*TB 9-6625-381-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR CAPACITANCE ANALYZER ZM-3/U AND ZM-3/AU

Headquarters, Department of the Army, Washington, DC
10 July 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, US 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 provide DA Form 2028 information to AMCOM via e-mail, fax, or the World Wide Web. Our FAX number is: DSN 788-6546 or Commercial 256-842-6546. Our e-mail address is: 2028@redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual. For the World Wide Web, use: https://amcom2028.redstone.army.mil.

*This bulletin supersedes TB 9-6625-381-35, 11 July 1988.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Capacitance Analyzer, ZM-3/U and ZM-3A/U. 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. Front panels and input requirements vary among models.

b. Time and Technique. The time required for this calibration is approximately 2.5 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. 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 specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Meter	Range: 0 to 600 V dc Accuracy: ± 3% FS
Leakage voltage	Range: 0 to 60 and 0 to 600 V dc
Capacitance	Range: 0 to 10,000 μF[1] Accuracy: 5 to 100 pF, ± 3 pF; 100 pF to 100 μF, ±5%
Insulation resistance	Range: 1.1 to 10,000 MΩ[2] Accuracy: ±20%
Power factor	Range: 0 to 50% Accuracy: ± 10%

[1]Verified to 1.4 μF only.
[2]Verified to 1000 MΩ only.

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 Sets AN/GSM-287 or AN/GSM-705. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. 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 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.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
AUTOTRANSFORMER	Range: 0 to 150 Vac Accuracy: ±1 Vac	Ridge, Model 9020A (9020A)
CAPACITANCE STANDARD	Range: 100 pF to 1.4 μF Accuracy: ±1.25%	Arco, Model SS32 (7907233)
MULTIMETER	Range: 18.2 to 618 V dc 0 to 50 V ac Accuracy: ± 0.75%	Hewlett-Packard, Model 3458A (3458A)
RESISTANCE STANDARD No.1	Range: 0 to 1 MΩ Accuracy: [1]	Biddle-Gray, Model 71-631 (7910328)
RESISTANCE STANDARD No.2	Range: 1 to 10 MΩ Accuracy: [1]	Beckman, Model CR10M (8598965)
RESISTANCE STANDARD No.3	Range: 10 to 100 MΩ Accuracy: [1]	Beckman, Model CR100M (8598966)
RESISTANCE STANDARD No.4	Range: 100 to 1000 MΩ Accuracy: [1]	Beckman, Model CR1000M (8579478)

[1]Combined accuracy of any two ± 5%.

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.

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. Remove TI from protective case only when necessary to make adjustments. Replace cover after completing the adjustment.

b. Connect TI to autotransformer.

c. Connect autotransformer to 115 V ac source and adjust for 115 V ac output.

d. Position controls as listed in (1) through (3) below:

(1) **110V-220V** switch (rear of chassis) to **110V**.

(2) **SELECTOR** switch to **INSULATION RESISTANCE**.

(3) **POWER** switch to **ON**.

e. Allow at least 15 minutes for warm-up and stabilization.

f. Meter on TI should indicate between 10 V and 10 mA scale markings. If not, remove dust cover and adjust R23 (fig. 1) for meter indication midway between 10 V and 10 mA scale markings.

g. Set **SELECTOR** switch to **LEAKAGE**.

8. Meter Accuracy and Leakage

a. Performance Check

(1) Connect multimeter to TI leakage + (positive) and - (negative) binding posts.

(2) Operate and hold **METER SWITCH** to **60 VOLTS**, and adjust **OPERATING VOLTAGE** control for a 20 V indication on TI meter. Multimeter will indicate between 18.2 and 21.8 V dc.

(3) Adjust **OPERATING VOLTAGE** control for a 40 V indication on TI meter. Multimeter will indicate between 38.2 and 41.8 V dc.

(4) Adjust **OPERATING VOLTAGE** control for a 60 V indication on TI meter. Multimeter will indicate between 58.2 and 61.8 V dc.

(5) Release **METER SWITCH**.

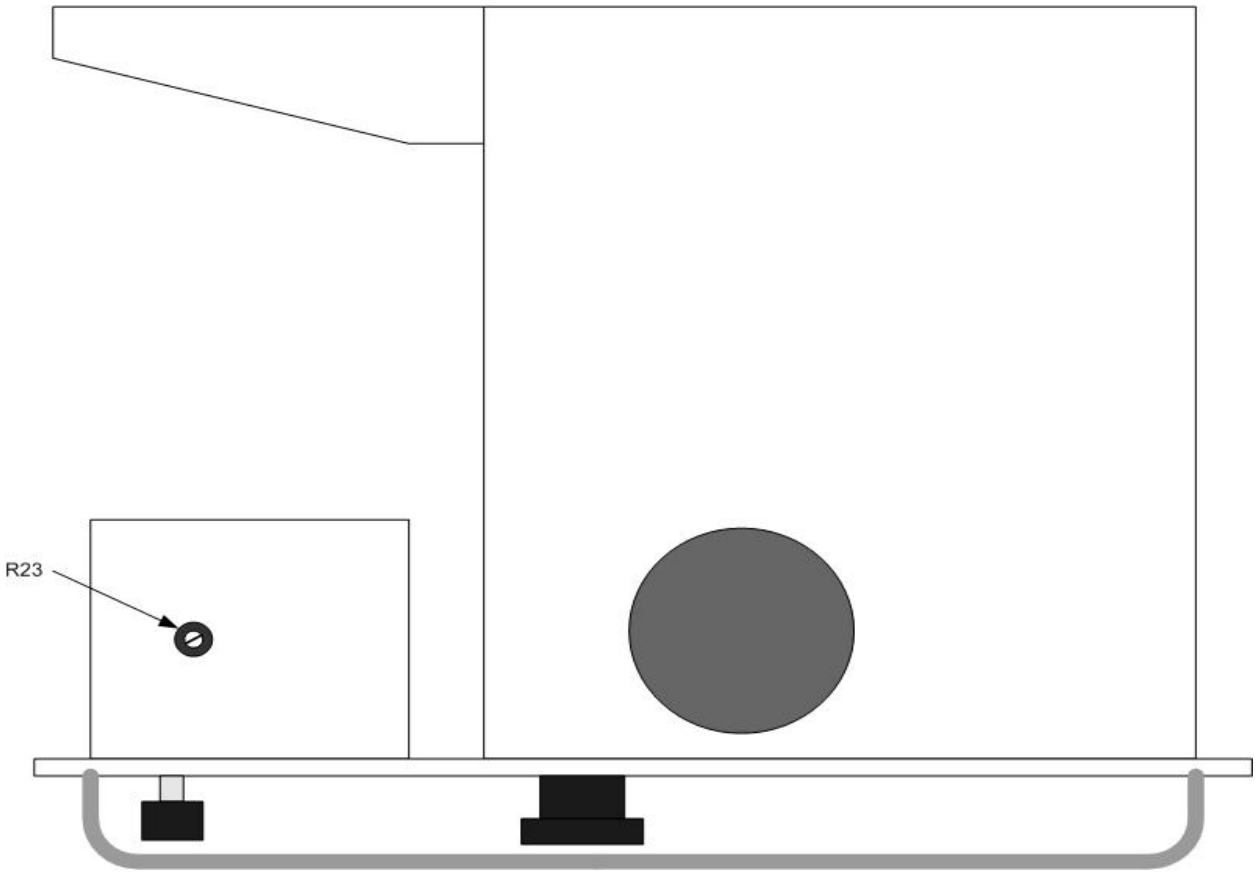

Figure 1. Left-side - adjustment location.

CAUTION

Do not allow **METER SWITCH** to go to **60 VOLTS** position during the following checks; damage to TI meter will result.

(6) Adjust **OPERATING VOLTAGE** control for a 500 V indication on TI meter.

(7) Operate and hold **METER SWITCH** to **50 MA**. Multimeter will indicate between 482 and 518 V dc. Release **METER SWITCH**.

(8) Adjust **OPERATING VOLTAGE** control for a 600 V indication on TI meter.

(9) Operate and hold **METER SWITCH** to **50 MA**. Multimeter will indicate between 582 and 618 V dc. Release **METER SWITCH**.

(10) Adjust **OPERATING VOLTAGE** control for minimum indication on TI meter.

b. Adjustments. No adjustments can be made.

9. Capacitance

a. Performance Check

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

(a) **DIAL CONTROL** to **0** on dial drum (**RANGE 2**).
(b) **SELECTOR** switch to **CAPACITANCE**.
(c) **PERCENT POWER FACTOR** control to **0**.
(d) Capacitance range switch to **5 TO 100 MMF** (position 2).

(2) If TI meter indication is not below **MIDSCALE**, perform **b** below.

(3) Adjust **DIAL CONTROL** for minimum indication on TI meter. TI dial drum indication will be within 0.5 pF of 0.

(4) Connect multimeter and 100 pF capacitance standard to TI capacitance binding posts. Bend adapters 90 degrees to connect capacitance standard to TI binding posts.

(5) Turn **DIAL CONTROL** throughout its range while observing multimeter. Indication on multimeter will not exceed 50 V ac. Disconnect multimeter.

(6) Adjust **DIAL CONTROL** for minimum indication on TI meter. Dial drum of TI will indicate between 97 and 103 pF. If not reverse connection of capacitance standard to TI and readjust **DIAL CONTROL** for minimum meter indication. If dial drum still does not indicate between 97 and 103 pF, perform **b** below.

(7) Turn capacitance range switch to **80** to **50000 MMF**.

(8) Repeat (4) above.

(9) Turn **DIAL CONTROL** throughout its range while observing multimeter. Indication on multimeter will not exceed 20 V ac. Disconnect multimeter.

(10) Adjust **DIAL CONTROL** for minimum indication on TI meter. Dial drum will indicate between 95 and 105 pF.

(11) Repeat technique of (10) above using capacitance standard values listed in table 3. Dial drum will indicate within limits specified. If TI indications are not within limits listed in table 3, perform **b** (11) below.

Table 3. 80 to 50,000 MMF Range

Capacitance standard values (pF)	Test Instrument dial drum indications (pF)	
	Min	Max
400	380	420
1000	950	1050
2000	1900	2100
5000	4750	5250
10,000	9500	10,500
20,000	19,000	21,000
30,000	28,500	31,500
40,000	38,000	42,000

(12) Turn capacitance range selector switch to **.04 TO 30 MF**.

(13) Repeat technique of (4) above, using 0.05 μF capacitance standard.

(14) Turn **DIAL CONTROL** throughout its range while observing digital voltmeter. Indication on multimeter will not exceed 10 V ac. Disconnect multimeter.

(15) Adjust **DIAL CONTROL** and **PERCENT POWER FACTOR** control for minimum indication on TI meter. Dial drum indication will be between 0.047 and 0.053 μF.

(16) Repeat technique of (15) above, using capacitance standard values listed in table 4. Dial drum indications will be within limits specified.

Table 4. .04 to 30 MF Range

Capacitance standard (μF)	Test instrument dial drum indications (μF)	
	Min	Max
0.20	0.19	0.21
0.4	0.38	0.42
0.7	0.665	0.735
1.0	0.95	1.05
1.4	1.33	1.47

(17) Connect resistance standard No. 1 and 1 μF capacitance standard in series with capacitance binding posts.

(18) Adjust resistance standard No. 1 to 500 Ω.

(19) Adjust **DIAL CONTROL** and **PERCENT POWER FACTOR** control for minimum indication on TI meter. Indication on **PERCENT POWER FACTOR** control will be between 26.5 and 33.5.

b. Adjustments

(1) Remove dust cover from TI.

(2) Turn rotor of C19 (fig. 2) to midrange.

(3) Connect 100 pF capacitance standard to TI capacitance binding posts.

(4) Turn capacitance range switch to **5 TO 100 MMF** and turn **DIAL CONTROL** to **100 μF**.

(5) Unlock set screws of capacitors C12 (fig. 2).

(6) Adjust C12 shaft for minimum indication on TI meter (R).

(7) Disconnect capacitance standard from TI.

(8) Set **DIAL CONTROL** to **0**.

(9) Adjust C19 (fig. 2) for minimum indication on TI meter (R).

(10) Repeat technique of (3) through (9) above until minimum indications are obtained on TI meter at both **100 μF** and **0** settings of **DIAL CONTROL**.

(11) On opposite end of tuning indicator drum, from drive wheel's (top side), there is a screw in a curved slot. Loosen screw (R16, tuning resistor) and slide in curved slot to adjust. Repeat steps **9 a** (1) through (6).

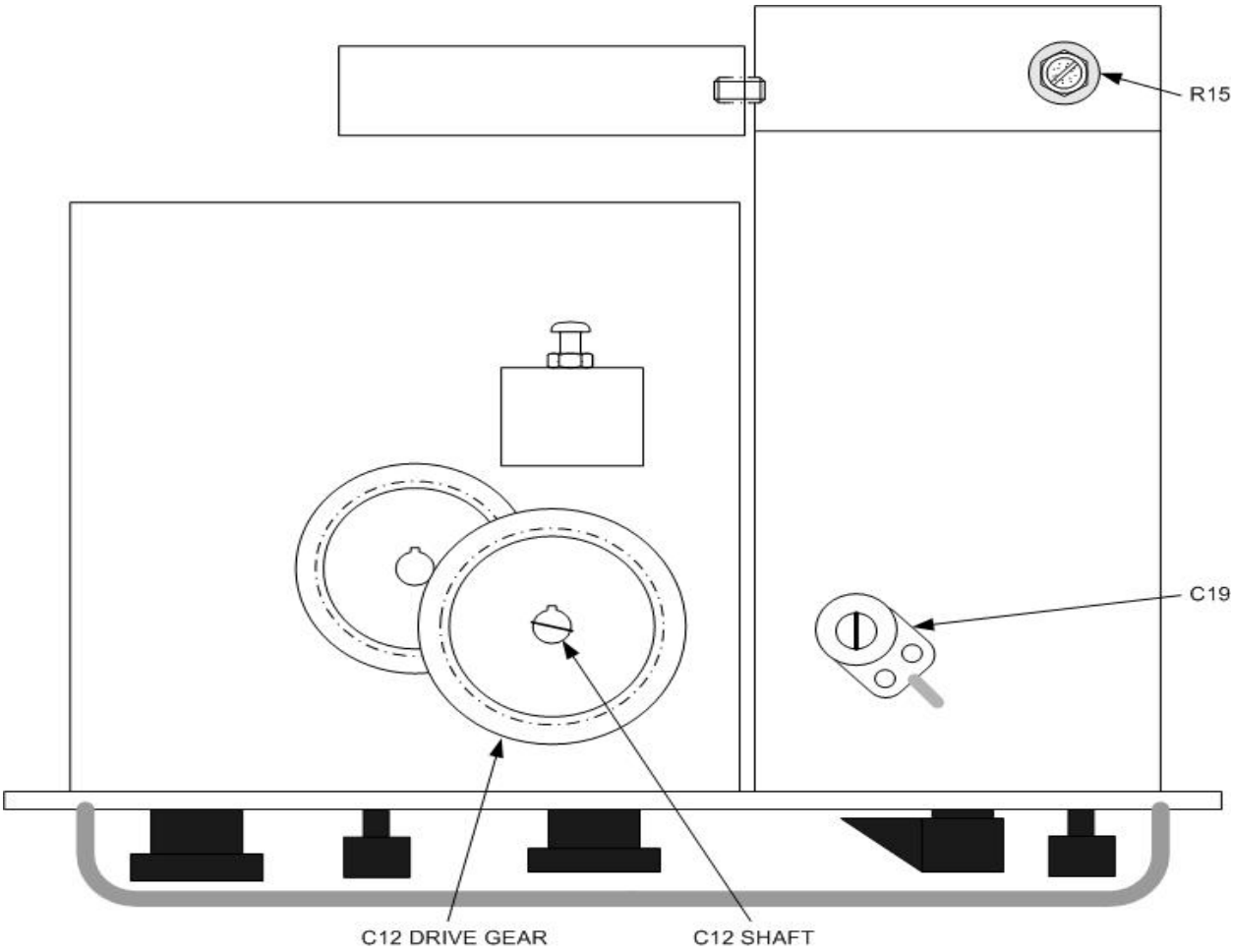

Figure 2. Right-side view - adjustment locations.

10. Insulation Resistance

a. Performance Check

(1) Set **SELECTOR** switch to **INSULATION RESISTANCE** and megohm range switch to **MEGOHMS X1**.

(2) Remove dust cover from TI.

(3) Adjust R23 (fig. 1) for 10 mA indication on TI meter.

(4) Turn **DIAL CONTROL** fully ccw and operate **KEY** switch. Indication on TI meter will remain at 10 mA.

(5) Set **SELECTOR** switch to **LEAKAGE**.

(6) Connect equipment as shown in figure 3.

CAUTION

Remove connection ground strap from resistance standard No. 1 to prevent high voltage from being present on chassis of resistance standard when TI's **KEY** switch is operated.

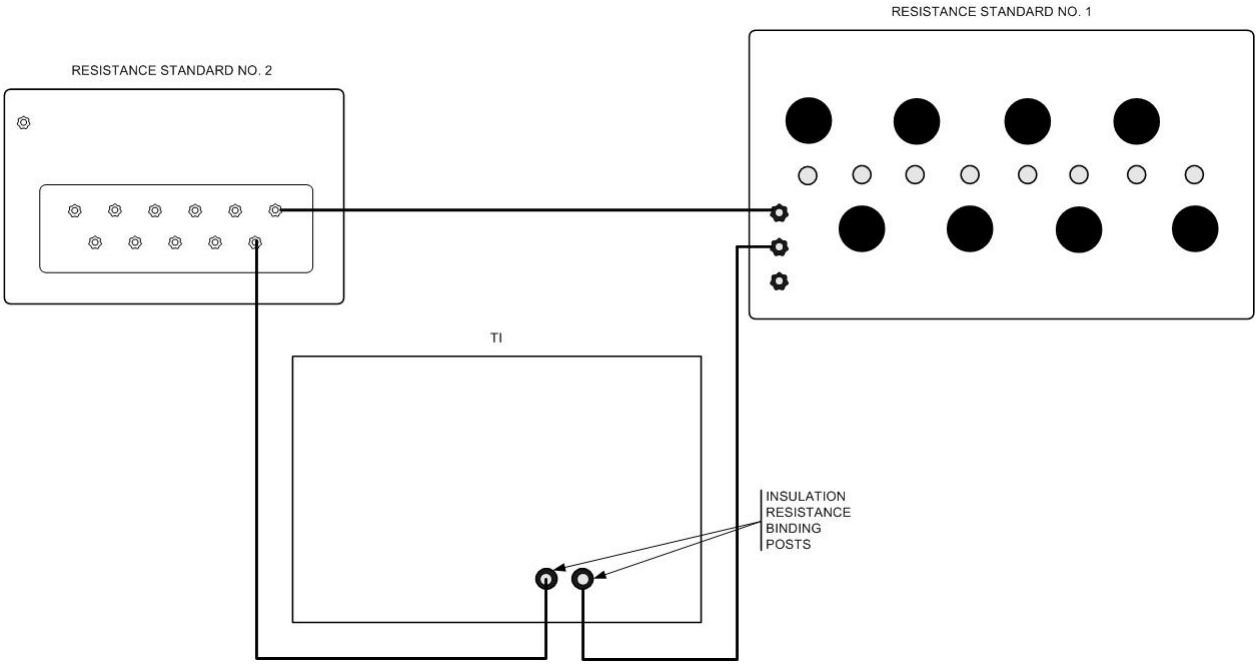

Figure 3. Insulation resistance - equipment setup.

(7) Set **SELECTOR** switch to **INSULATION RESISTANCE**.

(8) Adjust **DIAL CONTROL** for indication of 1.1 MΩ on dial drum (**RANGE 1**).

(9) With resistance standard No. 2 connected for 1 MΩ, adjust resistance standard No. 1 to 100 kΩ. Note indication on TI meter.

(10) Operate **KEY** switch and adjust resistance standard No. 2 and resistance standard No. 1 for same TI meter indication noted in (9) above. Combined resistance of resistance standard No. 1 and resistance standard No. 2 will be between 0.88 and 1.32 MΩ.

(11) Repeat technique of (8) through (10) above, using indications listed in table 5.

(12) Set megohm range switch to **MEGOHM X100**.

(13) Replace resistance standard No. 2 with resistance standard No. 4.

(14) Repeat technique of (8) through (10) above, using indications listed in table 6. If total applied resistance is not within limits specified, perform **b** below.

Table 5. Insulation Resistance (**MEGOHMS X1** range)

Test instrument dial drum indications	Total applied resistance (MΩ)	
	Min	Max
1.5	1.2	1.8
2	1.6	2.4
3	2.4	3.6
5	4.0	6.0
15[1]	12.0	18.0
25	20.0	30.0
50	40.0	60.0
90	72.0	108.0

[1]Replace decade resistor with resistance standard No. 3.

Table 6. Insulation Resistance (**MEGOHMS X100** range)

Test instrument dial drum indications	Total applied resistance (MΩ)	
	Min	Max
1.50	120	180
2.00	160	240
5.00	400	600
10.00	800	1200

b. Adjustments

(1) Remove dust cover from TI.

(2) Connect 200 MΩ terminals of resistance standard No. 4 to TI insulation resistance binding posts.

(3) Set megohms range switch to **MEGOHMS X100** and adjust **DIAL CONTROL** for dial drum indication of 2.00 on range 1.

(4) Adjust R15 (fig. 2) to obtain same indication on TI meter with **KEY** switch either operated or released (R).

11. 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

0712805

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342101, requirements for calibration procedure TB 9-6625-381-24.

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.