

## 1620-A High Precision Capacitance Measurements

The 1620-A is a self-contained assembly of the 1615-A Capacitance Bridge with appropriate oscillator and null detector for measurements at 11 frequencies between 50 Hz and 10 kHz. For applications requiring other or higher frequencies, to 100 kHz, the 1615-A Bridge can be supplied separately and the oscillator and detector selected to meet your needs.

- Accurate and precision measurements of capacitance and dissipation factor
- Measurement of circuit capacitances
- Dielectric measurements
- Intercomparison of capacitance standards differing in magnitude by as much as 1000:1
- $10^{-5}$  pF to 11.1  $\mu$ F, 2- or 3- terminal
- 0.01% accuracy, 1 ppm resolution
- Lever balance, in-line readout
- Reads dissipation factor or conductance

The 1615-A Capacitance Bridge brings to the measurement of capacitance, the intercomparison of standard, and to the measurement of dielectric properties an unusual degree of accuracy, precision, range, and convenience.

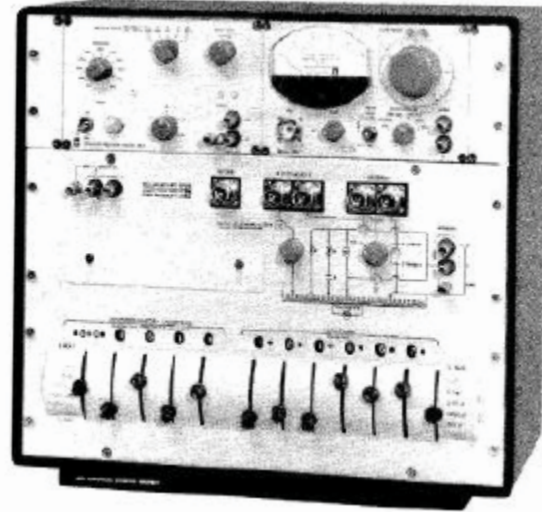
High accuracy is achieved through the use of precisely wound transformer ratio arms and highly stable standards fabricated from Invar and hermetically sealed in dry nitrogen. For calibration these standards can be intercompared.

Two- or Three- Terminal Connection - Accurate three-terminal measurements can be made even in the presence of capacitances to ground as large as 1  $\mu$ F, as might be encountered with the unknown connected by means of long cables. The bridge has the necessary internal shielding to permit one terminal of the unknown capacitor to be directly grounded, so that true two-terminal and three-terminal measurements can both be made over the whole capacitance range.

### 1620 PRECISION CAPACITANCE MEASUREMENT SYSTEM

Performance: See 1615-A for performance specifications.

Supplied: 1615-A Precision Capacitance Bridge.  
1311-A Oscillator.



Model 1620-A Measurement System

Convenient Operation - For both capacitance and dissipation factor, the balance controls are smoothly operating, lever-type switches. The readout is digital and decimal point is automatically positioned. Each capacitance decade has a - 1 position to facilitate rapid balancing.

The 1615-A elementary diagram is also clearly delineated on the front panel of the bridge. Changes in connections and grounds are automatically indicated, as you switch the bridge terminals for different measurement conditions.

Extend Range to 11.1 F - With the 1615-P1 Range-Extension Capacitor, the 1615-A will measure to a maximum of 11.1110 F. This capacitor plugs into front-panel bridge terminals and can be adjusted for calibration to the bridge standards.

1232-A Tuned Amplifier and Null Detector.  
1232-P2 Preamplifier added in 1620-AP.

# 1620-A Precision Capacitance Measurement System

## Features

Power: 105 to 125 V and 210 to 250 V, 50 to 400 Hz, 22 W for oscillator.

Dimensions:

Bench: 48.3 cm H x 50.2 cm W x 28.0 cm D (19" x 19.75" x 11")

Weight: 27 kg (59 lb.) net, 44 kg (96 lb.) shipping

## ORDERING INFORMATION

1620-A, 115 V

1620-9701

1620-AP, with 1232-P2, 115V

1620-9829

1620-A, 230 V

1620-9702

1620-AP, with 1232-P2, 230 V

1620-9830

## 1615-A CAPACITANCE BRIDGE

The 1615-A is an accurate, high-precision bridge for the measurement and intercomparison of standard capacitors, circuit component capacitors, or dielectric materials. It is available with oscillator and detector in the 1620-A system. Or, to take

full advantage of its wide frequency range, the bridge can be ordered separately for use with oscillator and detector especially selected for your purposes.

## SPECIFICATIONS

### Capacitance Measurement:

Range: 10 aF to 1.11110  $\mu$ F ( $10^{-17}$  to  $10^{-6}$  F) in 6 ranges, direct reading, 6-figure resolution; least count  $10^{-17}$  F (10 aF). With Range Extension Capacitor, upper limit is 11.11110  $\mu$ F.

Accuracy: At 1 kHz,  $\pm(0.01\% + 0.00003 \text{ pF})$ . At higher frequencies and with high capacitance, additional error is:  
 $[\pm 3 \times 10^{-5}\% + 2 (C_{\mu\text{F}}) \times 10^{-3}\% \pm 3 \times 10^{-7} \text{ pF}] \times (f_{\text{kHz}})^2$

At lower frequencies and with low capacitance, accuracy may be limited by bridge sensitivity.

Comparison accuracy, external standard to unknown, 1 ppm.

### Dissipation Factor:

Range: At 1 kHz, 0.000001 to 1; 4-figure resolution, least significant digit count: 0.000 001 ( $10^{-6}$ ); range varies directly with frequency.

### Accuracy:

$\pm[0.1\% \text{ of measured value} + 10^{-5} (1 + f_{\text{kHz}} + 5f_{\text{kHz}}C_{\mu\text{F}})]$ .

### Conductance:

Range:  $10^{-6} \mu\text{S}$  to 100  $\mu\text{S}$ , ranges +, 2 ranges-, 4 figure resolution, least count  $10^{-6} \mu\text{S}$ , independent of frequency, range varies with C range.

Accuracy:  $\pm[1\% \text{ measured value} + 10^{-5} \mu\text{S} + 6 \times 10^2 f_{\text{kHz}} C_{\mu\text{F}} \times (1 + f_{\text{kHz}} + 5f_{\text{kHz}} C_{\mu\text{F}}) \mu\text{S}]$ .

Frequency: Approximately 50 Hz to 10 kHz. Useful with reduced accuracy to 100 kHz. Below 100 Hz, resolution better than 0.01% or 0.01 pF required preamplifier or special detector.

Standards: 1000, 100, 10, 1, 0.1, 0.01, 0.001 and 0.0001 pF.

Temperature coefficient of capacitance is less than 5 ppm/C for the 1000, 100, and 10 pF standards, slightly greater for the smaller units.

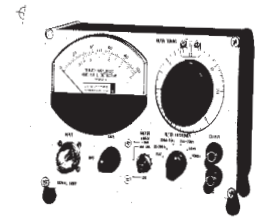
Generator: Maximum safe generator voltage ( $30 \times f_{\text{kHz}}$ ) volts, 300 V max. If generator and detector connections are interchanged, 150 to 500 V can be applied, depending on switch settings.

IET 1311-A Audio Oscillator is recommended.



## 1232-A Tuned Amplifier And Null Detector

A sensitive null detector like this is the key to many a fussy bridge measurement. Battery operation frees the 1232 from power-line noise and makes it ultra portable. Low-noise solid state circuitry and high gain make it very sensitive. Its tunability and choice of bandwidth enable your to reject broadband noise as well as the harmonics that might otherwise impair good measurements.



- Bridge detector at audio frequencies; with 1232-P2 Preamplifier it is equally sensitive for extremely high-impedance sources
- Audio preamplifier and general-purpose, tunable or broadband audio amplifier

- Sensitive audio wave analyzer for approximate measurements
- 20 Hz to 20 kHz, 50 and 100 kHz
- 0.1  $\mu\text{S}$  sensitivity
- Bandwidth approximately 5%
- 120 dB gain

### SPECIFICATIONS

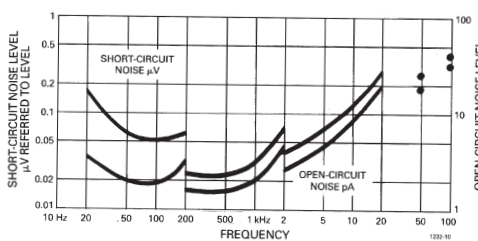
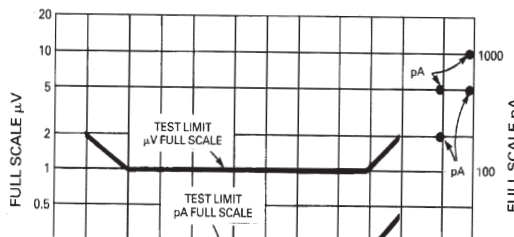
#### Frequency:

Tunable filters: 20 Hz to 20 kHz in 3 ranges, between 2% and 6% bandwidth to 15 kHz. Second harmonic at least 34 dB down from peak, third harmonic at least 40 dB down, rejection filter on two highest ranges reduces 60 Hz level to at least 60 dB below peak response (50 Hz level is down >50 dB). Dial accuracy is  $\pm 3\%$ .

Fixed-Tunable Filters: 50 kHz, 2-nd harmonic is 44 dB down; 100 kHz, 2-nd harmonic is 53 dB down.

Flat Response:  $\pm 3$  dB from 20 Hz to 100 kHz.

Sensitivity: See fig. 1. Typically better than 0.1  $\mu\text{S}$  over most of the frequency range.



Noise Level: Referred to input: See fig. 2. Noise at 1 kHz < 2 dB at optimum source impedance of 27 k $\Omega$ . Referred to output: < 5 mV on FLAT filter-frequency position, main gain setting, and 20 dB switch position. <50 mV in MAX SENS position.

#### Signal Input:

Impedance: Approximately 50 k $\Omega$  at max gain; varies inversely with gain to 1 M $\Omega$  at min gain.

Max Safe Voltage: 200 Vac or 400 Vdc.

#### Output:

Voltage Gain: Approximately 120 dB on the tunable ranges; 100 dB, flat range; 106 dB at 50 kHz; 100 dB at 100 kHz position.

Level: 1 V into 10 k $\Omega$  when meter indication is full scale.

Internal Impedance: 3 k $\Omega$ .

Meter Linearity: dB differences are accurate to  $\pm 5\% \pm 0.1\%$  division for inputs of less than 0.3 V.

Compression: (meter switched to LOG) Reduces full-scale sensitivity by 40 dB. Does not affect bottom 20% of scale.

Attenuation: (meter switched to - 20 dB). Linear response with 20 dB less gain than MAX SENS.

Distortion: (filter switched in FLAT position): <5 % (due to meter rectifiers).

#### Terminals:

Input: 874 Coaxial Connector.

Output: binding posts.

Available: 1232-P2 Preamplifier to maintain sensitivity of 1232-A at low frequencies when operating from a source impedance above 100 k $\Omega$ .

### Features

Power: 12 Vdc, from 9 mercury (Eveready type E4 or equivalent) cells in series. Estimated battery life 1500 hours.

Mechanical: Convertable-bench cabinet.

Dimensions: 15.2 cm H x 20.3 cm W x 19.0 cm D (6" x 8" x 7.5").

Weight: 2.6 kg (5.75 lb) net, 3.7 kg (8 lb) shipping.

### ORDERING INFORMATION

1232-A 1232-9701 Tuned Amplifier and Null Detector

1232-AP 1232-9829 Tuned Amplifier and Null Detector with preamplifier



**IET LABS, INC.** in the **GenRad** Tradition  
534 Main Street, Westbury, NY 11590

www.ietlabs.com  
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

## 1232-P2 Preampifier

The 1232-P2 has particular application to measurements with the 1615-A Capacitance Bridge. It increases sensitivity for measurements made at frequencies well below 1000 Hz if the bridge is set to both its lowest C

and D (not G) ranges simultaneously. Low-frequency measurement of small samples of dielectric materials can be made more accurately with the addition of this preamplifier.

### SPECIFICATIONS

Voltage Gain: Approximately 0.7.

Noise: (referred to input) Open-circuit equivalent, 0.1 pA. Short-circuit equivalent, 0.3  $\mu$ S (when used with Type 1232-A tuned to 100 Hz).

Impedances:

Input: > 100 m $\Omega$  in parallel with 70 pF.  
Optimum Source: 3 M $\Omega$ .  
Output: 10 k $\Omega$ .

Connectors: 874 on cables, input and output.

### Features

Power: 12 V, 200  $\mu$ A, supplied by 1232-A.

Mechanical: Special cabinet.

Dimensions: 15.2 cm H x 1.9 cm W x 19.0 cm D  
(6" x 0.75" x 7.5").

Weight: 0.43 kg (0.94 lb) net, 1.9 kg (4 lb) shipping.

### ORDERING INFORMATION

1232-P2 1232-9602 Preampifier

## 1620 PRECISION CAPACITANCE MEASUREMENT SYSTEM

### SPECIFICATIONS

Detector: IET 1232-A Tuned Amplifier and Null Detector is recommended. For increased sensitivity needed to measure low-loss small capacitors (on lowest C and D ranges simultaneously) at frequencies below 1 kHz, use the 1232-AP Tuned Amplifier and Null Detector or 1238 Detector (with 1311-A Audio Oscillator).

Connections: Gen Input; Binding posts, ground terminal with shorting link. Detector, External Std, and Unknown; 874 connectors, Unknown, 2-Terminals; Binding posts.

Required: Oscillator and Detector.

Supplied: 874-WO Open-Circuit Termination, 874-R22A Patch Cord, 274-NL Patch Cord.

Available: Type 1615-P1 Range Extension Capacitor  
Type 1615-P2 Coaxial Adaptor converts 2-terminal binding post connection of 1615-A bridge to G900 Precision Coaxial Connector for highly repeatable connections and enables measurements with adaptor to be reading by compensating for terminal capacitance.

### Features

Dimensions: Bench: 32.4 cm H x 48.3 cm W x 26.7 cm D  
(12.75" x 19" x 10.5")

Rack: 31.1 cm H x 48.3 cm W x 21.7 cm D  
(12.25" x 19" x 8.5")

Weight: 18 kg (39 lb.) net, 27 kg (58 lb.) shipping

### ORDERING INFORMATION

1615-A Capacitance Bridge  
Bench Model 1615-9801  
Rack Model 1615-9811

ACCESSORIES  
1615-P1 Range-Extension Capacitor 1615-9601  
1615-P2 Coaxial Adaptor, G900 to binding posts 1615-9602

