*TB 9-4931-405-40

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR INSTRUMENT SHUNT, GUILDLINE, MODEL 9711 AND MULTIRANGE INSTRUMENT SHUNT RUBICON, MODEL 2759

Headquarters, Department of the Army, Washington, DC
14 September 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 9-4931-405-50, dated 31 May 1994.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Instrument Shunt, Guildline, Model 9711 and Multirange Instrument Shunt, Rubicon, Model 2759. The manufacturers' manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are described in text.

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

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
Range resistance (Ω)	Current rating (plug position) (A)	Accuracy (±%)
Guildline, Model 9711		
0.000333	300	0.10
0.001	100	0.05
0.01	10	0.01
0.10	1.0	0.01
1.0	0.1	0.01
10.0	0.01	0.01
100	0.001	0.01
1000	0.0001	0.01
10000	0.00001	0.01
Rubicon, Model 2759		
0.01	15	0.01
0.10	1.5	0.01
1.0	0.15	0.01
10.0	0.015	0.01
100	0.0015	0.01
1000	0.00015	0.01
10000	0.000015	0.01

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 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.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
CALIBRATOR	Range: 10 μA to 20 A dc Accuracy: Nominal	Fluke, Model 5720A (5720A) (p/o MIS-35947); w amplifier, Fluke 5725A/AR (5725A/AR)
DC POWER SUPPLY	Range: 20 A dc Accuracy: Nominal	Elgar, Model DCS40-30EM1-2 (13589313)
DC REFERENCE STANDARD	Range: 10 V dc Accuracy: Test report	Fluke, Model 732A (732A)
MULTIMETER	Range: 20 to 100 mV dc Accuracy:[1]	Agilent, Model 3458A (3458A)
STANDARD RESISTOR NO. 1	Range: 10 kΩ Accuracy: Test report	General Radio, Type 1444A (MIS-10400)
STANDARD RESISTOR NO. 2	Range: 1Ω Accuracy:[1]	Leeds & Northrup, Model 4020B (8616289)
STANDARD RESISTOR NO. 3	Range: 10Ω Accuracy:[1]	Leeds & Northrup, Model 4025B 8616290)
STANDARD RESISTOR NO. 4	Range: 100Ω Accuracy:[1]	Leeds & Northrup, Model 4030B 8616291)
STANDARD RESISTOR NO. 5	Range: 1000Ω Accuracy:[1]	Leeds & Northrup, Model 4035B (8616292)
STANDARD RESISTOR NO. 6	Range: 10000Ω Accuracy:[1]	Leeds & Northrup, Model 4040B (8616293)
STANDARD RESISTOR NO. 7	Range: 0.1Ω Accuracy:[1]	Leads & Northrup, Model 4221B (8616294)
STANDARD RESISTOR NO. 8	Range: 0.01Ω Accuracy:[1]	Biddle Grey, Model 601235 7902994)
STANDARD RESISTOR NO. 9	Range: 0.001Ω Accuracy:[1]	Biddle Grey, Model 601240 (7902993)

[1]Combined accuracy of multimeter and standard resistors No. 2 through No. 9 is ±0.0025%.

SECTION III
CALIBRATION PROCESS FOR
GUILDLINE, MODEL 9711

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. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturers' manuals 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 OUTPUTS(s) to minimum after each step within the performance check where applicable.

a. Utilizing the dc reference standard and standard resistor no. 1, characterize multimeter to obtain 24 hour manufacturer specifications for dc voltage.

b. Connect equipment as shown in figure 1, CONNECTION A.

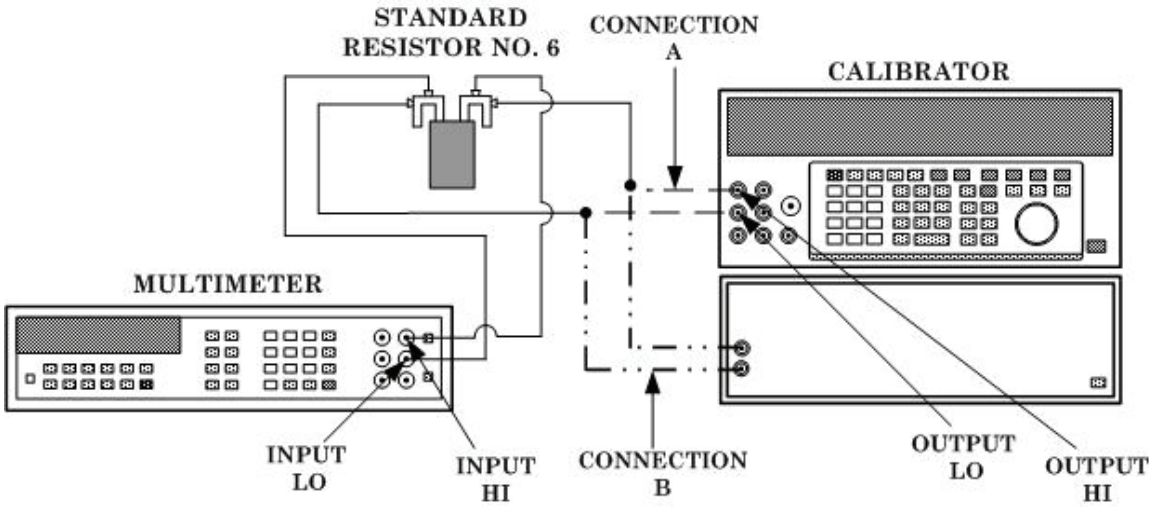


Figure 1. Calibrator characterization.

8. Resistance

a. Performance Check

(1) Set multimeter for most accurate dc voltage measurements.

(2) Set calibrator for a nominal 10 μA dc output.

(3) Allow sufficient time for stabilization (1 to 3 minutes), then record multimeter dc voltage indication in table 3, section A. Calculate the calibrator's actual 10 μA output using the formula:

$$10\ \mu A\ \text{Actual Output} = \frac{\text{Multimeter indication (in V)}}{\text{Test report value of standard resistor}}$$

(4) Record resulting value in table 3, section A, actual calibrator output column.

(5) Repeat technique of (2) through (4) above for remaining nominal calibrator outputs listed in table 3, substituting standard resistors as specified.

(6) Connect equipment as shown in figure 2.

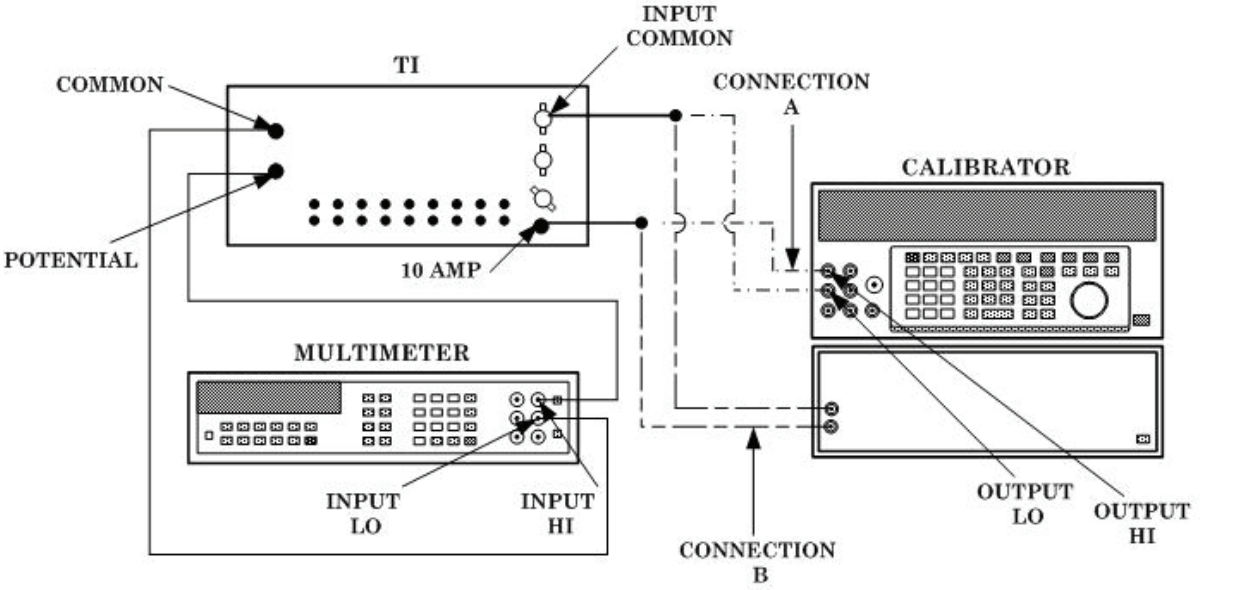


Figure 2. Resistance.

(7) Insert TI plugs in **.00001 AMPERES** position. Set calibrator for a nominal 10 μA dc output.

(8) Allow sufficient time for stabilization (1 to 3 minutes), then record new multimeter dc voltage indication in table 3, section B.

(9) Transcribe actual calibrator output data from table 3 section A to section B.

(10) Calculate resistance of **.00001 AMPERES** plug position using formula:

$$\text{Plug position } \Omega = \frac{\text{Multimeter dc V indication}}{\text{Calculated calibrator output (in A)}}$$

(11) Record resulting resistance value in table 3, section B, calculated resistance value column.

(12) Set plug positions as specified and repeat technique of (7) through (11) above for remaining plug positions listed in table 3, section B.

(13) Transcribe calculated resistance value from table 3, section B, to calibration test report.

b. Adjustments. No adjustments can be made.

9. Calibration Test Report. A calibration test report is required for this TI. The purpose of the test report is to allow utilization of:

a. Instruments whose values have drifted outside manufacturer's specifications when referenced to nominal values, yet the drift rate is sufficiently low to allow use within manufacturer's specified accuracy of the previous test report value.

b. Instruments that have values and stability better than manufacturer's specifications may be utilized at greater accuracies when test report values are used. The performance specifications shall be ascertained by referencing present measured values to previous measured values, in lieu of present to nominal values. If present measured values are not within manufacturer's accuracy specifications of last measured value, the TI must be red-tagged. Calibration activities will maintain a case history file of test reports for the TI. The file will contain an accumulation of at least six of the most recent test reports. If in four successive calibrations the measured value drifts from the nominal value as much as three times the manufacturer's accuracy specification, the TI must be red-tagged. An example of calibration data to be annotated on the test report is shown on the sample test report.

10. Final Procedure

a. Deenergize and disconnect all equipment.

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

Table 3. Guildline, Model 9711 Calculations Worksheet

Section A						
Nominal calibrator output		Multimeter indication (in V)		Standard resistor test report value	(No.)	Actual calibrator output (in A)
10	μA	_____	÷	_____	(6) =	_____
100	μA	_____	÷	_____	(5) =	_____
1.0	mA	_____	÷	_____	(4) =	_____
10.0	mA	_____	÷	_____	(3) =	_____
100	mA	_____	÷	_____	(2) =	_____
1.0	A	_____	÷	_____	(7) =	_____
2.0	A	_____	÷	_____	(8) =	_____
10	A[1]	_____	÷	_____	(8) =	_____
20	A[2]	_____	÷	_____	(9) =	_____

Section B						
Test instrument plug position	Nominal calibrator output		Multimeter indication (in V)		Actual calibrator output[3]	Test instrument calculated resistance value
.00001	10	μA	_____	÷	_____ =	_____
.0001	100	μA	_____	÷	_____ =	_____
.001	1.0	mA	_____	÷	_____ =	_____
.01	10.0	mA	_____	÷	_____ =	_____
.1	100	mA	_____	÷	_____ =	_____
1	1.0	A	_____	÷	_____ =	_____
10	2.0	A	_____	÷	_____ =	_____
10	10	A[4]	_____	÷	_____ =	_____
100	20	A[2,5]	_____	÷	_____ =	_____
300	20	A[2,6]	_____	÷	_____ =	_____

[1]Set calibrator output to minimum; then connect test lead as shown in figure 1, CONNECTION B.

[2]Substitute DC power supply for calibrator.

[3]Transcribe recorded values from section A to section B.

[4]Set calibrator output to minimum; then connect test leads as shown in figure 2, CONNECTION B.

[5]Set calibrator output to minimum; then move test lead from TI's 10 AMP terminal to 100 AMP terminal.

[6]Set DC power supply output to minimum; then move test lead from TI's 100 AMP terminal to 300 AMP terminal. Allow 20 minutes to warm-up.

SAMPLE CALIBRATION TEST REPORT

(Organization) _____
_____

REPORT OF CALIBRATION FOR
INSTRUMENT SHUNT
GUILDLINE, MODEL 9711

SERIAL NO _____
SUBMITTED BY: _____
_____
_____

Test instrument					
Plug position	Nominal resistance	Test current		Measured value	Limits of error (%)
.00001	10000Ω	10	μA	_____	±0.01
.0001	1000 Ω	100	μA	_____	±0.01
.001	100 Ω	1.0	mA	_____	±0.01
.01	10 Ω	10	mA	_____	±0.01
.1	1.0 Ω	100	mA	_____	±0.01
1	0.1 Ω	1.0	A	_____	±0.01
10	0.01 Ω	2.0	A	_____	±0.01
10	0.01 Ω	10	A	_____	±0.01
100	0.001 Ω	20	A	_____	±0.05
300	0.000333 Ω	20	A	_____	±0.10

Under the conditions stated, the limits of error are as indicated. This calibration is traceable to and compatible with the National Institute of Standards (NIST) measurements.

Calibration Report No. _____ _____
Calibrating Technician

Temperature: _____

Page 1 of 1

Date: _____ _____
Verified by

SECTION IV
CALIBRATION PROCESS FOR
RUBICON, MODEL 2759

11. Preliminary Instructions

a. The instruction outlined in paragraphs **11** and **12** 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.

12. 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. Utilizing the dc reference standard and standard resistor no. 1, characterize multimeter to obtain 24 hour manufacturer specifications for dc voltage, resistance and dc current.

b. Connect equipment as shown in figure 1, CONNECTION A.

13. Resistance

a. Performance Check

(1) Set multimeter for most accurate dc voltage measurements.

(2) Set calibrator for a nominal 10 μA dc output.

(3) Allow sufficient time for stabilization (1 to 3 minutes), then record multimeter dc voltage indication in table 4, section A. Calculate the calibrator's characterized 10 μA output using the formula:

$$10\ \mu A\ \text{Actual Output} = \frac{\text{Multimeter indication (in V)}}{\text{Test report value of standard resistor}}$$

(4) Record resulting value in table 4, section A, calculated calibrator output (A) column.

(5) Repeat technique of (2) through (4) above for remaining calibrator nominal outputs listed in table 4, substituting standard resistors as specified.

(6) Connect equipment as shown in figure 2.

(7) Insert TI plugs in **.000015 AMPERES** position. Set calibrator for a nominal 10 μA dc output.

(8) Allow sufficient time for stabilization (1 to 3 minutes), then record new multimeter dc voltage indication in table 4, section B.

(9) Transcribe calculated calibrator output data from section A to section B.

(10) Calculate resistance of **.000015 AMPERES** plug position using formula:

$$\text{Plug position } \Omega = \frac{\text{Multimeter dc V indication}}{\text{Calculated calibrator output (in A)}}$$

(11) Record resulting resistance value in table 4, Section B., calculated resistance value column.

(12) Set plug positions as specified and repeat technique of (7) through (11) above for remaining plug positions listed in table 3, Section B.

(13) Transcribe calculated resistance value from table 4, section B, to calibration test report.

b. Adjustments. No adjustments can be made.

14. Calibration Test Report. Calibration test report is required for this TI. The purpose of the test report is to allow utilization of:

a. Instruments whose values have drifted outside manufacturer's specifications when referenced to nominal values, yet the drift rate is sufficiently low to allow use within manufacturer's specified accuracy of the previous test report value.

b. Instruments that have values and stability better than manufacturers specifications may be utilized at greater accuracies when test report values are used. The performance specifications shall be ascertained by referencing present measured values to previous measured values, in lieu of present to nominal values. If present measured values are not within manufacturer's accuracy specifications of last measured value, the TI must be red-tagged. Calibration activities will maintain a case history file of test reports for the TI. The file will contain an accumulation of at least six of the most recent test reports. If, in four successive calibrations, the measured value drifts from the nominal value as much as three times the manufacturer's accuracy specification, the TI must be red-tagged. An example of calibration data to be annotated on the test report is shown on the sample test report.

Table 4. Rubicon, Model 2759 Calculations Worksheet

Section A						
Nominal calibrator output		Multimeter indication (in V)		Standard resistor test report value	(No.)	Actual calibrator output (in A)
10	µA	_____	÷	_____	(6) =	_____
100	µA	_____	÷	_____	(5) =	_____
1.0	mA	_____	÷	_____	(4) =	_____
10.0	mA	_____	÷	_____	(3) =	_____
100	mA	_____	÷	_____	(2) =	_____
1.0	A	_____	÷	_____	(7) =	_____
10	A[1]	_____	÷	_____	(8) =	_____

Section B						
Test instrument plug position	Nominal calibrator output		Multimeter indication (in V)		Actual calibrator output[2]	Test instrument calculated resistance value
.000015	10	µA	_____	÷	_____ =	_____
.00015	100	µA	_____	÷	_____ =	_____
.0015	1.0	mA	_____	÷	_____ =	_____
.015	10.0	mA	_____	÷	_____ =	_____
.15	100	mA	_____	÷	_____ =	_____
1	1.0	A	_____	÷	_____ =	_____
15	2.0	A[3]	_____	÷	_____ =	_____

[1]Set calibrator output to minimum; then connect test lead as shown in figure 1, CONNECTION B.
[2]Transcribe recorded values from section A to section B.
[3]Set calibrator output to minimum, then connect test leads as shown in figure 2, CONNECTION B.

15. Final Procedure

a. Deenergize and disconnect all equipment.

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

SAMPLE CALIBRATION TEST REPORT

(Organization) _____

_____

REPORT OF CALIBRATION FOR
MULTIRANGE INSTRUMENT SHUNT
RUBICON, MODEL 2759

SERIAL NO _____
SUBMITTED BY: _____
_____
_____

Test instrument					
Plug position	Nominal resistance	Test current		Measured value	Limits of error (%)
.000015	10,000Ω	10	μA	_____	±0.01
.00015	1,000 Ω	100	μA	_____	±0.01
.0015	100 Ω	1.0	mA	_____	±0.01
.015	10 Ω	10	mA	_____	±0.01
.15	1.0 Ω	100	mA	_____	±0.01
1	0.1 Ω	1.0	A	_____	±0.01
15	0.01 Ω	10	A	_____	±0.01

Under the conditions stated, the limits of error are as indicated. This calibration is traceable to and compatible with the National Institute of Standards (NIST) measurements.

Calibration Report No. _____ _____
Calibrating Technician

Temperature: _____

Page 1 of 1

Date: _____ _____
Verified by

APPENDIX A
DUPLICATED WORKSHEETS

Table 3. Guildline, Model 9711 Calculations Worksheet

Section A					
Nominal calibrator output	Multimeter indication (in V)		Standard resistor test report value	(No.)	Actual calibrator output (in A)
10 µA	_____	÷	_____	(6) =	_____
100 µA	_____	÷	_____	(5) =	_____
1.0 mA	_____	÷	_____	(4) =	_____
10.0 mA	_____	÷	_____	(3) =	_____
100 mA	_____	÷	_____	(2) =	_____
1.0 A	_____	÷	_____	(7) =	_____
2.0 A	_____	÷	_____	(8) =	_____
10 A[1]	_____	÷	_____	(8) =	_____
20 A	_____	÷	_____	(9) =	_____

Section B					
Test instrument plug position	Nominal calibrator output	Multimeter indication (in V)	Actual calibrator output[2]		Test instrument calculated resistance value
.00001	10 µA	_____ ÷	_____	=	_____
.0001	100 µA	_____ ÷	_____	=	_____
.001	1.0 mA	_____ ÷	_____	=	_____
.01	10.0 mA	_____ ÷	_____	=	_____
.1	100 mA	_____ ÷	_____	=	_____
1	1.0 A	_____ ÷	_____	=	_____
10	2.0 A	_____ ÷	_____	=	_____
10	10 A[3]	_____ ÷	_____	=	_____
100	20 A[4]	_____ ÷	_____	=	_____
300	20 A[5]	_____ ÷	_____	=	_____

[1]Set calibrator output to minimum then connect test lead as shown in figure 1, CONNECTION B.

[2]Transcribe recorded values from section A to section B.

[3]Set calibrator output to minimum; then connect test leads as shown in figure 2, CONNECTION B.

[4]Set calibrator output to minimum; then move test lead from TI's 10 AMP terminal to 100 AMP terminal.

[5]Set calibrator output to minimum; then move test lead from TI's 100 AMP terminal to 300 AMP terminal. Allow 20 minutes to warm-up.

Table 4. Rubicon, Model 2759 Calculations Worksheet

Section A						
Nominal calibrator output		Multimeter indication (in V)		Standard resistor test report value	(No.)	Actual calibrator output (in A)
10	µA	_____	÷	_____	(6) =	_____
100	µA	_____	÷	_____	(5) =	_____
1.0	mA	_____	÷	_____	(4) =	_____
10.0	mA	_____	÷	_____	(3) =	_____
100	mA	_____	÷	_____	(2) =	_____
1.0	A	_____	÷	_____	(7) =	_____
10	A[1]	_____	÷	_____	(8) =	_____

Section B						
Test instrument plug position	Nominal calibrator output		Multimeter indication (in V)		Actual calibrator output[2]	Test instrument calculated resistance value
.000015	10	µA	_____	÷ _____	=	_____
.00015	100	µA	_____	÷ _____	=	_____
.0015	1.0	mA	_____	÷ _____	=	_____
.015	10.0	mA	_____	÷ _____	=	_____
.15	100	mA	_____	÷ _____	=	_____
1	1.0	A	_____	÷ _____	=	_____
15	2.0	A[3]	_____	÷ _____	=	_____

[1]Set calibrator output to minimum; then connect test lead as shown in figure 1, CONNECTION B.

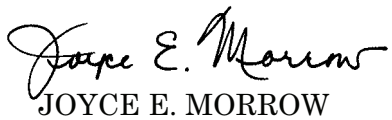
[2]Transcribe recorded values from section A to section B.

[3]Set calibrator output to minimum, then connect test leads as shown in figure 2, CONNECTION B.

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

0719901

Distribution:

To be distributed in accordance with STD IDS No. RLC-1500, 2 January 2003, requirements for calibration procedure TB 9-4931-405-40

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.