΩ<br>Accuracy: Certified value | ESI SR1050-1M | |
| 2.11 | NANOVOLTMETER | Range: 0 to 200 mV<br>Accuracy: ±0.02% | Keithley 181 | |
| 2.12 | DIGITAL VOLTMETER | Range: 0 to 1 VDC<br>Resolution: 1 μV<br>Accuracy: N/A<br>Range: 0 to 1 Ω<br>Accuracy: ±0.01% | Fluke 8506A | |
| 2.13 | PARALLEL NETWORK | Range: N/A<br>Accuracy: N/A | ESI PC101 | |
| 2.14 | SHORTING BARS | Range: N/A<br>Accuracy: N/A | ESI SB103 | |
| 2.15 | METER CALIBRATOR | Range: 0 to 1 ADC, 0 to 20 VDC<br>Accuracy: N/A | Fluke 5100 | |

## 3 PRELIMINARY OPERATIONS:

3.1 Review and become familiar with entire procedure before beginning calibration process.

**WARNING**

Unless otherwise designated, and prior to beginning the Calibration Process, ensure that all test equipment voltage and/or current outputs are set to zero (0) or turned off, where applicable. Ensure that all equipment switches are set to the proper position before making connections or applying power.

3.2 Calibrate Resistance Standards (SR1010) before use IAW 33K8-4-1-1. Certification Label updating is not required. This step is not required if the Standard has been charted within 30 days and the temperature is within ±1 deg C of the temperature on the current chart.

3.3 Calibrate Resistance Standard (SR1050) before use IAW 33K8-4-467-1. Certification Label updating is not required. This step is not required if the Standard has been charted within 30 days and the temperature is within ±1 deg C of the temperature on the current chart.

**NOTE**

Check the rear panel of the instrument for the lithium battery renewal date. If the renewal date has passed, or will pass prior to the next scheduled calibration, take the necessary steps to procure and replace the battery IAW manufacture's data. Once the replacement has been completed, cover the old renewal label and annotate the Certification Label with the next renewal date.

3.4 Connect the TI and all test equipment to a 115 V/60 Hz power source.

**NOTE**

The Null Detector may be used in Battery mode or Line mode. If the Battery mode is selected, connect the case ground to the test set-up.

3.5 Set the TI POWER switch to STBY and allow a 4 hour warm-up period.

3.6 Set all test equipment POWER switches to ON and allow a 15 minute warm-up. The 181 Nanovoltmeter must have a minimum 24 hour warm-up to attain the stability required for this calibration.

3.7 Perform the Self-Cal on the 752A Reference Divider IAW the Commercial Manual.

3.8 Set all TI MODE switches and the OUTPUT switch to OFF. "cal" should not be present on the TI MODE display.

3.9 Generate an AFTO Form 249 listing the accuracies from Table 1. Annotate the Certification Label SPECIAL block. "See AFTO Form 249 for TI accuracy. Disregard TI SPEC Mode".

3.10 All Figures are simplified hook-ups. Use of shielded, low EMF cables or shielded copper pair cables is essential for accurate calibration. Use single point ground and single GUARD to LOW connection for stable and accurate readings. (LOCAL GUARD connects TI LO and GUARD together. Connect cable shields, 732A and 752A GUARDS to the TI GUARD. Connect the TI GND and GUARD together).

## 4 CALIBRATION PROCESS:

**NOTE**

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding. All TI Ranges should be calibrated prior to making any adjustments to the TI.

### 4.1 DC VOLTAGE ZERO CALIBRATION:

4.1.1 Connect the equipment as shown in Figure 1.

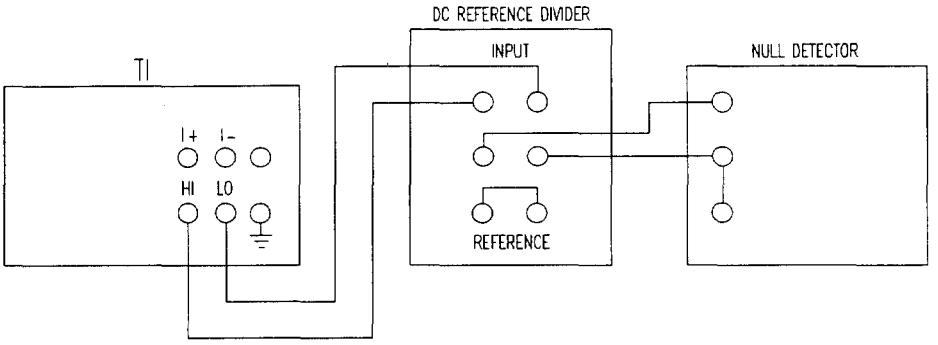


Figure 1.

4.1.2 Press the TI DC (volts) FUNCTION switch.

4.1.3 Press the TI 100 μV RANGE switch then press the TI Zero switch.

4.1.4 Set the Reference Divider FUNCTION switch to 0.1 V.

4.1.5 Set the Null Detector RANGE switch to 10 V and the ZERO/OPR switch to OPR.

4.1.6 Disconnect the leads from the TI HI and LO terminals and then connect a copper shorting strap across the INPUT terminals of the Reference Divider.

4.1.7 While increasing the Null Detector RANGE sensitivity to 3 μV, use the ZERO ADJUST control to achieve the best null indication. Set the RANGE switch to 10 V.

4.1.8 Remove the shorting strap connected in 4.1.6 and reconnect the leads to the TI HI and LO terminals observing polarity.

4.1.9 Set the TI OUTPUT switch to (+) and allow a 15 second settling time.

4.1.10 Increase the Null Detector sensitivity as required. The Null Detector voltage indication must be less than ±0.5 μV for the 4000A and less than ±1.0 μV for the 4000. Set the RANGE switch to 10 Volts.

4.1.11 Set the TI OUTPUT switch to OFF.

4.1.12 Repeat step 4.1.3 thru 4.1.11 using each remaining TI Range. 4000; The Null Detector must indicate less than ±1.0 μV thru the 100 mV RANGE and less than ±2 ppm of RANGE for each remaining check. 4000A; The Null Detector must indicate less than ±0.5 μV thru the 100 mV RANGE and less than ±0.5 ppm of RANGE for each remaining check.

**4.2 DC VOLTAGE CALIBRATION:**

4.2.1 Set the TI POWER switch to OFF and connect the equipment as shown in Figure 2.

**NOTE**

Set the Variac for 115 V output.

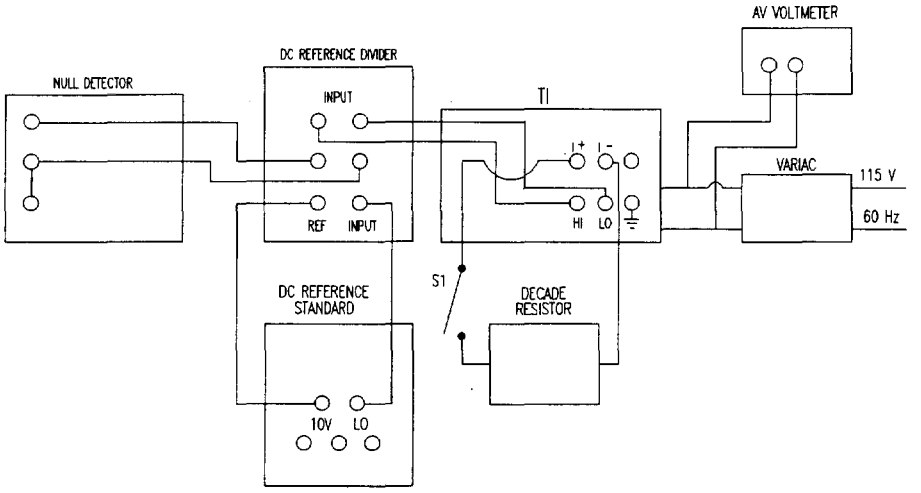


Figure 2.

4.2.2 Set the Reference Divider MODE switch to 10 V.

4.2.3 Set the TI POWER switch to ON and press the TI 10 V RANGE switch. Set the TI OUTPUT 1/1 controls for the 10 V certified value of the DC Voltage Standard.

4.2.4 Set the Null Detector ZERO/OPR switch to ZERO.

4.2.5 While increasing the Null Detector RANGE sensitivity to 3 μV, use the ZERO ADJUST control to achieve the best null indication. Set the RANGE switch to 10 V and ZERO/OPR switch to OPR.

4.2.6 Set the TI OUTPUT switch to (+) and allow a 15 second settling time.

4.2.7 Increase the Null Detector sensitivity as required. The Null Detector voltage indication must be less than ±100 μV. Record the Null Detector indication. Set the RANGE switch to 10 V.

4.2.8 Set the TI OUTPUT switch to OFF.

4.2.9 Reverse the leads on the DC Reference Standard.

4.2.10 Press the TI OUTPUT (-) switch to (-).

4.2.11 Repeat steps 4.2.6 thru 4.2.8.

4.2.12 Reverse the leads on the DC Reference Standard.

4.2.13 Set the Variac for 105 V output and repeat steps 4.2.4 thru 4.2.7.

4.2.14 The TI OUTPUT difference between the 115 V and 105 V Line Voltage input must be less than 10 μV.

4.2.15 Set the Variac for 125 V output and repeat steps 4.2.7 and 4.2.8.

4.2.16 The TI OUTPUT difference between the 115 V and 125 V Line Voltage input must be less than 10 μV. Set the Variac for 115 V output.

4.2.17 Set the Decade Resistor to 400 Ω, close switch S1 in Figure 2, set the TI SENSE REMOTE ON, and connect the TI HI to I+ and LO to I-.

4.2.18 Repeat steps 4.2.4 thru 4.2.8. The TI OUTPUT difference between the LOADED and UNLOADED values in step 4.2.7 must be less than 10 μV.

4.2.19 Open switch S1 in Figure 2, remove the shorts connected in 4.2.17 and set the TI SENSE REMOTE OFF.

4.2.20 Set the Reference Divider MODE switch to 1 V.

4.2.21 Press the TI 1 V RANGE switch. Set the TI OUTPUT 1/1 controls for 0.1 times the certified value of the DC Reference Standard.

4.2.22 Repeat steps 4.2.4 thru 4.2.7. The Null Detector voltage indication must be less than ±10 μV. Set the Null Detector RANGE switch to 10 V.

**NOTE**

While increasing the Null Detector RANGE sensitivity to 3 μV, maintain a null indication with the TI OUTPUT 1/1 controls. Set the Null Detector RANGE switch to 10 V. Record the TI OUTPUT value.

4.2.23 Set the TI OUTPUT switch to OFF.

4.2.24 Press the TI 100 mV RANGE switch. Set the TI OUTPUT 1/1 controls for 0.01 times the DC Voltage Standard 10 V Certified Value.

4.2.25 Set the Reference Divider MODE switch to 0.1 V.

4.2.26 Repeat steps 4.2.4 thru 4.2.7. The Null Detector voltage indication must be less than ±1.5 μV for Model 4000A or ±1.7 μV for Model 4000. Set the RANGE switch to 10 V.

4.2.27 Set the TI OUTPUT switch to OFF.

4.2.28 Set the Reference Divider MODE switch to 10:1.

4.2.29 Press the TI 100 V RANGE switch. Set the TI OUTPUT 1/1 controls for 10 times the certified value of the DC Reference Standard.

4.2.30 Repeat steps 4.2.4 thru 4 2.8.

4.2.31 Set the Reference Divider MODE switch to 100:1.

4.2.32 Press the TI 1000 V RANGE switch. Set the TI OUTPUT 1/1 controls for 100 times the certified value of the DC Reference Standard.

4.2.33 Repeat steps 4.2.4 thru 4.2.8.

4.2.34 The Null Detector voltage indication must be less than ±100 μV for Model 4000A or less than ±150 μV for Model 4000. Set the RANGE switch to 10 V.

4.2.35 Connect the equipment as shown in Figure 3.

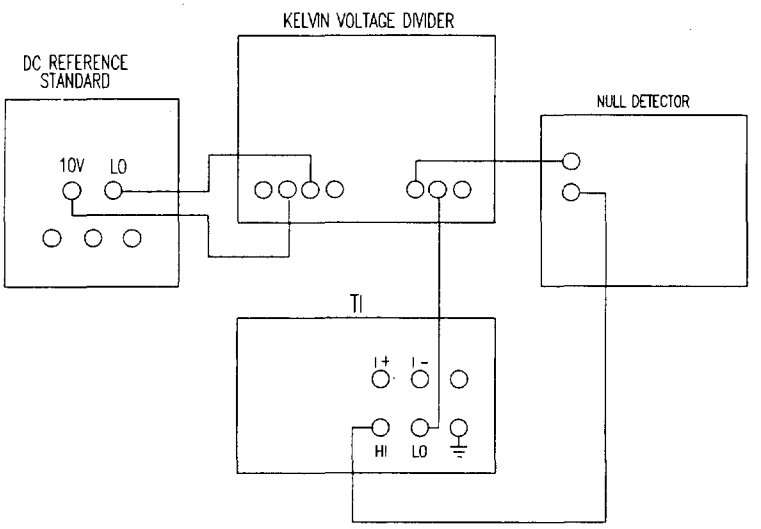


Figure 3.

4.2.36 Press the TI 10 V RANGE switch. Set the TI OUTPUT 1/1 controls for the first TI Calculated value listed in Table 2. (Multiply the listed decimal times the DC Voltage Standard 10 V Certified Value to obtain the TI Calculated value).

4.2.37 Set the Null Detector RANGE switch to 10 V and the ZERO/OPR switch to ZERO.

4.2.38 While increasing the Null Detector RANGE sensitivity to 3 μV, maintain a null indication with the ZERO ADJUST control. Set the RANGE switch to 10 V and ZERO/OPR switch to OPR.

4.2.39 Set the Kelvin Voltage Divider to the first Divider Setting listed in Table 2.

4.2.40 Set the TI OUTPUT switch to (+) and allow a 15 second TI settling time.

4.2.41 Increase the Null Detector sensitivity as required. The Null Detector voltage indication must be less than the corresponding Limits listed in Table 2. Set the RANGE switch to 10 V.

4.2.42 Set the TI OUTPUT switch to OFF.

4.2.43 Repeat steps 4.2.36 thru 4.2.42 for each remaining TI Calculated value in Table 2.

*Table 2.*

| TI Calculated | Divider Setting | Limits |
|---|---|---|
| 0.1111111 X 10 V STD | 0.1111111 | ±11 μV |
| 0.2222222 X 10 V STD | 0.2222222 | ±22 μV |

*Table 2. (Cont.)*

| TI Calculated | Divider Setting | Limits |
|---|---|---|
| 0.3333333 X 10 V STD | 0.3333333 | ±33 µV |
| 0.4444444 X 10 V STD | 0.4444444 | ±44 µV |
| 0.5555555 X 10 V STD | 0.5555555 | ±56 µV |
| 0.6666666 X 10 V STD | 0.6666666 | ±67 µV |
| 0.7777777 X 10 V STD | 0.7777777 | ± 78 µV |
| 0.8888888 X 10 V STD | 0.8888888 | ±89 µV |
| 0.9999999 X 10 V STD | 0.9999999 | ±100 µV |

4.2.44 Set the TI OUTPUT switch to OFF.

4.2.45 Connect the equipment as shown in Figure 4.

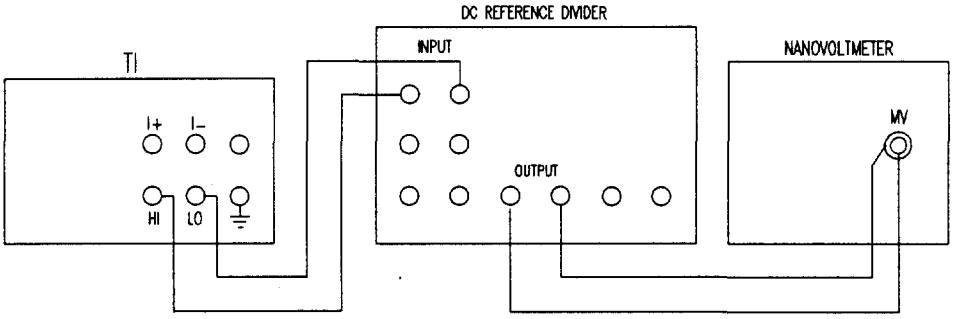


Figure 4.

4.2.46 Set the Reference Divider MODE switch to 100:1.

4.2.47 Press the TI 1 V RANGE switch. Calculate the true 1 V output value for the TI with the following formula. Set the result on the TI OUTPUT display.

$$\text{TI True 1 V output} = \text{Value recorded in 4.2.22} - \frac{\text{732A Certified Value} - 10.000000}{10}$$

4.2.48 Set the Nanovoltmeter RANGE switch to 20 mV, HI RES to ON and ZERO mode OFF.

4.2.49 Set the TI OUTPUT switch to + and allow the Nanovoltmeter to stabilize.

4.2.50 After the Nanovoltmeter has stabilized, press the Nanovoltmeter ZERO mode button. (The Nanovoltmeter will read 0.)

4.2.51 Set the TI OUTPUT switch to OFF and disconnect the test set-up.

4.2.52 Connect the Nanovoltmeter millivolt input leads to the TI HI and LO terminals observing polarity.

4.2.53 Press the TI 10 mV RANGE and FULL RANGE switches, set the TI OUTPUT switch to (+) and allow a 15 second settling time.

4.2.54 The Nanovoltmeter indication must be less than ±0.61 μV for Model 4000A or ±1.15 μV for Model 4000.

4.2.55 Set the Nanovoltmeter ZERO mode switch OFF.

4.2.56 Set the TI OUTPUT switch to OFF.

4.2.57 Press the Tl 1 mV RANGE and Full Range switches.

4.2.58 Set the Nanovoltmeter RANGE switch to 2 mV and connect both leads to the TI LO terminal.

4.2.59 Engage the Nanovoltmeter ZERO mode and then reconnect the Nanovoltmeter + input lead to the TI HI terminal.

4.2.60 Set the TI OUTPUT switch to +. The Nanovoltmeter must indicate between 0.9995 to 1.0005 mV for the 4000A or 0.9990 to 1.0010 mV for the 4000.

4.2.61 Press the TI 100 μV RANGE and Full Range switches.

4.2.62 The Nanovoltmeter must indicate between 0.0995 to 0.1005 mV for the 4000A or 0.0990 to 0.1010 mV for the 4000.

4.2.63 Set the TI OUTPUT switch to OFF.

4.2.64 Disconnect the Nanovoltmeter from the TI.

## 4.3 RESISTANCE CALIBRATION 4 WIRE:

4.3.1 Connect the equipment as shown in Figure 5.

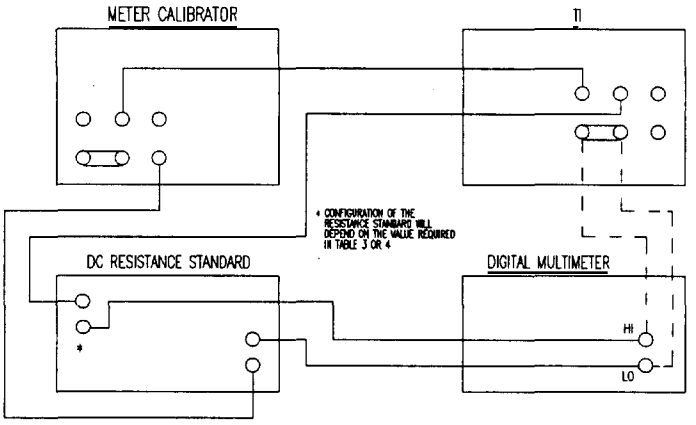


Figure 5.

4.3.2 Set the Digital Voltmeter controls to DCV and AUTO Range.

4.3.3 Press the TI Ω (resistance) FUNCTION switch. REMOTE SENSE light will come ON.

4.3.4 Set the Meter Calibrator controls as follows:

| | |
|---|---|
| INT/EXT | INT |
| OPR/STDBY | STDBY |
| LOCAL/REM | LOCAL |
| CLEAR | depress twice |

4.3.5 Press the first TI RANGE switch listed in Table 3.

4.3.6 Set the TI OUTPUT switch to (+).

4.3.7 Press the Meter Calibrator switches in the following sequence to obtain the first Applied value listed in Table 3: NUMERALS (amperes) - MULTIPLIER (if required) - A - ENTER - OPR.

4.3.8 Using the Meter Calibrator EDIT controls adjust the output until the Digital Voltmeter indicates as near 100 mV/1.00 V/10.00 VDC (as applicable) as possible. Record the Digital Voltmeter indication as Vs.

**NOTE**

Allow sufficient settling time prior to recording the Vs and V1 values.

4.3.9 Move the Digital Voltmeter leads from the Resistance Standard to the TI HI and LO terminals (dashed lines in Figure 5).

4.3.10 Record the Digital Voltmeter indication as V1.

4.3.11 Compute the TI's actual resistance (R) using the following formula:

$$R = \frac{V1 \times Rs}{Vs}$$

Vs = step 4.3.8
Rs = Resistance Standard charted value
V1 = step 4.3.10
R = TI actual resistance

4.3.12 The computed actual resistance of step 4.3.11 must be the TI displayed value ± the corresponding ppm value listed in the Limits (4W) column of Table 3.

4.3.13 Set the TI OUTPUT switch to OFF.

4.3.14 Reconnect the equipment as shown in Figure 5 using the next Resistance Standard listed in Table 3.

4.3.15 Repeat steps 4.3.5 thru 4.3.14 for each remaining TI Range and Standard Resistance listed in Table 3.

*Table 3.*

| TI Range | Applied | Resistance Std | Limits (4W) | Limits (2W) |
|---|---|---|---|---|
| 1 Ω | 100 mADC | 1 Ω | ±54 ppm | ±5.0% |
| 10 Ω | 10 mADC | 10 Ω | ±33 ppm | ±0.5% |
| 100 Ω | 2 VDC | * 100 Ω | ±19 ppm | ±508 ppm |
| 1 kΩ | 2 VDC | * 1 kΩ | ±14 ppm | ±58 ppm |
| 10 kΩ | 2 VDC | * 10 kΩ | ±14 ppm | ±14 ppm |
| 100 kΩ | 20 VDC | * 100 kΩ | ±16 ppm | ±16 ppm |
| 1 MΩ | 20 VDC | * 1 MΩ | ±30 ppm | ±30 ppm |
| 10 MΩ | 20 VDC | * 10 MΩ | ±54 ppm | ±54 ppm |

* Use the Meter Calibrator in the VOLTAGE Mode in step 4.3.7.

4.3.16 Set the TI OUTPUT switch to OFF.

4.3.17 2W Resistance: In Figure 5 move the leads from the TI I+ and I- connections to the TI HI and LO terminals respectively.

4.3.18 Set TI REMOTE SENSE Mode switch to OFF (LED OFF).

4.3.19 Repeat steps 4.3.4 thru 4.3.16 except use the 2W Limits for step 4.3.12.

4.3.20 Depress the Meter Calibrator CLEAR switch twice.

4.3.21 Disconnect the equipment shown in Figure 5.

4.3.22 Connect the Digital Multimeter, using 4-WIRE configuration, to the TI HI and LO terminals.

4.3.23 Set the Digital Multimeter controls to measure 4-wire resistance and 0.1 k range.

4.3.24 Set the TI to LOCAL SENSE (Sense LED OFF) and press the 1 Ω RANGE switch.

4.3.25 Set the TI OUTPUT switch to (+) and press the TI OUTPUT Zero switch.

4.3.26 The Digital Multimeter must indicate 0.9 Ω or less.

4.3.27 Set the TI OUTPUT switch to OFF.

4.3.28 Repeat steps 4.3.24 thru 4.3.27 using each remaining TI RANGE switch.

4.3.29 Set the TI OUTPUT switch to OFF.

## 4.4 CURRENT CALIBRATION:

4.4.1 Connect the equipment as shown in Figure 6.

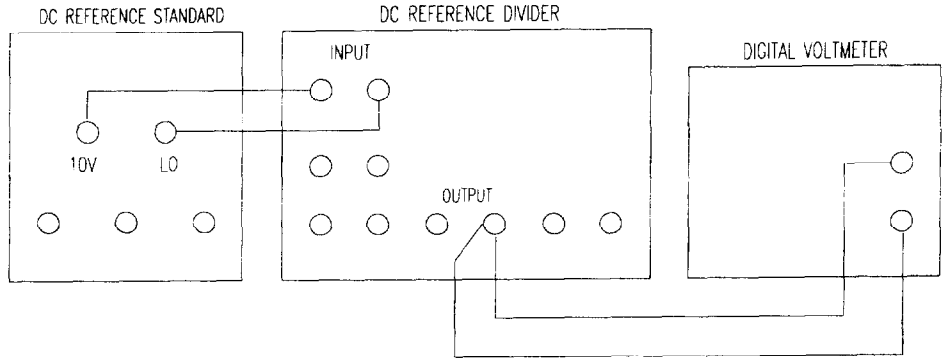


Figure 6.

4.4.2 Set the Digital Voltmeter to VDC and AUTO Range.

4.4.3 Set the Reference Divider MODE switch to 10:1.

4.4.4 Press the Digital Voltmeter ZERO switch.

4.4.5 Disconnect the Digital Voltmeter HI lead from the Reference Divider OUTPUT LO terminal and connect it to the Reference Divider OUTPUT HI terminal.

4.4.6 Record the Digital Voltmeter indication as V. Allow sufficient settling time prior to recording the Digital Voltmeter indication.

**NOTE**

**Repeat steps 4.4.1 thru 4.4.6 as required during the Current Calibration to verify the accuracy of the "V" value recorded in step 4.4.6.**

4.4.7 Disconnect the Digital Voltmeter from the Reference Divider.

4.4.8 Connect the equipment as shown in Figure 7.

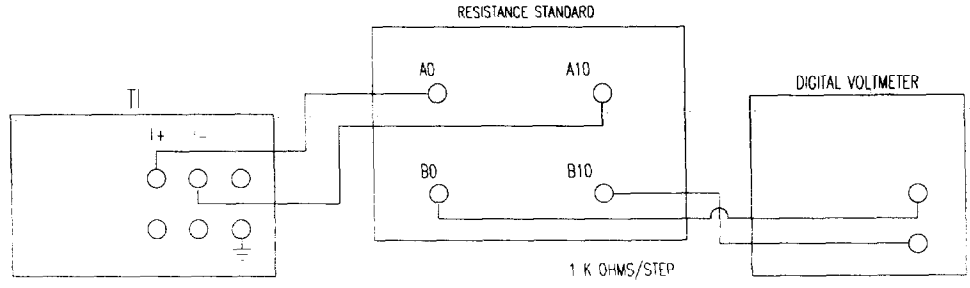


Figure 7.

4.4.9 Press the TI I (current) FUNCTION switch.

4.4.10 Press the TI 100 μ A RANGE switch.

4.4.11 Set the TI OUTPUT switch to (+).

4.4.12 Adjust the TI OUTPUT 1/1 controls until the Digital Voltmeter indicates the recorded value in step 4.4.6 (V).

4.4.13 Calculate the true current using the following formula:

$$\text{True I} = \frac{\text{V}}{\text{(Resistance Standard Charted Value)}} \qquad \text{V} = \text{732A 10 V Cert Value/10.}$$

4.4.14 The TI OUTPUT display indication and True I calculated in step 4.4.13 must agree within ±0.0055 μ A.

4.4.15 Set the TI OUTPUT switch to OFF.

4.4.16 Move leads from Resistance Standard A10/B10 to C1/B1 respectively.

4.4.17 Press the TI 1 mA RANGE switch.

4.4.18 Set the TI OUTPUT switch to (+).

4.4.19 Adjust the TI OUTPUT 1/1 controls until the Digital Voltmeter indicates the recorded value in step 4.4.6 (V).

4.4.20 Calculate the true current using the following formula:

$$\text{True I} = \frac{\text{V}}{\text{(Resistance Standard Charted Value)}} \qquad \text{V} = \text{732A 10 V Cert Value/10.}$$

4.4.21 The TI OUTPUT display indication and the True I calculated in step 4.4.20 must agree within ±0.000055 mA.

4.4.22 Set the TI OUTPUT switch to OFF.

4.4.23 Reverse the Digital Voltmeter leads at the Resistance Standard.

4.4.24 Set the TI OUTPUT switch to (-).

4.4.25 Repeat steps 4.4.19 thru 4.4.23 for a negative output.

4.4.26 Reconnect the equipment as shown in Figure 7 substituting the SR1010-10 Ω box for the SR1010-1 kΩ box.

4.4.27 Press the TI 10 mA RANGE switch.

4.4.28 Set the TI OUTPUT switch to (+).

4.4.29 Adjust the TI OUTPUT 1/1 controls until the Digital Voltmeter indicates the recorded value in step 4.3.6 (V).

4.4.30 Calculate the true current using the following formula:

$$\text{True I} = \frac{\text{V}}{\text{(Resistance Standard Charted Value)}} \qquad \text{V} = \text{732A 10 V Cert Value/10.}$$

4.4.31 The TI OUTPUT display indication and True I calculated in step 4.4.31 must agree within ±0.00055 mA.

4.4.32 Set the TI OUTPUT switch to OFF.

4.4.33 Move leads from Resistance Standard A10/B10 to C1/B1 respectively.

4.4.34 Press the TI 100 mA RANGE switch.

4.4.35 Set the TI OUTPUT switch to (+).

4.4.36 Adjust the TI OUTPUT 1/1 controls until the Digital Voltmeter indicates the recorded value in step 4.4.6 (V).

4.4.37 Calculate the true current using the following formula:

$$\text{True I} = \frac{V}{\text{(Resistance Standard Charted Value)}} \qquad V = \text{732A 10 V Cert Value/10.}$$

4.4.38 The TI OUTPUT display indication and the True I calculated in step 4.4.37 must agree within ±0.0055 mA.

4.4.39 Set the TI OUTPUT switch to OFF.

4.4.40 Connect the equipment as shown in Figure 8.

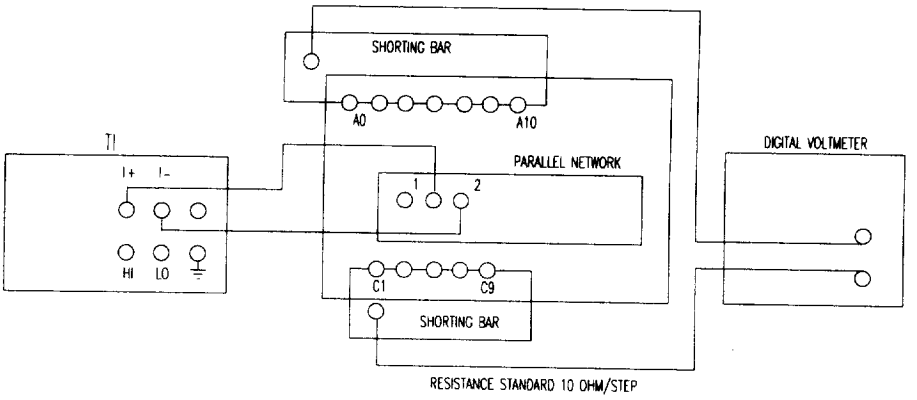


Figure 8.

4.4.41 Press the TI 1 A RANGE switch.

4.4.42 Set the TI OUTPUT switch to (+).

4.4.43 Adjust the TI OUTPUT 1/1 controls until the Digital Voltmeter indicates the recorded value in step 4.4.6 (V).

4.4.44 Calculate the true current using the following formula:

$$\text{True I} = \frac{V}{\text{(Resistance Standard Charted Value)}} \qquad V = \text{732A 10 V Cert Value/10.}$$

4.4.45 The TI OUTPUT display indication and True I calculated in step 4.4.44 must agree within ±0.000105 A.

4.4.46 Set all POWER switches to OFF.

4.4.47 Disconnect and secure all equipment.

## CALIBRATION PERFORMANCE TABLE

DC VOLTAGE ZERO CALIBRATION

| Range | Applied (VDC) | Limits (VDC 4000) | Limits (VDC 4000A) |
|---|---|---|---|
| 100 μV | ZERO | ±1.0 μV | ±0.5 μV |
| 1 mV | ZERO | ±1.0 μV | ±0.5 μV |
| 10 mV | ZERO | ±1.0 μV | ±0.5 μV |
| 100 mV | ZERO | ±1.0 μV | ±0.5 μV |
| 1 V | ZERO | ±2.0 μV | ±0.5 μV |
| 10 V | ZERO | ±20 μV | ±5.0 μV |
| 100 V | ZERO | ±200 μV | ±50 μV |
| 1000 V | ZERO | ±2.0 mV | ±500 μV |

DC VOLTAGE CALIBRATION:

| Range | Applied (VDC) | Limits (VDC 4000A) | Limits (VDC 4000) |
|---|---|---|---|
| 100 μV | 100 μV | 99.5 to 100.5 μV | 99.5 to 100.5 μV |
| 1 mV | 1 mV | 0.9995 to 1.0005 mV | 0.9995 to 1.0005 mV |
| 10 mV | 10 mV | 9.994 to 10.0006 mV | 9.994 to 10.00062 mV |
| 100 mV | 100 mV | 99.9985 to 100.0015 mV | 99.9983 to 100.0017 mV |
| 1V | 1V | 0.99999 to 1.00001 V | 0.99999 to 1.00001 V |
| 10 V | 10 V | 9.9999 to 10.0001 V | 9.9999 to 10.0001 V |
| | -10 V | -9.9999 to -10.0001 V | -9.9999 to -10.0001 V |
| | 1V | 0.99999 to 1.00001 V | 0.9999 to 1.00001 V |
| | 2V | 1.99998 to 2.00002 V | 1.99998 to 2.00002 V |
| | 3V | 2.99997 to 3.00003 V | 2.99997 to 3.00003 V |
| | 4V | 3.99996 to 4.00004 V | 3.99996 to 4.00004 V |
| | 5 V | 4.99995 to 5.00005 V | 4.99995 to 5.00005 V |
| | 6 V | 5.99994 to 6.00006 V | 5.99994 to 6.00006 V |
| | 7 V | 6.99993 to 7.00007 V | 6.99993 to 7.00007 V |

CALIBRATION PERFORMANCE TABLE (Cont.)

DC VOLTAGE CALIBRATION: (Cont.)

| Range | Applied (VDC) | Limits (VDC 4000A) | Limits (VDC 4000) |
|---|---|---|---|
| | 8 V | 7.99992 to 8.00008 V | 7.99992 to 8.00008 V |
| | 9 V | 8.99991 to 9.00009 V | 8.99991 to 9.00009 V |
| 100 V | 100 V | 99.999 to 100.001 V | 99.999 to 100.001 V |
| 1000 V | 1000 V | 999.99 to 1000.01 V | 999.985 to 1000.015 V |

RESISTANCE CALIBRATION 4W and 2W:

| TI Range | Applied | Resistance Std | Limits (4W) | Limits (2W) |
|---|---|---|---|---|
| 1 Ω | 100 mADC | 1 Ω | ±54 ppm | ±5.0% |
| 10 Ω | 10 mADC | 10 Ω | ±33 ppm | ±0.5% |
| 100 Ω | 2 VDC | * 100 Ω | ±19 ppm | ±508 ppm |
| 1 kΩ | 2 VDC | * 1 kΩ | ±14 ppm | ±58 ppm |
| 10 kΩ | 2 VDC | * 10 kΩ | ±14 ppm | ±14 ppm |
| 100 kΩ | 20 VDC | * 100 kΩ | ±16 ppm | ±16 ppm |
| 1 MΩ | 20 VDC | * 1 MΩ | ±30 ppm | ±30 ppm |
| 10 MΩ | 20 VDC | * 10 MΩ | ±54 ppm | ±54 ppm |

2-WIRE ZERO RESISTANCE CALIBRATION:

| Range | Limits |
|---|---|
| all | 0.9 Ω or less |

CURRENT CALIBRATION:

| Range | Applied (ADC) | Limits (ADC) |
|---|---|---|
| 100 µA | 100 µA | 99.9945 to 100.0055 µA |
| 1 mA | 1 mA | 0.999945 to 1.000055 mA |
| | -1 mA | -0.999945 to -1.000055 mA |

CALIBRATION PERFORMANCE TABLE (Cont.)

CURRENT CALIBRATION: (Cont.)

| Range | Applied (ADC) | Limits (ADC) |
|---|---|---|
| 10 mA | 10 mA | 9.99945 to 10.00055 mA |
| 100 mA | 100 mA | 99.9945 to 100.0055 mA |
| 1 A | 1 A | 0.999895 to 1.000105 A |