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616/Digital Electrometer

Autoranging

- Measures V, I, R and Q, and is a current source
- 2 × $10^{14}\Omega$ input resistance
- 2 × 10^{-15}A current noise



The 616 is an autoranging digital electrometer with sensitivity to 10μV/digit and 0.2% voltage accuracy. The easy-to-read 3½-digit LED display includes the convenience of automatic polarity and decimal point. The 616 is essentially a digital multimeter optimized for measurements from high source impedance.

The input amplifier provides high input resistance (2 × $10^{14}\Omega$), low offset current (less than 5 × 10^{-15}A) and low noise. The double-shielded input section permits floating operations up to ±1000V above chassis. The Model 616's box-within-a-box construction keeps unshielded capacitance from input HI to chassis ground below 0.1pF, so that CMRR is greater than 140dB with up to $10^{11}\Omega$ source resistance.

When combined with the optional Model 6162 Isolated Output/Control, the 616 can be used in measurement systems with control of sensitivity as well as digital output data.

Voltage measurements

As a high input resistance voltmeter, the 616 provides fully automatic ranges from ±10mV (10μV sensitivity) to ±200V DC. Voltage sensitivity can be selected over a range of five decades - automatically, manually or remotely with the optional Model 6162 Isolated Output/Control. With an input resistance greater than 2 × $10^{14}\Omega$, the 616 accurately measures over a wide range of source resistances with negligible loading error. The 616 also provides quick recovery from overloads. Voltage stability is better than 50μV/°C.

Current measurements

As a picoammeter, the 616 has ranges from 10^{-13}A (10^{-16}A digital sensitivity) to 10^{-3}A with 100% overranging. Measurements can be made in either the shunt (normal) mode or the feedback (fast) mode, thus permitting an optimum speed/noise/input voltage tradeoff.

Resistance measurements

As an ohmmeter, the 616 employs a two terminal, constant current method of resistance measurement to read $10^{3}\Omega$ to $10^{14}\Omega$ full range with 100% overranging. The constant current source may also be used to test semiconductors for breakdown voltage and other I-V characteristics.

Charge measurements

As a coulombmeter, the 616 measures from 10^{-5}C to 10^{-12}C full range with 100% overranging. The instrument can be used for current integration with voltages from 10μV to 200V developed on the integrating capacitor.

Optional output/control

With the Model 6162 Isolated Output/Control, remote control lines allow selection of measurement sensitivity over five decades, by means of controlling the voltage gain of the amplifier. Individual strobe lines permit date transfer using a minimum of four control lines (bit-parallel, character serial output). The 6162 outputs are fully isolated, providing complete data, timing outputs and multiple strobe lines. The open-collector BCD outputs are compatible with most TTL and DTL logic.

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AS AN AUTORANGING VOLTMETER

RANGE: ±10μV per digit (10mV full range) to ±100V full range in five decade ranges. 100% overranging to 1999 on all ranges.

ACCURACY (18°C to 28°C): ±(0.2% of reading + 0.1% of range).

READING TIME: Less than 4 seconds to within 0.1% of final reading, except where limited by source characteristics.

ZERO DRIFT: Less than (50μV + 0.01% of range) per °C, and less than 100μV per 24-hour period after two hours warmup.

NOISE: ±10μV with input shorted.

INPUT IMPEDANCE: Greater than 2 × $10^{14}\Omega$ shunted by 20pF. Input resistance may be selected in decade steps from 10 to $10^{11}\Omega$.

NORMAL MODE REJECTION RATIO

RANGE	NMRR	MAXIMUM AC
10mV	94dB	2V p-p
100mV	80dB	2V p-p
1 V	80dB	20V p-p
10 V	60dB	20V p-p
100 V	60dB	200V p-p

For voltage of line frequency and at least 10% of full range DC reading. Maximum total input 200V peak AC & DC.

COMMON MODE REJECTION RATIO: Greater than 140dB at line frequency with 300V peak-to-peak from LO to ground, up to $10^{11}\Omega$ source resistance, and at least 10% of full range DC reading.

AS AN AMMETER

RANGE: ±10^{-16}A per digit (10^{-13}A full range) to ±0.1A full range in 13 decade ranges. 100% overranging to 1999 on all ranges.

ACCURACY (18°C to 28°C):

RANGE SWITCH SETTING	ACCURACY
10^{-1} to 10^{-7} A	±(0.5% of reading + 0.1% of range)
10^{-8}A	±(2 % of reading + 0.1% of range)
10^{-9} to 10^{-11}A	±(5 % of reading + 0.1% of range)

NOISE: 2 × 10^{-15}A peak-to-peak on the most sensitive range, exclusive of alpha particle disturbance.

OFFSET CURRENT: Less than 5 × 10^{-15}A.

COMMON MODE REJECTION: 300V peak-to-peak at line frequency from circuit LO to chassis ground on any range and with at least 10% of full range DC reading will not degrade accuracy more than 0.3% of range. (Equivalent to 140dB CMRR.)

AS AN OHMMETER

RANGE: 1Ω per digit (1000Ω full range) to $10^{14}\Omega$ full range in 12 decade ranges. 100% overranging to 1999 on all ranges.

ACCURACY (18°C to 28°C):

RANGE SWITCH SETTING	ACCURACY
10^{5} to 10^{7}	±(0.5% of reading + 0.1% of range)
$10^{8}\Omega$	±(2 % of reading + 0.1% of range)
10^{9} to $10^{12}\Omega$	±(5 % of reading + 0.1% of range)

METHOD: Two-terminal constant-current. Current equals reciprocal of Ohms range.

AS A COULOMBMETER

RANGE: ±10^{-15}C per digit (10^{-12}C full range) to ±10^{-5}C full range in 8 decade ranges. 100% overranging to 1999 on all ranges.

ACCURACY (18°C to 28°C): ±(5% of reading + 0.1% of range).

AS AS CONSTANT CURRENT SOURCE

RANGE: 8 currents in decade steps from 10^{-5} to 10^{-12}A using Ohms ranges. HI terminal is positive.

COMPLIANCE: Up to 200V.

ACCURACY (18°C to 28°C): ±0.5% from 10^{-5} to 10^{-7}A. ±2% at 10^{-8}A. ±5% from 10^{-9} to 10^{-12}A.

LOAD REGULATION: Better than 0.1% for loads up to $10^{11}\Omega$.

GENERAL

DISPLAY: 3 digits plus 1 overrange digit; decimal position, polarity and overload indication; 5 readings per second. Depending on sensitivity setting, 3 least-significant digits blink or blank when overload condition exists.

POLARITY SELECTION: Automatic.

SENSITIVITY SELECTION: Automatic: Voltage sensitivity selection is fully automatic. Sensitivity selection is automatic two decades above and below range switch setting for resistance, charge and most current measurements. Manual: Front panel switch. Remote: Programmable with the Model 6162 Output/Control (optional).

ISOLATION: Circuit LO to chassis ground greater than $10^{9}\Omega$ shunted by 500pF (decreasing to $10^{8}\Omega$ at 30°C and 70% relative humidity). Circuit LO may be floated up to ±1000V with respect to chassis ground.

ANALOG OUTPUTS: Unity Gain: For DC inputs, output is equal to input within 20ppm for output currents of 1mA or less. In the fast mode, output polarity is opposite input polarity. 1V: ±1V at up to 1mA with respect to circuit LO for full range input; 100% overrange capability. In the normal mode, the output polarity is opposite input polarity.

OPERATING ENVIRONMENT: 18°C to 28°C, 0% to 70% relative humidity. 10°C to 50°C with derated specifications. Storage: 0°C to 70°C.

CONNECTORS: Input: Teflon-insulated triaxial. Analog Outputs: Unity gain, 1V, chassis, LO and guard: binding posts. BCD Output: Internal connectors for interfacing the Model 6162 Isolated Output/Control.

DIMENSIONS, WEIGHT: Style M, 90mm (3½") half-rack, overall bench size 100mm high × 220mm wide × 400mm deep (4" × 8¾" × 15¾"). Net weight, 4.8kg (11 lbs.).

POWER: Line operation: 90-125 or 180-250V (switch selected), 50-60 Hz, 9W.

ACCESSORY SUPPLIED: Model 6011 Input Cable: 1m (3 ft.) triaxial cable with triaxial connector and 3 alligator clips.

SPECIFICATIONS/6162

DIGITAL OUTPUT: BCD (8421) open collector logic represents each of 3 digits (0 = "0000"), overrange digit, uprange ("0"), polarity (+ = "1"), decimal position (5 lines), exponent (5 line, BCD), exponent polarity (+ = "1"), downrange ("0"), zero check ("1"), and function (2 bit code).

ACCURACY: ±1 digit with respect to 616 display.

FLAG ($\overline{\text{FLAG}}$): Logic "1" ("0") from 50ms to 7 seconds depending on Print Rate setting. No change in digital output is made during this interval.

OUTPUT LOGIC LEVELS: Output Logic "1" ≡ open collector to output LO. Output Logic "0" ≡ closure to output LO. Output Device MC858P or equivalent (greater than 6V breakdown, 0.5V at +35mA sink).

REMOTE CONTROLS:

Zero Check: Logic "0" actuates 616 Zero Check.

Sensitivity: 4-line code for remote sensitivity setting of 616.

Display Hold: Logic "0" retains last reading on display (except polarity).

Output Hold: Logic "0" retains data from last reading.

Strobe: 8 lines for serializing in multiples of 4 bits. Logic "1" inhibits controlled output lines.

CONTROL LOGIC LEVELS: Logic "1" ≡ either an open circuit or a voltage between +2 and +12V referenced to output LO. Logic "0" ≡ closure to output LO within 0.5V while sinking 2.5mA.

PRINT RATE: Variable via front panel control from 1/5 second per reading to 7 seconds per reading in 1/5 second increments.

ISOLATION: Input LO to output LO: sufficient to maintain 616 isolation specifications except adds 200pF capacitance. Output LO to ground: greater than $10^{9}\Omega$ shunted by 0.1μF. Output LO may be floated up to ±100V with respect to ground.

CONNECTORS: Input: Attached cable connects to 616. Output: 50-pin AMP type 205211-1. Mating connector supplied.

ENVIRONMENT: Operating: 10°C to 50°C, 0% to 70% relative humidity. Storage: 0°C to 70°C.

POWER: 90-125 or 180-250V (switch selected), 50-60Hz, 9W.

DIMENSIONS, WEIGHT: Style M, 90mm (3½") half-rack, overall bench size 100mm high × 220mm wide × 400mm deep (4" × 8¾" × 15¾"). Net weight, 3.2kg (7 lbs.).

ACCESSORY SUPPLIED: Model 1007 Dual Rack Mounting Kit.

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