HIOKI

Instruction Manual

SM-8216

SUPER MEGOHMMETER

HIOKI E. E. CORPORATION

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1. Safety Precautions

Operators of the SM-8216 super megohmmeter are requested to read this operation manual thoroughly before operation for safety and to obtain best performance.

Operators are also requested to strictly observe all the DANGER, WARNING, and CAUTION notices in this manual and on the instrument to prevent injury and damage.

1-1 Safety Warnings

This operation manual includes some DANGER!, WARNING!, and CAUTION! notice with a symbol. These must be observed for safety of the operator and other persons, as well as for protection of your super megohmmeter and samples from possible damage and destruction.

DANGER

A “DANGER” CALLS ATTENTION TO A CONDITION OR POSSIBLE SITUATION THAT CAN CAUSE DEATH OR INJURY TO THE OPERATOR OR NEARBY PERSONS.

WARNING

A “WARNING” CALLS ATTENTION TO A CONDITION OR POSSIBLE SITUATION THAT COULD CAUSE DEATH OR INJURY TO THE OPERATOR OR NEARBY PESRONS.

CAUTION

A “CAUTION” calls attention to a condition or possible situation that could cause injury to the operator or persons nearby and damage and destroy the super megohmmeter and samples.

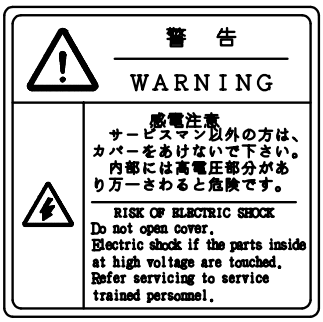
Congratulations on your purchase of a HIOKI SM-8216 super megohmemeter.
The super megohmmeter is a unique analog resistance meter designed to measure high resistance in a wide range.
The MS-8216 meter outputs a high test voltage – 1000 V maximum to apply across the sample circuit.
Operators are requested to read this operation manual thoroughly before trying to operate the instrument for safety and to prevent electrical shock and damage to the circuit to measure.
Keep this manual where all staff can access it any time.

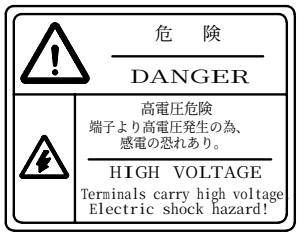
1.2 Symbols on the Super Megohmmeter

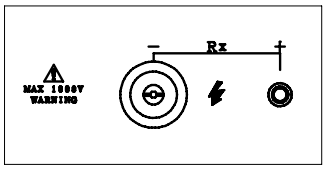
Symbol	Meaning	Description
	WARNING	This symbol is shown at pats whose usage needs reference to the operation manual.
	DANGER – HIGH VOLTAGE HAZARD	This symbol is shown at the Rx '–'/'+' Measuring terminals which carry a high voltage to be applied across the circuit to be measured.

Safety Warning Labels on the Super Megohmmeter

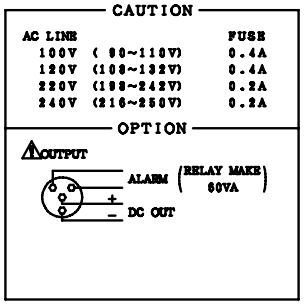
1) DANGER and WARNING Labels on the Housing and Front

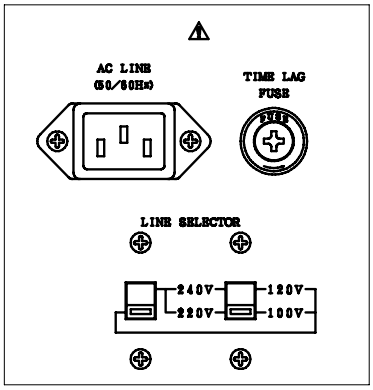


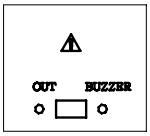


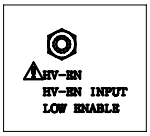


2) DANGER and WARNING Labels on the Rear Panel









2. Operating Environmental Precautions

DANGER

- Do not operate the super megohmmeter in the presence of flammable gas. There is s possibility of an explosion and/or fire.
- Do not touch the Rx '–'/'+' measuring terminals on the front panel of the SM-8216 during measurement. They output a maximum measuring voltage of 1000 V.

WARNING

- Ground the ground prong of the power cord plug to avoid electrical shock. If the ground prong cannot be grounded, connect the GND terminal on the rear of the instrument to a ground. When the power cord plug is connected to the AC line socket via an accessory 3-prong to 2-prong adapter, the green ground tab of the adapter to the ground.
- Do not remove the housing cover of the instrument. Even after turning off the instrument power switch, a dangerous residual voltage may be present for several minutes after the power is turned off. If repair or internal readjustment is needed, contact your local HIOKI Electronics distributor.

CAUTION

- Before turning on the power switch for the instrument, check that the LINE SELECTOR switches are set for your local AC line voltage. If the wrong AC line voltage is applied to the unit, it will be damaged (higher voltage supply) or will not function properly (lower voltage supply). See 1.3 Setting LINE SELECTOR Switches for switch setting. Use the right size and amperage power fuse. If a fuse of incorrectamperage is inserted into the fuse holder, the unit will be damaged. See 1.4 Checking the Fuse Amperage for a correct fuse amperage.
- Do not install or operate the super meghommeter in a placewhere is affected by dust, shock and vibration, direct sunshine, steam, heat generating facilities, air conditioning draft, etc. These can cause a failure with the instrument.

3. Installation Precaution

CAUTION

Do not install or place the super megohmmeter in a location which is not level, not stable or not sturdy enough to hold the instrument and other related items.

4. Instrument Handling Precautions

WARNING

- If the instrument generates smoke or smell, unplug the power cord. If such an instrument is kept powered on, it may cause a fire. Contact your local HIOKI Electronics distributor for repair.
- Do not operate the instrument with a wet hand. This may cause electrical shock.

CAUTION

- When moving or transporting the super megohmmeter, avoid shockand vibration as much as possible. For long-distance transportation, put the instrument in a shock-absorbing carton or use the originalshipping carton.
- When not using the super megohmmeter for an extended period oftime, unplug the power cord from the AC line socket. Put a dustcover on the instrument. Store it in a place free of corrosive gas andvibration, with a surrounding temperature within the range from –5 to 45℃, and humidity 80% RH or less(non-condensating).
- Do not place anything on the instrument.

BRIEF DESCRIPTION

About the SM-8216 Super Megohmmeters

The SM-8216 super megohmmeter is insulation resistance meters consisting of a constant voltage power supply and a high sensitive current measuring section. The super megohmmeter is designed to measure the electrical resistance of insulating materials with high insulation properties.

The resistance measuring ranges of the SM-8216 is as follows:

5.0×10^4 to $2 \times 10^{13} \Omega$

The SM-8216 super megohmmeters is provided with a large analog meter for easy reading of a measured insulation resistance.

The following shows the main specifications for the SM-8216.

For detailed specifications, see 2. SPECIFICATIONS.

For optional accessories, see 7. OPTIONAL ACCESSORIES.

Main Specifications – For detailed specifications, see 2. SPECIFICATIONS. For optional accessories, see 7. OPTIONAL ACCESSORIES.

Measuring Voltage Ranges:

10, 25, 50, 100, 250, 500 and 1000 V

Measuring Resistance Ranges:

5.0×10^4 to $2 \times 10^{13} \Omega$, 6 ranges

Voltage Charging Function: Provided

Voltage Discharging Function: Provided

HV-EN (High Voltage Enable) Interlocking Function: Provided

DC Signal Output Function: Optionally available on factory installation basis

Either one of 1/R output or proportional to resistance value output can be optionally incorporated in a single SM-8216 unit.

Alarm Function: Optionally available on factory installation basis

Organization of This Operation Manual

This operation manual contains the following 9 sections.

1. PREPARATION BEFORE OPERATION

   This section describes precautions for unpacking and AC line voltage setting.

2. SPECIFICATIONS

   This section describes the specifications for the SM-8216 super meg-ohmmeters and optional accessories.

3. OPERATING PRINCIPLE

   This section describes the operating principle with a block diagram of the SM-8216.

4. FAMILIARIZATION WITH CONTROLS AND PARTS

   This section describes the functions of the controls and parts on the front and rear panels.

5. PREPARATION FOR MEASUREMENT

   This section describes the measuring mode, and setting mode before operation.

6. MEASUREMENT

   This section provides details for function setting, connection to the sample to be measured in a variety of insulation resistance measurement.

7. OPTINAL ACCESSOIRIES

   This section describes the optional accessories, including guard chip, DC signal outputs, and others.

8. MAINTENANCE AND MISCELANEOUS

   This section describes maintenance, storage, transportation and abandon of old instrument.

9. EXTERNAL APPEARANCE

   This section includes front, rear and side view illustrations of the instrument with dimensions.

CONTENTS

1. PREPARATION BEFORE OPERATION

1.1 Unpacking and Checking of the Contents

When you have received the carton of the SM-8216 super megohmmeter, carefully unpack it, and take out every thing from the carton.
Although the instrument and its accessories are severely inspected before shipment from factory, visually check the items and their quantities.
Keep the shipping carton for reuse at a later time.

1) Visually check the external view of the instrument and its accessories.
2) Check the quantities of the list in accordance with the following list:

Table 1.1.1 List of Standard Accessories

Item	Reference No.	Q'ty	Remarks
Operation manual	—	1	This item means this booklet.
Power cord	—	1	Power cord with 3-prong plug with third for grounding
Measuring rod (Red)	0GE00002	1	A measuring rod with a 1-meter cord to be connected to the Rx '-' measuring terminal.
Measuring rod (Black)	0GE00001	1	A measuring rod with a 1-meter cord to be connected to the Rx '+' measuring terminal.
Shorting plug	—	1	A plug to be plugged to the HV-EN connector on the rear of the instrument. It is plugged to the HV-EN connector when shipping from factory.

CAUTION
When plugging the shorting plug, make sure that the power is turned off, otherwise, there is an electric shock hazard.

Upon checking the instrument and accessories, if any damage is found, immediately contact the forwarder or your local HIOKI distributor.
Upon checking the instrument and accessories, if any shortage is found, immediately contact your local HIOKI distributor or directly HIOKI E.E. CORPORATION .

1.2 Operating AC Line Voltage

The super megohmemeter can be operated from one of the following AC power source when the LINE SELECTOR switches are set accordingly.

AC Line Voltage	Frequency
100 V ±10%	50/60 Hz
120 V ±10%	50/60 Hz
220 V ±10%	50/60 Hz
240 V +10V, -10%	50/60 Hz

CAUTION

Before connecting the power cord to the AC outlet socket, confirm that the LINE SELECTOR switches on the rear panel are set to the positions, accordingly (See 1.3 Setting the LINE SELECTOR Switches.).

1.3 Setting the LINE SELECTOR Switches

The super megohmmeter can be operated from one of the AC line voltages of 100 V, 120 V, 220 V and 240 V by setting the LINE ELECTOR switches to the specific positions, respectively.

Confirm the switch setting to the specific positions in accordance with Fig. 1.1.1. If they are not set properly, correct their positions, accordingly.

To change the position of the switch, insert the tip of a flat blade screwdriver into the slot of the switch lever, and slide the leverupward or downward.

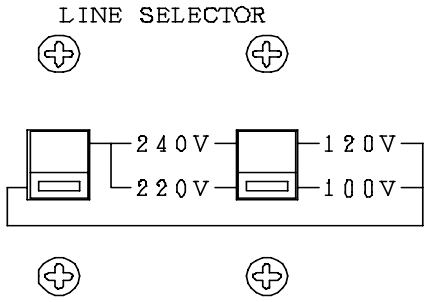
CAUTION

To change the LINE SELECTOR switch positions, unplug the power cord plug from the AC line socket to prevent a possible damage. When the switch position is changed while the voltage is on, the switch contacts will be damaged.

CAUTION

The LINE SELECTOR switches have two positions – up and down. Slide the switch lever to either position until it stops.

Do not leave the lever at a neutral position. If the lever is set at A neutral position, a normal function cannot be obtained, and it will cause a failure.



	LINE SELECTOR
100V	
120V	
220V	
240V	

Fig. 1.1.1 LINE SELECTOR Switch Setting

The super megohmmeter can be operated from one of the following AC power source when the LINE SELECTOR switches are set accordingly.

LINE SELCTOR Setting	Acceptable Line Voltage Range
100 V	90 V to 110V (100 V ±10%)
120 V	108 V to 132 V (120 V ±10%)
220 V	198 V to 242 V (220 V ±10%)
240 V	216 V to 250 V (240 V +10V, -10%)

CAUTION

When the LINE SELECTOR switch position is changed, fuse amperage must be changed to meet the requirements of the new AC line voltage.

Incorrect fuse amperage will cause a failure of the instrument.

1.4 Checking the Fuse Amperage

The fuse holder of the instrument contains a time lag fuse of the following amperage:

Time Lag Fuse

AC Line Voltage	Fuse Amperage
100 V/120 V	0.4 A
220 V/240 V	0.2 A

Fuse Replacement

The fuse is inserted in the FUSE holder (Fig. 1.1.2) on the rear of the unit. Remove the cap, and replace the fuse with a new one with a correct amperage.

To remove the cap of the fuse holder, use a 4 mm Phillips screwdriver, and turn the cap counterclockwise.

To set the cap in position, insert the cap, holding the fuse into the holder, and turn it with the screwdriver.

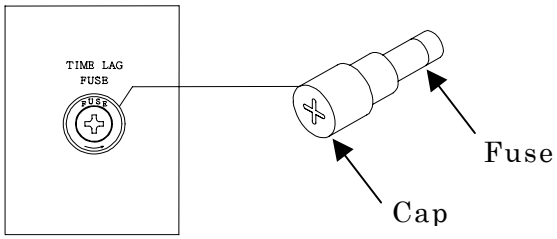


Fig. 1.1.2 Fuse Holder and Fuse Replacement

WARNING

To replace or check the fuse, make sure to disconnect the power cord from the AC line socket. If not, there is a fear of electrical shock.

1.5 Grounding the Chassis

To avoid an electrical shock accident, connect the ground prong of the power
cord to the ground post of the AC line system.

The round prong of the 3-prong plug of the power cord is the ground prong. It is recommended to use an AC line socket with its third contact grounded for connection of the accessory 3-prong power cord.

To use the accessory 3-prong to 2-prong adapter to connect the power cord to a 2-contact AC line socket, make sure to ground the green tab of the adapter.

WARNING

To prevent an accident, connect the ground prong of the power cord Plug to the ground post of the AC line system. If it is impossible to ground the ground prong of the power cord plug, be sure to connect the GND terminal on the rear of the unit.

1.6 Warm-up Period

To obtain the performance of published specifications, allow the SM-8200 Series super megohmmeter to warm for a minimum of 30 minutes.

2. SPECIFICATIONS

2.1 Measuring Performance

Insulation Resistance Measurement

(RANGE : $\times 1$, $\times 10$, $\times 10^2$, $\times 10^3$, $\times 10^4$, or $\times 10^5$)

Measurement Range (MΩ) [RANGE=$\times 10^R$]	Target Voltage
5 $\times$ 10^R to 200 $\times$ 10^R	1000 V
2.5 $\times$ 10^R to 100 $\times$ 10^R	500 V
1.25 $\times$ 10^R to 50 $\times$ 10^R	250 V
0.5 $\times$ 10^R to 20 $\times$ 10^R	100 V
0.25 $\times$ 10^R to 10 $\times$ 10^R	50 V
0.125 $\times$ 10^R to 5 $\times$ 10^R	25 V
0.05 $\times$ 10^R to 2 $\times$ 10^R	10 V

Accuracy of target voltage: ±3% of set value

Measuring output current: 2 mA, maximum

Accuracy of measurement: ±10% (A range of 10 times of the minimum value of each range)

Note: The above performance can be obtained under the following operating conditions;

Temperature: 0℃ to 40℃, 80% RH or less(non-condensating)

2.2 Function Specifications

1) CHARGE Function

This function charges the sample to be measured by applying the selected measuring voltage when the MEASURE/CHARGE/DIS-CHARGE function switch is set to the CHARGE position.

2) DISCHARGE Function

This function discharges a residual voltage on the sample after measurement when the MEASURE/CHARGE/DISCHARGE function switch is set to the DISCHARGE position.

Internal Resistance: Approx. 100kΩ

3) HV-EN (High Voltage Enable) – Interlocking Function

This function externally controls to make the output of measuring voltage on or off. This function is used in combination with an interlock switch on the measuring jig so as to prevent an electrical shock during measurement.

The measuring voltage can be output only when the HV-EN circuit is closed.

2.3 Other Electrical and Physical Data

1) Environmental Temperature and Humidity

Operation: 0℃ to 40℃, 80% RH or less(non-condensating)

Storage: -5℃ to 45℃, 80% RH or less(non-condensating)

2) Power Requirements

AC 100 V, 120 V, 220 V, ±10%, 240 V +10 V, -10% 50/60 Hz

3) Power Consumption

Approx. 20 VA

4) Dimensions

Approx. 280 (W) × 190 (H) × 222 (D) mm

Also, see 9. EXTERNAL APPEARANCE.

5) Weight

Approx. 5 kg

2.4 Optional Functions and Accessories

In addition to the standard accessories shown in 1.1 Unpacking and Checking of the Contents and Table 1.1.1 List of Standard Accessories, the following two groups of optional accessories are available to expand the applications of the SM-8216 super megohmmeter.

1) Options – available exclusive for the SM-8216

Name	Model	Remarks
DC signal output (resistance value Proportional or linear signal)	RP-8000[1)/2)]	Factory installed
DC signal output (1/R signal)	RI-8000[1)/2)]	Factory installed

[1)]Either one of the RP-8000 or RI-8000 optional function can be installed in a single SM-8216 unit.

[2)]The RP-8000/RI-8000 optional function is available on factory-installation basis, only.

2) Options – designed for common to the SM-8216, SM-8200 Series, and SM-8000 Series super megohmmeters.

Name	Model	Description
Electrode for plate samples	SME-8310	With surface/volumetric selector, interlock function 8311 has a smaller electrode.
Electrode for plate samples	SME-8311	
Weight electrode	SME-8320	With surface/volumetric selector. Needs shield box.
Shield box	SME-8350	Electromagnetic shielding

-- continued --

Name	Model	Description
Electrode for surface Resistance measurement	SME-8301	Simplified electrode for surface resistance measurement
Electrode for surface Resistance measurement	SME-8302	Simplified electrode for curved surface resistance measurement
Electrodes for liquid sample Measurement	SME-8330	Capacity, approx. 25 mL Electrode constant: Approx. 500 cm
Electrodes for continuous Liquid sample Measurement	SME-8335	Capacity, approx. 30 mL Electrode constant: Approx. 75 cm
Electrodes for chip Capacitors	SME-8360	Chip capacitor measurement

Other types of optional electrodes and devices are available upon request. For details, contact your local HIOKI Electronics distributor.

3. OPEARATING PRINCIPLE

The SM-8216 super megohmmeters consist of a constant voltage power supply and a high sensitive current measuring section to be combined to compose a resistance measuring circuit.

The current measuring section is composed of a current detective resistor, And low drift voltage amplifier.

A measured resistance value is on a large analog meter.

Fig. 3.1.1 shows a circuit composition of the SM-8216.

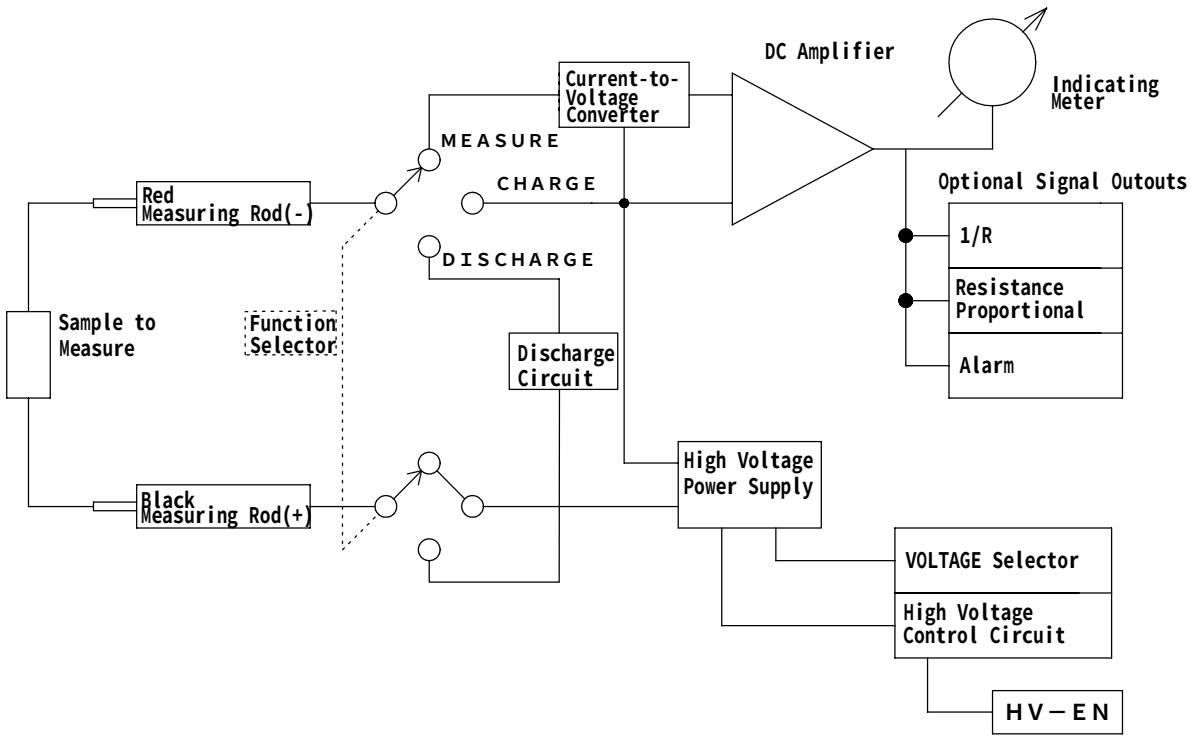


Fig. 3.1.1 SM-8216 Circuit Block Diagram

4. FAMILIARIZATION WITH CONTROLS AND PARTS

4.1 Front Panel

The figure below shows the front panel of the SM-8216.

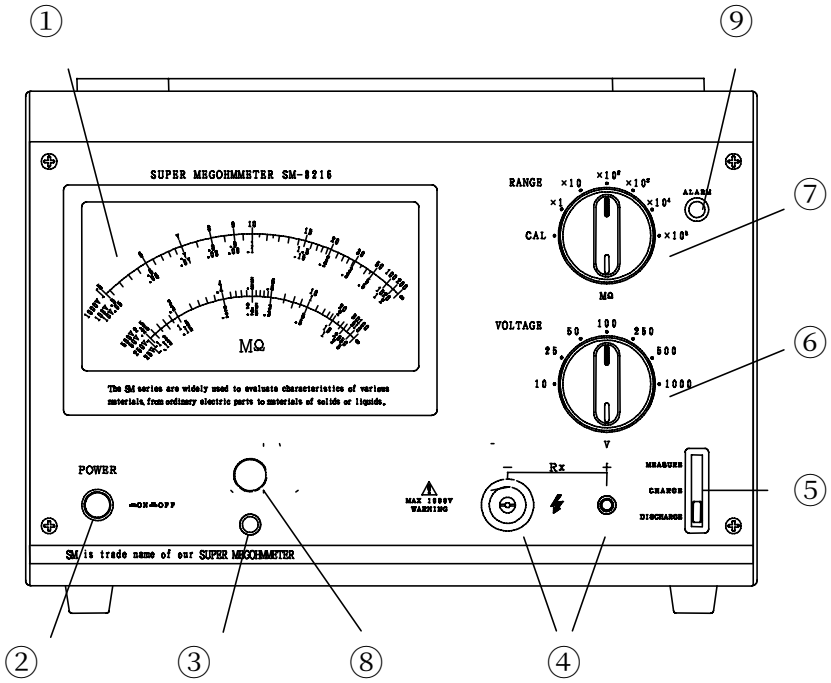


Fig. 4.1.1 Front Panel

① Indicating Meter: This meter has a multi-scale to indicate a wide range of measured insulation resistance values.
Reading must be multiplied by the factor of the RANGE selector.

② POWER switch: This is a power switch to turn on or off the instruments.
A press of this switch in the released position turns ON the unit.
When On, the incorporated green indicator lights.
A press of this switch in the pushed position turns OFF the unit.

③ Meter Needle Position Adjusting Screw: This screw is exposed when a protective black rubber cap is removed. Adjust this screw to bring the meter needle to the ∞ mark when the power is turned off.
(See Fig. 4.1.2.)

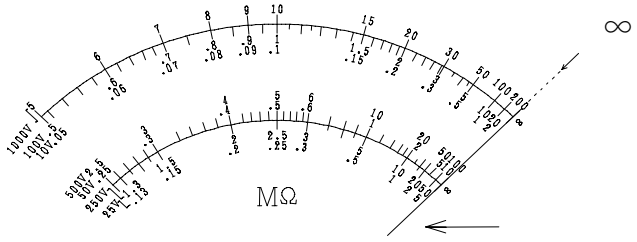


Fig. 4.1.2 Meter Scale

④ Rx '-'/'+' Measuring Terminals: These terminals carry a selected measuring voltage across them to measure the insulation resistanceof a sample via a pair of measuring rods or electrodes.

The polarity of the terminals is as follows:

Rx '–' measuring terminal: Red measuring rod

Rx '+' measuring terminal: Black measuring rod.

Note: Each of the terminals is incorporated with a plug insertion detector switch. Unless otherwise this switch is turned on by afull insertion of the plug of the measuring rod or electrode, theoutput voltage circuit cannot be completed – no output.

⑤ MEASURE/CHARGE/DISCHARGE Function Selector Switch: This switch selects the function of the unit. Before turning the power on, be sureto set this switch to the DISCHARGE position. After turning the power on, and connecting the Rx -/+ measuring terminals to thesample to be measured, set the switch to the CHARGE position. Keepit there for several seconds (to be adjusted, depending upon thecapacitance of the sample) to charge the sample for a reliable measurement.

When the sample is completely charged, set the switch to the MEASURE position.

For details of the charging time, see 6.2 Usage of the MEASURE/ CHARGE/DISCHARGE Function Switch.

Fig. 4.1.2 shows the MEASURE/CHARGE/DISCHARGE function selector switch.

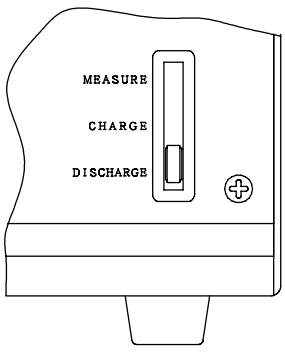


Fig. 4.1.3 Function Selector Switch

⑥ VOLTAGE Selector Switch: This switch selects the voltage to be applied across the Rx +/- measuring terminals. The arrow on the knob shows a voltage to output.

⑦ RANGE Selector Switch: This switch selects the factor to be multiplied to the measured value shown with the indicating meter.
The CAL position is used for calibration. For details of the calibration procedures, see 5. PREPARATION FOR A MEASUREMENT.

⑧ ALARM Level Setting Knob: This knob is provided only when the optional AL-8000 alarm device is installed. The trigger level for the alarm can be adjusted with this knob.

⑨ ALARM Indicator: This indicator is provided only when the optional AL-8000 alarm device is installed.
When the measured insulation resistance is lower than the trigger level set with the ALARM level setting knob, this indicator lights.

4.2 Rear Panel

The figure below shows the rear panel of the SM-8216. However, note that the LINE SELECTOR switches are set for the operation from 100 V AC line.

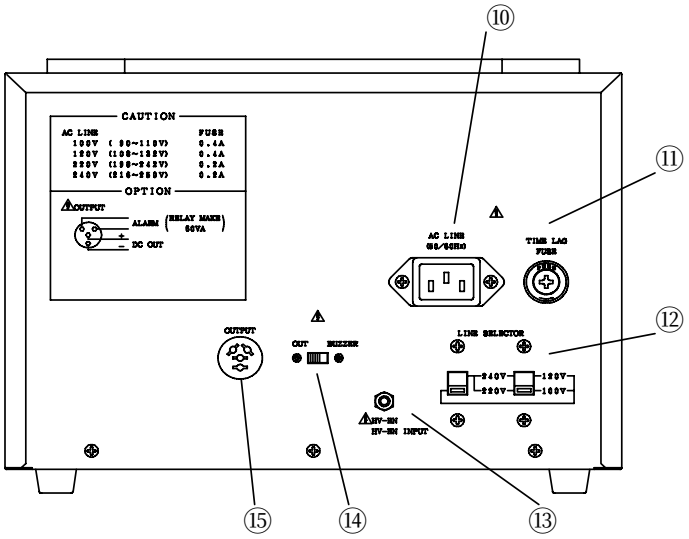


Fig. 4.1.4 Rear Panel

⑩ AC LINE Receptacle: This connects the accessory power cord.

⑪ TIME LAG FUSE Holder: This holder contains a time lag fuse in a glass tube. The amperage of the fuse must agree with the local AC line voltage from which the unit is powered.

AC Line Voltage	Fuse Amperage
100 V/120 V	0.4 A
220 V/240 V	0.2 A

⑫ LINE SELECTOR Switches: These two switches are to be set in accordancewith the local AC line voltage (50 or 60 Hz) for the instrument. For a proper setting, see 1.3 Setting LINE SELECTOR Switches.

For line voltage change between 100 V/120 V and 220 V/ 240 V, thepower fuse amperage must be also changed accordingly.

Note: When the AC line voltage for the unit is changed after receipt of The shipping carton box of your super megohmmeter, check the fuse amperage.

⑬ HV-EN (High Voltage Enable) Interlocking Connector: This connector is provided for connection of an external interlocking switch on the measuring jig designed to block the application of a high voltage across the Rx +/- measuring terminals for safety of the operator when the switch is in the off position.

If such a switch is not provided, keep this connector plugged with the accessory shorting plug, instead.

⑭ OUT/BUZZER Selector Switch: This switch selects the mode of alarm output – to the buzzer or relay contacts when the AL-8000 optional alarm device is installed.

⑮ OUTPUT Connector: This connector is provided when the optional alarm device (AL-8000) or DC output (PR-8000 or PI-8000) is installed. For details, see 7-2 Alarm Device, AL-8000 (Option) or 7-3 DC Output, PR-8000 or PI-8000 (Option).

5. PREPARATION FOR A MEASUREMENT

WARNING

Before connecting the power cord to the AC outlet socket, confirm that the LINE SELECTOR switches on the rear panel are set to the positions, accordingly (See 1.3 Setting the LINE SELETOR Switches.). If the switches are set to wrong positions, a fire or burn may occur.

WARNING

To prevent an accident, connect the ground prong of the power cord plug to the ground post of the AC line system.

CAUTION

For safety, the measuring high voltage is not output unless otherwise the accessory shorting plug is plugged to the HV-EN (High Voltage Enable) connector.

Notes:

1) The shorting plug is plugged to the HV-EN connector when shipping from factory.
2) When plugging the shorting plug, make sure that the power is turned off, otherwise there is an electric shock hazard.

1) Checking and Setting before a Measurement

(1) Meter Needle Alignment

Check that the meter needle is aligned with the ∞ mark on the right most of the meter scale. If not, align it by using the meter needle adjusting screw

2) Initial Setting of the Switches

(2) Set the DISCHARGE/CHARGE/MEASURE function selector to the DISCHARGE position.

(3) Set the RANGE selector switch to the×1 (minimum factor) position.

(4) Set the VOLTAGE selector switch to the lowest voltage available.

3) AC Power Line Connection

(5) Confirm that the LINE SELECTOR switches are set to the positions in accordance with the local AC line voltage. If necessary, refer to 1.3 Setting the LINE SELECTOR Switches.

(6) Confirm that the POWER switch is set to OFF (released position).
Note: If the switch is in the pushed position, it is set to ON.

(7) Connect the accessory power cord to the AC LINE receptacle of the unit. Plug the other end of the cord to the AC line outlet. If the outlet is of 2-prong type, use the 3-prong adapter, and connect the green ground tag to the ground.

4) Connecting the Measuring Rods

(8) Connect the accessory red measuring rod to the '-' measuring terminal, and the black one to the '+' terminal, respectively.

5) Turning Power On and Warm-up

(9) Confirm that the end of each measuring rod is in contact with nothing.

(10) Turn the unit on by pushing the POWER switch. The green indicator incorporated in the switch lights to show that the unit is being powered. Allow the unit to warm for a minimum of 30 minutes to obtain the specified performance.

6) Calibrating the Super Megohmmeter

(11) Confirm that the indicating meter of the unit indicates the ∞ mark.

(12) Set the function selector to the CHARGE position.

(13) Set the RANGE selector to the CAL position, and read the position of the indicating needle. The calibration is successfully done when the needle stays within the range from 4.95 to 5.05 of the 1000 V scale.

(14) Set the function selector to the DISCHARGE position.

7) Check the Measuring Rods

(15) Set the function selector to the DISCHARGE position.

(16) Connect the measuring rods each other. Do not place the measuring rods anywhere.

(17) Set the function selector to the MEASURE position.

(18) Confirm that the meter needle is shown less than minimum value.

(19) Set the function selector to the DISCHARGE position.

(20) Separate the measuring rods.

8) Setting the Measuring Voltage

(21) Set the VOLTAGE selector switch to the position in accordance with your measurement program.

(22) If there is no idea about the measuring voltage to use, set the VOLTAGE selector to the lowest voltage available (10 V) to try the first measurement, then, increase the voltage in response with the result of the measurement.

9) Setting the Measuring Range

(23) Set the RANGE selector to the position in response to the set position of the VOLTAGE selector.

(24) If there is no idea about the insulation resistance range to use, set the RANGE selector to the lowest range available (×1) to try the first measurement, then, widen the range in response with the result of the measurement.

DANGER

When the MEASURE/CHARGE/DISCHARGE function selector is to the CHARGE or MEASURE position, never touch the Rx '-'/'+' measuring terminals nor the sample in connection. This is because the voltage set with the VOLTAGE selector is directly applied to the above-mentioned sites.

An inadvertent touch of any of the mentioned sites will give an electrical shock to the operator.

6. MEASUREMENT

6.1 Measuring Method

This describes a few measuring methods using the accessory measuring rods.

WARNING

The tip of the black measuring rod (to be connected to the Rx '+' measuring terminal) should be connected to the ground of the sample to be measured if one end of the sample is connected to the ground, or should be connected to the exposed external partof the sample if either end of the sample is not grounded. As the redmeasuring rod (to be connected to the Rx '-' measuring terminal) carries the measuring voltage, do not touch the part connected with the red measuring rod.

CAUTION

A sample with a large capacitance keeps an electric charge evenafter the measurement, and if you touch it you will have an electricshock. To avoid such a hazard, set the MEASURE/CHARGE/DISCHARGE function selector to the DISCHARGE position, and touch the measuring rod to the part of the sample to discharge the charge. For detailed discharge function, see 6.2 Using the MEASURE/ CHARGE/DISCHARGE Function Selector.

Notes:

1) When the red measuring rod (connected to the Rx '-' terminal) is connected to the ground end of the grounded sample, themeasurement can not be performed because of a shortedmeasuring voltage.
2) The black measuring rod (connected to the Rx '+' terminal) is connected to the chassis (ground) of the SM-8216 unit.
   This design makes it possible, when measuring the insulation resistance of a shielded wire sample between its conductor and shielding braid where one end of the sample (shielding braid, in this case) covers the other end (conductor), to connect the black measuring rod to the outside end (shielding braid). This arrange ment has two advantages; 1) minimizing the opportunity for the operator to receive an electric shock, and 2) reducing the external noise by shielding effect.

1) Measurement Using the Measuring Voltage Output without Interruption

This is a basic and practical measuring method.

Note: With this measuring method, the red measuring rod tip carries the measuring voltage without interruption. This can cause an electrical shock if the operator handles the measuring rods without care.

(1) Set the RANGE and VOLTAGE selectors according to your measurement program. Set the MEASURE/CHARGE/DISCHARGE function selector to theMEASURE position. In this status, the meter outputs the selected measuring voltage, making a measurement possible.

(2) Measure the sample by touching the tips of the measuring rods to the part to be measured.

(3) If necessary, change the RANGE selector setting to optimize the reading on the indicating meter.

(4) When the measurement is completed, set the function selector to the DISCHARGE position. Again, touch the measuring rod to the measured part of the sample to discharge the charge , and disarm the sample.

2) Measurement Using the Charge Function

This is a convenient method to measure a number of similar samples without changing the RANGE selector setting.

(1) Set the RANGE and VOLTAGE selectors according to your measurement program. Set the MEASURE/CHARGE/DISCHARGE function selector to the DIS- CHARGE position. Connect the measuring rods to the sample.

(2) Set the function selector to the CHARGE position to apply the measuring voltage to the sample. The sample will be charged across an internal impedance of approx. 30 kΩ.

(3) When the charge is completed, set the selector to the MEASURE position.

(4) After completion of the measurement, set the function selector to the DISCHARGE position to discharge and disarm the sample.

3) Measurement by changing the RANGE Selector Position

This is a modification of the method described in 2) Measurement Using the Charge Function to accelerate the stability of the resultant reading.

(1) Set the VOLTAGE selector according to your measurement program. Set the MEASUE/CHRAGE/DISCHARGE function selector to the DISCHARGE position. Connect the measuring rods to the sample. Set the RANGE selector to the ×1 or ×10 position. Set the function selector to the MEASURE position to start the measurement.

(2) When the meter needle raises and as it will approach the ∞ mark on the right most of the meter scale, turn the RANGE selector clockwise to optimize the reading on the meter scale.

(4) After completion of the measurement, set the function selector to the DISCHARGE position to discharge and disarm the sample.

Notes:

1) Use utmost care to read the indicated value on the meter because the the indicating meter of the instrument has a multi-scale. The full scale values are shown at the left most of the scales.

2) In insulation resistance measurement, it takes time for the measured value to stabilize due to the effect of static capacitance and dielectric absorption phenomena. To secure the reproducibility of the measured value, it is widely employed to set the measuring voltage charging timeconstant. Most widely used measuring voltage charging times are 1-minute rating and 3-minute rating.

6.2 Usage of the MEASURE/CHARGE/DISCHARGE Function Selector

The MEASSURE/CHARGE/DISCHARGE function selector selects one of three different functions as shown below.

1) DISCHARGE Function – lower position

This function is intended to discharge the change on the sample connected to the Rx '-'/'+' measuring terminals by inserting an internal resistance of approx. 100 kΩ across the terminals. Discharging is performed with most samples within a period of several seconds which is determined by the time constant composed of a static capacitance of the sample to be measured and the resistance of 100 kΩ to be inserted across the terminals. When no measurement, keep the selector set at the DISCHARGE position.

Note: The DISCHARGE function is operative only when the instrument is being powered.

When the unit is turned off, the charge of sample connected to the Rx '-'/'+' measuring terminals cannot be discharged by setting the function selector to the DISCHARGE position.

CAUTION

Before turning on the unit, be sure to set the MEASURE/CHARGE/ DISCHARGE function selector to the DISCHARGE position. If the function selector is set to the CHARGE or MEASURE position, a high voltage may be generated across the Rx '-'/'+' measuring terminals, making them live and dangerous.

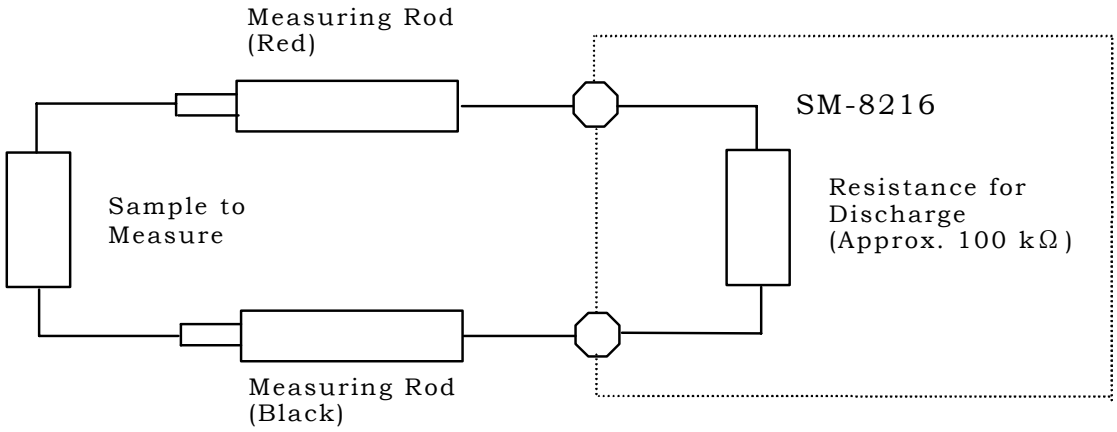


Fig. 6.2.1 Equivalent Circuit of the DISCHARGE Status

2) CHARGE Function – mid position

This function is used to output the measuring voltage to the Rx '-'/'+' measuring terminals not through the measuring circuit, but through a resistance of approx. 30 kΩ. This function is conveniently used with samples of a large capacitance to minimize the stabilizing time of the measured value by precharging the sample enough with this setting, followed by setting the function selector to the MEASURE position.

3) MEASURE – upper position

This function performs the measurement.

The measuring voltage is output to the Rx '-'/'+' measuring terminals and the current measuring circuit is connected to the terminals, and measured insulation resistance value is indicated on the analog meter.

CAUTION

When the function selector is set to the CHARGE or MEASURE position, a high measuring voltage is applied to the Rx '-'/'+' measuring terminals and an indicator in the Rx '-' terminal lights to call attention.

When the indicator is on, use utmost care to avoid an electric shock.

6.3 Interlocking Function – Using the HV-EN Connector

The super megohmmeter generates a high voltage to be used as a measuringpower source. It is dangerous if this measuring voltage is output to the sample or measuring jig not ready for measurement, yet. To protect the operator from a hazard of electrical shock, the HV-EN (high voltage enable)connector is provided on the rear of the unit to provide an interlocking function in combination with a measuring jig.

If a measurement does not need a jig with an interlocking mechanism, keep the HV-EN connector plugged with the accessory shorting plug.

Usage of the HV-EN Connector for Interlocking

Connect the HV-EN connector to a switch to be actuated by the interlocking mechanism of a measuring jig via an optionally available HV-EN plug connected with a cord. Fig. 6.3.1 shows an example interlocking circuit.

The optional accessories shown below have a safety interlocking switch.

SME-8310 – Electrode for plate samples

SME-8311 – Electrode for plate samples

SME-8350 – Shield box

Connect the plug at the end of the measuring cord of the optional accessory to the HV-EN connector on the rear of the unit.

For connection of a customer designed measuring jig to the HV-EN connector, use an optional HV-EN plug.

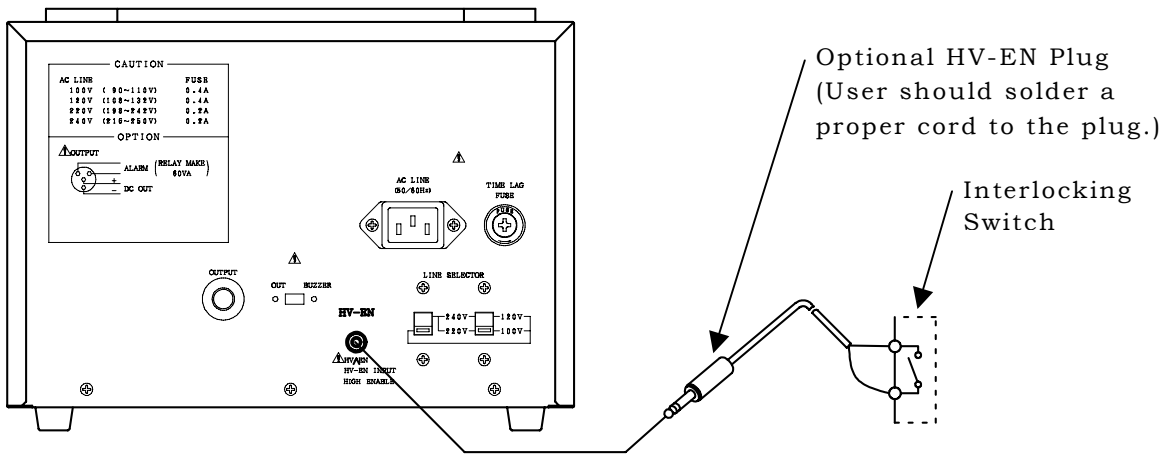


Fig. 6.3.1 HV-EN Plug Application

6.4 Calibration Function

This function is intended to check the accuracy of the measuring voltage and the integrity of the current measuring circuit.

To perform the calibration, take the following procedures.

Set the MEASURE/CHARGE/DISCHARGE function selector to the CHARGE or MEASURE position. Set the RANGE selector to the CAL position.

If the meter needle deflects towards the right within the range from 4.95 to 5.05 of the 1000 V scale, the calibration is successfully done.

If the meter needle deflection is out of the said range, the internal adjustments need readjustment or a failure of the unit is suspected. Contact your local HIOKI Electronics distributor for technical advice.

6.5 Changes in the Current Flowing through an Insulator

In insulation resistance measurements, a large amount of current flows Upon the application of the measuring voltage to the insulator. The current gradually reduces its value with time, but it takes a time until the value becomes stable and fixed. This phenomena is due to the combination of the charging current, absorption current, and leakage current, and it is generally called dielectric absorption phenomena. The equivalent circuit of an insulator is considered as shown in Fig. 6.5.1.

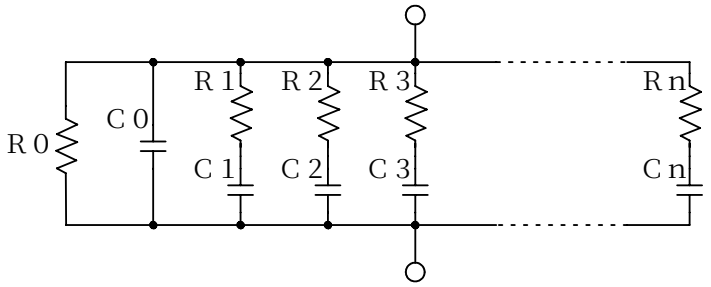


Fig. 6.5.1 Equivalent Circuit of an Insulator

When a voltage is applied to the circuit, a charging current flows through a bank of capacitors, C_0, C_1, C_2, ... C_n. Firstly, C_0 is charged, and other capacitors follow. As the charging progresses the current through R_0 constantly flows as shown in Fig. 6.5.2.

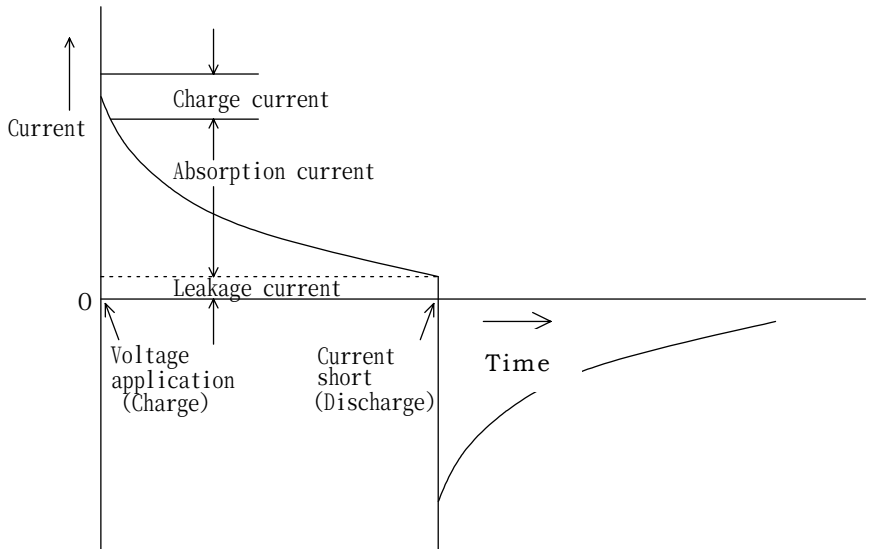


Fig. 6.5.2 Current Flowing through an Insulation Material

R_0 is an insulation resistance to be measured, but, C_0, C_1, C_2, ... C_n Have series resistors R_0, R_1, R_2, ... R_n. Therefore, a measurement of R_0 only is very difficult. It is said that, with some insulation resistance

measurements, it takes several hours to a few days for the leakage current to stabilize. This is not practical.

To avoid this problem, a method is customarily used in the insulation resistance measurement for convenience to read the resistance value one minute after charging the test voltage to the sample. This value is called 1-minute rate value for the resistance value of an insulator, and is widely employed among a variety of electrical standards.

In the 1-minute rate insulation resistance measurement, the measured values may vary when a measurement is repeated once or twice with the same sample. To minimize such a deviation, it is important to completely discharge the sample before the start of each measurement. The required discharge time mainly depends upon the charging voltage and the size of C_0 in Fig. 6.7.1, but, generally it can be said to be 5 to 6 times longer than the time of test voltage charging.

7. OPTIONAL ACCESSORIES

With the SM-8216, SM-8200 Series and SM-8000 Series super megohmmeters, any of the following options can be provided as needed. However, note that some of them can be installed at factory, only.

7.1 DC Signal Outputs

Either one of two different types of DC signal outputs can be optionally installed with the unit at factory. The output can be used to make a permanent record of measured data by connecting a chart recorder such as the HIOKI EPR-3000 Series.

One of the outputs provides a linear DC signal directly proportional to the measured resistance (RP-8000), and the other outputs a 1/R DC signal which is inversely proportional to the measured resistance (RI-8000).

7.1.1 DC Output, RP-8000 – Directly proportional or linear to resistance

An insulation resistance can be obtained when the measuring voltage is divided by the current flowing through the circuit. When the measuring voltage is constant, if the insulation resistance is doubled, the current flowing through the circuit is halved. The RP-8000 DC output is designed to convert the measured insulation resistance into a DC signal directly proportional to the resistance.

1) Specifications

Output Range: : From minimum value of each range of super megohmmeter to 10 times minimum value(see 2.1)

Output Voltage: 1V/minimum value , 10 V/10 times minimum value

Output Accuracy: Within 10% of displayed value in the range from minimum value to 10 times minimum value

2) Usage

Measure the insulation resistance of a sample with the method designed in 6.1 Measuring Method. There is no limitation in the applications in relation with the provision of the RP-8000 DC output. Fig. 7.3.1 illustrates an example connection with the HIOKI EPR-3000 Series chart recorder.

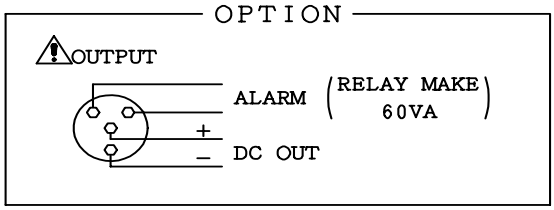


Fig. 7.1.1

Fig. 7.1.1 shows the pin arrangement label for the DC OUT (OPTION) connector on the rear of the unit.
A DC measuring instrument whose input impedance is greater than 1MΩ like a HIOKI chart recorder can be connected to the connector. For permanent data recording, a HIOKI chart recorder is recommended for better technical follow-up, including a supply of a variety of recording charts and technical service.

3) Output voltage

These tables show the relations between displayed value of SM-8216 super megohmmeter and output voltage of RP-8000.

Target voltage 10V

Displayed value	0.05 →	0.25 →	0.5
Output voltage	1V →	5V →	10V

Target voltage 25V

Displayed value	0.125 →	0.625 →	1.25
Output voltage	1V →	5V →	10V

Target voltage 50V

Displayed value	0.25 →	1.25 →	2.5
Output voltage	1V →	5V →	10V

Target voltage 100V

Displayed value	0.5 →	2.5 →	5
Output voltage	1V →	5V →	10V

Target voltage 250V

Displayed value	1.25 →	6.25 →	12.5
Output voltage	1V →	5V →	10V

Target voltage 500V

Displayed value	2.5	→	12.5	→	25
Output voltage	1V	→	5V	→	10V

Target voltage 1000V

Displayed value	5	→	25	→	50
Output voltage	1V	→	5V	→	10V

Example

・SM-8216

Target voltage : 500V

RANGE : $\times 10^4$

Measurement range : 2.5×10^4 MΩ to 100×10^4 MΩ

・Output voltage of RP-8000

Output range : 2.5×10^4 MΩ to 25×10^4 MΩ

Output voltage : 1V/2.5×10^4 MΩ , 10V/25×10^4 MΩ

7.1.2 DC Output, RI-8000 – Inversely proportional or 1/R to resistance

In insulation resistance, as described in 7.1.1 DC Output, RP-8000, if the measuring voltage is constant, the current flowing through the sample is halved, and the output voltage is also halved when the insulation resistance -- R -- is doubled. This relation can be expressed as "1/R."
The RI-8000 provides this type of DC signal output.

1) Specifications

Output Range: Full range of the measuring range of the SM-8216 super megohmmeter

Output Voltage: 10V/minimum value of each range of super megohmmeter , 1 V/10 times minimum value

Output Accuracy: Within 10% of displayed value in the range from minimum value to 10 times minimum value

2) Usage

Measure the insulation resistance of a sample with the method designed in 6.1 Measuring Method. There is no limitation in the applications in relation with the provision of the RI-8000 DC output.
Fig. 7.1.1 on the previous page shows the DC OUT (OPTION) connector on the rear of the unit.
A DC measuring instrument like a HIOKI chart recorder whose input impedance is greater than 1 MΩ can be connected to these terminals.
For permanent data recording, a HIOKI chart recorder is recommended for better technical follow-up, including a supply of a variety of recording charts and technical service.

2) output voltage

These tables show the relations between displayed value of SM-8216 super megohmmeter and output voltage of RI-8000.

Target voltage 10V

Displayed value	0.05	→	0.1	→	0.5
Output voltage	10V	→	5V	→	1V

Target voltage 25V

Displayed value	0.125	→	0.25	→	1.25
Output voltage	10V	→	5V	→	1V

Target voltage 50V

Displayed value	0.25	→	0.5	→	2.5
Output voltage	10V	→	5V	→	1V

Target voltage 100V

Displayed value	0.5	→	1	→	5
Output voltage	10V	→	5V	→	1V

Target voltage 250V

Displayed value	1.25	→	2.5	→	12.5
Output voltage	10V	→	5V	→	1V

Target voltage 500V

Displayed value	2.5	→	5	→	25
Output voltage	10V	→	5V	→	1V

Target voltage 1000V

Displayed value	5	→	10	→	50
Output voltage	10V	→	5V	→	1V

Example

・SM-8216

Target voltage : 100V

RANGE : $\times 10^2$

Measurement range : 0.5×10^2 MΩ to 20×10^2 MΩ

・Output voltage of RI-8000

Output range : 0.5×10^2 MΩ to 5×10^2 MΩ

Output voltage : 10V/0.5×10^2 MΩ , 1V/5×10^2 MΩ

8. MAINTENANCE AND MISCELANEOUS

Periodical maintenance, including checking and calibration is required for the SM-8216 super megohmmeter to perform reliable measurements and prevent a trouble and accident.

If necessary, ask your local HIOKI Electronics distributor to do such a Service as periodical checking, calibration and routine maintenance

8.1 Periodical Checking

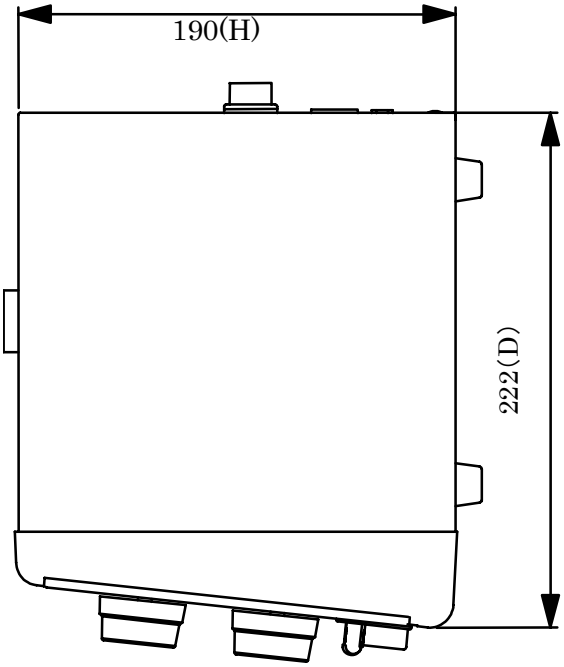
To keep your instrument its at best condition, the following checking is required at monthly periods.

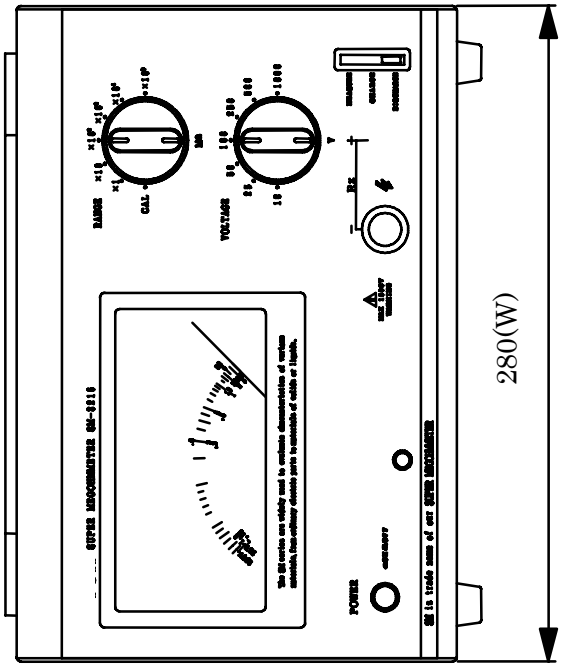
1) Check the Rx measuring terminals and input/output terminal block for integrity.
   As the Rx measuring terminals carry a high voltage (100 V to 1000 V, maximum, depending upon the set-up, visually check the terminals for any crack, loose connection, etc.
   Cracked terminal and loose connection will lead a trouble and accident.
2) Clean the panels, Rx measuring terminals, and input/output terminal board with soft cloth.
3) Visually check the LCD display for brightness and clearness.
4) Check the action of the switches and pushbutton switches for smooth and trouble-free operation.
5) Measure the measuring voltage across the Rx -/+ measuring terminals With a voltmeter. The voltage should be within ±3% of the selected value.

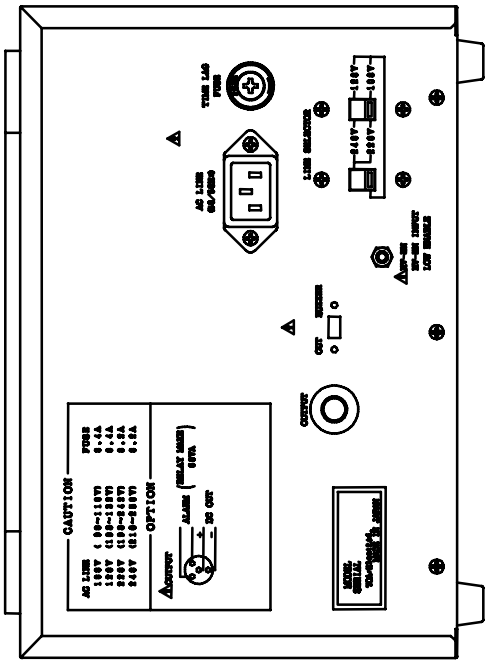
8.2 Storage, Transportation and Abandon

1) Storage
   When the SM-8216 unit is shutdown for a long period of time, unplug the power cord from the AC line outlet, put a dust cover over it, and store the unit in a place meeting the following conditions.
   (1) Free of corrosive gas, dust and vibration
   (2) Environment temperature of -5 to 45℃,
   80% RH or less(non-condensating)
2) Transportation
   When the unit is transported, avoid shock and vibration.
   For long distance transportation, place the unit in a shock absorbing carton box with a HANDLE WITH CARE label to prevent rough handling.
3) Abandon
   To abandon an old unit, observe the rules of your local government.

9. EXTERNAL APPEARANCE







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