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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR MULTIMETER, FLUKE MODEL 8846A

Headquarters, Department of the Army, Washington, DC
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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.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Multimeter, Fluke Model 8846A. 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. To ensure that the TI will continue to meet the performance specifications throughout the entire calibration interval, a complete adjustment is performed. Do not report all adjustments. Report only those adjustments made as a result of a failed AS FOUND condition.

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

Table 1. Calibration Description

Test instrument parameters	Performance specifications		
DC voltage	Range		Accuracy ±(% measurement +% range)
	100 mV		0.0037+0.0035
	1 V		0.0025+0.0007
	10 V		0.0024+0.0005
	100 V		0.0038+0.0006
	1000 V		0.0041+0.001
AC voltage	Range	Frequency	Accuracy ±(%measurement +% range)
	100 mV	3-5 Hz[1]	1.0 +1.04
		5-10 Hz[1]	0.35 + 0.04
		10 Hz-20 kHz	0.05 + 0.04
		20 – 50 kHz	0.11 + 0.05
		50-100 kHz	0.6 + 0.08
		100-300 kHz	4.0 + 0.50
	1 V to 100 V	3-5 Hz[1]	1.0 + 0.03
		5-10 Hz[1]	0.35 + 0.03
		10 Hz-20 kHz	0.06 + 0.03
		20 – 50 kHz	0.12 + 0.05
		50-100 kHz	0.6 + 0.08
		100-300 kHz	4.0 + 0.50

See footnote at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications		
AC voltage	Range	Frequency	Accuracy ±(%measurement +% range)
	1000 V	3-5 Hz[1]	1.0 + 0.0225
		5-10 Hz[1]	0.35 + 0.0225
		10 Hz-20 kHz	0.06 + 0.0225
		20 – 50 kHz	0.12 + 0.0375
		50-100 kHz	0.6 + 0.06
		100-300 kHz	4.0 + 0.375
DC current	Range		Accuracy ±(% measurement +% range)
	100 uA		0.05+0.025
	1mA		0.05+0.005
	10 mA		0.05+0.02
	100 mA		0.05+0.005
	400 mA		0.05+0.005
	1 A		0.05+0.02
	3 A		0.1+0.02
	10 A		0.15+0.008
AC current	Range	Frequency	Accuracy ±(%measurement +% Range)
	100 uA	3 - 5 Hz[1]	1.1 + 0.06
		5 - 10 Hz[1]	0.35 + 0.06
		10 Hz – 5 kHz	0.15 + 0.06
		5 - 10 kHz	0.35 + 0.7
	1 mA	3 - 5 Hz[1]	1.0 + 0.04
		5 - 10 Hz[1]	0.3 + 0.04
		10 Hz – 5 kHz	0.1 + 0.04
		5 - 10 kHz	0.2 + 0.25
	10 mA	3 - 5 Hz[1]	1.1 + 0.06
		5 - 10 Hz[1]	0.35 + 0.06
		10 Hz – 5 kHz	0.15+ 0.06
		5 - 10 kHz	0.35 + 0.7
	100 mA	3 - 5 Hz[1]	1.0 + 0.04
		5 - 10 Hz[1]	0.3 + 0.04
		10 Hz – 5 kHz	0.1 + 0.04
		5 - 10 kHz	0.2 + 0.25
	400 mA	3 - 5 Hz[1]	1.0 + 0.1
		5 - 10 Hz[1]	0.3 + 0.1
		10 Hz – 5 kHz	0.1 + 0.1
		5 - 10 kHz	0.2 + 0.7
	1 A	3 - 5 Hz[1]	1.0 + 0.04
		5 - 10 Hz[1]	0.3 + 0.04
		10 Hz – 5 kHz	0.1 + 0.04
		5 - 10 kHz	0.35 + 0.7
	3 A	3 - 5 Hz[1]	1.1 + 0.06
		5 - 10 Hz[1]	0.35 + 0.06
		10 Hz – 5 kHz	0.15 + 0.06
		5 - 10 kHz	0.35 + 0.7
	10 A	3 - 5 Hz[1]	1.1 + 0.06
		5 - 10 Hz[1]	0.35 + 0.06
		10 Hz – 5 kHz	0.15 + 0.06
		5 - 10 kHz	0.35 + 0.7

See footnote at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications	
Resistance 4-wire, 2-wire and 2X4 wire[2]	Range (Ω)	Accuracy ±(% measurement +% range)
	10	0.01+0.03
	100	0.01+0.004
	1 k	0.01+0.001
	10 k	0.01+0.001
	100 k	0.01+0.001
	1 M	0.01+0.001
	10 M	0.04+0.001
	100 M	0.8+0.01
	1 G	2.0+0.01
Frequency	Range	Accuracy
	3 to 5 Hz	± 0.1%[1]
	5 to 10 Hz	± 0.05%[1]
	10 Hz to 40 Hz	± 0.03%
	40 Hz to 300 kHz	± 0.01%
	300 kHz to 1 MHz	± 0.01%
Capacitance[3]	Range	Accuracy ±(% measurement +% range)
	1 nF	2% + 2.5%
	10 nF to 10 mF	1% + 0.5%
	100 mF	4% + 0.2%
Temperature[4]	Range	Accuracy
	-200º C	±0.09º C + probe accuracy
	-100º C	±0.08º C+ probe accuracy
	0º C	±0.06º C+ probe accuracy
	100º C	±0.08º C+ probe accuracy
	300º C	±0.12º C+ probe accuracy
	600º C	±0.22º C+ probe accuracy
Ratio	Range: 0 to 1000V Accuracy: ±(Input accuracy + Reference accuracy) See DCV	

[1]Not verified below 10 Hz in this procedure.
[2] If zero is not used add 0.2 Ω for 2-wire plus lead resistance and 0.02 Ω for 2X4 wire.
[3]Not verified in this procedure.
[4] Verified indirectly during resistance test.

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 Transfer Calibration Standards Set AN/GSM-286; AN/GSM-287; or AN/GSM-705 and Secondary Reference Calibration 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. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

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 accessories are required: Fluke 4-wire low thermal short model 2653346 and Instrument Controller, Polywell, with National Instruments Automation Explorer software.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
CALIBRATOR	DC volts Range: 0–1000 V Accuracy: ± 0.000725% (0.00084%) Resistance Range: 10 Ω–100 MΩ Accuracy: ± 0.00275% DC current Range: 100 uA–10 A Accuracy: ± 0.01375% (0.0170%) AC volts Frequency range: 20 Hz -300 kHz Range: 100 mV–1000 V Accuracy: ±0.0250% (0.0340%) AC current Range: 100 uA– 10 A Frequency range: 1 kHz Accuracy: ± 0.0350% (0.0360%)	Fluke, Model 5720A (5720A) (p/o MIS-35947); w/amplifier, Fluke 5725A/AR (5725A/AR)
RESISTANCE STANDARD	Range: 1 GΩ ± 0.5% Accuracy: See test report	Beckman, Model CR1000M (8579478)
FUNCTION GENERATOR	Square wave amplitude: 0.1V_{RMS} and 1 V_{RMS} Frequency range: 10 Hz to 1 MHz Accuracy: 0.0025%	Agilent Model 33250A (33250A)

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 result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. 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 checks where applicable.

NOTE

Before connecting TI, the protective earth terminal of the instrument must be connected to the protective conductor of the line power cord. The line plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.

NOTE

Meter accuracy will stay within specification only if the adjustment procedure is performed. First, the TI should be tested entirely to determine the AS FOUND condition noting any out of tolerance condition. Next, the TI should be adjusted to guarantee specification, and reporting the adjustment in accordance with **2. b** above that were made as a result of any failures previously recorded. Finally, the TI should be retested to ensure the AS LEFT condition meets all specifications.

a. Set TI **POWER** on and allow at least 60 minutes for TI to stabilize.

b. Use high quality, low thermal leads throughout entire calibration process.

8. DC Voltage and Linearity Accuracy

a. Performance Check

(1) Connect equipment as listed in (a) through (e) below:

(a) Calibrator OUTPUT HI to TI **INPUT HI**.
(b) Calibrator OUTPUT LO to TI **INPUT LO**.
(c) Calibrator SENSE HI to TI **SENSE HI**.

(d) Calibrator SENSE LO to TI **SENSE LO**.
(e) Calibrator AUX CURRENT OUTPUT HI to TI **400 mA**.

(2) Configure the TI as listed in (a) through (e) below:

(a) Terminals **FRONT REAR** to **FRONT**.
(b) Function: **DCV**.
(c) Press **MEAS SETUP.**
(d) Press **F1** (RESOLUTN # DIG PLC).
(e) Press **F5** (6 DIGIT 100 PLC).

(3) Set the TI range to the first value in table 3.

(4) Set the calibrator output voltage to the first value in table 3.

(5) TI will indicate within the limits of table 3, if not, perform **b** below.

(6) Repeat technique of (3) through (5) above for remaining TI ranges and calibrator output voltages in table 3.

Table 3. DC Voltage And Linearity

Calibrator	TI		
Voltage (VDC)	Range (VDC)	Min (VDC)	Max (VDC)
0	100 m	-0.0035 m	0.0035 m
0	1	-0.000007	0.000007
0	10	-0.00005	0.00005
0	100	-0.0006	0.0006
0	1000	-0.010	0.010
0.1	100 m	99.9928 m	100.0072 m
-0.1	100 m	-100.0072 m	-99.9928 m
1	1	0.999968	1.000032
-1	1	-1.000032	-0.999968
5	10	4.99983	5.00017
-5	10	-5.00017	-4.99983
10	10	9.99971	10.00029
-10	10	-10.00029	-9.99971
100	100	99.9956	100.0044
-100	100	-100.0044	-99.9956
1000	1000	999.949	1000.051
-1000	1000	-1000.051	-999.949

(7) Set calibrator output to minimum.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

9. AC Voltage Accuracy

a. Performance Check

(1) With equipment connected as stated in **8 a** (1) (a) through (e), configure the TI as listed in (a) through (f) below:

(a) Function: **ACV**.
(b) Press **F4** (FILTER).
(c) Press **F1** (3 HZ SLOW).
(d) Press **MEAS SETUP.**

(e) Press **F1** (RESOLUTN).
(f) Press **F5** (HIGH).

(2) Set the TI range to the first value in table 4.

(3) Set the calibrator voltage and frequency output to the first values in table 4.

(4) TI will indicate within the limits of table 4, if not, perform **b** below.

(5) Repeat technique of (2) through (4) above for remaining TI ranges and calibrator output voltage and frequency values in table 4.

Table 4. AC Voltage

Calibrator		TI		
Voltage (V_{RMS})	Frequency (kHz)	Range (V_{RMS})	Min (V_{RMS})	Max (V_{RMS})
100 m	0.01	100 m	99.9000 m	100.1000 m
100 m	20	100 m	99.9000 m	100.1000 m
100 m	50	100 m	99.8300 m	100.1700 m
100 m	100	100 m	99.3200 m	100.6800 m
100 m	300	100 m	95.5000 m	104.5000 m
1	0.01	1	0.999100	1.000900
1	20	1	0.999100	1.000900
1	50	1	0.998300	1.001700
1	100	1	0.993200	1.006800
1	300	1	0.955000	1.045000
10	0.01	10	9.99100	10.00900
10	20	10	9.99100	10.00900
10	50	10	9.98300	10.01700
10	100	10	9.93200	10.06800
3	300	10	2.83000	3.17000
100	0.045	100	99.9100	100.0900
100	20	100	99.9100	100.0900
100	50	100	99.8300	100.1700
100	100	100	99.3200	100.6800
1000	0.045	1000	999.100	1000.900
1000	1	1000	999.100	1000.900
1000	10	1000	999.100	1000.900
320	20	1000	319.583	320.417
320	50	1000	319.241	320.759
320	100	1000	317.480	322.520

(6) Set calibrator output to minimum.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

10. Resistance Accuracy

a. Performance Check

(1) With equipment connected as stated in **8 a** (1) (a) through (e), configure the TI as listed in (a) through (e) below:

(a) Function: **OHMS**.
(b) Press **F2** (4 wire).
(c) Press **MEAS SETUP.**
(d) Press **F1** (RESOLUTN # DIG PLC).

(e) Press **F5** (6 DIGIT 100 PLC).

(2) Set the TI range to the first value in table 5.

(3) Set the calibrator 4-wire resistance output to 0 Ω (EX SNS ON).

(4) TI will indicate within the limits of table 5, if not, perform **b** below.

(5) Repeat technique of (2) through (4) above for remaining TI ranges in table 5.

Table 5. 4-Wire Zero Resistance

TI		
Range (Ω)	Min (Ω)	Max (Ω)
10	0.0	3.0 m
100	0.0	4.0 m
1 k	0.0	10.0 m
10 k	0.0	100 m
100 k	0.0	1.0

(6) Set the TI range to the first value in table 6.

(7) Set the calibrator 4-wire resistance output (EX SNS ON) to first value in table 6.

(8) Use calibrator output adjustment controls to set calibrator control display reading equal to TI indication. Calibrator display error indications will be within the limits of table 6, if not, perform **b** below.

(9) Repeat technique of (6) through (8) above for remaining TI ranges in table 6.

Table 6. 4-Wire Full Scale Resistance

TI	Calibrator		
Range (Ω)	Output (Ω)	Min (%)	Max (%)
10	10	-0.04	0.04
100	100	-0.014	0.014
1 k	1 k	-0.011	0.011
10 k	10 k	-0.011	0.011
100 k	100 k	-0.011	0.011

(10) Set calibrator output to minimum.

(11) Move connection at TI **SENSE HI** and **LO** to TI **INPUT HI** and **LO** (stack the leads).

(12) Configure the TI for a 2-wire resistance measurement by pressing **F1** (2 W 2X4W).

(13) Set the TI range to the first value in table 7.

(14) Set the calibrator resistance output to 0 Ω, EX SNS ON, 2-WIRE COMP ON.

(15) After TI display has stabilized, press **ZERO (**TI will display **MATH** indicating zero offset is active).

(16) TI will indicate within the limits of table 7, if not, perform **b** below.

(17) On TI press **ZERO (**TI will no longer display **MATH** indicating zero offset is not active).

(18) Repeat technique of (13) through (17) above for remaining TI ranges in table 7.

Table 7. 2-Wire Zero Resistance

TI		
Range (Ω)	Min (Ω)	Max (Ω)
1 k	0.0	10.0 m
10 k	0.0	100 m
100 k	0.0	1.0
1 M	0.0	10
10 M	0.0	100
100 M	0.0	10 k
1G	0.0	1.0 M

(19) Set the TI range to the first value in table 8.

(20) Set the calibrator resistance output to 0 **Ω**.

(21) On TI press **ZERO (**TI will display **MATH** indicating zero offset is active).

(22) Set the calibrator resistance output to first value in table 8.

(23) Use calibrator output adjustment controls to set calibrator control display reading equal to TI indication. Calibrator display error indications will be within the limits of table 8, if not, perform **b** below.

(24) On TI press **ZERO (**TI will no longer display **MATH** indicating zero offset is not active).

(25) Repeat technique of (19) through (24) above for remaining TI ranges in table 8.

Table 8. 2-Wire Full Scale Resistance

TI	Calibrator		
Range (Ω)	Output (Ω)	Min	Max
1 k	1 k	-0.011%	0.011%
10 k	10 k	-0.011%	0.011%
100 k[1]	100 k	-0.011%	0.011%
1 M	1 M	-0.011%	0.011%
10 M	10 M	-0.041%	0.041%
100 M[2]	100 M	-0.81%	0.81%
1G	100 M	-2.01%	2.01%

[1] Calibrator 2-WIRE COMP OFF.
[2] Calibrator EX SNS OFF.

(26) Set calibrator output to minimum.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

11. DC Current Accuracy

a. Performance Check

(1) Configure the TI as listed in (a) through (d) below:

(a) Function: **DCI**.
(b) Press **MEAS SETUP.**
(c) Press **F1** (RESOLUTN # DIG PLC).
(d) Press **F5** (6 DIGIT 100 PLC).

(2) Set the TI range to the first value in table 9.

(3) Configure the calibrator for AUX Current Output and set calibrator DC current output to the first value in table 9.

(4) TI will indicate within the limits of table 9, if not, perform **b** below.

(5) Repeat technique of (2) through (4) above for remaining TI ranges and calibrator DC current output values in table 9.

Table 9. DC Current Below 400 mA

Calibrator	TI		
Output (ADC)	Range (ADC)	Min (ADC)	Max (ADC)
0	100 u	-0.0250 u	0.0250 u
0	1 m	-0.000050 m	0.000050 m
0	10 m	-0.00200 m	0.00200 m
0	100 m	-0.0050 m	0.0050 m
0	400 m	-0.020m	0.020m
100 u	100 u	99.9350 u	100.0750 u
-100 u	100 u	-100.0750 u	-99.9350 u
1 m	1 m	0.999450 m	1.000550 m
-1 m	1 m	-1.000550 m	-0.999450 m
10 m	10 m	9.99300 m	10.00700 m
-10 m	10 m	-10.00700 m	-9.99300 m
100 m	100 m	99.9450 m	100.0550 m
-100 m	100 m	-100.0550 m	-99.9450 m
400 m	400 m	399.780 m	400.220 m
-400 m	400 m	-400.220 m	-399.780 m

(6) Set calibrator output to minimum.

(7) Move connection at the TI from the **400 mA** jack to the **10 A** jack.

(8) Set the TI range to the first value in table 10.

(9) Set calibrator DC current output to the first value in table 10.

(10) TI will indicate within the limits of table 10, if not, perform **b** below.

(11) Repeat technique of (8) through (10) above for remaining TI ranges and calibrator DC current output values in table10.

Table 10. DC Current Above 400 mA

Calibrator	TI		
Output (ADC)	Range (ADC)	Min (ADC)	Max (ADC)
0	1	-0.002000	0.002000
0	3	-0.00060	0.00060
0	10	-0.00080	0.00080
1	1	0.999300	1.000700
-1	1	-1.000700	-0.999300
1.9	3	1.89750	1.90250
-1.9	3	-1.90250	-1.89750
10[1]	10	9.98420	10.01580
-10[1]	10	-10.01580	-9.98420

[1]Move connections from calibrator **AUX CURRENT OUTPUT HI** and **LO** to amplifier **Current Output HI** and **LO**.

(12) Set calibrator output to minimum.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

12. AC Current Accuracy

a. Performance Check

(1) Move connection at the TI from the **10 A** jack to the **400 mA** jack and from amplifier Current Output HI and LO to calibrator AUX CURRENT OUTPUT HI and LO**.**

(2) Configure the TI as listed in (a) through (f) below:

(a) Function: **ACI**.
(b) Press **F4** (FILTER).
(c) Press **F1** (3 HZ SLOW).
(d) Press **MEAS SETUP**.
(e) Press **F1** (RESOLUTN).
(f) Press **F5** (HIGH).

(3) Set the TI range to the first value in table 11.

(4) Set the calibrator AC current and frequency output to the first values in table 11.

(5) TI will indicate within the limits of table 11, if not, perform **b** below.

(6) Repeat technique of (3) through (5) above for remaining TI ranges and calibrator AC current output values in table 11.

Table 11. AC Current Below 400 mA

Calibrator		TI		
Current (AAC)	Frequency (kHz)	Range (AAC)	Min (AAC)	Max (AAC)
100 u	1	100 u	99.9790 u	100.2100 u
1 m	1	1 m	0.998600 m	1.001400 m
10 m	1	10 m	9.97900 m	10.02100 m
100 m	1	100 m	99.8600 m	100.1400 m
329 m	1	400 m	328.271 m	329.729 m

(7) Set calibrator output to minimum.

(8) Move connection at the TI from the **400 mA** jack to the **10 A** jack.

(9) Set the TI range to the first value in table 12.

(10) Set calibrator AC current and frequency output to the first value in table 12.

(11) TI will indicate within the limits of table 12, if not, perform **b** below.

(12) Repeat technique of (9) through (11) above for remaining TI ranges and calibrator DC current output values in table 12.

Table 12. AC Current Above 400 mA

Calibrator		TI		
Current (AAC)	Frequency (kHz)	Range (AAC)	Min (AAC)	Max (AAC)
1	1	1	0.998600	1.001400
1.9	1	3	1.89535	1.90465
10[1]	1	10	9.97900	10.02100

[1]Move connections from calibrator **OUTPUT HI** and **LO** to amplifier **Current Output HI** and **LO**.

(13) Set calibrator output to minimum and disconnect equipment set-up.

b. Adjustments.

Perform entire alignment procedure listed in paragraph **15**.

13. DC Ratio Accuracy

(1) Connect equipment as listed in (a) through (d) below:

(a) Calibrator OUTPUT HI to TI **INPUT HI**.
(b) Calibrator OUTPUT LO to TI **INPUT LO**.
(c) Calibrator OUTPUT HI to TI **SENSE HI** (leads stacked at calibrator output).
(d) Calibrator OUTPUT LO to TI **SENSE LO** (leads stacked at calibrator output).

(2) Configure the TI as listed in (a) through (e) below.

(a) Function: **DCV**.
(b) Press **F1** (RATIO).
(c) Press **MEAS SETUP**.
(d) Press **F1** (RESOLUTN # DIG PLC).
(e) Press **F5** (6 DIGIT 100 PLC).

(3) Set the TI range to the first value in table 13.

(4) Set the calibrator output voltage to the first value in table 13.

(5) TI will indicate within the limits of table 13, if not, perform **b** below.

(6) Repeat technique of (3) through (5) above for remaining TI ranges and calibrator output voltage values in table 13.

Table 13. Ratio

Calibrator	TI		
Voltage (VDC)	Range (VDC)	Min (VDC)	Max (VDC)
0.100	100 m	0.999856	1.000144
1	1	0.999936	1.000064
-10	10	0.999942	1.000058

(7) Set calibrator output to minimum and disconnect equipment set-up.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

14. Frequency Accuracy

a. Performance Check

(1) Connect function generator output to TI input using a 50 Ω termination.

(2) Press TI **FREQ PERIOD** pushbutton.

(3) Set the function generator square wave output voltage and frequency to the first values in table 14.

(4) TI will indicate within the limits of table 14, if not, perform **b** below.

(5) Repeat technique of (3) and (4) above for remaining signal generator voltage and frequency values in table 14.

Table 14. Frequency

Function generator		TI	
Voltage (V_{RMS})	Frequency (Hz)	Min (Hz)	Max (Hz)
1	10	9.99700	10.00300
1	40	39.9960	40.0040
0.1	300 k	299.970 k	300.030 k
0.1	1 M	999.900 k	1001.000 k

(6) Set function generator output to minimum and disconnect equipment setup.

b. Adjustments. Perform entire alignment procedure listed in paragraph **15**.

15. Alignment

a. Ensure that the TI has had at least 60 minutes for warm-up and stabilization.

b. Use high quality, low thermal leads throughout entire alignment process.

c. Use the instrument controller to align the TI by performing (1) through (11) below.

(1) Open the National Instruments Measurement and Automation Explorer program.

(2) Under the CONFIGURATON tab, expand DEVICES AND INTERFACES.

(3) Select GPIB0, right click, then SCAN FOR INSTRUMENTS.

(4) Double click on TI from the list of instruments found.

(5) From the toolbar, select COMMUNICATE WITH INSTRUMENT.

NOTE

The factory default secure code is FLUKE884X. If the secure code has been changed and is now unknown, the manufacturer's calibration manual describes how to reset it.

(6) On the display of the instrument controller, in the COMMUNICATOR dialog box, enter the following command on the SEND line to UNLOCK the instrument:

CAL:SEC:STAT OFF, FLUKE884X

(7) Click the WRITE button.

(8) Apply the first input signal (open terminals, no signal) listed in table 15.

(9) On the display of the instrument controller, in the COMMUNICATOR dialog box, enter the following command on the SEND line to configure the TI for the first step of table 15:

CAL:VAL ORES, 100000000

(10) Click the WRITE button.

(11) On the display of the instrument controller, in the COMMUNICATOR dialog box, enter the following command on the SEND line to perform the first step of table 15:

CAL? ON

(12) Click the QUERY button. Routine is complete and ready for the next command when TI returns a value to the string received box of the Measurement and Automation Explorer software.

(13) Repeat technique of (8) through (12) above for remaining steps in table 15. Substitute commands and input signals as necessary to complete table 15. The input signal must be present before the command is executed.

NOTE

In table 15, the CAL:REC (CALibration RECord) command is executed at the end of each major section. In the event of an interrupted alignment, the procedure may be restarted from the last executed CAL:REC point.

NOTE

In table 15, Test description and Input signal refer to the front terminals except where rear is specifically indicated. **FRONT / REAR** terminal switch should be activated accordingly.

Table 15. Alignment Group 1

Test description	Input signal	Command
100 M Range Open	Open terminals (no signal)	CAL:VAL ORES,100000000 CAL? ON
1G Range Open	Open terminals (no signal)	CAL:VAL ORES,1000000000 CAL? ON
1 nF Range Open	Open terminals (no signal)	CAL:VAL ZCAP,1.00E-09 CAL? ON CAL:REC

Table 16. Alignment Group 2

AC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVAC,100.0E-3 CAL? ON
AC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVACS,100.0E-3 CAL? ON
AC 1V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVAC,1 CAL? ON
AC 1V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVACS,1 CAL? ON
AC 10V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVAC,10 CAL? ON
AC 10V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVACS,10 CAL? ON
AC 100V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVAC,100 CAL? ON
AC 100V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVACS,100 CAL? ON
AC 1000V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVAC,1000 CAL? ON
AC 1000V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVACS,1000 CAL? ON

Table 16. Alignment Group 2 - Continued

DC 1000 V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDC,1000 CAL? ON
DC 100 V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDC,100 CAL? ON
DC 10 V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDC,10 CAL? ON
DC 1 V Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDC,1 CAL? ON
DC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDC,0.1 CAL? ON
DC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL DFVDC60,100E-3 CAL? ON
DC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL DFVDC60_1,100E-3 CAL? ON
DC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL DFVDC50,100E-3 CAL? ON
DC 100 mV Range Zero	SHORT 4-wire low-thermal	CAL:VAL DFVDC50_1,100E-3 CAL? ON
4W 10 MΩ Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,10000000 CAL? ON
4W 1 MΩ Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,1000000 CAL? ON
4W 100 kΩ Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,100000 CAL? ON
4W 10 kΩ Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,10000 CAL? ON
4W 1 kΩ Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,1000 CAL? ON
4W 100 Ω Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,100 CAL? ON
4W 10 Ω Range Zero	SHORT 4-wire low-thermal	CAL:VAL ZRES,10 CAL? ON
Front Ratio Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDCREF,10 CAL? ON
Front Ratio Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDCREF,1 CAL? ON
Front Ratio Zero	SHORT 4-wire low-thermal	CAL:VAL ZVDCREF,100E-3 CAL? ON CAL:REC

Table 17. Alignment Group 3

Rear 4W 100 kΩ Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZRESR,100000 CAL? ON
Rear 4W 10 kΩ Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZRESR,10000 CAL? ON
Rear 4W 1 kΩ Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZRESR,1000 CAL? ON
Rear 4W 100 Ω Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZRESR,100 CAL? ON
Rear 4W 10 Ω Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZRESR,10 CAL? ON
Rear 1 VDC Range Zero	SHORT (rear panel) 4-wire low-thermal	CAL:VAL ZVDCR,1 CAL? ON

Table 17. Alignment Group 3 - Continued

Rear 0.1 VDC Range Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZVDCR,100E-3 CAL? ON
Rear Ratio Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZVDCRREF,1 CAL? ON
Rear Ratio Zero	SHORT(rear panel) 4-wire low-thermal	CAL:VAL ZVDCRREF,100E-3 CAL? ON
DC 400 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIDC,400.0E-3 CAL? ON
DC 100 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIDC,100.0E-3 CAL? ON
DC 1 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIDC,1.0E-3 CAL? ON
DC 10 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIDC,10.0E-3 CAL? ON
DC 100 uA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIDC,100.0E-6 CAL? ON
AC 100 uA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIAC,0.0 CAL? ON
AC 100 uA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIACS,0.0 CAL? ON
AC 1 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIAC,1.0E-3 CAL? ON
AC 1 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIACS,1.0E-3 CAL? ON
AC 10mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIAC,10.0E-3 CAL? ON
AC 10 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIACS,10.0E-3 CAL? ON
AC 100 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIAC,100.0E-3 CAL? ON
AC 100 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIACS,100.0E-3 CAL? ON
AC 400 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIAC,400.0E-3 CAL? ON
AC 400 mA Range Zero	Open Terminals 400 mA to LO	CAL:VAL ZIACS,400.0E-3 CAL? ON
DC 10A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIDC,10 CAL? ON
DC 1A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIDC,1 CAL? ON
AC 1A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIAC,1 CAL? ON
AC 1A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIACS,1 CAL? ON
AC 10A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIAC,10 CAL? ON
AC 10A Range Zero	Open Terminals 10 A to LO short	CAL:VAL ZIACS,10 CAL? ON CAL:REC

Table 18. Alignment Group 4

AC 1V Range Linearity	1.19 V @1200 Hz	CAL:VAL ACLIN,1.19 CAL? ON
AC 1V Range Linearity	0.8 V @1200 Hz	CAL:VAL ACLIN,0.8 CAL? ON
AC 1V Range Linearity	0.4 V@1200 Hz	CAL:VAL ACLIN,0.4 CAL? ON
AC 1V Range Linearity	0.005 V @1200 Hz	CAL:VAL ACLIN,0.005 CAL? ON CAL:REC
AC 100 mV Range Gain	0.1V @ 1200 Hz	CAL:VAL GVAC,0.1 CAL? ON
AC 100 mV Range Gain	0.1V @ 1200 Hz	CAL:VAL GVACS,0.1 CAL? ON
AC 100 mV Range Gain	0.1V @ 50 kHz	CAL:VAL ACPOLE,0.1 CAL? ON
AC 1 V Range Gain	1 V@ 1200 Hz	CAL:VAL GVAC,1 CAL? ON
AC 1 V Range Gain	1 V @ 1000 Hz	CAL:VAL GVACS,1 CAL? ON
AC 1 V Range Gain	1 V @ 10 Hz	CAL:VAL FVAC,1 CAL? ON
AC 10 V Range Gain	1 V @ 50 kHz	CAL:VAL ACPOLE,1 CAL? ON
AC 10 V Range Gain	10 V @ 1200 Hz	CAL:VAL GVAC,10 CAL? ON
AC 10 V Range Gain	10 V @ 1200 Hz	CAL:VAL GVACS,10 CAL? ON
AC 100 V Range Gain	10 V @ 50 kHz	CAL:VAL ACPOLE,10 CAL? ON
AC 100 V Range Gain	100 V @ 1200 Hz	CAL:VAL GVAC,100 CAL? ON
AC 100 V Range Gain	100 V @ 1200 Hz	CAL:VAL GVACS,100 CAL? ON
AC 100 V Range Gain	100 V @ 50 kHz	CAL:VAL ACPOLE,100 CAL? ON
AC 1000 V Range Gain	1000 V @ 1200 Hz	CAL:VAL GVAC,1000 CAL? ON
AC 1000 V Range Gain	1000 V @ 1200 Hz	CAL:VAL GVACS,1000 CAL? ON
AC 1000 V Range Gain	329 V @ 50 kHz	CAL:VAL ACPOLE,329 CAL? ON CAL:REC

Table 19. Alignment Group 5

DC 1000 V Range Gain	1000 VDC	CAL:VAL GVDC,1000 CAL? ON
DC 1000 V Range Gain	-1000 VDC	CAL:VAL GVDC,-1000 CAL? ON
DC 100 V Range Gain	100 VDC	CAL:VAL GVDC,100 CAL? ON
DC 100 V Range Gain	-100 VDC	CAL:VAL GVDC,-100 CAL? ON

Table 19. Alignment Group 5 - Continued

DC 10 V Range Gain	10 VDC	CAL:VAL GVDC,10 CAL? ON
DC 10 V Range Gain	-10 VDC	CAL:VAL GVDC,-10 CAL? ON
DC 1 V Range Gain	1 VDC	CAL:VAL GVDC,1 CAL? ON
DC 1 V Range Gain	-1 VDC	CAL:VAL GVDC,-1 CAL? ON
DC 0.1 V Range Gain	0.1 VDC	CAL:VAL GVDC,0.1 CAL? ON
DC 0.1 V Range Gain	-0.1 VDC	CAL:VAL GVDC,-0.1 CAL? ON CAL:REC

Table 20. Alignment Group 6

1 ADC Range Gain	1 ADC	CAL:VAL GIDC,1 CAL? ON
1 ADC Range Gain	-1 ADC	CAL:VAL GIDC,-1 CAL? ON
10 ADC Range Gain	10 ADC	CAL:VAL GIDC,10 CAL? ON
10 ADC Range Gain	-10 ADC	CAL:VAL GIDC,-10 CAL? ON CAL:REC
AC 10 A Range Gain	10 A @ 1200 Hz	CAL:VAL GIAC,10 CAL? ON
AC 10 A Range Gain	10 A@ 1200 Hz	CAL:VAL GIACS,10 CAL? ON
AC 1 A Range Gain	1 A @ 1200 Hz	CAL:VAL GIAC,1 CAL? ON
AC 1 A Range Gain	1 A @ 1200 Hz	CAL:VAL GIACS,1 CAL? ON
AC 400 mA Range Gain	329 mA @ 1200 Hz	CAL:VAL GIAC,329.0E-3 CAL? ON
AC 400 mA Range Gain	329 mA@ 1200 Hz	CAL:VAL GIACS,329.0E-3 CAL? ON
AC 100 mA Range Gain	100 mA@ 1200 Hz	CAL:VAL GIAC,100.0E-3 CAL? ON
AC 100 mA Range Gain	100 mA@ 1200 Hz	CAL:VAL GIACS,100.0E-3 CAL? ON
AC 10 mA Range Gain	10 mA@ 1200 Hz	CAL:VAL GIAC,10.0E-3 CAL? ON
AC 10 mA Range Gain	10 mA@ 1200 Hz	CAL:VAL GIACS,10.0E-3 CAL? ON
AC 1 mA Range Gain	1 mA@ 1200 Hz	CAL:VAL GIAC,1.0E-3 CAL? ON
AC 1mA Range Gain	1 mA@ 1200 Hz	CAL:VAL GIACS,1.00E-3 CAL? ON
AC 100 uA Range Gain	100 uA@ 1200 Hz	CAL:VAL GIAC,100.0E-6 CAL? ON
AC 100 uA Range Gain	100 uA@ 1200 Hz	CAL:VAL GIACS,100.0E-6 CAL? ON CAL:REC

Table 21. Alignment Group 7

DC 100 uA Range Gain	100 uADC	CAL:VAL GIDC,100.0E-6 CAL? ON
DC 100 uA Range Gain	-100 uADC	CAL:VAL GIDC,-100.0E-6 CAL? ON
DC 1 mA Range Gain	1 mADC	CAL:VAL GIDC,1.0E-3 CAL? ON
DC 1 mA Range Gain	-1 mADC	CAL:VAL GIDC,-1.0E-3 CAL? ON
DC 10 mA Range Gain	10 mADC	CAL:VAL GIDC,10.0E-3 CAL? ON
DC 10 mA Range Gain	-10 mADC	CAL:VAL GIDC,-10.0E-3 CAL? ON
DC 100 mA Range Gain	100 mADC	CAL:VAL GIDC,100.0E-3 CAL? ON
DC 100 mA Range Gain	-100 mADC	CAL:VAL GIDC,-100.0E-3 CAL? ON
DC 400 mA Range Gain	329 mADC	CAL:VAL GIDC,329.0E-3 CAL? ON
DC 400 mA Range Gain	-329 mADC	CAL:VAL GIDC,-329.0E-3 CAL? ON CAL:REC

Table 22. Alignment Group 8

R 100 MΩ Range Gain[1]	100 MΩ	CAL:VAL GRES,100000000 CAL? ON
4W 10 MΩ Range Gain[1]	10 MΩ	CAL:VAL GRES,10000000 CAL? ON
4W 1 MΩ Range Gain[1]	1 MΩ	CAL:VAL GRES,1000000 CAL? ON
4W 100 kΩ Range Gain[1]	100 kΩ	CAL:VAL GRES,100000 CAL? ON
4W 10 kΩ Range Gain[1]	10 kΩ	CAL:VAL GRES,10000 CAL? ON
4W 1 kΩ Range Gain[1]	1 kΩ	CAL:VAL GRES,1000 CAL? ON
4W 100 Ω Range Gain[1]	100 Ω	CAL:VAL GRES,100 CAL? ON
4W 10 Ω Range Gain[1]	10 Ω	CAL:VAL GRES,10 CAL? ON CAL: REC

[1]On command line, enter actual resistance value applied, i.e. At 10 Ω, enter CAL:VAL GRES,9.99987.

NOTE

High resistance measurements are very susceptible to ambient disturbances. During the alignment of the 1 GΩ Range Gain, technician should move away from the measurement and ensure that immediate area is completely free of personnel movements, etc.

Table 23. Alignment Group 9

1 GΩ Range Gain[1]	1 GΩ	CAL:VAL GRES,1000000000 CAL? ON
10 nF Range Gain[2]	10 nF	CAL:VAL GCAP1,10.0E-9 CAL? ON
10 nF Range Gain[2]	10 nF	CAL:VAL GCAP2,10.0E-9 CAL? ON

[1]On command line, enter actual resistance value applied, i.e. At 10 Ω, enter CAL:VAL GRES,9.99987.
[2]This step may be omitted if 10 nF capacitor is not available. If this step is performed, enter the actual value of the capacitor on the command line.

(14) On the display of the instrument controller, in the COMMUNICATOR dialog box, enter the following command on the SEND line to RECORD the new calibration constants and update the calibration date:

CAL:REC

(15) Click the WRITE button.

(16) On the display of the instrument controller, in the COMMUNICATOR dialog box, enter the following command on the SEND line to LOCK the TI:

CAL:SEC:STAT ON, FLUKE884X

(17) Click the WRITE button.

(18) Power down the TI to make the new calibration constants operational.

(19) Repeat paragraphs **8 a** through **14 a** to verify that the alignment was successful.

16. Final Procedure

a. De-energize 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

0909102

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 344967, requirements for calibration procedure TB 9-6625-2379-24.

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.