

TB 9-4931-523-24

CHANGE 4

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR ATTENUATORS, FIXED AND VARIABLE (10 MHZ TO 40 GHZ) (GENERAL)

Headquarters, Department of the Army, Washington, DC
30 March 2010

Distribution Statement A: Approved for public release; distribution is unlimited.

TB 9-4931-523-24, 23 March 2009, is changed as follows:

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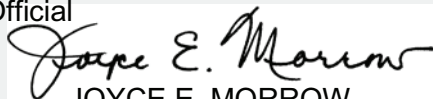
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Distribution: To be distributed in accordance with IDN 342070, requirements for calibration procedure TB 9-4931-523-24.

TB 9-4931-523-24

CHANGE 3

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR ATTENUATORS, FIXED AND VARIABLE (10 MHZ TO 40 GHZ) (GENERAL)

Headquarters, Department of the Army, Washington, DC
14 July 2009

Distribution Statement A: Approved for public release; distribution is unlimited.

TB 9-4931-523-24, 23 March 2009, is changed as follows:

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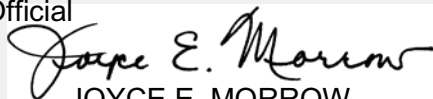
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Distribution: To be distributed in accordance with IDN 342070, requirements for calibration procedure TB 9-4931-523-24.

TB 9-4931-523-24

CHANGE 2

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR ATTENUATORS, FIXED AND VARIABLE (10 MHZ TO 40 GHZ) (GENERAL)

Headquarters, Department of the Army, Washington, DC
7 May 2009

Distribution Statement A: Approved for public release; distribution is unlimited.

TB 9-4931-523-24, 23 March 2009, is changed as follows:

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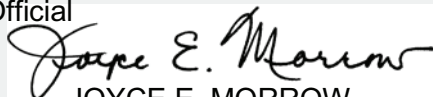
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Distribution: To be distributed in accordance with IDN 342070, requirements for calibration procedure TB 9-4931-523-24.

TB 9-4931-523-24

CHANGE 1

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR ATTENUATORS, FIXED AND VARIABLE (10 MHZ TO 40 GHZ) (GENERAL)

Headquarters, Department of the Army, Washington, DC
3 April 2009

Distribution Statement A: Approved for public release; distribution is unlimited.

TB 9-4931-523-24, 23 March 2009, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page.

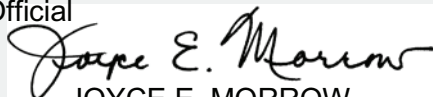
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Distribution:

To be distributed in accordance with IDN 342070, requirements for calibration procedure
TB 9-4931-523-24.

*TB 9-4931-523-24

CALIBRATION PROCEDURE FOR ATTENUATORS, FIXED AND VARIABLE (10 MHZ TO 26.5 GHZ) (GENERAL)

Headquarters, Department of the Army, Washington, DC
23 March 2009

Distribution Statement A: Approved for public release; distribution is unlimited.

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 9-4931-523-35, dated 14 May 2003, including all changes.

SECTION I IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This procedure provides instructions for the calibration of Attenuators, Fixed and Variable (10 MHz to 26.5 GHz) (General). 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 Appendix A.

b. Time and Technique. The time required for this calibration is approximately 2 hours for fixed and variable attenuators from 10 MHz to 26.5 GHz.

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 that pertain to this calibration are listed in Appendix A. TIs other than those listed in the appendix may be checked using the techniques in this TB if the manufacturers' specifications are available.

SECTION II EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 1 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, 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 1. The accuracies listed in table 1 provide a four-to-one ratio between the standard and TI. Appendix A is footnoted where the four-to-one ratio may not be met.

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 1. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
MEASURING RECEIVER	Frequency measurement: Range: 10 MHz to 26.5 GHz Accuracy: $\pm 0.5\%$ Power measurement: Frequency: 250 kHz to 26.5 MHz Range: +10 dB to -113 dB Accuracy: ± 0.125 dB	Measuring receiver system N5530S consisting of: Spectrum Analyzer, Agilent Model E4440A (E4440A), Power meter, Agilent Model E4419B (E4419B), and Sensor module, Agilent Model N5532A opt. 504 (504), 518 (518), 526 (526)
SYNTHESIZED SIGNAL GENERATOR	Frequency range: 0.01 to 40 GHz ¹ Power output: +8 dBm, ± 1 dB Flatness: 10 to 50 MHz: ± 2 dB .05 to 18 GHz: ± 0.8 dB	Wiltron/Anritsu, Model 68369NV (68369NV)

¹Not calibrated above 18 GHz.

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 1.

c. This calibration bulletin contains information and techniques for the calibration of attenuators from 10 MHz to 26.5 GHz.

d. Attenuators with specifications below 10 MHz should use the techniques presented in TB 9-6625-2181-35.

7. Equipment Setup

a. Refer to TI as listed in appendix and evaluate TI for connector type, impedance, and frequency range. Determine and record at least 10 equally spaced frequency test points.

NOTE

The calibration frequencies attached to TI or test report furnished with TI may be used if desired.

b. Refer to TI type and frequency range for performance paragraph as listed in (1) through (2) below:

(1) Fixed attenuator with frequency range between 10 MHz and 26.5 GHz refer to **d** below.

(2) Variable attenuator with frequency range between 10 MHz and 26.5 GHz refer to **d** below.

NOTE

The insertion loss measurements for attenuators listed in the appendix are considered adequate for determining their accuracy and serviceability. VSWR checks are not required.

NOTE

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.

c. Connect sensor modules to the power reference output. Perform sensor zero and calibration.

d. Connect equipment as shown in figure 1 and allow equipment to warm up for 1 hour before performing paragraph 8 or 9 below.

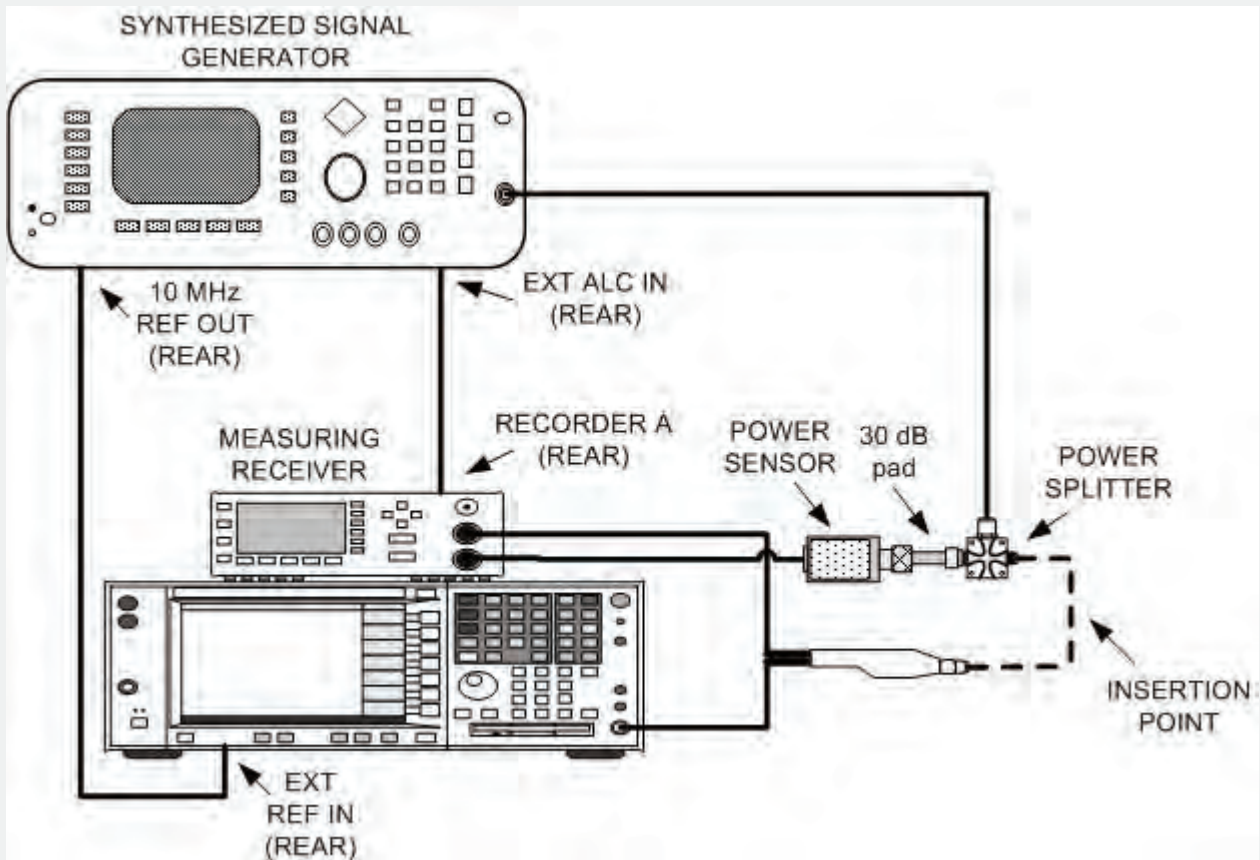


Figure 1. Attenuation measurement (10 MHz to 26.5 GHz equipment setup)

8. Fixed Attenuation Measurement (10 MHz to 26.5 GHz)

a. Performance Check

NOTE

The frequency range of the TI will determine which sensor module is used. 504: 100 KHz – 4.2 GHz, 518: 10 MHz – 18 GHz, 526: 30 MHz – 26.5 GHz.

NOTE

Verify the proper Cal Factors are loaded for the power sensor module being utilized.

NOTE

Ensure measuring receiver measurement accuracy is set to high.

(1) Adjust signal generator frequency controls to the first test frequency recorded in **7 a** above and adjust output for 0.0 dBm.

(2) Configure measuring receiver for tuned RF level measurements and manually enter carrier frequency into measuring receiver. Record reading as reference.

(3) Adjust signal generator output in 10 dBm steps to -70 dBm. Allow the measuring receiver to acquire the signal at each level.

NOTE

Use adapters as needed.

NOTE

Use 50 Ω to 75 Ω or 50 Ω to 93 Ω adapters when TI is 75 Ω or 93 Ω .

(4) Adjust signal generator output for 0.0 dBm indication on measuring receiver.

(5) Configure measuring receiver in the ratio mode.

(6) Connect the attenuator at the TI INSERTION POINT as shown in figure 1.

(7) Measure and record measuring receiver indication. Measured attenuation will be within range and accuracies specified in Appendix A for TI being calibrated.

NOTE

When calibrating a set of attenuators test each attenuator in the set at each test frequency before setting a new reference frequency.

(8) Repeat steps (1) through (7) above for remaining test frequencies recorded in **7 a** above.

b. Adjustments. No adjustments can be made; however, a correction chart may be prepared listing actual measuring receiver indications at frequencies of interest.

9. Variable Attenuation Measurement (10 MHz to 26.5 GHz)

a. Performance Check

NOTE

The frequency range of the TI will determine which sensor module is used. 504: 100 KHz – 4.2 GHz, 518: 10 MHz – 18 GHz, 526: 30 MHz – 26.5 GHz.

NOTE

Verify the proper cal factors are loaded into the controller for the power sensor module being utilized.

NOTE

Ensure measuring receiver measurement accuracy is set to high.

(1) Adjust signal generator frequency controls to the first test frequency recorded in **7 a** above and adjust output for 0.0 dBm.

(2) Configure measuring receiver for tuned RF Level measurements and manually enter carrier frequency into measuring receiver. Record reading as reference.

(3) Adjust signal generator output in 10 dBm steps to -70 dBm. Allow the measuring receiver to acquire the signal at each level.

NOTE

Use adapters as needed.

NOTE

Use 50 Ω to 75 Ω or 50 Ω to 93 Ω adapters when TI is 75 Ω or 93 Ω .

(4) Adjust signal generator output for 0.0 dBm indication on measuring receiver.

(5) Configure measuring receiver in the ratio mode.

(6) Connect the attenuator at the TI INSERTION POINT as shown in figure 1.

(7) Measure and record measuring receiver indication as insertion loss. Measured attenuation will be within range and accuracies specified in Appendix A, insertion loss column, for TI being calibrated.

(8) Increase TI attenuation setting in one step increments (or one cardinal point as desired.)

(9) Measure and record measuring receiver indication. Measured attenuation will be within range and accuracies specified in Appendix A for TI being calibrated.

(10) Repeat steps (1) through (9) above for remaining test frequencies recorded in **7 a** above.

b. Adjustments. No adjustments can be made; however, a correction chart may be prepared listing actual measuring receiver indications at frequencies of interest.

10. Final Procedure

a. Deenergize and disconnect all equipment.

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

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model Number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
A200302	Weinschel	10	DC to 18		
			DC to 12.4	±0.3	
			12.4 to 18	±0.5	
A2648B ² (MIS-10263)	RLC Electronics	0 to 120 ³	DC to 1		≤0.25
			DC to 0.1		≤0.75
			0.1 to 0.5		≤1.50
			0.5 to 1		
		0 to 60	DC to 0.01	±0.15 ⁴	
		60 to 120 ³		±0.30	
		0 to 60	0.01 to 0.1	±0.35 ⁵	
		60 to 120 ³		±0.70 ⁵	
		0 to 120 ³	0.1 to 1	±3.0	
AB20B	Microlab/FXR	20	DC to 4.5		
			DC to 3	±0.7	
			3 to 4.5	±1.0	
AB30N	Microlab/FXR	30	DC to 4.5		
			DC to 3	±0.7	
			3 to 4.5	±1.0	
AC20N	Microlab/FXR	20	DC to 3	±1.2	
AD06N	Microlab/FXR	6	3 to 4.5	±0.6	
AC119A-99-33	Weinschel	0 to 99	DC to 18	±0.05	
		1 to 9	DC to 18		≤0.5
		10 to 19	DC to 18		≤1.0
		20 to 29	DC to 18		≤1.2
		30 to 39	DC to 18		≤1.4
		40 to 49	DC to 18		≤1.5
		50 to 59	DC to 18		≤1.7
		60 to 69	DC to 18		≤1.9
		70 to 79	DC to 18		≤2.1
		80 to 89	DC to 18		≤2.3
		90 to 99	DC to 18		≤2.5
AF117A69-34 ²	Weinschel	0 to 69	DC to 18		≤1.2
		1 to 9	DC to 18	±0.5	
		10 to 19	DC to 18	±1.0	
		20 to 29	DC to 18	±1.2	
		30 to 39	DC to 18	±1.4	
		40 to 49	DC to 18	±1.5	
		50 to 59	DC to 18	±1.7	
		60 to 69	DC to 18	±1.8	
AN9444-3	Arra	3	DC to 18	±0.3	
AN9444-6	Arra	6	DC to 18	±0.3	
AS1	Weinschel	See Weinschel 50-3, 50-6, 50-10, 50-20, and 210-3, 210-6, 210-10, 210-20			
AS4	Weinschel	See Weinschel 50-3, 50-6, 50-10, 50-20, and 530A-3, 530A-6, 530A-10, 530A-20			
AS5	Weinschel	See Weinschel 1-3, 1-6, 1-10, 1-20			
AS5A	Weinschel	See Weinschel 1-3, 1-6, 1-10, 1-20			
AS6	Weinschel	See Weinschel 2-3, 2-6, 2-10, 2-20			
AS6A	Weinschel	See Weinschel 2-3, 2-6, 2-10, 2-20			

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
AT201SR ²	RLC Electronics	0 to 120 ³	DC to 1	±0.5 or 2% whichever is greater	
			DC to 0.2		
			0.25 to 0.5		
			0.5 to 1.0		
CN713U		0 to 20	4.4 to 5	±2.0	
CN797U	PRD Electronics	10	2.0 to 10	±0.12	
CN895	Cessna Aircraft	20	DC to 1	±0.5	
CN908U	Hewlett-Packard	See Hewlett-Packard G382A			
CN970U	Hewlett-Packard	See Hewlett-Packard 355C			
G382A	Hewlett-Packard	0 to 50	3.95 to 5.85	±0.1 or ±2% whichever is greater	
GGLFHN100	PRD Electronics	20	6	±1.0	
H101	PRD Electronics	0 to 60	7.05 to 10	0± 1 or ± 2% whichever is greater	≤0.5
		0 to 50			
		50 to 60			
H101SH	PRD Electronics	See H101			
H175A20DB	Microlab/FXR	20	3.95 to 5.85	±0.5	
H382A	Hewlett-Packard	0 to 50	7.05 to 10.0	±0.1 or ±2% whichever is greater	≤1.0
K175AF10DB	Microlab/FXR	10	18 to 26.5	±0.3	
K375A	Hewlett-Packard	0 to 20	18 to 26.5		
		0 to 10		±1.0	
		10 to 20		±2.0	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
K382A	Hewlett-Packard	0 to 50	18 to 26.5	±0.1 or ±2% whichever is greater	≤1.0
MDC1078S-3	Midisco	3	DC to 3		
			3	±0.3	
MDC1078S-6	Midisco	6	DC to 18	±0.3	
MDC5078S-10	Midisco	10	DC to 18	±0.5	
MDC5078S-20	Midisco	20	DC to 18	±0.7	
MDC5078S-3	Midisco	3	DC to 18	±0.3	
MDC5078S-6	Midisco	6	DC to 18	±0.3	
MDC88014-10	Midisco	10	DC to 12.4		
			DC to 6	±0.2	
			6 to 12.4	±0.4	
MIS-10263	See RLC Electronics A2648B				
MIS-38936	Telonic Berkeley	0 to 120 ³	DC to 1		≤3.0
		0 to 120	DC to 0.01	±0.30	
		0 to 60	0.01 to 0.1	±0.35 ⁵	
		60 to 120		±0.70 ⁵	
		0 to 120	0.1 to 1	±3.00	
		0 to 60	DC to 0.01	±0.05 ^{5, 6}	
			0.01 to 0.1	±0.10 ^{5, 6}	
			0.1 to 1	±0.75 ⁶	
N9412-10	Arra Inc	10	DC to 18		
			DC to 12	±1.0	
			12 to 18	±2.0	
N9412-20	Arra Inc	20	DC to 18		
			DC to 12	±1.5	
			12 to 18	±2.0	
P382A	Hewlett-Packard	0 to 50	12.4 to 18	±0.1 or ±2% whichever is greater	≤1.0
R382A	Hewlett-Packard	0 to 50	26.5 to 40	±0.1 or ±2% whichever is greater	≤1.0
RFB551-50	Meggitt Avionics	0 to 80	DC to 0.225	±1.6	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
TAD50A	Telonic	0 to 110	DC to 0.9		
		0 to 10	0.03	±0.15	≤0.1
			0.4	±0.3	≤0.5
			0.9	±0.5	≤0.7
		11 to 110	0.03	±3% + 0.15 dB	
			0.4	±5% + 0.3 dB	
0.9	±8% + 0.5 dB				
TG950A	Telonic	0 to 102	DC to 0.3		≤0.8 dB/100 MHz
			DC to 0.05	0.05 or ±1% whichever is greater	
			0.05 to 0.2	0.2 or ±1% whichever is greater	
			0.2 to 0.3	±0.5/step	
TG950X9	Telonic	See TG950A			
U175AF10DB	Microlab/FXR	10	26.5 to 40	±0.3	
V727	Narda	0 to 20	26.5 to 40		≤0.5
		0 to 10		±1.0	
		10 to 20		±1.5	
W175A20DB	Microlab/FXR	20	7.05 to 10	±0.5	
X175A10DB	Microlab/FXR	10	8.2 to 12.4	±0.3	
X175A20DB	Microlab/FXR	20	8.2 to 12.4	±0.5	
X370B	Hewlett-Packard	6	8.2 to 12.4	±20%	
X370C	Hewlett-Packard	10	8.2 to 12.4	±20%	
X382A (7909033)	Hewlett-Packard	10 to 50	8.2 to 12.4	±0.1 or ±12.4% whichever is greater	≤1.0
Y175A10DB	Microlab/FXR	10	12.4 to 18	±0.3	
Y175A20DB	Microlab/FXR	20	12.4 to 18	±0.5	
011-0085-00	Tektronix	10	DC to 12.4	±1.0	
011-0086-00	Tektronix	20	DC to 12.4	±1.0	
011-0087-00	Tektronix	40	DC to 12.4	±1.5	
0880-3100 (7913358-1-2)	General Radio	6	DC to 12.5		
			At DC	±0.04	
			DC to 5	±0.3	
0880-3110 (7913358-2-2)	General Radio	See 0880-3100		±0.4	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
1	Weinschel	See 1-10, 1-20, 1-3,1-30, and 1-6			
1-10	Weinschel	10	DC to 12.4	±0.5	
1-10N(7911956)	Weinschel	10	DC to 12.4	±0.5	
1-20	Weinschel	20	DC to 12.4	±0.5	
1-20N	Weinschel	20	DC to 12.4		±0.5
1-3	Weinschel	3	DC to 12.4	±0.3	
1-3N	Weinschel	3	DC to 12.4	±0.3	
1-30	Weinschel	30	DC to 12.4	±0.75	
1044-18N	Midwest Mwave	0 to 69	DC to 18		
			DC to 4		≤0.7
			4 to 12.4		≤1.0
			12.4 to 18		≤1.5
		1 to 9	DC to 18	±0.5	
		10 to 19		±1.0	
		20 to 29		±1.2	
		30 to 39		±1.4	
		40 to 49		±1.5	
		50 to 59		±1.6	
60 to 69		±1.8			
1100A	PRD Electronics	3	DC to 4.0	±0.3 at 1.2 GHz	
1100B	PRD Electronics	6	DC to 6.0	±0.5	
1100C (8520731)	PRD Electronics	10	DC to 4.0	±1.0 at 1.2 GHz	
11708A	Hewlett-Packard	30	At 50 MHz	±0.05	
118A4	Narda	See 777C-3, 777C-6, 777C-10, and 777C-20			
119A4	Narda	See 757C-3, 757C-6, 757C-10, and 757C-20			
12N-10	Inmet Corp	10	DC to 12.4	±0.5	
12N-20	Inmet Corp	20	DC to 12.4	±0.75	
12N-3	Inmet Corp	3	DC to 12.4	±0.3	
12N-6	Inmet Corp	6	DC to 12.4	±0.3	
13534006	Weinschel	40	DC to 4	±0.4	
			4 to 8.5	±0.75	
18N-10	Inmet Corp	10	DC to 18	±0.75	
18N-10S	Inmet Corp	10	DC to 18	±0.75	
18N-20	Inmet Corp	20	DC to 18	±0.75	
18N-30	Inmet Corp	30	DC to 18	±0.75	
18N-6	Inmet Corp	6	DC to 18	±0.3	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
190-599	Weinschel	50	DC to 18	±1.0	
2-10DB	Weinschel	10	DC to 18	±0.5	
2-20DB	Weinschel	20	DC to 18	±0.5	
2-3DB	Weinschel	3	DC to 18	±0.3	
2-30DB	Weinschel	30	DC to 18	±1.0	
2-6DB	Weinschel	6	DC to 18	±0.3	
20-0	Kay Elemetrics	0 to 41	DC to 0.5		
			DC to 0.25	±0.5	≤0.1
			0.25 to 0.5	±1.2	≤0.2
20-20	Weinschel	20	DC to 18	±0.5	
219-10	Midwest Mwave	10	DC to 18	±0.5	
219-20	Midwest Mwave	20	DC to 18	±0.5	
219-3	Midwest Mwave	3	DC to 18	±0.3	
219-6	Midwest Mwave	6	DC to 18	±0.3	
2082-4182-03	Omni Spectra	3	DC to 21.5	±0.3	
2701	Tektronix	0 to 79	DC to 1		≤ -(0.5 + 0.14 dB/100 MHz)
		Units error		+0.1 to -0.5	
		Max error		+0.1 to -0.7	
		1	0.01 to 1	+0.31 to -0.71	
		2		+0.32 to -0.72	
		4		+0.33 to -1.02	
		8		+0.36 to -1.34	
		10		±0.58	
		20		±0.66	
		30		±0.74	
		40		±0.92	
2936 (7913175)	Narda	5 to 90	.95 to 1.25		±9.0
		5 to 20		±0.5	
		20 to 40		±0.3	
		40 to 70		±0.5	
		70 to 90		±0.75	
30-0	Kay Elemetrics	0 to 101	DC to 0.5		
			DC to 0.25	±1.0	≤0.10
			0.25 to 0.5	±2.0	≤0.20
32-0	Kay Elemetrics	See 30-0			
355C ²	Hewlett-Packard	0 to 12	DC to 1		See Footnote ⁸
			0.0001	±0.1	
			DC to 0.5	±0.25	
			0.5 to 1	±0.35	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
355D ²	Hewlett-Packard	0 to 120 ³	DC to 1		≤.20 dB+2.30 dB/GHz
			0.0001	±0.3	
		0 to 90	< 1GHz	±1.5	
		90 to 120 ³	< 1GHz	±3.0	
3750A	Hewlett-Packard (75Ω)	0 to 99	Dc to 0.1		≤0.1
			0.05		≤0.04
			0.1		
	Cumulative	Units	DC to 0.1	±0.1	
		Tens		±0.2	
		0 to 79		±0.5 ⁵	
0 to 89			±1.0		
		0 to 99	±2.0		
389-10	Midwest Mwave	10	DC to 18	±0.5	
389-3	Midwest Mwave	3	DC to 18	±0.3	
3M	Weinschel	1 to 10	DC to 12.4	±0.3	
		20		±0.5	
		30 and 40		±0.75	
		50 and 60		±1.0	
4108-10DB	ITT Electronics	10	DC to 8	±0.5	
4108-20DB	ITT Electronics	20	DC to 8	±0.5	
4108-3DB	ITT Electronics	3	DC to 8	±0.5	
4108-6DB	ITT Electronics	6	DC to 8	±0.5	
432D	Kay Elemetrics	0 to 101	DC to 1		
			DC to 0.25	±0.6	≤0.1
			0.25 to 0.5	±1.2	≤0.2
			0.5 to 1	±2.0	≤0.6
44-20	Weinschel	20	DC to 18	±0.5	
44-30	Weinschel	30	DC to 18	±1.0	
44-6	Weinschel	6	DC to 18	±0.3	
44-60	Weinschel	60	DC to 18	±1.5	
442D	Kay Elemetrics (75Ω)	0 to 101	DC to 1		
			DC to 0.25	±1.0	≤.1
			0.25 to 0.5	±1.2	≤.
			0.5 to 1	±2.0	≤.4
464A (MIS-10263)	Kay Elemetrics	See RLC Electronics A2648B			
467A	Kay Elemetrics	0 to 12	DC to 1.5		≤0.05dB/100 MHz
			DC to 1	±0.3	
			1 to 1.5	±0.5	
49-20-33	Weinschel	20	DC to 8.5		
			DC to 4	±0.4	
			4 to 8.5	±0.7	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)	
50-1	Weinschel	1	DC to 3.0	±0.2		
50-10	Weinschel	10	DC to 3.0	±0.2		
50-2	Weinschel	2	DC to 3.0	±0.2		
50-20	Weinschel	20	DC to 3.0	±0.2		
50-3	Weinschel	3	DC to 3.0	±0.2		
50-6	Weinschel	6	DC to 3.0	±0.2		
50CV120-726	Alan Inc	0 to 120 ³	DC to 1	±0.5 or 2% whichever is greater	≤1.0	
50MP10-1100	Alan Inc	10	DC to 18	±0.5		
50MP30-864	Alan Inc	30	DC to 18	±1.0		
50TA101-377	Alan Inc	0 to 101	DC to 1	±2.0	≤1.0	
50TA101-814	Alan Inc	0 to 101	DC to 1	±0.2 or 2% whichever is greater		
50TA102-261	Alan Inc	0 to 102	DC to 0.3			≤1.0
			DC to 0.1			
			0.1 to 0.2			
			0.2 to 0.3	≤2.0		
			DC to 0.05	±0.05 or 1%		
0.05 to 0.2	±0.2 or 1%					
			0.2 to 0.3	±0.5		
530-10	Weinschel	10	1 to 12.4			
			4			±0.1
			1			0, -0.8 ⁷
			10			+0.5, -0.1 ⁷
530-20	Weinschel	20	2 to 12.4			
			4			±0.2
			2			0, -0.9 ⁷
			10	+0.4, -0.1 ⁷		
530-3	Weinschel	3	0.6 to 12.4			
			4			±0.1
			1			0, -0.2 ⁷
			10	+0.2 -0.1 ⁷		
530-7	Weinschel	7	1 to 12.4			
			4			±0.1
			1			0, -0.6 ⁷
			10	+0.3, -0.1 ⁷		
5729-30	See 44-30					
60562	Waveline	0 to 60	8.2 to 12.4	0.1 or ±2% whichever is greater	1 dB max 0.5 dB typical	
		0 to 50				
		50 to 60				REF only
611	Waveline	0 to 30	8.2 to 12.4	±0.5	≤0.5	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
64A	Weinschel	0 to 64	DC to 2		
			1		
			2		
		Range A: 3 to 3.9	1 and 2	±0.7	
		Range B: 1 to 5	1 and 2	±0.12	
		Range B: 6 to 10	1 and 2	±0.15	
		Range C 10 to 50	1 and 2	±0.15 for the 10dB step, ±0.1/10dB +0.1 for 20 to 50dB step	
711	Waveline	0 to 30	12.4 to 18	±0.5	≤0.5
749B	Narda	0 to 40	12.4 to 18	±0.3	≤0.5
757-10	Narda	10	1 to 12.4	±0.17	
			1	+0 to -1.1	
			2	+0 to -0.7	
			3	±1.0	
			7	+0.6 to -0.1	
			12.4	+1.3 to -0	
757-20	Narda	20	1 to 12.4	±0.27	
			2	+0 to -1.2	
			3	±0.2	
			7	+1.3 to -0.2	
			12.4	+1.9 to -0	
757-3	Narda	3	0.6 to 12.4	±0.17	
			1	+0 to -0.3	
			2	+0 to -0.2	
			3	1.0	
			7	+0.2 to -0.1	
			12.4	+0.5 to -0	
757-6	Narda	6	1 to 12.4	±0.17	
			1	+0 to -0.6	
			2	+0 to -0.5	
			3	±0.1	
			7	+0.4 to -0.1	
			12.4	+0.7 to -0	
757C10	Narda	10	DC to 12.4		
			DC to 6	±0.3	
			6 to 12.4	±0.5	
757C20	Narda	20	DC to 12.4		
			DC to 6	±0.3	
			6 to 12.4	±0.5	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
757C3	Narda	3	DC to 12.4	±0.3	
757C40	Narda	40	DC to 12.4		
			DC to 6	±1.0	
			6 to 12.4	±1.25	
757C6	Narda	6	DC to 12.4	±0.3	
765-10	Narda	10	DC to 5		
			DC to 3	±0.25	
			3 to 5	±0.5	
765-20	Narda	20	DC to 5		
			DC to 3	±0.25	
			3 to 5	±0.5	
766-10	Narda	10	DC to 4		
			DC to 3	±0.25	
			3 to 4	±0.50	
766-20	Narda	20	DC to 4		
			DC to 3	±0.25	
			3 to 4	±0.50	
766-3	Narda	3	DC to 4		
			DC to 3	±0.25	
			3 to 4	±0.50	
766-30	Narda	30	DC to 4	±0.75	
768-10	Narda	10	DC to 11		
			DC to 3	±0.25	
			3 to 6	±0.50	
768-20	Narda	20	6 to 11	±0.75	
			DC to 11		
			DC to 3	±0.25	
768-3	Narda	3	3 to 6	±0.50	
			6 to 11	±0.75	
			DC to 11		
768-30	Narda	30	DC to 3	±0.25	
			3 to 6	±0.50	
			6 to 11	±0.75	
769-30	Narda	30	DC to 6		
			DC to 2	±0.5	
			2 to 6	±1.0	
773-20	Narda	20	DC to 6		
			DC to 3	±0.3	
			3 to 6	±0.5	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
773-3	Narda	3	DC to 6		
			DC to 3	±0.3	
			3 to 6	±0.5	
773-6	Narda	6	DC to 6		
			DC to 3	±0.3	
			3 to 6	±0.5	
777C10	Narda	10	DC to 12.4	±0.3	
777C20	Narda	20	DC to 12.4	±0.3	
777C3	Narda	3	DC to 12.4	±0.3	
777C6	Narda	6	DC to 12.4	±0.3	
779-10	Narda	10	DC to 18		
			DC to 12.4	±0.3	
			12.4 to 18	±0.5	
779-20	Narda	20	DC to 18		
			DC to 12.4	±0.5	
			12.4 to 18	±0.7	
779-3	Narda	3	DC to 18	±0.3	
779-6	Narda	6	DC to 18	±0.3	
7913358-1-2	See General Radio 0880-3100				
7913358-2-2	See General Radio 0880-3110				
7916821-1		3	DC to 18	±0.3	
7916821-2		6	DC to 18	±0.3	
7916821-4		20	DC to 18	±0.5	
7916821-5		30	DC to 18	±1.0	
7916821-8		60	DC to 18	±1.5	
793FM		Narda	0 to 20	4 to 8	±1.5
794FM	Narda	0 to 40	4 to 8	±1.5	≤1.5
8144A-102	Telonic	See MIS-38936			
8322	Bird Electronics	30	DC to 0.5	±0.5	
8323	Bird Electronics	30	DC to 0.5	±0.5	
8325	Bird Electronics	30	DC to 0.5	±0.5	
8329	Bird Electronics	30	DC to 0.5	±0.5	
8329-300	Bird Electronics	30	DC to 0.5	±0.5	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)			
839	Kay Elemetrics	0 to 101	DC to 3					
		1.0 to 20 dB steps	DC to .25	±0.1	≤0.2			
		1.0 to 10 dB steps	0.25 to 1	±0.2	≤0.4			
		20 dB steps	0.25 to 1	±0.3				
		1.0 to 10 dB steps	1 to 2	±0.3	≤0.7			
		20 dB steps	1 to 2	±0.5				
		1.0 to 10 dB steps	2 to 3	±0.6	≤1.0			
		20 dB steps	2 to 3	±0.8				
84904K	Agilent	0 to 11	DC to 26.5		≤0.8 + .04/GHz			
		1	DC to 18	±0.35				
		2		±0.45				
		3 to 6		±0.55				
		7 to 8		±0.60				
		9		±0.65				
		10		±0.70				
		11	±0.80					
		1	18 to 26.5	±0.40				
		2		±0.50				
		3 to 6		±0.70				
		7 to 8		±0.80				
		9		±0.85				
		10		±0.90				
		11		±1.10				
		84904L	Agilent	0 to 11		DC to 26.5		≤0.8 + 0.04/GHz
				1		DC to 18	±0.35	
				2			±0.45	
3 to 6	±0.55							
7 to 8	±0.6							
9	±0.65							
10	±0.7							
11	±0.8							
1	18 to 26.5			±0.4				
2				±0.5				
3 to 6				±0.7				
7 to 8				±0.8				
9				±0.85				
10				±0.9				
11				±1.1				

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
84906K	Agilent	0 to 90	DC to 40		$\leq 0.8 + 0.04/\text{GHz}$
		10		± 0.5	
		20		± 0.6	
		30		± 0.7	
		40		± 1.0	
		50		± 1.2	
		60		± 1.6	
		70		± 1.8	
		80		± 2.7	
90	± 2.9				
84906L	Agilent	0 to 90	DC to 40		$\leq 0.8 + 0.04/\text{GHz}$
		10		± 0.5	
		20		± 0.6	
		30		± 0.7	
		40		± 1.0	
		50		± 1.2	
		60		± 1.6	
		70		± 1.8	
		80		± 2.7	
90	± 2.9				
8490D10DB	Hewlett-Packard	10	DC to 50		
			DC to 26.5	-0.6 to +0.9	
			26.5 to 50	-0.6 to +1.3	
8490D20DB	Hewlett-Packard	20	DC to 50		
			DC to 26.5	-0.8 to +1.3	
			26.5 to 50	-0.8 to +1.7	
8491A10DB	Hewlett-Packard	10	DC to 12.4	± 0.5	
8491A20DB	Hewlett-Packard	20	DC to 12.4	± 0.5	
8491A30DB	Hewlett-Packard	30	DC to 12.4	± 1.0	
8491A3DB	Hewlett-Packard	3	DC to 12.4	± 0.3	
8491A40DB	Hewlett-Packard	40	DC to 12.4	± 1.5	
8491A6DB	Hewlett-Packard	6	DC to 12.4	± 0.3	
8491B010	Hewlett-Packard	10	See 8491B10		
8491B030	Hewlett-Packard	30	See 8491B30		
8491B050	Hewlett-Packard	50	DC to 18	± 1.5	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
8491B10	Hewlett-Packard	10	DC to 18	±0.6	
8491B20	Hewlett-Packard	20	DC to 18		
			DC to 12.4	±0.6	
			12.4 to 18	±1.0	
8491B30	Hewlett-Packard	30	DC to 18	±1.0	
8491B3	Hewlett-Packard	3	DC to 18	±0.3	
8491B6	Hewlett-Packard	6	DC to 18		
			DC to 12.4	±0.3	
			12.4 to 18	±0.54	
8492A003	Hewlett-Packard	3	DC to 18	±0.3	
8492A006	Hewlett-Packard	6	DC to 18		
			DC to 12.4	±0.3	
			12.4 to 18	±0.54	
8492A010	Hewlett-Packard	10	DC to 18	±0.6	
8492A020	Hewlett-Packard	20	DC to 18		
			DC to 12.4	±0.6	
			12.4 to 18	±1.0	
8492A050	Hewlett-Packard	50	DC to 18	±1.5	
8493A30DB	Hewlett-Packard	30	DC to 12.4	±1.0	
8493B006	Hewlett-Packard	6	DC to 18		
			DC to 12.4	±0.3	
			12.4 to 18	±0.4	
8493B010	Hewlett-Packard	10	DC to 18	±0.6	
8493B020	Hewlett-Packard	20	DC to 18		
			DC to 12.4	±0.6	
			12.4 to 18	±1.0	
8493C10	Hewlett-Packard	10	DC to 26.5		
			DC to 18	±0.3	
			18 to 26.5	±0.5	
8493C20	Hewlett-Packard	20	DC to 26.5		
			DC to 18	±0.5	
			18 to 26.5	±0.6	

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
8493C3	Hewlett-Packard	3	DC to 26.5		
			DC to 18	±0.5	
			18 to 26.5	±1.0	
8493C6	Hewlett-Packard	6	DC to 26.5	±0.6	
8494A (All Options)	Hewlett-Packard	0 to 11	DC to 4.0		<0.6 dB +0.09 dB/ GHz
				±0.2	
				±0.2	
				±0.3	
				±0.3	
				±0.3	
				±0.4	
				±0.4	
				±0.4	
				±0.5	
8494B	Hewlett-Packard	0 to 11	DC to 18		
		1	DC to 12.4	±0.3	
			12.4 to 18	±0.7	
		2	DC to 12.4	±0.3	
			12.4 to 18	±0.7	
		3	DC to 12.4	±0.4	
			12.4 to 18	±0.7	
		4	DC to 12.4	±0.4	
			12.4 to 18	±0.7	
		5	DC to 12.4	±0.5	
			12.4 to 18	±0.7	
		6	DC to 12.4	±0.5	
			12.4 to 18	±0.8	
		7	DC to 12.4	±0.6	
			12.4 to 18	±0.8	
		8	DC to 12.48	±0.6	
			12.4 to 18	±0.8	
9	DC to 12.4	±0.6			
	12.4 to 18	±0.8			
10	DC to 12.4	±0.6			
	12.4 to 18	±0.9			
11	DC to 12.4	±0.7			
	12.4 to 18	±0.9			

See footnotes at end of table.

APPENDIX A

TEST INSTRUMENT IDENTIFICATION

Model number	Manufacturer	Nominal attenuation (dB)	Frequency range (GHz) ¹	Accuracy (dB)	Insertion loss at 0 dB (dB)
8494B001	Hewlett-Packard	See 8494B			
8495B001	Hewlett-Packard	0 to 70	DC to 18		±0.4 dB +0.07 dB/GHz
			DC to 12.4	±3% of setting	
			12.4 to 18	±4% of setting	
8495D	Hewlett-Packard	0 to 70	DC to 26.5		±0.5 dB +0.13 dB/GHz
			DC to 12.4	±3% of setting	
			12.4 to 18	±4% of setting	
			18 to 26.5	±7% of setting	
8496A001	Hewlett-Packard	0 to 110	DC to 4	± 0.4 or ±1.7% whichever is greater	±0.6 dB +0.09 dB/GHz
8496B	Hewlett-Packard	0 to 110	DC to 18		±0.6 dB +0.09 dB/GHz
			DC to 12.4	±3% of setting	
			12.4 to 18	±4% of setting	
8420731	See PRD Electronics 1100C				
9918-30 ²	Weinschel	30	DC to 18	±1.0	
9918-60 ²	Weinschel	60	DC to 18	±1.5	
9918-3 ²	Weinschel	3	DC to 18	±0.3	
9918-6 ²	Weinschel	6	DC to 18	±0.3	
9918-10 ²	Weinschel	10	DC to 18	±0.5	
9918-20 ²	Weinschel	20	DC to 18	±0.5	

¹Not calibrated below 10 MHz using this TB.

²Prepare test report for this item using receiver system indications for system codes: U04, U06, U10, U11, U12, F00 and W05.

³Not checked below -100 dB.

⁴Accuracy of measuring receiver must be considered as well as losses associated with any adapter used.

⁵Some attenuation settings (≥ 30 dB) will result in accuracy ratios between standard and TI to be $<4:1$.

⁶This is a flatness specification. The maximum recorded attenuation value minus the minimum recorded attenuation value for each setting will be less than or equal to this accuracy.

⁷Deviation from value measured at 4 GHz.

⁸Insertion loss for serial number 2524A44630 and below is $\pm (0+0.11+1.39 \text{ (frequency in GHz)})$. Insertion loss for serial number 2524A44630 and above is $\pm (0+0.2 + 2.3 \text{ (frequency in GHz)})$.

By Order of the Secretary of the Army:

Official:



JOYCE E. MORROW

*Administrative Assistant to the
Secretary of the Army*

07109045

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

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342070, requirements for calibration procedure TB 9-4931-523-24.

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.

