

# **\*TB 9-6625-047-35**

**DEPARTMENT OF THE ARMY TECHNICAL BULLETIN**

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**CALIBRATION PROCEDURE FOR  
AC VOLTMETER AN/USM-265  
(HEWLETT-PACKARD, MODEL 400EL-02),  
ME-459/U (HEWLETT-PACKARD MODEL 400EL),  
AND  
ME-465/U (HEWLETT-PACKARD, MODEL 400E)**

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Headquarters, Department of the Army, Washington, DC  
29 May 2002

*Approved for public release; distribution is unlimited*

**REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedure, please let us know. Mail your letter or DA Form 2028 to: Commander, U. S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. A reply will be furnished to you. You may also send in your comments electronically to our e-mail address: [2028@redstone.army.mil](mailto:2028@redstone.army.mil) or by FAX (256) 842-6546/DSN 788-6546.

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\*This bulletin supersedes TB 9-6625-047-35, 17 July 1992.

**SECTION I  
IDENTIFICATION AND DESCRIPTION**

**1. Test Instrument Identification.** This bulletin provides instructions for the calibration of Ac Voltmeter AN/USM-265 (Hewlett-Packard, Model 400EL-02), ME-459/U (Hewlett-Packard, Model 400EL), and ME-465/U (Hewlett Packard, Model 400E). The manufacturer's 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 1.5 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	
Ac voltage	Range: 1.0 mV to 300 V	
	Frequency: 10 Hz to 10 MHz	
	Accuracy: ±(% of FS + % of reading)	
	Frequency	Range (V) <sup>12</sup>
	10           to   40   Hz	.001 to 300.....2.5 + 2.5
	40   Hz   to 500   kHz	.001 to 300.....1.0 + 0.0
	500   kHz to   2.0   MHz	.001 .....2.5 + 2.5
	2.0       to   4.0   MHz	.003 to 300.....1.0 + 0.0
4.0       to 10   MHz	.001 .....2.5 + 2.5	
	.003 to 300.....1.5 + 1.5	
	.001 .....N/A	
	.003 to 30.....2.5 + 2.5 <sup>3</sup>	
	100 to 300.....N/A	

See footnotes at end of table.

**Table 1. Calibration Description - Continued**

Test instrument parameters	Performance specifications	
Ac to dc converter output	Range: .001 to 300 V Frequency: 10 Hz to 10 MHz Accuracy: ±(% of FS + % of reading) <sup>4</sup>	
	Frequency	Range (V) <sup>1</sup>
	1.0 to 20 Hz 20 to 100 Hz 100 Hz to 500 kHz 500 kHz to 1.0 MHz 1.0 to 4.0 MHz 4.0 to 10 MHz	.001 to 300.....2.5 + 2.5 .001 to 300.....1.0 + 1.0 .001 .....0.4 + 0.1 .003 to 300.....0.25 + 0.25 .001 .....1.0 + 1.0 .003 to 300.....0.5 + 0.5 .001 to 300.....2.5 + 2.5 .001 .....N/A .003 to 30.....2.5 + 2.5 <sup>3</sup> 100 to 300.....N/A

<sup>1</sup>Accuracy applies to 1/3 FS to FS (.001 V range only).

<sup>2</sup>Accuracy for the 3 V range at 1/3 FS and below; 6 to 10 MHz is 3.75 + 3.75.

<sup>3</sup>For serial numbers 1208A22144, 1208A22173, 1208A22184, 1208A22221, 1208A22259, and above for ME-465/U (model 400E) and 1208A22209, 1208A22221, 1208A22227, 1208A22231, 1208A22258, and above for ME-459/U (model 400EL): .01 to 3 V range, 4.0 to 10 MHz accuracy is 3.0 + 2.0; 10 to 30 V range, 4.0 to 10 MHz accuracy is 3.5 + 3.5.

<sup>4</sup>Verified only at 10 mV, 1 kHz.

## **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. 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.

**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	<p>Ac voltage:                      Range: 30 mV to 200 V                      Frequency: 1.0 kHz (all ranges)                      10 Hz, 20 Hz, and 200 kHz                      (ranges 10 V to 300 V)                      Accuracy: +0.25% (1.25% at 10 and 20 Hz)                      Wideband voltage:                      Voltage: 1.0 mV to 3.0 V                      Frequency: 10 Hz to 10 MHz (1 kHz reference)                      Amplitude flatness: ± (%)</p> <table border="1" data-bbox="462 651 1047 1041"> <thead> <tr> <th colspan="2">Frequency</th> <th colspan="2">Range</th> </tr> <tr> <td colspan="2"></td> <td>1.0 mV</td> <td>≥3.0 mV</td> </tr> </thead> <tbody> <tr> <td>10</td> <td>Hz .....</td> <td>1.25</td> <td>1.25</td> </tr> <tr> <td>100</td> <td>kHz.....</td> <td>N/A</td> <td>.25</td> </tr> <tr> <td>500</td> <td>kHz.....</td> <td>0.25</td> <td>N/A</td> </tr> <tr> <td>1.0</td> <td>MHz.....</td> <td>1.25</td> <td>.25</td> </tr> <tr> <td>3.0</td> <td>MHz.....</td> <td>N/A</td> <td>.75</td> </tr> <tr> <td>4.0</td> <td>MHz.....</td> <td>1.25</td> <td>N/A</td> </tr> <tr> <td>10</td> <td>MHz.....</td> <td>N/A</td> <td>1.25</td> </tr> </tbody> </table>	Frequency		Range				1.0 mV	≥3.0 mV	10	Hz .....	1.25	1.25	100	kHz.....	N/A	.25	500	kHz.....	0.25	N/A	1.0	MHz.....	1.25	.25	3.0	MHz.....	N/A	.75	4.0	MHz.....	1.25	N/A	10	MHz.....	N/A	1.25	John Fluke, Model 5700A/EP UGP (p/o MIS-35947); w/ac divider, John Fluke, Model 7405A-4207 (7405A-4207)
Frequency		Range																																				
		1.0 mV	≥3.0 mV																																			
10	Hz .....	1.25	1.25																																			
100	kHz.....	N/A	.25																																			
500	kHz.....	0.25	N/A																																			
1.0	MHz.....	1.25	.25																																			
3.0	MHz.....	N/A	.75																																			
4.0	MHz.....	1.25	N/A																																			
10	MHz.....	N/A	1.25																																			
DIGITAL MULTIMETER	Range: 1.0 V dc Accuracy: ±0.125%	John Fluke, Model 8840A/AF 05/09 (AN/GSM-64D)																																				

**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 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 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 check where applicable.

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

**b.** For model 400E, adjust front panel mechanical zero adjustment for a zero indication. For model 400EL-02, set **REL REF** adjustment (located in center of **RANGE** switch) to **ABSOLUTE** (fully cw).

**c.** Set **RANGE** switch to **10 VOLTS**. Connect to an appropriate ac voltage source and set **LINE** switch to **ON**. Allow at least one-half hour for warm up.

## **8. Voltage Accuracy**

### **a. Performance Check**

(1) Connect voltage divider **INPUT** (p/o calibrator) to calibrator **OUTPUT** terminals and voltage divider **OUTPUT** to TI **INPUT** terminal.

(2) Set TI **RANGE** and calibrator initial output as indicated in table 3. Adjust calibrator for the TI meter indication specified. Final calibrator **Error** display indication will be within the specified limits; if not, perform indicated adjustments.

### **NOTE**

In table 3 below where "--" appears in "Meter indication" column and "N/A" appears in "**Error** display indication" column, a reference point is being established on the TI to be used in (4) through (8) below. TI accuracy is not being verified at these points.

(3) Connect TI **INPUT** to calibrator **WIDEBAND** output and press calibrator **W BND** pushbutton.

(4) Set TI **RANGE** to **.001 VOLTS**.

(5) Set calibrator for an initial .90 mV, 1 kHz wideband output. Adjust calibrator for a TI indication equal to value recorded in table 3 for **.001 VOLTS** (1 kHz) to establish a 1 kHz reference. Press calibrator **NEW REF** pushbutton.

(6) Set calibrator frequency to 10 Hz; then readjust amplitude for the reference TI meter indication established in (5) above. Calibrator **Error** display indication will be  $\leq \pm 5.28\%$

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(7) Repeat technique of (6) above for remaining calibrator frequencies listed in table 4 (**.001 VOLTS RANGE**). Calibrator **Error** display indication will be within the limits specified.

(8) Repeat technique of (4) through (7) above for TI **RANGE** and calibrator outputs listed in table 4. Calibrator **Error** display indication will be within the limits specified; if not, perform indicated adjustments.

**b. Adjustments.** No further adjustments can be made.

Table 3. Range Accuracy

Test instrument		Calibrator			Adjustments fig. (1) (R)
<b>RANGE (VOLTS)</b>	Meter indication	Initial input		<b>Error</b> display indication <(+%)	
		Voltage	Frequency		
.001	1	1.0 V	1.0 kHz	1.0	A2R44
.001	--	0.9 V	1.0 kHz	N/A <sup>1</sup>	---
.003	3	3.0 V	1.0 kHz	1.0	---
.003	--	3.0 V	1.0 kHz	N/A <sup>1</sup>	---
.01	1	10	1.0 kHz	1.0	A2R38
.01	--	9.0 V	10 kHz	N/A <sup>1</sup>	---
Set calibrator to <b>STANDBY</b> and remove voltage divider from setup.					
.03	3	30 mV	1.0 kHz	1.0	---
.03	--	30 mV	1.0 kHz	N/A <sup>1</sup>	---
.1	1	100 mV	10 kHz	1.0	---
.1	--	90 mV	1.0 kHz	N/A <sup>1</sup>	---
.3	3	.3 V	1.0 kHz	1.0	---
.3	--	.3 V	1.0 kHz	N/A <sup>1</sup>	---
1	1	1.0 V	1.0 kHz	1.0	---
1	--	0.9 V	1.0 kHz	N/A <sup>1</sup>	---
3	3	3 V	1.0 kHz	1.0	---
3	--	3 V	1.0 kHz	N/A <sup>1</sup>	---
10	1	10 V	10 Hz	5.0	
10	1	10 V	1.0 kHz	1.0	
10	1	10 V	200 kHz	1.0	
30	3	30 V	10 Hz	5.0	
30	3	30 V	1.0 kHz	1.0	---
30	3	30 V	200 kHz	1.0	---
100	1	100 V	10 Hz	5.0	---

<sup>1</sup>See footnote at end of table.

Table 3. Range Accuracy – Continued

Test instrument		Calibrator			Adjustments fig. (1) (R)
RANGE (VOLTS)	Meter indication	Initial input		Error display indication	
		Voltage	Frequency	<(+%)	
100	.8	80 V	1.0 kHz	1.25	---
100	.5	50 V	200 kHz	2.0	
300	2	200 V	20 Hz	6.25	
300	3	300 V	1.0 kHz	1.0	
300	1	100 V	200 kHz	3.0	

<sup>1</sup>Record resulting TI indication for use in (5) below.

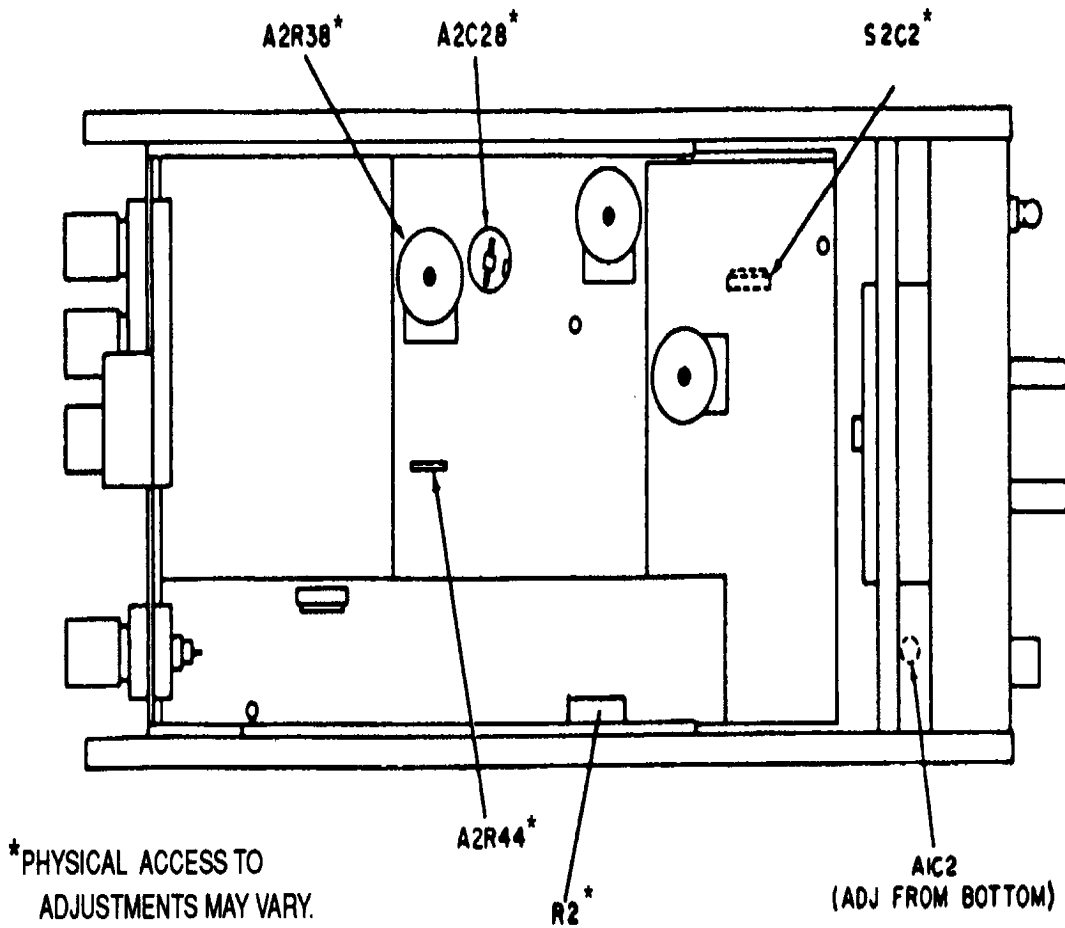


Figure 1. Test instrument (top view) - adjustment locations.

Table 4. Frequency Response

Test instrument <b>RANGE (VOLTS)</b>	Calibrator			Adjustments (fig. 1) (R)
	Initial output		Error display indication (±%)	
	Voltage	Frequency		
.001	---	500 kHz	1.11	---
.001		1.0 MHz	5.0	---
.001		4.0 MHz	5.0	---
.003 <sup>1</sup>	3.0 mV	1.0 kHz	---	---
.003		10 Hz	5.0	---
.003		1.0 MHz	1.0	---
.003		3.0 MHz	3.0	---
.003		10 MHz	5.0	S2C2
.01 <sup>1</sup>	9.0 mV	1.0 kHz	---	---
.01		10 Hz	5.0	---
.01		1.0 MHz	1.0	---
.01		3.0 MHz	3.17	---
.01		10 MHz	5.0	A2C28
.03 <sup>1</sup>	30 mV	1.0 kHz	---	---
.03		10 Hz	5.0	---
.03		1.0 MHz	1.0	---
.03		3.0 MHz	3.0	---
.03		10 MHz	5.0	---
.1 <sup>1</sup>	90 mV	1.0 kHz	---	---
.1		10 Hz	5.28	---
.1		1.0 MHz	1.0	---
.1		3.0 MHz	3.0	---
.1		10 MHz	5.0	---
.3 <sup>1</sup>	300 mV	1.0 kHz	---	---
.3		10 Hz	5.0	---
.3		1.0 MHz	1.0	---
.3		3.0 MHz	3.0	---
.3		10 MHz	5.0	---
1 <sup>1</sup>	0.9 V	1.0 kHz	---	---
1		10 Hz	5.0	---
1		1.0 MHz	1.0	---
1		3.0 MHz	3.0	---
1		10 MHz	5.0	---
3 <sup>1</sup>	3.0 V	1.0 kHz	---	---
3		10 Hz	5.0	---
3		1.0 MHz	1.0	---
3		3.0 MHz	3.0	---
3		10 MHz	5.0	---



<sup>1</sup>Repeat (4) and (5) above to establish calibrator reference; then repeat (6) above for remaining frequencies.

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### **9. Ac to Dc Converter Output**

#### **a. Performance Check**

(1) Connect calibrator **OUTPUT** terminals to TI **INPUT** terminal and digital multimeter **INPUT** to TI rear panel **DC OUTPUT** terminals.

(2) Set **RANGE** switch to **.01 VOLTS** and set calibrator for a 10 mV, 1.0 kHz output. If digital multimeter does not indicate between .9950 and 1.0050 V dc, perform **b** below.

**b. Adjustments.** Adjust R2 (fig. 1) for a 1.0000 V indication on digital multimeter (R).

### **10. Final Procedure**

**a.** Deenergize and disconnect all equipment.

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

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**THESE ARE THE INSTRUCTIONS FOR SENDING 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@avma27.army.mil](mailto:whomever@avma27.army.mil)

To: [2028@redstone.army.mil](mailto: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:** TB 9-6625-xxxx-35
9. **Pub Title:** Calibration Procedure for ...
10. **Publication Date:**
11. **Change Number:**
12. **Submitted 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:**

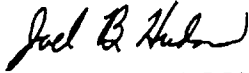
This is the text for the problem below line 27.

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By Order of the Secretary of the Army:

**ERIC K. SHINSEKI**  
*General, United States Army*  
*Chief of Staff*

**OFFICIAL:**



**JOEL B. HUDSON**  
*Administrative Assistant to the*  
*Secretary of the Army*  
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