



OPERATING AND SERVICE MANUAL

(HP PART NO. 00400-90005)

MODEL 400F/FL
AC VOLTMETER

SERIALS PREFIXED: 734-

Appendix C, Manual Backdating Changes,
adapts this manual to serials prefixed 617-.

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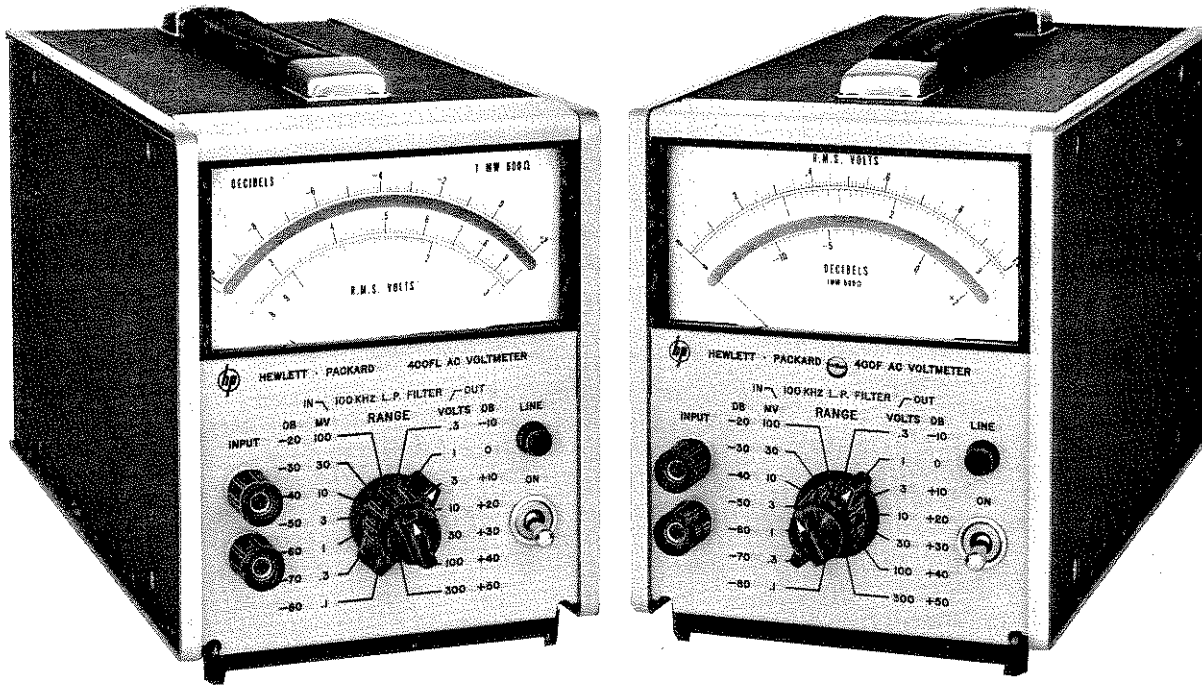


Figure 1-1. Model 400F/FL AC Voltmeter

Table 1-1. Specifications

-hp- Model 400F/FL	-hp- Model 400F/FL									
Voltage Range: 100 μ V to 300 V full scale, 14 ranges in 1, 3, 10 sequence.	Recovery From Overload: < 2 seconds for 80 dB overload.									
Frequency Range: 20 Hz to 4 MHz.	AC Power: 115 or 230 volts \pm 10%, 50 to 1000 Hz, 5 watts.									
Calibration: Responds to absolute average value of applied signal, calibrated in rms volts.	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 45 mA.									
Noise Referred to Input: (1000 ohm termination)	Temperature Range: 0 to +55°C.									
<table border="1"> <thead> <tr> <th>RANGE</th> <th>Filter In</th> <th>Filter Out</th> </tr> </thead> <tbody> <tr> <td>300 μV to 300 V</td> <td>< 5 μV</td> <td>< 30 μV</td> </tr> <tr> <td>100 μV</td> <td>< 5 μV</td> <td>< 15 μV</td> </tr> </tbody> </table>	RANGE	Filter In	Filter Out	300 μ V to 300 V	< 5 μ V	< 30 μ V	100 μ V	< 5 μ V	< 15 μ V	Weight:
RANGE	Filter In	Filter Out								
300 μ V to 300 V	< 5 μ V	< 30 μ V								
100 μ V	< 5 μ V	< 15 μ V								
Input Impedance: 10 megohms shunted by 25 pF on the 100 μ V - 300 mV ranges and 10 megohms shunted by 10 pF on the 1 V - 300 V ranges.	Net: 6 lbs. (2,7kg).									
Amplifier AC Output: 1 V rms open circuit for full scale meter indication; output impedance 600 ohms, 20 Hz to 4 MHz.	Shipping: 9 lbs. (4kg).									
Meter Response: < 0.7 seconds after application of signal.	Dimensions: 6-1/2" high, 5-1/8" wide, 11" deep (165, 1 x 130, 2 x 279, 4 mm).									

SECTION I GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp- Models 400F and 400FL are versatile ac voltmeters and dB meters. Both models can be used as wideband amplifiers. The Model 400F is primarily intended for voltage measurements, whereas the Model 400FL is primarily a dB meter. However, both meters indicate both volts and dB. The 400F has a linear ac scale with a logarithmic dB scale underneath, and the 400FL 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 400F/FL in reference to both instruments.

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

1-4. OPTION (400F ONLY).

1-5. Option 01 is a standard -hp- Model 400F AC Voltmeter which has a dB scale that reads from -15

to +2 instead of from -12 to +2. The dB scale is placed at the top of the meter face for better resolution.

1-6. INSTRUMENT AND MANUAL IDENTIFICATION.

1-7. Hewlett-Packard instruments are identified by a two-section, eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 400F/FL described in this manual.

1-8. If a letter prefixes the serial number, the instrument was manufactured outside the United States.

1-9. BACKDATING INFORMATION.

1-10. Appendix C contains backdating information that adapts this manual to instruments with serials prefixed 617.

Table 1-1. Specifications (Cont'd)

MODEL 400F						
Accuracy: \pm (% Full Scale + % Reading)						
300 μV TO 300 V RANGES						
Frequency	20 Hz	40 Hz	100 Hz	1 MHz	2 MHz	4 MHz
	$\pm(2 + 2)$	$\pm(1 + 1)$	$\pm(1/2 + 1/2)$	$\pm(1 + 1)$	$\pm(2 + 2)$	
100 μV RANGE						
Frequency		30 Hz	60 Hz	100 kHz	500 kHz	
		$\pm(2 + 2)$	$\pm(1 + 1)$	± 1	$+0$	-7

MODEL 400FL						
Accuracy: \pm % Reading						
300 μV TO 300 V RANGES						
Frequency	20 Hz	40 Hz	100 Hz	1 MHz	2 MHz	4 MHz
	± 4	± 2	± 1	± 2	± 4	
100 μV RANGE						
Frequency		30 Hz	60 Hz	100 kHz	500 kHz	
		± 4	± 2	$+1 -8$		

SECTION II INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 400F and 400FL 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 marks 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 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 400F/FL 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 400F/FL 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. BENCH MOUNTING.

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

2-14. RACK MOUNTING.

2-15. The Model 400F/FL 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. For additional information, address inquiries to your -hp- Sales and Service Office. (See Appendix B for office locations.)

2-16. COMBINATION MOUNTING.

2-17. The Model 400F/FL 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, it 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 instrument for shipment. Refer to Paragraph 2-20 if the original container is to be used; 2-21 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

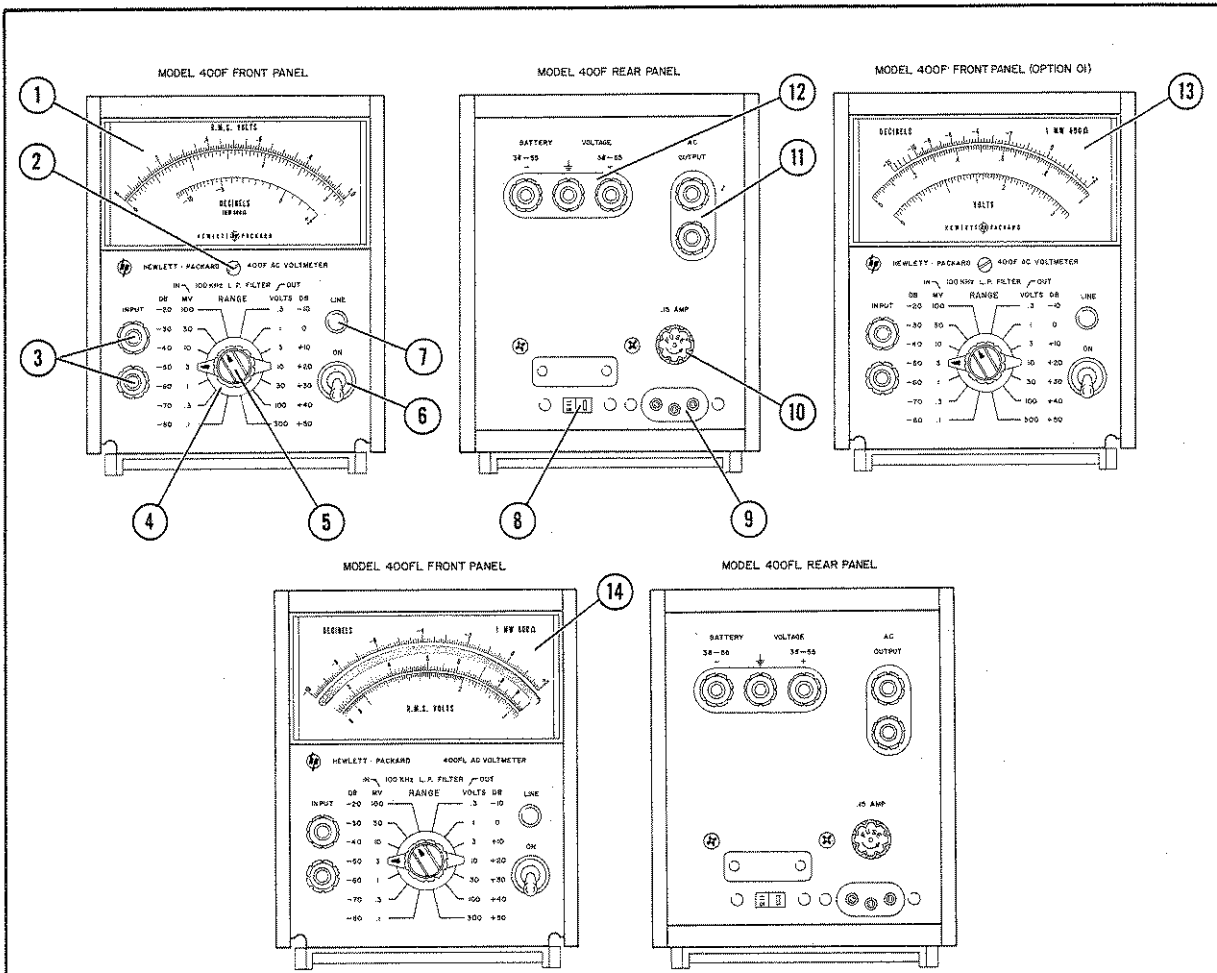
If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number, and serial number prefix.

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

- a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.
- b. Ensure 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.



400F/FL-B-0839A

- ① **400F Scale:** Indicates magnitude of applied signal in volts and dBm.
- ② **Mechanical Zero Adjust:** Provides a mechanical meter zero adjustment.
- ③ **INPUT Terminals:** Connects signal to be measured to 400F/FL.
- ④ **RANGE Selector (S1):** Selects full scale reading of meter. DBm reading on scale adds algebraically to dB setting of RANGE selector.
- ⑤ **100 KHz LP FILTER Switch (S2):** Switches 100 KHz filter either in or out of circuit.
- ⑥ **Line ON Toggle Switch (S3):** Applies primary power.
- ⑦ **LINE Indicator Lamp:** Indicates application of primary power.
- ⑧ **115/230 Volt Slide Switch (S4):** Selects 115 or 230 volts ac for line operation.
- ⑨ **Primary Power Connector:** Line voltage is applied through this connector.
- ⑩ **FUSE:** Protects instrument against current overload.
- ⑪ **AC OUTPUT:** Ac amplifier output. Output impedance is 600 Ω .
- ⑫ **BATTERY VOLTAGE Terminals:** 400F/FL may be powered by connecting two 35 to 55 volt batteries to these terminals.
- ⑬ **400 F Scale, Option 01:** The dBm scale is placed uppermost for greater resolution.
- ⑭ **400FL 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. 0 dBm = 1 mW in 600 Ω .

Figure 3-1. Location of Controls and Indicators

SECTION III OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and information necessary for the operation of the 400F/FL AC Voltmeters. Included is identification of controls, indicators and connectors, turn on procedures, and operating instructions.

3-3. CONTROLS, INDICATORS AND CONNECTORS.

3-4. Each control, indicator, and connector on the 400F/FL is identified and described in Figure 3-1.

3-5. METER MECHANICAL ZERO ADJUSTMENT (400F ONLY).

3-6. The mechanical zero adjustment is located in the center of the instrument front panel. If the meter pointer does not indicate zero after the instrument has been off at least one minute, mechanically zero the meter, following the steps outlined below.

- a. Turn instrument power off, and allow at least one minute for meter pointer to stabilize.
- b. Rotate zero adjustment screw clockwise until pointer is left of zero and moving upscale.
- c. Continue rotating screw clockwise until pointer is at zero. Stop when pointer is exactly on zero. If pointer overshoots, repeat step b.
- d. When pointer is exactly over zero, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension. If pointer moves to the left, repeat whole procedure, but make counterclockwise rotation less.

3-7. TURN ON PROCEDURES.

- a. If line voltage is used, ensure that the 115-230 vac switch (located on the rear panel) is in the correct position. Turn the line ON toggle switch to the ON position. The LINE lamp will glow, indicating that line power is applied.
- b. If batteries are used, connect two 35 to 55 volt batteries as shown in Figure 3-2. The line ON switch is not in the circuit when batteries are used, therefore an external DPST switch should be used to provide a means for disconnecting the batteries when the instrument is not in use.

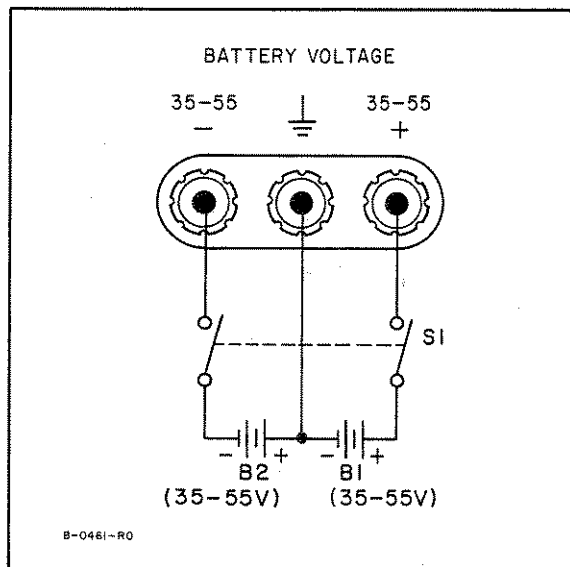


Figure 3-2. External Battery Connection

3-8. AC VOLTAGE MEASUREMENTS.

NOTE

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

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	0.033
	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	0.380

*Depends on phase relationship between harmonic and fundamental.

- a. Perform the steps listed under Paragraphs 3-5 and 3-7.
- b. Set the meter RANGE switch to the approximate range of the voltage to be measured.



DO NOT APPLY MORE THAN 600 VOLTS TO INPUT. DO NOT OVERLOAD THE .1 MV THROUGH .3 VOLT RANGES WITH MORE THAN 300 VOLTS AT FREQUENCIES BELOW 300 kHz OR WITH MORE THAN 64 VOLTS AT FREQUENCIES ABOVE 300 kHz. IF ANY OF THESE OVERLOADS ARE EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

- c. If the signal to be measured is a frequency less than 100 kHz, the 100 kHz L. P. FILTER may be switched in to filter out all frequency components above 100 kHz.
- d. Connect the signal to be measured to the INPUT terminals. The RMS voltage amplitude of the input will be indicated on the meter.

3-9. DB MEASUREMENTS.

- a. Perform the steps listed under Paragraphs 3-5 and 3-7.
- b. The dB measurement is equal to the algebraic sum of the meter indication and the RANGE setting. For example: if the RANGE setting is +20 dB, and the meter reading is -3 dB, the actual dB measurement is +17 dB.
- c. The dB scale of the 400F/FL is calibrated in dBm. 0 dBm is equivalent to 1 milliwatt dissipated by a 600 ohm load. Therefore, all measurements in dBm must be made across a total impedance of 600 ohms. Measurements across all other impedances will be in dB, but not in dBm.
- d. A reading in dB may be converted to dBm by using the Impedance Correction Graph (Figure 3-3). For example: to convert a 40 dB reading across 100 ohms to dBm, locate the 100 ohm 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 100 ohms is +7.5 dBm, and the corrected reading is +47.5 dBm.

3-10. WIDE BAND AC AMPLIFIER.



EXTREME CARE SHOULD BE TAKEN TO AVOID COMMON GROUND PATHS BETWEEN THE INPUT AND OUTPUT SIGNALS. BECAUSE OF THE HIGH GAIN OF THE INSTRUMENT ON THE MORE SENSITIVE RANGES (80 DB ON .1 MV RANGE, ETC.), COMMON GROUND PATHS CAN CAUSE OSCILLATIONS AT HIGHER FREQUENCIES.

- a. Perform the steps listed in Paragraphs 3-5 and 3-7.
- b. Set the meter RANGE switch to the approximate range of the input signal.
- c. When signals of frequencies less than 100 kHz are being amplified, the 100 kHz, L. P. FILTER may be switched in to reduce high frequency noise and lessen the possibility of oscillations.
- d. Connect the input signal to the INPUT terminals.
- e. Table 3-2 shows the gain factor for each range of the 400F/FL into an open circuit.

Table 3-2. AC Amplifier Gain Factors

RANGE	GAIN	RANGE	GAIN
300 V	-50 dB	100 mV	+20 dB
100 V	-40 dB	30 mV	+30 dB
30 V	-30 dB	10 mV	+40 dB
10 V	-20 dB	3 mV	+50 dB
3 V	-10 dB	1 mV	+60 dB
1 V	0 dB	.3 mV	+70 dB
.3 V	+10 dB	.1 mV	+80 dB

3-11. 400F WITH OPTION 01.

3-12. Operating procedures for the 400F with Option 01 are the same as the operating procedures for the standard 400F. The only difference between the two models is the scale layout. The 400F with Option 01 has a dB scale which reads from -15 to +2, instead of from -12 to +2. The dB scale is placed at the top of the meter face for better resolution.

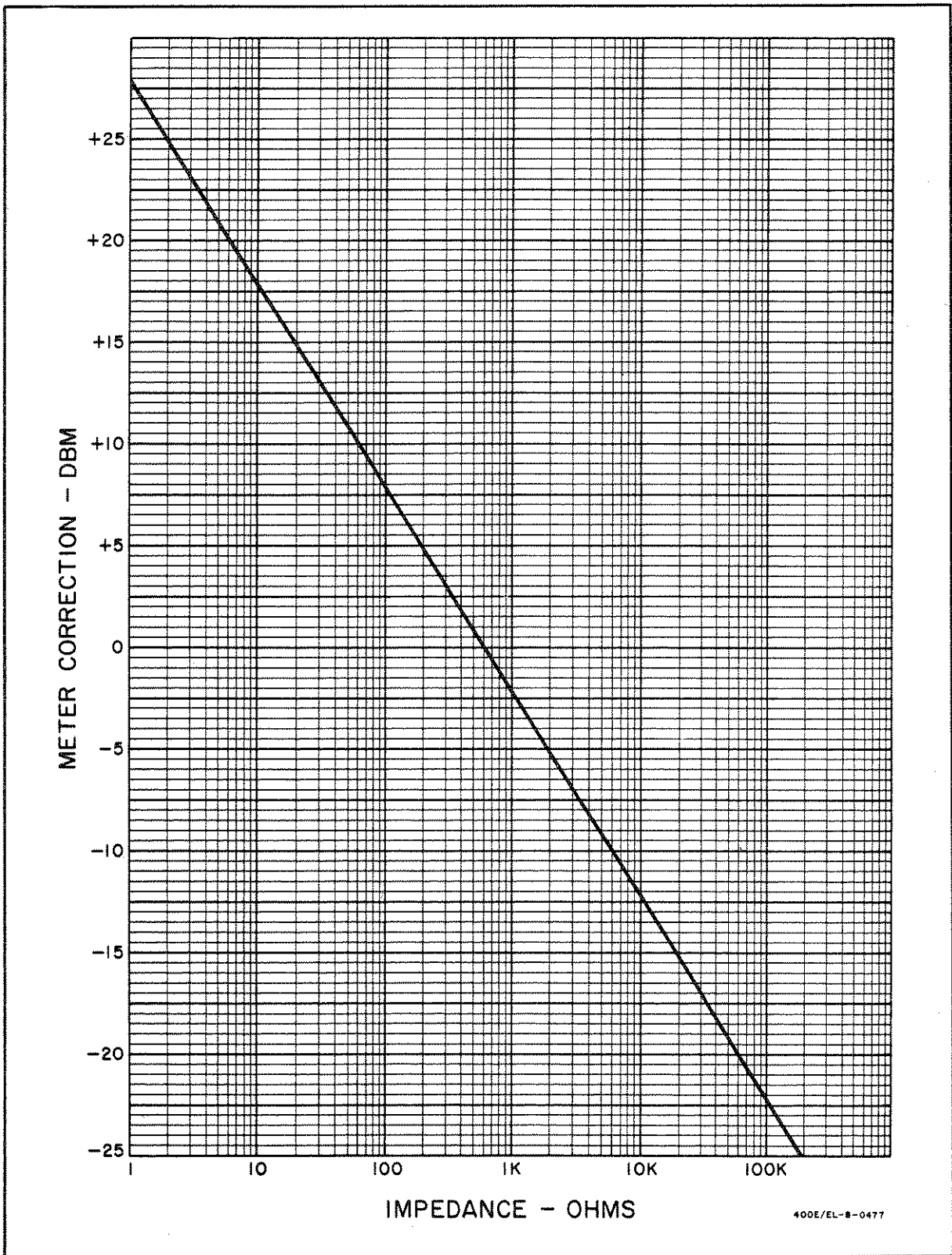


Figure 3-3. Impedance Correction Graph