TM 11-6625-1538-15

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENANCE MANUAL

HEWLETT-PACKARD AC VOLTMETER AN/USM-265
(MODEL 400EL02) NSN 6625-00-935-4294
ME-459 (MODEL 400EL) NSN 6625-00-229-0457
ME-465 (MODEL 400E) NSN 6625-00-995-7716

This copy is a reprint which includes current pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY
MAY 1967

WARNING

DANGEROUS VOLTAGES

EXIST IN THIS EQUIPMENT

Be careful when working on the power supplies and their circuits, or on the 230-or 115-volt ac line connections.

DO NOT TAKE CHANCES!

CHANGE
NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 15 December 1983

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT MAINTENANCE MANUAL FOR HEWLETT-PACKARD AC VOLTMETER AN/USM-265 (MODEL 400EL02) NSN 6625-00-935-4294 ME-459 (MODEL 400EL) NSN 6625-00-229-0457 ME-465 (MODEL 400E) NSN 6625-00-995-7716

TM 11-6625-1538-15, 11 May 1987, is changed as follows:

1. New or added material is indicated by a vertical bar in the margin of the page.
2. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number.
3. Remove old pages and insert new pages as indicated below.

Remove Pages	Insert Pages
i and ii	i and ii
10.1 and 10.2	10.1/(10.2 blank)
5-1 and 5-2	5-1 through 5-2.2
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4. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

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The Adjutant General

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CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON,DC, *27 December 1979*

Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual For HEWLETT-PACKARD AC VOLTMETER AN/USM-265 (MODEL 400EL02) NSN 6625-00-935-4294 ME-459 (MODEL 400EL) NSN 6625-00-229-0457 ME-465 (MODEL 400E) NSN 6625-00-995-7716

TM 11-6625-1538-15, 11 May 1967, is changed as follows:

1. Title is changed as indicated above.
2. A vertical bar appears opposite changed material.
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Remove	*Insert*
iii and 1-0	i and ii
None	1-0
1-0.1	1-0.1 and 1-0.2
None	D-1 through D-4

4. File this change sheet in front of the manual for reference purposes.

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USAFAS (2)
USAARMS (2)
USAIS (2)
USAES (2)
USAICS (3)
MAAG (1)
USARMIS (1)
USAERDAA (1)
USAERDAW (1)
Fort Gordon (10)
Fort Carson (5)
Army Dep (1) except
LBAD (14)
SAAD (30)
TOAD (14)
SHAD (3)
Fort Gillem (10)
USA Dep (1)
Sig Sec USA Dep (1)
Fort Richardson (CERCOM Ofc) (2)
Units org under fol TOE:
(2 copies each unit)
29-207
29-610

ARNG: None
USAR: None
For explanation of abbreviations used, see AR 310-50.

TECHNICAL MANUAL
TM 11-6625-1538-15

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *11 May 1967*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT MAINTENANCE MANUAL FOR

HEWLETT-PACKARD AC VOLTMETER AN/USM-265 (MODEL 400EL02) NSN 6625-00-935-4294 ME-459 (MODEL 400EL) NSN 6625-00-229-0457 ME-465 (MODEL 400E) NSN 6625-00-995-7716

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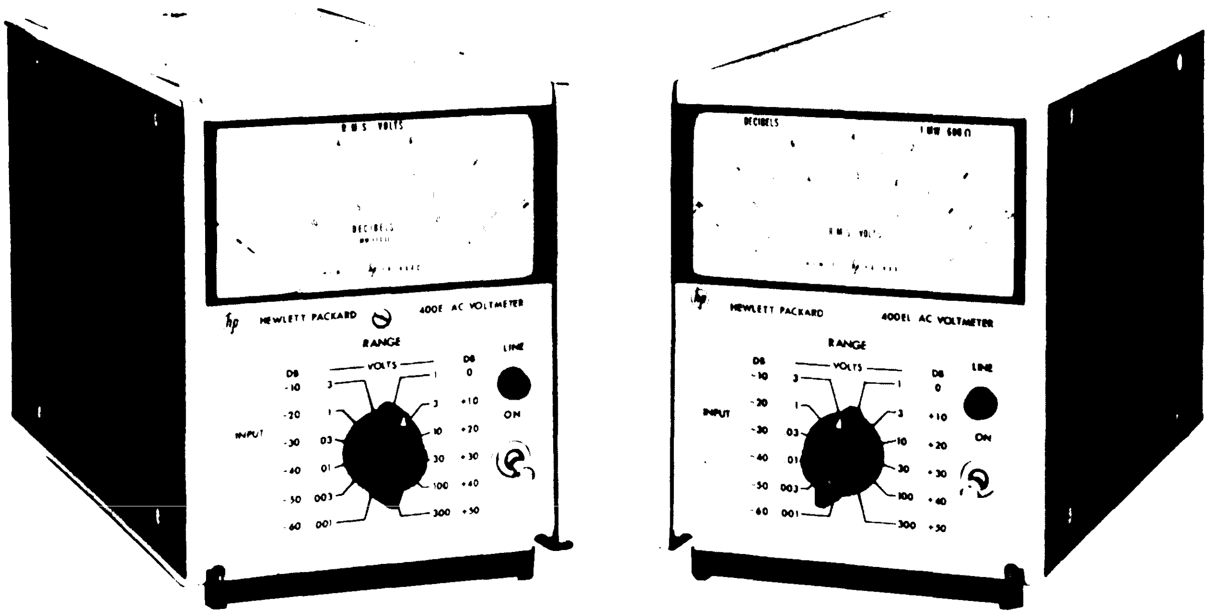


FIGURE I–I. MODELS 400E AND 400EL AC VOLTMETERS

EL6625—1538—TM—CI—I

Table 1-1. Specifications

-hp- MODEL 400E/EL

Voltage Range: 1 mv full scale to 300 v full scale in 12 ranges in 1, 3, 10 sequence.
-72 dbm to +52 dbm in 12 ranges with 10 dbm between ranges.

Frequency Range: 10 Hz to 10 MHz.

Calibration: Responds to absolute average value of applied signal, calibrated in rms volts.

Input Impedance: 10 megohms shunted by 21 pf on the 1 mv-1 v ranges and 10 megohms shunted by 8 pf on the 3 v-300 v ranges.

Amplifier AC Output: 150 mv rms for full scale meter indication; output impedance 50 ohms, 10 Hz to 10 MHz (105 mv on the 1 mv range).

AC-DC Converter Output: 1 vdc output for full scale meter deflection.

Output Resistance: 1000 ohms.

-hp- MODEL 400E/EL (Cont’d)

Response Time: 1 second to within 1% of final value for a step change.

AC Power: 115 or 230 volts +10%, 50 to 1000 cps, approximately 5 watts.

Temperature Range: 0 to +55°C (except where noted on accuracy charts).

External Battery Operation: Terminals are provided on rear panel; positive and negative voltages between 35 v and 55 v are required; current drain from each voltage is approximately 54 ma.

Weight:

Net: 6 lbs. (2, 7 kg).

Shipping: 9 lbs. (4 kg).

Dimensions: 6-1/2” high, 5-1/8” wide, 11” deep (165, 1 x 130,2 x 279,4 mm).

SECTION I

GENERAL INFORMATION

1-A.1. SCOPE

This manual includes installation and operation instruction and covers operator's, organizational, direct support (DS), general support (GS), and depot maintenance of the Hewlett-Packard AC Voltmeter AN/USM-265 (Model 400EL02), ME-459 (Model 400EL), and ME-465 (Model 400E). The repair parts and special tools list are located in TM 11-6625-1538-24P.

1-A.2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS

Refer to the 1 test issue of DA Pam 310-1 to determine whether there are new editions, changed or additional publications pertaining to the equipment.

1-A.3. MAINTENANCE FORMS, RECORDS, AND REPORTS

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System.

b. Report of Packaging and Handling Deficiencies, Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/ NAVMATINST 4355.73A/AFR 400-54/ MCO 430.3F.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/ DLAR 4500.15.

1-A.4. REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703.

In either case, a reply will be furnished direct to you.

1-A.5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your AC Voltmeter AN/USM-265 needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703. We'll send you a reply.

1-A.6. ADMINISTRATIVE STORAGE

Administrative Storage of Equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the PMCS charts before storing. When removing the equipment from administrative storage the PMCS should be performed to assure operational readiness. Disassembly and repacking of equipment for shipment or limited storage are covered in paragraphs 2-18 through 2-21, and TM 740-90-1 Administrative Storage of Equipment.

1-A.7. DESTRUCTION OF ARMY ELECTRONICS MATERIEL

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

NOTE

In this manual, the international standard unit of frequency, the Hertz, will be used rather than cycles per second.

1 Hertz (Hz) = 1 cycle per second

1-1. DESCRIPTION.

1-2. The -hp- Models 400E and 400EL are versatile ac voltmeters and db meters. Both models can be used as ac to dc converters or wideband amplifiers. The Model 400E is primarily intended for voltage measurements, whereas the Model 400EL is primarily a db meter. However, both meters indicate both volts and db. The 400E has a linear ac scale with a logarithmic db scale underneath, and the 400EL has a linear db scale with a logarithmic ac scale underneath. Since the difference in scales is the only difference between the two instruments, this manual will use the term 400E/EL in reference to both instruments.

1-3. Figure 1-1 shows both the Model 400E and the Model 400EL. Table 1-1 is a list of specifications.

1-4. OPTIONS AVAILABLE.

1-5. OPTION 01 (400E Only).

1-6. Option 01 places the db scale uppermost for greater resolution when making db measurements.

1-7. OPTION 02.

1-8. Option 02 adds a relative reference adjustment to the 400E/EL. The REL. REF. control allows a continuous reduction in sensitivity by a maximum of 3 db in order to make relative voltage or db measurements.

1-9. INSTRUMENT AND MANUAL IDENTIFICATION.

1-10. Hewlett-Packard instruments are identified by a two-section, eight-digit serial number (000-00000).

1-11. If the first three digits of the two-section, eight-digit serial number are prefixed with an E or G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.

Table 1-1. Specifications (Cent'd)

MODEL 400E

3 MV TO 300 V RANGES — **Accuracy % Of Reading**

<table>
<tr><th>Frequency</th><th>10 Hz – 20 Hz</th><th>20 Hz – 40 Hz</th><th>40 Hz – 500 KHz</th><th>500 KHz – 1 MHz</th><th>1 MHz – 2 MHz</th><th>2 MHz – 4 MHz</th><th>4 MHz – 10 MHz</th></tr>
<tr><td>At Full Scale</td><td>± 4</td><td>±2</td><td colspan="3">±1</td><td>±2</td><td>± 4</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+3
-5</td><td>±3</td><td>+3
-4</td><td colspan="2">+3
-5</td><td>+ 4
-10</td></tr>
</table>

1 MV RANGE

<table>
<tr><th>Frequency</th><th>10 Hz – 20 Hz</th><th>20 Hz – 40 Hz</th><th>40 Hz – 100 Hz</th><th>100 Hz – 100 KHz</th><th>100 KHz – 200 KHz</th><th>200 KHz – 500 KHz</th><th>500 KHz – 1 MHz</th><th>1 MHz – 2 MHz</th><th>2 MHz – 4 MHz</th><th>4 MHz – 6 MHz</th></tr>
<tr><td>At Full Scale</td><td>+ 4
-10</td><td>± 2</td><td colspan="4">± 1</td><td>± 2</td><td colspan="2">± 4</td><td>+ 4
-10</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+ 3
- 5</td><td colspan="3">± 3</td><td>+3
-4</td><td colspan="2">+3
-5</td><td>+ 3
-10</td><td></td></tr>
<tr><td>At 1/10 Full Scale</td><td></td><td>+10
-20</td><td>+10
-15</td><td>±10</td><td colspan="2">+10
-15</td><td>+10
-20</td><td colspan="2">+10
-30</td><td></td></tr>
</table>

Table 1-1. Specifications (Cont'd)

MODEL 400EL

3 MV TO 300 V RANGES — Accuracy % Of Reading

Frequency: 10 Hz, 20 Hz, 40 Hz, 500 KHz, 1 MHz, 2 MHz, 4 MHz, 10 MHz

<table>
<tr><td>At Full Scale</td><td>± 4</td><td>±2</td><td colspan="2">±1</td><td></td><td>±2</td><td>± 4</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+2
-4</td><td>±1.5</td><td>±2</td><td colspan="2">+2
-4</td><td>+ 3
-10</td></tr>
</table>

1 MV RANGE

Frequency: 10 Hz, 20 Hz, 40 Hz, 200 KHz, 500 KHz, 1 MHz, 2 MHz, 4 MHz, 6 MHz

<table>
<tr><td>At Full Scale</td><td>+ 4
-10</td><td>±2</td><td colspan="2">±1</td><td>±2</td><td colspan="2">±4</td><td>+ 4
-10</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+2
-4</td><td>±1.5</td><td>±2</td><td colspan="2">+2
-4</td><td>+ 3
-10</td><td></td></tr>
</table>

MODELS 400E/EL DC OUTPUT

3 MV TO 300 V RANGES — Accuracy % Of Reading

Frequency: 10 Hz, 20 Hz, 40 Hz, 100 Hz, 500 KHz, 1 MHz, 2 MHz, 4 MHz, 10 MHz

<table>
<tr><td>At Full Scale</td><td>± 4</td><td>±2</td><td>±1</td><td>±0.5*</td><td colspan="2">±1</td><td>±2</td><td>± 4</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+2
-4</td><td colspan="2">±1</td><td>±2</td><td colspan="2">+2
-4</td><td>+ 3
-10</td></tr>
</table>

1 MV RANGE

Frequency: 10 Hz, 20 Hz, 40 Hz, 100 Hz, 100 KHz, 200 KHz, 500 KHz, 1 MHz, 2 MHz, 4 MHz, 6 MHz

<table>
<tr><td>At Full Scale</td><td>+ 4
-10</td><td>± 2</td><td>± 1</td><td>±0.5*</td><td colspan="2">± 1</td><td colspan="2">± 2</td><td>± 4</td><td>+ 4
-10</td></tr>
<tr><td>At 1/3 Full Scale</td><td>+ 4
-10</td><td>+ 2
- 4</td><td colspan="2">±1</td><td>±2</td><td colspan="2">+2
-4</td><td>+ 3
-10</td><td></td></tr>
<tr><td>At 1/10 Full Scale</td><td></td><td>+ 4
-15</td><td>+ 4
-10</td><td>±4</td><td colspan="2">+ 4
-10</td><td>+ 4
-15</td><td colspan="2">+ 4
-30</td><td></td></tr>
</table>

* For 15°C - 40°C on 1 mv - 1 volt ranges only.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 400E and 400EL voltmeters. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-7. Report any damage or deficiencies in accordance with paragraph 1-A. 3.

2-5. POWER REQUIREMENTS.

2-6. The Model 400E/EL can be operated from any source of 115 or 230 volts at 50 to 1000 cycles or from two 35 to 55 volt batteries connected to the rear panel BATTERY terminals. The 115/230 v slide switch on the rear panel selects the desired line voltage. Power dissipation is 5 watts maximum.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett- Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. The Model 400E/EL is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F) or the relative humidity exceeds 95%.

2-12. <u>BENCH MOUNTING</u>.

2-13. The Model 400E/EL is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. <u>RACK MOUNTING</u>.

2-15. The Model 400E/EL may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only.

2-16. <u>COMBINATION MOUNTING</u>.

2-17. The Model 400E/EL may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full- module unit, the combining case can be bench or rack mounted and is analogous to any full-module instrument.

2-18. REPACKAGING FOR SHIPMENT.

2-19. The following paragraphs contain a general guide for repackaging of the equipment. Refer to paragraph 2-20 if the original container is to be used; paragraph 2-21 if it is not.

2-20. If original container is to be used, proceed as follows:

a. Place equipment in original container.

b. Make sure that container is well sealed with strong tape or metal bands.

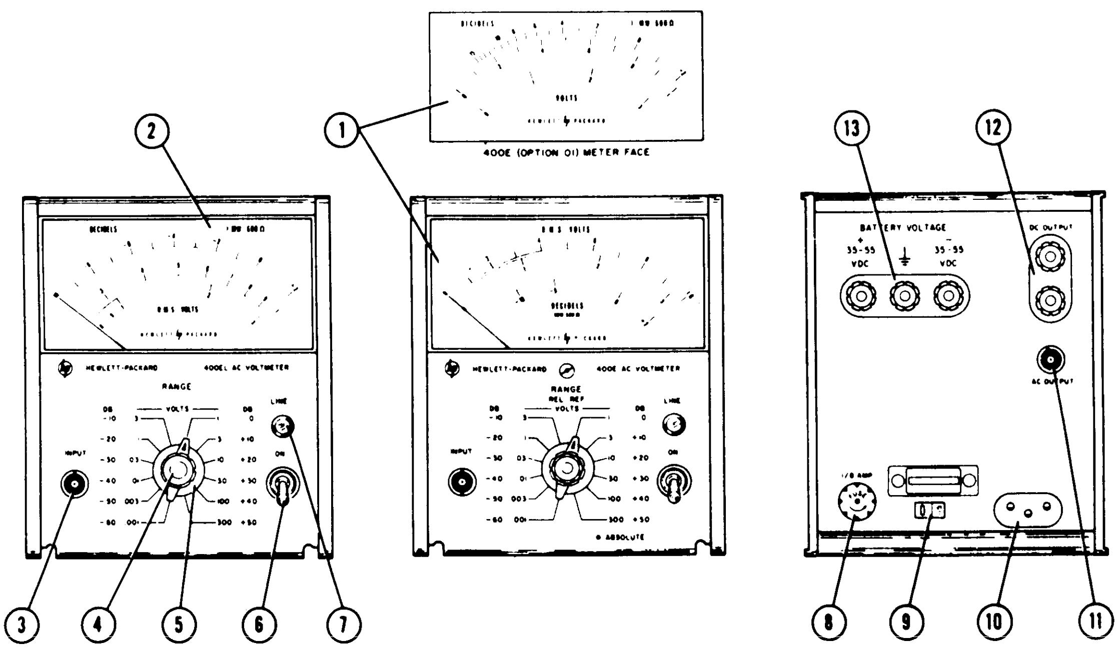
2-21, If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.



(1) 400E Scale: Indicates magnitude of applied signal in volts and dbm. Option 01 places the dbm scale uppermost for greater resolution. 0 dbm = 1 mw in 600 Ω.

(2) 400EL Scale: Indicates magnitude of applied signal in volts and dbm. Dbm scale is linear. and voltage scales are logarithmic. This arrangement allows better resolution for db reading. O dbm = 1 mw in 600 Ω.

(3) AC INPUT BNC input jack connects signal to be measured.

(4) REL. REF Adjust (Option 02): Lowers sensitivity of meter by 3 db. Fully clockwise ABSOLUTE position retains full meter sensitivity. This control is used to vary meter indication with a given input in order to make relative readings easier.

(5) RANGE Selector: Selects full scale reading of meter. Dbm reading on scale adds algebraically to DB setting of RANGE selector.

(6) Line ON Toggle Switch Applies primary power.

(7) LINE Indicator Lamp: Indicates application of primary power.

(8) FUSE: 1/8 amp. Protects instrument against current overload.

(9) 115 230 Volt Slide Switch: Selects 115 or 230 volts ac for line operation.

(10) PRIMARY POWER CONNECTOR: Line voltage is applied through this connector.

(11) AC OUTPUT: Ac amplifier output. Output impedance is 50 Ω.

(12) DC OUTPUT: Ac to dc converter output. Dc voltage is proportional to percentage of meter deflection. Output impedance is 1000 Ω.

(13) BATTERY VOLTAGE Terminals: 400E/EL may be powered by connecting two 35 to 55 volt batteries to these terminals.

Figure 3-1. Location of Controls and Indicators

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 400E/EL is primarily an ac voltmeter and db meter, but it can be used as an ac to dc converter or as a wide band amplifier.

3-3. This section explains the controls of the 400E/EL and outlines the operating procedures for each mode of operation.

3-4. LOCATION OF CONTROLS AND INDICATORS.

3-5. Figure 3-1 *shows* the location of each of the 400E/EL controls and explains the function of each.

3-6. OPERATING INSTRUCTIONS.

3-7. STANDARD 400 E/EL.

3-8. AC VOLTMETER.

NOTE

Since the 400E/EL is average responding and rms calibrated, any distortion will affect the accuracy of the measurement. Table 3-1 shows the errors caused by distortion.

Table 3-1. Effect of Distortion on Average Responding Meter

HARMONIC	% DISTORTION	% ERROR (* Fundamental)	
		MAX. POSITIVE	MAX. NEGATIVE
Any even	0.1	0.000	
	0.5	0.001	
	1.0	0.005	
	2.0	0.020	
Third	0.1	0.033	0.003
	0.5	0.168	0.167
	1.0	0.338	0.328
	2.0	0.687	0.667
Fifth	0.1	0.020	'0.020
	0.5	0.101	0.099
	1.0	0.205	0.195
	2.0	0.420	1.380

* Depends on phase relationship between harmonic and fundamental.

a. Ensure that 115-230 vac slide switch on the rear panel matches line voltage used, and connect power to the instrument. Mechanically zero the instrument using the procedure outlined in Paragraph 5-5.

b. To operate the Model 400E/EL with battery power, connect two 35 to 55 volt batteries as shown in Figure *3-2. Since* the front panel LINE switch has no effect during battery operation, the switch in Figure 3-2 can be used as a convenient method of disconnecting the batteries when the instrument is not in use.

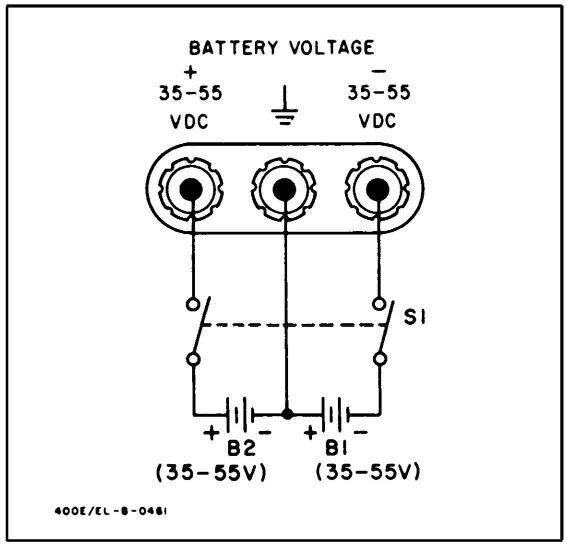


Figure 3-2. External Battery Connection

c. Turn line ON toggle switch to up position. LINE lamp will glow.

d. Select approximate range of signal to be measured.

CAUTION

DO NOT APPLY MORE THAN 600 VOLTS TO INPUT. DO NOT OVERLOAD THE .001 THROUGH 1 VOLT RANGES WITH MORE THAN 300 VOLTS AT FREQUENCIES BELOW 300 KC OR WITH MORE THAN 64 VOLTS AT FREQUENCIES ABOVE 300 KC. IF ANY OF THESE OVERLOADS ARE EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

e. Connect signal to be measured to INPUT terminals, and read the rms voltage on the scale.

3-9. DB METER.

a. To make a db or dbm measurement, follow steps a through e in Paragraph 3-8, and add the scale reading to the RANGE setting. For example: If the scale reading is +1.5 and the RANGE is -30 db, the final measurement is -28.5 db.

b. The 400E/EL db scale is calibrated in dbm. 0 dbm is equivalent to 1 milliwatt dissipated by a 600 ohm load. Consequently, any dbm measurements must be made across a total impedance of 600 Ω. Measurements across other impedances will be in db, but not dbm.

c. To convert a db reading to dbm, use the Impedance Correction Graph (Figure 3-3). For example: To convert a +30 db reading made across 50 Ω to dbm, locate the load impedance on the bottom of the graph. Follow the impedance line to the heavy black line and read the meter correction at that point. The correction for 50 Ω is +10.5 dbm, and the corrected reading is +40.5 dbm.

3-10. AC TO DC CONVERTER.

a. Follow steps a through e in Paragraph 3-8.

b. Connect the rear panel DC OUTPUT terminals to a dc measuring device with a high input impedance, The dc output resistance is 1000 Ω; and if it is loaded, the dc output signal will be inaccurate.

c. The dc output is a 0 to 1 volt signal proportional to the percentage of 400E/EL meter deflection.

3-11. WIDE BAND AC AMPLIFIER.

a. Follow turn-on steps a through c in Paragraph 3-8.

b. Select approximate range of input on RANGE switch.

c. Connect SIGNAL to be amplified to INPUT terminals.

d. Connect a 50 Ω amplifier load to rear panel AC OUTPUT connector.

e. The gain of the amplifier depends on the RANGE selection. On the 0.1 volt range and below, the 400E/EL amplifies the input; and on the 0.3 volt range and above, it attenuates the input. On the 0.001 volt ranges, the maximum output is 105 mv. On all other ranges, the maximum output is 150 mv. Table 3-2 shows the ac amplifier gain for each range setting.

Table 3-2. AC Amplifier Gain

RANGE	GAIN	RANGE	GAIN
0.001	+40 db	1	-16 db
0.003	+34 db	3	-26 db
0.01	+24 db	10	-36 db
0.03	+14 db	30	-46 db
0.1	+ 4 db	100	-56 db
0.3	- 6 db	300	-66 db

3-12. 400E WITH OPTION 01.

3-13. Operation of the 400E with Option 01 is essentially the same as operation of the standard 400E. The db scale reads from -15 to +2 instead of from -12 to +2, and is placed at the top of the scale for better resolution.

3-14. 400E/EL WITH OPTION 02.

3-15. Option 02 adds a relative reference adjustment to the 400 E/EL. This adjustment allows a continuous reduction in sensitivity by 3 db. Use the REL. REF adjustment to set the meter at any convenient reference (0 db for example) in order to make relative readings easier. When the REL. REF adjustment is in the fully clockwise ABSOLUTE position, it has no effect on the meter sensitivity.

3-16. In all other respects, operation of an Option 02 instrument is the same as operation of a standard Model 400E/EL.

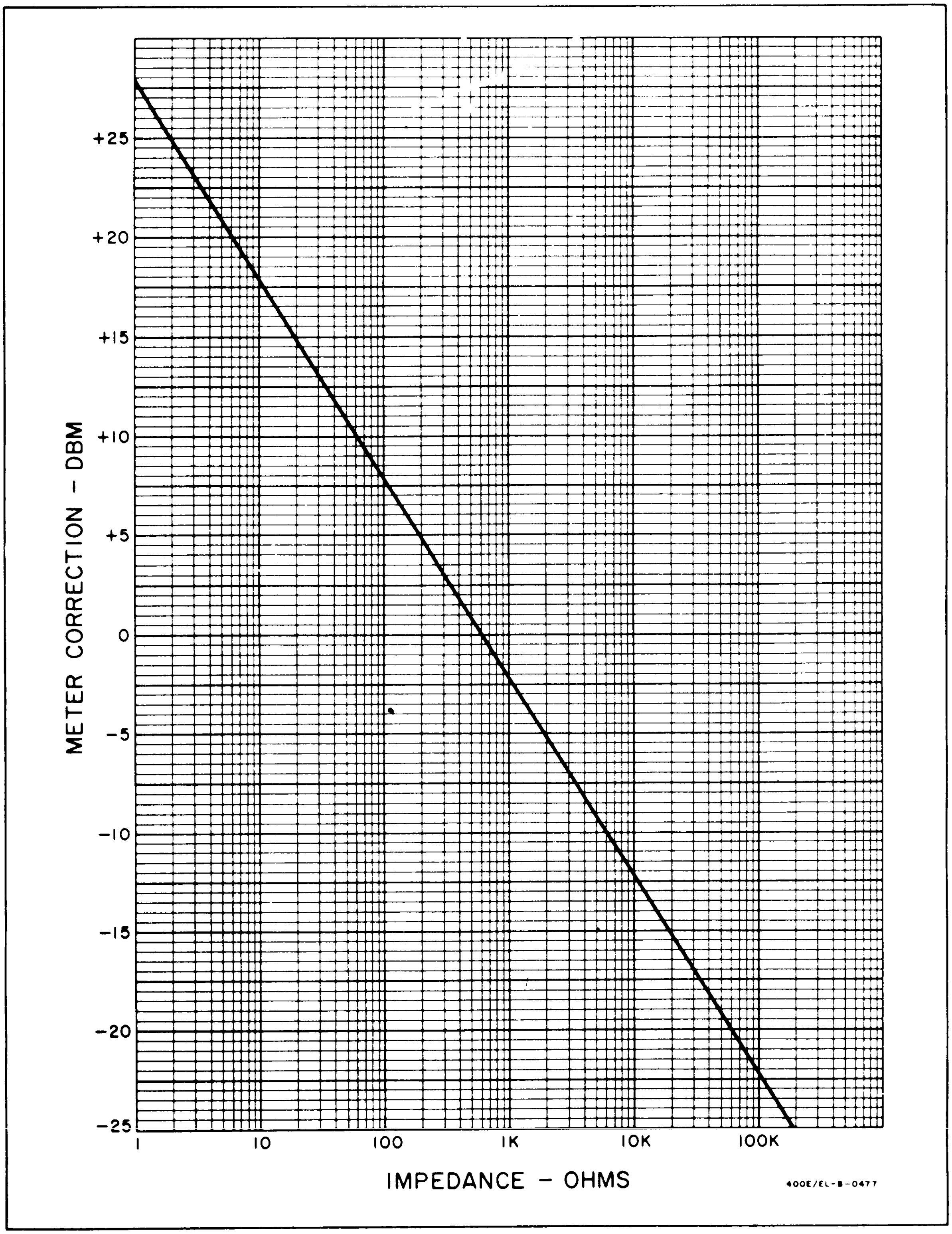


Figure 3-3. Impedance Correction Graph

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The 400E/EL is a solid state, average responding, rms calibrated voltmeter. It also has applications as an ac to dc converter and a wide band amplifier. Figure 4-1 shows a simplified block diagram of the instrument.

4-3. When relay K1 is closed, the input is not attenuated; and when K2 is closed, the input is attenuated by 50 db. On the 0.001 through 1 volt ranges, K1 is closed and K2 is open. K2 is closed and K1 is open on the 3 through 300 volt range. The entire Input Attenuator assembly is shielded, and the relays are operated remotely by voltages applied through the RANGE switch. Variable capacitor A1C2 is adjusted on the 3 volt range with a 3 volt 100 KHz input in order to shape the frequency response of the Input Attenuator.

4-4. The signal from the input attenuator is applied to the impedance converter. The impedance converter is a unity gain, feedback stabilized amplifier that matches the high Impedance of the Input Attenuator to the much lower impedance of the post attenuator.

4-5. The Post Attenuator attenuates the output of the Impedance Converter by 10 db for each step of the RANGE switch. On the 3 volt range, the Post Attenuator is switched back to the 30 db position, and then it attenuates 10 db per step on the higher ranges. Variable capacitor S2C2 is adjusted on the .003 volt range with a 3 mv 8 MHz input to adjust the 8 MHz response of the .003 volt range. With a full scale input on any range except the .001 volt range, the output of the Post Attenuator should be 3 mv. On the .001 volt range, the output should be 1 mv.

4-6. The Meter Amplifier is a four-stage, high-gain amplifier utilizing both ac and dc feedback for gain stabilization. The Meter Bridge, connected in the ac feedback path of the meter amplifier, converts the ac output of the amplifier to a dc voltage proportional to its average value. This dc voltage drives the meter. A1C28 and A1R38 adjust the gain of the amplifier so that the meter will read rms volts. A1R28 is adjusted at 400 Hz, and A1C28 is adjusted at 10 MHz.

4-7. The DC Output is a 0-1 volt level that is proportional to percentage of meter deflection. R2 is adjusted to calibrate the dc output. The AC Amplifier samples the ac feedback and generates O to 150 mv ac output that is directly proportional to meter deflection.

4-8. SCHEMATIC DESCRIPTION (See Figure 6-1).

4-9. IMPEDANCE CONVERTER.

4-10. The impedance converter, located on the main voltmeter board (A2), matches the high impedance of the input attenuator to the relatively low impedance of the Post Attenuator. Breakdown diodes A2CR17 and 18 bias diodes A2CR9 and 10 at +5 and -5 volts respectively. A2CR9 and 10 limit the input to 10 volts peak-to-peak, providing overload protection. Fuse A2F1 protects the instrument against destructive overloads.

4-11. A field-effect transistor (A2Q5) is used in the input stage of the impedance converter because of its characteristically high input impedance and good frequency response. The output is taken from the emitter

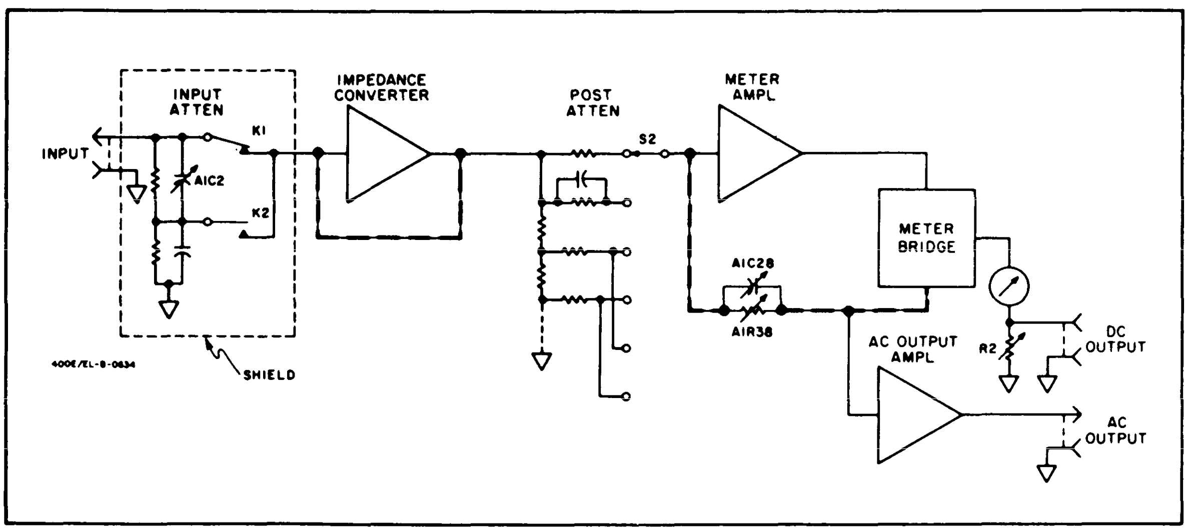


Figure 4-1. Simplified Block Diagram

circuit of A2Q7 and applied to the post attenuator and then applied to the meter amplifier. The solid black lines on the schematic show the signal path, and the broken lines show the feedback paths. A2R17 adjusts the dc bias of the impedance converter.

4-12. METER AMPLIFIER.

4-13. The meter amplifier amplifies its input signal by a fixed gain on all ranges except the .001 volt range. The amplifier itself is a four-stage, dc coupled amplifier with a cascode-coupled final stage (A2Q12 and 13). Dc feedback is coupled from the emitter of A2Q12 back to the base of A2Q9. Breakdown diodes A2CR12, 13 and 14 establish fixed dc bias levels in the amplifier.

4-14. The output from the collector of A2Q13 is coupled through the Meter Bridge and fed back to the emitter of A2Q9. A2C28 in the feedback circuit adjusts the amount of feedback at the high end of the frequency range, and A2R38 adjusts the feedback at the low end. This calibrates the amplifier gain at both ends of the frequency range. A2R44 and 45 are switched into the feedback circuit on the 0.001 volt range, boosting the gain on that range. A2R31 adjusts the dc bias level of the amplifier.

4-15. METER BRIDGE.

4-16. Figure 4-2 shows a partial schematic of the Meter Bridge. The meter bridge rectifies the ac amplifier output and supplies the dc current to drive the meter. In order to use part of the meter bridge output as the rear terminal dc output, the meter has to be referenced to ground. Transistor A2Q14 references the meter to ground.

4-17. During the positive half cycle, A2CR15 conducts. Part of the current (solid line) goes through A2C34 into the feedback path, and part of the current goes through A2R53 and the meter to ground. The current through A2R53 turns on A2Q14, and A2Q14 draws current from the positive supply. The current from A2Q14 goes through A2C36 into the feedback path. The current through A2Q14 and A2C36 is equal to the current drawn through the meter, so the current out of the bridge is equal to the current into the bridge.

4-18. During the negative half cycle, A2CR16 conducts and draws current from the feedback path (dotted line). Part of the current goes through A2C36 and A2CR16 into the amplifier, and part goes through A2R53 and the meter to ground. The current through A2R53 turns on A2Q14, and the current from A2Q14 goes through A2R54 and A2CR16 to the amplifier, Again the current through the meter equals the current

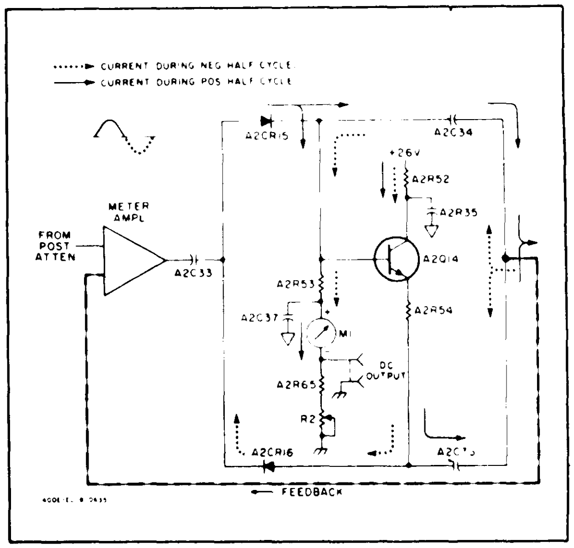


Figure 4-2. Meter Bridge

through A2R54, and the current into the bridge equals the current out.

4-19. Transistor A2Q14 replaces current drawn by the meter, so the meter bridge is kept floating while the meter is referenced to ground. The dc output, taken across A2R65 and R2, is also referenced to ground.

4-20. AC OUTPUT CIRCUIT.

4-21. The ac output circuit isolates the meter bridge and amplifier from the ac output load. It consists of two emitter followers (A2Q15 and Q16) connected in cascade. A2R59 in the base circuit of A2Q15 zeroes the output dc level at the ac output.

4-22. POWER SUPPLY.

4-23. The power supply produces regulated +26 volts and -26 volts. Breakdown diode A2CR7 establishes a reference voltage of 6.98 volts. Part of the power supply output is applied to the base of A2Q2, and A2Q2 senses the difference between the supply output and the reference. If the output voltage changes, the emitter to base voltage of A2Q2 will change; and the output of A2Q2 will change the current through A2Q1, the regulator.

4-24. The negative regulator, A2Q3 and A2Q4, uses the +26 volt output as a reference. Consequently, the negative supply is dependent upon the positive supply.

Table 5-1. Required Test Equipment

INSTRUMENT TYPE	REQUIRED SPECIFICATIONS	USE	RECOMMENDED MODEL
Test Oscillator	Frequency Range: 10 Hz to 10 MHz Output: 3.0 volts rms max. Distortion: <1%	Performance Checks and Calibration	-hp- Model 651A Test Oscillator
DC Voltmeter	Range: 0 to 100 volts Sensitivity: 100 μvolts Accuracy: >0.1%	Performance Checks and Calibration	-hp- Model 3439A Digital Voltmeter with -hp- 3443A High Gain/Auto Range Unit
DC Null Meter	Range: ±3 μvolts full scale to 10 mv full scale Accuracy: 2% of full scale	Performance Checks and Calibration	-hp- Model 419A DC Null Voltmeter.
Thermal Converters	a. Input: 3 volts rms, R_{in} = 200 Ω/volt Output: 7 mv dc b. Input: 1 volt rms Output: 7 mv dc Accuracy: 0.2% or better Frequency Range: Dc to 10 MHz	Performance Checks and Calibration	a. -hp- Model H02-11049A b. -hp- Model 11050A Thermal Converters
DC Standard	Output: Continuously adjustable to 3.000 vdc Accuracy: 0.1% or better	Performance Checks and Calibration	-hp- Model 741A AC/DC Differential Voltmeter/ DC Standard
0-10 MV Reference Supply	See Figure 5-1 for schematic. a. Resistor: fxd, 6500 Ω ±1% b. Resistor: var, 500 Ω ±5%, 10-turn c. Resistor: var, 50 Ω ±5%, 10-turn d. Battery: 1.34 volts	Performance Checks and Calibration	a. -hp- Part No. 0811-0392 b. -hp- Part No. 2100-0324 c. -hp- Part No. 2100-1481 d. Mallory RM-42R
AC-DC Voltmeter	Accuracy: ±3% Input Capacity: <5 pf Input Impedance: >10 megohms	Troubleshooting	-hp- Model 410C Electronic Voltmeter
Resistors	Fxd, 100 K Ω ±1% Var, 15 K Ω, ww ±5%, 10-turn	Performance Checks and Calibration	-hp- Part No. 0757-0465 -hp- Part No. 2100-0896

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary to maintain the Model 400 E/EL. The following paragraphs describe the Preventive Maintenance, the Performance Checks, the Calibration Procedures, and the Troubleshooting Procedures.

5-3. REQUIRED EQUIPMENT

5-4. Table 5-1 is a list of the equipment required to properly maintain the Model 400E/EL. If the model recommended in Table 5-1 is not available, a substitute may be used as long as it meets the required specifications

5-4.1. PREVENTIVE MAINTENANCE

NOTE

Refer to TM 750-244-2 for proper procedures for destruction of this equipment to prevent enemy use.

a. Operator/crew preventive maintenance is the systematic care, servicing and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to maintain equipment in serviceable condition, To be sure that your voltmeter is always ready for your mission, you must do scheduled preventive maintenance checks and services (PMCS).

(1) BEFORE OPERATION, perform your B PMCS to be sure that your equipment is ready to go.

(2) When an item of equipment is reinstalled after removal, for any reason, perform the necessary B PMCS (para 5-4.2) to be sure the item meets the readiness report - ing criteria.

(3) Use the ITEM NO. column in the PMCS table to get the number to be used in the TM ITEM NO. column on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) when you fill out the form.

b. There are no organizational PMCS to be performed.

c. Routine checks like CLEANING, DUSTING, WASHING, CHECKING FOR FRAYED CABLES, STOWING ITEMS NOT IN USE, COVERING UNUSED RECEPTACLES, CHECKING FOR LOOSE NUTS AND BOLTS, AND CHECKING FOR COMPLETENESS, are not listed as PMCS checks. They are things that you should do any time you see they must be done. If you find a routine check like one of those listed in your PMCS, it is because other operators reported problems with this item.

NOTE

When you are doing any PMCS or routine checks, keep in mind the warnings and cautions.

WARNINGS

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame, the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

NOTES

The PROCEDURES column in your PMCS charts instruct how to perform the required checks and services. Carefully follow these instructions and, if tools are needed or the chart so instructs, get organizational maintenance to do the necessary work.

If your equipment must be in operation all the time, check those items that can be checks and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

d. Deficiencies that cannot be corrected must be reported to higher category maintenance personnel. Records and reports of preventive maintenance must be made in accordance with procedures given in TM 38-750.

NOTE

The checks in the interval column are to be performed in the order listed.

5-4.2. OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES CHART

B — Before

Item No.	Interval B	Item to be Inspected	Procedures – Check for and have repaired or adjusted as necessary	Equipment is not Ready/Available If:
1	•	Mission Essential Equipment	Check for completeness and satisfactory condition of the equipment. Report missing items.	Available equipment is insufficient to support the combat mission.

*Do this check before each deployment to a mission location. This will permit any existing problems to be corrected before the mission starts, The check does not need to be done again until redeployment.

5-5. MECHANICAL ZERO ADJUST (400E Only).

5-6. Before any performance checks or calibration is begun, complete the mechanical zero adjustment in the following steps:

a. Be sure the meter has been off for at least one minute,

b. Rotate mechanical adjustment screw CLOCKWISE until meter pointer is to the left of zero and moving upscale toward zero.

c. Continue to rotate adjustment screw clockwise. STOP when needle is exactly on zero. If needle overshoots, repeat step b.

d. When pointer is exactly over zero, rotate adjustment screw slightly COUNTERCLOCKWISE to relieve tension on suspension. If the pointer moves to the left, repeat whole procedure, but make counterclockwise rotation less.

5-7. PERFORMANCE CHECKS.

5-8. The performance checks are ‘in cabinet’ tests that compare the 400E/EL with its specifications. These procedures can be used for both incoming inspection and periodic inspection.

5-9. ACCURACY AND FREQUENCY RESPONSE TEST.

5-10. The accuracy and frequency response test compares the Model 400E/EL with its accuracy specifications over the entire frequency range. For this test, a stable voltage reference and an extremely flat broad band signal generator are needed.

5-11. The test setup in Figure 5-1 uses a thermal converter with a null circuit to adjust the frequency response of the test oscillator to within 0.2% over its entire band. Construct the 0 to 10 mv Reference Supply shown in Figure 5-1 and allow it at least 24 hours to stabilize.

NOTE

The test oscillator used must have very low distortion (< 170). A thermal converter and an average responding circuit react differently to distortion, and any distortion present would create a calibration error.

5-12. REFERENCE SUPPLY CALIBRATION.

5-13. Using the following procedure to calibrate the thermal converter and reference supply.

a. Connect the dc standard, the 400E/EL, the null voltmeter, the reference supply, and a 3 volt thermal converter as shown in Figure 5-1. Set switch S1 to position A connecting the dc standard output to the thermal converter input. The reference supply and the thermal converter are sensitive to variations in ambient temperature. Ensure that the ambient temperature variations are less than ±2.0°C.

NOTE

If a 400E/EL Option 02 instrument is used, set the REL. REF adjustment to the fully clockwise ABSOLUTE position before making accuracy check.

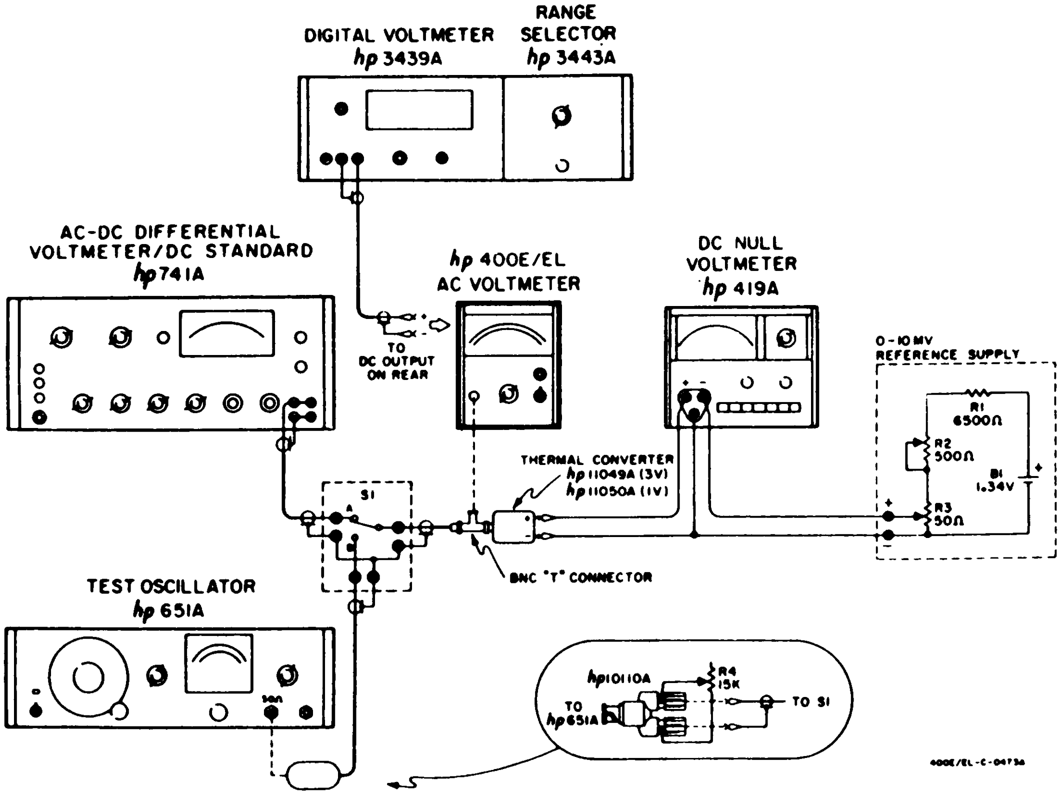


Figure 5-1. Accuracy and Frequency Response Test Setup

b. Set the dc standard output to +3.000 volts dc.

c. Using the null voltmeter, adjust the reference supply until its output is within ±l.5 microvolt of the thermal converter output.

5-14. MODEL 400E/EL ACCURACY TEST.

5-15. Check the 400E/EL accuracy and frequency response according to the following steps.

CAUTION

SET TEST OSCILLATOR OUTPUT TO MINIMUM BEFORE CONNECTING. REDUCE OSCILLATOR OUTPUT BEFORE CHANGING FREQUENCY RANGE. DO NOT ALLOW OSCILLATOR OUTPUT TO EXCEED RATED INPUT OF THERMAL CONVERTER. ANY OVERLOAD MAY DESTROY THERMAL CONVERTER.

a. Set switch S-1 in figure 5-1 to position B, connecting the test oscillator to the thermal converter input. Connect the digital voltmeter to the 400E/EL DC OUTPUT terminals.

b. Set the 400E/EL Range Switch to 3 volts and set the oscillator frequency to 10 Hz.

c. Using the oscillator amplitude control as coarse adjustment and resistor R4 (Figure 5-1) as fine adjustment, increase the oscillator amplitude until the thermal converter output nulls the reference supply. Observe the 400E/EL meter indication and dc output.

d. Repeat steps b and c for each frequency listed in Table 5-2. If the 400E/EL is within specifications, the meter indication and the dc output will be within the tolerances listed in Table 5-2.

e. Repeat the procedure in Paragraph 5-1l using a 1 volt thermal converter and a 1 volt output from the dc standard.

f. Repeat steps a through d in this paragraph using the one volt thermal converter. Set the 400E/EL to the 1 volt range.

5-16. RANGE TRACKING TEST.

5-17. The range tracking test checks the accuracy of the 400E/EL with a 1/3 scale input over its entire frequency range.

5-18. After verifying the full scale calibration with the accuracy test in Paragraph 5-13, check the range tracking with the following procedures.

a. Connect the dc standard, 3 volt thermal converter, dc null voltmeter, and reference sup ply as shown in Figure 5-1.

b. Set the dc standard output to +3.000 volts dc, and adjust the reference supply output to null the thermal converter output.

CAUTION

SET TEST OSCILLATOR OUTPUT TO MINIMUM BEFORE CON– NECTING. REDUCE OSCILLATOR OUTPUT BEFORE CHANGING FREQUENCY RANGE. DO NOT

Table 5-2. Calibration Tolerant es

3 VOLT RANGE					1 VOLT RANGE				
FREQUENCY Hz	METER READING		DC OUTPUT		FREQUENCY Hz	METER READING		DC OUTPUT	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
10	2.88	3.12	0.911	0.987	10	0.96	1.04	0.960	1.040
40	2.94	3.06	0.930	0.968	40	0.96	1.02	0.960	1.020
100	2.97	3.03	0.940	0.958	100	0.99	1.01	0.990	1.010
1000	2.97	3.03	0.940	0.958	1000	0.99	1.01	0.995	1.005
10 K	2.97	3.03	0.940	0.958	10 K	0.99	1.01	0.995	1.005
100 K	2.97	3.03	0.940	0.958	100 K	0.99	1.01	0.995	1.005
l M	2.97	3.03	0.940	0.958	l M	0.99	1.01	0.990	1.010
2 M	2.97	3.03	0.940	0.958	2 M	0.99	1.01	0.990	1.010
4 M	2.94	3.06	0.930	0.968	4 M	0.98	1.02	0.980	1.020
10 M	2.88	3.12	0.911	0.987	10 M	0.96	1.04	0.960	1.040

ALLOW OSCILI.ATOR OUTPUT TO EXCEED RATED INPUT OF THERMAL CONVERTER. ANY OVERLOAD MAY DESTROY THERMAL CONVERTER.

c. Disconnect the dc standard, and connect the test oscillator, the digital voltmeter, and the 400E/EL as shown in Figure 5-1.

d. Set the 400E/EL RANGE switch to 10 volts and the oscillator to 10 Hz.

e. Using the oscillator amplitude control as coarse adjustment and resistor R4 as a fine adjustment, set the oscillator output so that the thermal converter output nulls the reference supply output.

f. Repeat steps band c for each frequency listed in Table 5-3 (400E) or Table 5-4 (400EL). If the 400E/EL is within specifications, the meter indication and the dc output will be within the tolerances listed in the tables.

g. Repeat steps a through fin this paragraph using a 1 volt thermal converter and a +1.000 volt dc output from the dc standard. Set the 400E/EL to the 3 volt range.

5-19. INPUT IMPEDANCE CHECK.

5-20. INPUT RESISTANCE CHECK.

a. Connect the 50 Ω output of the test oscillator to the input of the 400E/EL.

b. Set the test oscillator and the 400E/EL to the 3 volt range. Set the oscillator output to 40 Hz, and adjust the output for a full scale indication.

c. Connect a 100 K Ω resistor between the test oscillator output and the 400E/EL input as shown in Figure 5-2.

d. The 400E/EL indication should not drop more than one small scale division from full scale. This verifies an input resistance of 10 M Ω.

Table 5-3. 1/3 Scale Tracking Tolerances (400E)

10 VOLT RANGE					3 VOLT RANGE				
FREQUENCY Hz	METER READING		DC OUTPUT		FREQUENCY Hz	METER READING		DC OUTPUT	
	MIN	MAx	MIN	MAX		MIN	MAX	MIN	MAX
10	2.70	3.12	0.270	0.312	10	0.90	1.04	0.285	0.328
40	2.85	3.09	0.291	0.309	40	0.95	1.03	0.301	0.325
100	2.91	3.09	0.291	0.309	100	0.97	1.03	0.307	0.325
1000	2.91	3.09	0.291	0.309	1000	0.97	1.03	0.307	0.325
10 K	2.91	3.09	0.291	0.309	10 K	0.97	1.03	0.307	0.325
500 K	2.91	3.09	0.291	0.309	500 K	0.97	1.03	0.307	0.325
l M	2.88	3.09	0.288	0.309	l M	0.96	1.03	0.304	0.325
4 M	2.85	3.09	0.285	0.309	4 M	0.95	1.03	0.301	0.325
10 M	2.70	3.12	0.270	0.312	10 M	0.90	1.04	0.285	0.328

Table 5-4. 1/3 Scale Tracking Tolerances (400 EL)

10 VOLT RANGE					3 VOLT RANGE				
FREQUENCY Hz	METER READING		DC OUTPUT		FREQUENCY Hz	METER READING		DC OUTPUT	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
10	2.70	3.12	0.270	0.312	10	0.90	1.04	0.284	0.304
40	2.96	3.04	0.297	0.303	40	0.98	1.02	0.311	0.321
100	2.96	3.04	0.297	0.303	100	0.98	1.02	0.311	0.321
1000	2.96	3.04	0.297	0.303	1000	0.98	1.02	0.311	0.321
10 K	2.96	3.04	0.297	0.303	10 K	0.98	1.02	0.311	0.321
500 K	2.94	3.06	0.294	0.306	500 K	0.98	1.02	0.311	0.321
1 M	2.94	3.06	0.294	0.306	1 M	0.98	1.02	0.310	0.322
4 M	2.88	3.06	0.288	0.306	4 M	0.96	1.02	0.304	0.322
10 M	2.70	3.07	0.270	0.309	10 M	0.90	1.03	0.284	0.325

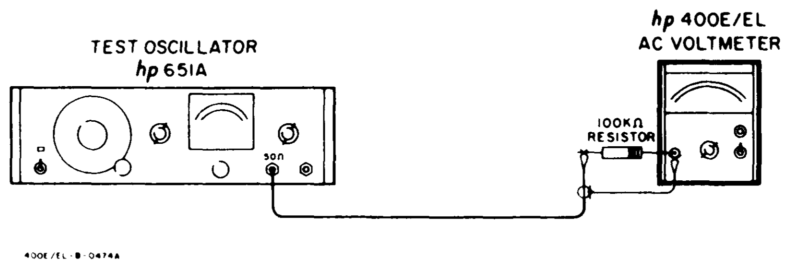


Figure 5-2. Input Impedance Check

5-21. INPUT CAPACITY CHECK.

a. Connect a test oscillator, a 100 K Ω resistor, and the 400E/EL as shown in Figure 5-2. Insert the resistor lead directly into the BNC connector on the 400E/EL, and connect the ground lead to the outer shield of the 400E/EL input connector. Do not use an adapter, as any adapter will add input capacity.

b. With the 400E/EL on the 3 volt range, adjust the test oscillator for a full scale reading on the 400E/EL at 40 Hz.

c. Increase the test oscillator frequency until the 400E/EL indication drops to 2.12 volts. This should occur at a frequency of 180 KHz or greater, verifying an input capacity of 8 pf or less on the 3 volt range.

d. Repeat steps a and b with the 400E/EL on the 1 volt range.

e. Increase the test oscillator frequency until the 400E/EL indication drops to 0.707 volts. This should occur at a frequency of 72 KHz or greater, verifying an input capacity of 21 pf or less on the 1 volt range.

5-22. ALIGNMENT AND CALIBRATION PROCEDURE.

5-23. The calibration adjustments are “cover off” procedures to adjust the 400E/EL to its performance specifications. If the instrument cannot be properly adjusted, refer to the Troubleshooting Procedures (Paragraph 5-34). Figure 5-3 shows the location of all the internal adjustments.

5-24. COVER REMOVAL.

5-25. To remove the top or bottom covers, remove the Phillips screw at the rear of the cover, slide the cover about 1 inch to the rear, and lift if off. To replace the cover, reverse the removal procedure.

5-26. To remove a side cover, remove the four Phillips screws and lift it off.

5-27. BIAS ADJUST.

5-28. Connect a dc voltmeter (410C) to TP3 and adjust A2R17 for -6.0 ±0.25 vdc. Connect a dc voltmeter to TP4 and adjust A2R31 for +10.0 ±0.5 vdc.

5-29. AC OUTPUT ZERO.

5-30. Connect a dc voltmeter (410C) to TP5 and adjust A2R59 for 0.0 ±0.050 vdc.

5-31. CALIBRATION.

NOTE

If a 400E/EL Otpion 02 is to be calibrated, set the REL. REF adjustment to the fully clockwise ABSOLUTE position before beginning the calibration.

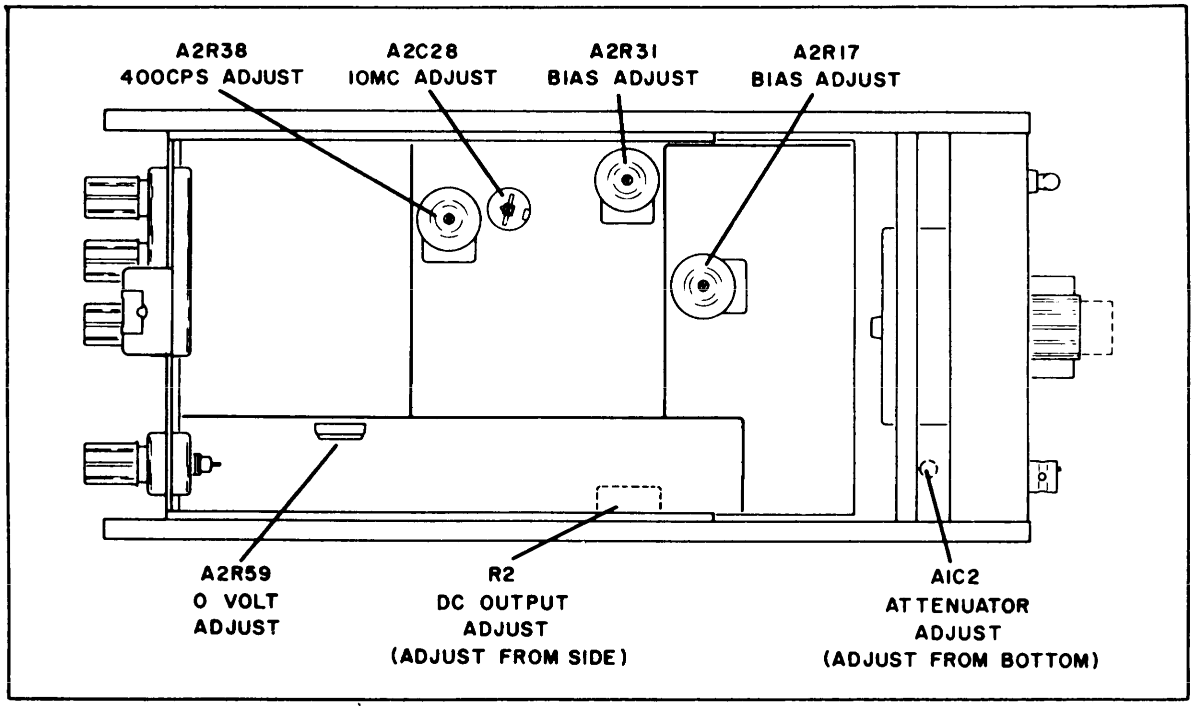


Figure 5-3. Location of Internal Adjustments

5-32. LOW AND HIGH FREQUENCY CALIBRATION.

a. Calibrate the reference supply in Figure 5-1 with a 1 volt thermal converter according to the steps in Paragraph 5-10.

b. Disconnect the dc standard and connect the test oscillator, the 400E/EL, and the digital voltmeter as shown in Figure 5-1. Set the oscillator frequency to 400 Hz and the 400E/EL to the 1 volt range. Using the amplitude control as coarse adjustment and R4 as fine adjustment, increase the oscillator output until the thermal converter output nulls the reference supply.

c. Adjust A2R38 for a 400E/EL meter reading of 1.004.01 volts.

d. Adjust R2 for a digital voltmeter display of 1.000 ±0.005 vdc.

e. Lower test oscillator output and set frequency to 10 MHz. Readjust oscillator amplitude until thermal converter output nulls reference Supply.

f. Adjust A2C28 for digital voltmeter display of 1.000 ±0.04.

5-33. ATTENUATOR ALIGNMENT.

a. Use the setup shown in Figure 5-1 to align the attenuator. Calibrate the reference supply according to the procedures in Paragraph 5-10 using a 3 volt thermal converter.

CAUTION

SET TEST OSCILLATOR OUTPUT TO MINIMUM BE FORE CONNECTING. REDUCE OSCILLATOR OUTPUT BEFORE CHANGING FREQUENCY RANGE. DO NOT ALLOW OSCILLATOR OUTPUT TO EXCEED RATED INPUT OF THERMAL CONVERTER. ANY OVERLOAD MAY DESTROY THERMAL CONVERTER.

b. Disconnect the dc standard and connect the test oscillator and 400E/EL as shown in Figure 5-1. Set the oscillator frequent y to 100 KHz and the 400E/EL to the 3 volt range. Using the amplitude control as coarse adjustment and R4 as fine adjustment, increase the oscillator output until the thermal converter output nulls the reference supply.

c. Adjust A1C1 in the 400E/EL for a meter reading of 3.00 volts.

5-34. TROUBLESHOOTING.

5-35. When the 400E/EL operates improperly, first determine if it is adjusted improperly or if a circuit is malfunctioning by adjusting and calibrating the instrument according to the procedures in Paragraph 5-22. If calibration is impossible, proceed with the troubleshooting steps.

5-36. Check the instrument for any obvious evidence of trouble, such as loose or broken wires or broken connectors. Check the printed circuit boards for separations or cracks and ensure that all pins are clean.

5-37. First isolate the trouble to a particular circuit using the block diagram (Figure 4- 1) and the schematic (Figure 6- 1). Table 5-5 lists some likely troubles and their probable causes. Then refer to the trouble-shooting steps for that circuit.

NOTE

The test voltages shown in this section are nominal. A tolerance of ±5% is allowable.

Table 5-5. Troubleshooting Guide

SYMPTOM	PROBABLE TROUBLE
No response to input.	Fuse A2F1 open.
Instrument will not up-range above 1 volt, but works on 1 volt range and below.	Relay K1 stuck closed.
Instrument will not downrange below 3 v, but works on 3 v range and above.	Relay K2 stuck closed.
TP3 voltage cannot be properly adjusted.	Impedance Converter (A2Q5, 6, and 7).
TP5 voltage cannot be properly adjusted.	Ac output circuit (A2Q15, 16).
TP4 voltage cannot be properly adjusted.	Meter amplifier (A2Q8 - 13).

5-38. POWER SUPPLY.

5-39. Check with a dc voltmeter (410C) at TP1 and TP2 for +26 volts and -26 volts respectively. If the TP voltages are improper, check the voltages listed in Table 5-6. If the voltage for a given component is wrong, the trouble is probably in that component or its associated circuit.

Table 5-6. Power Supply Voltages

COMPONENT	VOLTAGE
Collector Q1	+39 v
Collector Q2	+26. 5 v
Emitter Q2	+6.98 v
Base Q3	-0.6 v
Collector Q3	-23.5 v
Collector Q4	-39 v

5-40. AMPLIFIERS.

5-41. Set the 400E/EL to the 1 volt range, and connect a full scale input. With a sensitive ac voltmeter, monitor the ac amplifier output at the negative side of A2C34 or A2C36. The output should be 150 mv. If it is not 150 mv, measure the ac voltage at A2 pin 22. The voltage at pin 22 should be 3 mv. If these two voltage readings are correct, the meter amplifier and meter bridge are operating properly.

5-42. If the voltage at pin 22 is low, pull the wht/orn/yel wire from pin 22, and measure the ac signal at the wire. It should be 3 mv. If the voltage on the wire is proper, the trouble is in the meter amplifier If it isn't correct, the trouble is either in the Post Attenuator or the Impedance Converter.

5-43. To check the Impedance Converter, measure the ac voltage at its output (A2 pin 21). The output voltage should be very close to the input voltage since the Impedance Converter is a unity gain amplifier. With a 1 volt input, the output should be 0.98 volts ±0.02 volts.

5-44. Both the Impedance Converter and the meter amplifier are internally dc coupled. If the dc voltages anywhere in the amplifier are incorrect, the amplifier won't operate properly. Consequently a check of the dc voltages is a good check of the amplifiers.

5-45. Tables 5-7 and 5-8 contain the dc voltages on all of the transistors in the meter amplifier and the Impedance Converter. If the measured voltage on a given transistor is wrong, the trouble is probably in that transistor or its associated circuit.

NOTE

Measure these dc voltages with the in,put shorted. A dc voltmeter with low input capacitance and very high input resistance must be used. The -hp- Model 410C is recommended.

Table 5-7. Impedance Converter Voltages

TRANSISTOR	E	B	C
Q5	(S) -6 v	(G) *	(D) 14. 4v
Q6	-15 v	-14.3v	- 7.4v
Q7	- 6.7 v	- 7.4v	-21.5v
* Cannot be measured.			

Table 5-8. Meter Amplifier Voltages

TRANSISTOR	E	B	c
Q8	+22. 25 v	+23 v	+25. 5 v
Q9	+0.02 v	+0.57 v	+7.5 v
Q1O	+ 8.2 v	+7.5 v	+1.8 v
Q11	+1.25 v	+1.8 v	+ 8 v
Q12	+ 9 v	+ 8 v	+0.27 v
Q13	+0.27 v	0	-6.2 v
Q14*	- 0.45 v	+ 0.02 v	+26 v
* In bridge circuit.			

5-46. AC OUTPUT CIRCUIT.

5-47. To check the ac output circuit, measure the dc voltages at the points shown in Table 5-9. If a given measured voltage is incorrect, the trouble is probably in that component or its associated circuit.

Table 5-9. AC Voltage Output Circuit

TRANSISTOR	E	B	c
Q15	+0. 68 v	+1.3 v	+4. 6 V
916	0	+0. 66 v	+4. 6 V

5-48. ADJUSTMENT OF FACTORY SELECTED COMPONENTS.

5-49. Certain components within the Model 400E/EL are individually selected in order to compensate for slightly varying circuit parameters. These components are denoted by an asterisk (*) on the schematic, and the typical value is shown. Table 5-10 describes the function of the factory selected components and gives instruct ions for their select ion. Normally, these components do not need to be changed unless another associated component is changed. Replacement of a transistor, for example, may require the changing of a factory selected component.

Table 5-10. Factory Selected Components

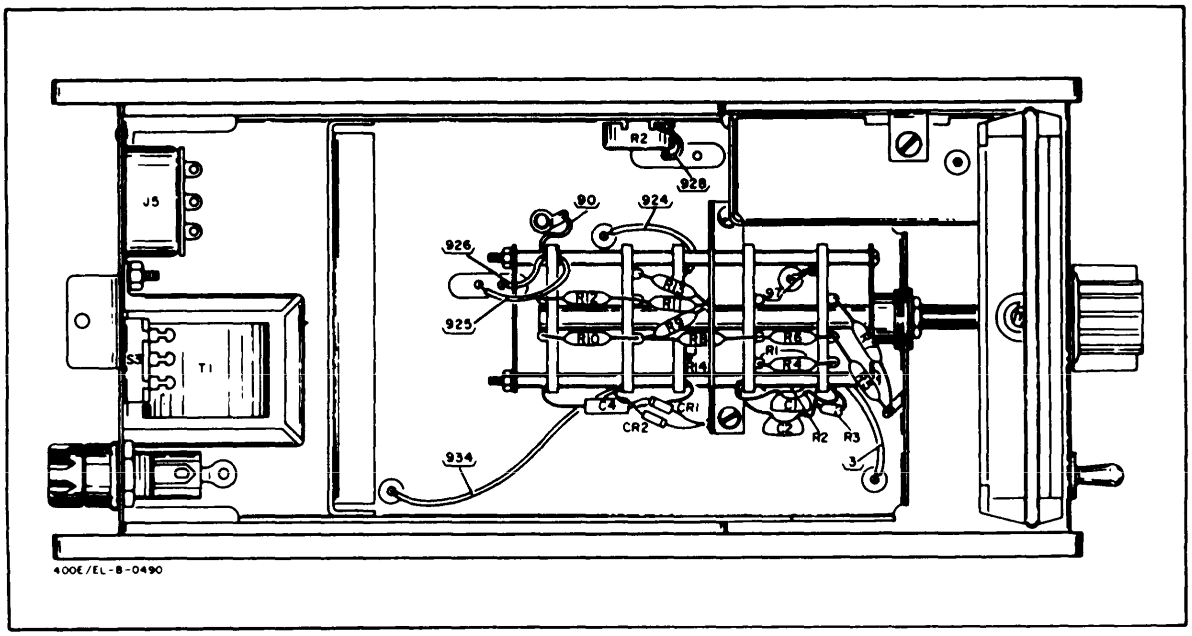
COMPONENT	FUNCTION AND SELECTION
A2C12*	56 to 110 pf. Adjusts 2 MHz response of impedance converter. With consistently high readings at 2 MHz on 1 volt range, decrease A2C12.
A2C31*	18 to 22 pf. Adjusts 10 Hz response on 3 volt range. With consistently low readings at 10 Hz on 3 volt range, decrease A2C31.
A2R44*	110-182 Ω. Adjusts 400 Hz response on the 1 mv range. With consistently low readings, decrease A2R44.
S2C4*	1.8 to 6.8 pf. Adjusts 10 Hz response on 1 mv and 3 mv range. With consistently high readings at 10 Hz on 3 mv or 1 mv range, decrease S2C4.

SECTION VI

CIRCUIT DIAGRAMS

6-1. INTRODUCTION.

6-2. This section contains the circuit diagrams necessary for maintenance of the Model 400E/EL. A schematic, a component location drawing, and a diagram of the RANGE switch are included. Location grids are drawn on the more complicated diagrams making the search for individual components easier.



p/o Figure 6-1. 400E/EL Schematic Diagram and Location of Components

APPENDIX A

REFERENCES

DA Pam 310-1	Consolidated Index of Army Publications and Blank Forms.
TM 11-6626-1538-24P	Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools List for Voltmeters, AN/USM-265 (NSN 6625-00-935-4294), ME-459 (6625-00-229-4457) and ME-465 (6625-00-995-7716).
TM 38-740	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use.

APPENDIX D
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

D-1. General

This appendix provides a summary of the maintenance operations for AC Voltmeter AN/USM-265, ME-459, and ME-465. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

D-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

.*j. Overhaul.* That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/ components.

D-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumns(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of task-hours specified by the "work time" figure represent the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C — Operator/Crew
O — Organizational
F — Direct Support
H — General Support
D — Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Not applicable.

D-4. Tool and Test Equipment Requirements (See III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. Not applicable.

D-5. Remarks (See IV)

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

(Next printed page is D-3.)

SECTION II MAINTENANCE ALLOCATION CHART
FOR
VOLTMETER AN//USM-265, ME-459, AND ME-495

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
00	AC VOLTMETER AN/USM 265, NE-459, AND 465	Inspect		0.2				8	
		Test		0.3				1 thru 8	
		Test				0.8		1 thru 9	
		Service		0.4				8	
		Adjust				0.5		1 thru 7	
		Repair		0.2				1 thru 8	
		Repair				0.6		1 thru 9	
		Overhaul				2.0		1 thru 8	

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
VOLTMETER AN//USM-265, ME-459, ME-465

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL NATO STOCK NUMBER	TOOL NUMBER
1	O, H, D	OSCILLATOR TS-221/TSM HP-651A	625-00-910-0849	
2	O, H, D	DC VOLTMETER ME-231/FYQ-5, HP-3440A	625-00-013-2630	
3	O, H,D	DC NULL METER HP-419A	625-00-212-6589	
4	0, H, D	THERMAL CONVERTERS HP-HO 2-11049A	931-00-111-6681	
5	O, H, D	THERMAL CONVERTER HP-11050A	931-00-130-5381	
6	O, H, D	DC SUPPLY, ME-202 (*)/U, HP-741B	625-00-709-0288	
7	O, H, D	AC-DC VOLTMETER ME-26/U, HP-410A	625-00-360-2493	
8	O, H	TOOLS AND TEST EQUIPMENT AVAILABLE TO THE REPAIRMAN BECAUSE OF HIS ASSIGNED MISSION		
9	H, D	TOOLS AND TEST EQUIPMENT MOUNTED IN AN/TSM 55 (V)		

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SAAD (5)
TOAD (5)
LEAD (3)

NG: None.
USAR: None.
For explanations of abbreviations used, see AR 320-50.

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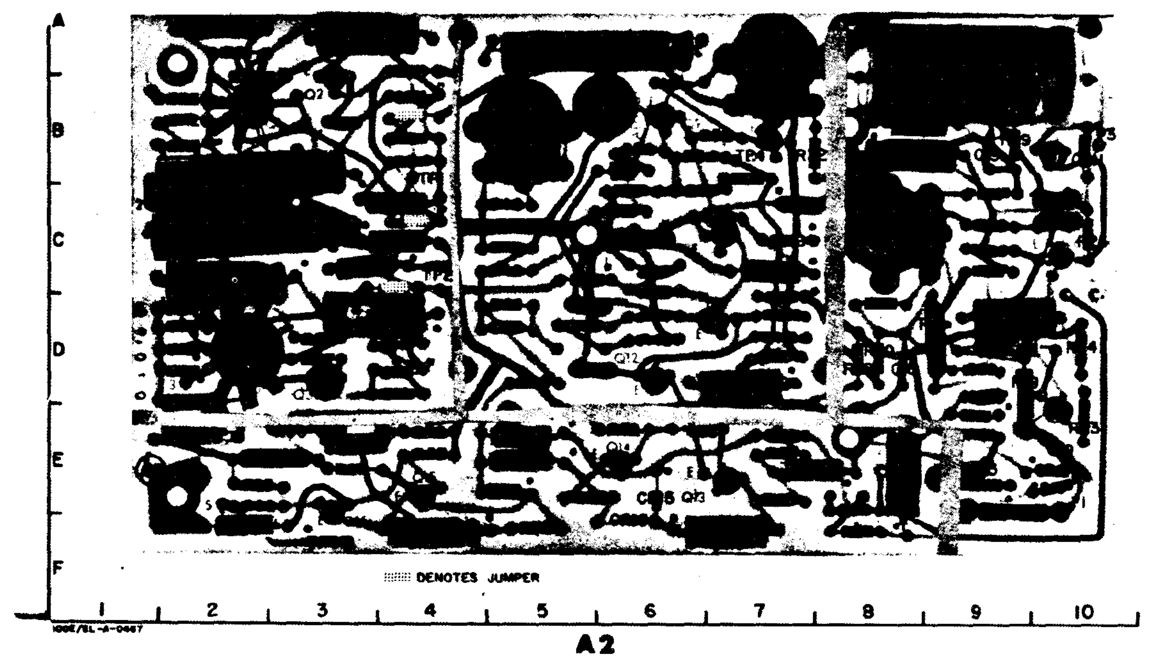
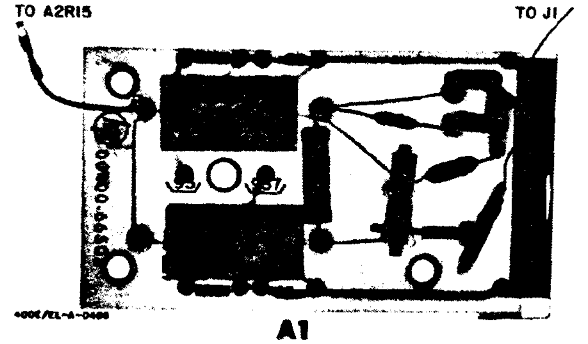


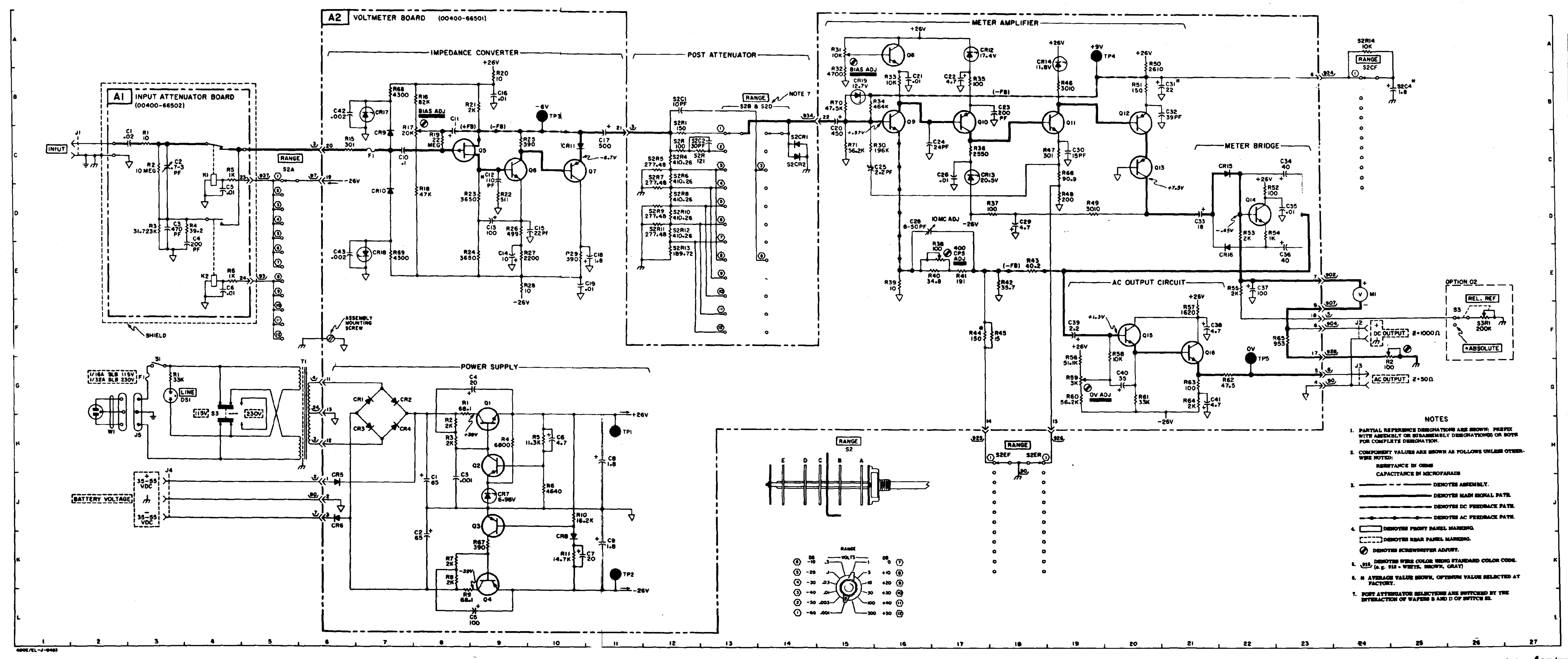
A2
(hp Part No. 00400-66501)



A1
(hp Part No. 00400-66502)

A2 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R	TP	F		C	R		R
1	B2	D2	B2	A2	B4	E10	25	B6	C10	49	E7
2	C2	B2	A3	A2	C4		26	C6	C9	50	D7
3	B3	D2	D3	A2	B10		27	--	C9	51	D7
4	A3	B2	D2	B4	B7		28	B6	D6	52	E6
5	C2	B2	E10	B4	F3		29	E8	B9	53	E7
6	C4	D2	C10	A4			30	D5	B6	54	E5
7	D4	B4	B10	D3			31	D7	A7	55	F6
8	C4	D4	B7	D2			32	D5	B6	56	E4
9	C3	E10	B6	D2			33	F7	B7	57	E4
10	E10	E10	C7	D4			34	E5	B7	58	F5
11	D9	B10	D7	D4			35	E7	C7	59	E3
12	C10	C7	D6	--			36	E5	C6	60	E3
13	D9	C5	E7	--			37	E8	E7	61	E3
14	B9	D7	E6	--			38	F3	B5	62	E2
15	C10	E6	E4	E9			39	E5	C6	63	E2
16	D6	F6	E3	D6			40	F4	C5	64	E3
17	A9	E9		C8			41	E3	C5	65	E8
18	B9	E9		C9			42	D9	C5	66	D5
19	B9	B7		D10			43	E9	D5	67	D3
20	A5			D8			44		D5	68	D8
21	B6			D9			45		D6	69	E9
22	C7			C9			46		D7	70	C7
23	C6			E10			47		D6	71	C6
24	C7			D10			48		D6	72	



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. DENOTES ASSEMBLY.
   DENOTES MAIN SIGNAL PATH.
   DENOTES DC FEEDBACK PATH.
   DENOTES AC FEEDBACK PATH.
4. DENOTES FRONT PANEL MARKING.
   DENOTES REAR PANEL MARKING.
   DENOTES SCREWDRIVER ADJUST.
5. 916 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 916 = WHITE, BROWN, GRAY)
6. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
7. POST ATTENUATOR SELECTIONS ARE SWITCHED BY THE INTERACTION OF WAFERS B AND D OF SWITCH S2.

A2 SCHEMATIC COMPONENT LOCATIONS

	C	CR	Q	R	F		R
1	J8	G7	G9	G8	C7	46	B19
2	K8	G7	H9	H8		47	C19
3	J8	H7	J9	H8		48	D19
4	G9	H7	L9	H9		49	D19
5	L9	J8	C9	H10		50	A20
6	H10	J8	C9	J10		51	B20
7	K11	J9	C10	K8		52	D22
8	H11	K10	A16	K8		53	D22
9	K11	C7	B16	L8		54	D22
10	C7	D7	B17	J10		55	E22
11	B8	C10	B19	K10		56	F19
12	C9	A17	B20	--		57	F21
13	D9	C17	C20	--		58	F20
14	E9	A19	D22	--		59	G19
15	D10	C22	F20	C6		60	G19
16	B9	E22	F21	B8		61	G20
17	C11	B7		C8		62	G22
18	E11	E7		D8		63	G21
19	E11	B15		C8		64	G21
20	B15			B9		65	F23
21	B16			B9		66	C19
22	B17			D9		67	E9
23	B18			D9		68	B7
24	C17			E9		69	E7
25	C18			C9		70	B15
26	C17			D9		71	C15
27	--			E9		72	
28	D18			E9			
29	D18			E10			
30	C19			C18			
31	B21			A15			
32	B21			A15			
33	D21			B16			
34	C23			B16			
35	D23			B17			
36	E23			C17			
37	E22			D18			
38	F21			E17			
39	F19			E16			
40	C20			E17			
41	G21			E17			
42	B6			E18			
43	E6			E18			
44				F17			
45				F18			

Figure 6-1. 400E/EL Schematic Diagram and Location of Components

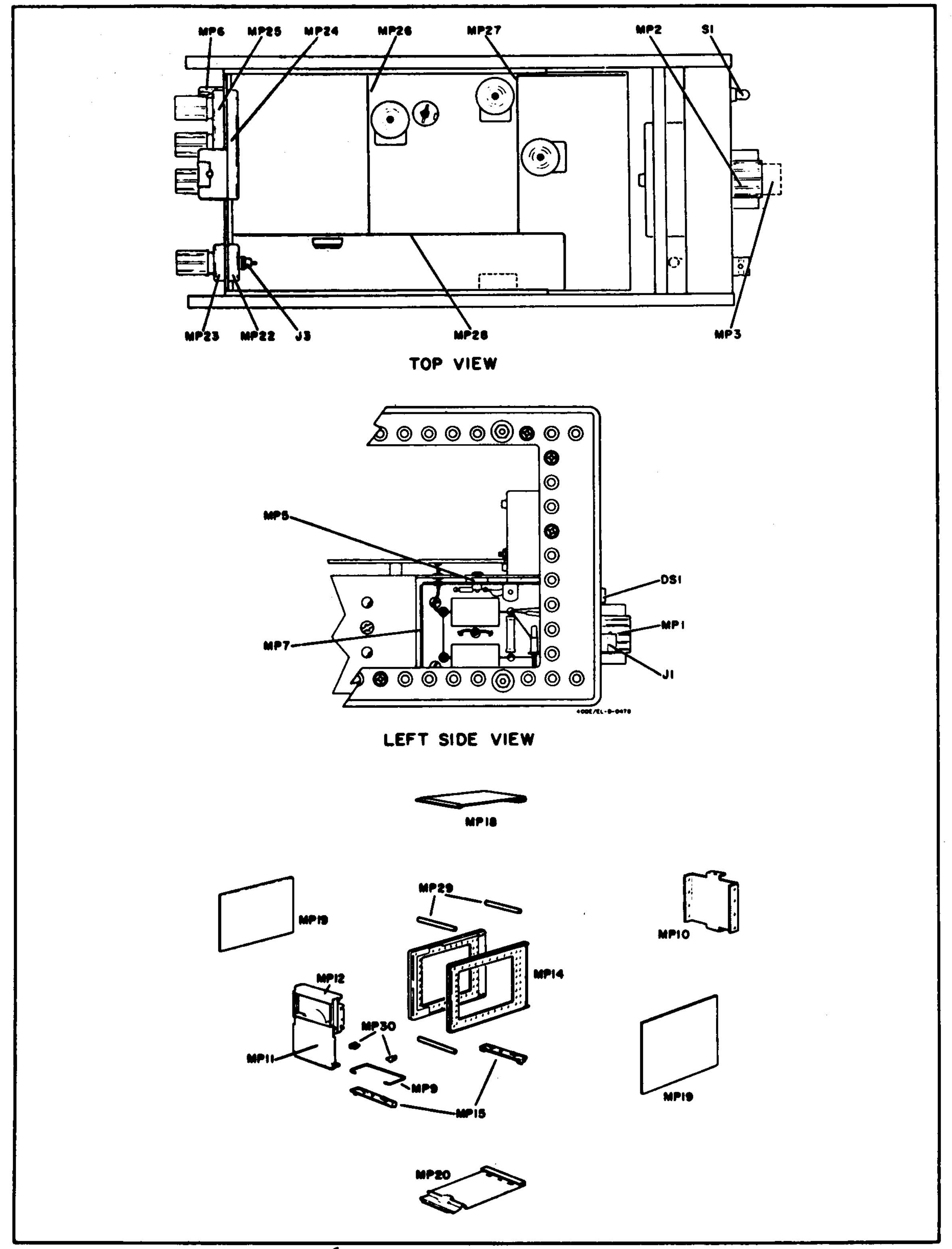


Figure 6-2. Location of Important Mechanical Parts

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