*TB 9-6625-2246-40

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR MULTIMETER AGILENT, MODEL 3458A

Headquarters, Department of the Army, Washington, DC
27 December 2007

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: https://amcom2028.redstone.army.mil. Instructions for sending an electronic 2028 can be found at the back of this manual.

*This bulletin supersedes TB 9-6625-2246-50, dated 19 May 2003.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Multimeter, Hewlett-Packard Model 3458A. The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. All software adjustments made in **SECTION IV** are reportable. Report software adjustments made using parameter and range failing performance check; i.e., 10 V dc, 100 Ω, etc.

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

<table>
<tr><th>Test instrument parameters</th><th>Performance specifications</th></tr>
<tr><td>Dc Voltage</td><td>Range: 0 to 1000 V (in 5 ranges)
Accuracy: ±(ppm of reading + ppm of range)
<table>
<tr><th>Range</th><th>Accuracy</th></tr>
<tr><td>100 mV</td><td>11 + 10.3</td></tr>
<tr><td>1 V</td><td>10 + 1.1</td></tr>
<tr><td>10 V</td><td>10 + 0.3</td></tr>
<tr><td>100 V</td><td>12 + 0.4</td></tr>
<tr><td>1000 V</td><td>12[1] + 0.2</td></tr>
</table></td></tr>
<tr><td>Resistance</td><td>Range 0 to 1 GΩ (in 9 ranges)
Accuracy: ±(ppm of reading + ppm of range)[2]
<table>
<tr><th>Range</th><th>Accuracy</th></tr>
<tr><td>10 Ω</td><td>18 + 6</td></tr>
<tr><td>100 Ω</td><td>15 + 6</td></tr>
<tr><td>1 kΩ</td><td>13 + 0.6</td></tr>
<tr><td>10 kΩ</td><td>13 + 0.6</td></tr>
</table></td></tr>
</table>

See footnotes at end of table

Table 1. Calibration Description – Continued

Test instrument parameters	Performance specifications
Resistance (continued)	100 kΩ: 13 + 0.6 1 MΩ: 18 + 3 10 MΩ: 53 + 11 100 MΩ: 503 + 18 1 GΩ: 5003 + 82
Dc current	Range: 0 to 1 A (in 8 ranges) Accuracy: ±(ppm of reading + ppm of range)

Range[3]	Accuracy
100 µA	25 + 8.6
1 mA	25 + 5.6
10 mA	25 + 5.6
100 mA	41 + 5.6
1 A	115 + 10.6

Frequency	Range: 1 Hz to 10 MHz Accuracy: 1 to 40 Hz ±0.05% of reading 40 Hz to 10 MHz ±0.01% of reading

Ac voltage[4]

Range: 0 to 700 V rms (in 6 ranges)
Accuracy: ±(% of reading +% of range)

Frequencies	Range			
	10 mV	100 mV to 10 V	100 V	1000 V
10 to 20 Hz	0.4 +0.32	0.4 + 0.02	0.4 + 0.02	0.42 + 0.03
20 to 40 Hz	0.15 +0.25	0.15 + 0.02	0.15+ 0.02	0.17 + 0.03
40 to 100 Hz	0.06 +0.25	0.06 + 0.01	0.06+ 0.01	0.08 + 0.02
100 Hz to 20 kHz	0.02 +0.25	0.02 + 0.01	0.03+ 0.01	0.06 + 0.02
20 to 50 kHz	0.15 +0.25	0.15 + 0.04	0.15+ 0.04	0.15 + 0.04
50 to 100 kHz	0.7 +0.35	0.6 + 0.08	0.5 + 0.08	0.6 + 0.2
100 to 250 kHz	4.0 + 0.7	2.0 + 0.5	2.0 + 0.5	- - -
250 to 500 kHz	- - -	3.0 + 0.6	3.0 + 0.6	- - -
500 kHz to 1 MHz	- - -	5.0 + 2.0	5.0 + 2.0	- - -
1 to 2 MHz	- - -	10.0 + 5.0	- - -	- - -

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications			
Ac current[5]	Range: 0.1 μA to 1 A (in 5 ranges) Accuracy: ±(% of reading + % of range)[6]			
	Frequencies	Range		
		100 μA	1 mA to 100 mA	1A
	10 to 20 Hz	0.4 + 0.02	0.4 + 0.02	0.4 + 0.02
	20 to 45 Hz	0.15 + 0.02	0.15 + 0.02	0.16 + 0.02
	45 to 100 Hz	0.06 + 0.02	0.06 + 0.02	0.08 + 0.02
	0.1 to 1 kHz	0.06 + 0.02	0.03 + 0.02	0.1 + 0.02
	1 to 5 kHz	- - -	0.03 + 0.02	0.1 + 0.02

[1]Add 10 ppm x (Vin/1000)[2] of reading additional error for inputs >100 V.
[2]Four-wire ohms; for two-wire ohms accuracy add 250 mΩ offset.
[3]Manufacturer does not provide official specifications for 100 nA, 1 μA and 10 μA ranges.
[4]Calibrated in analog mode only.
[5]Performance verified in DCI and ACV checks.
[6]Add 0.001025% of reading error.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Standards Set, NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2.

5. Accessories Required. The accessories required for this calibration are common usage accessories issued as indicated in paragraph **4** above and are not listed in this calibration procedure. The following peculiar accessory is also required for this calibration: Sensitivity Box, Galvanometer Key, 7913207.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
CALIBRATOR	Dc voltage Range: 10 to 1000 V Accuracy:[1] Ac voltage: Voltage: 10 mV to 700 V Frequency: 15 Hz to 950 kHz Accuracy: (±%)	Fluke, Model 5720A (5720A) (p/o MIS-35947); w amplifier, Fluke 5725A/AR (5725A/AR)

	Volts	Frequency (kHz)								
		0.015	0.030	0.090	15	45	90	200	450	950
	10 mV	0.18	0.1	0.077	0.07	0.1	0.26	1.17	- - -	- - -
	100 mV	- - -	- - -	- - -	- - -	- - -	0.17	0.62	.9	1.7
	1 V	- - -	- - -	0.017	- - -	0.047	- - -	- - -	- - -	- - -
	10 V	0.1	0.042	- - -	- - -	- - -	- - -	- - -	- - -	- - -
	20 V	- - -	- - -	- - -	- - -	- - -	- - -	1.125	1.5	3.75
	100 V	0.1	0.042	0.017	0.01	0.047	0.14	- - -	- - -	- - -
	700 V	- - -	- - -	0.027	0.022	0.061	- - -	- - -	- - -	- - -

	Wideband ac voltage: Voltage: 100 mV to 3 V Frequency: 100 kHz to 8 MHz Accuracy: ±3.75% Dc current: Range: 100 μA to 1A	
DC REFERENCE STANDARD	Range: 10 V Accuracy: Test report	Fluke, Model 732A (732A)
DC VOLTAGE DIVIDER	Range: 10:1 Accuracy:[1]	ESI, Model RV726 (MIS-10295)
FUNCTION/ARBITRARY GENERATOR	Range: 20 Hz, 10 MHz 1 V rms Accuracy: ±0.0025%	Agilent, Model 33250A (33250A)
MULTIMETER	Range: 1 V dc Accuracy:[2]	Agilent, Model 3458A (3458A)
NULL METER	Resolution: 1 μV	Fluke, Model 845AB (845AB)
RESISTANCE MEASURING SYSTEM	Range: 1, 10, and 100 MΩ Accuracy:[3, 4]	ESI, Model SP 2980 (MIS-10281)
RESISTANCE STANDARD NO. 1	Range: 1 and 10 MΩ Accuracy:[3]	Beckman, Model CR10M (8598965)

See footnotes at end of table.

Table 2. Minimum Specifications of Equipment Required - Continued

Common name	Minimum use specifications	Manufacturer and model (part number)
RESISTANCE STANDARD NO. 2	Range: 100 and 1000 MΩ Accuracy:[4]	Beckman, Model CR1000M (8598966)
STANDARD RESISTOR NO. 1	Value: 10 Ω Accuracy: ±6.0 ppm[2]	L&N, Model 4025B (8616290)
STANDARD RESISTOR NO. 2	Value: 100Ω Accuracy: ±5.25 ppm[2]	L&N, Model 4030B (8616291)
STANDARD RESISTOR NO. 3	Value: 1 kΩ Accuracy: ±3.4 ppm[2]	L&N, Model 4035B (8616292)
STANDARD RESISTOR No. 4	Value: 10 kΩ Accuracy:[2]	L&N, Model 4040B (8616293)
STANDARD RESISTOR NO. 5	Value: 100 kΩ Accuracy: ±3.4 ppm	L&N, Model 4045B (7907139)
STANDARD RESISTOR NO. 6	Value: 0.1Ω Accuracy:[2]	L&N, Model 4221B (8616294)
STANDARD RESISTOR NO. 7	Value: 10 kΩ Accuracy: ±2.5 ppm w/test report	General Radio, Model 1444A (MIS-10400)

'Combined accuracy of calibrator and dc voltage divider is ±2.575 ppm when standardized with dc reference standard.

[2]Combined accuracy of multimeter and standard resistor Nos. 1, 2, 3, 4, and 6 is ±7.65 ppm.

[3]Combined accuracy of resistance standard No. 1 standardized with resistance measuring system is ±5.25 ppm at 1 MΩ and ±16 ppm at 10 MΩ.

[4]Combined accuracy of resistance standard No. 2 standardized with resistance measuring system is ±0.013% at 100 MΩ and ±0.127% total (100 MΩ steps) for 1000 MΩ value.

SECTION III
CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs **6** and **7** are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.

c. Unless otherwise specified, verify the results of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. **SECTION IV** contains the adjustments required to calibrate the TI. Adjustments to be performed are described in **b** portion of each paragraph. Additional maintenance information is contained in the manufacturer's manual for this TI.

d. Unless otherwise specified, all controls and control settings refer to the TI.

7. Equipment Setup

WARNING

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(s) to minimum after each step within the performance check where applicable.

a. Press **Power On/Off** pushbutton to **On** and allow at least 4 hours for equipment to warm-up and stabilize.

b. Release **Terminals Front/Rear** pushbutton to **Front**.

c. Press keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift then **NUMERIC/USER Menu/E**.

(2) **FUNCTION/RANGE Menu Scroll** ⇓ until **MENU FULL** is displayed.

(3) **NUMERIC/USER Enter**.

d. Press keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift then **MENU T/Recall State**.

(2) **FUNCTION/RANGE Menu Scroll** ⇓ until **TEMP?** is displayed.

(3) **NUMERIC/USER Enter**.

e. Record displayed temperature as current internal temperature.

f. Press keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift then **MENU C/Auto Cal**.

(2) **FUNCTION/RANGE Menu Scroll** ⇓ until **CAL?** is displayed.

(3) **NUMERIC/USER 58** then **Enter**.

g. Current internal temperature of TI recorded in **e** above must be within 5 degrees Celsius of its displayed calibration temperature when last adjusted.

h. Repeat technique of **f** and **g** above for **CAL? 59** and **CAL? 60**.

i. Verify all inputs are disconnected and press **FUNCTION/RANGE** blue shift key then **Test/**⇐ key.

NOTE

Once the test is completed, the display shows SELF TEST PASSED or SELF TEST FAILED. If SELF TEST FAILED take corrective action before continuing.

8. Dc Voltage

a. Performance Check

NOTE

The TI is shipped from the factory with its security code set to 3458. This code is used throughout this procedure whenever an autocalibration (ACAL) or software calibration adjustment (CAL and SCAL) is being executed.

(1) Press **FUNCTION/RANGE** blue shift key then **Reset/⇒** key and release **Guard Open/To LO** pushbutton to **Open**.

(2) Execute ACAL DCV command by pressing keys as listed in (a) through (c) below:

(a) **MENU Auto Cal**.

(b) **FUNCTION/RANGE Menu Scroll ⇓** until **ACAL DCV** is displayed.

(c) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL DCV takes approximately 2 minutes to complete.

(3) Press keys as listed in (a) through (g) below:

(a) **FUNCTION/RANGE** blue shift then **MENU N/Offset Comp Ω**.

(b) **NUMERIC/USER 8** then **Enter**.

(c) **MENU NPLC**.

(d) **NUMERIC/USER 100** then **Enter**.

(e) **MENU Trig**.

(f) **FUNCTION/RANGE Menu Scroll ⇓** until **TRIG SGL** is displayed.

(g) **NUMERIC/USER Enter**.

(4) Connect a low thermal short across TI front panel **HI** and **LO** terminals as shown in figure 1.

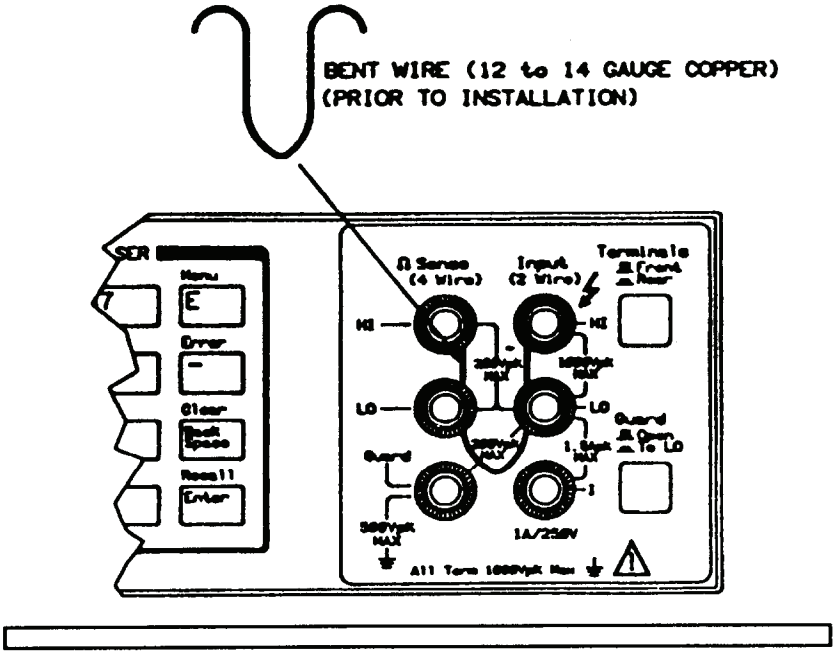

Figure 1. 4-terminal short.

(5) Press **FUNCTION/RANGE Range** ⇑ or ⇓ key to range settings listed in table 3. Allow 5 minutes before taking 100 mV range reading for the range relay and short to thermally stabilize. Press **MENU Trig** key then **NUMERIC/USER Enter** key at each range setting. TI will indicate within limits specified.

Table 3. Dc Offset

Test instrument range settings		Test instrument indications	
		Min	Max
100	mV	-000.00106	+000.00106
1	V	-0.00000106	+0.00000106
10	V	-00.0000023	+00.0000023
100	V	-000.000036	+000.000036
1000	V	-0000.00013	+0000.00013

(6) Disconnect short from TI.

(7) Connect equipment as shown in figure 2. Ensure calibrator **EX SNS** and **EX GRD** are off and sensitivity box L and H switches are open.

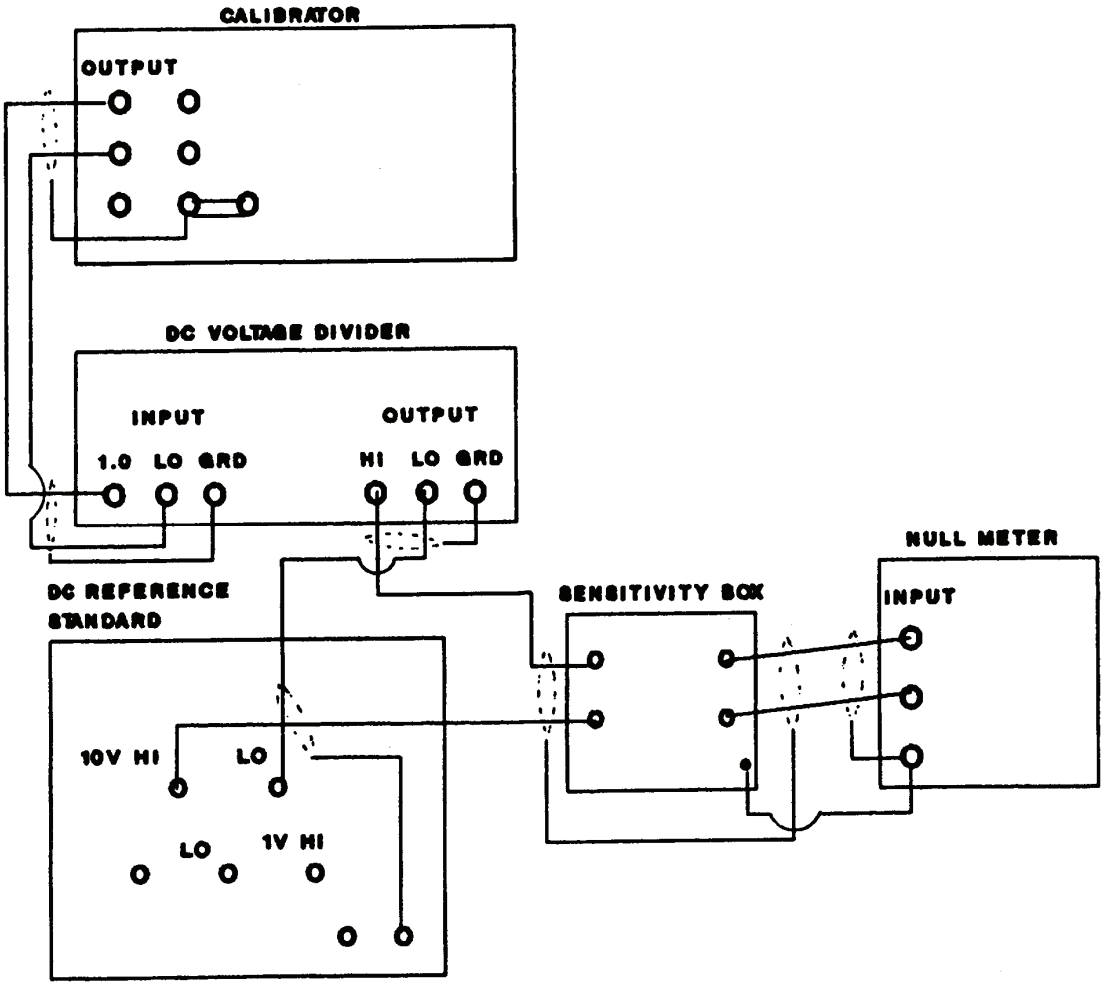

Figure 2. 10-volts dc accuracy - equipment setup.

(8) Set dc voltage divider dials to .999999TEN.

(9) Set calibrator output to dc reference standard 10 V output test report value.

(10) After reading has settled, operate sensitivity box L and H switches and null meter **RANGE** switch while using calibrator output adjustment control to obtain best null on null meter 10 μV range.

(11) Record final calibrator output voltage indication as 10 V reference.

(12) Up-range null meter and set dc voltage divider dials to .1000000.

(13) Set calibrator output to 10 times dc reference standard 10 V output test report value.

(14) After reading has settled, operate sensitivity box L and H switches and null meter **RANGE** switch while using calibrator output adjustment control to obtain best null on null meter 10 μV range.

(15) Record final calibrator output voltage indication as 100 V reference.

(16) Up-range null meter and set dc voltage divider dials to .0100000.

(17) Set calibrator output to 100 times dc reference standard 10 V output test report value.

(18) After reading has settled, operate sensitivity box L and H switches and null meter **RANGE** switch while using calibrator output adjustment control to obtain best null on null meter 10 μV range.

(19) Record final calibrator output voltage indication as 1000 V reference.

(20) Up-range null meter and press calibrator **RESET** key.

(21) Disconnect dc reference standard, sensitivity box, and null meter from equipment setup. Connect TI **Input HI, LO,** and **Guard** to dc voltage divider **OUTPUT** terminals.

(22) Set dc voltage divider dials to .0100000.

(23) Press keys as listed in (a) through (c) below:

(a) **MENU Trig**.

(b) **FUNCTION/RANGE Menu Scroll** ⇓ until **TRIG AUTO** is displayed.

(c) **NUMERIC/USER Enter**.

(24) Set calibrator output to value recorded as 10 V reference in (11) above.

(25) Press **FUNCTION/RANGE Range** ⇓ key to 100 mV range. TI will indicate within ±21.3 ppm of 0.01 times dc reference standard 10 V output test report value.

Example: Dc reference standard 10 V output test report value = 10.000055
0.01 times dc reference standard 10 V output test report value = .10000055
Tolerance: .10000055 X .0000213 = .000002130011715
Tolerance rounded to 8 digits: ±0.00000213
100 mV lower limit = .10000055 -.00000213 = 099.99842 mV
100 mV upper limit = .10000055 +.00000213 = 100.00268 mV

(26) Press **FUNCTION/RANGE Range** ⇑ key to 1 V range.

(27) Set dc voltage divider dials to .1000000. TI will indicate within ±11.1 ppm of 0.1 times dc reference standard 10 V output test report value.

(28) Press **FUNCTION/RANGE Range** ⇑ key to 10 V range. TI will indicate within ±13.0 ppm of 0.1 times dc reference standard 10 V output test report value.

(29) Reverse lead connections at dc voltage divider input terminals. TI will remain within tolerance with a negative indication.

(30) Set dc voltage divider dials to .999999TEN. TI will have a negative indication within ±10.3 ppm of dc reference standard 10 V output test report value.

(31) Set calibrator to **STANDBY**; remove dc voltage divider from equipment setup, connecting calibrator directly to TI.

(32) Set calibrator to **OPERATE**. TI will indicate within ±10.3 ppm of dc reference standard 10 V output test report value.

(33) Press **FUNCTION/RANGE Range** ⇑ key to 100 V range.

(34) Set calibrator output to value recorded as 100 V reference in (15) above. TI will indicate within ±12.4 ppm of 10 times dc reference standard 10 V output test report value.

(35) Press **FUNCTION/RANGE Range** ⇑ key to 1000 V range.

(36) Set calibrator output to value recorded as 1000 V reference in (19) above. TI will indicate within ±22.2 ppm of 100 times dc reference standard, 10 V output test report value.

b. Adjustments. If an out-of-tolerance condition exists, perform paragraphs **13** through **17** below and repeat paragraph **8** above.

9. Resistance

a. Performance Check

(1) Press **FUNCTION/RANGE** blue shift key then **Reset/⇒** key.

(2) Execute ACAL OHMS command by pressing keys as listed in (a) through (c) below:

(a) **MENU Auto Cal**.

(b) **FUNCTION/RANGE Menu Scroll** ⇓ until **ACAL OHMS** is displayed.

(c) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL OHMS takes approximately 10 minutes to complete.

(3) Press keys as listed in (a) through (k) below:

(a) **FUNCTION/RANGE OHM**.

(b) **FUNCTION/RANGE** blue shift then **MENU N/Offset Comp Ω**.

(c) **NUMERIC/USER 8** then **Enter**.

(d) **MENU NPLC**.

(e) **NUMERIC/USER 100** then **Enter**.

(f) **MENU Offset Comp Ω**.

(g) **FUNCTION/RANGE Menu Scroll** ⇑ until **OCOMP ON** is displayed.

(h) **NUMERIC/USER Enter**.

(i) **MENU Trig**.

(j) **FUNCTION/RANGE Menu Scroll** ⇓ until **TRIG SGL** is displayed.

(k) **NUMERIC/USER Enter**.

(4) Connect a low thermal short across TI front panel **Input HI** and **LO**.

(5) Press **FUNCTION/RANGE Range** ⇓ key to 10 Ω range and allow 5 minutes for the range relays to thermally stabilize.

(6) Press **MENU Trig** key then **NUMERIC/USER Enter** key. TI indication will be ≤ 00.25007.

(7) Remove short from front panel **Input HI** and **LO** and reinstall across rear panel **Ω Sense** and **Input HI** and **LO** using technique shown in figure 1.

(8) Press **Terminals Front/Rear** pushbutton to **Rear**.

(9) Press **FUNCTION/RANGE** blue shift key then **OHMF/OHM** key.

(10) Press **FUNCTION/RANGE Range** ⇓ key to 10 Ω range.

(11) Press **MENU Trig** key then **NUMERIC/USER Enter** key. TI indication will be ≤ 00.00007.

(12) Remove short from rear panel **Ω Sense** and **Input HI** and **LO**. Release **Terminals Front/Rear** pushbutton to **Front** and press **Guard Open/To LO** pushbutton to **To LO**.

NOTE

Value of resistance standard No. 1 at 1 and 10 MΩ and each 100 MΩ step of resistance standard No. 2 must be measured with resistance measuring system and recorded.

(13) Press keys as listed in (a) through (c) below:

(a) **MENU Trig**.

(b) **FUNCTION/RANGE Menu Scroll** ⇓ until **TRIG AUTO** is displayed.

(c) **NUMERIC/USER Enter**.

(14) Connect TI **Ω Sense** and **Input HI** and **LO** to appropriate standard resistor or resistance standard, as required, using 4 wire technique then press **FUNCTION/RANGE Range** ⇑ or ⇓ key to TI range settings listed in table 4. TI will indicate within limits specified.

Table 4. Resistance

Standard resistor or resistance standard	Test instrument	
	Range settings	±(ppm of test report or prerecorded value +ppm of range)
No. 1	10 Ω	18 + 6
No. 2	100 Ω	15 + 6
No. 3	1 kΩ	13 + 0.6
No. 7	10 kΩ[1]	13 + 0.6
No. 5	100 kΩ	13 + 0.6
No. 1	1 MΩ	18[2] + 3
No. 1	10 MΩ	53[3] + 11
No. 2	100 MΩ	503[4] + 18
No. 2	1 GΩ	5003[5] + 82

'Repeat technique of (3) (f) through (h) above to select **OCOMP OFF**.

[2]From recorded value of resistance standard No. 1 for 1 MΩ

[3]From recorded value of resistance standard No. 1 for 10 MΩ

[4]From recorded value of resistance standard No. 2 for 100 MΩ

[5]From recorded value of resistance standard No. 2. Each 100 MΩ step must be measured and values added for a nominal 1 GΩ

b. Adjustments. If an out-of-tolerance condition exists and, if not previously completed, perform paragraphs **13** through **17** below and repeat paragraphs **8** and **9** above.

10. Dc Current

a. Performance Check

(1) Press **FUNCTION/RANGE** blue shift key then **Reset/⇒** key and release **Guard Open/To LO** pushbutton to **Open**.

(2) Execute ACAL OHMS command by pressing keys as listed in (a) through (c) below:

(a) **MENU Auto Cal**.

(b) **FUNCTION/RANGE Menu Scroll ⇓** until **ACAL OHMS** is displayed.

(c) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL OHMS takes approximately 10 minutes to complete.

(3) Press keys as listed in (a) through (h) below:

(a) **FUNCTION/RANGE DCI**.

(b) **FUNCTION/RANGE** blue shift then **MENU N/Offset Comp Ω**.

(c) **NUMERIC/USER 8** then **Enter**.

(d) **MENU NPLC**.

(e) **NUMERIC/USER 100** then **Enter**.

(f) **MENU Trig**.

(g) **FUNCTION/RANGE Menu Scroll ⇓** until **TRIG SGL** is displayed.

(h) **NUMERIC/USER Enter**.

(4) Press **FUNCTION/RANGE Range ⇑** or **⇓** key to 100 μA range and wait 5 minutes to allow range relays to thermally stabilize.

(5) Press **MENU Trig** key then **NUMERIC/USER Enter** key. TI will indicate between -000.00095 and +000.00095 μA.

(6) Repeat technique of (4) and (5) above using range settings and indications listed in table 5.

Table 5. Offset Test

Test instrument		
Range settings	Indications	
	Min	Max
1 mA	-0.0000065 mA	+0.0000065 mA
10 mA	-00.000065 mA	+00.000065 mA
100 mA	-000.00065 mA	+000.00065 mA
1 A	-0.0000115 A	+0.0000115 A

(7) Press TI keys as listed in (a) through (c) below:

(a) **MENU Trig**.

(b) **FUNCTION/RANGE Menu Scroll** ⇓ until **TRIG AUTO** is displayed.

(c) **NUMERIC/USER Enter**.

(8) Perform paragraphs **13** through **17** below on multimeter (not TI) to establish manufacturer's 24 hour accuracy.

(9) Connect equipment as shown in figure 3.

(10) Set multimeter to measure dc voltage on 1 V range.

(11) Press TI **FUNCTION/RANGE Range** ⇑ or ⇓ key to 100 μA range.

(12) Set calibrator for a 100 μA dc output, then using output adjustment controls; adjust calibrator output for a 100.00000 (±20 digits) TI indication.

(13) Divide multimeter indication by standard resistor test report value. Calculated value will be between 99.99664 and 100.00336 μA.

(14) Repeat technique of (9) through (13) above using standard resistors and settings listed in table 6. Calculated values will be within limits specified.

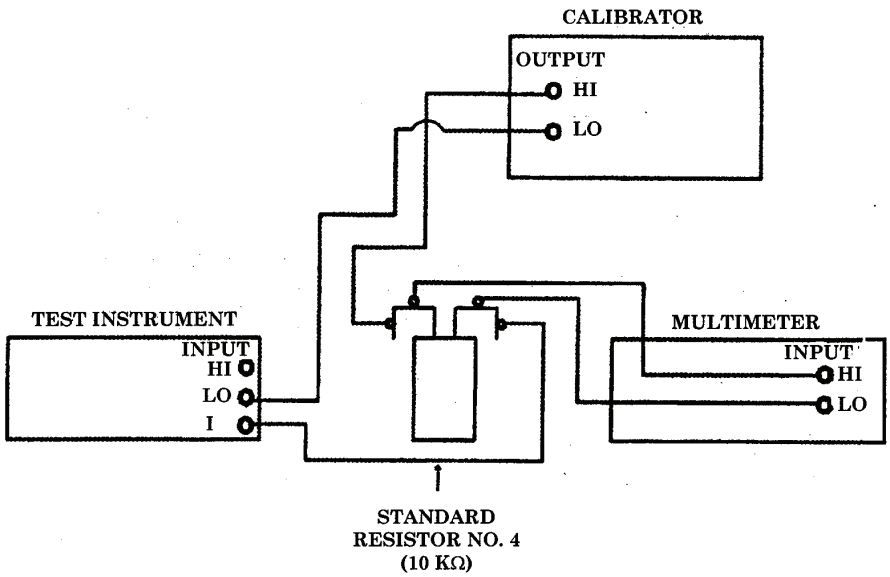

Figure 3. Dc current – equipment setup.

Table 6. Dc Current

Standard resistor	Test instrument range and calibrator output settings	Calculated values	
		Min	Max
No. 3 (1k)	1 mA	0.9999694 mA	1.0000306 mA
No. 2 (100)	10 mA	9.999694 mA	10.000306 mA
No. 1 (10)	100 mA	99.99534 mA	100.00466 mA
No. 6 (.1)	1 A	0.9998744 A	1.0001256 A

b. Adjustments. If not previously completed, perform paragraphs **13** through **17** below and repeat paragraphs **8** through **10** above.

11. Ac Voltage

a. Performance Check

(1) Press **FUNCTION/RANGE** blue shift key then **Reset/⇒** key.

(2) Execute ACAL AC command by pressing keys as listed in (a) through (c) below:

(a) **MENU Auto Cal**.

(b) **FUNCTION/RANGE Menu Scroll** ⇓ until **ACAL AC** is displayed.

(c) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL AC takes approximately 1 minute to complete.

(3) Press keys as listed in (a) through (k) below:

(a) **FUNCTION/RANGE ACV**.

(b) **FUNCTION/RANGE** blue shift then **MENU C/Auto Cal**.

(c) **FUNCTION/RANGE Menu Scroll** ⇑ until **ACBAND** is displayed.

(d) **NUMERIC/USER 10,2E6** then **Enter**.

(e) **FUNCTION/RANGE** blue shift then **MENU R/Trig**.

(f) **FUNCTION/RANGE Menu Scroll** ⇓ until **RES** is displayed.

(g) **NUMERIC/USER .01** then **Enter**.

(h) **FUNCTION/RANGE** blue shift then **MENU L/Auto Zero**.

(i) **FUNCTION/RANGE Menu Scroll** ⇓ until **LFILTER** is displayed.

(j) **NUMERIC/USER ,** then **FUNCTION/RANGE Menu Scroll** ⇓ until **ON** is displayed.

(k) **NUMERIC/USER Enter**.

(4) Connect calibrator **OUTPUT HI**, **LO**, and **V-GUARD** to TI **Input HI**, **LO**, and **Guard**.

(5) Press **FUNCTION/RANGE Range** ⇑ or ⇓ key to range settings and set calibrator output settings as listed in table 7. TI will indicate within limits specified.

Table 7. Ac Voltage

Test instrument range settings	Calibrator output settings		Test instrument indications	
	Voltage	Frequency	Min	Max
10 mV	10 mV	15 Hz	9.928 mV	10.072 mV
10 mV	10 mV	30 Hz	9.960 mV	10.040 mV
10 mV	10 mV	90 Hz	9.969 mV	10.031 mV
10 mV	10 mV	15 kHz	9.973 mV	10.027 mV
10 mV	10 mV	45 kHz	9.960 mV	10.040 mV
10 mV	10 mV	90 kHz	9.895 mV	10.105 mV
10 mV	10 mV	200 kHz	9.530 mV	10.470 mV
100 mV	100 mV	90 kHz	99.32 mV	100.68 mV
100 mV	100 mV	200 kHz	97.50 mV	102.50 mV
100 mV	100 mV	450 kHz	96.40 mV	103.60 mV
100 mV	100 mV	950 kHz	93.00 mV	107.00 mV
1 V	1 V	90 Hz	0.9993 V	1.0007 V
1 V	1 V	45 kHz	0.9981 V	1.0019 V
10 V	10 V	15 Hz	9.9580 V	10.0420 V
10 V	10 V	30 Hz	9.9830 V	10.0170 V
100 V	100 V	15 Hz	99.5800 V	100.4200 V
100 V	100 V	30 Hz	99.8300 V	100.1700 V
100 V	100 V	90 Hz	99.9300 V	100.0700 V
100 V	100 V	15 kHz	99.9600 V	100.0400 V
100 V	100 V	45 kHz	99.8100 V	100.1900 V
100 V	100 V	90 kHz	99.4200 V	100.5800 V
100 V	20 V	200 kHz	19.1000 V	20.9000 V
100 V	20 V	450 kHz	18.8000 V	21.2000 V
100 V	20 V	950 kHz	17.0000 V	23.0000 V
1000 V	700 V	90 Hz	699.240 V	700.760 V
1000 V	700 V	15 kHz	699.380 V	700.620 V
1000 V	700 V	45 kHz	698.550 V	701.450 V

(6) Press calibrator **RESET** key and disconnect from TI.

(7) Connect calibrator **WIDEBAND** to TI **Input HI** and **LO** using cable and termination supplied with calibrator.

(8) Press TI **Guard Open/To LO** pushbutton to **To LO**.

(9) Press **FUNCTION/RANGE Range** ⇓ key to 100 mV range.

(10) Set calibrator for a 100 mV, 2 MHz wideband output. TI will indicate between 85 and 115 mV.

(11) Press **FUNCTION/RANGE Range** ⇑ key to 1 V range.

(12) Set calibrator for a 1 V, 2 MHz wideband output. TI will indicate between 0.85 and 1.15 V.

(13) Press **FUNCTION/RANGE Range** ⇑ key to 10 V range.

(14) Set calibrator for a 3 V, 2 MHz wideband output. TI will indicate between 2.2 and 3.8 V.

b. Adjustments. If an out-of-tolerance condition exists, perform paragraph **18** below and repeat **11** above.

12. Frequency Counter

a. Performance Check

(1) Press keys as listed in (a) through (f) below:

(a) **FUNCTION/RANGE** blue shift key then **Reset/⇒** key.

(b) **FUNCTION/RANGE FREQ**.

(c) **FUNCTION/RANGE** blue shift then **MENU E/NPLC**.

(d) **FUNCTION/RANGE Menu Scroll ⇓** until **FSOURCE** is displayed.

(e) **NUMERIC/USER,** then **FUNCTION/RANGE Menu Scroll ⇓** until **ACDCV** is displayed.

(f) **NUMERIC/USER Enter**.

(2) Connect function/arbitrary generator **Output** to TI **Input HI** and **LO** using 50 Ω feedthrough termination.

(3) Set function/arbitrary generator for a sine wave, 20 Hz, 1 V rms output. TI will indicate between 19.99000 and 20.01000 Hz.

(4) Set function/arbitrary generator frequency to 10 MHz. TI will indicate between 09.99900 and 10.00100 MHz.

b. Adjustments. If an out-of-tolerance condition exists, and if not previously completed, perform paragraph **18** below and repeat paragraphs **11** and **12** above.

SECTION IV
ADJUSTMENT PROCESS

13. Preliminary Instructions

a. Remove all external input signals from front and rear terminals.

b. Press **FUNCTION/RANGE DCV** key and **Range ⇓** key to 100 mV range.

c. Release **Terminals Front/Rear** pushbutton to **Front** and **Guard Open/To LO** pushbutton to **Open**.

d. Ensure that at least a 4 hour warm-up has elapsed since power was applied.

14. Front Terminal Offset

a. Connect a 4 terminal short across front panel **Ω Sense** and **Input HI** and **LO** as shown in figure 1.

b. After connecting short, allow 5 minutes for thermal stabilization.

NOTE

Take precautions to prevent thermal changes near 4 wire short. Do not touch short after it is installed. If drafts exist, cover **Input** terminals/short to minimize thermal changes.

c. Execute CAL 0 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.

(2) **MENU C/Auto Cal**.

(3) **NUMERIC/USER 0,3458** then **Enter**.

NOTE

Adjustment takes approximately 5 minutes. When completed, TI will return to displaying dc voltage measurements.

15. Rear Terminal Offset

a. Connect 4 terminal short to rear terminals.

b. Press **Terminals Front/Rear** pushbutton to **Rear**.

c. After connecting short, allow 5 minutes for thermal stabilization. Continue taking precautions to prevent thermal changes.

d. Execute CAL 0 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU C/Auto Cal**.
(3) **NUMERIC/USER 0,3458** then **Enter**.

NOTE

Adjustment takes approximately 5 minutes. When completed, TI will return to displaying dc voltage measurements.

e. Remove 4 terminal short from rear terminals.

16. Dc Gain

a. Release **Terminals Front/Rear** pushbutton to **Front** and press **FUNCTION/RANGE Range** ⇑ key to 10 V range.

b. Connect dc reference standard **10V HI**, **LO** and **GUARD** to TI **Input HI**, **LO** and **Guard**.

c. Execute CAL command specifying dc reference standard test report value. For example execute CAL 10.000123 by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU C/Auto Cal**.
(3) **NUMERIC/USER 10.000123,3458** then **Enter**.

NOTE

Adjustment takes approximately 2 minutes. When completed, TI will return to displaying dc voltage measurements.

d. Disconnect dc reference standard from TI.

17. Resistance and Dc Current

a. Press keys as listed in (1) through (4) below:

(1) **FUNCTION/RANGE** blue shift then **OHMF/OHM**.

(2) **MENU Offset Comp Ω**.

(3) **FUNCTION/RANGE Menu Scroll ⇑** until **OCOMP ON** is displayed.

(4) **NUMERIC/USER Enter**.

b. Connect TI **Ω Sense** and **Input HI** and **LO** to standard resistor No. 7 using 4 wire technique and press **Guard Open/To LO** pushbutton to **To LO**.

c. Execute CAL command specifying standard resistor test report value. For example execute CAL 10.00011 kΩ by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.

(2) **MENU C/Auto Cal**.

(3) **NUMERIC/USER 10.00011E3, 3458** then **Enter**.

NOTE

Adjustment takes approximately 12 minutes. When completed, TI will return to displaying resistance readings.

d. Disconnect standard resistor from TI.

e. Execute ACAL AC command by pressing keys as listed in (1) through (3) below:

(1) **MENU Auto Cal**.

(2) **FUNCTION/RANGE Menu Scroll ⇓** until **ACAL AC** is displayed.

(3) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL AC takes approximately 1 minute to complete.

18. Ac

a. Execute ACAL AC command by pressing keys as listed in (1) through (3) below:

(1) **MENU Auto Cal**.

(2) **FUNCTION/RANGE Menu Scroll ⇓** until **ACAL AC** is displayed.

(3) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL AC takes approximately 1 minute to complete.

b. Press **FUNCTION/RANGE** blue shift key and then **Reset/⇒** key.

c. Press **Guard Open/To LO** pushbutton to **To LO**.

d. Connect function/arbitrary generator **Output** to TI **Input HI** and **LO** using 50 Ω feedthrough termination.

e. Set function/arbitrary generator for a sine wave, 100 kHz, 3 V rms output.

NOTE

In **f** through **r** below when SCAL command is executed adjustment is automatically performed. When adjustment is complete, TI returns to displaying dc voltage readings.

f. Execute SCAL 1E5 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU S/N Rdgs Trig**.
(3) **NUMERIC/USER 1E5,3458** then **Enter**.

g. Disconnect function/arbitrary generator and 50 Ω feedthrough termination from TI.

h. Connect calibrator **WIDEBAND** to TI **Input HI** and **LO** using cable and termination supplied with calibrator.

i. Set calibrator for a 100 kHz, 3 V wideband output.

j. Execute SCAL 10 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU S/N Rdgs Trig**.
(3) **NUMERIC/USER 10,3458** then **Enter**.

k. Set calibrator for a 2 MHz, 3 V wideband output and repeat **j** above.

l. Set calibrator for an 8 MHz, 3 V wideband output and repeat **j** above.

m. Set calibrator for a 100 kHz, 1 V wideband output.

n. Execute SCAL 1 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU S/N Rdgs Trig**.
(3) **NUMERIC/USER 1,3458** then **Enter**.

o. Set calibrator for an 8 MHz, 1 V wideband output and repeat **n** above.

p. Set calibrator for a 100 kHz, 100 mV wideband output.

q. Execute SCAL .1 command by pressing keys as listed in (1) through (3) below:

(1) **FUNCTION/RANGE** blue shift.
(2) **MENU S/N Rdgs Trig**.
(3) **NUMERIC/USER .1,3458** then **Enter**.

r. Set calibrator for an 8 MHz, 100 mV wideband output and repeat **q** above.

s. Press calibrator **RESET** key and disconnect from TI.

t. Execute ACAL AC command by pressing keys as listed in (1) through (3) below:

(1) **MENU Auto Cal**.

(2) **FUNCTION/RANGE Menu Scroll** ⇓ until **ACAL AC** is displayed.

(3) **NUMERIC/USER 3458** then **Enter**.

NOTE

ACAL AC takes approximately 1 minute to complete.

u. Release **Guard Open/To Lo** pushbutton to **Open** and perform paragraphs **11** and **12** above.

19. Final Procedure

a. Deenergize and disconnect all equipment

b. Annotate and affix DA label/form in accordance with TB 750-25.

By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.
General, United States Army
Chief of Staff

Official:

JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army

0729612

Distribution:

To be distributed in accordance with STD IDS No. RLC-1500, 2 January 2003, requirements for calibration procedure TB 9-6625-2246-40.

INSTRUCTIONS FOR SUBMITTING AN ELECTRONIC 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" whomever@redstone.army.mil
To: <2028@redstone.army.mil

Subject: DA Form 2028

1. **From**: Joe Smith
2. Unit: home
3. **Address**: 4300 Park
4. **City**: Hometown
5. **St**: MO
6. **Zip**: 77777
7. **Date Sent**: 19-OCT –93
8. **Pub no:** 55-2840-229-23
9. **Pub Title**: TM
10. **Publication Date**: 04-JUL-85
11. Change Number: 7
12. Submitter Rank: MSG
13. **Submitter FName**: Joe
14. Submitter MName: T
15. **Submitter LName**: Smith
16. **Submitter Phone**: 123-123-1234
17. **Problem**: 1
18. Page: 2
19. Paragraph: 3
20. Line: 4
21. NSN: 5
22. Reference: 6
23. Figure: 7
24. Table: 8
25. Item: 9
26. Total: 123
27. **Text**

This is the text for the problem below line 27.

PIN: 084484-000