Digital Multimeters

DMM with a Resolution of 10 nV and 1 μΩ and 6 1/2 Digit Display

R6561

- **Maximum Display of "1199999" and 6 1/2 Digit Display**
- **High-Sensitivity Measurement with 10 nV Resolution**
- **Low-Resistance Measurement with 1μΩ Resolution**
- **Built-In Floating Current Source**
- **Digital Smoothing Function and Null Function for Stable Measurement**
- **Standard GPIB Interface**

R6561
Digital Multimeter

In addition to DC voltage, micro DC voltage measurement and both high- and low-power resistance measurements, the R6561 features a 6 1/2 digit display with a maximum display of 1199999.

Micro DC current measurements are made with a sensitivity of up to 10 nV, and the multimeter is designed for minimum aging drift, ensuring highly stable measurements over a longer period of time. With this performance, the R6561 is suitable for use in basic research and experimentation in semiconductors and electronic components, in metals and superconductivity.

Resistance measurements with a maximum resolution of 1 μΩ, combined with automatic offset cancellation, and the use of a floating current source ensures high-precision measurements free from the influence of thermo electromotive force and the line resistances. In addition, the open-circuit measurement voltage has been held to below 20 mVpeak (in low-power mode), making the R6561 suitable for measurement of contact resistance of electronic components.

To ensure stable measurements and measurement results with enhanced reliability, the R6561 provides diverse features such as selectable integration time, the null function that enables offset correction, the digital smoothing function, and calculation functions for processing of measured data. The input and output functions include full remote operation via the GPIB interface, analog output, trigger input, measurement completion signal output - all provided as standard features.

■ 10 nV Resolution is Ideal for Use in R&D of Electronic Components and Metals

The R6561 can measure micro DC volt with a maximum resolution of 10 nV, highest in its class, which is sufficient for measurements of thermo electromotive force. When combined with a current generator to measure micro resistances with very small current, this level of resolution is essential. The R6561 is suitable for such applications as measurement of critical temperature in superconductivity requires a resolution of 10 nV.

■ 1 μΩ Resolution Ideal for Contact Resistance Measurement of Electronic Components

In measurements of relay ON resistance of several tens of mΩ and connector contact resistance which can be as low as several mΩ, the R6561 with its 1 μΩ resolution and the ability to measure to 1% order is ideal.

■ Built-in Floating Current Source

The R6561, in contrast to conventional digital multimeters, features a built-in floating power supply for the constant current source. This enables resistance measurement with very small voltage and large connection resistance and suppressed heat generation in the same way as super-conductivity measurement of ceramic devices.

In addition, the number of sampling required for each measurement to eliminate the influence of lead resistance can be minimized, thereby achieving reduced measurement time.

■ Limiter for Holding the Open Terminal Voltage to below 20 mVpeak or Less

In measurement of the contact resistance of electronic components under low voltage and current, the open circuit voltage is held to 20 mVpeak or less so that the oxide film of the device be measured directly without destruction. This allows measurement under the conditions prescribed by the JIS C5402 standard, test method of connectors of electronic equipment.

■ Built-In Digital Smoothing and Null Functions for Highly Reliable Measurement

The R6561 employs moving average which displays the average of the number of samples as the measurement result. The digital smoothing function can average noise components without sacrificing the measurement speed, allowing highly reliable data to be obtained even with low signal levels.
The R6561 is also provided with the null function for micro resistance measurement, which measures errors of connection cables, compensates the offset voltage, inputs the offset voltage value, and measures the relative value with respect to the input value.

■ Resistance Measurement with Maximum Power Consumption of 10 μW

When measuring thermisters or thermoresistances whose resistance varies with temperature, the heat generated in the device has remarkable effect on measurements. The ability of the R6561 to minimize the power consumption with low current, allows measurements which are free from effects of heat.

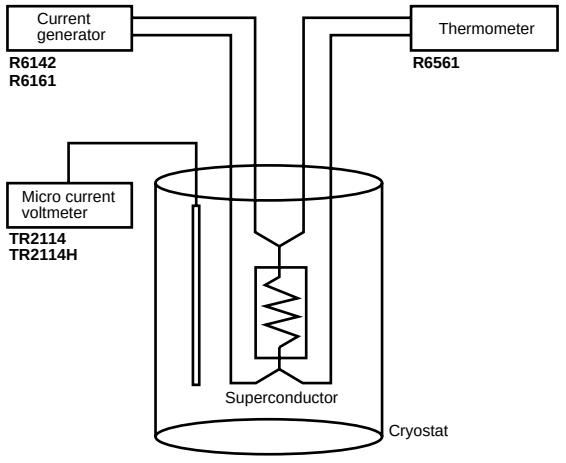
■ Automatic Offset Cancellation for Micro Resistance Measurement

In resistance measurements, since the voltage sensitivity is measured with a resolution of 10 nV, the thermoelectromotive force generated at contact points becomes problematic.
The R6561 obtains accurate measurement values by means of the automatic offset cancellation function which eliminates thermoelectromotive force under no-current condition from the voltage at the time of current drawing.

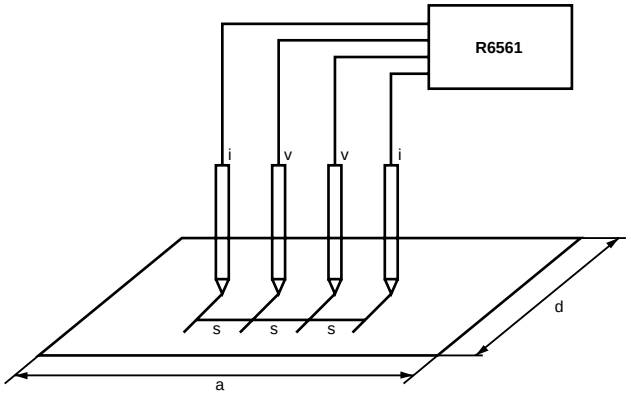
■ D/A Converter Output Analog Signal Monitoring

In high-sensitivity measurement with 10 nV resolution, it is sometimes necessary to make relative measurement by checking voltage variation within a defined period of time. With the standard D/A converter output, the R6561 allows recording and observation of voltage variation when a pen recorder is connected.

Applying superconductor to critical temperature measurement



Measurement of the resistance rate of sheet resistance by 4-wire method.



$$\rho_s = \frac{V}{i} C$$

$\frac{V}{i}$: Measured directly by the R6561.

C : Constants determined by s, a and d.

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Specifications

DC Voltage Measurement
Ranges, maximum display, maximum resolution, input impedance, maximum input voltage:

Range	6 1/2-digit display		5 1/2-digit display		4 1/2-digit display		Input impedance	Input bias current	Maximum input voltage		
	Maximum display	Maximum resolution	Maximum display	Maximum resolution	Maximum display	Maximum resolution			Hi-Lo terminal voltage	GUARD-Chassis voltage	GUARD-Lo terminal voltage
1000 mV	1199.999 mV	1μV	1199.99 mV	10μV	1199.9 mV	100μV	10^{10} Ω or more	20 pA max.	±600 Vpeak, continuously	±500 Vpeak, continuously	±50 Vpeak continuously
10 V	11.99999 V	10μV	11.9999 V	100μV	11.999 V	1mV					
100 V	119.9999 V	100μV	119.999 V	1mV	119.99 V	10mV	10 MΩ ±0.5%				
500 V	519.999 V	1mV	519.99 V	10mV	519.9 V	100mV					

Measurement accuracy: Expressed as ± (% of reading + digits) of the value obtained with auto zero and auto calibration on (with a calibration interval of less than 1 hour)
Measurement accuracy for 6 1/2-digit display:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23± 1°C)	90 days (23± 5°C)	180 days (23± 5°C)
1 PLC	1000mV	0.002 +6	0.004 +7	0.005 +7
	10 V	0.0018+4	0.0035+4	0.0045+4
	100 V	0.002 +5	0.0042+6	0.0052+6
	500 V	0.002 +4	0.004 +4	0.005 +4
5 PLC to 100 PLC	1000mV	0.002 +5	0.004 +6	0.005 +6
	10 V	0.0018+3	0.0035+3	0.0045+3
	100 V	0.002 +4	0.0042+5	0.0052+5
	500 V	0.002 +3	0.004 +3	0.005 +3

Measurement accuracy with 5 1/2-digit display: Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.
Measurement accuracy with 4 1/2-digit display: Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/100.
Temperature coefficient: Expressed as ± (% of reading + digits) / °C for values in the temperature range of 0 to 40°C

Range	6 1/2-digit display	5 1/2-digit display	4 1/2-digit display
1000 mV	0.0004+0.3	0.0004+0.03	0.0004+0.003
10 V	0.0003+0.1	0.0003+0.01	0.0003+0.001
100 V	0.0004+0.3	0.0004+0.03	0.0004+0.003
500 V	0.0004+0.1	0.0004+0.01	0.0004+0.001

Noise rejection: With unbalanced 1 kΩ impedance between GUARD and Lo terminals

Effective CMR		NMR
50/60 Hz ±0.09%	DC	50/60 Hz ± 0.09%
160 dB	140dB	60dB

Measurement rate: 35 times/s (with 1 PLC integration time, auto-zero off)

Low DC Voltage Measurement
Ranges, maximum display, maximum resolution, input impedance, maximum allowable signal-source resistance, maximum input voltage:

Range	6 1/2-digit display		5 1/2-digit display		4 1/2-digit display		Input impedance	Maximum allowable signal-source resistance	Maximum input voltage		
	Maximum display	Maximum resolution	Maximum display	Maximum resolution	Maximum display	Maximum resolution			Hi-Lo terminal voltage	GUARD-Chassis voltage	GUARD-Lo terminal voltage
1000 μV	–	–	1199.99 μV	10 nV	1199.9 μV	100 nV	10^{8} Ω or more	100 Ω	±30 Vpeak, continuously	±500 Vpeak, continuously	±50 Vpeak, continuously
10 mV	11.99999 mV	10 nV	11.9999 mV	100 nV	11.999 mV	1 μV					
100 mV	119.9999 mV	100 nV	119.999 mV	1 μV	119.99 mV	10 μV	10^{9} Ω or more	1 kΩ			
1000 mV	1199.999 mV	1 μV	1199.99 mV	10 μV	1199.9 mV	100 μV	10^{10} Ω or more	—			
10 V	11.99999 V	10 μV	11.9999 V	100 μV	11.999 V	1 mV					

Measurement accuracy: Expressed as ± (% of reading + digits) the value obtained with auto zero and auto calibration on (with a calibration interval of less than 1 hour) and with zero adjustment performed by pressing the ZERO ADJ key
Measurement accuracy for 6 1/2-digit display:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23± 1°C)	90 days (23± 5°C)	180 days (23± 5°C)
5 PLC 10 PLC	10 mV	0.005+15	0.008+15	0.009+15
	100 mV	0.003+8	0.005+8	0.006+8
	1000 mV	0.002+6	0.004+6	0.005+6
	10 V	0.0018+4	0.0035+4	0.0045+4
20 PLC 50 PLC 100 PLC	10 mV	0.005+10	0.008+10	0.009+10
	100 mV	0.003+5	0.005+5	0.006+5
	1000 mV	0.002+5	0.004+5	0.005+5
	10 V	0.0018+3	0.0035+3	0.0045+3

Measurement accuracy for 5 1/2-digit display:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23± 1°C)	90 days (23± 5°C)	180 days (23± 5°C)
5 PLC 10 PLC	1000 μV	0.005+15	0.008+15	0.009+15
	10 mV to 10 V	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
20 PLC 50 PLC 100 PLC	1000 μV	0.005+10	0.008+10	0.009+10
	10 mV to 10 V	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		

Measurement accuracy for 4 1/2-digit display:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23± 1°C)	90 days (23± 5°C)	180 days (23± 5°C)
5 PLC 10 PLC	1000 μV	Multiply the digit term of the measurement accuracy for 5 1/2-digit display by 1/10.		
	10 mV to 10 V	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/100.		
20 PLC 50 PLC 100 PLC	1000 μV	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
	10 mV to 10 V	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/100.		

Temperature coefficient: Expressed as ± (% of reading + digits) / °C for values in the temperature range of 0 to 40°C) with ± 100 nV / °C (temperature difference between Hi and Lo terminals) added

Range	6 1/2-digit display	5 1/2-digit display	4 1/2-digit display
1000 μV	–	0.0005+3	0.0005+0.3
10 mV	0.0005+3	0.0005+0.3	0.0005+0.03
100 mV	0.0004+1	0.0004+0.1	0.0004+0.01
500 mV	0.0004+0.3	0.0004+0.03	0.0004+0.003
10 V	0.0004+0.1	0.0004+0.01	0.0004+0.001

Zero stability: ± 50 nV/day
Measurement rate: 4 times/s (with 5 PLC integration time, auto-zero off)

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Resistance Measurement

Ranges, maximum display, maximum resolution, measurement current, maximum power dissipation, maximum open-circuit voltage:

Mode	Range	6 1/2-digit display		5 1/2-digit display		4 1/2-digit display		Measurement current	Maximum power dissipation	Maximum open-circuit voltage
		Maximum display	Maximum resolution	Maximum display	Maximum resolution	Maximum display	Maximum resolution			
Hi Power	1000 mΩ	1199.999 mΩ	1 μΩ	1199.99 mΩ	10 μΩ	1199.9 mΩ	100 μΩ	10 mA	100 μW	1 V max.
	10 Ω	11.99999 Ω	10 μΩ	11.9999 Ω	100 μΩ	11.999 Ω	1 mΩ	10 mA	1 mW	
	100 Ω	119.9999 Ω	100 μΩ	119.999 Ω	1 mΩ	119.99 Ω	10 mΩ	1 mA	100 μW	
	1000 Ω	1199.999 Ω	1 mΩ	1199.99 Ω	10 mΩ	1199.9 Ω	100 mΩ	100 μA	10 μW	
	10 kΩ	–	–	11.9999 kΩ	100 mΩ	11.999 kΩ	1 Ω	10 μA	1 μW	
Lo Power	100 mΩ	–	–	119.999 mΩ	1 μΩ	119.99 mΩ	10 μΩ	10 mA	10 μW	20 mV max.
	1000 mΩ	–	–	1199.99 mΩ	10 μΩ	1199.9 mΩ	100 μΩ	1 mA	1 μW	
	10 Ω	–	–	11.9999 Ω	100 μΩ	11.999 Ω	1 mΩ	100 μA	100 nW	
	100 Ω	–	–	119.999 Ω	1 mΩ	119.99 Ω	10 mΩ	10 μA	10 nW	
	1000 Ω	–	–	–	–	1199.9 Ω	100 mΩ	1 μA	1 nW	

Maximum input voltage:

Between Hi and Lo terminals: ±30 V peak, continuously

Between GUARD terminal and chassis: ± 500 V peak, continuously

Between GUARD and Lo terminals: ± 50 V peak, continuously

Measurement accuracy: Expressed as ± (% of reading + digits) of the value obtained with auto zero and auto calibration on (with a calibration interval of less than 1 hour) and with zero adjustment performed by pressing the ZERO ADJ key

Measurement accuracy for 6 1/2-digit display in the Hi POWER mode:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23°C ± 1°C)	90 days (23°C ± 5°C)	180 days (23°C ± 5°C)
5 PLC 10 PLC	1000 mΩ	0.012+20	0.017+20	0.02+20
	10 Ω	0.008+8	0.012+8	0.015+8
	100 Ω			
	1000 Ω			
20 PLC 50 PLC 100 PLC	1000 mΩ	0.012+15	0.017+15	0.02+15
	10 Ω	0.008+5	0.012+5	0.015+5
	100 Ω			
	1000 Ω			

Measurement accuracy for 5 1/2-digit display in the Hi POWER mode:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23°C ± 1°C)	90 days (23°C ± 5°C)	180 days (23°C ± 5°C)
5 PLC 10 PLC	1000 mΩ	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
	10 Ω			
	100 Ω			
	1000 Ω			
	10 kΩ	0.008+6	0.0a12+6	0.015+6
20 PLC 50 PLC 100 PLC	1000 mΩ	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
	10 Ω			
	100 Ω			
	1000 Ω			
	10 kΩ	0.008+5	0.012+5	0.015+5

Measurement accuracy for 4 1/2-digit display in the Hi POWER mode:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23°C ± 1°C)	90 days (23°C ± 5°C)	180 days (23°C ± 5°C)
5 PLC 10 PLC	1000 mΩ	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
	10 Ω			
	100 Ω			
	1000 Ω			
	10 kΩ	Multiply the digit term of the measurement accuracy for 5 1/2-digit display by 1/10.		
20 PLC 50 PLC 100 PLC	1000 mΩ	Multiply the digit term of the measurement accuracy for 6 1/2-digit display by 1/10.		
	10 Ω			
	100 Ω			
	1000 Ω			
	10 kΩ	Multiply the digit term of the measurement accuracy for 5 1/2-digit display by 1/10.		

Measurement accuracy for 5 1/2-digit display in the Lo POWER mode:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23°C±1°C)	90 days (23°C±5°C)	180 days (23°C±5°C)
5 PLC 10 PLC	100 mΩ	0.02+20	0.025+20	0.03+20
	1000 mΩ	0.015+15	0.02+15	0.025+15
	10 Ω	0.01+15	0.015+15	0.02+15
	100 Ω			
20 PLC 50 PLC 100 PLC	100 mΩ	0.02+15	0.025+15	0.03+15
	1000 mΩ	0.015+10	0.02+10	0.025+10
	10 Ω	0.01+10	0.015+10	0.02+10
	100 Ω			

Measurement accuracy for 4 1/2-digit display in the Lo POWER mode:

Integration time (IT)	Range	Measurement accuracy		
		24 hours (23°C ± 1°C)	90 days (23°C ± 5°C)	180 days (23°C ± 5°C)
5 PLC 10 PLC	100 mΩ	Multiply the digit term of the measurement accuracy for 5 1/2-digit display by 1/10.		
	1000 mΩ			
	10 Ω			
	100 Ω			
	1000 Ω	0.01+10	0.015+10	0.02+10
20 PLC 50 PLC 100 PLC	100 mΩ	Multiply the digit term of the measurement accuracy for 5 1/2-digit display by 1/10.		
	1000 mΩ			
	10 Ω			
	100 Ω			
	1000 Ω	0.01+5	0.015+5	0.02+5

Temperature coefficient:

Multiple the reading and digits terms of the 90-day measurement accuracies by 1/10 each, for the temperature range of 0 to +40°C, in the Hi POWER or Lo POWER mode, with an integration time of 5 PLC.

Measurement rate: 1 time/second (with an integration time of 5PLC)

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Integration Time
The following six integration times can be selected. (1 PLC can be used only for DC voltage measurement.)
1, 5, 10, 20, 50, and 100 PLC
PLC (Power Line Cycle)
50 Hz: 1 PLC = 20 ms
60 Hz: 1 PLC ≒ 16.7 ms

Null Function
When the NULL function is switched from off to on, the null value is measured, and this value is subtracted from subsequent measured values. The correction range is ±1% of each range.

Smoothing Function
A moving average of the measurement data is taken from a specified number of samples to apply digital filtering.

Sampling Modes
RUN: Sampling is performed continuously.
HOLD: One sample only is made for each input of a trigger signal.

Calculation Functions
Primary calculation functions: The following calculations are performed with respect to measured value D (X, Y and Z are constants).

(1) Scaling $R=\frac{D-Y}{X}\times Z$

(2) % deviation $R=\frac{D-Y}{|X|}\times 100(\%)$

(3) Delta $R(\Delta D)=D_t - D_{t-1}$ (difference with respect to the previous data value)

(4) Multiply $R=D_t \times D_{t-1}$ (product with the previous data value) D

(5) Decibels $R(dB)=20Y\log\left|\frac{D}{X}\right|$

(6) Effective value (rms) $R=\sqrt{\frac{1}{X}\times\sum_{K=1}^{X}Dk^2}$

(7) dBm $R\ (dBm) = 10\log\frac{D^2/X}{1mw}$

D: Voltage measurement value
This performs a conversion to units of dBm, with 0 dBm representing the voltage that results in 1 mW dissipation when applied to a reference resistance value of X.

(8) Resistance temperature correction

$$R_{20}=\frac{R_x}{1+0.00393\times(X-20)}\times\frac{1000}{Y}\ (\Omega/km)$$

R_{20}: Lead resistance (Ω/km) at 20°C
R_X: Resistance value (Ω) at temperature X°C
X: Room temperature at measurement (°C)
Y: Length of wire measured (m)

Secondary calculation functions:
Calculations performed on measured values or on the results of primary calculations
(1) Comparator 1
R(H2): HIGH2 < D
R(H1): HIGH1 < D ≤ HIGH2
P(PASS): LOW1 ≤ D ≤ HIGH1
R(L1): LOW2 ≤ D < LOW1
R(L2): D < LOW2
(2) Comparator 2
R(H2): (LIMIT + %2) < D
R(H1): (LIMIT + %1) < D ≤ (LIMIT + %2)
P(PASS): (LIMIT – %1) ≤ D ≤ (LIMIT + %1)
R(L1): (LIMIT – %2) ≤ D < (LIMIT – %1)
R(L2): D < (LIMIT - %2)
(3) Statistical processing
R(MAX): Maximum value for N measurements
R(MIN): Minimum value for N measurements

R(AVE): $R=\frac{1}{N}\times\sum_{K=1}^{N}Dk$

R(P-P): |R(MAX) - R(MIN)|

R(σ): $\sqrt{\frac{1}{N-1}\times\sum_{K=1}^{N}(Dk-\overline{D})^2}$

R(UCL): R(AVE) + 3R(σ)
R(LCL): R(AVE) – 3R(σ)
R(COUNT): Number of samples (N)

Input and Output Functions
Trigger input signal: A signal that triggers a measurement can be supplied from a BNC connector on the rear panel.
Negative TTL-level pulse with a pulse width of 100 us or more
Complete output signal: When measurement is completed, a signal that notifies the end of measurement is output from a BNC connector on the rear panel.
Negative TTL-level pulse with a pulse width of approx. 130 μs
GPIB Interface:
Standard: IEEE 488-1978
Output data format: ASCII format
Interface functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E2
Remote programming: All R6561 front panel functions (with the exception of the POWER switch, Lo-GUARD shorting switch, and ZERO ADJ key switch) can be controlled.

Analog Output
Output voltage: 0 to 0.999 V
Output modes and converted output:

Output mode	Converted output
OFF	0 V
Lower 3 digits of displayed value	Digital display 000 to 500 to 999 Analog output 0.000 to 0.500 to 0.999 V
Lower 3 digits of displayed value + OFFSET (500)	Digital display -500 to 000 to 499 Analog output 0.000 to 0.500 to 0.999 V
Lower 2 digits of displayed value	Digital display 00 to 50 to 99 Analog output 0.000 to 0.500 to 0.990 V
Lower 2 digits of displayed value + OFFSET (50)	Digital display -50 to 00 to 49 Analog output 0.000 to 0.500 to 0.990 V

Conversion accuracy: ± 0.3% of full scale (23 ± 5°C, 85% humidity max., for 180 days)
Output impedance: Approx. 600 Ω
Output connector: Type BNC

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General Specifications

Measurement method: Integration
Input configuration: Floating and guarded
Input terminals: Binding posts (DC voltage measurement)
Round 6-pin connector (low DC voltage and resistance measurements)
Range switching: Manual, auto and remote
Data display: 7-segment green LED
Polarity display: For negative values only
Unit display: 5 × 7 dot matrix LED
Beeper function: Can be turned on or off. When on, the beeper sounds for the following conditions
- Input signal overscale
- Error
- Panel key entry
- Comparator calculation execution
- Other special conditions

Error display: If an error occurs during measurement, calculation, parameter setting, or self-test, the corresponding error code is displayed.
Soft calibration: Calibration of each function and range for DC voltage, low DC voltage and resistance measurement can be performed from the front panel or via the GPIB interface.
Warm-up time: Approx. 60 minutes
Operating environment: Temperature: 0 to 40˚C,
Humidity: 85% RH or less
Storage temperature: -25 to 70˚C
Power requirements: To be selected from the following for your order

Option No.	Standard	32	42	44
Line voltage (V)	90 to 110	103 to 132	198 to 242	207 to 250

Line frequency: 48 to 66 Hz
Power consumption: 33 VA or less
Outer dimensions: Approx. 240(W) × 132(H) × 400(D) mm
Mass: 7.0 kg max.

Standard Accessories

Product name	Model	Remarks
Power cable	**A01402**	
Input cable	**MI-37**	For DC voltage measurement
Input cable	**A01004**	For low DC voltage and 4-wire resistance measurement

Accessories (Sold separately)

A01015 Input Cable for 4-Wire Resistance Measurements
A01020 Input Cable
A02240 Rack Mount Set (JIS Standard)
A02439 Rack Mount Set (EIA Standard)
A02031 Panel Mount Set
A01031 Pen type kelvin probe (connector type)