HIOKI

INSTRUCTION MANUAL

SME-8300 Series

SME-8301
SURFACE RESISTANCE MEASUREMENT ELECTRODE

SME-8310
PLATE SAMPLE ELECTRODE

SME-8320
WEIGHT ELECTRODE

SME-8322
MERCURY ELECTRODE

SME-8330
LIQUID SAMPLE ELECTRODE

SME-8335
CONTINUOUS LIQUID SAMPLE ELCTRODE

SME-8350
SHIELDING BOX

HIOKI E. E. CORPORATION

Contents

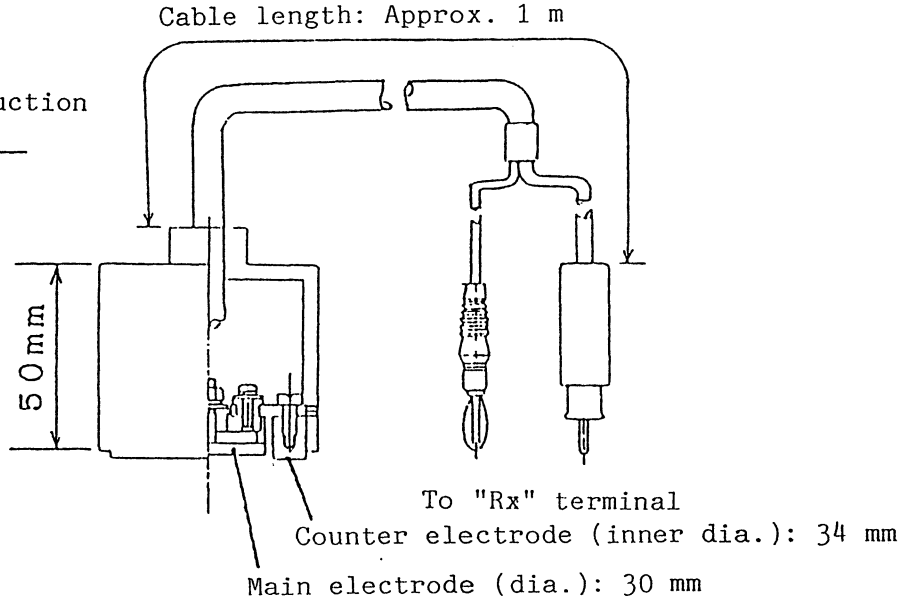
1. SME-8301 Surface Resistance Measurement Electrode

1.1 Outline

This is an electrode which enables simple sample surface resistance measurement with only this electrode pressed onto the sample.

Use this electrode mainly together with "Model SM-8001 Ohm-Meter".

Figure 1 SME-8001 Construction and Dimensions



1.2 Operation

Measurement is ready with only the attached lead connected to the SM-8001 "Rx" terminal.

Then, measurement can be performed if the necessary samples are prepared and the electrode is pressed against a measured section of the respective sample.

1.3 Operational Precautions

If the measured object has an extremely large insulation resistance, its resistance may not be measured due to induction effect, etc. If the resistance value is not definite, make measurement using the "SME-8320" weight electrode or "SME-8322" mercury electrode.

2. SME-8310 Plate Sample Measurement Electrode

2.1 Outline

This is an electrode to measure sample surface resistance and volume resistance with a sample accommodated in the electrode. The main electrode dia. is 50mm and the inner and outer ring electrode dias. are 70mm and 80mm, respectively.

Measurable sample size is up to "100mm × 100mm" and sample thickness is up to "8mm".

2.2 Operation

- To best display the function of this electrode, it is recommended that the "SM-8000 Series" ultra-high insulation resistance meter be used.
- First, confirm that the "Charge/Discharge" switch ⑤ on the SM-8000 Series meter is set to "DISCHARGE", then connect the electrode to the meter.

  For best results, provide "HV-EN" (external control of measuring power supply) when using the "SM-8000 Series".

  When "HV-EN" is provided, the measuring voltage can be controlled by cover open/close.
- Open the cover. It can be opened when the handle is lifted by pressing the white button at center front. Fully open the cover until it is stopped. Load a sample at the center of the electrode and then close the cover. When closing, first hold the handle with the thumb and the index and middle fingers and lower the cover until the male lock metal engages the female lock metal, and then further lower the cover while pressing the white pushbutton with the thumb, remove the thumb from the white push button. Sample size is "100mm × 100mm".
- Turn the "FUNCTION" switch (see Figure 2.) on the right side of this electrode to "Rs" for surface resistance measurement, and to "Rv" for volume resistance measurement. See Figure 3. Turn the same switch to "RESET" during sample replacement.

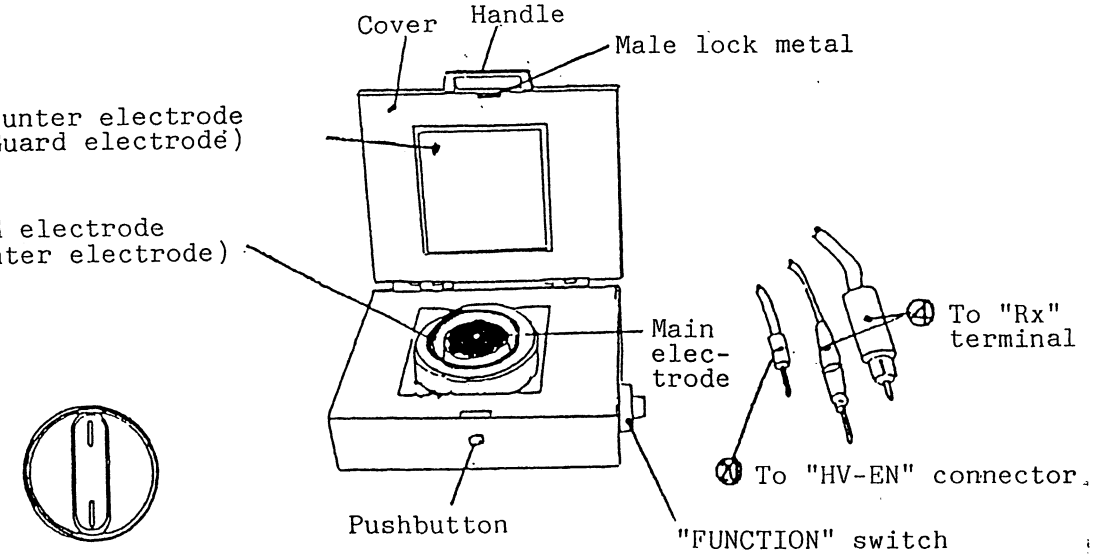


Figure 2 "FUNCTION" Switch

Figure 3 Name of Each SME-8310 Section

. Conduct measurement in accordance with Hioki's SM-8000 Series ultra-high insulation resistance meter instruction manual.
If the cover on the SME-8310 is opened with the "Charge/Discharge" switch ⑤ on the meter turned to "MEASURE", measuring voltage is turned "OFF" to avoid electric shock. However, the indication on the indicator ① may change depending on the SM meter measuring range, because the main electrode is not disconnected even in the "MEASURE" position.

2.3 Handling Precautions

. Full attention must be exercised in electrode handling including sample pre-treatment.
Avoid conducting measurement immediately on a sample stored at a cold location and then brought into the measuring room at ambient temperature.
Also, holding of a sample with the bare hands or storing many samples by stacking may exert an influence on measurement.
Some samples may generate a potential which causes reverse indicator ① deflection.
There is no one rule on how to handle each sample, but it is always best to select the measuring instruments, measuring conditions, measuring methods and measuring environment for comparison of measured data.

The details of consideration are described in the following.

[Pre-Treatment]	Cut a sample to the desired size and remove any surface contamination. Sample thickness measurement and recording of items noticed.
[Sample Storage]	Temperature control, humidity control and storage status.
[Sample Handling]	Specified tweezers are used.
[Measuring Condition]	Measuring voltage and measuring time.
[Measuring Method]	The SME-8310 is used as an electrode.
[Measuring Environment]	Measuring room temperature and humidity.

It is important that these values be recorded along with the measured result (data).

Dimensions (See Figure 4.)

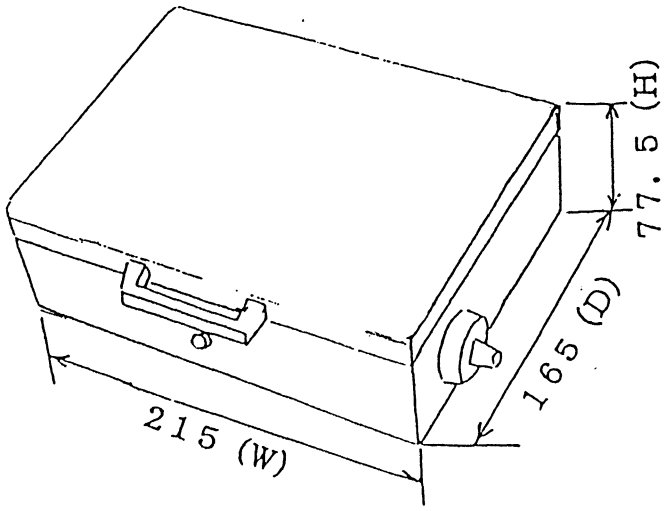


Figure 4 Dimensional Drawing

2.4 Volume Resistivity and Surface Resistivity

Values obtained by multiplying the measured results of volume resistance and surface resistance by cell constant are called volume resistivity (ρ) and surface resistivity (σ).

Main electrode dia. : R1 (cm) For the SME-8310: 5 (cm)
Inner guard electrode dia. : R2 (cm) For the SME-8310: 7 (cm)
Sample thickness : t (cm)
Measured volume resistance : Rv (Ω)

Measured surface resistance: Rs (Ω)

$$\text{Volume resistivity } (\rho) = \frac{\Pi \cdot R1^2}{4t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots (1)$$

$$= \frac{K1^2}{t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots (2)$$

$$\text{Surface resistivity } (\sigma) = \frac{\Pi\ (R1+R2)}{R2-R1} \times Rs\ (\Omega) \quad \ldots\ldots (3)$$

$$= K2 \times Rs\ (\Omega) \quad \ldots\ldots\ldots\ldots (4)$$

In Equations (2) and (4), [K1] and [K2] are called cell constants.

By substituting the actual values for Equations (1) and (3), the SME-8310 cell constant can be obtained.

$$\text{Volume resistivity } (\rho) = \frac{19.6}{t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots (5)$$

$$\text{Surface resistivity } (\sigma) = 18.8 \times Rs\ (\Omega) \quad \ldots\ldots\ldots (6)$$

Equations (5) and (6) are used for the actual measured result.

3. SME-8320 Weight Electrode

3.1 Output

This electrode is calibrated using 3 parts shown in Figures 5 and 7.

Figure 5 shows "Main electrode". Its dia. is 50mm and it weights approx. 500g.

Figure 6 shows "Counter electrode".

Its inner and outer dia. are 70mm and 80mm, respectively for the ring type.

It weights approx. 300g.

Figure 7 shows a jig which concentrically positions the main and counter electrodes.

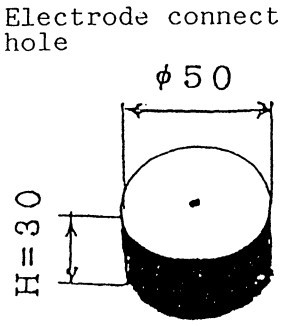


Figure 5 Main Electrode

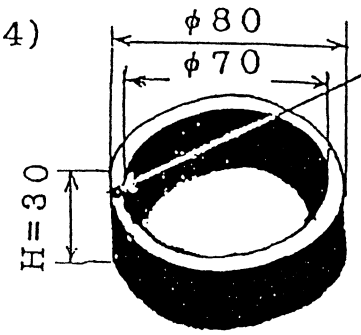


Figure 6 Counter Electrode

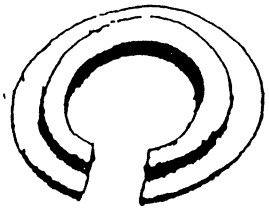


Figure 7 Positioning "Jig"

3.2 Handling

This is a plate sample surface resistance measurement electrode.

First, prepare a measured sample, place the "Main electrode" and "Counter electrode" on that sample and then position the jig on them (see Figure 8.). For electrode connection, "φ 4" holes are drilled. Then, insert the attached banana plugs into these holes and connect them with an ultra-high insulation resistance meter via a measuring cable using clips.

Remove the positioning jig with this measuring cable connected. (See Figure 9.)

Thus, measurement is ready.

Hereafter, apply voltage in accordance with the ultra-high insulation resistance instruction manual.

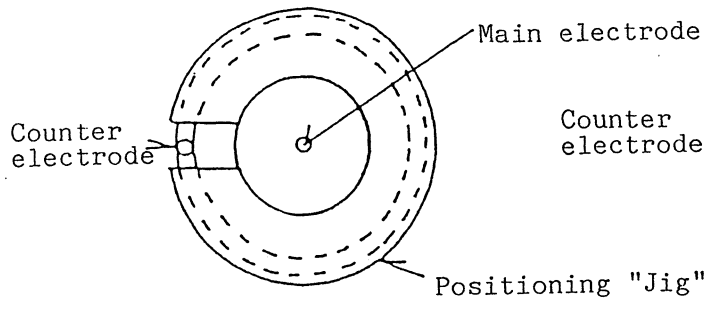


Figure 8 Figure Showing Each Electrode Stacked During Positioning

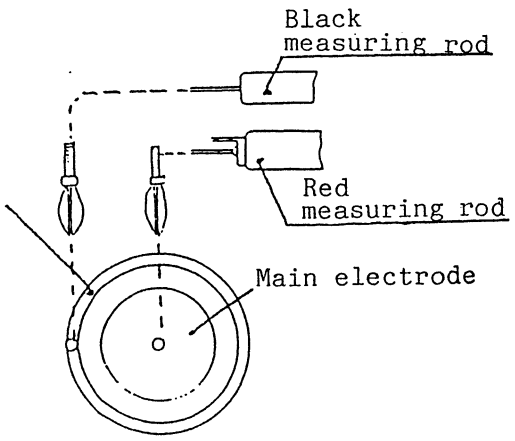


Figure 9 Measuring Cable Connection

For volume resistance measurement, a "Counter electrode" (plate electrode) is required.
The SME-50 shielding box has a built-in plate electrode.
The combination of the SME-8320 and SME-8350 enables not only volume resistance measurement but also stable measurement without external noise. For details, see Item 7.

3.3 Operational Precautions

. When sample insulation resistance exceeds 10^{10} Ω , it is recommended that the SME-8350 shielding box be used along with their electrode. Large insulation resistance may disable stable measurement due to noise and/or hum (induction) from the surroundings.

. It is recommended that the "SM-8000 Series" ultra-high insulation resistance meter be used.
Since the "SM-8000 Series" enables measuring voltage ON/OFF, electric shock during sample connection can be avoided.
Prior to sample connection, turn the Charge/Discharge switch ⑤ to "DISCHARGE".

. The sample surface status exerts an influence on the measured value.
For example, for measurement such as for fiber, surface status recording is important.

. Also see "Item 2.3".

3.4 Volume Resistivity and Surface Resistivity

Volume resistance cannot be measured only by the SME-8320 weight electrode. For volume resistance measurement, the "SME-8350" shielding box is necessary together with the electrode. For details, see "Item 7".

In order to obtain volume resistivity and surface respectively from volume resistance and surface resistance measured by the SME-8320 weight electrode, the respective cell constants are necessary. These cell constants are the same as in "Item 2.4".

Calculate the respective resistivity using Equation (5) or (6).

$$\text{Volume resistivity } (\rho) = \frac{19.6}{t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots (5)$$

$$\text{Surface resistivity } (\sigma) = 18.8 \times Rs\ (\Omega) \quad \ldots\ldots\ldots (6)$$

4. SME-8322 Mercury Electrode

4.1 Outline

This is an electrode for measuring solid plate sample insulation resistance.

This electrode consists of 9 rings with dia. from 20mm to 100mm.

For actual measurement, select 3 rings out of these 9 rings if necessary.

For example, for "JIS C-6481" copper lining layer plate testing, 50mm, 70mm and 80mm are used.

4.2 Handling

The actually required electrode size is in accordance with the measuring method stipulated in "JIS" and various industrial standards.

For example, make a main electrode with a "50mm" ring, and ring electrodes with "70mm and 80mm" rings. (In this case, the guard electrode becomes the counter electrode.)

Figure 10 shows a JIS example.

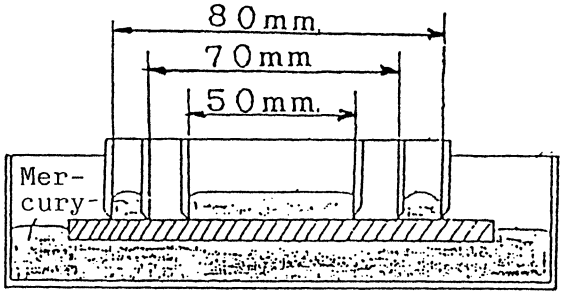


Figure 10 Electrode Configuration Example by Mercury Electrode

First, pour mercury into the attached vessel and place a measured sample on it.

Place the main electrode (50mm) at the center of the sample and rings (70mm and 80mm) on the sample so that these 3 rings are positioned so as to be concentric.

Next, pour mercury into the main electrode and ring electrode. Since it is difficult to pour mercury into the ring electrode, it is better to use a funnel made of thick paper.

Extend the cables from the main, ring and counter electrodes and make their necessary connections.

For cable connection, use the small hole drilled in each ring, then connect a cable to the "M2" threaded lug plate installed in the hole via the cable using a clip.
It is also possible to connect each cable to a copper wire immersed in the mercury.

Hereafter, conduct measurement in accordance with the respective ultra-high insulation resistance meter instruction manual.

Figure 11 shows connection for volume resistance measurement and Figure 12, that for surface resistance measurement.

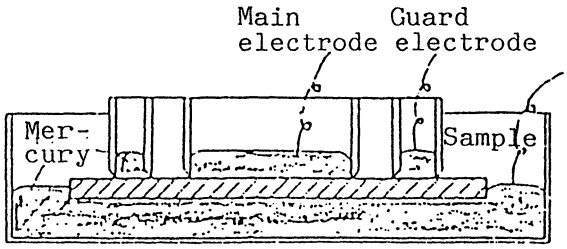


Figure 11 Connection for Volume Resistance Measurement

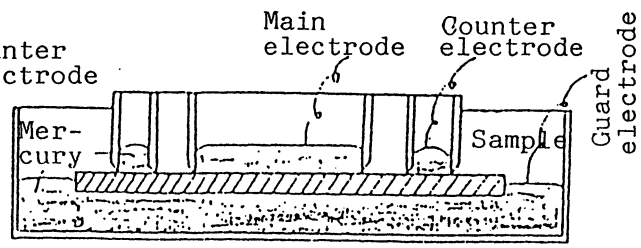


Figure 12 Connection for Surface Resistance Measurement

4.3 Operational Precautions

. A small hole is drilled in the electrode ring used. It becomes simple to connect a cable if a lug terminal is screwed into this (ϕ 3.2mm) hole.

. Approx. 2kg of mercury is used. The mercury is likely to be oxidized by the application of voltage and also will attach to the sample surface.

. When pouring the mercury into the electrodes, never pour the mercury between the main and ring electrodes.

. Mercury Handling Precautions

Exercise care in mercury handling because of its heavy specific gravity and strong surface tension. If it is dropped, it scatters in small balls. For pouring into the

electrode, use a funnel made of thick paper to avoid mercury splashing out due to the narrow electrode space. Voltage application results in progressive mercury oxidization changing its color to black. Blackened mercury needs to be collected in another container to make other processings.

. The cell constant can be calculated by Equations (1) and (2) in "Item 2.4".

$$\text{Volume resistivity } (\rho) = \frac{\Pi \cdot R1^2}{4t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots\ (1)$$

$$= \frac{K1^2}{t} \times Rv\ (\Omega \cdot cm) \quad \ldots\ldots\ (2)$$

$$\text{Surface resistivity } (\sigma) = \frac{\Pi\ (R1+R2)}{R2-R1} \times Rs\ (\Omega \cdot cm) \quad \ldots\ (3)$$

$$= K2 \times Rs\ (\Omega) \quad \ldots\ldots\ldots\ldots\ (4)$$

If the electrodes used are "50mm, 70mm and 80mm", use Equations (5) and (6).

. Cell constant calculation with respect to each electrode combination.

For volume resistance

R1(mm)	20	30	40	50	60	70	80
A(cm^2)	3.14	7.07	12.6	19.6	28.3	38.5	50.2

$$A = \frac{\Pi R1^2}{4t} \quad (cm^2)$$

For surface resistance

R2(mm) / R1(mm)	30	40	50	60	70	80	90
20	15.7	9.42					
30		22.0	12.6	9.42			
40			28.3	15.7	11.5	9.42	
50				34.5	18.8	13.6	11.0
60					40.8	22.0	15.7
70						47.1	25.4
80							53.1

Figure 13 Dimensional Diagram

"Ks" from 20 mm to 100 mm are available and construction is common to all.

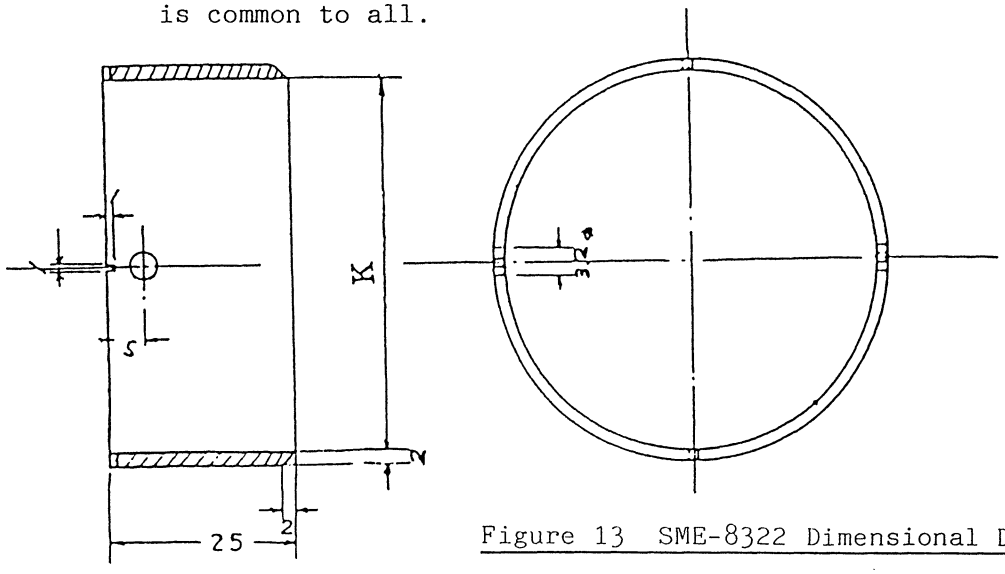


Figure 13 SME-8322 Dimensional Diagram

5. SME-8330 Liquid Sample Electrode

5.1 Outline

This electrode is used for liquid sample insulation resistance (volume resistance) measurement and its construction is in accordance with the attached drawing of JIS C-2320 "Electrical insulation oil". See Figure 14.

This electrode consists of main and counter electrodes and a protection electrode (guard) which removes leakage current through the insulator to sustain the above electrodes.

As insulators, extremely chemically stable and strong insulators (Teflon, KelF, Difron) are used and the electrode surface is nickel-plated in order to increase electrolysis uniformity and chemical strength. Also, the electrode has a construction that facilitates disassembly and assembly for easy washing, enabling a wide range of sample measurement.

Get 25cc sample for its measurement.

When its cell constant is approx. 500cm and Toa's ultra-high insulation resistance meter SM-8210 is used, up to "$10^{19}\Omega \cdot cm$" can be measured.

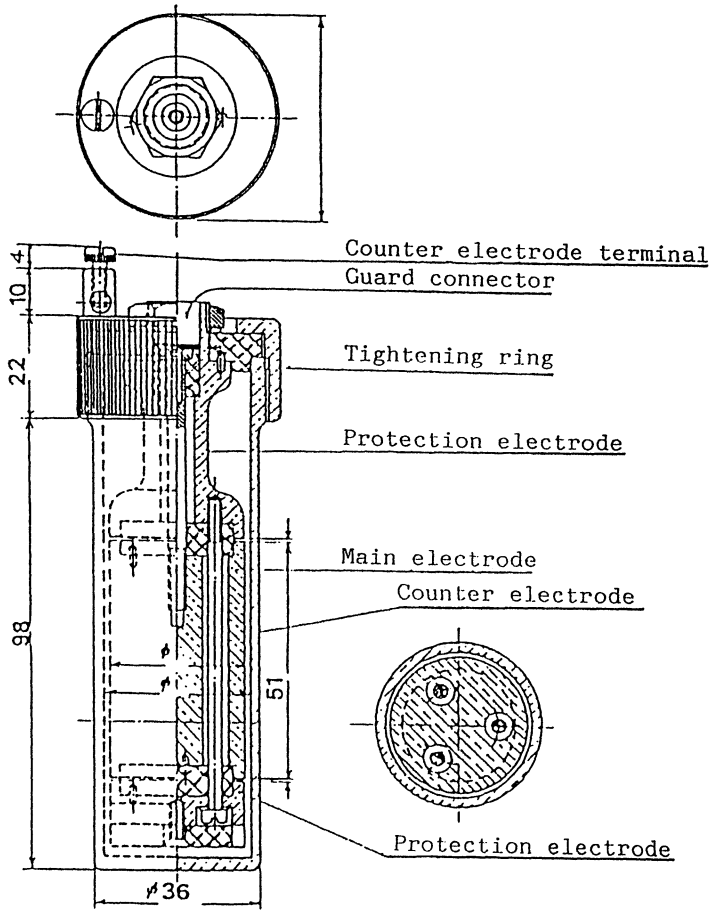


Figure 14 SME-8330 Construction Diagram

5.2 Operation Procedure

First confirm that the electrode is washed clean. Also confirm that a value larger than the insulation resistance of a measured sample is indicated with the insulation resistance measured using an empty electrode. Actually, if the measured resistance value is "10^{13} Ω ", it is necessary that the resistance value measured using an empty electrode be more than "10^{14} Ω ".

If a measured sample insulation resistance is unknown, clean the electrode so that the insulation resistance meter used indicates the maximum value (∞).

1) Remove the electrode tightening ring, then pour a measured sample in the electrode twice or 3 times for electrode washing with the measured sample.
2) Next, pour an approx. 25cc sample into the electrode then firmly tighten the ring.
3) Connect the electrode correctly to the "Rx" terminal on a Toa insulation resistance meter with a connection lead.
   When the SM-8000 series is used, always turn the "Charge/Discharge" switch to "DISCHARGE" prior to electrode connection.
   When the mainframe manufactured before the SME-series is used, voltage is applied simultaneously with the connection.
4) Sample volume resistivity becomes as follows:
   Volume resistivity = Insulation resistance obtained (Rv) × Cell constant (Ω ·cm)

5.3 Operational Precautions

. Electrode contamination exerts an influence directly on measuring accuracy. If the electrode is contaminated, disassemble it for cleaning.

. For disassembly, remove the 3 screws at the bottom of the inner electrode, then fully clean the insulator between the main electrode and the guard electrode. For cleaning, a cleaning solvent depending on the contamination is used but avoid the use of an organic cleaning solvent. After cleaning, fully dry

the insulator, then assemble the electrode to measure insulation resistance of the empty electrode.

- Overly hasty inner electrode insertion for measurement may cause sample overflow.
  If that occurs, immediately wipe the overflow ample off.
- If a measured sample is easily volatilized and/or is easily ignited, explosion and/or fire may result.
- A measured sample of high viscosity may heavily contaminate the electrode and as a result electrode cleaning becomes difficult.
- As electrode materials described in the outline, chemically stable materials are used. Avoid the use of acid, alkali or halogen compound.
- Measured values may vary with measuring voltage, measuring time, sample temperature, etc.
  Therefore, it is necessary to ensure that measuring conditions are always constant. In addition, it is important that measuring and environmental conditions are clearly recorded together with the measured data.
- Maximum electrode operating temperature is 60℃ . Since the whole electrode becomes high temperature, pay attention to burn.
- If a measured sample contains metal particles and sludge, measurement may be disabled.
  Therefore, filtering should be considered if the sample contains solids.

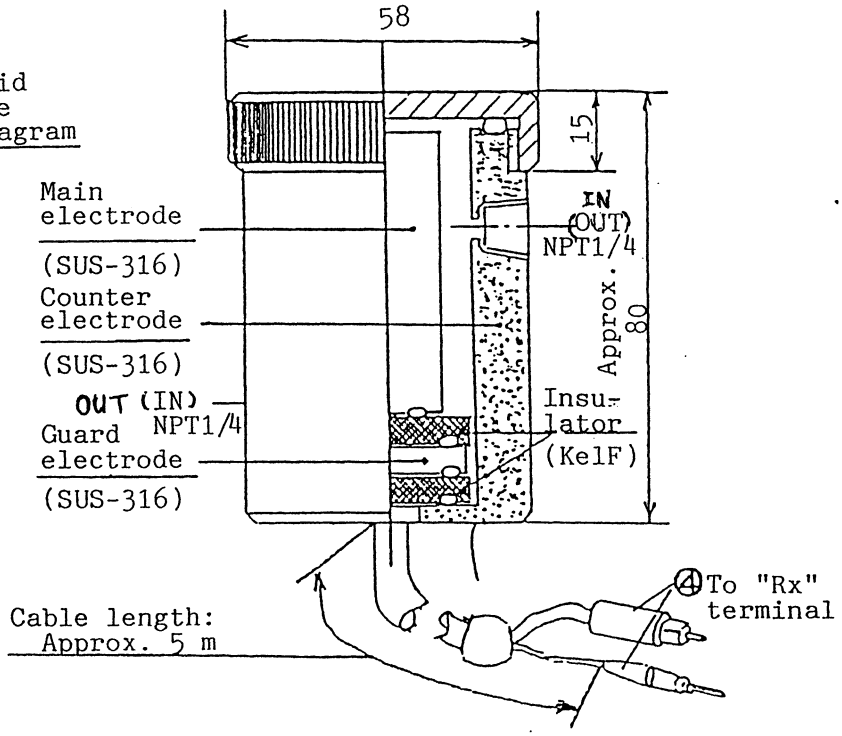
6. SME-8335 Continuous Liquid Sample Electrode

6.1 Outline

This electrode can measure and continuously monitor insulation resistance of a circulating liquid sample or flowing sample. Approx. 30cc of sample remains inside the electrode. The cell constant is approx. 75cm.

Figure 15 shows the construction diagram.

Figure 15 Continuous Liquid Sample Electrode Construction Diagram



6.2 Installation

A pipe can be connected to this electrode using Swagelock "1/4NPT".

Two installation methods are available: one is to directly install the electrode in a process line (Figure 16) and the other is to install the electrode in a branched process line (Figure 17).

If the electrode becomes faulty, the process line must be stopped. Therefore, use of the branching method is recommended.

Also, only use the electrode after firm securing. Use the attached bracket for securing the electrode.

Figure 18 shows the hole dimensions in the bracket.

Figure 16 Direct Installation

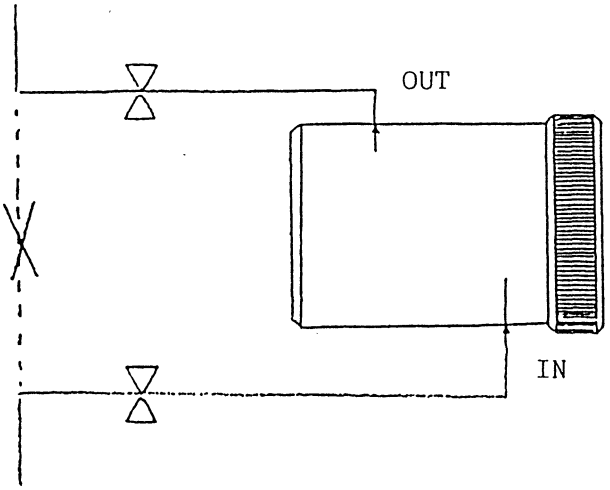
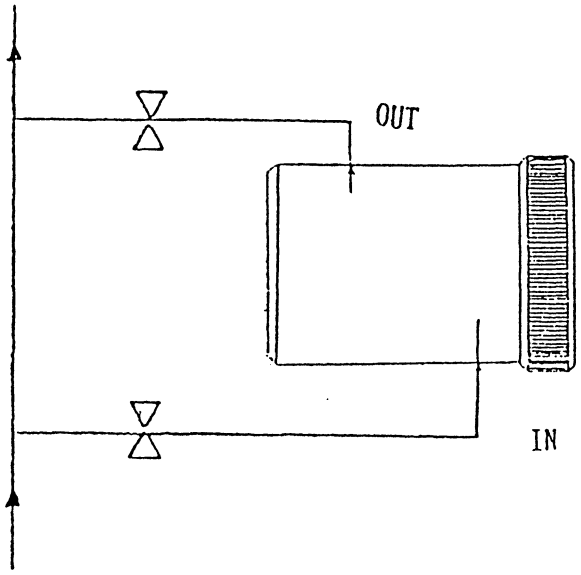


Figure 17 Branching



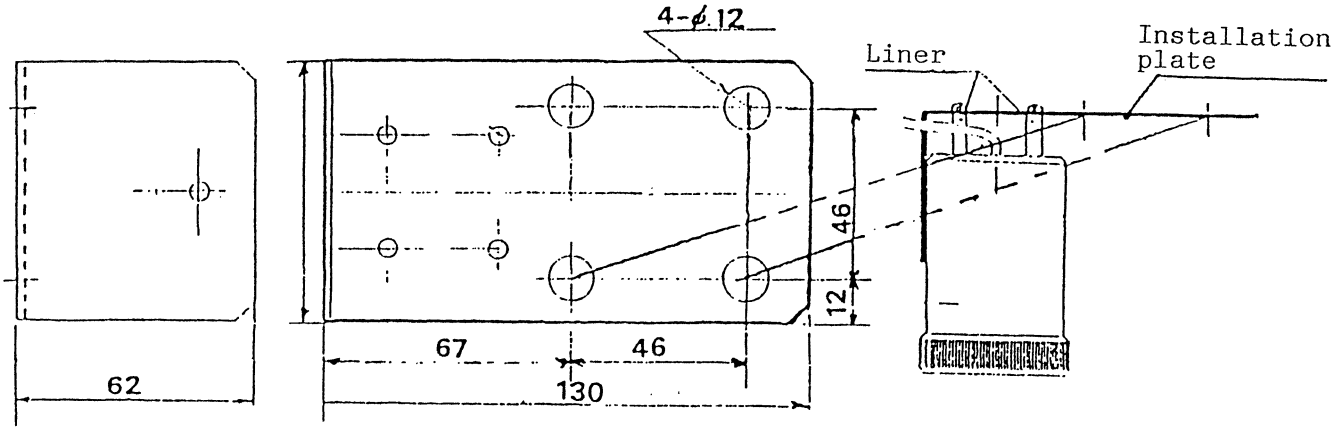


Figure 18 Electrode Installation Plate Hole Dimensions

The electrode needs to be connected to the pipe for liquid as shown in Figures 16 or 17 and cable connected to an ultra-high insulation resistance meter. Just after connection, pass measured sample through the electrode for cleaning.

6.3 Operational Precautions

. This electrode is tested at about 1.5kg/cm² liquid pressure. If it is used beyond the above pressure, some pretesting becomes necessary. Contact HIOKI or your nearest HIOKI agent.
. The maximum liquid temperature at which this electrode is operable is 60℃ . Therefore, do not expose the electrode to a temperature higher than the above temperature.
. For the electrode connection direction, see Figure 16 or 17. Air inside the electrode is easily vented, and even if air bubbles remain inside the electrode, the probability of air contacting the main electrode is reduced.
. This electrode can be connected to any ultra-high insulation resistance meter Series.
However, the meter applies DC voltage to a measured sample (liquid). Therefore, a sample which may be polarized by the application of DC voltage cannot be measured.
. If a measured sample is easily volatilized and/or is easily ignited, explosion and/or fire may result.
. If a measured sample contains metal particles and sludge, measurement may be disabled.
Therefore, filtering should be considered if the sample contains solids.

7. SME-8350 Shielding Box

7.1 Outline

This is used to accommodate a measured sample during insulation resistance measurement of insulators and electronic parts.

Generally, high insulation resistance cannot be measured accurately because of the influence of measuring environments especially such as noise and induction hum. In such measurement, this shielding box displays its power.

7.2 Operation

This shielding box is used to measure insulator surface resistance and volume resistance in combination with the "SME-8322 mercury electrode" or "SME-8320 weight electrode", and also to accommodate directly an electronic part for insulation resistance measurement.

Connect a measured sample between the main electrode (red clip) and the counter electrode (black clip). For guard connection, use a "Blue clip". (See Figure 19.)

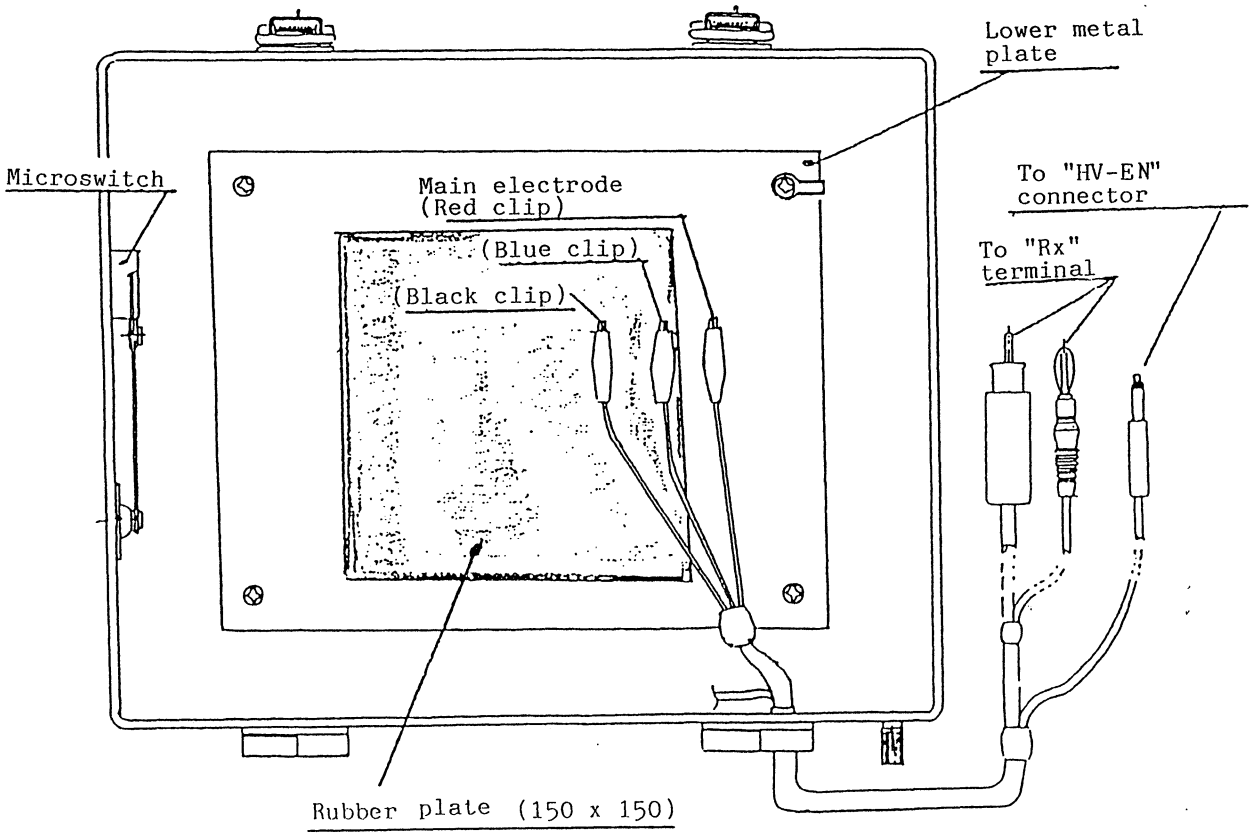


Figure 19 SME-8350 Internal Construction

Table 12 shows the connection methods.

Table 1 Relationship between measurement by SME-8350 and connection

SME-8350 internal clip	General parts	In combination with SME-8320 weight electrode	
		Surface resistance	Volume resistance
Red clip	○ (Main electrode)	Main electrode	Main electrode
Blue clip	(Lower metal plate)	(Lower metal plate)	Guard electrode
Black clip	○ (Counter electrode)	Counter electrode	(Lower metal plate)
Attached rubber sheet	Used	Not used	Not used

Example 1 Power transformer insulation resistance measurement (See Figure 20.).

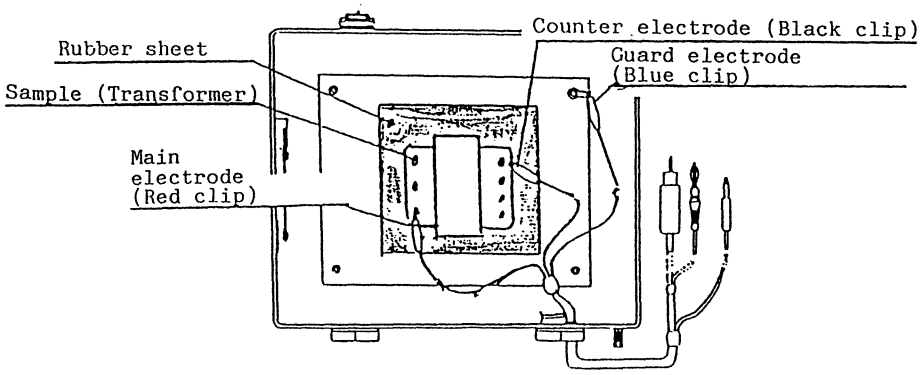


Figure 20 Power Transformer Insulation Resistance Measurement

Example 2 Usage in combination with SME-8320 (See Figures 21 and 22.)

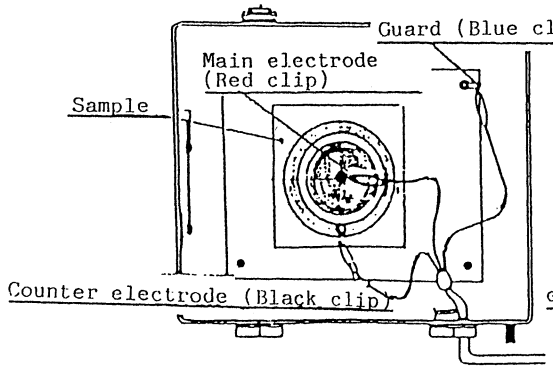


Figure 21 Surface Resistance Measurement by SME-8320

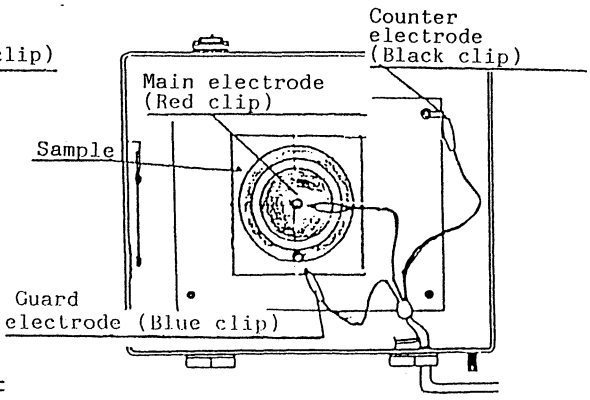


Figure 22 Volume Resistance Measurement by SME-8320

7.3 Operational Precautions

. Generally, for insulation resistance measurement, the metal plate attached to this box is used for "Guard". Use the "Blue clip" for connection. Always place the attached rubber sheet or a resin plate on the metal plate and place a measured. Resistance may vary with the polarity of the part connection This is caused by part characteristics.

. The blue clip attached to this box is used as guard. It it is not used as guard, do not allow it to contact another section. The measuring voltage is generated between the blue and black clips.

. Measured value may change if the red clip contacts the black or blue clip during measurement.

. For surface resistance or volume resistance measurement, also use the "SME-8320 weight electrode" or the "SME-8322 mercury electrode". See Table 1 for connection.
Only for measurement, a measured sample can be connected between the (red and black clips), but for more accurate measurement, the (blue clip) is used as guard. The use of this guard may be troublesome; however, it is best to use this guard for the measurement of more than "× 10^{10} Ω ".

. This can be connected to the "HV-EN".
Attach the "HV-EN" to a HIOKI SM-8000 series ultra-high insulation resistance meter as an option.

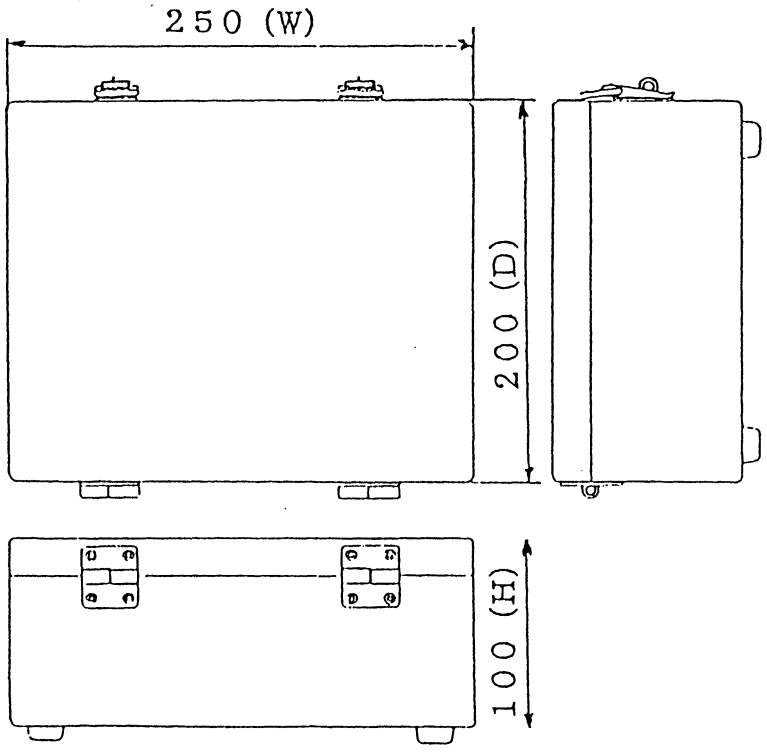


Figure 23 SME-8350 Dimensional Drawing (See Figure 23.)

HIOKI SME-8300 Series
(SME-8301,8310,8320,8322,8330,8335,8350)
Instruction Manual

Publication date: November 2006 Edition 1

Edited and published by HIOKI E.E. CORPORATION
Technical Support Section

All inquiries to International Sales and Marketing Department
81 Koizumi, Ueda, Nagano, 386-1192, Japan
TEL: +81-268-28-0562 / FAX: +81-268-28-0568
E-mail: os-com@hioki.co.jp
URL http://www.hioki.co.jp/

Printed in Japan SM8301A981-00

HIOKI

HIOKI E. E. CORPORATION

HEAD OFFICE
81 Koizumi, Ueda, Nagano 386-1192, Japan
TEL +81-268-28-0562 / FAX +81-268-28-0568
E-mail: os-com@hioki.co.jp / URL http://www.hioki.co.jp/

HIOKI USA CORPORATION
6 Corporate Drive, Cranbury, NJ 08512, USA
TEL +1-609-409-9109 / FAX +1-609-409-9108

SM8301A981-00 06-11H

Printed on recycled paper