SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 4815A RF Vector Impedance Meter (Figure 1-1) is a general purpose, self-contained instrument for measuring complex impedance in a wide variety of laboratory applications as well as production testing of circuits and components. The frequency range is 0.5 to 108 MHz; impedance magnitude is measured in 9 ranges from 10 Ω to 100 KΩ full scale; and phase angle between 0^{o} and 360^{o} is indicated on two ranges.

1-3. Impedance measurement is made at the tip of a probe that is at the end of a 5 ft. cable, with rf test signal and measuring circuits brought close to the probe tip to reduce residual impedances.

1-4. An internal rf oscillator, 0.5 to 108 MHz supplies a test signal to the unknown impedance, 12.6 μa on the 10 ohm range and 4 μa on all other ranges. Provision is made for using an external rf source, particularly useful when measuring quartz crystals and other high Q devices.

1-5. Dc voltages proportional to magnitude, phase and frequency are available at the rear panel for recording equipment.

1-6. Complete specifications are given in Table 1-1.

1-7. Additional information on the Model 4815A is given in Table 1-2. The characteristics are general design parameters that are useful in the application of the Impedance Meter.

1-8. ACCESSORIES FURNISHED.

1-9. Accessory kit number 00600A is supplied with the 4815A. The kit consists of adapters for probe to BNC and Type N connectors, a probe socket for use on circuit boards, a component mounting adapter, probe holder, probe ground assembly and center pins. The probe accessories are described in detail in Paragraphs 1-9 to 1-16 and shown in Figure 1-1 and 1-2. Also supplied is a rack mounting kit with hardware (-hp- Stock No. 5060-0776) and a circuit board extender for servicing.

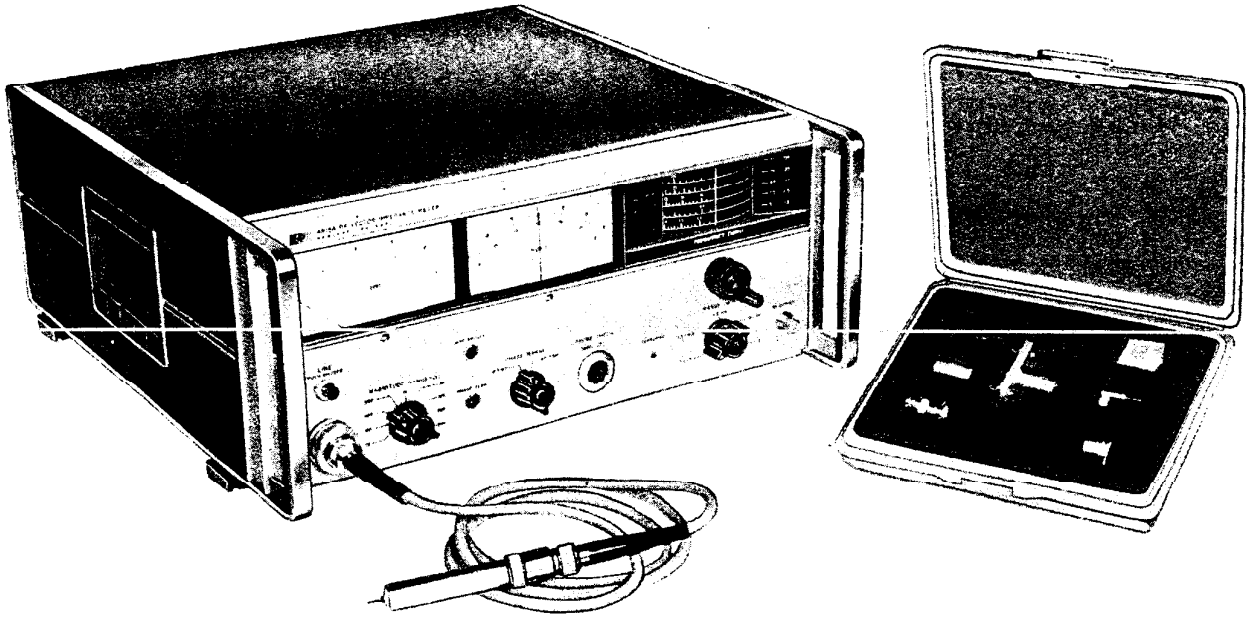


Figure 1-1. Model 4815A RF Vector Impedance Meter with 00600A Probe Accessory Kit

Table 1-1. Specifications

FREQUENCY

Range: 500 kHz to 108 MHz in five bands: 500 kHz to 1.5 MHz, 1.5 to 4.5 MHz, 4.5 to 14 MHz, 14 to 35 MHz, 35 to 108 MHz.

Accuracy: ±2% of reading, ±1% of reading at 1.592 and 15.92 MHz.

RF monitor output: 100 mV minimum into 50 ohms.

IMPEDANCE MAGNITUDE MEASUREMENT

Range: 1 ohm to 100K ohms; full-scale ranges: 10, 30, 100, 300, 1K, 3K, 10K, 30K, 100K ohms.

Accuracy: $\pm 4\%$ of full scale $\pm \left(\frac{f}{30\ \text{MHz}} + \frac{Z}{25\ \text{K}\Omega}\right)\%$ of reading, where f = frequency in MHz and Z in ohms; reading includes probe residual impedance.

Calibration: linear meter scale with increments 2% of full scale.

PHASE ANGLE MEASUREMENT

Range: 0 to 360° in two ranges: $0 \pm 90^\circ$, $180^\circ \pm 90^\circ$.

Accuracy: $\pm\left(3 + \frac{f}{30\ \text{MHz}} + \frac{Z}{25\ \text{K}\Omega}\right)$ degrees; where f = frequency in MHz and Z is in ohms.

Calibration: increments of 2°.

Adjustments: front panel screwdriver adjustments for Magnitude and Phase Zero.

RECORDER OUTPUTS

Frequency: 0 to 1 volt from 0 to 1K ohm source, proportional to dial rotation.

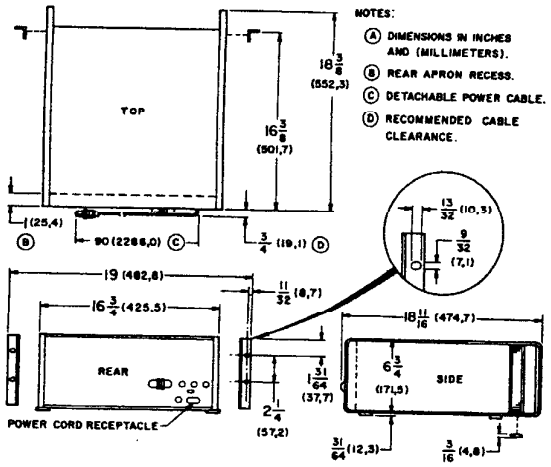
Impedance magnitude: 0 to 1 volt from 1K ohm source.

Phase angle: 0 ± 0.9 volt from 1K ohm source.

ACCESSORIES FURNISHED:

1. 00600A Accessory Kit.
2. Rack Mounting Kit.
3. Plugin board extender.

DIMENSIONS:



WEIGHT: net 39 lbs. (17,6 kg), shipping 50 lbs. (22,5 kg).

POWER: 105 to 125 v or 210 to 250 v, 50 to 400 Hz, 50 w.

Table 1-2. Additional Information

MEASURING TERMINAL CHARACTERISTICS

Configuration: Both excitation and measuring circuits are contained in a single sampling probe attached to instrument by a cable. Measurement is made between probe center pin and ground pin on probe case.

Residuals: indicated impedance includes approximately 0.5 ohm resistance and 8 nH inductance in series with the unknown, and 0.3 pF capacitance in parallel with the unknown.

Impedance: 25 ohms in series with 0.01 μF, looking into probe. Probe is constant-current driving source to circuit being measured.

TEST SIGNAL CHARACTERISTICS

Waveshape: sinusoidal.

Level: approximately 4 μA on all ranges except 10-ohm scale where it is approximately 13 μA.

External oscillator input: Rear BNC connector accepts excitation signal, 100 mV ±10% into 50 ohms; maximum instantaneous rate of change 1 MHz/s.

RFI CHARACTERISTICS

Conducted and radiated leakage limits are below those specified for MIL-I-6181D, except for RF excitation and sampling pulses emitted from probe. The sampling pulses are approximately 75 mV peak to peak, from 25-ohm source, with a duration of 3 ns occurring at a maximum repetition rate of 1 MHz. Probe may be stored in front panel probe check socket to obtain full compliance with MIL-I-6181D.

SELF-CONTAINED CALIBRATION

Probe check: 100 ohms ±.5% at phase angle of $0^\circ \pm 2^\circ$.

Table 5-3. Performance Checks (cont'd)

Connect 4815A to 513A. Look for parallel resonance near 3.5 MHz (coil inductance resonating with distributed capacitance of coil + 4815A probe). Record frequency, f=_____MHz.

Calculate $C_d' = \frac{1}{4\pi^2 f^2 L}$ (notations are those used in 513A Application Instructions, accompanying Q-Standard)

Record C_d' =_____ pF (approximately 10 pF)

Test frequency will be 0.6 MHz (where OHMS meter will read near full scale when measuring coil impedance) Calculate effective inductance of Q-Standard at 600 kHz:

$$L_e = \frac{L}{1 - \omega^2 L C_d'}$$ or the simplified expression $L_e = L(1 + \omega^2 L C_d')$

This is possible because $\omega^2 L C_d' \ll 1$

Record calculated L_e=_____μH. This will be approximately 4% greater than L.

Calculate $X_L = 2\pi f L_e$ where f= 0.6 MHz.

Record X_L=_____ OHMS (approximately 980Ω)

$Z = X_L$ for purposes of 4815A testing, since series resistance of the high-Q coil is approximately 9Ω, very small compared to X_L.

Enter Z in space above marked ++. Tolerance of 5% is ± 4% for 4815A and ±1% due to accuracy of L calibration of 513A.

4. PHASE ANGLE CALIBRATION

Specification ± $\left(3 + \frac{f}{30\ \text{MHz}} + \frac{Z}{50K}\right)$ degrees

a. Set 4815A controls as follows:
   Probe in PROBE CHECK receptacle
   MAGNITUDE RANGE (Ω) 100
   PHASE RANGE $0^o \pm 90^o$
   FREQUENCY (MHz) 2

b. Adjust PHASE ZERO front panel screwdriver adjust for 0^o reading.

c. DEGREES Meter should read $0^o \pm 6^o$ at any frequency between 0.5 MHz and 108 MHz.

d. Set 4815A controls as follows:
   Connect probe to 513A Q-Standard
   MAGNITUDE RANGE (Ω) 1K
   FREQUENCY (MHz) 0.6

e. DEGREES Meter should read $+90^o \pm 3^o$ in both positions of the PHASE RANGE Switch.

f. Set 4815A controls as follows:
   Connect probe to GR 1409F standard (0.001 μF)
   FREQUENCY (MHz) 0.5
   MAGNITUDE RANGE (Ω) 300

g. DEGREES meter should read $-90^o \pm 3^o$ in both positions of the PHASE RANGE switch.

1-10. PROBE ADAPTER. This adapter converts the probe tip to a male type N connector and is available under accessory number 10206A.

1-11. PROBE TO BNC ADAPTER. With the use of the 10206A accessory, this adapter converts the probe tip to a male BNC connector and is available under accessory number 10207A.

1-12. PROBE SOCKET. This socket supports the probe and guides the center pin to the test point. An excellent ground return is obtained with the socket, which is available under accessory number 10210A.

1-13. COMPONENT MOUNTING ADAPTER. This adapter allows many types of components to be measured with minimum addition of residual impedance to affect measurements, and is separately available as accessory number 00601A. Additional pin receptacles (HP PT. No. 1250-0928) are provided for this adapter.

1-14. PROBE GROUND ASSEMBLY is a grounding device that may be positioned at a convenient point on the probe barrel. A spring-loaded pin makes ground contact. This accessory is available as -hp- Stock No. 187B-21A-8.

1-15. PROBE CENTER PINS. Six additional center pins are supplied against possible damage or loss. ~~The small-diameter end of the center pin is inserted into the mating jack in the probe tip.~~ The threaded end of the center pin is tightened in the probe tip using the (HP Pt. No. 8710-0906) Hex-Nut Driver. Caution: Do not overtighten the center pins.

1-16. PROBE HOLDER. This accessory clips onto the front handle of the 4815A to hold the probe when not in use, and is available separately as -hp- Stock No. 5040-0404

1-17. ACCESSORIES AVAILABLE.

1-18. SHIELDED BANANA PLUGS TO FEMALE BNC. This adapter converts banana post inputs to shielded BNC, and is available as accessory 10111A. The adapter has approximately 10 pF shunt capacity.

1-19. INSTRUMENT IDENTIFICATION.

1-20. Each Model 4815A is identified by an eight-digit (000-00000) serial number on the rear panel. The five digit number is an identification number unique to each instrument and the three digit number is a serial prefix number used to document changes.

1-21. All instruments with the same serial prefix are the same. The group of instruments to which this manual applies directly is identified on the title page. For instruments with serial numbers higher than those listed on the title page, a Manual Change sheet describing the changes is included with the manual. The manual for an instrument having special electrical modifications will include an insert sheet describing that modification. If a change sheet or special information sheet is missing, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

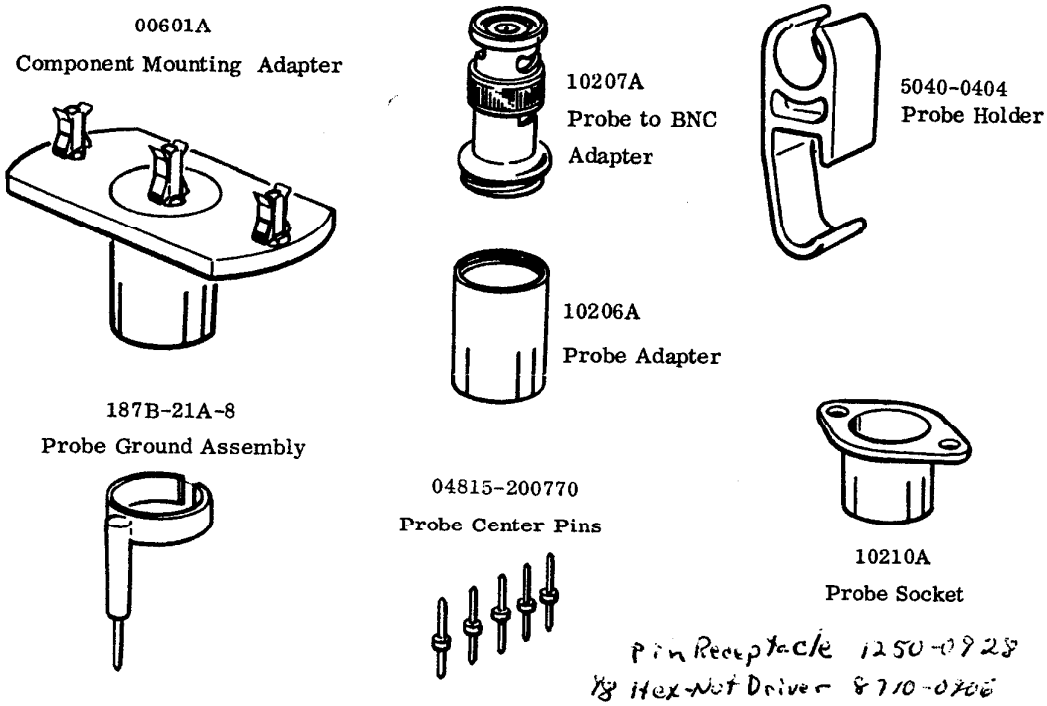


Figure 1-2. Probe Accessories

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Table 5-3. Performance Checks

1. FREQUENCY

Specifications: 500 kHz to 108 MHz
Accuracy ± 2% of reading; ± 1% at 1.592 MHz and 15.92 MHz.
RF Monitor Output 150 mV into 50Ω.

a. Connect equipment to counter as shown in Figure 5-2.

b. Set counter controls to read frequency to at least four significant figures.

c. Set 4815A frequency to 1.592 MHz and 15.92 MHz (indicated by small 'vee' on scale). Counter should read between 1.576 and 1.607 MHz (or 15.76 and 16.07 MHz).

d. Check frequencies at low, middle and high end of each band as below. Check other frequencies of interest to ± 2% of reading.

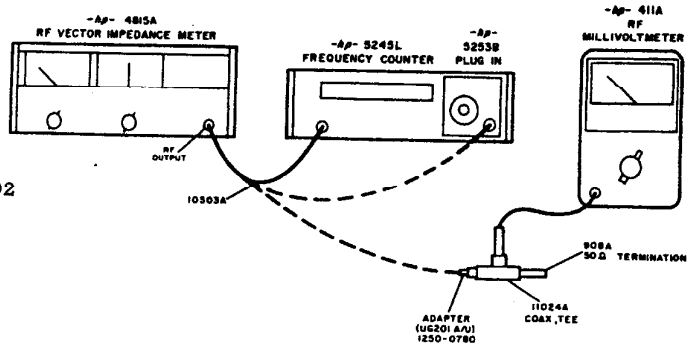

Figure 5-2. Connections for Testing Frequency and Output Level

Band	Low			Middle			High		
	Min, -2%	Dial Set	Max, +2%	Min, -2%	Dial Set	Max, +2%	Min, -2%	Dial Set	Max, +2%
0.5 - 1.5	0.490	0.50	0.510	0.889	0.90	0.918	1.4700	1.50	1.5300
1.5 - 4.5	1.470	1.5	1.530	2.450	2.5	2.550	4.410	4.5	4.590
4.5 - 14	4.410	4.5	4.590	7.840	8.0	8.160	13.72	14	14.28
14 - 35	13.62	14	14.38	19.60	20	20.40	34.40	35	35.60
35 - 108	34.40	35	35.60	58.80	60	61.20	100.84	108	110.16

e. Connect RF OUTPUT of 4815A -hp- 411A as shown in Figure 5-2.

f. RF Millivoltmeter should read >150 mV rms over range of 500 kHz to 108 MHz.

2. IMPEDANCE AND PHASE ACCURACY — Preliminary

a. Set 4815A controls as follows:
Probe in PROBE CHECK receptacle
MAGNITUDE RANGE (Ω) 100
PHASE RANGE $0^{o} \pm 90^{o}$
FREQUENCY (MHz) approx 2 MHz

b. Adjust front panel screwdriver controls, MAG ADJUST and PHASE ZERO for meter indications of 1.0 (full scale) and 0^{o}.

c. Set frequency to 0.5 MHz, 100 MHz and any other frequency of interest. Meters should read within accuracy below (from Table 1-1).

Magnitude ±4% of F.S. ± $(\frac{f}{30\ MHz} + \frac{Z}{25K\Omega})$ % of reading

Phase angle ± $(3 + \frac{f}{30\ MHz} + \frac{Z}{50K})$ degrees.

Table 5-3. Performance Checks (cont'd)

d. Set 4815A controls as follows:
Probe removed from PROBE CHECK receptacle
FREQUENCY (MHz) 100
MAGNITUDE RANGE (Ω) 10K
PHASE RANGE $0^{o} \pm 90^{o}$

e. Magnitude meter will read approximately 5KΩ (indicating 0.3 pF shunt C of probe); phase angle should read $-90^{o} \pm 6.4^{o}$. Change PHASE RANGE to $180^{o} \pm 90^{o}$; meter should still indicate $-90^{o} \pm 6.4^{o}$.

f. Install accessory 00601A (Component Mounting Adapter) and mount a small trimmer capacitor (-hp- Stock No. 0132-0005). See Figure 5-3. Adjust trimmer for OHMS Meter reading of .95 (95% of F. S.) (on 1K RANGE)

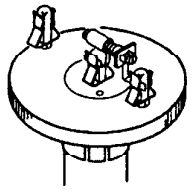

Figure 5-3. Test Component Installed for Checking High Impedance Ranges

g. Change frequency as follows and check OHMS Meter reading. Use counter to set frequency or add ± 2% to allowable magnitude error. Note: Read upper scale only; one division = 2%.

Frequency, MHz	MAGNITUDE RANGE (Ω)	Nominal	Magnitude Error	Phase angle Error
100	1K	0.95	set	$\pm 6^{o}$
31.62	3K	0.95	±5%	$\pm 4^{o}$
10	10K	0.95	±4.3%	$\pm 3.5^{o}$
3.162	30K	0.95	±5%	$\pm 3.9^{o}$
1	100K	0.95	±8%	$\pm 5^{o}$

NOTE: The procedures in steps 2a through 2g above check the range-to-range decading from 1K to 100K and the linearity of the probe voltage sampler.

3. IMPEDANCE MAGNITUDE CALIBRATION

NOTE

Impedance calibration consists of taking known capacitance and inductance standards and comparing the calculated impedance with the 4815A indication. The technique requires caution, however. The useful frequency range of large-value capacitors is limited by series inductance, negligible at 1 kHz but significant as series resonance is approached. For example, a test frequency of 1/5 the series resonant frequency causes a -4% magnitude error (without noticeably affecting the phase angle). Small value capacitors are difficult to standardize because of differing measuring terminal configurations and fringing effects. Inductors are more seriously frequency limited by series resistance and shunt capacity. The following procedures will check absolute magnitude calibration of the 4815A. Although substitutions can be made, care must be taken to avoid measurement situations that introduce unpredictable errors as indicated above. The 4815A calibration with capacitors requires correction for the predictable error due to series inductance of the standard (and probe inductance); if f = measuring frequency (MHz)