2.9 Basic Methods of Operation

This section describes basic methods of operation for DC/AC voltage measurement, DC/AC current measurement, resistance, and network resistance measurement.

2.9.1 Basic Operations

(1) Make sure that the operating supply voltage is the same as the voltage that has been set using the line voltage value marked on the rear panel located in the rear panel.

(2) Set the POWER switch to the ON position. This causes automatic execution of the self-diagnostic functions. When the R6871E/E-DC is found to be normal, all panel lamps light up during execution of the self-diagnostic functions. (See subsection 2.8.21, "TEST function", for details.)
If an R6871E/E-DC malfunction is detected, then the appropriate error code is displayed. (See section 5.2, "Error Codes", for details.)
Following this, the R6871E/E-DC software revision number, the existing line frequency, the GPIB address are each displayed at 1 sec intervals. Check that all these settings match the actual operating conditions.

(3) If no errors are detected throughout the entire execution time of the self-diagnostic functions, then the R6871E/E-DC is set to the operating conditions preset when the POWER switch was last set to the ON position. (Note, however, that the COMPUTE, STORE, RECALL, NULL, and SMOOTH keys are set to the OFF position whenever power is turned on.)

(4) When execution of the self-diagnostic functions is completed, check each parameter setting to ensure that they match the actual operating conditions, as described below.
First, check that the FUNCTION, RANGE, SAMPLING, and INPUT keys (these are the basic measurement parameter keys) are all set to the correct positions.
Next, check that the settings of the A CAL, A ZERO, IT, SI, RES, and NULL parameters (these parameters are used to control the measurement functions and operations) are all correct.

CAUTION

In an environment where temperature suffers significant changes, set the AUTO CAL interval of the A CAL parameter to a small value.

2.9.2 DC Voltage Measurement

(1) Input Impedances

As shown in the table below, the input impedance varies according to the measurement range selected.

Range	200mV	2000mV	20V	200V	1000V
Input impedance	$10^{10}\Omega$ or more			10MΩ ± 0.5%	

(2) Input Cables

Connect the MI-37 (*) input cables (supplied) to the lower input terminals of the FRONT or REAR input terminals (select either with the INPUT key). (See Figure 2-4 below.)

* The MI-37 has three leads (red, black, blue).

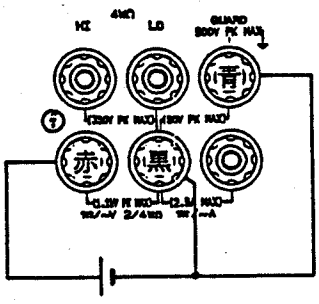


Figure 2-4 Input Cable Connection Diagram for DC Voltage Measurement

(3) Maximum Input Voltages

The maximum available input voltages are listed in the table below. Take great care to ensure that the maximum input voltage is not exceeded.

Voltage applied between:		Maximum input voltage
Hi terminal - LO terminal	200mV, 2000mV, 20V ranges	±1100V peak (for 10sec) ±500V peak (continuous)
	200V, 1000V ranges	±1100V peak (continuous)
GUARD terminal - chassis		±500V peak (continuous)
GUARD terminal - LO terminal		±50V peak (continuous)

(4) If a large influence is likely to result from noise included in measured signals, proceed as follows to minimize reading errors:
Setting the integral time (IT) to 1PLC or more will give improved effects of line noise rejection. In addition, a larger IT setting will give more stable measurements since low-frequency-component noise included in measured voltages will also be averaged.

Note : The integral time (IT) is initially set to 5PLC.

See section 2.8 for the parameter setting procedures.

CAUTION

The 200mV range (6 1/2 digit display) provides a resolution of 0.1μV/digit). When making measurements, therefore, careful attention should be paid to the occurrence of a thermal electromotive force.
A thermal electromotive force of several microvoltages to ten microvoltages per degree C may develop in the form of a thermocouple effect if temperature differences occur in signal wire connections between the clip terminals of measured signals and the input section of the R6871E/E-DC. This thermal electromotive force, if generated, will be added up for each wire connection, appear as zero drift, and thus result in significant measurement errors.
Therefore, strictly observe the following precautions:

(1) Notes on the connections of the measurement terminals
- Keep your hands away from the end of an input cable during measurement.
- Read the measured data only after a sufficient temperature balance has been attained.
- Do not make measurements in places where air circulates.

(2) Notes on the ambient conditions of the R6871E/E-DC
- Allow a sufficient warm-up time (approximately 60 minutes) after power has been turned on.
- Also take a sufficient warm-up time when making measurements in places where significant temperature differences occur.
- Avoid installing the R6871E/E-DC in places where air circulates.

2.9.3 Resistance Measurement

(1) Measurement Currents

Resistance measurement currents are listed in the table below.

Range	10Ω	100Ω	1000Ω	10kΩ	100kΩ	1000kΩ
Measurement current	10mA	10mA	10mA/1mA*	1mA	100μA	10μA

Range	10MΩ	100MΩ	1000MΩ
Measurement current	1μ	100nA	10nA

* : For option 10, 1mA is enabled.

(2) Voltages between Open Terminals

Resistance measurement voltages between open terminals (current source terminals) are listed in the table below.

Range	10Ω	100Ω	1000Ω	10kΩ	100kΩ	1000kΩ	10MΩ
Voltage between open terminals	24V				18V		

Range	100MΩ	1000MΩ
Voltage between open terminals	24V	

(3) Maximum Input Voltages

The maximum input voltages are listed in the table below. Take extra care to ensure that the voltages are not exceeded.

Votage applied between	Maximum input voltage (continous)
Between measurement terminals	±350V peak
GUARD terminal - chassis	±500V peak
GUARD terminal - measurement terminal	±50V peak

(4) Input Cables

Figure 2-5 shows the input cable connection diagrams for 2-wire and 4-wire system resistance measurement.
For 2-wire system resistance measurement, use the MI-37 input cables (supplied).
For 4-wire system resistance measurement, use the A01005 input cables (supplied).

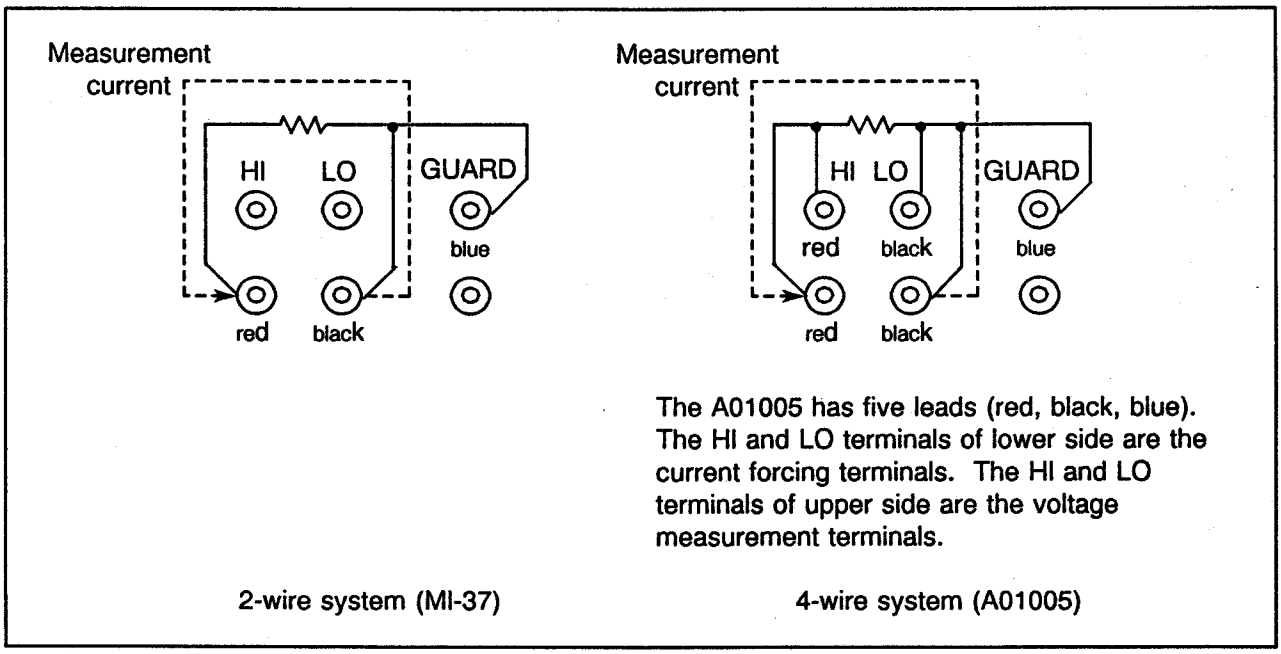


Figure 2-5 Input Cable Connection Diagrams for Resistance Measurement

(5) 2-wire System Resistance Measurement

The NULL function of the equipment is effective for measurement ranges in which the resistance of the MI-37 input cable (approximately 0.5/) becomes an error. (See subsection 2.8.20, "NULL".)
When using the NULL function, the end of the input cable must be short-circuited and the resistance of that cable measured in advance. Subtracting this value from subsequent measurements makes it possible to prevent the resistance of the input cable from becoming an error.

CAUTION

When measuring resistances using the 10M/ range or higher, apply a shielding case over the resistor to be measured, in order to achieve the maximum high accuracy of measurement. (See Figure 2-6.) In addition, fix the input cable to prevent its sagging during measurement, and take special notice of noise induced from peripheral measuring instruments.

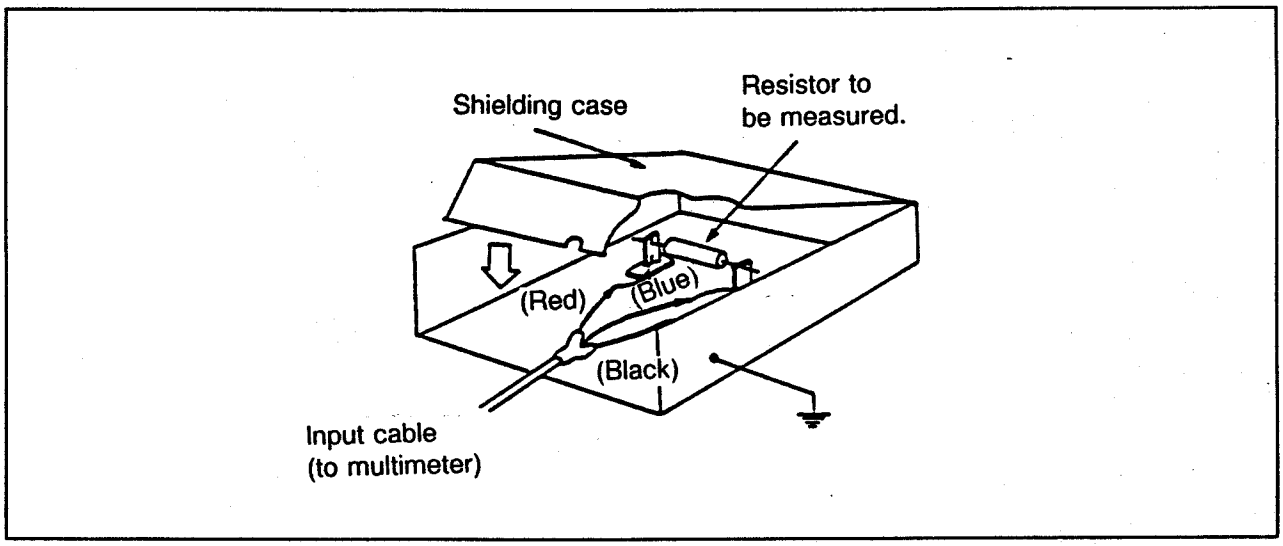


Figure 2-6 Shielding Example for Resistance Measurement

2.9.4 Network Resistance Measurement: Only the R6871E-OHM is enabled.

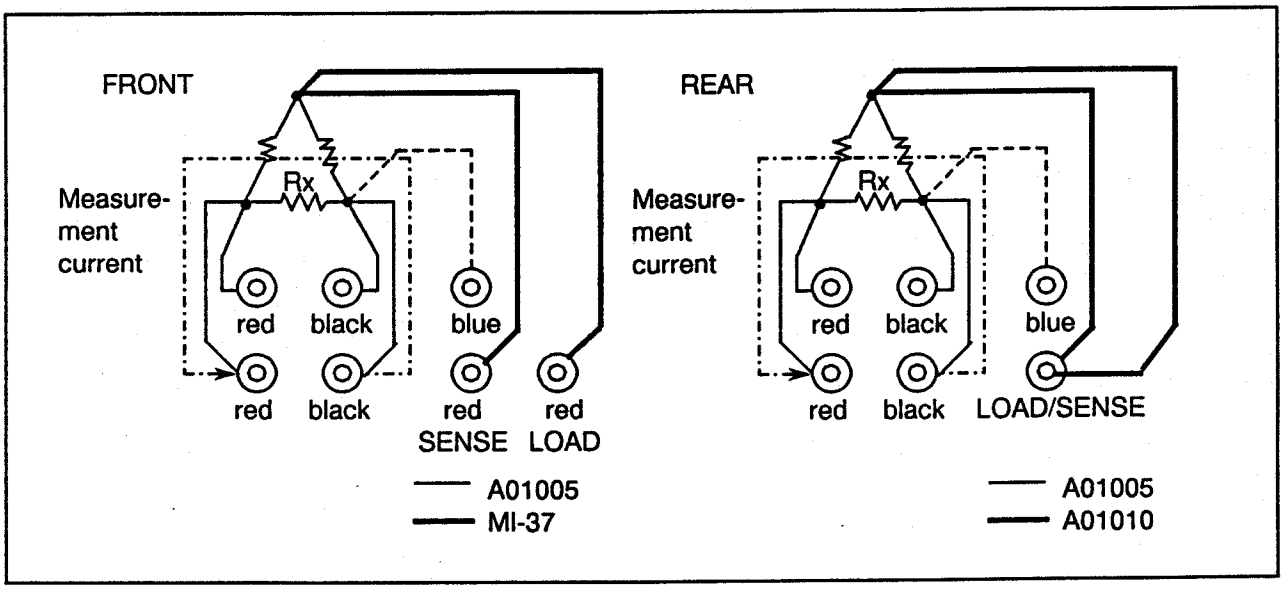
The network resistance measurement is a measurement method without need for switching off the network

(1) Measurement Range

Set the measurement function to four-wire resistance measurement. Set resistance for the closed circuit to 300Ω or more (5MΩ or less). (1kΩ to 10MΩ range)
Measurement result of 300Ω or less (5MΩ or more) is not guaranteed.
The output current will reach a limit if the resistance of about 300Ω or less is connected, and LED (OVERLOAD) on the front panel will light. The error increases for about 5MΩ or more.
Accuracy is not guranteed though the measurement operation is done in 10Ω , 100Ω , 100MΩ , or 1000MΩ range.
Select the integration time between 5PLC to 100PLCS.
Adjust the ratio of the resistance to be measured and resistance in the closed circuit to 1:100 or less.
The error increases when the ratio exceeds 1:100.

(2) Input Cable

The following figure shows the connection of the input cable of front and rear.
Both MI-37 and A01005 are used for the network resistance measurement. (Use optional A01010 for the REAR input.)
The FRONT and REAR terminals are internally connected to each of the SENSE and LOAD terminals. Connect the cable to either the FRONT or REAR terminal.
Do not connect with the LOAD terminal or SENSE terminal when usual resistance which is not the closed circuit is measured.



(3) Measurement Current, voltage between open terminals

Refer to "Resistance Measurement" of subsection 2.9.3.

(4) Maximum Input Voltages

Voltage applied between	Maximum input voltage (continuous)
Between measurement terminals (voltage/resistance)	±350V peak
Between measurement terminals (LOAD/SENSE)	±250V peak
GUARD terminal-chassis	±500V peak
GUARD terminal-measurement terminal	±50V peak

2.9.5 DC Current Measurement: Only the R6871E is enabled.

(1) Maximum Permissible Current Applied

The maximum permissible current applied is 2.5 amperes for the range from 2000 A to 2000mA.
If a protective fuse has blown due to an excessive input current, replace the current fuse (A FUSE), which is located in the lower central section of the front panel, with the required one (2A).
The fuse can be removed by turning the fuse holder counterclockwise with a light push upon the fuse holder.
Make the input cable connection securely: the circuit under measurement may be adversely affected if the input cable becomes disconnected during measurement.

(2) Input Impedances

Range	200μA	20mA	200mA	2000mA
Input impedance	102Ω or less	12Ω or less	3Ω or less	2Ω or less

(3) Input Cables

Figure 2-7 shows the input cable (MI-37) connection diagram for DC current measurement.

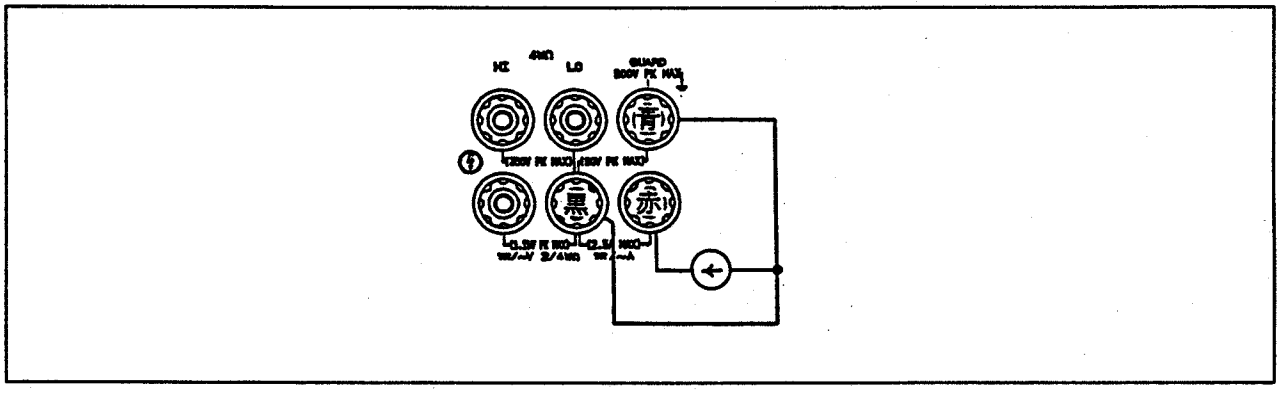


Figure 2-7 Input Cable Connection Diagram for DC Current Measurement

2.9.6 AC Voltage Measurement (DC + AC) Voltage Measurement: Only the R6871E is enabled.

(1) Input Impedances

The input impedance varies according to the measurement range selected, as shown in the table below.
The input impedance for each range is shown below.

Range	200mV	2000mV	20V	200V	500V
Input impedance	1MΩ ± 2% 300pF or less AC coupled				

(2) Input Cables

Connect the MI-37 (*) input cables (supplied) to the lower input terminals of the FRONT or REAR input terminals (select either with the INPUT key). (See Figure 2-8 below.)

* The MI-37 has three leads (red, black, blue).

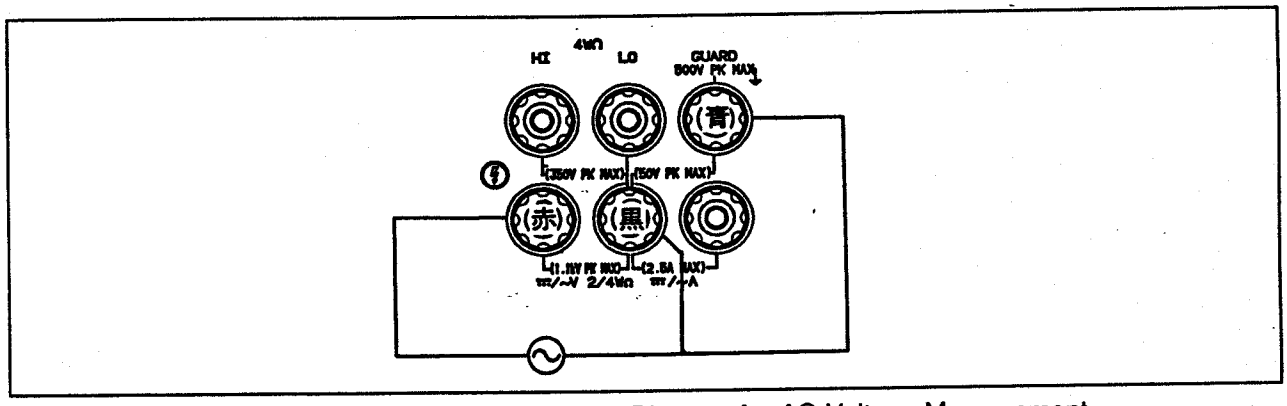


Figure 2-8 Input Cable Connection Diagram for AC Voltage Measurement

(3) Maximum Input Voltages

The maximum available input voltages are listed in the table below. Take great care to ensure that the maximum input voltage is not exceeded.

Voltage applied between:		Maximum input voltage
HI terminal - LO terminal	200mV, 2000mV, 20V, 200V, 500V ranges	HI terminal - LO terminal 520Vrms 750V peak

(4) If a large influence is likely to result from noise included in measured signals, proceed as follows to minimize reading errors:
Setting the integral time (IT) to 1PLC or more will give improved effects of line noise rejection. In addition, a larger IT setting will give more stable measurements since low-frequency-component noise included in measured voltages will also be averaged.

Note : The integral time (IT) is initially set to 5PLC.

See section 2.8 for the parameter setting procedures.

2.9.7 AC Current Measurement (DC + AC) Current Measurement: Only the R6871E is enabled.

(1) Maximum Permissible Current Applied

The maximum permissible current applied is 2.5Arms for the range from 2000μA to 2000mA.
If a protective fuse has blown due to an excessive input current, replace the current fuse (A FUSE), which is located in the lower central section of the front panel, with the required one (2A).
The fuse can be removed by turning the fuse holder counterclockwise with a light push upon the fuse holder.
Make the input cable connection securely; the circuit under measurement may be adversely affected if the input cable becomes disconnected during measurement.

(2) Input Impedances

Range	Input impedance
2000μA	102Ω or less
20mA	12Ω or less
200mA	3Ω or less
2000mA	2Ω or less

(3) Input Cables

Figure 2-9 shows the input cable (MI-37) connection diagram for AC current measurement.

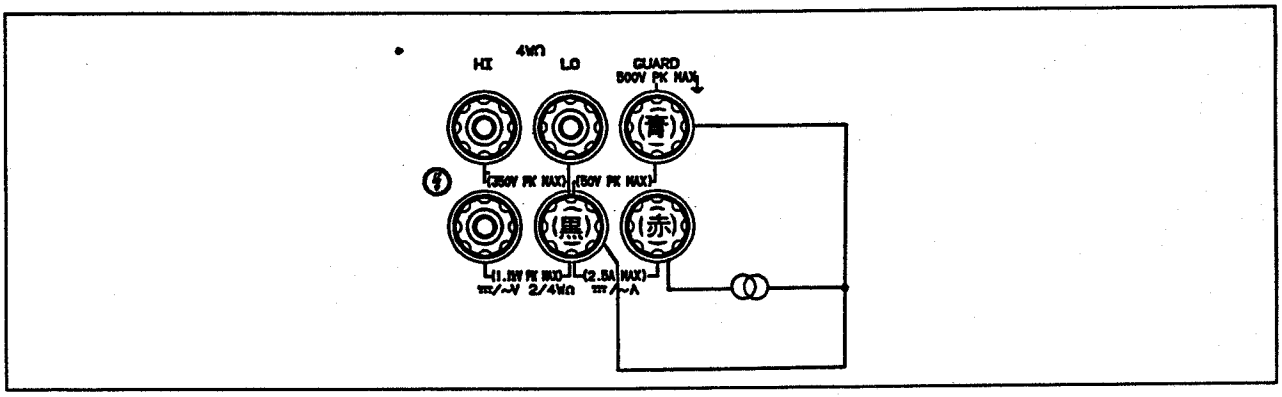


Figure 2-9 Input Cable Connection Diagram for AC Current Measurement

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