*TB 9-6625-388-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR RESISTANCE BRIDGE ZM-4/U, ZM-4B/U; LEEDS AND NORTHROP MODELS 5300, 5305, AND 5430AM1

Headquarters, Department of the Army, Washington, DC
8 April 2008

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.

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*This bulletin supersedes TB 9-6625-388-35, dated 11 March 1977, including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Resistance Bridge ZM-4/U, ZM-4B/U; Leeds and Northrop Models 5300, 5305, and 5430AM1. The manufacturers' manuals and TM 11-2019 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 table 1.

b. Time and Technique. The time required for this calibration is approximately 2 hours, using the dc and low frequency technique.

Table 1. Model Variations

Test instrument position/connections		
Models		
ZM-4( )/U	5430AM1	5300 and 5305
GA SENS switches	Same as ZM-4	None
RES-VAR-MUR switch	Same as ZM-4	R-MU-VR-M
BA +/- binding post	Same as ZM-4	BA +, 1 -
GA 1 and 2 binding post	Same as ZM-4	GA + and -
BA switch INT-BA-EXT	IN-BA-OUT	BA switch IN-OUT
GA switch RMV-GA-HIL	Same as ZM-4	Same as ZM-4
GR and RH binding post	Same as ZM-4	None
X1 and X2 binding post	Same as ZM-4	X1 and X2
MULTIPLE BY same as 5430AM1	MULTIPLE 1/1000, 1/100, 1/10, 1/9, 1/4, 1/1, 10/1, 100/1, M1000 M100, M10	Same as 5430AM1
Decade switches 1, 10, 100, 1000, 1-9, 1-9, 1-9, (O-INF)	Decade switches 1, 10, 100, 1000, 1-9, 1-9, 1-9, (O-INF)	Same as 5430AM1

2. Forms, records, and Reports

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

b. Adjustments to be reported are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance applications which pertain to this calibration are listed in table 2.

Table 2. Calibration Description

Test instrument parameters	Performance specifications
Leeds and Northrop Models 5300, 5305, and 5430AM1	
Ratio	Enclosed dial switch having even multiplying values: 0.001, 0.01, 0.1, 1, 10, 100, and 1000
Rheostat	Four decades 9 (1 + 10 + 100 + 1000) ohms
Decade accuracy	±0.1% for 10-, 100-, and 1000-ohm steps; ±0.25% for 1-ohm step
Bridge error (Models 5300, 5305, and 5430AM1)	±(0.15% + 0.01 ohm)
Ratio accuracy	±0.05%
Current rating max	1-ohm decade, 0.7A; 10-ohm decade, 0.22 A; 100-ohm decade, 0.07A; 1000-ohm decade, 0.022A
Galvanometer[1]	Sensitivity: 1 μ A per scale division
Power requirement	4.5V (3 type-D flashlight cells)
Models ZM-4( )/U	
Power requirements:[1]	Internal: 4.5 V dc (3 D cell batteries) External: 22.5 to 200 V dc (40 ohms per V) current limiting resistor must be used for voltages in excess of 45 V
Resistance measurement:	Range: 1 ohm to 1.011 M Ω Accuracy: ±0.25% for ZM-4A/U and ZM-4B/U on orders 19629-P-50 and 6870-P-51
Resistance box:[1]	Range: 0 to 1.011 k Ω ± (0.1% +0.01 ohm) Current limitations: 0.016 to 0.5 A

[1]This specification is for information only and is not verified in this bulletin.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 3 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Standards Sets AN/GSM-286; AN/GSM-287; or AN/GSM-705. 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 3. The accuracies listed in table 3 provide a four-to-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the four-to-one 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 accessory is also required for this calibration: DC Power Supply, MIS 38956.

Table 3. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer, model, and part number
DECADE RESISTOR[1]	Range: 1 to 900,000 ohms Accuracy: ±0.03%	Biddle-Gray, Model 71-631 (7910328)
MULTIMETER	Range: 1 to 1 Gohm Accuracy: ±0.03%	Agilent, Model 3458A (3458A)

[1]Two required (designated decade A and B, as applicable).

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 3.

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 and TM 11-2019 for this TI.

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

7. Equipment Setup

WARNING

HIGH VOLTAGE is used 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.

NOTE

Model ZM-4B/U positions/connections are used for callouts. For other model variations see table 1.

a. Remove cover of TI and rotate all decade switches at least three times throughout entire range.

b. Position TI controls as listed in (1) through (6) below:

(1) **RES-VAR-MUR** switch to **RES**.

(2) **BA** switch to **INT**.

(3) All decade switches to **9**.

(4) **MULTIPLY BY** switch to **1/1**.

(5) Unclamp galvanometer.

(6) **GA** switch to **RVM**.

c. Connect **X1** and **X2** terminals of TI to decade resistor. Adjust decade resistor for indication of 10,100.00 ohms. Momentarily depress sensitivity switches and note that the galvanometer deflects.

d. Set all decade switches on TI to 0. Reclamp galvanometer and remove mounting screw from right side of galvanometer. Disconnect decade resistor.

e. Connect multimeter terminals to TI **RH** and **X2** terminals.

NOTE

For Leeds and Northrup, model 5300, short **GA** and **X1** terminals and press **B** and **G** switches to obtain indication. This model does not have an **RH** terminal.

f. Measure resistance and record indication.

8. Decade Resistors

a. Performance Check

(1) Turn TI 1 ohm decade switch to **1**.

(2) Using multimeter measure resistance. (Depress **B** and **G** switch on Model 5300 to obtain indication). Note indication and subtract value recorded in **7 f** above. The resultant value will be between 0.989 and 1.011 ohms.

(3) Repeat technique of (1) and (2) above for decade switch and decade switch positions listed in table 4. Indications will be within limits specified.

Table 4. Decade Resistors

Test Instrument		Multimeter indications (less zero resistance) (Ohms)	
Decade switches	Decade switch positions	Min	Max
1	2	1.988	2.012
1	3	2.987	3.013
1	4	3.986	4.014
1	5	4.985	5.015
1	6	5.984	6.016
1	7	6.983	7.017
1	8	7.982	8.018
1	9[1]	8.981	9.019
1	10[1]	9.980	10.02
10	1	9.980	10.02
10	2	19.97	20.03
10	3	29.96	30.04
10	4	39.95	40.05
10	5	49.94	50.06
10	6	59.93	60.07
10	7	69.92	70.08
10	8	79.91	80.09
10	9[1]	89.90	90.10
10	10[1]	99.89	100.11
100	1	99.89	100.11
100	2	199.79	200.21

Table 4. Decade Resistors - Continued

Test Instrument		Multimeter indications (less zero resistance) (Ohms)	
Decade switches	Decade switch positions	Min	Max
100	3	299.69	300.31
100	4	399.59	400.41
100	5	499.49	500.51
100	6	599.39	600.61
100	7	699.29	700.71
100	8	799.19	800.81
100	9[1]	899.09	900.91
100	10[1]	998.99	1001.01
1000	1	998.99	1001.01
1000	2	1997.99	2002.01
1000	3	2996.99	3003.01
1000	4	3995.99	4004.01
1000	5	4994.99	5005.01
1000	6	5993.99	6006.01
1000	7	6992.99	7007.01
1000	8	7991.99	8008.01
1000	9[1]	8990.99	9009.01

[1]Position 10 not included on all models. Return switches to zero upon completion of last position.

b. Adjustments. No adjustments can be made.

9. Ratio Resistors

a. Performance Check

(1) Connect decade resistor to multimeter.

(2) Turn all decade resistor switches to 0.

(3) Measure and record resistance value.

(4) Turn decade resistor switches to 9.00 ohms.

(5) Measure and record resistance value. Subtract value recorded in (3) above from this value. (This is the value of 9 ohms at decade resistor.)

(6) Connect equipment as shown in figure 1.

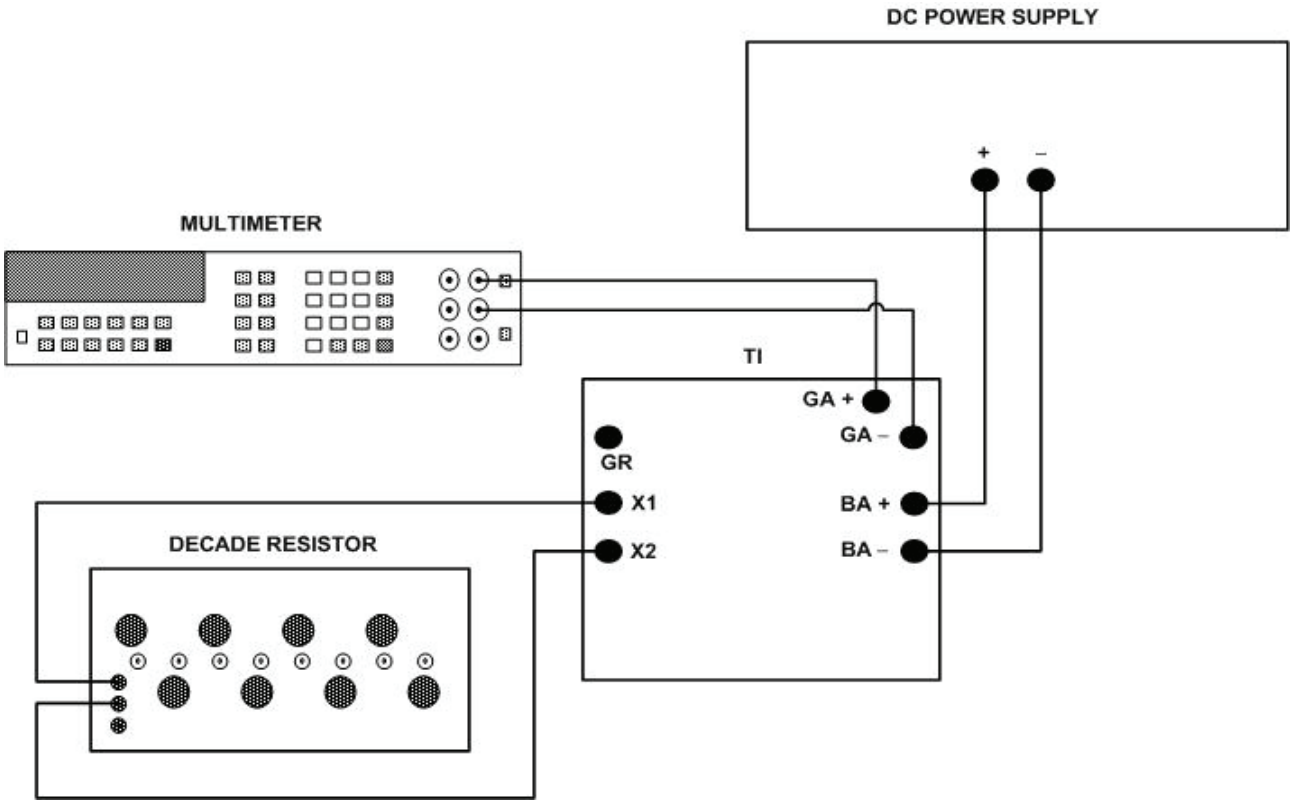

Figure 1. Ratio resistor check - equipment setup.

(7) Position TI controls as listed in (a) through (c) below:

(a) **MULTIPLY BY** switch to **1/1000**.
(b) **BA** switch to **EXT**.
(c) **1000** ohm decade switch to **9** and all others to **0**.

(8) Adjust decade resistor for 9 ohms.

(9) Adjust DC power supply for 20 volts.

(10) Operate **GA SENS** switches on TI while adjusting TI decade switches for null indications on resistance measuring system. Record value.

(11) Adjust decade resistor for 0 ohms.

(12) Repeat (10) above.

(13) Subtract the value recorded in (12) above from the value recorded in (10) above. The difference between this value divided by 1000 and the value recorded in (5) above will be less than 0.024 ohm.

(14) Turn TI **MULTIPLY BY** switch to **1/100** and set TI decade switches to 9000.

(15) Adjust decade resistor for 90 ohms.

(16) Operate TI **GA SENS** switches while adjusting decade switches for null indication on resistance measuring system. TI decade switches will indicate between 8986 and 9014.

(17) Repeat technique of (14) through (16) above for decade resistor switch settings and TI **MULTIPLY BY** switch settings listed in table 5.

Table 5. Ratio Check

Decade resistor switch settings (ohms)	Test instrument **MULTIPLY BY** switch settings
900	1/10
1000	1/9
2250	1/4
9000	1/1
90000	10/1
900000	100/1

b. Adjustment. No adjustments can be made.

10. Murray Loop Accuracy

a. Performance Check

NOTE

This performance check is not applicable for models 5305.

(1) Position TI controls as listed in (a) through (f) below:

(a) **RES-VAR-MUR** switch to **MUR**.
(b) **BA** switch to **EXT**.
(c) Decade dial **1000** to **1**.
(d) Decade dials **100**, **10** and **1** to **0**.
(e) Mechanically zero galvanometer.
(f) Replace mounting screw removed in paragraph **7 d** above.

(2) Connect equipment as shown in figure 2.

(3) Adjust both decade resistors to 0 ohms and record TI galvanometer reading as TI zero resistance.

(4) Adjust decade resistor A to 1000 ohms.

(5) Adjust DC power supply for 25 volt dc output as indicated on power supply meter.

(6) Position TI **MULTIPLY BY** switch and decade dials to settings listed in table 6.

(7) Depress TI **GA SENS .01**, **.l**, and **1** in turn while increasing or decreasing resistance of decade resistor B until TI galvanometer pointer indicates 0. Indications on decade resistor B will be within limits listed in table 6, minus zero resistance recorded in step (3) above.

Table 6. Murray Loop Accuracy

TI **MULTIPLY BY** switch positions	TI decade dials settings (ohms)	Decade B indication (ohms)	
		Min	Max
M1000	1000	998.5	1001.5
M100	100	998.5	1001.5
M10	10	998.5	1001.5

b. Adjustments. No adjustments can be made.

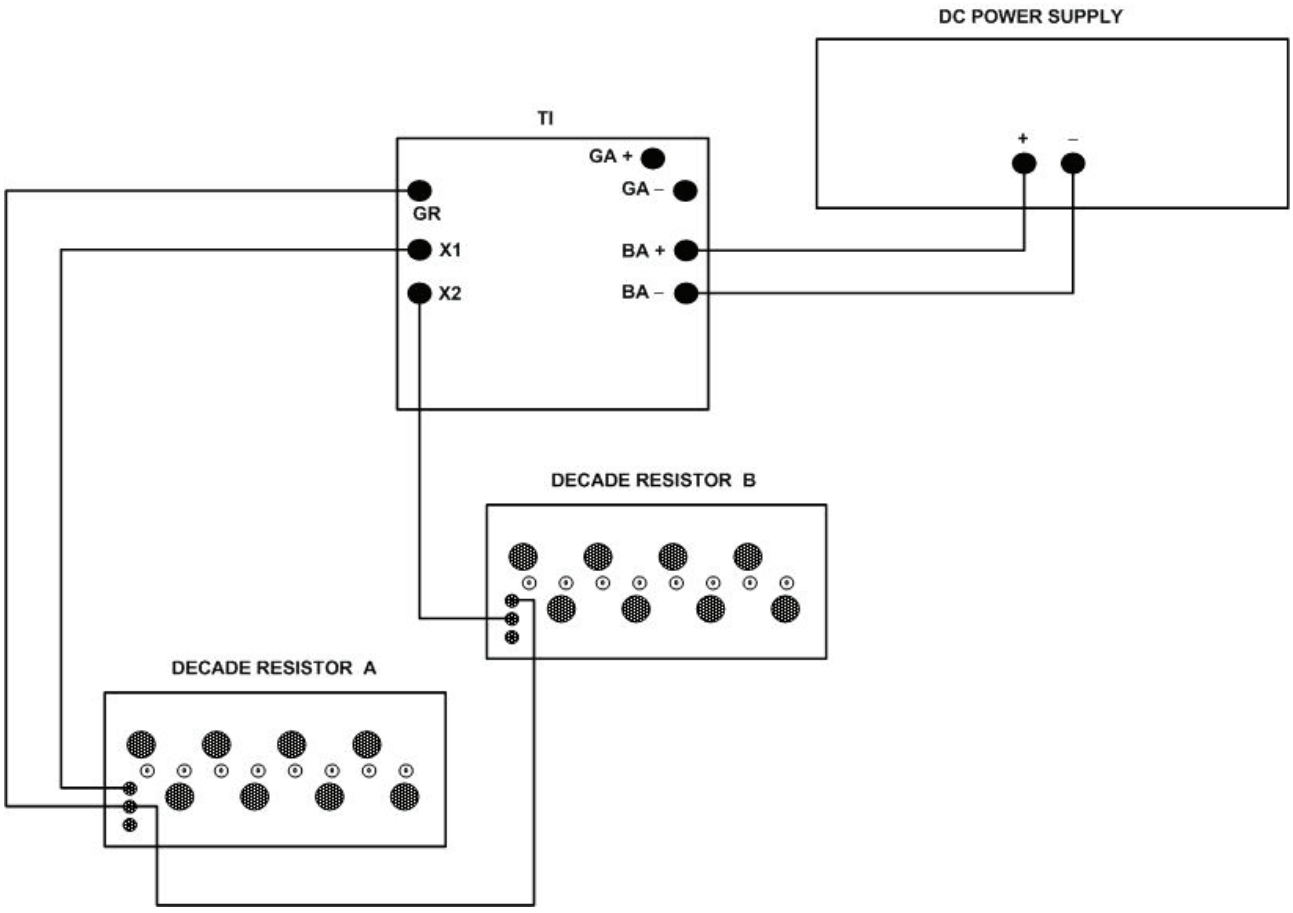

Figure 2. Murray loop check - equipment setup.

11. Resistance Accuracy (ZM-4/U and ZM-4B/U only)

a. Performance Check

(1) Unlock the galvanometer. If galvanometer does not indicate zero, loosen screws on adjustment knob and turn knob to zero the pointer. Tighten screws on adjustment knob.

(2) If necessary, insert three D cell batteries in TI.

NOTE

When measuring resistance below 1000 ohms, set **BA** switch to **INT**.

NOTE

When measuring resistance above 1000 ohms, set **BA** switch to **EXT** and connect DC power supply, adjusted to 25 volts as indicated on power supply meter, to **BA** terminals on TI.

CAUTION

During this procedure, depress and hold TI **GS SENS .01**, **.1**, and **1** switches only long enough to perform the required checks or adjustments.

(3) Position TI controls as listed in (a) through (e) below:

(a) **GA** switch to **RVM**.
(b) **RES-VAR-MUR** switch to **RES**.
(c) **MULTIPLY BY** dial to **1/1000**.
(d) Decade dials **1000**, **100**, **10**, and **1** to **1**.
(e) **BA** switch to **INT**.

(4) Connect decade resistor to TI **X1** and **X2** terminals.

(5) Set decade resistor for zero resistance.

(6) On TI, depress **GA SENS .01** switch and adjust decade dials until galvanometer pointer indicates 0. Depress **.1** and **1 GA SENS** switches in turn, and readjust decade dial as required until galvanometer pointer indicates 0. Record indicated resistance. The decade dial indication divided by 1000 will be called "test lead resistance" and will be subtracted from all measurements.

(7) Position controls on TI as noted in table 7. Depress **GA SENS .01**, **.1**, and **1** switches in turn, and adjust decade resistor to resistance value that provides 0 deflection on TI galvanometer at **GA SENS 1**. Decade resistor will indicate within limits specified in table 7.

Table 7. Resistance Accuracy

Test instrument settings					Decade resistor indications (ohms)			
Multiply By switch settings	Decade dials				A[1]		B[1]	
	1000	100	10	1	Min	Max	Min	Max
100/1	0	0	0	10	997.5	1002.5	998.5	1001.5
100/1	0	0	0	9	897.5	902.5	898.5	901.5
100/1	0	0	0	8	797.5	802.5	789.5	801.5
100/1	0	0	0	7	697.5	702.5	698.5	701.5
100/1	0	0	0	6	597.5	602.5	598.5	601.5
100/1	0	0	0	5	497.5	502.5	498.5	501.5
100/1	0	0	0	4	397.5	402.5	398.5	401.5
100/1	0	0	0	3	297.5	302.5	298.5	301.5
100/1	0	0	0	2	197.5	202.5	198.5	201.5

See footnotes at end of table.

Table 7. Resistance Accuracy - Continued

Test instrument settings					Decade resistor indications (ohms)			
Multiply By switch settings	Decade dials				A[1]		B[1]	
	1000	100	10	1	Min	Max	Min	Max
100/1	0	0	0	1	97.5	102.5	98.5	101.5
10/1	0	0	10	0	997.5	1002.5	998.5	1001.5
10/1	0	0	9	0	897.5	902.5	898.5	901.5
10/1	0	0	8	0	797.5	802.5	798.5	801.5
10/1	0	0	7	0	697.5	702.5	698.5	701.5
10/1	0	0	6	0	597.5	602.5	598.5	601.5
10/1	0	0	5	0	497.5	502.5	498.5	501.5
10/1	0	0	4	0	397.5	402.5	398.5	401.5
10/1	0	0	3	0	297.5	302.5	298.5	301.5
10/1	0	0	2	0	197.5	202.5	198.5	201.5
10/1	0	0	1	0	97.5	102.5	98.5	101.5
1/1	0	10	0	0	997.5	1002.5	998.5	1001.5
1/1	0	9	0	0	897.5	902.5	898.5	901.5
1/1	0	8	0	0	797.5	802.5	798.5	801.5
1/1	0	7	0	0	697.5	702.5	698.5	701.5
1/1	0	6	0	0	597.5	602.5	598.5	601.5
1/1	0	5	0	0	497.5	502.5	498.5	501.5
1/1	0	4	0	0	397.5	402.5	398.5	401.5
1/1	0	3	0	0	297.5	302.5	298.5	301.5
1/1	0	2	0	0	197.5	202.5	198.5	201.5
1/1	0	1	0	0	97.5	102.5	98.5	101.5
1/1	9	0	0	0	8977.5	9022.5	8988.5	9013.5
1/4	4	0	0	0	997.5	1002.5	998.5	1001.5
1/9	9	0	0	0	997.5	1002.5	998.5	1001.5
1/10	9	0	0	0	897.5	902.3	898.6	901.4
1/100	9	0	0	0	89.76	90.24[2]	89.85	90.15[2]

[1]Column A indications are for sets ZM-4A/U and ZM-4B/U purchased on Order Number 19629-P-50 and 6870-P-51. Column B indications are for all other order numbers.
[2]Set decade resistor to 90 ohms and adjust TI for galvanometer balance.

b. Adjustments. No adjustments can be made.

12. Final Procedure

a. Deenergize and disconnect all equipment.

b. Turn TI **BA** switch to **OUT** (**EXT** for ZM-4( )/U) position and lock galvanometer.

c. Replace TI protective cover.

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

By Order of the Secretary of the Army:

Official:

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

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0803811

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342102, requirements for calibration procedure TB 9-6625-388-24.

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.