HIOKI

INSTRUCTION MANUAL

DSM-8104

DIGITAL SUPER MEGOHMMETER

HIOKI E. E. CORPORATION

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Preface

Thank you for purchasing the DSM-8104 and welcome to the growing family of HIOKI's Digital Super Megohm Meters/Current Meters.
The DSM-8104 is an insulation resistance meter up to 1000V in measuring voltage. Incorrect operation of the meter potentially causes an electric shock or damage to a sample. Please read this manual thoroughly before using the meter and exercise reasonable caution regarding safety. Keep this manual handy for future reference.
The product has been shipped after minute preshipment inspection by HIOKI. Nevertheless, please contact our distributor or sales office near your location in case of a trouble.

I. Product Overview

The Digital Super Megohm Meter DSM-8104 is an insulation resistance meter embedded with a low-noise voltage source and high-sensitivity ammeter.
The meter has been developed to measure insulating materials of a high resistance value, capable of measuring resistance within the range of 1×10^3 to $3 \times 10^{16}\Omega$ and a current within the range of 30fA to 10mA.
The meter is suitable for measuring insulation resistance of insulating materials with a large capacity thanks to the low-noise voltage source embedded in the meter.
A liquid crystal display module (240 x 64 dots) of the meter allows easy viewing of needed information and ease of use.

Principal Features

Measurable voltage range : 0.1 to 1000V

Measurable current range : 30fA to 10mA

Measurable resistance range : 1×10^3 to $3 \times 10^{16}\Omega$

Current limiter setting : 5mA, 10mA, 50mA (0.1 to 250V)

: 5mA, 10mA (251 to 1000V)

Integral time setting function : 2ms to 300ms

Trigger delay setting function : 0 to 9999ms

Automatic averaging measurement function

Voltage check function

Contact check function

Self-calibration function

Comparison decision, volume resistivity, surface resistivity computing functions

Data save and search functions

Histogram display function

Sequence programming function

Interlock function

GP-IB is a standard provision

Handler interface is a standard provision

RS-232 is a standard provision

II. About This Operational Manual

- **Warning, Caution and Notice**

Important safety precautions and operational instructions are described in this manual under the following headings. Strictly follow these precautions and operational instructions.

> **[Warning]**
> Indicates a potentially hazardous situation that could result in an electric shock or equipment burning.
> It is extremely important to strictly follow these instructions to prevent a hazard.

> **[Caution]**
> Indicates a caution that could result in equipment damage.
> Operate the meter exercising reasonable caution.

> **[Notice]**
> Indicates an important item in operation.

III. Organizational Elements of Operational Manual

This operational manual has the following chapters. Please make certain to read the manual carefully before operating the meter.

1. Preparations Before Operation
   This chapter contains important information such as a check to be made during uncrating, operating power supply and measuring cables.

2. Specification
   The electrical specification of this meter is described.

3. Operating Principles
   This chapter contains the operating principles, block diagram and other information.

4. Names and Functions of Components
   This chapter describes the names and functions of keys and characters printed on the front and rear panels.

5. Preparations for Measurement
   This chapter describes the screen of the meter for measurement, settings on the screen, operating method, methods for indicating measured values and other matters.

6. Measurement
   This chapter describes function settings of the meter, connection of measuring terminals, and use of measuring jigs and measuring electrodes.

7. GP-IB Interface
   This chapter describes control by the GP-IB interface.

8. RS-232 Interface
   This chapter describes control by the RS-232 interface.

9. External Interfaces
   This chapter describes the handler interface, external trigger input and interlock input.

10. Maintenance
    This chapter describes checks and calibration to be made for safe and reliable use of this meter.

11. Product Full View
    This chapter contains a full view of the product with dimensions.

IV. Safety Precautions

FOR SAFE USE OF THE METER

- Do the power supply voltage of the meter and commercial power supply voltage to be supplied match? Please check it. Supplying 200V power supply voltage while the power supply voltage of the meter is 100V sometimes causes damage to the meter.
- Be certain to ground the grounding terminal on the rear or the grounding rod of the power cable to the ground.

V. Safety Alert Symbols

	**Warning symbol**	This symbol is marked where the operational manual needs to be referred.
	**Electrical**	This symbol indicates high voltage hazard and is indicated on terminals where high voltage is output such as measuring terminals.
	**Grounding terminal**	Indicated on the grounding terminal “GND” on the rear of the meter. If the grounding pin of the power cable cannot be grounded, be certain to ground this terminal.

VI. Operational Precautions

Please read this manual thoroughly before operating the meter to correctly handle it. Strictly follow all the warning, caution and other messages contained in this manual to prevent accidents and danger.

- Never operate the meter where a combustible gas exists. Otherwise an explosion or a fire may break out.
- Be certain to ground the grounding pin of the power cable to prevent an accident. If the grounding pin of the power cable cannot be grounded, be certain to ground the grounding terminal located on the rear of the meter.
- High voltage up to 1000V is output between the measuring terminals on the panel of this meter. Do not touch areas where a current is impressed during measurement to prevent an electrical shock.
- Do not operate the meter in a dusty place or in a place subjected to vibration, direct sunshine or steam. Otherwise a meter failure may result.
- Supply the power supply voltage specified in the operational manual. Otherwise a fire or meter damage may result.
- Do not remove the cover of the meter.
  Residual voltage sometimes still remains inside the meter after turning the power off and it is dangerous to touch the inside of the meter. Please contact our sales office near your location in case of a repair or internal adjustment.
- A cooling fan of a discharge type is installed inside the meter to prevent temperature rises inside the meter. Poor ventilation of the fan causes meter failures. Provide a space of more than 10cm behind the fan. Do not place anything on the ventilation grills on one side and bottom of the meter.

Contents

1. Preparations Before Operation

1.1 Check during Uncrating

This product has been inspected carefully at the HIOKI factory in preshipment inspection. Nevertheless, check the following items when uncrating the crate.

1) Any damage on the exteriors of the product.
2) Quantities of accessories
   Check in accordance with Table 1.1 List of Accessories.

Table 1.1 List of Accessories

Item	Quantity	Remarks
Power cable	1	Power cable with three poles and grounding pin
3P-2P conversion adapter	1	Changes the 3P plug of the power cable to a 2P plug
Operational manual	1	This manual

If any damage or missing accessory is found, please contact our distributor or sales office near your location.

1.2 Operating Power Supply

This meter is powered by the following power supply.

Power supply voltage	100V ±10%
Change in power supply voltage	Factory option other than 100V (115, 220 or 240V)
Power supply frequency	50/60Hz

[Warning]
Before connecting the power plug, check that the AC power supply voltage to be used matches the voltage specified on the rear panel.
If they do not match, a fire or damage to the meter may result.

[Caution]
Use a 3-conductor power cable conforming to the power supply voltage. A 100V power cable is supplied with the meter as an accessory. Do not use this accessory cable with other electric equipment.

1.3 Grounding

Be certain to ground the grounding terminal located on the rear of the meter or the grounding pin of the power cable to prevent an accident such as an electrical shock.
The round pin of the 3P plug attached to the power cable is the grounding pin. Plug the cable to a plug socket that has a grounding device.
When using the 3P-2P-conversion adapter, be certain to ground the grounding lead wire from the adapter or the grounding terminal located on the rear of the meter.

[Warning]
Be certain to ground the grounding pin of the power cable to prevent an accident.
If the grounding pin of the power cable cannot be grounded, be certain to ground the grounding terminal located on the rear of the meter.

1.4 Measuring Cable

1) Low-noise cable
   This meter measures a current at a high sensitivity and measured values sometimes are not stable due to noise generated by the measuring cable.
   Use low-noise shielded-conductor cable meeting the specification of HIOKI.
2) Limited length of measuring cable
   Depending on the length of the measuring cable, adjustment of the meter is necessary to correct open values in the contact check function.
   The meter was adjusted for use of the measuring cable in the length of 1m during preshipment inspection of the meter by HIOKI. Please contact our distributor or sales office near your location if other cable length is intended to be used.

1.5 Warming Up Time

Warm up the meter more than 30 minutes before operating the meter to obtain the specified performance.

1.6 Memory Initializing

• Memory initializing
1) Press the [F3] key.
   If the screen is displayed, the key is in the SAVE Function mode. The key can perform its function even if the key is not displayed.
2) Press the [MAN. T] (-) key.
3) Press the [ENTER] key.
   This completes memory initialization.
   The memory can be initialized by this method anytime as long as the meter is shut down. However, memory initialization also automatically clears data saved by the save function.
   Memory initialization will set the values that were set during preshipment inspection at the HIOKI factory shown in Table 7.9 “Settings by Factory Preshipment Inspection and Values Initialized by Message.”

2 Specification

2.1 Measurement Performance

2.1.1 DC current measurement

Current Measurement			
Measuring Range	Maximum Indication	Resolution	Accuracy
10 pA	9.9999 pA	0.1 fA	± (3.0% of rdg + 1.2% of range)
100 pA	99.999 pA	1.0 fA	± (1.5% of rdg + 0.6% of range)
1 nA	999.99 pA	10 fA	± (0.6% of rdg + 0.6% of range)
10 nA	9.9999 nA	100 fA	± (0.4% of rdg + 0.5% of range)
100 nA	99.999 nA	1 pA	± (0.4% of rdg + 0.5% of range)
1 µA	999.99 nA	10 pA	± (0.4% of rdg + 0.5% of range)
10 µA	9.9999 µA	100 pA	± (0.4% of rdg + 0.5% of range)
100 µA	99.999 µA	1 nA	± (0.4% of rdg + 0.5% of range)

1) Measuring time 300ms
2) Temperature range 23 ±5°C, humidity 85% RH or less
3) Mode Self-calibration automatically executed at 1 minute interval
4) Averaging process On

[Remarks]

The resistance measurement accuracy greatly affects the accuracies of voltage impressed and of current measured. The DSM-8104 specifies only the current accuracy as a specification. The resistance accuracy is calculated by the following formula assuming current measurement is a full-scale value. Normally, measured currents are lower than currents on a full scale and “resistance accuracy > current accuracy” is a normal value. Refer to 5.1.5 “Setting measuring range.

$$\left[\begin{array}{c}\text{Resistance accuracy}\\(\text{Resistance on full-scale current})\end{array}\right] = \left[\begin{array}{c}\text{Current accuracy}\\(\text{On full-scale current})\end{array}\right] + \left[\begin{array}{c}\text{Voltage accuracy Accuracy}\end{array}\right]$$

2.1.2 Measuring voltage output

(1) Setting voltage accuracy and resolution

Setting Voltage Range	Resolution	Accuracy
0.1 to 250.0V	100mV	±(0.1%+ 150mV)
251 to 1000V	1 V	±(0.1%+ 400mV)

(2) Current limiter

	Setting Voltage Range	Set Value	Total Current	Current on Measuring Side	Current on Charge Side
Charge ON	0.1 to 250.0V	50mA	±50mA	± 5mA	±45mA
		10mA	±10mA	± 5mA	± 5mA
		5mA	± 5mA	± 5mA	± 0mA
	251 to 1000V	10mA	±10mA	± 5mA	± 5mA
		5mA	± 5mA	± 5mA	± 0mA
Charge OFF	0.1 to 250.0V	50mA	±50mA	±50mA	± 0mA
		10mA	±10mA	±10mA	± 0mA
		5mA	± 5mA	± 5mA	± 0mA
	251 to 1000V	10mA	±10mA	±10mA	± 0mA
		5mA	± 5mA	± 5mA	± 0mA

1) There are power sources for measurement and for charging and currents for these voltage sources are “total current = current on measuring side + current on charge side. The power source on the charge side can be set ON and OFF by a setting.

2) Current setting errors are ±10%.

2.2 Functional Specification

2.2.1 Measuring time

Item	Setting Range
Delay Time	0 ～ 9999 ms
Averaging Cycles	Auto setting
Sampling time setting	2 to 300ms
power period	1 to 15 PLC

2.2.2 Voltage monitoring (Voltage check)

Voltage that is output is measured and is compared with the set voltage. Any deviation from the specified range is indicated by flashing of the side mark.

2.2.3 Contact check function

Connection of a work is checked by measuring the capacity by an RF signal and contact is checked by a difference between contact in an open circuit state.

Item	Remarks
Capacity range allowed for contact detection	Minimum 0.5pF. More than 1/10 of capacity on jig side.
Capacity offset range on jig side	Max. 100pF (0.1pF resolution)

[Notice] This specification is for a measuring cable length of 1m. Readjustment is needed if the length exceeds 1m. This function cannot be used if the measuring cable length exceeds 2m.

2.2.4 Self-calibration function and self-diagnosis function

The self-calibration function and self-diagnosis function are executed by keying the Execute key or by the Execute command from the interface.

Self-calibration can be executed automatically after setting an interval. Self-diagnosis is executed automatically when the power is turned on.

Execution items:

Self-calibration: Current range calibration (can be executed automatically)

Self-diagnosis: Current range calibration, memory check

2.2.5 Comparison measurement and deviation/percent measurement functions

Comparison measurement display: “NG” in decision results is indicated by flashing of the side mark.

An alarm is sounded by a beep tone (GO decision or NO-GO decision).

Deviation/percent measurement display: The unit is indicated by % or in a measuring mode during measurement.

Reference values can be set within whole measuring ranges.

	Description
Comparison method	Upper-limit comparison HI GO: Measured value > upper-limit value Intermediate comparison IN GO: Upper-limit value ≥ measured value ≥ lower-limit value Lower-limit comparison LO GO: Upper-limit value > measured value
Calculation method for Percent Measuring mode	(Measured value - reference value) x 100/reference value
Calculation method for Deviation Measuring mode	Measured value - reference value

2.2.6 Measurement (jig setting and data processing) function

Measurement of surface resistivity and volume resistivity.

Surface resistivity and volume resistivity can be measured directly by setting a constant for a jig (or an electrode).

Set items

Surface resistivity measurement: Outside diameter of inner electrode and inside diameter of outer electrode

Volume resistivity measurement: Outside diameter of inner electrode and thickness of sample

Any electrode constant can be set directly.

2.2.7 Measuring sequence program

Up to ten measuring sequence patterns of discharge, charge, measurement and discharge can be programmed.

	Description
Program sequence	(1) Discharge 1, (2) charge, (3) measurement (4) discharge 2
Settable patterns	10
Set time range	0.0 ~ 999.9s

2.2.8 Storage and display functions of measured data

(1) Measured data buffer

Measured data up to 1000 data groups can be sequentially stored.
Up to 1000 most recent data groups are stored and displayed on the measurement screen.
Note: Stored data is cleared when the power is shut down.

(2) Histogram counter

Measured values are classified into ten types and numbers of data groups are stored by digitally counting them by a counter. Thresholds are set for the individual measuring modes and are indicated on the screen in a bar graph.
Thresholds are set within the measuring range.
Note: Stored data is cleared when the power is shut down.

2.2.9 Operability and display

(1) Keyboard

Rubber key switches
Key clicking tone on or off can be selected
Key lock (prevention of malfunction in the Remote mode) on or off can be selected

(2) Displays

1) Liquid crystal display 240x64dot graphic LCD (30 columns, 8 rows)
Backlight (Yellowish green LEDs)

Character size

	Measured result	4 x 2 size
	Measuring conditions	Full size
	Bar graph display	

2) High-voltage warning display Red LED lit if higher than about 30V

2.2.10 Resume function

When the power supply goes off, the set parameters are automatically stored. When the power is turned on again, the operation is resumed at the set parameters that are automatically stored, except the voltage impression state.

2.2.11 Input and output functions (external control interfaces)

(1) GP-IB interface

All items that are operated on the panel can be GP-IB controlled.
Measured results comprising 5-digit exponential measured values, comparison results and check of measured state are sent in one line of data strings.
Responses in 4-digit fixed decimal points or 5-digit integers are sent to query commands.

(2) Specification of RS-232 interface function

All items that are operated on the panel can be RS-232 controlled.
Measured results comprising 5-digit exponential measured values, comparison results and check of measured state are sent in one line of data strings.
Responses in 4-digit fixed decimal points or 5-digit integers are sent to query commands.

(3) Specification of handler interface function

The interface for measurement by directly operating the meter using the handler used in measurement.

The communication items and electrical specification are as follows.

- Communication items
  Opening and closing of shielding box, key lock of front panel keys, contact start, measurement start, contact check start, contact check result measuring voltage on and off, decision results, analog measurement end measurement computing end, troubles that have occurred.
- Electrical specification
  Contact input and output by a photocoupler
  Connector product No. is 57RE-40360-730B (DDK)

2.3 General Specifications

General Specifications

HIOKI-specification insulation meter input connector	(INPUT)
Black binding post	(GND)
Blue binding post	(GUARD)
Red binding post	(OUTPUT)
Blue binding post	(CHARGE)

Operating environment

Temperature 0 to 40°C, humidity 85% RH or less

Power supply voltage

AC 100V ±10% (standard), 115/220/240V ±10% (factory option)

Power supply frequency

50／60Hz

Power consumption

55VA max.

External dimensions (mm)

332 W x 89 H x 450 D

Weight

6.7kg

2.4 Options

In addition to the standard accessories listed in Table 1.1 List of Accessories, the following products are available as options for dedicated use with this meter for easy and expanded uses of the meter and as options that are common to the meters manufactured by HIOKI.

2.4.1 Special options

The special options for dedicated use with this meter are as follows.

Option	Product Name	Standard
Measuring lead with test rod	0GE00002 0GE00001	Length 1m, red Length 1m, black
Measuring lead with alligator clip	0GA00007 0GA00008	Length 1m, red Length 1m, black
Interlock connection cable	DSM8104F	Length 1m

2.4.2 Common options

The options common to all HIOKI insulation meters are as follows.

Option	Product Name	Remarks
Electrode for planar sample,Ø50 diameter	SME-8310	With changeover switch for surface and volume measurement and interlock*
Electrode for planar sample, Ø 19.6 diameter	SME-8311	Same as above*
Weight electrode	SME-8320	For surface and volume resistances, shielding box used
Shielding box	SME-8350	For shielding dielectric trouble*
Electrode for surface resistance measurement	SME-8301	For anti-electrostatic product
Electrode for surface resistance measurement	SME-8302	Electrode spacing 10mm
Electrode for liquid sample	SME-8330	Capacity about 25ml, electrode constant about 500cm
Chip capacitor electrode	SME-8360	For chip capacitor
Surface/Volume Resistance Measurement Electrode	SM9001	Surface/Volume Resistance measurement for static prevention floor material
Standard Resistor	SR-2	Calibrating standard resistor for super insulator meter

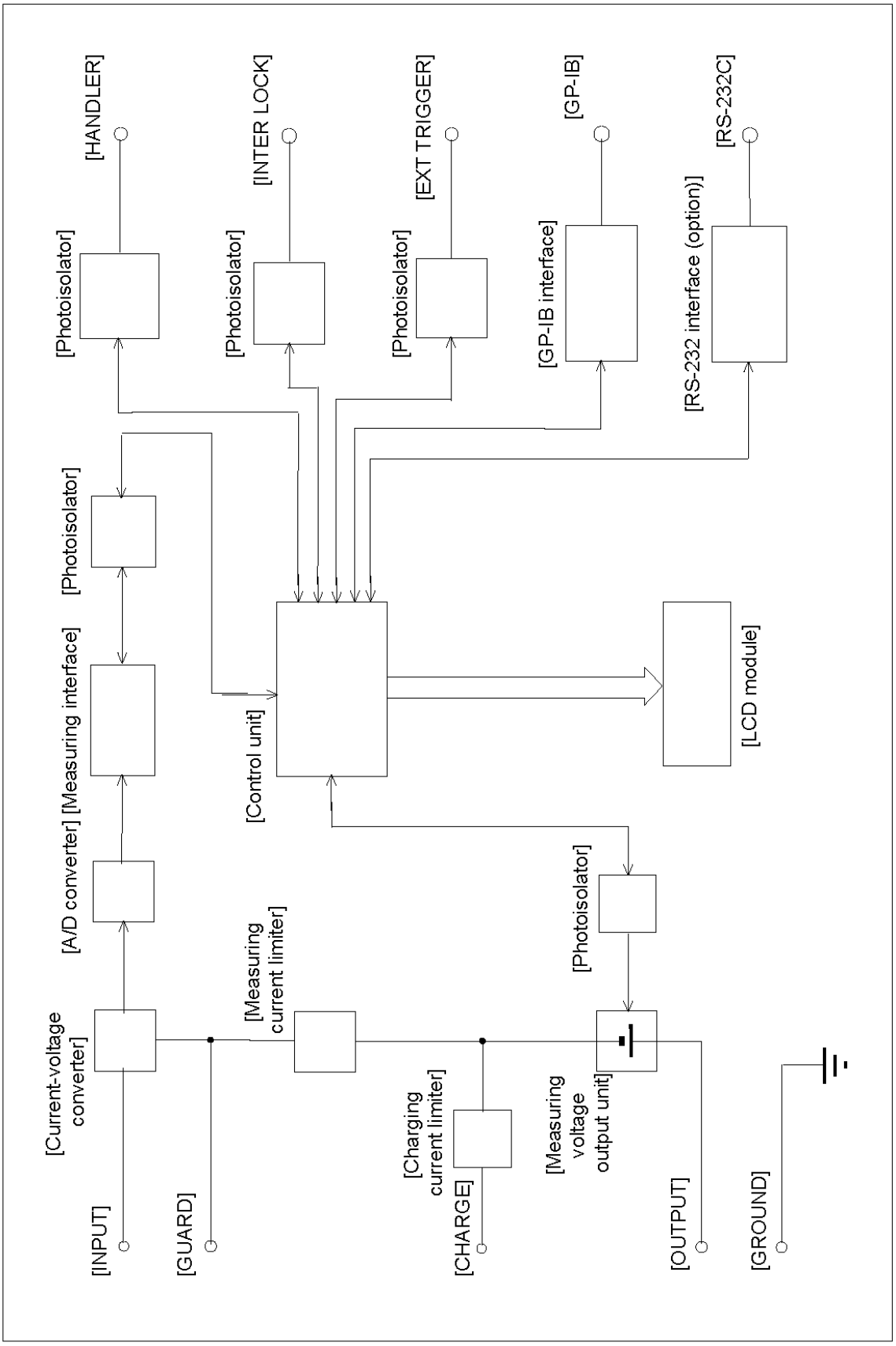
*When connecting this meter to an electrode for planar sample (SME-8310 or SME-8311) or a shielding box (SME-8350), the interlock connecting cable (DSM8104F) is necessary.

3 Operating Principles

3.1 Operating Principles

Equipped with a stable measuring voltage source and high-sensitivity current measuring unit, this meter calculates an insulation resistance value based on measuring voltage impressed to the work and measured current value. The meter also outputs a current value and can be used also as a high-sensitivity ammeter embedded with a voltage source.
The control unit of the meter has a 32bit CPU for calculations of resistance values and for other functions.
Current-voltage conversion of the current measuring unit is based on current-voltage conversion of a charge measuring type that integrates input current. This system features measurement of feeble current with a high accuracy by lengthening the integral time.
The output of the current-voltage converter is converted into digital data by an A/D converter and is fed to the memory in the control unit after being isolated by a photoisolator.
The control unit computes measured data input to the memory and outputs it to the display screen and interfaces.
The measuring voltage source is a variable voltage source capable of outputting 1000V/10mA and 250V/50mA maximum, supplying stable measuring voltage. The measuring voltage source of this meter can set a large maximum output current so that measuring time can be shortened in measuring a sample with a large electrostatic capacity such as a capacitor by shortening the charging time.
This meter has a dedicated voltage output for charging (charging terminal), which can be used to precharge the meter before taking measurement to enhance the measuring throughput.
The measuring voltage output and charge output are separated by a current limiter, enabling continual measurement without affecting measurement even if a sample on the charge terminal side is short-circuited.
An isolated handler interface that can be connected directly to a contact signal, a GP-IB interface conforming to the IEEE-488 standard and an RS-232 interface are available as external interfaces that are supplied as standard provisions.
The measuring terminals can be changed to guard grounding or to measuring power grounding by connecting a short bar on the panel.
The meter can be used as an independent ammeter by measuring a current between the “INPUT” and “GUARD” terminals. In this case, however, measuring voltage is output on start of measurement and a minimum value needs be set as measuring voltage.

3.2 Block Diagram



4 Names and Functions of Components

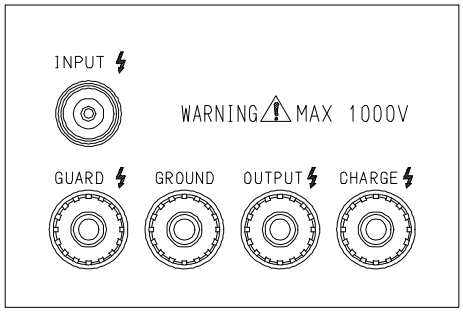
[Notice]
In the following descriptions, characters enclosed by “[ ]” such as [ENTER] are the characters printed on key tops. Characters enclosed by “ ” such as “POWER” are the characters printed on the panels.

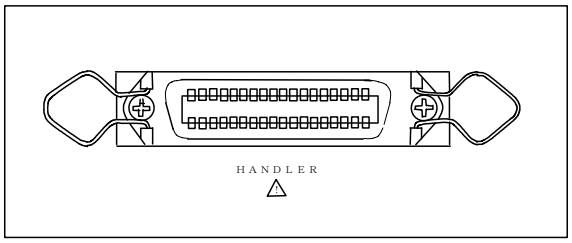
4.1 Safety Alert Symbols

The following safety alert symbols are placed on the front and rear panels of this meter.

	Warning symbol	This symbol is marked where the operational manual needs to be referred to.
	Electrical	This symbol indicates high voltage hazard and is indicated on terminals where high voltage is output such as measuring terminals.
	Grounding terminal	Indicated on the grounding terminal “GND” on the rear of the meter. If the grounding pin of the power cable cannot be grounded, be certain to ground this terminal.

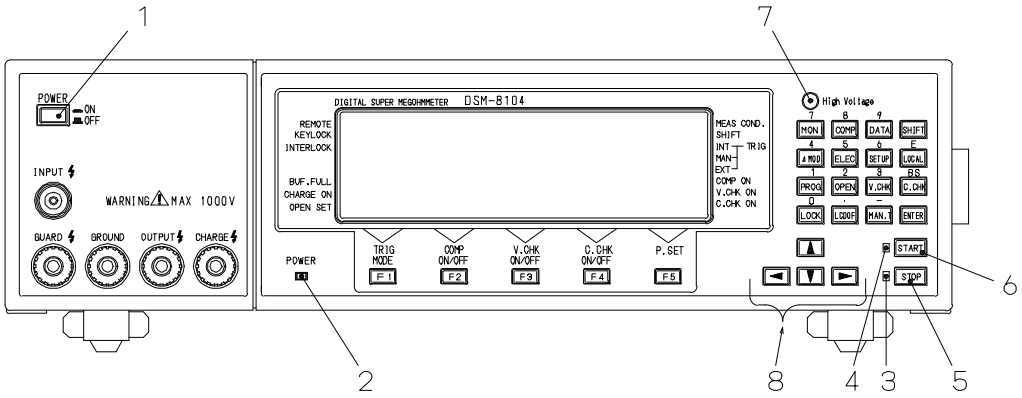
The locations where the safety alert symbols are placed are illustrated below.





4.2 Front Panel

The front panel of the DSM-8104 is illustrated below.



1: “POWER” switch
The power supply switch to select power on and off.
Press this switch once to depress it to turn the power on. Press once again to pull up the key and to turn the power off.

2: “POWER” lamp
Lit when the POWER switch is turned on.

3: “STOP” lamp
Lit when the [STOP] key is pressed. Extinguished when the [START] key is pressed.
The output voltage lowers to “0” while the “STOP” lamp is lit, disabling receiving of trigger input.

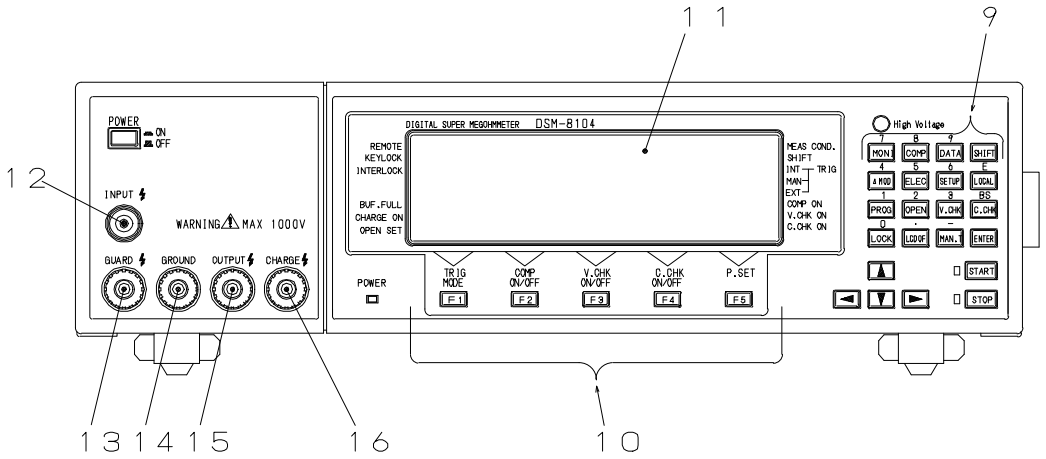
4: “START” lamp
Pressing the [START] key lights up this lamp, going off when the [STOP] key is pressed.
The set voltage is output and trigger input can be received while the “START” lamp is lit.

5: [STOP] key
Stops measurement and lowers voltage output to 0V.
This key is given the highest priority and can be operated even when the keys are locked.

6: [START] key
This key outputs set voltage and enables trigger input.
Measurement is started when the Trigger mode is “INT.”

7: “High Voltage” lamp
Indicates output of high voltage.
The lamp is lit when voltage higher than about 30V is output.

8: Cursor moving keys
The keys move the cursor around on the screen or scroll the screen.



9: Command/numeric input keys
Operate the keys when setting parameters.
Pressing the [SHIFT] key changes the keys to the numeric input keys.

10: [F1]/“TRIG MODE” [F2]/“COMP ON/FF”
[F3]/“V. CHK ON/OFF” [F4]/“C. CHK ON/FF”
[F5]/“P.SET”
These keys are the function keys. The functions of these keys are displayed on the LCD screen above the keys. Pressing the [SHIFT] key on the measurement screen sets the functions indicated in “ .” The information is displayed on the screen also.

11: Display
This is a liquid crystal display module 240 x 64 dots in resolution to display measured results, measuring conditions and various setting screens.

12: “INPUT” connector
The connector for measurement input.
The connector of a double structure comprising a center conductor and outer conductor connecting to measurement input and the “GUARD” terminal, respectively.

13: “GUARD” terminal
A guard terminal of the measurement input unit.

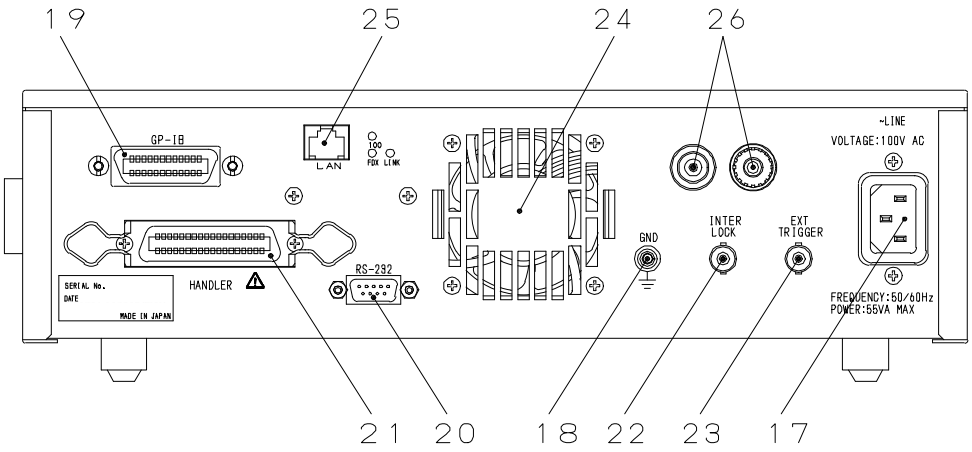
14: “GROUND” terminal
A grounding terminal connected to the housing of the meter.

15: “OUTPUT” terminal
A terminal for measuring voltage output.
Resistance is measured between the “OUTPUT” and “INPUT” terminals.

16: “CHARGE” terminal
The charging output terminal for precharging. The same level of voltage as that of measuring voltage is output between the “CHARGE” and “OUTPUT” terminals.

4.3 Rear Panel

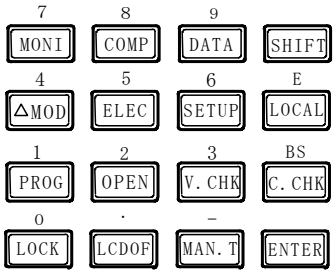
The rear panel of the DSM-8104 is illustrated below.



17: “AC LINE 50/60Hz” connector
The connector for input of power supply voltage.
18: “GND” terminal
The grounding terminal connected to the housing of the meter.
19: “GP-IB” connector
The connector for GP-IB connection.
20: “RS-232” connector
The connector for RS-232 connection.
21: “HANDLER” connector
The connector for handler connection.
22: “INTERLOCK” connector
The input connector for connection of signals from a fixture when an interlock function is used.
23: “EXT TRIGGER” connector
The connector for external trigger input.
This connector is used when the trigger mode is set to external “EXT.”
24: Cooling fan
The fan for cooling the inside of the meter.
25: “LAN” connector (option)
The connector for LAN connection.
26: Holes for mounting remodeled connector (special order)
Holes for a custom connector of special order.

4.4 Command/Numeric Input Keys

The command/numeric input keys have the following functions:



[SHIFT]: Shift

The key to change command/numeric input and the functions of the function keys on the measurement screen.

The command/numeric input keys are set to the Command Input mode when the [SHIFT] key is not pressed, set to the Numeric Input mode when the [SHIFT] key is pressed.

Each pressing of the [SHIFT] key alternately changes the mode of the key.

When the SHIFT key is pressed, a side mark ("◀") will be displayed beside "SHIFT" in the upper right of the screen.

[ENTER]: Enter

Pressing this key enters input results.

Exit after finishing setting the measurement screen and the setting screen by pressing this key.

[LOCK]/"0": Key lock

Press this key to prohibit key input.

Pressing this key prohibits operations of the keys other than the [STOP] and [LOCK] keys.

Press the [LOCK] key again to cancel the key lock status.

When the keys are locked, a side mark ("◀") will be displayed beside "KEY LOCK" in the upper left of the screen.

The key becomes a key for input of "0" when the [SHIFT] key is pressed and the Numeric Input mode is set.

[LCDOF]/".": LCD off

The key to exit the display screen. The key shuts down screen display and extinguishes the backlight.

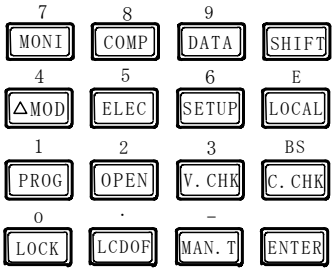
Press any key to cancel when the display is turned off.

The key becomes a decimal point input key "." in the Numeric Input mode.

[MAN.T]/"-": Manual trigger

A trigger is generated and measurement is started when pressed while the trigger mode is "MAN" (Manual Trigger mode).

When in the Numeric Input mode, the key will become a negative "-" polarity input key.



[PROG]/“1”: Program

The key to move to the sequence program creation screen.
See “Operating Program Creation Screen.”
When in the Numeric Input mode, the key will become an input key (“1”).

[OPEN]/“2”: Open correction

The key to move to the screen to set reference values for contact checks.
See “Operating Open Setting Screen.”
When in the Numeric Input mode, the key will become an input key (“2”).

[V. CHK]/“3”: Voltage check

The key to execute once a voltage check of measuring voltage output between “OUTPUT” and “GUARD.”
When in the Numeric Input mode, the key will become an input key (“3”).

[C. CHK]/“BS”: Contact check

The key to execute once a contact check.
When in the Numeric Input mode, the key will become a “BS (back space)” key to delete characters that are input.

[ΔMOD]/“4”: Deviation Measuring mode

The key to move to the Deviation Value Display and Setting screen.
See “Operating Deviation Value Display and Setting Screen.”
When in the Numeric Input mode, the key will become an input key (“4”).

[ELEC]/“5”: Electrode

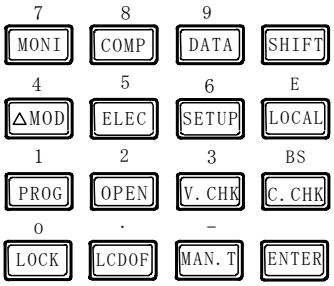
The key to move to the Electrode Parameter Setting screen.
See “Operating Electrode Setting Screen.”
When in the Numeric Input mode, the key will become an input key (“5”).

[SETUP]/“6”: Set up

The key to move to the Operation Environment Setting screen.
See “Operating Operation Environment Setting Screen.”
When in the Numeric Input mode, the key will become an input key (“6”).

[LOCAL]/“E”: Local

The key to cancel the Remote mode.
When in the Numeric Input mode, the key will become an exponent display and input key (“E”).



[MONI]/“7”: Monitoring

The key to change over the Regular Measurement screen and Sequential Measurement monitoring screen.

When in the Numeric Input mode, the key will become an input key (“7”).

[COMP]/“8”: Compare

The key to move to the Comparison Measurement Setting screen.

When in the Numeric Input mode, the key will become an input key (“8”).

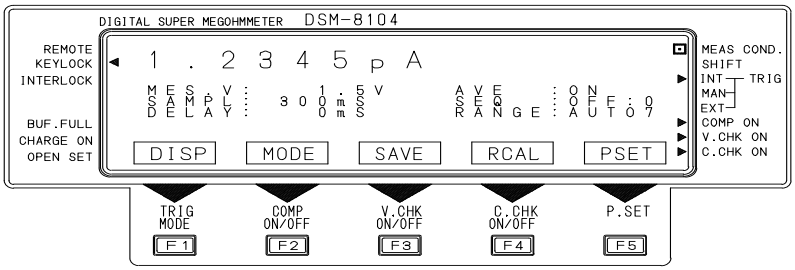
[DATA]/“9”: Data

The key to move to the acquired data screen to total measured results.

When in the Numeric Input mode, the key will become an input key (“9”).

4.5 Display Screen

The display screen of the DSM-8104 is illustrated below.



"REMOTE"

When in the Remote mode (GP-IB or RS-232 mode), a side mark ("◄") will be displayed on the screen.
The Remote mode is not set when the side mark is not displayed.

"KEY LOCK"

When in the Key Lock mode, a side mark ("◄") will be displayed on the screen.
The Key Lock mode is not set when the side mark is not displayed.

"INTERLOCK"

When the interlock function is on (enabled), a side mark ("◄") will be displayed on the screen.
The interlock function is off (disabled) when the side mark is not displayed.

"BUFF. FULL"

A side mark ("◄") will be lit when the number of data groups saved by the buffering function for 1000 data groups exceeds 1000. Measured data after this mark is lit will be discarded without being stored in the buffer.

"CHARGE ON"

A side mark ("◄") will be lit when the [CHARGE] terminal is usable. The [CHARGE] terminal cannot be used when this mark is not lit.

"OPEN SET"

A side mark ("◄") will be lit when open correction is executed. A contact check can be carried out while this mark is displayed.
Executing a contact check when this mark is not displayed results in an error.

"MEAS COND"

A side mark ("•") on the screen indicates that the meter is conducting measurement.

"SHIFT"

A side mark ("►") on the screen indicates the status of the Shift key.
The Shift mode is not set while the side mark is not displayed.

“TRIG-INT”

When in the Internal Trigger mode, a side mark (“►”) will be displayed on the screen.

“TRIG-MAN”

When in the Manual Trigger mode, a side mark (“►”) will be displayed on the screen.

“TRIG-EXT”

When in the External Trigger mode, a side mark (“►”) will be displayed on the screen.

“COMP ON”

A side mark (“►”) on the screen indicates the ON/OFF status of the decision function. The decision function is not on when the side mark is not displayed. The side mark flashes when a decision result is NG.

“V. CHK ON”

A side mark (“►”) on the screen indicates the ON/OFF status of the voltage check function. The voltage check function is not on when the side mark is not displayed.
The side mark flashes when the result of a voltage check is NG.

“C. CHK ON”

A side mark (“►”) on the screen indicates the ON/OFF status of the contact check function. The contact check function is not on when the side mark is not displayed.
The side mark flashes when the result of a contact check is NG.

5 Preparations for Measurement

5.1 Setting Measuring Conditions

The meter is capable of setting measuring methods and measuring conditions beforehand so that insulation resistances of materials, parts and circuits can be measured easily under preset conditions.
Before explaining about measurement, this chapter describes setting of various measuring conditions.
Press the “POWER” switch on the front panel to set it to “ON.” The “POWER” lamp on the front panel lights up.
After initializing, the regular measurement screen sets. Measuring condition settings such as measuring voltage and sampling time are set to the same states as those stored when the power was shut down after previous measurement thanks to the resume function.

[Warning]
Before turning the power on, check that the AC power supply voltage to be used matches the power supply voltage specified on the rear panel.
If they do not match, a fire or damage to the meter may result.

[Warning]
Be certain to ground the grounding pin of the power cable or a grounding wire to prevent an accident. If the grounding pin of the power cable or grounding wire cannot be grounded, ground the grounding terminal located on the rear of the meter.

Self-diagnosis
After switching the “POWER” on, press the SETUP (SET UP) key in the measured value display screen. This will take you to the screen to set the operation environment (Operation Environment Setting screen).
Press the [F2] SELF (SELF CHECK) key on the Operation Environment Setting screen. The screen will change to the Self-diagnosis Execute screen. (See Fig. 5.1)

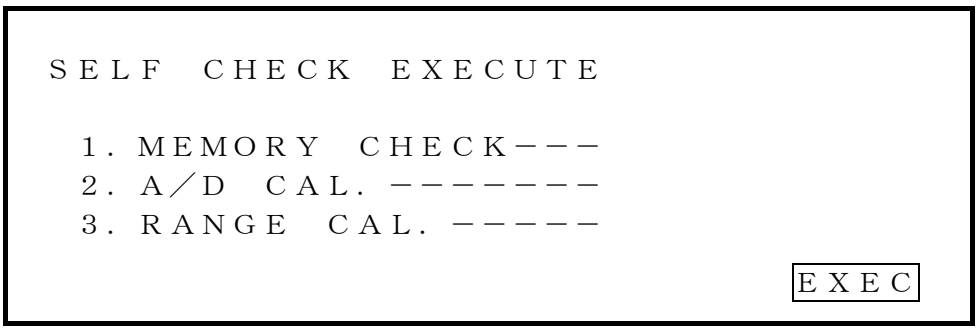


Fig. 5.1 Self-diagnosis Execute Screen

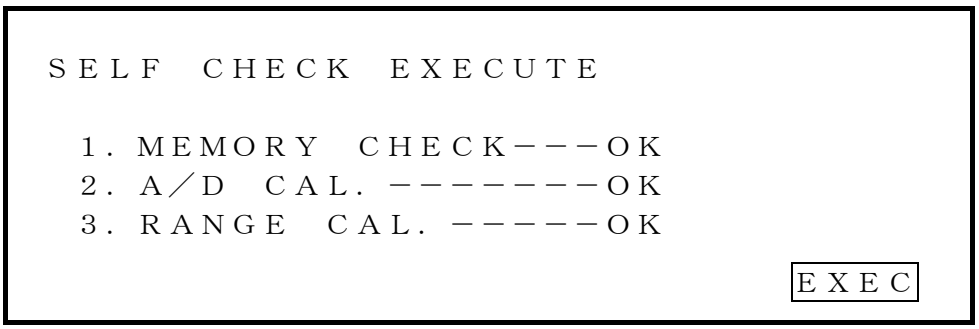


Fig. 5.2 Self-diagnosis Execute Screen

The function key [F5] will change to EXEC (EXECUTE). Pressing the [F5] EXEC key starts self-diagnosis.
In a self-diagnosis test, a memory check, as well as self-calibration checks of the A/D converter and range, are automatically carried out, displaying OK (acceptable) or NG (not acceptable). Fig. 5.2 shows an “OK” execution result on the Self-diagnosis Execute screen.
Press the [ENTER] key after finishing self-diagnosis to return to the measurement screen.

[Notice]
After executing self-diagnosis, if there are any items with [NG], switch on the POWER again and execute the self-diagnosis one more time. If there are still items with [NG] even after the power is resumed and a self-diagnosis test is executed, please contact the nearest HIOKI office for repair.

[Notice]
In addition to a [Self-diagnosis function], this meter has a [Self-calibration function] which allows users to execute self-calibration checks at preset intervals. The factory default settings are [Self-calibration function = ON] and [Self-calibration interval = 60 seconds].

The self-calibration check requires about 2 seconds to complete and during this interval, not only will the measured values not be displayed, but all controls, including key operations and communications, will also be stopped for the self-calibration to be executed. Therefore, when executing an automated measurement, set the self-calibration function OFF and execute a command from the interfaces GP-IB or RS-232C ([*CAL?] command or [*TST?] command) to execute self-calibration, or perform a self-diagnosis test by keying the keys on the panel periodically.

*[Self-calibration] executes [2. Calibration of A/D converter] and [3. Range calibration] of [Self-diagnosis]. For details on self-calibration, please refer to [10.3 Self-calibration Function].

5.1.1 Screen types

Set the various measuring conditions and other items in accordance with the screen on the front panel.
Two screens are available - Measured value display screen and setting screen.
(a) The Measured Value Display screen displays results of measurement.
(b) The setting screen is for setting measuring conditions and other items.

Table 5.1 Screen Types

Screen Type	Screen	Meter Status
Measured value display screen	Regular measurement screen	Measuring/waiting for key input
	Sequential Measurement Monitoring screen	Measuring/waiting for key input
Setting screen	Comparison Measurement Setting screen	Waiting for key input
	Acquired Data screen	Waiting for key input
	Histogram Display screen	Waiting for key input
	Histogram Threshold Display screen	Waiting for key input
	Measured Data Buffer Display screen	Waiting for key input/display
	Measured Data Buffer Erase screen	Waiting for key input
	Deviation Value Display and Setting screen	Waiting for key input
	Electrode Constant Setting screen	Waiting for key input
	Environment Setting screen	Waiting for key input
	External Interface Setting screen	Waiting for key input
	Self-diagnosis Test Execute screen	Waiting for key input
	Self-calibration Setting screen	Waiting for key input
	Measuring Power Source Setting screen	Waiting for key input
	Program Create screen	Waiting for key input
	Open Correction Value Setting screen	After measurement/waiting for key input

- A measured value is displayed in the top part of the screen in large characters. Measured values are always results of most recent measurement.
- Measuring conditions that are currently set are displayed under a measured value.
- Side marks are displayed on both sides of the screen indicating measurement and key statuses.
- Functions of the function keys are displayed in the bottom.

(1) Measured Value Display screen
The Measured Value Display screen displays measured results and measuring conditions.
A measured value is displayed in the top part of the screen in large characters. Measured values that are displayed are always results of most recent measurement.
The Measured Value Display screen is split into the Regular Measurement screen and Sequential Measurement Monitoring screen.
In addition to the Regular Measurement screen, the Sequential Measurement Monitoring screen allows monitoring of the progress of each sequence.
The Monitoring screen counts down the following items as the sequences advance, enabling viewing of sequence progresses at a glance.

Operate the [MONI] key to switch between the [Regular Measurement screen] and [Sequential Measurement Monitoring screen].

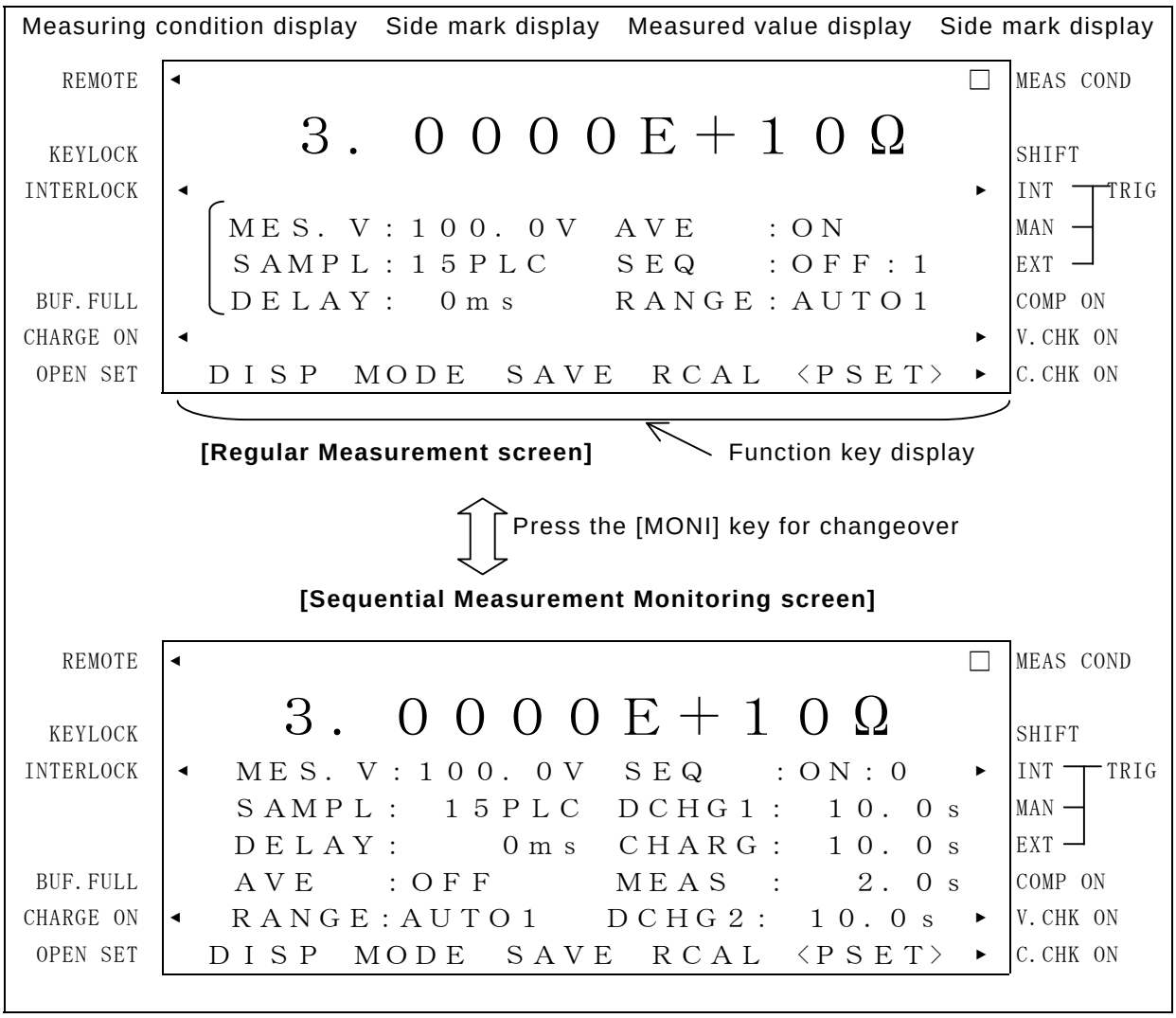


Fig. 5.3 Regular Measurement screen and Sequential Measurement Monitoring screen

Table 5.2 Display of Measured Values

Classification	Display	Setting Procedure
Indication type	Unit indication Exponential indication	[F1]DISP ⇒[F1]UNIT [F1]DISP ⇒[F2]EXP.
Number of effective digits	2 to 5 columns	[F1]DISP ⇒[F3]FIG
Measuring mode	Ω: Resistance measurement A: Current measurement ΩRs: Surface resistivity measurement ΩRv: Volume resistivity measurement	Press the [F2] MODE key to sequentially select a desired mode Ω → A→ ΩRs → ΩRv→ Ω
Deviation value display	Measured value - Reference value $\frac{\text{Measured value - Reference value}}{\text{Reference value}}$ X100%	Select [ΔMOD] and DEV Select [ΔMOD] and PAR
Error display	RANGE OVER: Overrange in current measurement*	

*An [RANGE OVER] display indicates a measurement value which is beyond the preset measurement range (resistance value of the measurement object is too low). An [RANGE OVER] display during Auto Range will mean that the value is beyond the measurable range.

Table 5.3 Meanings of Side Marks

Panel Character	Side Mark	Status	
REMOTE	◀	In external remote mode	
KEY LOCK	◀	In key lock mode	
INTERLOCK	◀	Interlock in operation ([START] disabled)	
BUF.FULL	◀	Data buffer is full	
CHARGE ON	◀	“CHARGE” terminal can be used	
OPEN SET	◀	Open correction already executed	
MEAS COND	□	In measurement	
SHIFT	▶	Key shift mode (Numeric and other keys can be input)	
TRIG INT MAN EXT	▶ ▶ ▶	Internal trigger is selected Manual trigger is selected External trigger is selected	
COMP ON	▶	Comparison measurement is selected The side mark flashes if a comparison result is NG.	NOTE 1
V.CHK ON	▶	Voltage check is executed automatically The side mark flashes if result of voltage check is NG.	NOTE 1
C.CHK ON	▶	Contact check is executed automatically The side mark flashes if result of contact check is NG.	NOTE 1

Note 1:
When a mark is flashing in case a result is NG, the mark does not go off till next check is carried out or a decision is made.

Set the measuring conditions for the Measured Value Display screen as follows.

(a) Press the [F5] RESET key.

(b) Move the cursor to a desired setting item operating the cursor move keys ([◄], [►], [▲] and [▼]). The selected items will be highlighted.

(c) Operate the function keys corresponding to the screen display or the numeric keys for setting each item. Select each setting by pressing the [ENTER] key.
When canceling a setting, erase a numeric value by pressing the [BS] key and press the [ENTER] key to return to data before the setting.
The functions keys corresponding to each setting item will be the scroll keys ([F2], [F3]) for specified value. Condition setting keys for each function will be [F4] and [F5].
See Table 5.4 for more information.

[Example] To set voltage 75.5V.

(a) Press the [F5] PSET key.

(b) Move the cursor to “MES. V” operating the [◄], [►], [▲] and [▼] keys.

(c) Voltage cannot be specified operating the [F2] DOWN and [F3] UP keys. Input voltage by keying the numeric keys.

(d) Set by sequentially keying the “7” [MONI], “5” [ELEC], “.” [LCDOF], “5” [ELEC] and [ENTER] keys.

Table 5.4 Measuring Conditions

Set Item	Description	Setting Range (Specified Value) *3	Resolution	
MES.V	Set voltage range	0.1 ~ 250 V 251 ~ 1000 V (0.1,0.5,1.0,2.5,5.0,10,25, 50,100,250,500,1000)	0.1 V 1 V	[F2] DOWN [F3] UP
SAMPL	Integral time	Time setting 2 ~ 300 ms (2,4,8,16,20,40,80,160,300) Period setting 1 ~ 15 PLC*1 (1,2,4,8,15)	1 ms 1 PLC	[F2] DOWN [F3] UP [F4] ms [F5] PLC
DELAY	Trigger delay time	0 ~ 9999 ms (0,5,10,50,100,500,1000, 5000,9999)	1 ms	[F2] DOWN [F3] UP
AVE	Averaging	ON/OFF		[F4] ON [F5] OFF
RANGE	Current range	Range 1 ~ 8 AUTO/HOLD		[F2] DOWN [F3] UP [F4] AUTO [F5] HOLD
SEQ	Sequential measurement	Program No. 0 ~ 9 ON/OFF		[F2] DOWN [F3] UP [F4] ON [F5] OFF
DCHG1	Discharging time (Before measurement)	0 ~ 999.9 s (0,10,20,30,40,50,60,600,900)	0.1 s	[F2] DOWN [F3] UP
CHARG	Charging time	0 ~ 999.9 s (0,10,20,30,40,50,60,600,900)	0.1 s	[F2] DOWN [F3] UP
MEAS	Measuring time	0 ~ 999.9 s (0,10,20,30,40,50,60,600,900)	0.1 s	[F2] DOWN [F3] UP
DCHG2	Discharging time (After measurement)	0 ~ 999.9 s (0,10,20,30,40,50,60,600,900)	0.1 s	[F2] DOWN [F3] UP

Range	Integral Capacity
1	10 µF
2	1 µF
3	100 nF
4	10 nF
5	1 nF
6	100 pF
7	10 pF
8	10 pF *2

NOTES

*1: “1 PLC” stands for “1 power line cycle.”

*2: “Range 8” increases the gain ten-fold while maintaining the same capacitor capacity of 10pF.

*3: The specified value is a preset value selected by the scroll keys.

Measuring conditions are set on the Measured Value Display screen after pressing the [F5] PSET key. To facilitate settings and to enable selection of a value operating the function keys [F2] to [F5], a specified value is given to each condition.
To reset after finishing setting, press the [ENTER] key.

(2) Setting screen
As shown in Fig. 5.4, the setting screen is displayed by moving from the Measured Value Display screen to the Setting screen in accordance with a measuring condition or other items.
The Setting screen has a dedicated screen for each set item.
To reset to the Measured Value Display screen, press the [ENTER] key.

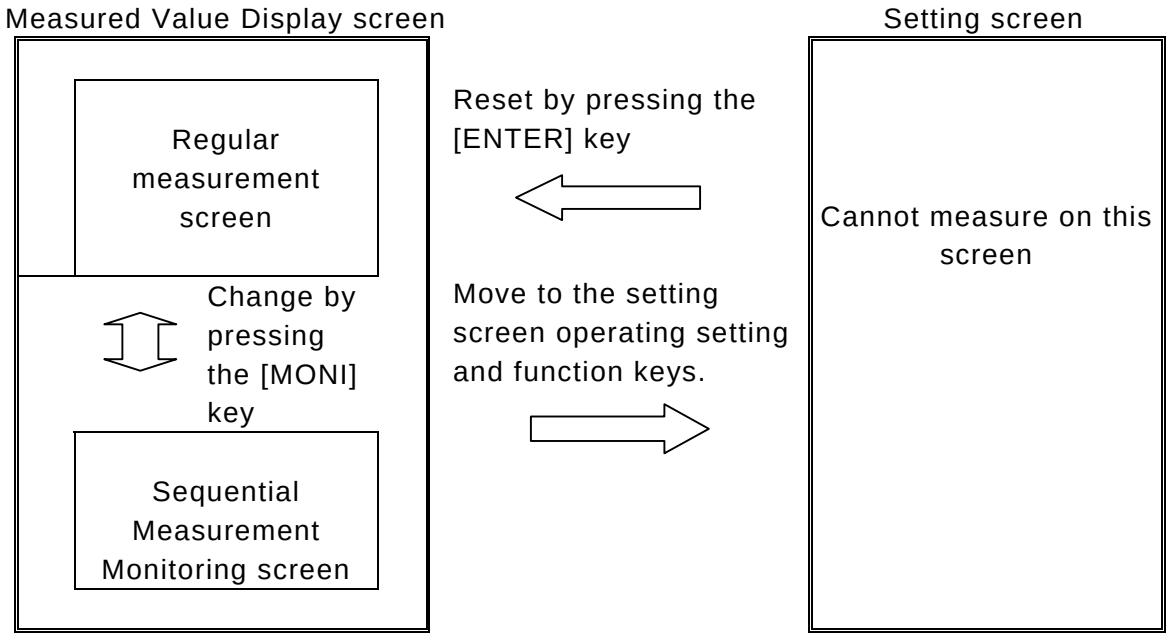


Fig. 5.4 Key Operation and Screen Change

Table 5.5 Setting keys and function keys for setting screen change

Setting Key	Function Key	Setting Screen
[COMP]		Comparison Measurement Setting screen (See 5.2.2)
[DATA]	[F1] HIST [F2] SETH [F3] CLRH [F4] CLRD [F5] ROLL	Acquired Data screen (See 5.2.4 onward) Histogram display screen Histogram display threshold setting screen Histogram counter clear screen Measured data buffer clear screen Measured data buffer display screen
[△MOD]		Deviation Value Display and Setting screen (See 5.2.3)
[ELEC]		Electrode Setting screen (See 6.3.3)
[SETUP]	[F1] CONF [F2] SELF [F3] CAL [F4] POWR	Environment Setting screen (See 5.1.12 onward) External interface setting screen Self-diagnosis test execute screen Self-diagnosis test execute screen Self-calibration setting screen
[PROG]		Program create screen (See 5.1.9)
[OPEN]		Open Correction Value Setting screen (See 6.7.2)

5.1.2 Setting measuring mode

This meter has four measuring modes capable of measuring resistance, current, surface resistivity and volume resistivity.
Set a desired measuring mode as follows.

(1) Key operation
  (a) Press the [F2] MODE key for mode selection.
    (NOTE: The modes are displayed on the Measured Value Display screen.)
  (b) Each pressing of the [F2] MODE key sequentially selects resistance measurement, current measurement, surface resistivity measurement and volume resistivity measurement.

(2) Mode display
  The individual measuring modes are displayed in the units displayed in the measured value display section.

Measuring Mode	Unit Indication
Resistance measurement	Ω
Current measurement	A
Surface resistivity measurement	Ω_{Rs}
Volume resistivity measurement	Ω_{Rv}

[Notice]
The actual unit for surface resistivity measurement is [Ω].
The actual unit for volume resistivity measurement is [Ω·cm].

5.1.3 Setting measuring voltage

(1) Keying
  (a) Press the [F5] PSET key on the Regular Measurement screen or the Sequential Measurement Monitoring screen shown in Fig. 5.3 to enter into the Measuring Condition Setting mode.

  (b) Input voltage after moving to “MES. V:” operating the cursor moving keys ([◄], [►], [▲] and [▼]).
    Voltage can be input by directly inputting on the numeric keys or by selecting from the following preset values.

  (c) The [F2] and [F3] keys perform the DOWN and UP functions respectively in the Measuring Condition Setting mode, to sequentially change preset fixed values.
    The following fixed values are preset:
    12 values: 0.1, 0.5, 1.0, 2.5, 5.0, 10, 25, 50, 100, 250, 500 and 1000

5.1.4 Setting current limiter

This meter limits a current to the work by a current limiter to expedite charging to the work and to prevent fracture of the work.
The “CHARGE” terminal is provided to facilitate precharging in auto measurement. The current to the “CHARGE” terminal is also limited by a current limiter.
These current limiters are set through “POWER SOURCE SELECT” on the setting screen by the [SETUP] key.
“POWER SOURCE SELECT” also sets “CHARGE” output and the filtering function, in addition to the current limiters.

[Caution]
The current limiter limits a steady-state current. A transient current several ten μs in width flows when the sample is changed by a relay or other means. When changing the measuring terminal by a relay or other means while outputting measuring voltage, serially insert protective resistance not exceeding the maximum permissible current of the contact to limit the current flow in the contact for protection of the relay contact.
This procedure is also repeated when changing the “CHARGE” terminal for precharging.
Protective resistance value ≧ (measuring voltage)/(maximum permissible current)

(1) Keying
(a) Press the [SETUP] key to set up the Setting screen.

(b) Press the [F4] POWR key to set up the “POWER SOURCE SELECT” screen.

(c) Move to “CURL :” operating the vertical cursor moving keys [▲] and [▼] and select a limit value operating the horizontal cursor moving keys [◄] and [►].
(d) Move to “CURL C:” operating the vertical cursor moving keys [▲] and [▼] and select (Use/Non-use) for the “CHARGE” terminal operating the horizontal cursor moving keys [◄] and [►].

(2) Limit value setting range
The limit value setting range is limited as follows depending on the measuring voltage:
Measuring voltage: 0.1 to 250V, 5mA/10mA/50mA
250V to 1000V, 5mA/10mA

(3) Selecting “CHARGE” terminal
Set “CURL C:” to ON and set “CURL :” to “10” or “50.” The “CHARGE” terminal can then be used and a side mark “◄” lights up near “CHARGE ON” on the panel.
The limit currents of the current limiters on the measuring side (“INPUT” or “GUARD”) and on the charge side (“CHARGE”) will be set as shown in Table 5.6.

Table 5.6 Set Values of Current Limiters

"CURL :" Setting		5mA	10mA	50mA
"CURL.C:" OFF	"INPUT" side	5mA	10mA	50mA
	"CHARGE" side	0	0	0
"CURL.C:" ON	"INPUT" side	5mA	5mA	5mA
	"CHARGE" side	0	5mA	45mA

(4) Power noise filter setting
Set in "FILTER:OFF/ON."
OFF: The filter is not used. (High-speed changeover mode: Fast)
ON: The filter is used. (Low-noise mode: Slow) [Standard setting]

(5) Power source noise filter
Noise of measuring voltage output greatly affects the measurement accuracy in measurement of samples which have a high electrostatic capacity such as capacitors. For this reason, the meter is equipped with a filter to reduce noise of measuring voltage output.
In regular measurement, stable measurement is possible by turning a filter on. The condition in which the filter is turned on is called the "low-noise mode." The low-noise mode enables stable measurement with less noise. However, one disadvantage with this mode is that the changeover speed of measuring voltage becomes slow depending on the filter response time.
Select the high-speed changeover mode with the filter turned off in measurement that requires fast changeover of measuring voltage.
The low-noise mode with the filter turned on is set during preshipment inspection of the meter at the HIOKI factory.

5.1.5 Setting measuring range

The meter consists of a high-sensitivity current measuring unit and a measuring voltage output unit and calculates an insulation resistance value based on a measured current value and measuring voltage.
The measuring range of the meter indicates a current measuring range of the current measuring unit, rather than a resistance measuring range. There are eight current measuring ranges for the current measuring unit. The full-scale sensitivity of each range is decided by the integral time setting.
The full-scale current value is expressed roughly by the following formula. (10mA is maximum)

$$I_{FS} = 3 \times 10^{-(4 + R)}/T$$

where I_{FS}: full-scale current value, R: range and T: integral time

Table 5.7 shows the relationship between typical integral times and full-scale sensitivities of the various ranges.
Range changeover enables setting of auto changeover and fixed range.

(1) Keying

(a) Press the [F5] PSET key to set the Measuring Condition Setting mode.

(b) Move to “RANGE:” operating the cursor moving keys [◄], [►], [▲] and [▼].

(c) Set “AUTO/HOLD” by operating the [F4] AUTO and [F5] HOLD keys.

(d) In case “HOLD” is set, operate the [F2] DOWN and [F3] UP keys and set a range.
“AUTO” sets auto changeover and “HOLD,” a fixed range.
“DOWN” changes the range toward low current sensitivity and “UP,” toward high current sensitivity.

Table 5.7 Integral Time and Full-scale Current Values of Various Ranges

Range Code	Integral Time				
	2ms	10ms	20ms	100ms	300ms
1	10mA	3.0mA	1.5mA	300µA	100µA
2	1.0mA	300µA	150µA	30µA	10µA
3	100µA	30µA	15µA	3µA	1µA
4	10µA	3.0µA	1.5µA	300µA	100nA
5	1.0µA	300nA	150nA	30nA	10nA
6	100nA	30nA	15nA	3nA	1nA
7	10nA	3.0nA	1.5nA	300pA	100pA
8	1.0nA	300pA	150pA	30pA	10pA

5.1.6 Setting integral time (sampling time)

Stable high-sensitivity current measurement is sometimes disabled due to impacts of noise components contained in the input current. This meter performs A/D conversion after integrating the input current to remove noise components for stable measurement. The noise removal rate increases longer the integral time is and power source noise (ham) can be greatly removed by increasing the integral time by integer multiplication of the power source period.
A long integral time also increases the measuring time. Set an appropriate integral time depending on measured resistance value (current value) referring to 5.1.5 Setting measuring range.
The integral time can be set in increment of 1ms or 1PLC.

(1) Keying

(a) Press the [F5] PSET key to set up the Measuring Condition Setting screen.

(b) Move to “SAMPL:” operating the cursor moving keys [◄], [►], [▲] and [▼] and input an integral time.

(c) [F4] and [F5] keys become the keys to select ms and PLC respectively. The [F2] and [F3] keys change to the DOWN and UP functions respectively.

(c) Press the [F4] ms key to set input in the unit of ms, allowing setting of integral time in increment of 1ms. The [F5] PLC key allows input in the unit of PLC, allowing settings in increment of 2ms to 300ms and in increment of 1 to 15PLC.

[Note]
"PLC" stands for "one power line cycle" and is about 17ms at 60Hz and 20ms at 50Hz.

[Notice]
Setting of an integral time changes the full-scale sensitivity of the current measuring unit. Refer to 5.1.5 "Setting measuring range."

5.1.7 Setting averaging function

The averaging function curbs dispersions of measured values by averaging measured results.
This function is enabled when the Trigger mode is internal trigger ([INT]).

(1) Keying
(a Press the [F5] PSET key to set the Measuring Condition Setting screen.
On the Measuring Condition Setting screen, the [F4] and [F5] keys change to keys that select ON and OFF, respectively.

(b) Move to "AVE:" operating the cursor moving keys [◄], [►], [▲] and [▼].
Set by keying the [F4] ON and [F5] OFF keys.

5.1.8 Setting trigger mode

This meter has three trigger modes, namely, the Internal Trigger [INT], Manual Trigger [MAN] and External Trigger [EXT] modes.
Select a suitable mode in accordance with the operation.

(1) Keying
(a) Press the [SHIFT] key to set to the Shift mode. The [F1] key changes to TRIG.

(b) Each pressing of the [F1] TRIG key alternately changes the trigger mode of the key to the Internal Trigger [INT], Manual Trigger [MAN] and External Trigger [EXT] modes.
The trigger mode is indicated by a side mark ("◄") on the right of the screen.

(2) Trigger mode operation
The meter operates in each trigger mode as shown in Table 5.8.

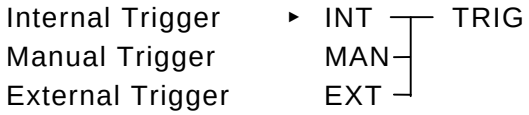
Table 5.8 Operation in Trigger Modes

Trigger Mode	Operation
Internal Trigger [INT]	Measurement is performed continuously on timing generated inside the meter.
Manual Trigger [MAN]	Performs one measurement when the [MAN.T] key is pressed on the panel or a trigger GP-IB command is input.
External Trigger [EXT]	Performs one measurement when trigger input is made to “EXT TRIGGER” input in the rear from the outside.

(3) Trigger mode change

Each pressing of the [F1] TRIG key alternately changes the trigger mode to Internal Trigger, Manual Trigger and External Trigger modes.

A side mark (“►”) indicates a trigger mode that is selected.



(Note: Example for internal trigger)

5.1.9 Creating a program

A program can be set for sequential measurement that will be useful when the time for impressing measuring voltage accurately to the sample needs be controlled accurately. Sequential measurement presets the following items and enables inspection under the same conditions.

(1) Discharge 1: Set a discharging time before impressing voltage.
(2) Charge: Set a time for impressing voltage before starting measurement.
(3) Measurement: Set a time for measurement.
Measured values after these set times are output.
(4) Discharge 2: Set a discharging time after finishing measurement.

[Warning]
Residual measuring voltage sometimes still remains inside the sample after measurement is finished when high voltage is impressed in manual measurement. Removal of a sample immediately after measurement is hazardous as there is a risk for an electrical shock. Set a time for Discharge 2 and remove a sample after sample is thoroughly discharged.

[Notices]
1. When shut down, the DSM-8104 is always in a discharge state. Set Discharge 1 when necessary taking the jig and scanner that have contacted the outside into consideration. Discharge 1 is almost irrelevant when the DSM-8104 is used independently.
2. The state between the measuring input terminal and [OUTPUT] terminal in a discharging condition (also during a shutdown) is the one to which a circuit that has a set current limiter and input resistance (about 100Ω) of the current measuring unit in series is connected.

Set the sequence program as follows.

(1) Press the [PROG] key on the Measurement screen.
The following Sequence Program Creation screen will be displayed.

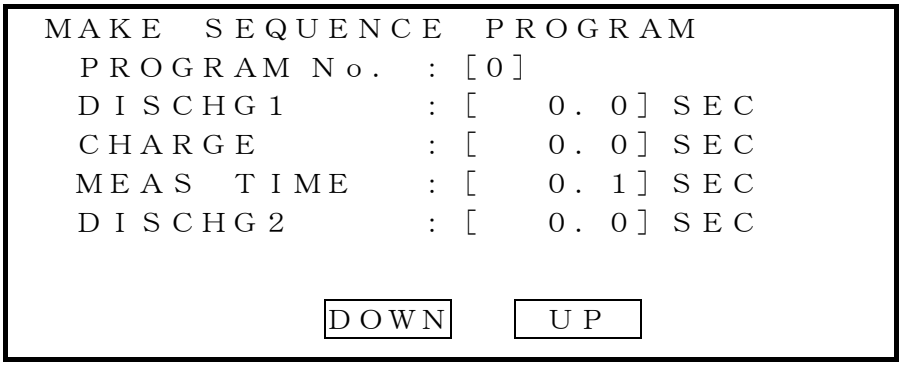


Fig. 5.5 Sequence Program Creation Screen

The Function keys [F2] and [F3] will respectively change to the DOWN and UP functions. A preset value can be chosen keying the DOWN and UP keys in addition to directly inputting it through the numeric input keys.
After finishing setting, return to the Measurement screen by pressing the [ENTER] key.

(2) Program No. setting
Input in “PROGRAM NO.” a program No. for a program to be created.
Ten types of sequence programs, 0 to 9, can be created.

(3) Charging time, measuring time and discharging time setting
In sequence program measurement, the operational sequence of DISCHG1 -- CHARG -- MEAS TIME -- DISCHG2 cannot be changed.

(a) Setting discharging time before measurement (DISCHG1)
Set a time to discharge the sample before starting measurement.
0 to 999.9s can be set.

(b) Setting charging time before measurement (CHARGE)
Set a time to charge the sample by impressing measuring voltage.
0 to 999.9s can be set.

(c) Setting measuring time (MEAS TIME)
Set a time to measure a sample.
0 to 999.9s can be set.

(d) Setting discharging time after measurement (DISCHG2)
Set a time to discharge the sample after measurement.
0 to 999.9s can be set.

5.1.10 Setting measured data buffer function

(1) Press the [DATA] key. (MEASURED RESULT DATA)
Move to the screen for selecting functions for totaling measured results (histogram data counter, measured data buffer). (See Fig. 5.14)

(2) Data buffer display ([DATA], ROLL)
Press the [F5] ROLL key (SCROLL DATA BUFFER) on the Function Select screen. The screen will display the Data Buffer Display screen shown in Fig. 5.6.

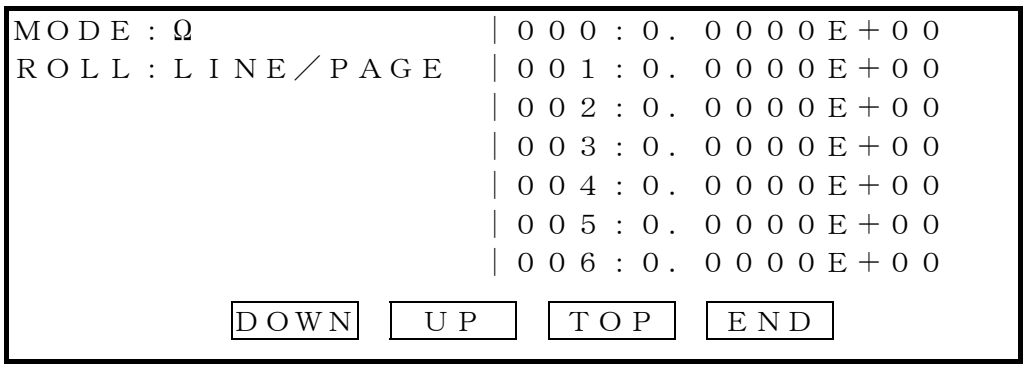


Fig. 5.6 Data Buffer Display Screen

Measured values will be displayed sequentially from oldest to newest. Measured values with numbers suffixed to measured valued are newer larger the numbers are.
The functions of the functions keys on this screen will change to [F2] DOWN, [F3] UP, [F4] TOP and [F5] END.
In the absence of data in the data buffer, "--- none ---" will be displayed.
The content in the data buffer will be "+0.0000E+00" in the resistance measuring mode (includes volume and surface resistivities) and "+9.9999E+99" in the current measuring mode in case measured results are overrange.

(a) [◄] and [►] keys
The keys change the number of scroll lines (ROLL: LINE/PAGE)
LINE: In increment of 1 line
PAGE: In increment of 1 page (7 lines)
(b) [F2] DOWN key
Scrolls the screen toward small data No.
(c) [F3] UP key
Scrolls the screen toward large data No.
(d) [F4] TOP key
Moves the screen to the top data No.
(e) [F5] END key
Moves the screen to the last data No.
(f) [ENTER] key
Exits data buffer display and returns to the function selection screen.

(3) Erasing data buffer ([DATA], CLRD)
Press the [F4] CLRD key in the function selection screen. (See Fig. 5.14)
The screen moves to the Data Buffer Erase screen shown in Fig. 5.7.

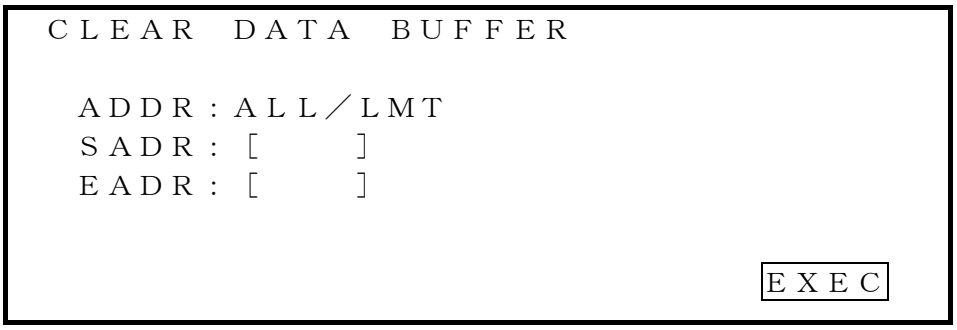


Fig. 5.7 Measured Data Buffer Clear Screen

On this screen, the function of the function key [F5] changes to EXEC.
Press the [F5] EXEC key to clear data.

(a) [◄] and [►] keys
The keys set an area for data clearing.
ALL: All data erase
LMT: Clearing of data in a specified area (Deletes data in the range of SADR to EADR)

(b) [▲] and [▼] keys
Select an item for start No. SADR and end No. EADR when the clearing range is LMT.
Input a data No. within the specified range operating the numeric keys when setting SADR and EADR. Press the [ENTER] key to enter the input.

(c) Press the [F5] EXEC key to clear data.

(d) Press the [ENTER] key to return to the Function Selection screen. (See Fig. 5.14)

(4) Data buffer usage
The data buffer is useful such as when analyzing data after taking measurement.
Measurement can be performed relatively quickly if data is fetched collectively after finishing all measurements since fetching of data for each measurement is time consuming such as when fetching data using an interface.
Take measurement after erasing data in the data buffer when using the buffer. Otherwise data separation point cannot be determined because previous data is still remaining.
Changing the measuring mode during measurement while using the data buffer disables distinction between saved data and new data.
All data is saved in the buffer in measured current values and is displayed after converting to a format matching the measuring mode when data is displayed. Values sometimes cannot be displayed correctly if the measuring mode during display differs from the measuring mode used during measurement.

5.1.11 Setting operating environment

Press the [SETUP] (SET UP) key on the Measurement screen.
The screen changes to the Operating Environment Setting screen. (See Fig. 5.8)

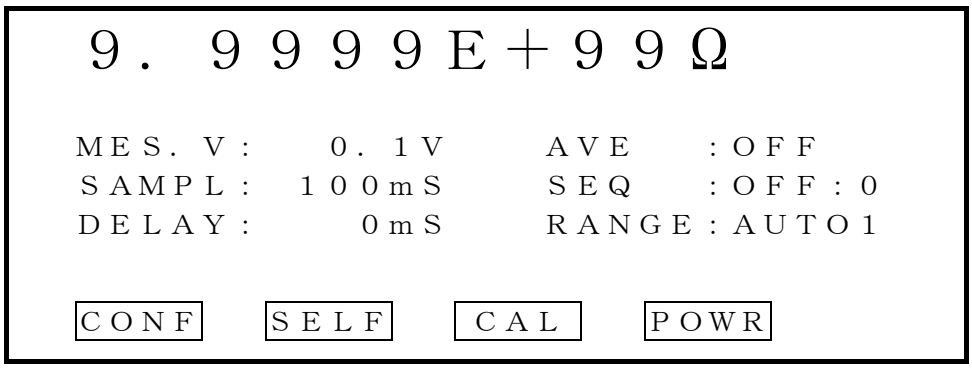


Fig. 5.8 Operating Environment Setting Screen

(1) Self-calibration setting
Press the [F3] CAL (CALIBRATION) key on the Operating Environment Setting screen.
The screen changes to the Self-calibration Setting screen. (See Fig. 5.9)

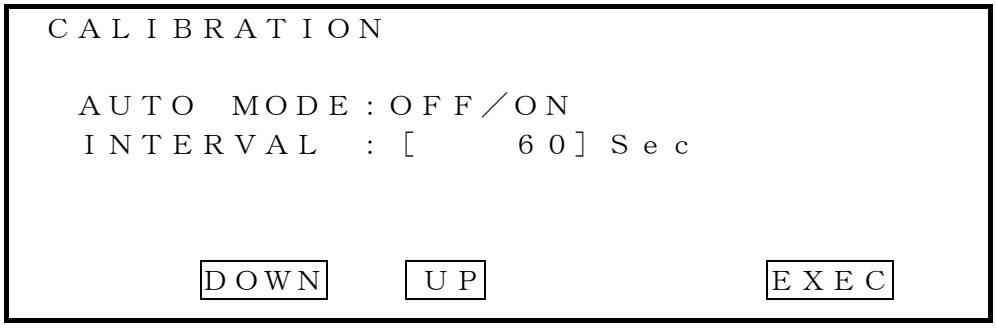


Fig. 5.9 Self-calibration Setting Screen

The function keys will change to [F2] DOWN, [F3] UP and [F5] EXEC.
Select an item to be set by operating the [▲] and [▼] keys.
After finishing settings, press the [ENTER] key to return to the Measurement screen.

(2) "AUTO MODE" setting
This function executes self-calibration (self-calibration check of the A/D converter and range) automatically at a preset time interval.
OFF: Auto self-calibration is not executed.
ON: Auto self-calibration is executed.

(3) "INTERVAL" setting
Set a time interval for auto self-calibration by inputting a time interval operating the numeric input keys and pressing the [ENTER] key.
Or, a time interval can be selected from among designated values operating the [F2] DOWN and [F3] UP keys because specified values are already set in the meter.

A time interval between 10s and 9999s can be set as “INTERVAL.”
60s is set with the meter during preshipment inspection at the factory.
The following values are set in advance as specified values.

10, 60, 300, 900, 1800, 3600, 7200 and 9999s

(4) Executing self-calibration check

Press the [F5] EXEC (EXECUTE) key.
This function executes self-calibration once on the Self-calibration screen regardless of whether or not AUTO MODE is ON or OFF. The display screen does not change.

[Notices]
1. The measuring time sometimes lengthens the self-calibration execution time (about 2s) when auto execute is on.
2. Auto self-calibration cannot be performed even when auto execute is set to ON if sequential measurement is ON.

5.1.12 Setting other items

The following items are set.

Interlock function setting
Beep tone setting
Key click tone setting
GP-IB address setting
RS-232 baud rate setting
RS-232 character length setting
RS-232 parity check setting
RS-232 stop bid length setting

(1) External interface condition setting

Press the [F1] (CONFIGURATION) key on the Operating Environment Setting screen (see Fig. 5.8).
The screen changes to the External Interface Condition Setting screen. (See Figs. 5.10 and 5.11)
The External Interface Condition Setting screen is divided into two pages.

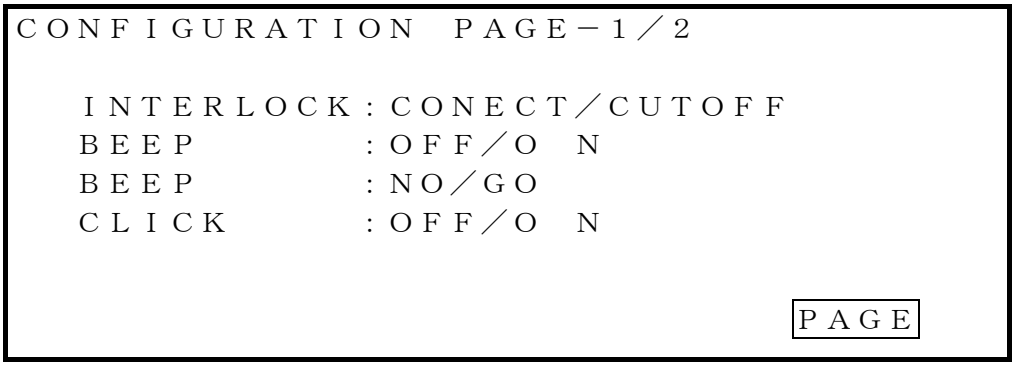


Fig. 5.10 External Interface Condition Setting Screen 1/2

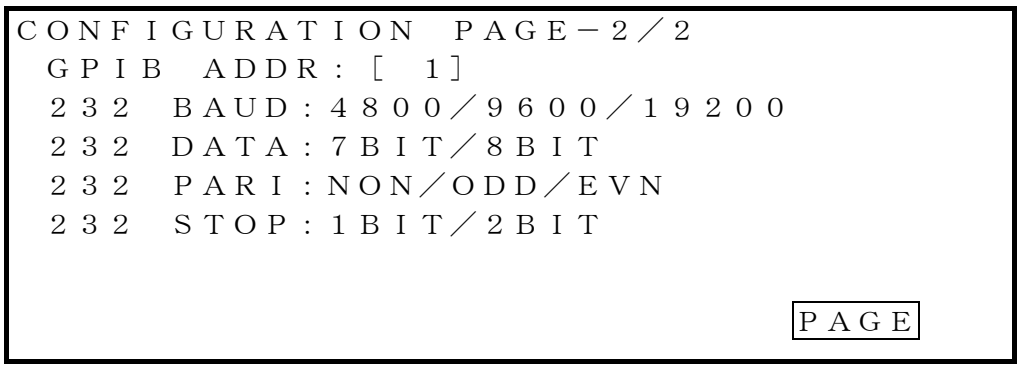


Fig. 5.11 External Interface Condition Setting Screen 2/2

The [F5] key changes to the PAGE (PAGE) function. Each pressing of the key alternately changes pages.
Select an item to be set by operating the [◄], [►], [▲] and [▼] keys and set it. The selected item will be highlighted in the display.

(2) Interlock function setting
Select “PAGE-1/2” and set an INTERLOCK: item.
The following function will set.
CONECT: The interlock function will be enabled.
In this case, output of measuring voltage will be enabled if “INTERLOCK” input in the rear is short-circuited (low level input), prohibiting output of measuring voltage if open-circuited (high level input).
When disabled, the [START] key will be disabled and a side mark (“◄”) will light up in the “INTERLOCK” display on the left of the LCD screen.
CUTOFF: Disables the interlock function.
In this case, measuring voltage can always be output irrespective of “INTERLOCK” input in the rear.

(3) Beep tone setting
Set “BEEP: OFF/ON” and “BEEP: NO/GO” items on “PAGE-1/2.”
OFF: Beep tone is not sounded.
ON: Beep tone is sounded.
NO: Beep tone is sounded if decision is NG.
GO: Beep tone is sounded if decision is GOOD.

(4) Key click tone setting
Set “CLICK: OFF/ON” on “PAGE-1/2.”
OFF:Click tone is not sounded.
ON: Click tone is sounded.

(5) GP-IB address setting
Set “GP-IB ADDR” on “PAGE-2/2.” An address 0 to 30 can be set.
Input an address value operating the numeric input keys and press the [ENTER] key to set.

[Note] If a GP-IB address is changed, the status register and mask register will be initialized. New settings will become necessary.

(6) RS-232 communication condition setting
Set RS-232 communication conditions in “232” items on “PAGE-2/2.”

232 BAUD RS-232C baud rate setting

4800	4800BPS
9600	9600BPS
19200	19200BPS

232 DATA RS-232C character length setting

7- bit	length/word
8- bit	bit length/word

232 PARI RS-232C parity check setting

NON	Parity check not performed
ODD	Odd parity check performed
EVE	Even parity check performed

232 STOP RS-232C stop bit length setting

1BIT	1 bit
2BIT	2 bits

5.2 Display and Processing of Measured Value

5.2.1 Displaying measured value

Measured values are displayed on the Measured Value Display screen, to display measured results and measuring conditions. As shown in Fig. 5.3, the Measured Value Display screen is split into the Regular Measurement screen and Sequential Measurement Monitoring screen.

(1) Regular Measurement screen
A measured value is displayed in the top part of the screen in large characters.
Measured values are always results of most recent measurement.
Measuring conditions that are currently set are displayed under a measured value.
Side marks are displayed on both sides of the screen indicating measurement and key statuses.
Functions of the function keys are displayed in the bottom.

(2) Sequential Measurement Monitoring screen
In addition to the Regular Measurement screen, the Sequential Measurement Monitoring screen allows monitoring of the progress of each sequence.
The Sequence Monitoring screen counts down the following items as the sequences advance, enabling viewing of sequence progresses at a glance.

Discharging time before measurement “DCHG1”
Charging time before measurement “CHARG”
Measuring time “MEAS”
Discharging time after measurement “DCHG2”

The “Regular Measurement screen” and “Sequential Measurement Monitoring screen” can be changed by operating the [MONI] key.

(3) Changing measured value display format. [F1] DISP (DISPLAY)
Change unit indication of measured value and display format of exponential indication as follows.
The following menu is displayed for the function keys.
Functions UNIT EXP. FIG

Measured value is displayed in unit	[F1] UNIT (UNIT)
Measured value is displayed in EXPONEN	[F2] EXP. (EXPONENT)
Number of display columns of measured value is set	[F3] FIG (FIGURE)

In display column count setting, “ENTER SIGNIFICANT FIGURE” is displayed in the bottom of the screen.

Input the number of display columns (2 to 5) through the numeric keys.
Press the [ENTER] key after inputting to enter the selection.

Types and indication methods of measured values are shown in Table 5.2.
Meanings of side marks displayed on the screens are shown in Table 5.3.

5.2.2 Comparison measurement

Set conditions for comparing a measured value with permissible upper-limit and lower-limit values and for automatically deciding acceptable or not acceptable.

Press the [COMP] (COMPARE ACTIVE) key.
The screen changes to the screen to set comparison measurement conditions. (See Fig. 5.12) This function decides whether measured results are large, small or between upper-limit and lower-limit values after comparing with upper-limit and lower-limit values and outputs a result by a side mark or to an external handler interface.
If a comparison result is NG, the side mark ("►") will flash.

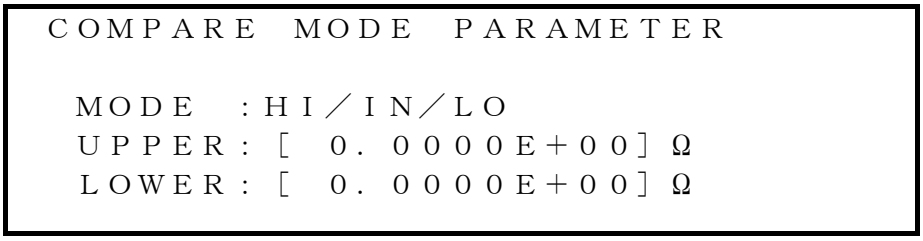


Fig. 5.12 Comparison Measurement Setting Screen

Select an item to be set on the setting screen by keying the [▲] and [▼] keys. The selected item will be highlighted on the screen.
Select a mode by keying the [◄] and [►] keys. Select "HI," "IN" or "LO."
Setting of "UPPER" or "LOWER" sets the input status of the numeric keys.
Input a numeric value to be input. Refer to 1) and 2) in the following.
Press the [ENTER] key to finish setting. The screen will return to the Measurement screen.

(1) Compare Mode setting
Select a range ("HI," "IN" or "LO") in which a comparison decision result is treated as "GO" (acceptable) by operating the "◄" and "►" keys.
Set by operating the "▲" and "▼" keys or by pressing the [ENTER] key.
Pressing the [ENTER] key exits the Setting screen and returns to the Measurement screen.

Table 5.11 Setting Ranges for Comparison Measurement

	HI	IN	LO
UPPER	GO		
LOWER		GO	
			GO

(2) Setting upper-limit UPPER and lower-limit LOWER
Setting UPPER and LOWER enables input by the numeric keys. Input a value to be set. The numeric input keys will be enabled automatically without pressing the [SHIFT] key.
Set the value input by pressing the [ENTER] key.
Press the [ENTER] key to finish setting and to return to the Measurement screen.

The setting ranges for UPPER and LOWER are limited depending on the measuring mode. See Table 5.12.

Table 5.12 Setting Ranges by Measuring Mode

Measuring Mode	Setting Range
Resistance measurement	1.0000E+01~3.0000E+16Ω
Current measurement	3.0000E-14~1.0000E-02A
Surface resistivity measurement	1.0000E+01~3.0000E+16ΩRs
Volume resistivity measurement	1.0000E+01~3.0000E+16ΩRv

[Notice]
Exercise caution when setting sequences. When setting UPPER and LOWER, an error results if the condition of (UPPER) > (LOWER) is not established, disabling keying of the [ENTER] key.

(3) Result display of comparison measurement
The side mark for “COMP ON” on the right in the screen flashes if the decision result of a comparison measurement is <NG>.
If beep tone output is set, a beep tone will be emitted as a decision result and the decision result will be output to the connector of the handler interface in the rear.

[Notice]
Comparison measurement is made only against the absolute value of each measurement item and comparison against deviation or % cannot be made.

5.2.3 Deviation display

(1) Setting deviation display
Press the [△MOD] (SET DEVIATION MODE PARAMETER) key on the measurement screen. The screen will change to the deviation (difference or ratio) display and setting screen. (See Fig. 5.13)

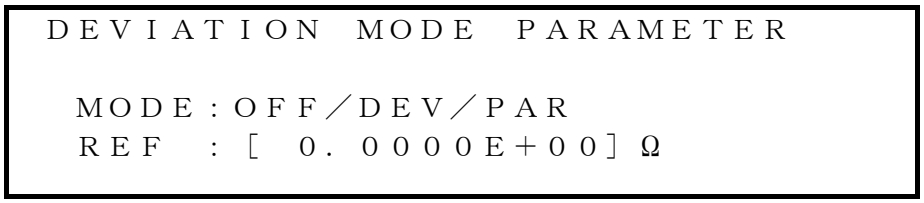


Fig. 5.13 Deviation Display and Setting Screen

(2) Setting Deviation Display mode
Select an item by operating the [▲] and [▼] keys. Select a setting mode operating the [◄] and [►] keys. The selected mode will be highlighted.
The modes have the following meanings.

OFF: Deviation is not displayed.
DEV: Displays (measured value - reference value).
PAR: Displays (measured value - reference value) x 100/reference value (%).

(3) Reference value setting
Select “REF” by operating the [▲] and [▼] keys and input a reference value to be set by keying the numeric input keys.
p.42 Press the [ENTER] key to set the input reference value.

(4) End setting
Press the [ENTER] key to finish setting and to return to the measurement screen.

[Notice]
Deviation is displayed only on the screen and normal measured values are output to the interface.

5.2.4 Creating histogram

This function is enabled in manual trigger, external trigger and sequential measurement. This function cannot be used in the Internal Trigger mode.

(1) Press the [DATA] (MEASURED RESULT DATA) key.
Pressing the key changes the screen to the screen to select a function for totaling (histogram data counter, measured data buffer). (See Fig. 5.14)
This screen is for condition setting for histogram creation, data buffer display and data buffer clear.
Select an item to be executed by operating the function key. Selecting an item changes the screen to the execution screen.

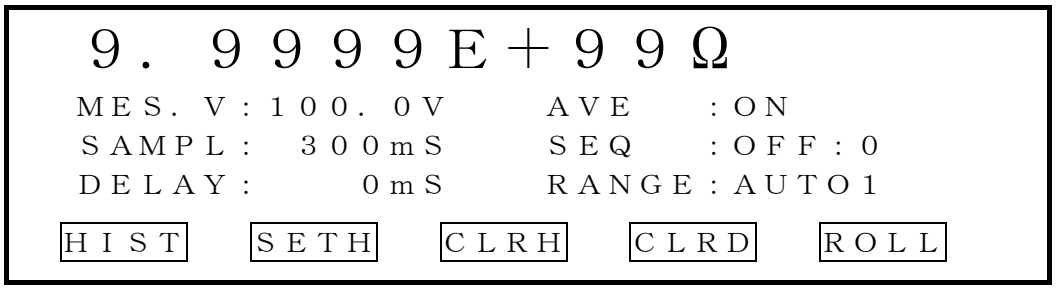


Fig. 5.14 Function Selection Screen

Press the [ENTER] key on this Function Select screen to return to the Measurement screen.

(2) Histogram threshold setting
Press [SETH] (SET HISTOGRAM) on the Function Select screen.
The screen changes to the screen for setting nine thresholds for creating a histogram.

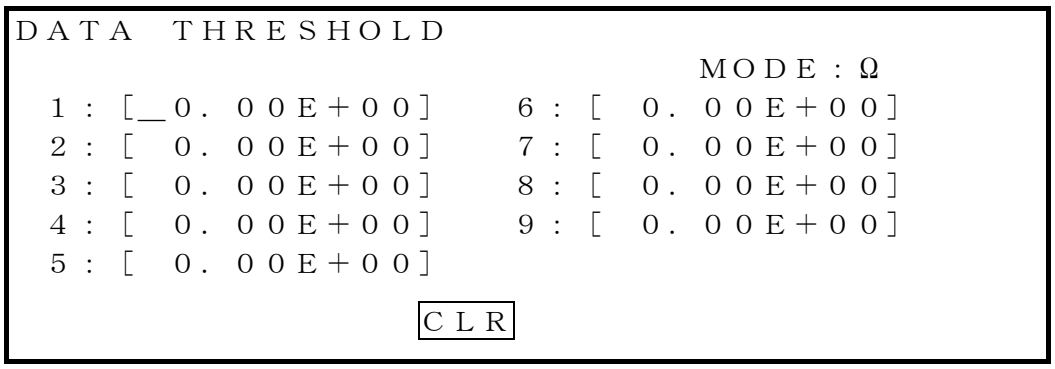


Fig. 5.15 Histogram Threshold Setting Screen

On this screen, the [F3] key functions as CLR and collectively clears all thresholds that are set.
The threshold input position can be selected operating the cursor moving keys [◄], [►], [▲] and [▼] keys.
The thresholds 1: to 9: that are input are automatically rearranged in the order of largeness. (1: large, 9: small)
When greatly changing a set value, collectively clear all the previously set values by pressing the [F3] CLR key to move the input position to “9:” and input new thresholds beginning large values.
When partially changing a set value, move the cursor to the position desired to change and input a new value. The setting in that position will be changed.
Press the [ENTER] key to set the input threshold. When setting is finished, press the [ENTER] key to return to the previous Function Select screen.

(3) Histogram counter clear
Press the [CLRH] (CLEAR HISTOGRAM COUNTER) key on the Function Select screen to change to the Histogram Counter Clear screen.

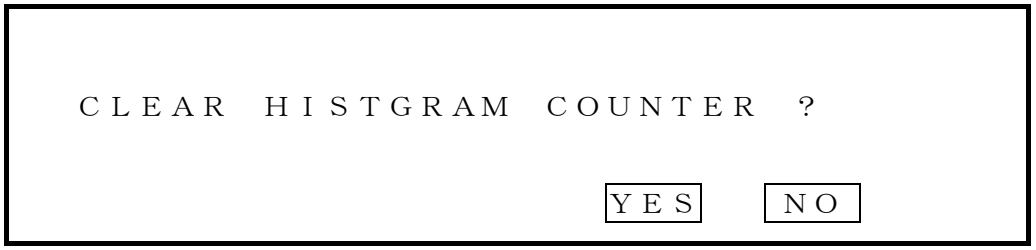


Fig. 5.16 Histogram Counter Clear Screen

On this screen, the [F4] and [F5] keys change to the “YES” and “NO” functions respectively. Press “YES” to clear the counter and to return to the Function Select screen. Press “NO” to return to the Function Select screen without clearing the counter.

(4) Histogram display
Press the [F1] HIST (HISTOGRAM) key on the Function Select screen to change to the Histogram Display screen.

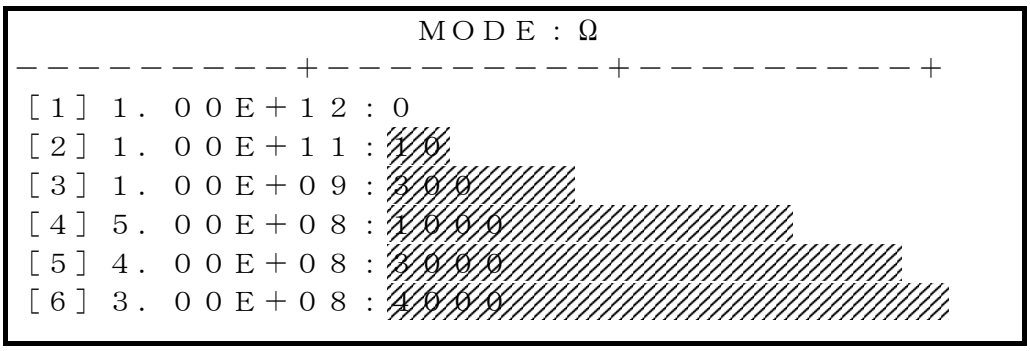


Fig. 5.17 Histogram Display Screen 1

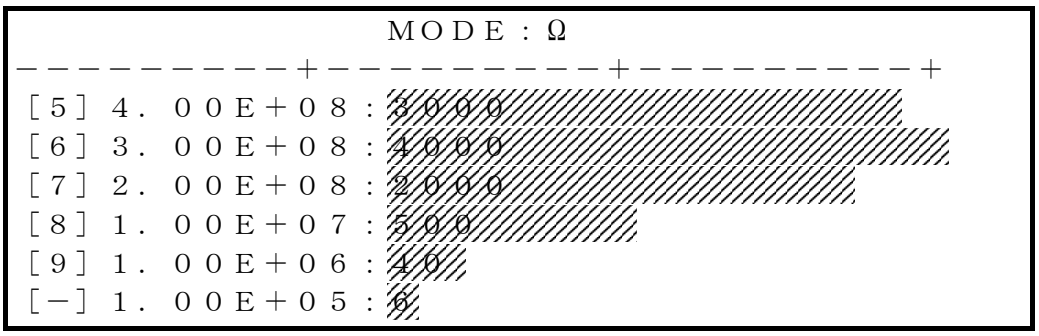


Fig. 5.18 Histogram Display Screen 2

The screen displays the numbers of data groups in the range divided into ten by the nine thresholds set by SETH in a bar graph.
The number shown in [1] represents a data quantity larger than Threshold 1:, the number shown in [2] represents a data quantity between Thresholds 2: and 1: and similarly the numbers shown in [-] represents data group quantities smaller than Threshold 9:.
The length of the bar graph sets the place with the maximum number as a full scale and other values are displayed in log ratios.
The whole bar graph in ten parts cannot be displayed on one screen and data is displayed by scrolling by the [▲] and [▼] keys.

6. Measurement

Works for insulation resistance are diverse in materials, shapes, electrical characteristics and other parameters. Insulation resistance is measured by various methods suiting these parameters.
This chapter describes the measuring terminals of the meter and measuring methods for insulation resistance that are suitable to various works.

6.1 Functions of and Connecting Measuring Terminals

6.1.1 Functions of measuring terminals

The functions of the measuring terminals located on the front panel are described.

“INPUT”: A coaxial measuring input terminal whose outer electrode (shielded side) is connected to the “GUARD” terminal.

“GUARD”: A guard terminal and is on the common side of the current measuring unit. The terminal is used for guarding to eliminate impacts of a leakage current that passes through the holder and jig of a sample. The electrical polarity of the “GUARD” terminal is “-.”

“GROUND”: A grounding terminal for reducing impacts of noise and hazard of an electrical shock.Normally connected to the “OUTPUT” terminal or “GUARD” terminal by a short bar.

“OUTPUT”: A measuring voltage output terminal. Insulation resistance is measured between this “OUTPUT” terminal and the “INPUT” terminal. The electrical polarity of the “OUTPUT” terminal is “+.”

“CHARGE”: A charging voltage output terminal that is used when precharging a sample before measurement. The precharge voltage is output between the “OUTPUT” and “CHARGE” terminals. The precharge voltage is the same level as that of measuring voltage. The potential of the “CHARGE” terminal is the same as that of the “GUARD” terminal and the polarity of it is “-.”

[Warning]
Setting of measuring voltage outputs voltage of maximum 1000V between the “OUTPUT” terminal and “INPUT” terminal or “GUARD” terminal. It is very hazardous. Be certain to connect a measuring terminal by turning the POWER switch off and checking that “POWER” on the panel is extinguished. Caution. High voltage is output also between the “OUTPUT” terminal and ground if the “GUARD” terminal and “GROUND” terminal are connected.

6.1.2 Connecting measuring terminals

Insulation resistance is measured by connecting a sample between the “INPUT” and “OUTPUT” terminals. Insulated cable with sufficient withstand voltage to measuring voltage can be used between the “OUTPUT” terminal and sample terminal. However, use measuring cable with a guard (shielded-conductor cable with a densely braided shielding braid) between the “INPUT” terminal and sample terminal. Be certain to connect the outer conductor (shielding braid) to the “GUARD” terminal.

[Notice]
Noise that is generated by the measuring cable sometimes hampers stable measurement of high resistance.
Use a low-noise shielded-conductor cable meeting the specification of HIOKI as a cable connected between the “INPUT” terminal and sample for stable measurement.

As mentioned in 6.1.1 “Functions of measuring terminals,” the “GROUND” terminal is connected to the “OUTPUT” terminal or “GUARD” terminal by a short bar. The difference between connection to the “OUTPUT” terminal and “GUARD” terminal is explained below.

(1) Grounding “OUTPUT” terminal
“+” voltage must be impressed to the terminal on the grounding side when insulation resistance (insulation resistance to the earth) of a sample (a part or circuit), whose one wire is grounded, such as a lightning arrestor. transformer, transmission cable and distribution cable, is measured. Connect the “OUTPUT” terminal on the panel of the meter to the “GROUND” terminal through the short bar, connecting the terminal on the grounding side of the sample to the “OUTPUT” terminal through the measuring cable.
“+” voltage can be impressed to the grounding side terminal of the sample by connecting the “OUTPUT” terminal to the grounding terminal of the sample even if it is not connected to the “GROUND” terminal. In this case, however, noise voltage enters the input circuit, sometimes hampering stable measurement.
Be certain to connect the “GROUND” terminal to the “OUTPUT” terminal (or to the “GUARD” terminal).

[Warning]
Connecting the “OUTPUT” terminal and “GROUND” terminal in measurement of a sample whose one wire is grounded, voltage of maximum 1000V is impressed onto the “GUARD” terminal, “INPUT” terminal and outer electrode (shielding side of the measuring cable) to the ground depending on the measuring voltage setting.
Exercise reasonable care with an electric shock.

Fig. 6.1 illustrates connection of a short bar when the “OUTPUT” terminal is grounded and an equivalent circuit.

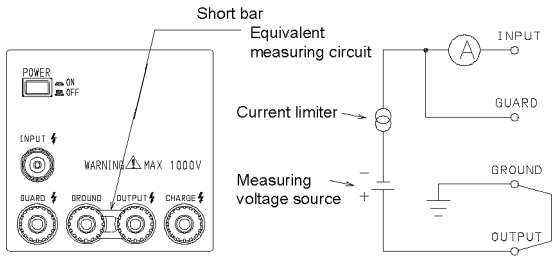


Fig. 6.1 Grounding of “OUTPUT” Terminal

(2) Grounding “GUARD” terminal
The “OUTPUT” terminal or “GUARD” terminal can be connected to the “GROUND” terminal if the sample is not grounded. However, when measurement is made using a holder or a measuring jig of a part or material and by providing a guard, the same potential is obtained between the guard circuit and ground if the “GUARD” terminal is connected to the “GROUND” terminal.

[Warning]
Connecting the “GUARD” terminal and “GROUND,” voltage of maximum 1000V is impressed between the “OUTPUT” terminal and ground (“GROUND” terminal is grounded) depending on the measuring voltage setting.
Exercise reasonable care with an electric shock.

Fig. 6.2 illustrates connection of a short bar when the “GUARD” terminal is grounded and an equivalent circuit.

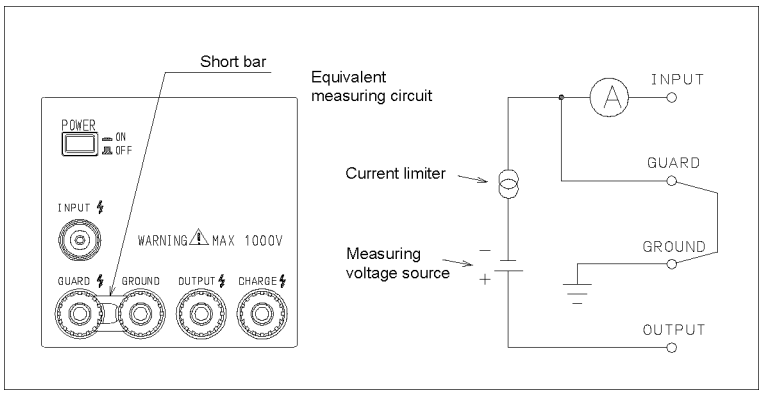


Fig. 6.2 Grounding of “GUARD” Terminal

(3) “CHARGE” terminal connection
Measuring time can be shortened by taking measurement after charging a sample (precharge) in advance when measuring a sample of a large electrostatic capacity such as a capacitor. The meter is equipped with a terminal for charge voltage output (“CHARGE” terminal) for precharging, which is useful in automatic measurement. (See 6.2.2 Auto measurement)

6.2 Measuring Parts and Circuits

Measurement is taken by setting the mode to the “Resistance Measurement” mode referring to 5.1.2 “Setting measuring mode.”
Automatic measurement using a jig is effective when measuring parts and circuits of the same shapes in a large quantity or with many points of measurement. A holder or a jig for measurement is needed when measuring very small samples.
If shapes of parts and circuits are not uniform, when shapes or weights are large, or when fewer samples are measured, more measurements are made without using a holder or a jig for measurement.

6.2.1 Using measuring jigs

Efficient measurement can be made if a measuring jig or holder is used when there are many parts to be measured or there are many points of measurement such as circuits.
Generally speaking, insulation resistance is measured by measuring a current that flows through a sample and flows from one terminal to a terminal on the other side and by converting the current into a resistance value.
To measure only a current that flows through a sample, a current that does not pass through the sample, such as a current flowing through an insulating material of a sample holder, must be escaped to the “GUARD” terminal to prevent a current from entering the “INPUT” terminal
In 6.1.1 “Functions of measuring terminals,” it was mentioned that a guard terminal is on the common side of the current measuring unit. Taking a guard means flowing of currents other than for measurement is flowed directly to the common side to prevent them from entering the “INPUT” terminal.
When a jig is used, the insulation resistance of the jig is much higher than the sample insulation resistance, such as higher by more than two digits. Guard must be provided for the part holding section of the jig, except when insulation resistances of both a sample and jig are measured together without any problem.

Structures of actual jigs and holders will be varied depending on shapes of parts. However, a guard circuit to let escape all currents that do not pass through parts collectively to the “GUARD” terminal is needed.
Using an example of a holder with a guard function illustrated in Fig. 6.3 and Fig.

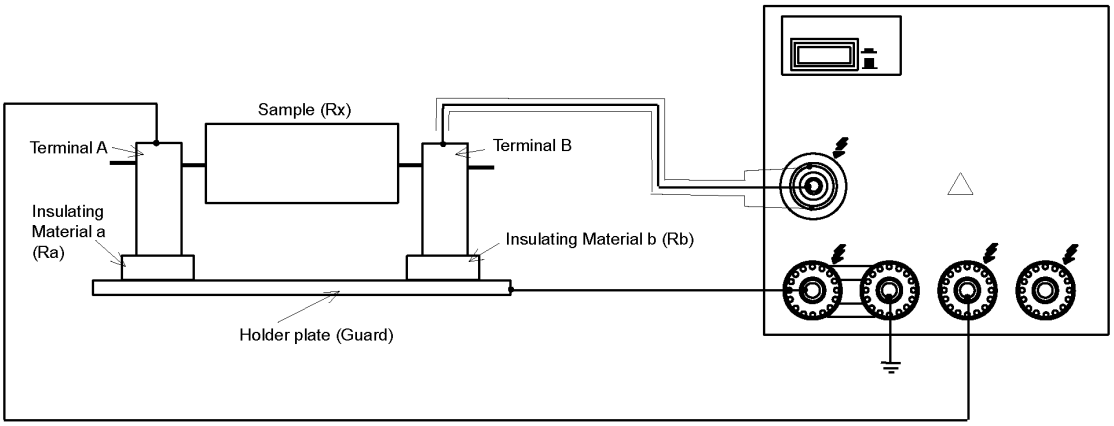


Fig. 6.3 Example of Holder with Guard

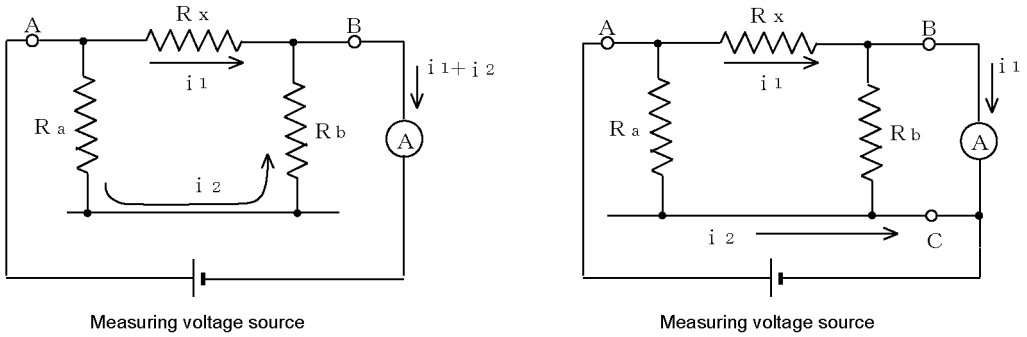


Fig. 6.4 Principle of guard

In measurement using a holder with a guard illustrated in Fig. 6.3 and considering the flow of a current from Terminal A to Terminal B, one channel passes through Sample (Rx), while the other channel flows to Terminal B passing through Insulating Material a (Ra), the holder plate and Insulating Material b (Rb).

Starting measurement after connecting Terminal A to the “OUTPUT” terminal of this meter and Terminal B to the “INPUT” terminal of the meter, currents that flow insulation resistance (Rx) of the sample, as well as insulation resistances Ra and Rb of Insulating Materials a and b, are collectively measured. This flow can be illustrated by the equivalent circuit shown in Fig. 6.4 (a) without a guard.

The equivalent circuit shows that Current i_1 flowing through the sample and current i_2 that flows through Insulating Materials a and b both flow to the input circuit through the Terminal B.

Next, using a meal plate for example as the holder plate of the holder and connecting it to the “GUARD” terminal of the meter, the current flowing to the “INPUT” terminal will be only the current that flows through the sample after the current that flows through Insulating Materials a and b is eliminated. The equivalent circuit in this case is the circuit in Fig. 6.4 (b) with a guard.

This equivalent circuit shows that Current i_2 that has passed through Insulating Materials a flows directly to the common side of the current measuring unit without entering the input circuit, to which only Current i_1 that has passed through the sample is input.

Generally speaking, a guard is provided to a jig or a holder by connecting this guard circuit to the “GUARD” terminal of the meter by making all currents that are not measured to flow a guard circuit.

6.2.2 Auto measurement

Auto measurement, in which a jig or a terminal to be measured is automatically changed, facilitates measurement when there are many parts to be measured or there are many points of measurement.
When measuring samples by changing samples, jigs or terminals to be measured, a change must be must be made tuned to timing of meter operation by the following two methods.

(a) Change the sample or the jig tuned to the “/INDEX” signal output from the “HANDLER” connector on the rear panel of the meter.
In this event, the meter should be set to the Internal Trigger mode or Manual Trigger mode and measurement is started by the Internal Trigger mode or Manual Trigger.
In the Internal Trigger mode, averaging setting to average measured results can be set.

(b) Output a trigger pulse on timing to change a sample and input the pulse to the “EXT TRIGGER” connector or the “HANDLER” connector on the rear panel of the meter.
In this event, the meter should be set to the External Trigger mode and measurement is started tuned to a trigger pulse that is input to the “EXT TRIGGER” connector or the “HANDLER” connector on the rear panel of the meter.

Note:
See 9. “External Interfaces” for more information on output of a synchronous pulse and input of an external trigger pulse.
See 5.1.7 “Setting averaging function” and 5.1.8 “Setting Trigger mode” for setting of the averaging function and trigger mode respectively.

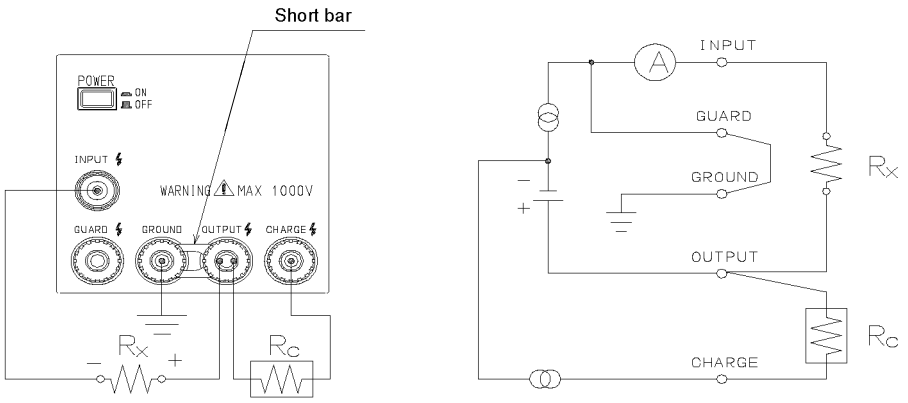
[Notice]
The [START] key outputs measuring voltage to ready a trigger. Pressing the [START] key while the trigger mode is “INT” starts measurement. Note that measurement is started by the [MAN. T] key or trigger input to “EXT TRIGGER” input when the trigger mode is “MAN” or “EXT.”

[Notice]
The following conditions are needed for an external trigger signal:

Pulse width	100μs or more
Signal logic	Negative logic (active low)
Drive output	Open collector or TTL output
Drive current	Sync current of more than 1mA

[Caution]
When changing the measuring terminal by a relay while outputting measuring voltage, serially insert a protective resistance to limit the current passing through the contact to not exceed the maximum permissible current of the contact, for protection of the relay contact.
Protective resistance value ≥(measuring voltage)/(maximum permissible current)

The meter is equipped with a contact check function that checks connection (contact) of the sample and measuring circuit including a jig and other devices to enhance reliability of insulation resistance measurement of samples with a large electrostatic capacity such as capacitors. For more information, refer to 6.7.2 “Contact check.”
Measuring time can be shortened and measurement accuracy can be enhanced by taking measurement after charging a sample in advance when automatically measuring a sample of a large electrostatic capacity such as a capacitor.
The “CHARGE” terminal is provided for this purpose.
When using the “CHARGE” terminal, setting on the Setting screen is needed.
Press [SETUP] [F5] (POWR) to set the “POWER SOURCE SELECT” screen, set 10mA or 50mA as a current limiter set value “CURL :” and set “ON” in charge voltage output terminal setting “CURL C:” Setting to ON lights up a side mark at “CHARGE ON” on the left of the screen.
In this case, fix the current limiter on the “INPUT” terminal side to 5mA irrespective of the setting of “CURL :” outputting a charging current of 5mA or 45mA is output to the “CHARGE” terminal.
Connect the “CHARGE” terminal as exemplified in Fig. 6.5.



Rc is a sample measured after Rx

Fig. 6.5 Connection of CHARGE terminal (Grounding sample)

6.2.3 When measuring jig is not used

When making measurement without using a jig or other means, use a measuring lead with a test rod or a measuring lead with an alligator clip as an option and connect it to the part to be measured.
Both of the measuring leads that are connected to the “OUTPUT” terminal have no guard, while the measuring lead connected to the “INPUT” terminal has a guard. The measuring lead with a test rod has a guard including a test rod so that measurement can be performed by holding the test rod by hand. The alligator clip of the measuring lead with an alligator clip is not guarded. Connect it to a terminal of the sample and measure the sample with a hand off.
Connect the terminals on the panels and handle the meter by the same method as that when a jig is used.

[Tip] Resistance values of insulation resistance naturally vary depending on the insulating material. Impacts by measuring voltage, temperature and measuring time are not small.
Typically, insulating materials are complex circuits with resistances and electrostatic capacities that are connected serially and in parallel. Therefore, impressing voltage to an insulating material, a dielectric absorption current and leakage current corresponding to a charging current flow.
Insulation resistance is calculated by measuring this leakage current and converting it into a resistance value. Generally, a dielectric absorption current is substantially large compared with a leakage current and time constant of it is very large depending on the type of insulating material so that a long time is needed till a dielectric absorption current becomes smaller than a leakage current. When insulation resistance is measured using such insulating material as a sample, insulation resistance is low in measurement for a short time, becoming high longer the measuring time is. The time constant and insulation resistance of a dielectric absorption current vary significantly depending on the voltage impressed to the insulating material. In general, insulation resistance lowers higher the measuring voltage is.
Temperature also affects greatly. The type of insulating material also makes a difference, but insulation resistance generally lowers higher the temperature is.
Correct measurement of insulation resistance is time consuming and is also difficult.
Depending on the withstand voltage of a sample, measuring voltage sometimes cannot be decided freely. Values obtained in one minute as measuring time are used as measuring time and one-mute values of insulation resistance are used by adding measuring voltage such as “DC 500V 1000MΩ.
When comparing insulation resistances, measurement must be made after deciding measuring voltage and measuring time. It is sometimes important to shorten measuring time (or inspection time) of parts and other samples. In this case, it is important to measure after deciding a time within a range in which correlation can be taken with a one-minute value.

6.2.4 Measurement of circuits

The circuit is a combination of plural parts. Insulation resistance is measured outside of circuits such as between circuits that are mutually insulated and between a circuit and casing. The measuring method and handling of this meter are the same as those used in measurement of insulation resistance of parts.
Normally, measuring voltage higher than voltage that is used inside the circuit is used in measurements of insulation resistances of circuits. Measurement must be made exercising reasonable caution so as not to affect circuits such as measuring voltage and polarity.
When measuring samples such as a telephone cable that has many points of measurement, it is effective to measure utilizing features of this meter, such as measuring by automatically changing measurement points and making measuring conditions identical.

6.3 Measuring Planar Sample

When measuring insulation resistance of a sample that has no terminals, devices that act as terminals must be installed on the sample in one form or the other.
Devices of various shapes that act as terminals can be considered. Convenience with which to easily exchange samples is desirable and devices of a structure that become terminals only by contacting a sample are used more.
Terminals for measurement must be free of malcontact and must contact the sample tightly. However, the shape and structure of the terminal differ depending on the sample shape and property. Various methods to measure insulation resistance are used with solid-state insulating materials by having a terminal (electrode) with a smooth and flat surface contact a sample of a pin type with a specified shape or smooth and flat surface so that contact can be made tightly without a gap.
This section describes these measuring methods.

6.3.1 Measurement by pin terminal

Insulation resistance is divided into “volume resistivity” caused by a current that flows inside a sample and “surface resistivity” caused by a current that runs the surfaces of a sample. Insulation resistance measurement is measurement of volume and surface resistivities.
For example, a measuring terminal is made using a planar sample, by drilling two holes of a specified diameter, such as tapered holes, at a predetermined spacing, and by inserting pins coated with a material with relatively low insulation resistance such as vaseline.
The surfaces of samples do not have to be finished into smooth surfaces and these terminals can achieve relatively stable contact with a simple structure.
Set the measuring mode to “resistance measurement.”

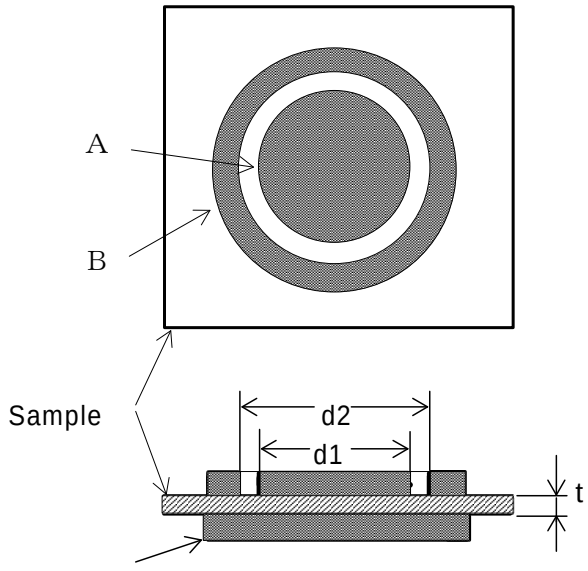
6.3.2 Measurement by electrode for surface resistance measurement

This electrode is used as a measuring terminal by pressing it onto a surface of the sample. It can be used simply when a sample is relatively soft.
Strictly speaking, this electrode does not separate volume resistivity strictly. However, in general, surface resistance is lower and can be measured in practice. It is especially convenient in measuring samples whose surfaces are treated for prevention of electrostatic resistance.
Set the measuring mode to “resistance measurement.”

6.3.3 Measurement by electrode for planar sample

Insulation resistance is divided into volume resistance and surface resistance and characters of them are different. Therefore, volume resistance and surface resistance must be measured separately.
When insulation resistances of insulating materials are mutually compared, insulation resistances unique to insulating materials that are not affected by terminal shape or other factors are needed. These are volume resistivity and surface resistivity and must be converted by multiplying volume resistance and surface resistance, which are separately measured, by a constant determined by the dimensions of an electrode used or other parameters.

(1) Volume resistivity and surface resistivity
An example of electrode to measure volume resistance and surface resistance and of usage are illustrated in Fig. 6.5.



Usages of electrodes suiting measurement objects are as follows.

	Volume resistance	Surface resistance
A	Main electrode	Main electrode
B	Guard electrode	Pair electrode
C	Pair electrode	Guard electrode

The main electrode is connected to the “INPUT” terminal, while the guard electrode is connected to the “GUARD” terminal and pair electrode is connected to the “OUTPUT” terminal.

Fig. 6.5 Example of Planar Sample Electrode

Volume resistance and surface resistance measured and multiplied by an electrode constant are called volume resistivity (ρ_v) and surface resistivity (ρ_s), respectively.

$$\text{Volume resistivity } \rho_v = \frac{\Pi \cdot D1^2}{4t} \times \frac{\text{Measured value}}{10}$$

where ρ_v : volume resistivity in [Ω·cm]
Π : circle ratio = 3.14
D : diameter of main electrode in [mm]
t : Sample thickness in [mm]

$$\text{Surface resistivity } \rho_s = \frac{\Pi \cdot (D2+D1)}{D2-D1} \times \text{Measured value}$$

where ρ_s : surface resistivity in [Ω]
Π : circle ratio = 3.14
D : diameter of main electrode in [mm]

(2) Electrode constant setting
Measure volume resistivity and surface resistivity by setting measuring modes for volume resistivity measurement and surface resistivity measurement respectively referring to 5.1.2 “Setting measuring mode.”
The meter is capable of automatically performing calculations of volume resistivity and surface resistivity mentioned in 1). For this purpose, set in advance constants of electrodes to be used in measurement as follows.

The following three electrode constants are set:
D1 (IN DIAMETER): Set diameter of the main electrode (A) in increments of mm.
D2 (OUT DIAMETER): Set inside diameter of the pair electrode (B) in increments of mm.
t (THICKNESS): Set thickness of the sample in increments of mm.

Set the desired electrode constants on the screen illustrated in Fig. 6.6.
On the measurement screen, measured volume resistivity and surface resistivity are indicated by “Rv” and “Rs” respectively.
Press the [ELEC] (SET ELECTRODE SIZE) key on the measurement screen.
The screen will change to a screen for setting electrode constants to be used in measurement of volume and surface resistivities. (See Fig. 6.6)

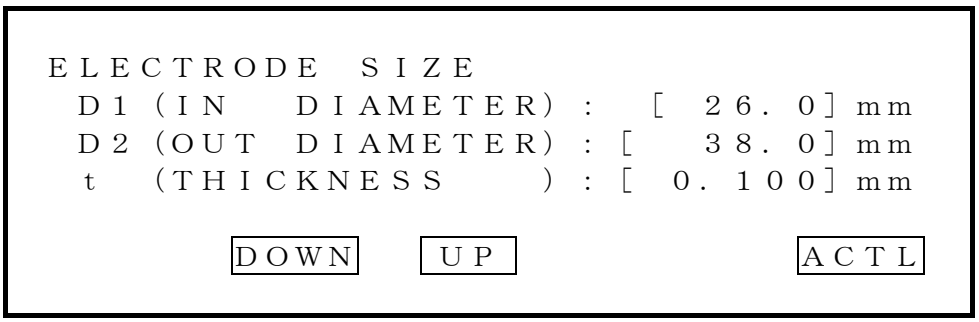


Fig. 6.6 Electrode Constant Setting Screen (Disc Electrode)

On the screen illustrated in Fig. 6.6, the function keys [F2], [F3] and [F5] will change to DOWN, UP and ACTL respectively. The [F2] DOWN and [F3] UP keys are used for selecting the constants preset in the meter. When setting a value other than specified values, select the item desired to set by operating the [▲] and [▼] keys and input the value by keying the numeric keys.

(3) Specified value of electrode constant
The meter has the following values as specified values.

D1, D2 Specified value of electrode diameter
If D1 = 26, D2 = 38
If D1 = 50, D2 = 70
If D1 = 70, D2 = 90
If D1 = 76, D2 = 88

t Specified value of sample thickness	
t=0.010	t= 2.000
t=0.100	t= 5.000
t=0.200	t=10.000
t=0.500	t=20.000
t=1.000	t=30.000

Press the [ENTER] key after finishing setting. The screen will return to the measurement screen. Select “surface resistivity measurement” or “volume resistivity measurement” as the measuring mode by pressing the F2 [MODE] key.

6.3.4 Use of shielding box

In measurement of high insulation resistance, stable measurement is sometimes hampered due to noise and induced current in the ambience as measurement is high-sensitivity measurement of a current.
Samples need be placed in a shielding box when measuring samples of high insulation resistance.

(1) Connection
An example of connection when a shielding box is used is illustrated in Fig. 6.7.

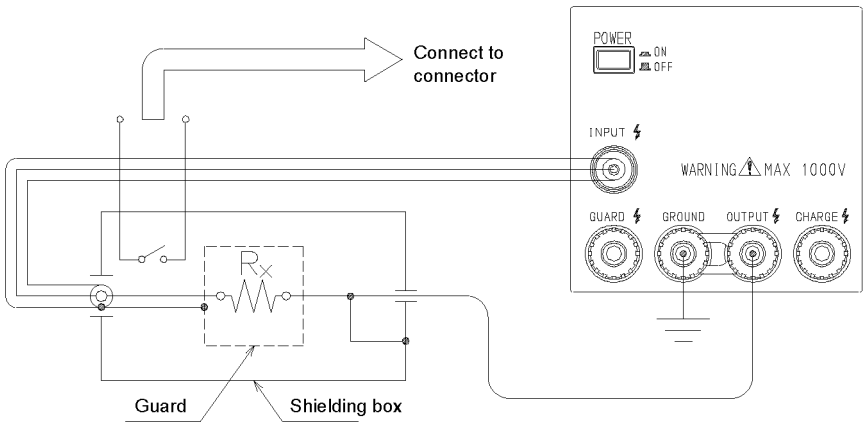


Fig. 6.7 Example of shielding box connection

[Warning]
Maximum 1000V of measuring voltage is output between the “GROUND”” terminal and “GUARD” terminal or the “OUTPUT” terminal depending on the connecting method of the short bar.
Be sure to connect the outer casing of the shielding box to the “GROUND” terminal.
Use the interlock function to prevent an electric accident.
Exercise reasonable care with an electric shock.

[Note]
As an option, a shielding box model SME-8350 is available.

Set the measuring mode in accordance with the measuring object as explained in 6.2 “Measuring Parts and Circuits” and 6.3 “Measuring Planar Sample” when a shielding box is used.

(2) Interlock function setting

Output of measuring voltage is sometimes not safe such as when the lid of a shielding box is opened. The INTERLOCK function is useful in these cases.
As in the example of use of a shielding box illustrated in Fig. 6.7, connect the “open” signal of the shielding box lid to the [INTERLOCK] connector in the rear of the meter through the interlock connection cable. Then set as follows.
Press the [F1] CONF (CONFIGURATION) key in the Operating Environment Setting screen. (See Fig. 5.6)
The screen will change to the External Interface Condition Setting screen. (Fig. 6.8)
The External Interface Condition Setting screen is split into two pages.

```
CONFIGURATION  PAGE－1／2

    INTERLOCK：CONECT／CUTOFF
    BEEP       ：OFF／ON
    BEEP       ：NO／GO
    CLICK      ：OFF／ON

                                PAGE
```

Fig. 6.8　External Interface Condition Setting Screen 1/2

Select “PAGE-1/2” and set an item in “INTERLOCK:.”　The following function will be displayed.

CONECT: The interlock function will be enabled.

Short-circuiting the “INTERLOCK” input on the rear (low level input) enables output of measuring voltage, disabling output of measuring voltage when the “INTERLOCK” input is open-circuited (high level input).
When disabled, the [START] key cannot be operated and a side mark (“◂ ”) will light up by “INTERLOCK” indication on the left of the LCD screen.

CUTOFF: The interlock function will be disabled.

Measuring voltage can always be output irrespective of the “INTERLOCK” input on the rear.

6.4　Measuring Liquid Sample

Measure volume resistance of a liquid sample by dipping electrodes of a preset shape in the liquid sample or use an electrode that also acts as a container of the liquid sample.

6.4.1　Measurement by electrode for liquid sample

(1)　Connection

A sketch of liquid sample electrodes and a connection example of them are illustrated in Fig. 6.9.

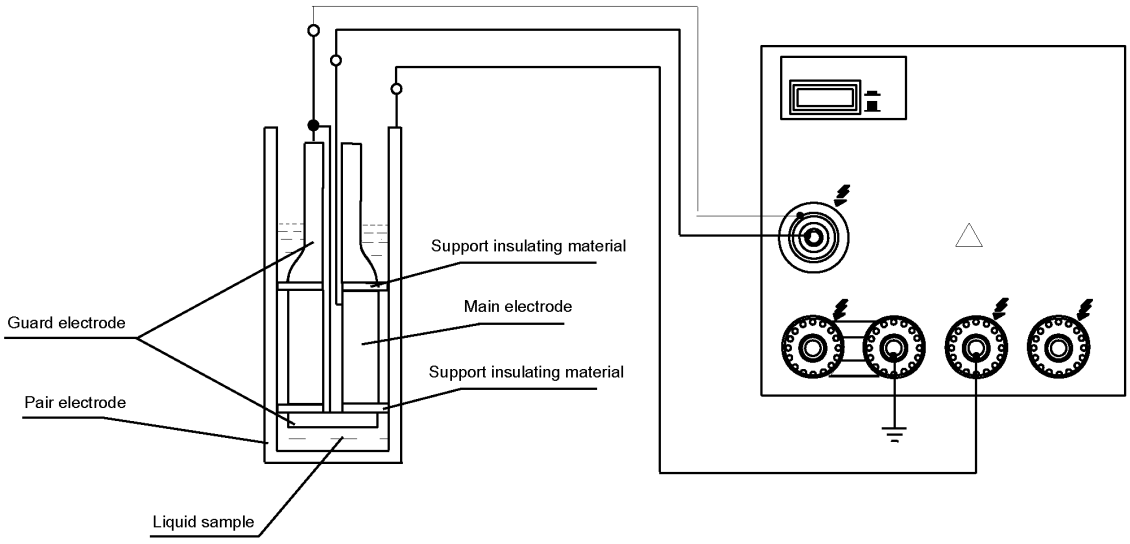


Fig. 6.9 Connection Example of Liquid Sample Electrodes

(2) Electrode constant setting
To set resistance values that are not affected by the electrode shape, set in this meter the electrode constants used in measurement and measure resistance as volume resistivity of a liquid sample.

[Note] Refer to the instruction manual of the liquid sample electrode for more information about electrode constants. The volume resistivity is calculated by multiplying a measured value by an electrode constant as follows.

Volume resistivity ρv = K·measured value [Ω·cm]
Where ρv: volume resistivity in [Ω·cm]
K : electrode constant in [cm]

The meter is capable of automatically calculating volume resistivity.
Set an electrode constant as follows.
On the screen illustrated in Fig. 6.6, press the [F5] ACTL key.
The screen will change to the Electrode Constant Setting screen illustrated in Fig. 6.10.
Input the electrode constant of the electrode to be used.
Press the [ENTER] key after finishing setting.
The screen will return to the measurement screen. Select “volume resistivity” [Rv] by pressing the F2 [MODE] key as the measuring mode. (Displayed measured values will be the same values as those of [Rv] values even when [Rs] is selected.)

Fig. 6.10 Electrode Constant Setting Screen

[Note]
Press the [ENTER] key to use constants on the screen set before returning to the measurement screen. The concept of electrode constant setting explained in 6.3.3 2) “Electrode constant setting” and 6.4 “Measuring Liquid Sample” is illustrated below.

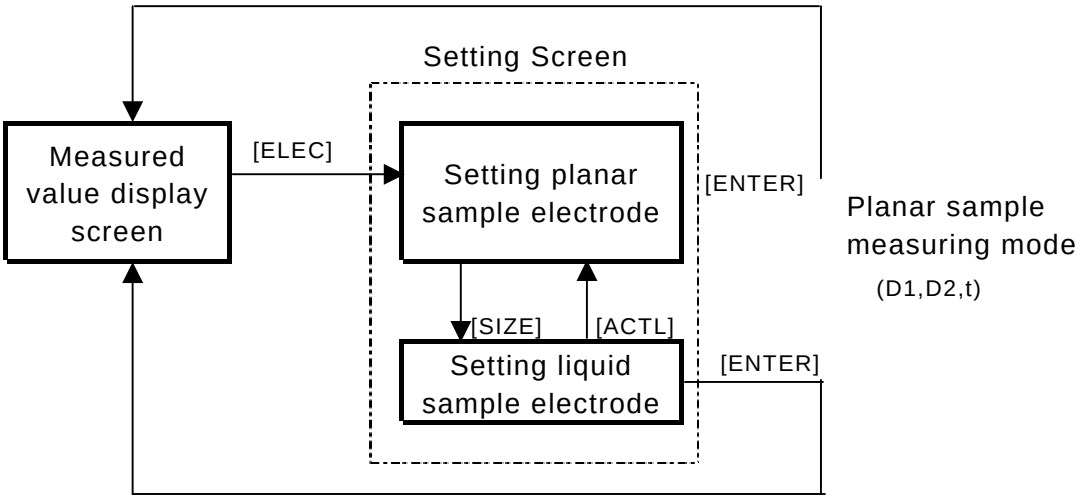


Fig. 6.11 Concept of Electrode Constant Setting

6.5 Current Measurement

Set the measuring mode to “Current Measurement” referring to 5.1.2 “Setting measuring mode” when measuring a current.

(1) Connection

When the measuring power source of the meter is used, connect measuring object such as a part and circuit between the “OUTPUT” terminal and “INPUT” terminal on the panel of the meter as in measurement of insulation resistance. The polarities of the “OUTPUT” terminal and “INPUT” terminal are “+” and “-” respectively. Connect the terminals matching the polarities of the work. Be sue to use a shielded-conductor cable as the measuring lead connected to the “INPUT” terminal to prevent induced troubles such as noise and connect the shielded conductor to the “GUARD” terminal.

Connect the “+” side of the work to the “INPUT” terminal and “-” side to the “GUARD” terminal when connecting to a work that generates a current.

In this case also, be sure to use a shielded-conductor cable as the measuring lead connected to the “INPUT” terminal and connect the shielded conductor to the “GUARD” terminal.

6.6 Ending Measurement

Press the [STOP] key when finishing measurement.
Pressing the [STOP] key lights up the [STOP] lamp beside the key. The measuring voltage output will become 0V and trigger input will be prohibited in a [STOP] state. The circuit between the “OUTPUT” terminal and “INPUT” terminal will become a discharge state (discharge state with a current limiter connected). The state of the “CHARGE” terminal will also become the same state.

[Warning]
Residual measuring voltage sometimes still remains inside the sample after pressing the [STOP] key. Be cautious and do not touch metal parts impressed with voltage till the inside of the meter is thoroughly discharged. Otherwise an electric shock may result.

6.7 Measurement Check

The meter is capable of checking “acceptable” or “non-acceptable” of a measured state as explained below.

6.7.1 Voltage check

The voltage check function checks output state of measuring voltage and determines if measuring voltage is output normally. The voltage check accuracy is ±3% and the setting accuracy of measuring voltage cannot be checked. The voltage check function is mainly used in detecting flaws of the voltage output circuit and operational state of current limiters.
If the measuring voltage is below 10V, correct decisions sometimes cannot be made due to voltage check accuracy problems. Use this function when the measuring voltage is higher than 10V.
Voltage checks can be made for each measurement and only when necessary by operating the panel keys or by issuing commands through interfaces.

[Notice]
Measurement and data output will be made as in normal operation even if a decision of voltage check is <NG>. However, signals will not be saved in the data buffer if the result of a voltage check is <NG>.

(1) Setting automatic voltage check
Press [SHIFT] [F3] V.CK on the setting screen referring to 4.5 “Display Screen” and
5.1.1 “Screen types.” Select on the screen whether to (execute · not execute) monitoring of the measuring voltage automatically.
Selection made for voltage checks will be indicated by a side mark.
The side mark will flash in case the result of a voltage check is not acceptable.

6.7.2 Contact check

Capacitors with defective insulation are judged “acceptable” in capacitor measurement if measurement is made while the measuring jig of the measuring system is not contacting a capacitor. To prevent these errors, this function checks whether or not the measuring jig is contacting a capacitor. This function is one of the features of the meter.
The side mark flickers (a sample is not connected) when the capacity of the measuring system becomes smaller than the reference value for contact check. Check the meter and measuring jig.

Detection is made by detecting the electrostatic capacity and this function cannot be used with samples whose electrostatic capacity component is small such as pure resistance.
The cable length is predetermined because an electrostatic capacity of the measuring cable enters the jig capacity in parallel. The measuring cable length was adjusted to 1m during a preshipment inspection at the factory. Readjustment will be necessary if a longer cable is required. However, the maximum cable length guaranteed for detection accuracy is 2m. The cable length can be lengthened up to about 4m if the electrostatic capacity of a sample is several thousand pF or higher. Nevertheless, the jig capacity offset capacity will deteriorate and errors of more than 50% will result. (Errors are ±20% or less if the cable length is 1m)
Contact checks are made in an auto execute mode, in which checks are made for each measurement, and in a single execute mode in which checks are made by keying the panel keys or by interface commands when needed.

(1) Setting auto contact check execute

Press [SHIFT] [F4] C.CK on the setting screen referring to 4.5 “Display Screen” and
5.1.1 “Screen types.” Select on the screen whether to (execute · not execute) contact check during measurement.
Selection made for contact checks will be indicated by a side mark.
The side mark will flash in case the result of a voltage check is not acceptable.

[Notice]
Measurement and data output will be made as normal even if a decision of contact check is <NG>. However, signals will not be saved in the data buffer if the result of a contact check is <NG>.

[Notice]
Be certain to set an open correction value when using the contact check function. Otherwise errors will result. A side mark (“◀”) will be lit in the “OPEN SET” window in the lower left of the front panel when open correction is executed once.

[Warning]
In open correction, measuring voltage is momentarily output to the measuring terminal. Carefully check that no hand or other body part is contacting the jig or measuring circuit before pressing the [OPEN] key. Maximum 1000V voltage is output and an electric shock is a hazardous possibility.

(2) Open correction value setting

Set a decision capacity in contact check when setting an open correction value. Press the [OPEN] (SET OPEN CHECK PARAMETER) key on the measurement screen. The screen will change to the screen to set a reference value for contact check. (See Fig. 6.12)

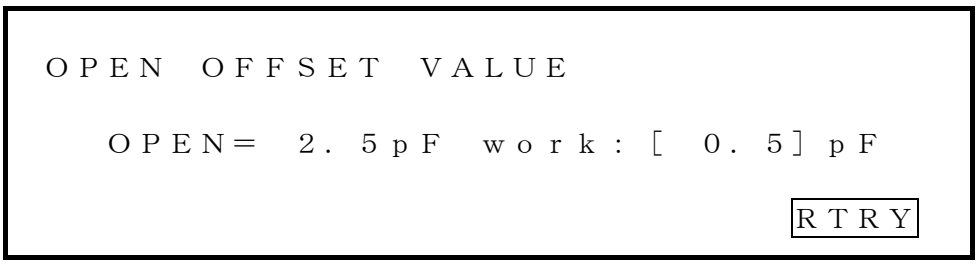


Fig. 6.12 Open Correction Value Setting Screen

Displaying this screen, the open capacity of the measurement system will be measured and the following data will be displayed:

OPEN = x.xpF work

The function key [F5] will change to the RTRY (RETRY) function. Pressing the [F5] RTRY key will redo measurement of the open capacity value of the measuring system.

(3 Setting decision capacity reference value

A minimum capacity value of a sample is set operating the numeric keys. (0.5 to 99.9)

The minimum capacity value is 1/10 the open capacity value of the measured measuring system or 0.5pF, whichever is larger.

The reference value for contact checks is a total of the open capacity value of the measured measuring system and of a 1/2 value of the set capacity value. Contact NG will result if the capacity is smaller than this value.

7. GP-IB Interface

7.1 Overview

The DSM-8104 is equipped with a GP-IB interface as a communication function among its standard provisions. This interface allows remote control and transfer of data by a GP-IB controller. See 5.1.12 “Setting other items” for setting of GP-IB addresses.

7.2 Specification

Electrical/mechanical : Conform to IEEE std. 488-1978
Code : ASCII code
Address setting : Talker/listener addresses 0 to 30 can be set.
Remote status cancel : Cancelled by pressing [LOCAL] key on the panel

Table 7.1 Interface Functions

Function	Description
SH1 (Source handshake)	All functions
AH1 (Acceptor handshake)	All functions
T6 (Talker)	Basic talker function Serial polling function Talker cancel by listener specification (MLA)
L48 (Listener)	Basic listener function Listener cancel by talker designation (MTA)
SR1 (Service·request)	All functions
RL1 (Remote·local)	All functions
PPO (Parallel·polling)	No function
DC1 (Bus·buffer)	All functions
DT1 (Device·clear)	All functions
CO (Controller)	No function
E2 (Bus·buffer)	Tri-state output

7.3 Talker Function

Output data format

The output format of measured data can be selected from the following four types by the “DFM” command.

(1) Basic format

±d.ddddE±dd , d , d $^{L}_{F}$ <EOI>

① ② ③ ④

① Measured value

Measured values will be set in an 11-byte exponential format.

±d.ddddE±dd	d: numeral

Output data in overrange will set “0s” in all numerals for resistance measurement and “9s” in all numerals for current measurement.

+0.0000E+00	Resistance measurement
+9.9999E+99	Current measurement

② Status

Results of voltage checks, contact checks and overrange will be set in numerals 0 to 4.

Individual results will be allocated to bit0 to bit2 in status and logical OR of them will be output.

bit0: Voltage check NG (Result of auto execution)
bit1: Contact check NG (Result of auto execution)
bit2: Overrange

If status is “0,” results are normal in all events.

③ Comparison result

0: HI (Measured value exceeded upper-limit reference value)
1: IN (Measured value remains within the range of upper- and lower-limit reference values)
2: LO (Measured value is less than lower-limit reference value)

[Note] When comparison measurement is off, the comparison result will not be added.

④ Delimiter

An output message delimiter can be designated from the following three delimiters by the “DLM” command.

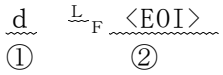
$^{L}_{F}$<EOI> Default
$^{C}_{R}$ $^{L}_{F}$<EOI>
<EOI>

[Note] A default will result when the power is turned on.

(2) Format with measured value only

Status and data of comparison result will not be added.
The other details are the same as those for the basic format.

(3) Format with comparison result only



① Comparison result
The details are the same as those for the basic format.

② Delimiter
The details are the same as those for the basic format.

(4) No data return
Specifying this format will return data as a trigger response. This format is used for storing data in the data buffer temporarily and reading it in batch.

Data separator
Two data fields are separated by one comma “,.”

7.4 Response to Query Program Message

Responses to query program messages are made in the following formats: NR1, NR2, NR3, any ASCII character string format and binary format with a specified length. See Table 7.3 List of Program Messages when deciding which format will be used.
NR1 format
Data strings: Integers (Mainly setting type and status)

NR1 format
Data strings: Integers (Mainly setting type and status)

－ｄｄｄｄｄ$^{L}_{F}$＜ＥＯＩ＞

NR2 format
Data strings: Number of fixed decimal points (Mainly set values)

－ｄｄｄ．ｄ$^{L}_{F}$＜ＥＯＩ＞

NR3 format
Data strings: Number of floating decimal points (Mainly set and measured values)

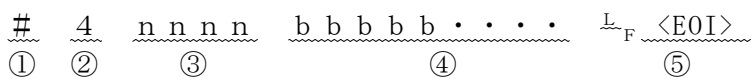
±ｄ．ｄｄｄｄＥ±ｄｄ$^{L}_{F}$＜ＥＯＩ＞

ASCII character string format
Data strings: Random ASCII character strings (Mainly equipment IDs)

ＸＸＸＸＸＸＸＸＸＸ$^{L}_{F}$＜ＥＯＩ＞

“X” denotes an ASCII character

Binary format with a specified length (Used in data buffer readout)



① Indicates binary format.

② Indicates the number of “n” columns that follow. Fixed to “4.”
③ A 4-digit numeric value indicating the number of bytes of binary data that follows.
④ Binary data.
⑤ Delimiter.

The data format is the 32bit floating decimal point format conforming to IEEE 754. In case of overrange, all bits in both exponent part and fixed-point part become “1s.” (Nonnumeric)

Message delimiter

An output message delimiter can be designated from among the following three delimiters by the “DLM” command.

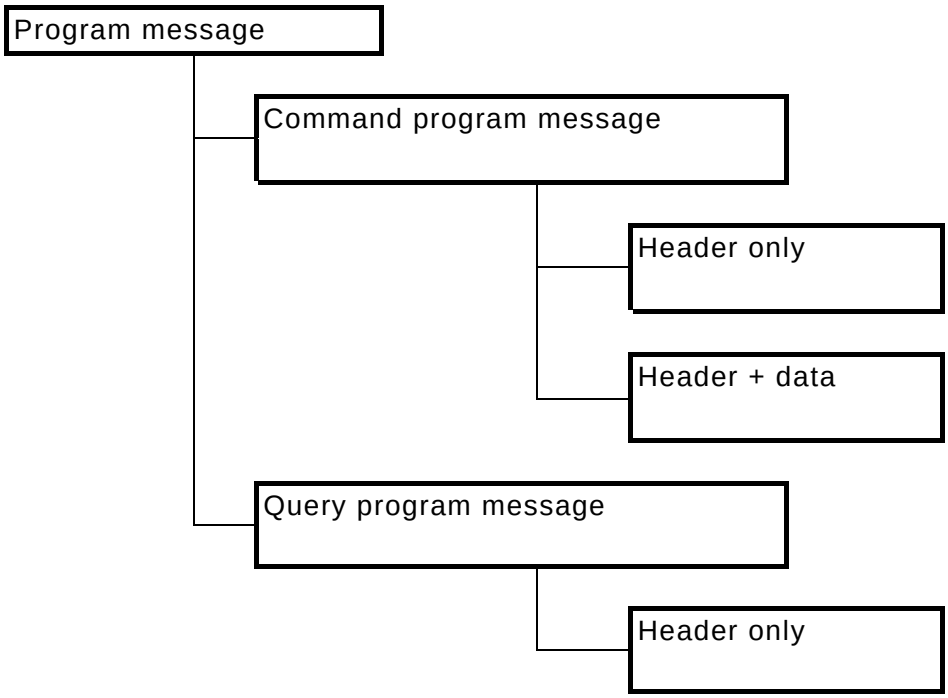
$^{L}_{F}$〈EOI〉 Default
$^{C}_{R}{}^{L}_{F}$〈EOI〉
〈EOI〉

[Note] A default will result when the power is turned on.

7.5 Listener Function

The DSM-8104 accepts program messages in ASCII character strings.
In this manual, program messages are also described generically as “commands” or “command messages.”
Program messages are classified as follows.

Table 7.2 Classification of Program Messages



Command program message
Command program messages are used in setting equipment, measurement start and for other purposes.

Query program message

Query program messages are used when querying about equipment status and for other purposes.

Program message composition

① A header only
② A header and one data group separated by a header separator.
③ Plural data groups separated by data separators.
④ Plural data groups separated by message separators.

①	XXX<Delimiter>
②	XXX ddddddd<Delimiter>
③	XXX ddd, ddd, ddd, ddd<Delimiter>
④	XXX ddd ; XXX ddd<Delimiter>

Separator

The separators use the following characters.

①	Header separator――――――( ) space
②	Data separator ――――――(,) comma
③	Message separator――――(;) semicolon

Message delimiter

The following six delimiters are accepted as effective input message delimiters:

②	$^{C}_{R}{}^{L}_{F}$<EOI> ―――C_R + L_F	<EOI> simultaneously with L_F
②	$^{L}_{F}$<EOI> ――――L_F	<EOI> simultaneously with L_F
②	$^{C}_{R}$<EOI> ――――C_R	<EOI> simultaneously with C_R
②	<EOI> ――――――<EOI> simultaneously with last data byte	
②	$^{C}_{R}{}^{L}_{F}$ ―――――――――― $^{C}_{R}$ + $^{L}_{F}$	
①	$^{L}_{F}$ ―――――――――― $^{L}_{F}$	

Format of command program message

Commands with plural program data groups can omit program data by using formats of the following examples. These commands can be used with program data that requires no alterations.

Example 1: Altering only sequence program No.
Example 2: Altering Sequence Discharge 2
Example 3: Shutting down a sequence

7.6 Device Clear Function

The DCL and SDC commands clear the input buffer and output queues. If in a start state (voltage being output, during measurement), the commands process stopping.

7.7 Device Trigger Function

The GET command performs the same function as that of the *TRG command message.

7.8 Remote and Local Functions

In the Remote mode, the panel keys are disabled except the [LOCAL], [STOP] and [LCDOF] keys. Press the [LOCAL] key to return to the Local mode.

The [LOCAL] key is also disabled when the Local Lockout (LLO) command is executed by an interface.

The [STOP] key and [LCDOF] key can be used even in the local lockout state.

Syntax Chart

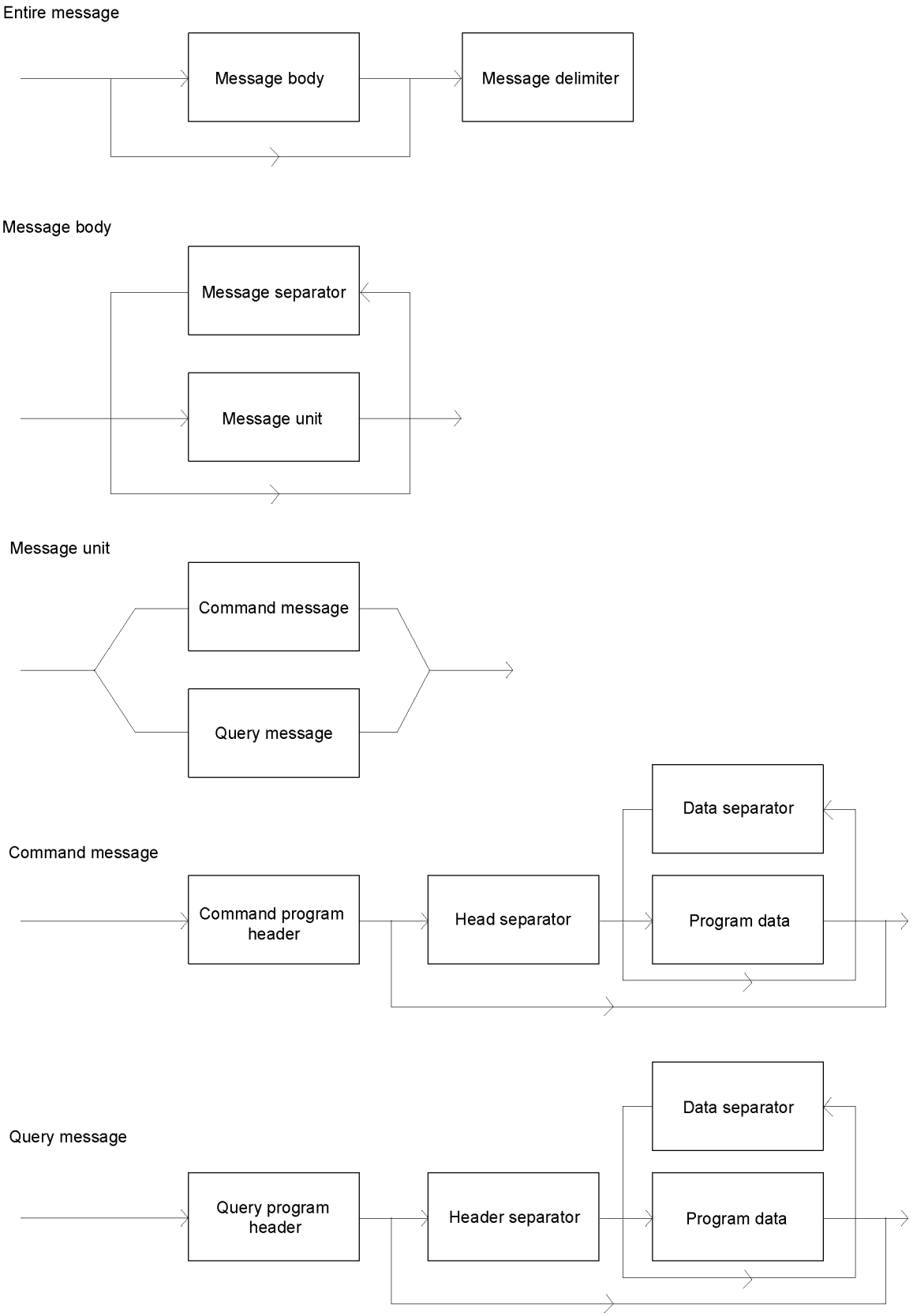


Fig. 7.1 Message Syntax Chart

Command program header

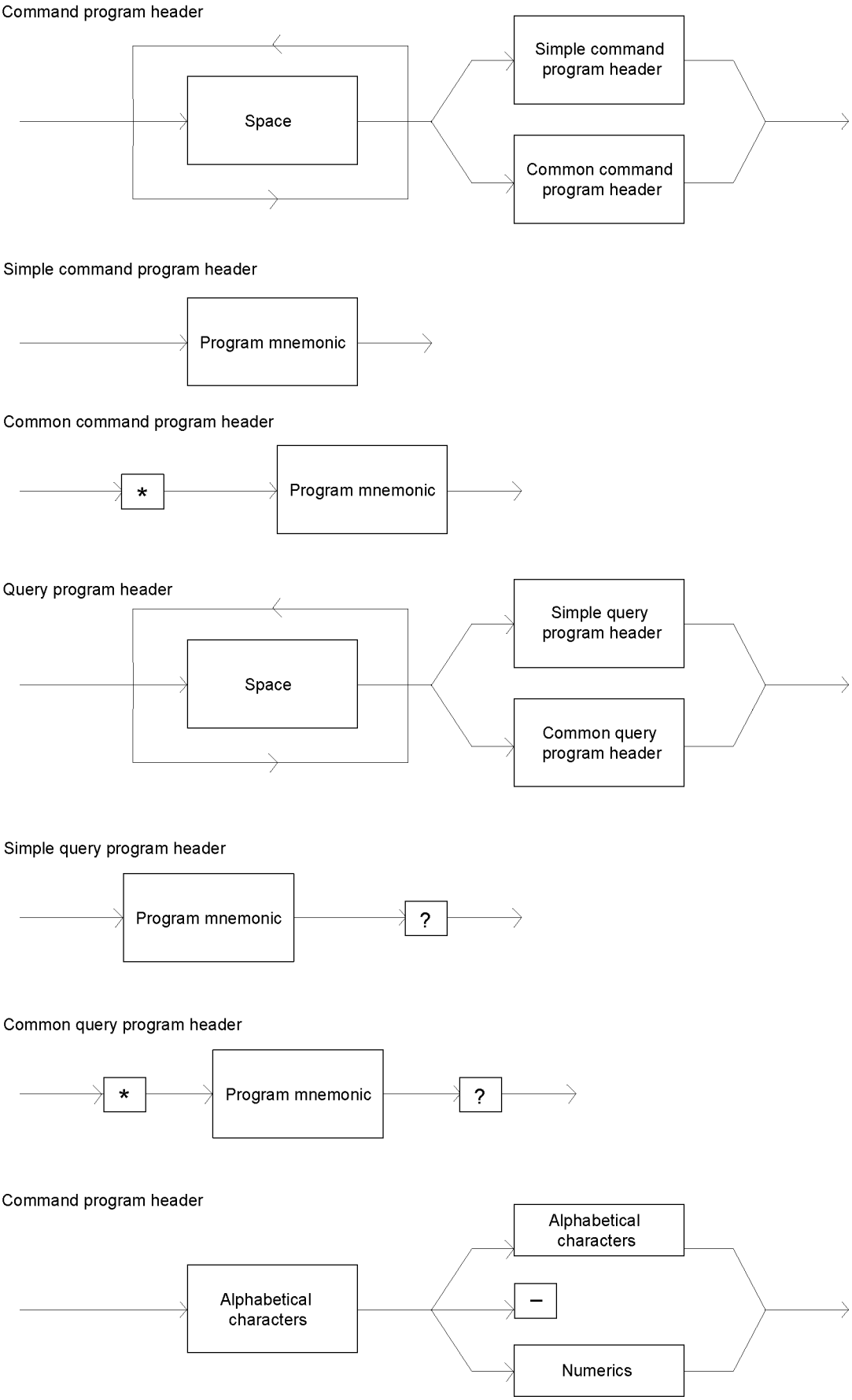


Fig. 7.2 Program Header Syntax Chart

NRf format

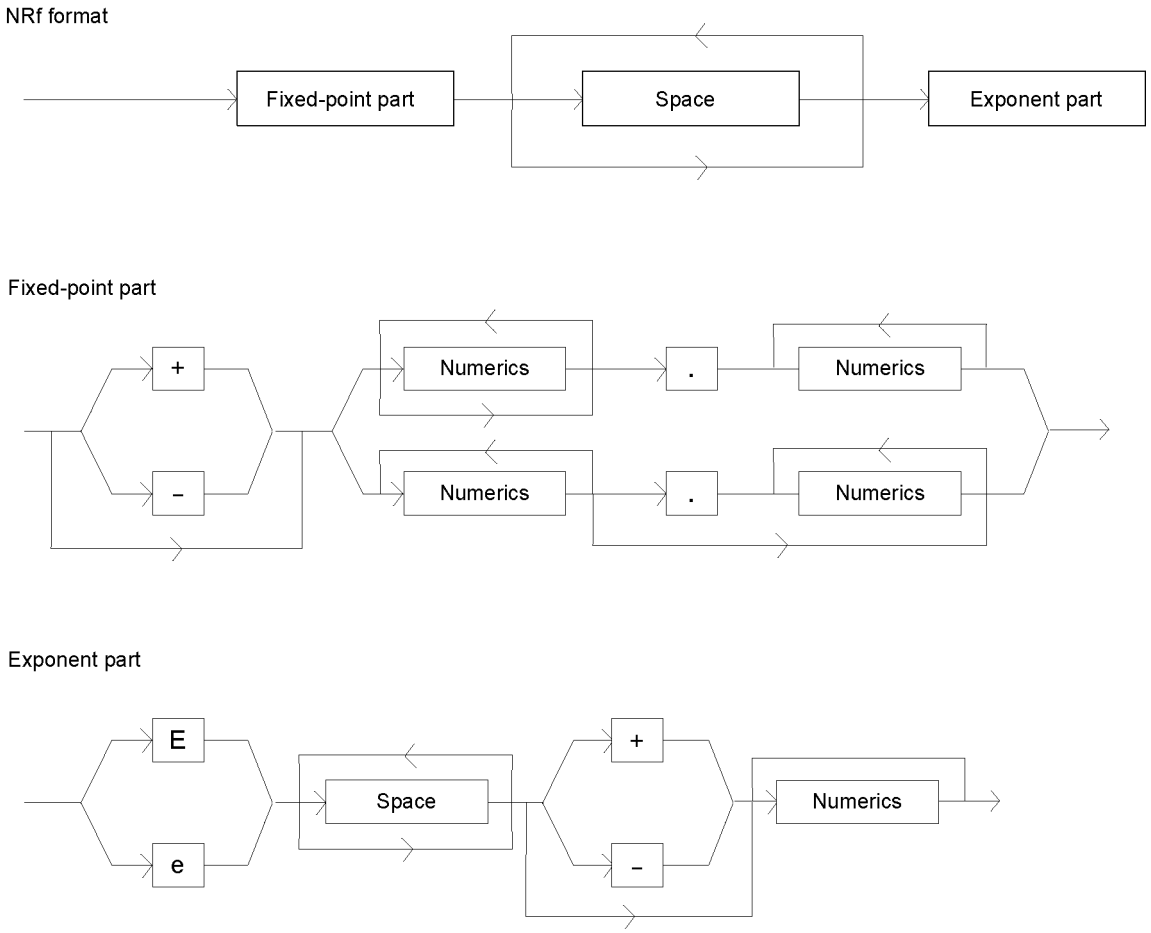


Fig. 7.3 Syntax Chart of Data Part

7.9 Program Messages

7.9.1 List of program messages

Table 7.3 Setting Control Program Messages 1/10

Mnemonic	Description	Format
D L M	Delimiter designation in talker mode d1 (Delimiter designation: 0 ~ 2) 0: L_F<EOI> Default 1: C_RL_F<EOI> 2: <EOI> Returns to default when power is turned on.	[Format] DLM d1 d1: NR1 format
D L M ?	Delimiter query Response is similar to setting.	[Format] DLM? [Response] d1
D F M	Output data format designation d1 (Format designation: 0 ~ 3) 0: Basic format Default 1: Measured values only output 2: Comparison results only output 3: No data output Returns to default when power is turned on.	[Format] DFM d1 d1: NR1 format
D F M ?	Query response in output data format designation is same as setting.	[Format] DFM? [Response] d1
M O D	Measuring mode setting d1 (Mode: 0 ~ 3) 0: Resistance measuring mode 1: Current measuring mode 2: Surface resistivity measuring mode 3: Volume resistivity measuring mode	[Format] MOD d1 d1: NR1 format
M O D ?	Query response in measuring mode is same as setting.	[Format] MOD? [Response] d1

Table 7.3 Setting Control Program Messages 2/10

Mnemonic	Description	Format
MON	Changeover between regular measurement screen and sequence monitoring screen d1 (Screen designation: 0 ~ 1) 0: Regular measurement screen 1: Sequence monitoring screen	[Format] MON d1 d1: NR1 format
MON?	Query response in screen state is same as setting.	[Format] MON? [Response] d1
LCD	LCD display mode setting d1 (Display mode: 0 ~ 1) 0: OFF Lamp extinguished 1: ON Lamp lit Corresponds to [LCDOF] key.	Format] DCD d1 d1: NR1 format
LCD?	Query response in LCD display mode is same as setting.	[Format] LCD? [Response] d1
FIG	Setting number of effective columns for measured value display d1 (Effective columns: 2 ~ 5)	[Format] FIG d1 d1: NR1 format
FIG?	Query response on setting number of effective columns for measured value display is same as setting.	[Format] FIG? [Response] d1
DSP	Display mode setting d1 (0 ~ 1) 0: Exponent display 1: Unit symbol display	[Format] DSP d1 d1: NR1 format
DSP?	Query response in display mode is same as setting.	[Format] DSP? [Response] d1

Table 7.3 Setting Control Program Messages 3/10

Mnemonic	Description	Format
D L Y	Trigger delay time (ms) setting d1 (Time: 0 ~ 9999)	[Format] DLY d1 d1: NR1 format
D L Y ?	Query response on trigger delay time is same as setting.	[Format] DLY? [Response] d1
A V E	Averaging setting d1 (Selection: 0 ~ 1) 0: OFF (Not done) 1: ON (Done)	[Format] AVE d1 d1: NR1 format
A V E ?	Query response in averaging is same as setting.	[Format] AVE? [Response] d1
S P L	Integral time setting (Unit, set values) d1 (Unit: 0 ~ 1) 0: PLC 1: ms d2 (Set value) PLC: 1 ~ 15 ms: 2 ~ 300	[Format] SPL d1, d2 d1: NR1 format d2: NR1 format
S P L ?	Query response on setting number of integral time (unit, set value) is same as setting.	[Format] SPL? [Response] d1, d2
R N G	Current range setting d1 (AUTO/HOLD Selection: 0 ~ 1) 0: HOLD 1: AUTO d2 (Range during HOLD: 0 ~ 7) 0: 10μF(Range 1) 4: 1nF(Range 5) 1: 1μF(Range 2) 5: 100pF(Range 6) 2: 100nF(Range 3) 6: 10pF(Range 7) 3: 10nF(Range 4) 7: 10pF(Range 8) Capacity of integrating capacity is set in range changeover	[Format] RNG d1, d2 d1: NR1 format d2: NR1 format
R N G ?	Query response on current range is same as setting.	[Format] RNG? [Response] d1, d2

Table 7.3 Setting Control Program Messages 4/10

Mnemonic	Description	Format
SRT	Function to interact with measuring voltage ON or measurement start [START] key.	[Format] SRT
STP	Function to interact with measuring stop (measuring voltage OFF) [STOP] key.	[Format] STP
MTG	Generates manual trigger. Enabled when trigger mode is manual or external.	[Format] MTG
IVS	Measuring voltage setting d1 (Voltage: 0.1 ~ 1000.0)V	[Format] IVS d1 d1: NR2 format
IVS?	Query response of measuring voltage is same as setting.	11 [Format] IVS? [Response] d1
PWS	Measuring power source setting d1 (Total current limit value: 0 ~ 2) 0: 5mA 1: 10mA 2: 50mA d2 (Charge output setting: 0 ~ 1) 0: OFF 1: ON d3 (Noise filter: 0 ~ 1) 0: OFF (Fast changeover mode) 1: ON (Low noise mode)	[Format] PWS d1, d2, d3 d1: NR1 format d2: NR1 format d3: NR1 format
PWS?	Query response on measuring power source setting is same as setting.	[Format] PWS? [Response] d1, d2, d3

Table 7.3 Setting Control Program Messages 5/10

Mnemonic	Description	Format
D E V	Deviation value display mode setting d1 (Mode: 0 ~ 2) 0: OFF 1: DEV 2: PAR d2 (Reference deviation value) (-9.999E+30 ~ 9.999E+30) [Note] Mode: d2 is enabled even when OFF. (Retained as current set value)	[Format] DEV d1, d2 d1: NR1 format d2: NR3 format
D E V ?	Query response in deviation value display mode is same as setting.	Format] DEV? [Response] d1, d2
E L C	Electrode data setting d1 (SIZE/ACTL selection) (0: ACTUAL, 1:SIZE) d2 (Electrode inside diameter SIZE) (0.0 ~ 999.9mm) d3 (Electrode outside diameter SIZE) (0.1 ~ 1199.9mm) d4 (Sample thickness SIZE) (0.001 ~ 30.000mm) d5 (Random coefficient ACTUAL) (0.01 ~ 999.99mm) [Note] Be sure to achieve (Electrode inside diameter < Electrode outside diameter). Ignored if not complied with and only settable parts are set.	Format] ELC d1, d2, d3, d4, d5 d1: NR1 format d2: NR2 format d3: NR2 format d4: NR2 format d5: NR2 format
E L C ?	Query response electrode data is same as setting.	[Format] ELC? [Response] d1, d2, d3, d4, d5

Table 7.3 Setting Control Program Messages 6/10

Mnemonic	Description	Format
VCM	Selection of auto voltage check execute mode d1 (Select: 0 ~ 1) 0: OFF 1: ON	[Format] VCM d1 d1: NR1 format
VCM?	Query response of auto voltage monitoring execute mode is same as setting.	[Format] VCM? [Response] d1
CCM	Selection of auto contact check execute mode d1 (Select: 0 ~ 1) 0: OFF 1: ON	[Format] CCM d1 d1: NR1 format
CCM?	Query response of auto contact check execute mode is same as setting.	[Format] CCM? [Response] d1
WCP	Work capacity setting Capacity of work for open correction value calculation d1 (0.5 ~ 99.9) pF	[Format] WCP d1 d1: NR2 format
WCP?	Query response of work capacity is same as setting.	[Format] WCP? [Response] d1
OST?	Executes open correction once and capacity value measured during open correction is returned as a response. In case of error, “999.9” is returned. d1 (Jig capacity: 0 ~ 99.9) In error: 999.9 [Note] Be sure to carry out open correction once before performing a contact check.	[Format] OST? [Response] d1: NR2 format
VCK?	Executes voltage check once and returns result of it as a response. d1 (0 ~ 1) 0: NO 1: GO	[Format] VCK? [Response] d1
CCK?	Executes contact check once and returns result of it as a response. d1 (0 ~ 1) 0: NO 1: GO	[Format] CCK? [Response] d1

Table 7.3 Setting Control Program Messages 7/10

Mnemonic	Description	Format
TGM	Trigger mode setting d1 (Mode: 0 ~ 2) 0: Internal trigger 1: Manual trigger 2: External trigger	[Format] TGM d1 d1: NR1 format
TGM?	Query response of trigger mode is same as setting.	[Format] TGM? [Response] d1
RDT?	Measured data query d1 (Format designation: 0 ~ 2) 0: Basic format 1: Measured value only 2: Comparison result only Most recent measured data is read out. This command is used to read data when measurement is made in the Internal Trigger mode. Needs not be used in manual trigger, external trigger and sequential measurement.	[Format] RDT? d1 d1: NR1 format [Response] (See 7.3)
CMP	Comparison Measuring mode setting d1 (Comparison execute: 0 ~ 1) 0: OFF 1: ON d2 (Mode: 0 ~ 2) 0: HI 1: IN 2: LO d3 (Upper-limit comparison value) (-9.999E+30 ~ 9.999E+30) d4 (Lower-limit comparison value) (-9.999E+30 ~ 9.999E+30) [Note] 1. Must be (d3 > d4). If not complied with, currently set value will be used. 2. Comparison execute: d2, d3 and d4 are enabled even when OFF. (Retained as current set value)	[Format] CMP d1, d2, d3, d4 d1: NR1 format d2: NR1 format d3: NR3 format d4: NR3 format
CMP?	Query response of Comparison Measuring mode is same as setting.	[Format] CMP? [Response] d1, d2, d3, d4

Table 7.3 Setting Control Program Messages 8/10

Mnemonic	Description	Format
S E Q	Sequential mode setting d1 (Mode: 0 ~ 1) 0: OFF 1: ON d2 (Program No.: 0 ~ 9) No. of program executed when sequential mode is turned ON d3 (Discharging time before measurement) (0.0 ~ 999.9s) d4 (Charging time) (0.0 ~ 999.9s) d5 (Measuring time) (0.0 ~ 999.9s) d6 (Discharging time after measurement) (0.0 ~ 999.9s) [Note] Sequential mode: Subsequent parameters are effective even on OFF. (Retained as current set value)	[Format] SEQ d1 d2, d3, d4, d5, d6 d1: NR1 format d2: NR1 format d3: NR2 format d4: NR2 format d5: NR2 format d6: NR2 format
S E Q ?	Same as set items of query SEQ command message in sequential mode. Returns current set data. d1 (Mode: 0 ~ 1) d2 (Program No.: 0 ~ 9) d3 (Discharging time before measurement) d4 (Charging time) d5 (Measuring time) d6 (Discharging time after measurement)	[Format] SEQ? [Response]
C N F	Operation environment setting d1 (Interlock control provided, not provided: 0 ~ 1) 0: CONNECT 1: CUTOFF d2 (Beep tone provided, not provided: 0 ~ 1) 0: OFF 1: ON d3 (Beep tone good/no good: 0 ~ 1) 0: NO 1: GO d4 (Click tone provided, not provided: 0 ~ 1) 0: OFF 1: ON	[Format] CNF d1, d2, d3, d4, d5 d1: NR1 format d2: NR1 format d3: NR1 format d4: NR1 format
C N F ?	Query response of operation environment is same as setting.	[Format] CNF? [Response] d1, d2, d3, d4

Table 7.3 Setting Control Program Messages 9/10

Mnemonic	Description	Format
THL	Histogram display threshold setting d1 ~ d9: Threshold 1 ~ threshold 9 [Note] 1. d1 to d9 are automatically sorted and can be set sequence free. d1 > d2 is observed relative to the screen. 2. Set “0s” where no settings are to be made such as when setting of d1 to d9 entirely is not required. Example: “THL 1E12, 5E11, 1E11, 5E10, 0, 0, 0, 0, 0”	[Format] THL d1, 2d, d3, d4, d5, d6, d7, d8, d9 d1 ~ d9: NR3 format
THL?	Query response of threshold is same as setting.	Format] THL? [Response] d1, 2d, d3, d4, d5, d6, d7, d8, d9
RHS?	Histogram counter readout Returns count values of bar graphs divided into ten and displayed on the screen as responses. d1 to d2 are output in order of large threshold.	[Format] RHS? [Response] d1 ~ d10: NR1 format
CHS	Histogram counter clear Corresponds to operation of [DATA] CLRH YES.	[Format] CHS
BSZ?	Reads number of data groups in the measured data buffer.	Format] BSZ? [Response] d1: NR1 format
RBF?	Measured data buffer readout d1 (Format designation: 0 ~ 1) 0: ASCII format 1: Binary format All data in the data buffer is output continually beginning oldest data	[Format] RBF? d1 [Response] If ASCII If binary Binary response data with length specification
CBF	Measured data buffer clear Corresponds to operation of [DATA] CLRD ALL	[Format] CBF

Table 7.3 Setting Control Program Messages 10/10

Mnemonic	Description	Format
ACL	Auto self-calibration (current range calibration) setting d1 (Auto self-calibration done and not done: 0 ~ 1) 0: OFF 1: ON d2 (Auto self-calibration interval time) (10 ~ 9999s)	[Format] ACL d1, d2 d1: NR1 format d2: NR1 format
ACL?	Query response of auto self-calibration (current range calibration) is same as setting.	[Format] ACL? [Response] d1, d2

Table 7.4 Program Messages of Execution and Execution Result Acquisition 1/3

Mnemonic	Description	Format
ERR?	Error information clear d1 (Error information: 0 ~ 255) See Table 7.7.	[Format] ERR? [Response] d1: NR1 format
DSE	Sets the device event status enable register. d1 (0 ~ 255) See Fig. 7.8.	[Format] DSE d1 d1: NR1 format
DSE?	Query response data of the device event status enable register is same as setting.	[Format] DSE? [Response] d1: NR1 format
DSR?	Query about data of the device event status enable register d1 (0 ~ 255) See Fig. 7.8 and Table 7.8. [Note] Data will be cleared simultaneously with response output.	[Format] DSR? [Response] d1: NR1 format
*SAV	Environmental data save d1 (Environmental data No.: 0 ~9)	[Format] *SAV d1 d1: NR1 format
*RCL	Environmental data recall d1 (Environmental data No.: 0 ~9)	[Format] *RCL d1 d1: NR1 format
*IDN?	Equipment ID query Returns equipment IDs of DSM as responses. d1 (HIOKI, DSM8104, 0, version)	[Format] *IDN? [Response] d1: Character string
*CAL?	Self-calibration (current range calibration) execute Executes self-calibration once and returns results of it as response. Response d1 0: NG 1: OK	[Format] *CAL? [Response] d1: NR1 format

Table 7.4 Program Messages of Execution and Execution Result Acquisition 2/3

Mnemonic	Description	Format
＊ＴＳＴ？	Self-diagnosis result query Executes self-diagnosis once and returns result of it as response. d1 (Self diagnosis result: 0 ~ 1) 0: NG 1: OK	[Format] *TST? [Response] d1: NR1 format
＊ＴＲＧ	The same function as the GET message and has the following functions. When the measuring sequence is OFF, the following operations are carried out in the Trigger mode. TRIG-INT: Ignored. -MAN: Generates trigger once if in start state. -EXT: Same as in -MAN. Measuring sequence is started if sequence ON.	[Format] *TRG
＊ＣＬＳ	Status register clear See Fig. 7.5.	[Format] *CLS
＊ＳＲＥ	Sets the service request enable register. d1 (0 ~ 255) See Fig. 7.5 and Table 7.5.	[Format] *SRE d1 d1: NR1 format
＊ＳＲＥ？	Query of data in the service request enable register. d1 (0 ~ 63, 128 ~ 191) [Note] Bit 6 cannot be set in *SRE.	[Format] *SRE [Response] d1: NR1 format
＊ＳＴＢ？	Query of data in the status byte register. d1 (0 ~ 255) See Table 7.5.	[Format] *STB? [Response] d1: NR1 format
＊ＥＳＥ	Sets the standard event status enable register. d1 (0 ~ 255) See Table 7.6.	[Format] *ESE d1 d1: NR1 format
＊ＥＳＥ？	Query of data in the standard event status enable register. Response data is same as setting.	[Format] *ESE? [Response] d1: NR1 format
＊ＥＳＲ？	Query of data in the standard event status register. d1 (0 ~ 255) See Table 7.6. [Note] Data will be cleared simultaneously with response output.	[Format] *ESR? [Response] d1: NR1 format

Table 7.4 Program Messages of Execution and Execution Result Acquisition 3/3

Mnemonic	Description	Format
＊ＲＳＴ	DSM initialize Initializes all settings to values set during preshipment inspection at the factory. Shuts down if in start state.	[Format] *RST
＊ＯＰＣ	Sets OPC bit of the standard event status register after all operations being executed are finished. This command is used for detecting end of commands that are time-consuming to process.	[Format] *OPC
＊ＯＰＣ？	Returns “1” after all operations being executed are finished. Response d1:1	[Format] *OPC? [Response] d1: NR1 format

7.10 Precautions for Listener Specification

7.10.1 Input buffer size

Plural command messages can be transferred once by linking them using message separators.
The input buffer size of the DSM-8104 is 128 bytes and message character strings exceeding 127 characters cannot be accepted. When this limit is exceeded, the entire command will be ignored (skipped) and the MLE (Message Length Error) bit of the error register will be set.

7.10.2 Input command message execute and message accept

Next messages are not accepted till execution of all received commands or of a command string is completed.
Command message characters can be upper-case or lower-case alphabetical letters.

7.10.3 Command parameter trouble

If a parameter in a command message is faulty, this command will be ignored and the DRE (Data Range Error) bit of the error register will be set.

7.10.4 Limit on command message execute

The following command messages can be executed only in a start state.
If executed in a stop state, no processing will be performed and a result of the previous execution will return.

VCK? and CCK?

The following command messages can be executed only in a stop state.
If executed in a start state, no processing will be performed. Executing OST? in a start state, a result of the previous execution returns.

OST?, *SAV, *RCL, SEQ, *TST? and RBF?

Receiving a program message that was not executed sets the CNE bit in the error register.

The read command RBF? of the measured data buffer needs be executed independently. Be certain to execute independently.

7.10.5 Output buffer readout

Data in the output buffer is processed FIFO (first-in first-out) and is read beginning the oldest data. For this reason, values that are read out sometimes differ from expected values such as when responses are not fetched.
The output buffer size is 511 bytes and data written in the buffer exceeding this size will be discarded, setting the QYE (Query Error) bit of the standard event status register.

7.11 Status Byte and Events

The DSM-8104 interacts with the service request function and can request services to the active controller in various event statuses.
The status byte, which is the core of the service request function, is briefly explained below.
Each bit in a status byte means a summary (logical OR) of events or statuses that use this bit.
In case a bit means several events or statuses, the enable register masks (enable or disable) for each event or status before ORing them.
As the MSS (Master Summary Status) bit, the bit in the DIO7 position becomes logical OR of the seven other bits.
These seven bits are masked by SRER (Service Request Enable Register) before they are ORed.
SRER is written by the *SRE command and is read out by *SRE? query.
MSS generates an rsv local message, by which RQS is generated. Executing serial polling reads the status byte and RQS is cleared by the SR function. However, MSS is not cleared. Therefore, MSS cannot be read by serial polling. (Can be read by an *STB? query)

7.12 Status Data

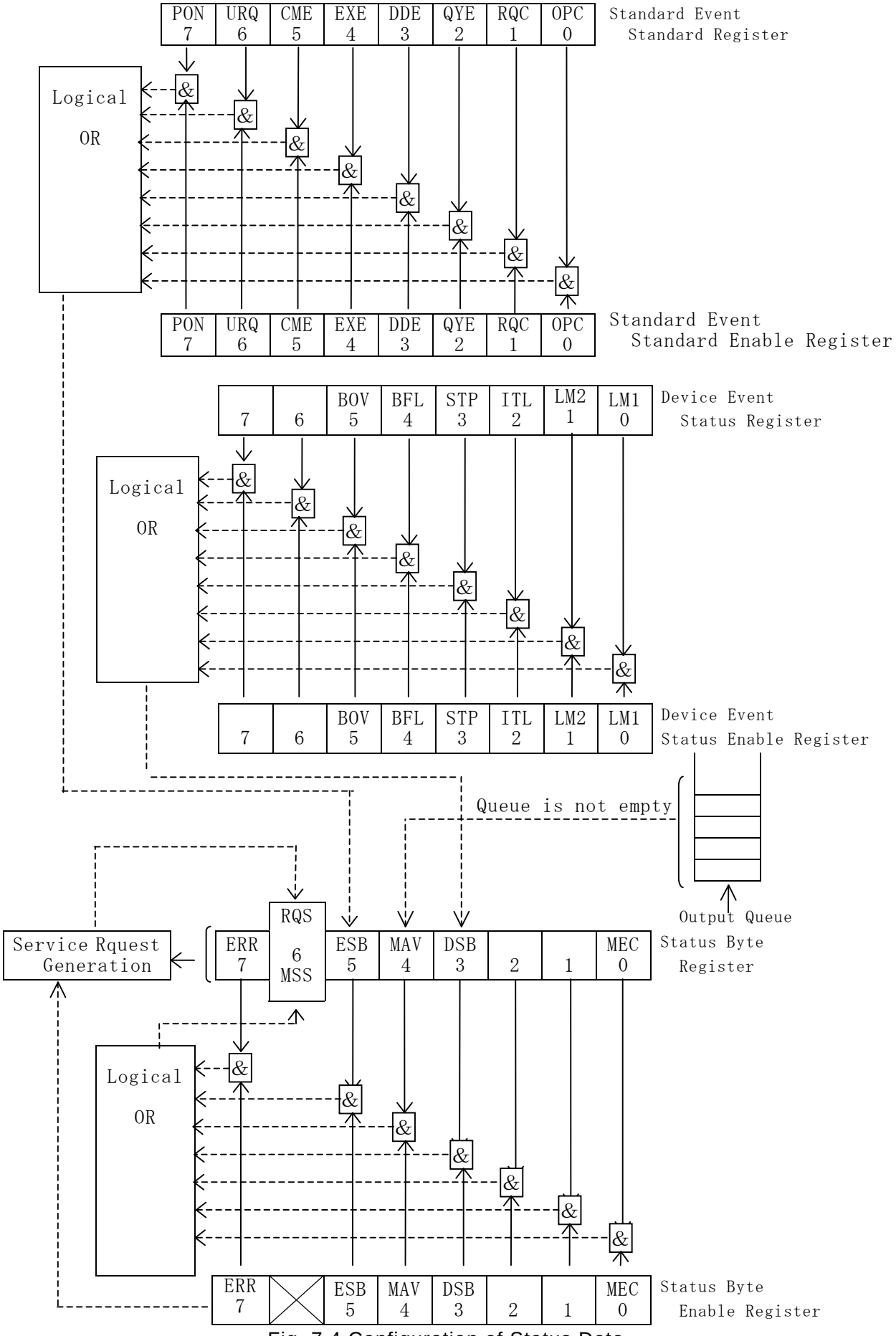
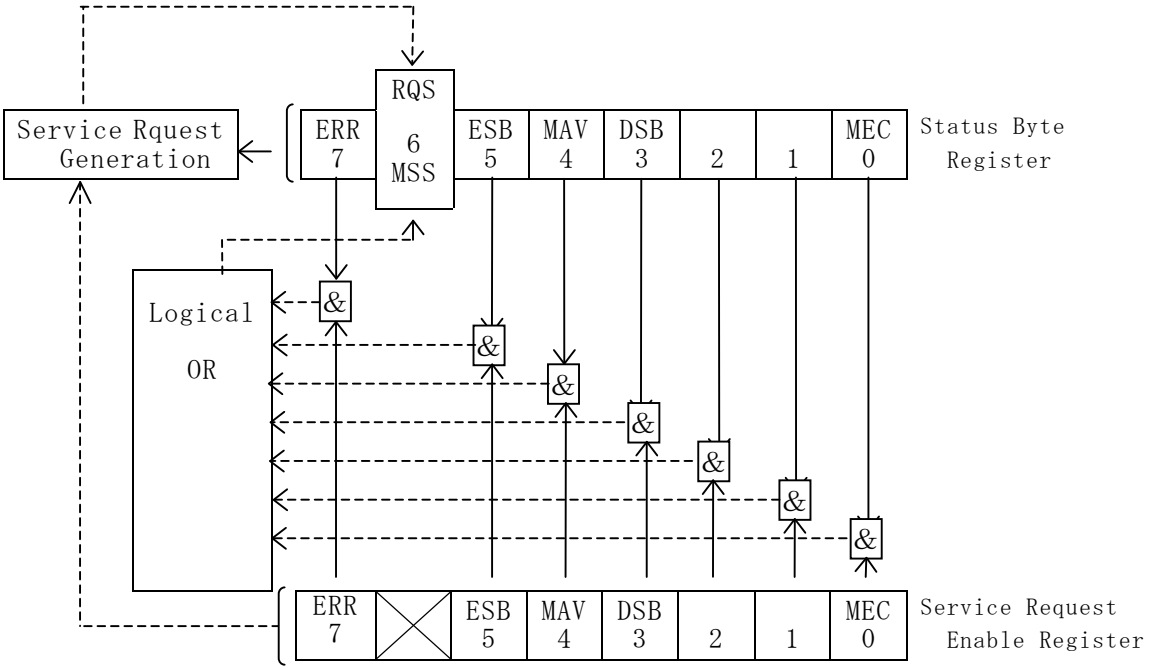


Fig. 7.4 Configuration of Status Data

7.13 Status Byte Register

The Status Byte register is the core of the service request function and all status information and event information is concentrated in this register.
The following messages relate to the Status Byte register.

＊ＣＬＳ	Clears the following registers: · Status Byte register · Standard event status register · Device event status register · Error register
＊ＳＲＥ	Sets Service Request Enable register
＊ＳＲＥ？	Queries Service Request Enable register
＊ＳＴＢ？	Queries Status Byte Register



ERR : ERROR
RQS : Request Service
ESB : Event Summary Bit
DSE : Device Event Summary Bit
MSS : Master Summary Status
MAV : Message Available
MEC : Measure Complete

Fig. 7.5 Configuration of Status Byte Register

Table 7.5 Status Byte Register

Bit No. and Name	Event/status indicated when bit is true
ｂｉｔ７：ＥＲＲ	Irrecoverable error has occurred EEPROM data is destroyed. Writing in EEPROM has failed. RAM read/write error. Current range calibration failure. A/D converter calibration failure Internal communication error. (Retry over) A/D interrupt not generated.
ｂｉｔ６：ＲＱＳ（ＭＳＳ）	Service request has been generated One of seven other bits that are set to enable has been set. RQS is cleared by SR function (status byte read during serial polling), but MSS is not cleared.
ｂｉｔ５：ＥＳＢ	Standard event has occurred. One of the bits of the standard event status register that are enable set is set.
ｂｉｔ４：ＭＡＶ	There are output messages. Output data is set in the output queue. Reset when the output queue becomes empty.
ｂｉｔ３：ＤＳＢ	Device event has occurred. One of the bits of the device event status register that are enable set is set. Can be reset by removing event factor.
ｂｉｔ２：	Not used
ｂｉｔ１：	Not used
ｂｉｔ０：ＭＥＣ	Measurement execute status Set when measurement is finished. Reset when next measurement is started.

7.14 Using Program Message

This section describes program messages that require caution when using them and programming hits. Program messages are generically called commands in this section.

(1) DFM command (Output data format setting)
If not set, data will be output in the basic default format. Data volume can be reduced if only measured values or only comparison results are designated as necessary, thus enabling a reduction of communication time slightly.。

(2) FIG and DSP commands (Display format setting)
Note that these commands set screen display only and do not affect output data.

(3) ELC command (Electrode coefficient setting)
Settings of the main electrode diameter (d2) and inside diameter of the outer electrode (d3) (see 6.3.3 “Measurement by electrode for planar sample”) will become invalid unless status after settings becomes (d2 < d3).

(4) CMP command (Comparison measurement condition setting)
Set an upper-limit comparison value (d3) and a lower-limit comparison value (d4) so that (d3 > d4) will be met after the setting as a condition. The settings will become invalid unless this condition is met.

(5) THL command (Histogram counter threshold setting)
Do not omit program data by this command.
Other commands that have more than one program data groups can omit unnecessary parameters. This command automatically sorts values of d1 to d9 so that intended settings cannot be set if parameters are omitted.
Set “0s” if all thresholds need not be set.

(6) MTG command (Manual trigger generate)
This command is accepted only in a start state after executing “SRT.” Note that this command will not be accepted in a stop state.

(7) RHS? command (Histogram counter readout)
When using the histogram function, measure after clearing the counter by the CHS command beforehand. Otherwise counting will be made adding to previous measured results.
The histogram function cannot be used in the Internal Trigger mode.

(8) RBF? command (Measured data buffer read)
Note that the measured data buffer saves all measured results even in the Internal Trigger mode.
A change in the measuring mode during measurement (resistance/current and other parameters) does not make distinction in the buffer.
Also note that the measured data buffer saves only up to 1000 data groups and discards all subsequent data groups.
[Note] See 5.1.10 “Setting measured data buffer function.”

(9) RDT? command (Most recent data read)
This command is mainly used in reading measured data during measurement in the Internal Trigger mode. No need to use this command in the other trigger modes or in the sequential measurement mode.

(10) *STB? command (Status byte register read)
This command is a query command and cannot be used in detection of measurement end and other states.
For example, sending the *STB? command after sending the MTG command will overwrite results of measurement performed by the MTG command with response data in answer to the next *STB? command, disabling readout of measured values.

(11) *OPC command (OPC bit setting after completing all processing)
Use this command to detect completion of processing of a command that does not have response data.
For example, when executing the *SAV command, SRQ can be generated upon the completion of saving by executing "*SAV 1;*OPC" after resetting the mask of the OPC bit of the Standard Event Status register by "*ESE 1" and after resetting the mask of the ESB bit of the Status Byte register by "*SRE32.".
The OPC bit is not cleared automatically and the registers must be cleared by issuing the *CLS command.

(12) Detecting end of command with response data
Query commands and trigger commands have response data and detection of end of processing of them can most suitably be accomplished by monitoring the MAV bit of the Status Byte register.
The MAV bit remains set as long as output data exists in the output queue. By resetting the mask by "*SRE 16," SRQ can be generated when the MAV bit is set first.
The MEC bit can be used in detection of end of detection only in the Manual Trigger, External Trigger and Sequential Measurement modes. However, the mask should be canceled by "*SRE 1" and monitoring by SRQ is required. The MEC bit indicates "during measurement" or " "during shutdown" and end of measurement cannot be detected merely by reading the status byte by polling. SRQ is generated by the MEC bit at the variation point of the MEC bit when measurement is completed so that detection by SRQ will be possible.

(13) End detection of command without response data
In case of a command without response data, detect it by the *OPC command mentioned in 11).

(14) Read of response to query (Output queue readout)
Several query command or trigger commands can be set by continually sending in the following formats. Response data of each command enters the output queue in the order of command execution.
Read response data as follows:

Example 1: When reading whole data of the mask register.
Send "DSE ; *SRE? ; *ESE?" Then read the data three times or repeat data reading till the MAV bit is cleared.

Example 2: When reading data after making measurement three times in the Manual Trigger mode, send “MTG ; MTG ; MTG.” Then read data three times or repeat data readout.

[Notes]

1. Caution for output queue readout
   When reading data from the output queue, the DSM-8104 adds a delimiter to each data group.
   All the data which was taken in one readout to the output queue by the reading of taking can be read.
   For this reason, the MAV bit is used to check data presence.

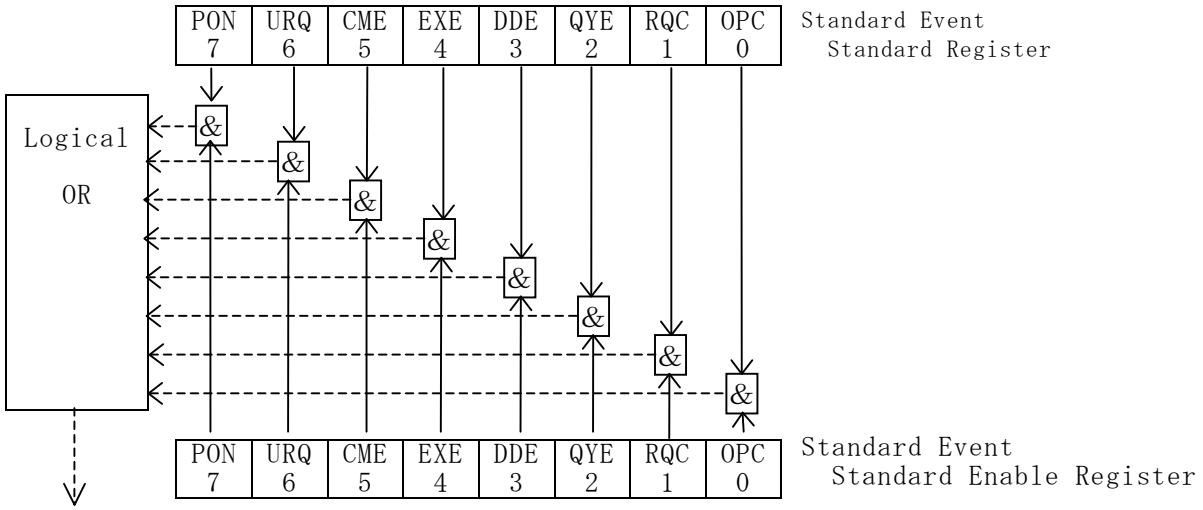
2. Caution when continually executing commands
   When executing commands that have response data, send the commands in one line by separating them by “;” as shown earlier.

3. Necessity for detection of end of command processing
   The DSM-8104 cannot receive a next command while processing a command that has been received earlier. If a command is received while reception is disabled, handshake is temporarily performed and NRFD is locked in a receive disable state till reception is enabled, to let the talker wait. This means that a bus is exclusively owned till processing of the DSM-8104 ends and the system speed becomes slow. For these reasons, detection of end of processing is necessary.

7.15 Standard Event Status Register

After mask processing by the Standard Event Status Enable register, messages are concentrated in the ESB bits of the Status Byte register.
The following is messaged related to the Standard Event Status register.

＊ＣＬＳ	Clears the following registers: · Status byte register · Standard Event Status register · Device Event Status Register · Error register
＊ＥＳＥ	Sets the Standard Event Status Enable register
＊ＥＳＥ？	Queries the Standard Event Status Enable register
＊ＥＳＲ？	Queries and clears the Standard Event Status register



ESBs of Status Byte Register

PON : Power On
URQ : User Request
CME : Command Error
EXE : Execution Error
DDE : Device Dependent Error
QYE : Query Error
RQC : Request Control
OPC : Operation Complete

Fig. 7.6 Configuration of Standard Event Status Register

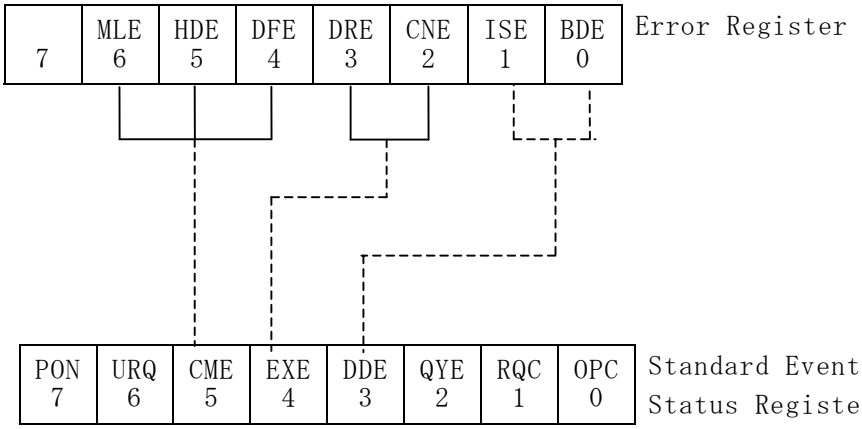
Table 7.6 Standard Event Status Register

Bit No. and Name	Event/status indicated when bit is true
b i t 7 : P O N	Power ON. Read first after turning the power on.
b i t 6 : U R Q	Not used
b i t 5 : C M E	Command error Errors were detected in received messages. Specifically, they are grouped in the bits MLE, HDE and DFE of the Error register in the following cases. · DSM received a message exceeding a limit. · A message header that could not be recognized and processed by DSM was received. · Formatting of a data part that followed the message was faulty. (Data format error and overflow of parameters) Note: A command that caused a data format error will be ignored and execution will be performed based on retained data. A parameter string that exceeds a specified number will be ignored in execution.
b i t 4 : E X E	Execution error A received message cannot be executed at present or a set parameter value is outside the range. These are errors grouped in DRE and CNE bits of the Error register. Note: A command whose set parameter value is outside the range will be ignored and execution will be made based on retained data.
b i t 3 : D D E	Equipment dependent errors Internal errors other than command, query and execute errors have been detected. These errors are grouped in ISE and RAM bits of the Error register. Reset after moving the error cause.
b i t 2 : Q Y E	Query error Data was lost due to overflow of the output queue. Data was read while the output queue was empty. Talker designation was made before data reception ended. Listener designation was made before data transmission ended.
b i t 1 : R Q C	Not used
b i t 0 : O P C	Operation complete All operations being executed are completed, enabling acceptance of next command. Set as response to the *OPC command.

7.16 Error Register

The Error register controls error information and is an 8-bit register.
The data of this register is grouped in the CME, EXE, DDE and QYE bits of the Standard Event Status register. (Mask processing is not performed)
The following messages relate to the Error register.

＊ＣＬＳ	Clears the following registers: · Status Byte register · Standard Event Status register · Device Event Status register · Error register
ＥＲＲ？	Queries and clears the Error register



MLE : Message Length Error
HDE : Header Error
DFE : Data Format Error
DRE : Data Range Error
CNE : Can Not Execute
REQ : Read Empty Queue
QOF : Queue Overflow
ISE : Internal communication Error

Fig. 7.7 Configuration of Error Register

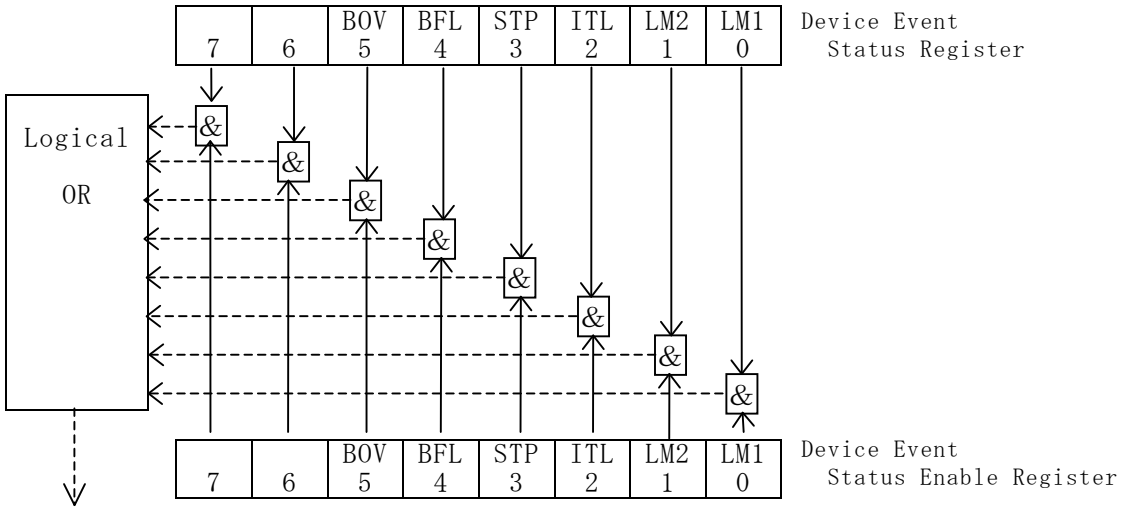
Table 7.7 Error Register

Bit No. and Name	Event/status indicated when bit is true
b i t 7 :	Not used
b i t 6 : M L E	Message length error Set when the length of a message exceeds a permissible range. Reset by reading this register.
b i t 5 : H D E	Message header error Set when a message header that cannot be recognized is received. Reset after reading this register.
b i t 4 : D F E	Data format error The number of parameters has exceeded a specified number. There are parameters that cannot be recognized. Reset by reading this register.
b i t 3 : D R E	Data range error Set when a parameter value is outside specified range. Reset by reading this register.
b i t 2 : C N E	A cannot-execute command Set when a command that cannot be executed is received. Reset by reading this register.
b i t 1 : I S E	Internal communication error Set when an internal communication error is found. Reset by reading this register.
b i t 0 : B D E	Environmental data destruction Set when data of a backup RAM is destroyed. Reset by reading this register.

7.17 Device Event Status Register

This register controls events and statuses unique to DSM.
The data of this register is grouped in the DSB bits of the Status Byte register after mask processing by the Device Event Status Enable register.
The following messages relate to the Device Event Status register.

＊ＣＬＳ	Clears the following registers: · Status Byte register · Standard Event Status register · Device Event Status register · Error register
ＤＳＥ	Sets Device Event Status Enable register
ＤＳＥ？	Queries Device Event Status Enable register
ＤＳＲ？	Queries Device Event Status register



DSB of Status Byte Register

BOV : Measure Buffer Over flow BFL : Measure Buffer Full
STP : Get Stop Event ITL : Interlock Condition
LM2 : Charge Current Limit LM1 : Measure Current Limit

Fig. 7.8 Configuration of Device Event Status Register

Table 7.8 Device Event Status Register

Bit No. and Name	Event/status indicated when bit is true
b i t 7 :	Not used
b i t 6 :	Not used
b i t 5 : B O V	Measured data buffer overflow Set when data is lost due to overflow of the measured data buffer. Reset by reading this register.
b i t 4 : B F L	Measured data buffer full Set when the measured data buffer becomes full. Reset when the buffer becomes empty.
b i t 3 : S T P	Measurement stop event Set by one of the following factors: The [STOP] key is pressed. The interlock function was activated. STOP was input by the handler interface. Reset by reading this register.
b i t 2 : I T L	Interlock state Set when the interlock function is activated and start is disabled. Reset when start is enabled.
b i t 1 : L M 2	Reserved bit
b i t 0 : L M 1	Reserved bit

7.18 Initialization Value by *RST Message

The *RST message initializes settings of this meter.
Initialization values by the *RST message and the settings set during a preshipment inspection at the HIOKI factory are shown below.
"---" in initialization values by *RST shown in the following table are the parts that do not affect the settings.

Table 7.9 Settings in Preshipment Inspection at HIOKI Factory and Initialization values by *RST Message.

Item	GP-IB Message	Settings in Preshipment Inspection	Initialization values by *RST
Measuring mode	MOD	Resistance measurement	Resistance measurement
Trigger mode	TGM	Internal	Internal
Measuring voltage	IVS	0.1 V	0.1 V
Integral time	SPL	300 ms	300 ms
Averaging	AVE	ON	ON
Measuring range	RNG	AUTO	AUTO
Trigger delay time	DLY	0 ms	0 ms
Sequential mode SEQ:ON/OFF PROG No.	SEQ	 OFF 0	 OFF 0
Sequential program parameters PROGRAM No. DISCHG1 CHARGE MEAS TIME DISCHG2	SEQ	 0 ～ 9 Common 0.0 s 0.0 s 0.1 s 0.0 s	 ---- ---- ---- ----
Display mode	DSP	Exponential display	Exponential display
Display columns	FIG	5	5
Deviation display MODE REF	DEV	 OFF [0.0000E+00]Ω	 OFF ----
Comparison measurement MODE UPPER LOWER	CMP	 HI [0.0000E+00]Ω [0.0000E+00]Ω	 ---- ---- ----
Auto comparison measurement	CMP	OFF	----
Auto voltage check	VCM	OFF	OFF
Auto contact check	CCM	OFF	OFF

Item	GP-IB Message	Settings in Preshipment Inspection	Initialization values by *RST
Histogram counter	RHS?	Clear state	----
Histogram thresholds	THL	All “0s”	----
Data buffer	RBF?	Not fixed	----
Electrode coefficients D1(IN DIAMETER) D2(OUT DIAMETER) t (THICKNESS) K	ELC	 [50.0]mm [70.0]mm [0.1]mm [0.01]	 ---- ---- ---- ----
Interfaces INTERLOCK BEEP ON/OFF BEEP NO/GO CLICK GP-IB ADRS 232 BAND 232 DATA 232 PARI 232 STOP	CNF	 CUTOFF ON NO ON [1] 4800 7BIT NON 1BIT	 ---- ---- ---- ---- ---- ---- ---- ---- ----
Auto calibration setting AUTO MODE INTERVAL	ACL	 ON 60 sec	 ---- ----
Power source conditions CURL CURL.C FILTER	PWS	 5 mA OFF ON	 5 mA OFF ON
Open correction setting	WCP	0.5 pF	0.5 pF
Saved environmental data	*SAV	0 to 9 common setting. Saved data is cleared	----

8. RS-232 Interface

8.1 Overview

The DSM-8104 features an RS-232 interface option as a communication function. Basically, the data format and program messages of the RS-232 interface are the same as those of the GP-IB interface, except some messages and other parts that are required due to differences in the hardware. This chapter describes only the differences with the GP-IB interface. For the other parts, the reader is requested to refer to Chapter 7 “GP-IB Interface.”

8.2 Connector Used and Signal Names

The connector for the RS-232 interface is a 9-pin D-sub female connector.

Table 8.1 Pin Nos. and Signal Names

Pin No.	Signal Name	Function	Remarks
1	DCD	Reception carrier detection	Not used with DSM-8104
2	RXD	Reception data	
3	TXD	Transmission data	
4	DTR	Data terminal ready	
5	GND	Signal ground	
6	DSR	Data setting ready	Not used with DSM-8104
7	RTS	Transmission request	
8	CTS	Transmission authorized	
9	RI	Incoming call indication	Not used with DSM-8104

8.3 Changeover to GP-IB

GP-IB and RS-232 cannot be used simultaneously. The GP-IB or RS-232 interface whichever accepts a message first is selected as an interface.
When changing the interface, temporarily reset to the local mode or turn the power supply on again.

8.4 Connecting Control Signals and Flow Control

The flow of data transmission and reception is controlled in the DSM-8104 by controlling the RTS signal. Control the controller in the Terminal mode by connecting as follows.

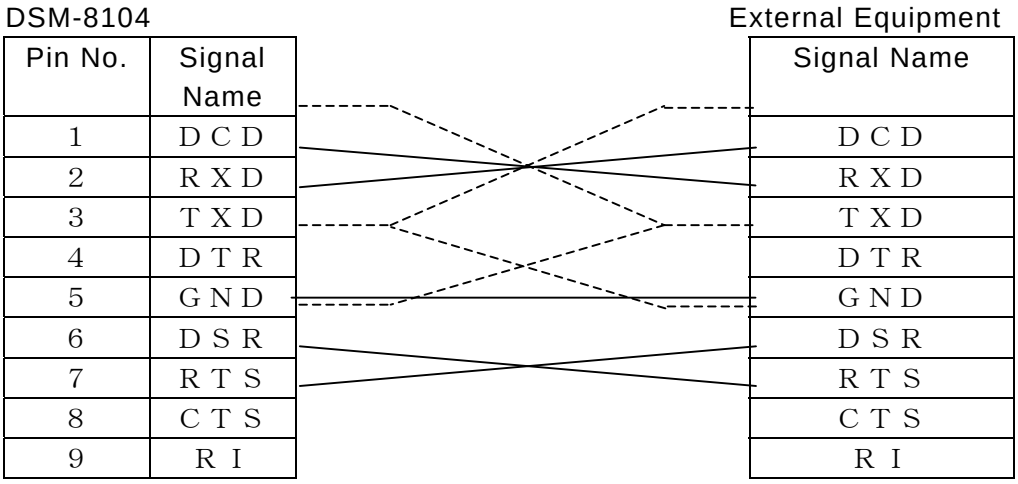


Fig. 8.1

The DSM-8104 turns RTS off during processing after receiving a command.
In the case of a query command or a trigger command, a response is sent after processing is completed. Command reception is disabled till response transmission is completed and RTS remains OFF. RTS turns ON when transmission completes.
CTS is checked during data transmission and transmission is continued if CTS is ON. Transmission is stopped if CTS is OFF. Note that transmission is discontinued if CTS or DSR is OFF more than about one second.
The DSM-8104 does not support flow control by the XON/XOFF code.

[Notice]
Data is sometimes lost if flow control by a control signal is not performed.
Wait a suitable time when processing a command message without a response. A "suitable time" must be confirmed by an experiment.
When processing a command message that requests a response, be certain to send a next command message after receiving a response.
DSM-8104 requires flow control by the RTS and CTS. Make sure to wire RTS and CTS. Please note that flow control cannot be performed even if the RTS and CTS are short-circuited.

8.5 Transmission Data Specification

The data format is the same as that of the talker function in GP-IB. Refer to Section 7.3. The binary format cannot be used in data buffer readout.

Transmission data format

Data
Measured value
Response to query

Measured value

±d.ddddE±dd, d, d C_R L_F

Response to query

Query response data C_RL_F

Delimiter

The power-on default is C_RL_F. However, a changeover is possible by the DLM command. EOI in GP-IB is not used in RS-232.

8.6 Reception Data Specification

Reception data format

The format is the same as that in the listener function of the GP-IB interface. However, the following additions to and deletions from messages can be made.

Table 8.2 Addition Message

Mnemonic	Description	Format
RMT	Remote changeover request	[Format] RMT

When controlling by the RS-232 interface, the DSM-8104 changes to a remote state when the RMT command is received, allowing control by RS-232. In the beginning, send this command.
Press the [LOCAL] key to reset to a local state from a remote state.

Table 8.3 Invalid Messages

Mnemonic	Description
＊OPC	OPC bit setting when processing ends
＊OPC?	“1” is returned when operation completes

Sending a command message requesting a response in RS-232, a response is received first and next command message can then be received. For this reason, commands for checking operation completion become invalid. (Actually such commands are accepted, but there is no reason to use them)

Caution for use of RBF? command
Use “RBF? 0” as the data buffer readout command. The format will still be the ASCII format even if “RBF? 1” is specified.

Delimiter during reception
Use “C_RL_F” as the delimiter when sending a command message.

8.7 Status Byte and Events

The following events differ from the GP-IB interface and will become invalid:

Bit 3 of the Status Byte register (MAV)
Bit 2 of the Standard Event Status register (QYE)

9. External Interfaces

9.1 Handler Interface

9.1.1 Handler Interface

Pin assignment

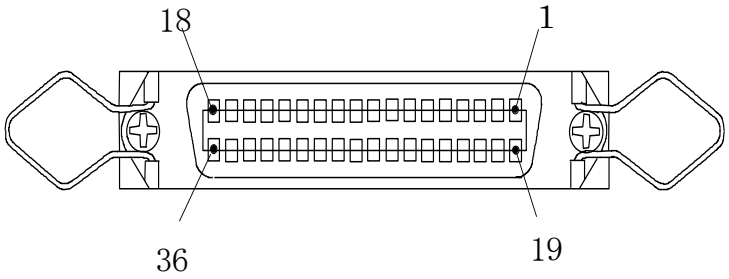


Table 9.1 Pin Nos. and Signal Names

Pin No.	Signal Name	Input/Output	Pin No. t	Signal Name	Input/Output
1	OUTCOM		19	OUTCOM	
2	INCOM		20	INCOM	
3			21		
4	/TRIGGER	Input	22	/V.CHECK	Input
5	/C.CHECK	Input	23	/OPEN	Input
6	/START	Input	24	/STOP	Input
7	/INTERLOCK	Input	25	/KEYLOCK	Input
8			26		
9	/V.CHECK GO	Output	27		
10	/C.CHECK GO	Output	28		
11			29		
12	/OPEN GO	Output	30		
13			31		
14	/COMP GO	Output	32		
15			33		
16	/EOM	Output	34	/INDEX	Output
17	/SRT.E	Output	35	/VON	Output
18	/ERROR	Output	36		

[Cautions]
1. Connector on DSM-8104: Product No. 57RE-40360-730B manufactured by DDK
2. Pin Nos. in the table without signal name are reserved.
   Do not connect other external signal lines.

9.1.2 Signal functions

(1) Input signals

INCOM: The common terminal for input signals.
Isolated from the common terminal for output signals.

/TRIGGER: An external trigger input signal.
Connected to “EXT TRIGGER” input on the rear panel.

/INTERLOCK: An interlock input signal.
Connected to “INTERLOCK” input on the rear panel.

/KEY LOCK: A key lock input signal.
Setting this signal to the LOW level disables all the panel keys except the [STOP] and [LCDOF] keys.

/START: Start input and has the same function as that of the [START] key on the panel.
In regular measurement, this signal is for output of measuring voltage and readies acceptance of trigger input. Starts measurement when in the Internal Trigger mode (INT).
Starts the measuring sequence when sequential measurement is ON.

/STOP: Stop input and has the same function as that of the [STOP] key on the panel.
Turns off voltage output and stops measurement.
Stop input can always be input.
(Not disabled even by /KEYLOCK input, remote state or other events.)

/OPEN: Open correction input.
Performs open correction once.
Functions only in a stop state.

/V.CHECK: Voltage check input and has the same function as that of the [V. CHK] key on the panel.
Executes voltage check once.
Functions only in a start state and when sequential measurement is turned OFF.

/C.CHECK: Contact check input and has the same function as that of the [C. CHK] key on the panel.
Functions only in a start state and when sequential measurement is turned OFF.

[Notice]
Setting of the interlock function CONECT/CUTOFF on the Setup screen is invalid to the /OPEN and /START input signals of the handler interface.
Note that control of /INTERLOCK input is always necessary.

(2) Output signals

OUTCOM: The common terminal for output signals.
Isolated from the common terminal for input signals.

/V.CHECK GO: Output for “acceptable/non-acceptable” decision in voltage check.
Output becomes active when decision is “acceptable.”

/C.CHECK GO: Output for “acceptable/non-acceptable” decision in contact check.
Output becomes active when decision is “acceptable.”

/OPEN GO: Output for “acceptable/non-acceptable” decision in open correction.
Output becomes active when decision is “acceptable.”

/COMP GO: Output for “acceptable/non-acceptable” decision in comparison measurement.
Output becomes active when decision is “acceptable” as measurement result.

/EOM: Output signal to indicate that measured data can be output.
Fetch output data on the timing this signal becomes LOW level.

/INDEX: Output signal to indicate that a sample can be changed.
Change the sample on the timing this signal becomes LOW level.

/SRT.E: Signal indicating that the meter can be started (voltage can be output).
Becomes HIGH level in a start disable state by the interlock function, becoming LOW level when starting is ready.

/VON: Signal to indicate measuring voltage is being output.

/ERROR: Output signal indicating a trouble has occurred with the meter.

9.1.3 Electrical characteristics of signals

(1) Signal logic level
All input and output signals are negative logic (active low).

(2) Handler output signal
The output signal is photocoupler output of the open collector.
The handler must be connected to the power source and pull-up resistance.
The common terminal of the output signals is DC-isolated from the internal circuit.
An equivalent circuit of the output circuit is illustrated in Fig. 9.1.

Output Signal Characteristics

Output Voltage		Maximum Output Current
LOW	HIGH	
≤ 0.5 V	5 V ~ 24 V	2 mA

[Notice]
Output voltage is HIGH depending on power source voltage connected to the handler side.
Output voltage is LOW when load resistance with which output current becomes less than maximum output current is connected.

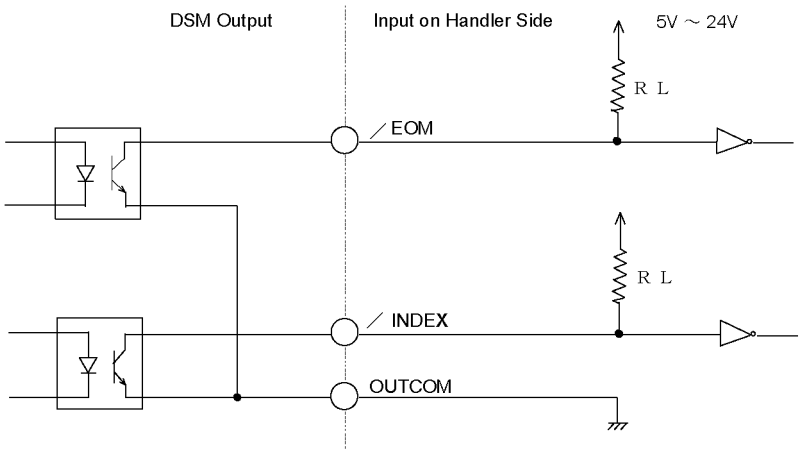


Fig. 9.1 Handler Output Circuit

(3) Handler input signal

The input signals are output by the cathode of an LED in the photocoupler through a current limiting resistance.

The anode side of the LED is connected to the 5V power source inside. Output the handler output by an open collector or TTL output.

The common terminal of the input signals is DC-isolated from the internal circuit.

An equivalent circuit of the input circuit is illustrated in Fig. 9.2.

Input Characteristics

Maximum Input Voltage		Maximum Input Current
LOW	HIGH	
0.5 V	5 V	1.2 mA

[Notice]
Output the output of the handler side by an open collector or by TTL output.
Do not impress voltage of more than 5V to input signals.

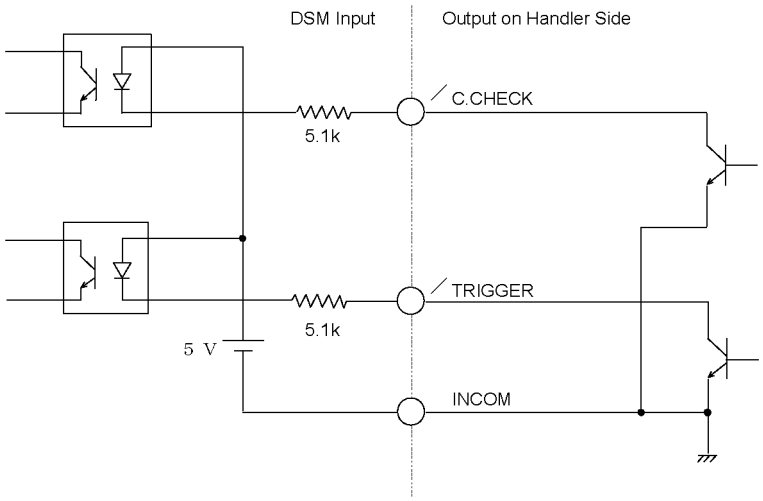


Fig. 9.2 Handler Input Circuit

[Notice]
The input-signal common terminals (Pins 2 and 20) of the handler interface, as well as common terminals (connector outer conductors) of the external trigger input (“EXT TRIGGER”) and interlock input (“INTERLOCK”) on the rear panel, are connected.

9.2 External Trigger Terminal

The “EXT TRIGGER” connector on the rear.
This terminal is used as trigger input when the trigger mode is set to External Trigger mode.

9.2.1 Connector

Use a BNC connector.

9.2.2 Electrical characteristics

The trigger signals are output by the cathode of an LED in the photocoupler through a current limiting resistance.
The anode side of the LED is connected to the 5V power source inside.
Output the control side output by an open collector or TTL output.
The common side (connector outer conductor) is DC-isolated from the internal circuit.
The common side is connected to the input-signal common terminal (Pins 2 and 20) of the handler interface.
An equivalent circuit of the input circuit is illustrated in Fig. 9.3.

(1) Signal logic level
The external-trigger input signal is negative logic (active low).
The signal is detected by the falling edge of an input signal.

(2) Electrical characteristics
Minimum pulse width 100µs

Input Characteristics

Maximum Input Voltage		Maximum Input Current
LOW	HIGH	
0.5 V	5 V	1.2 mA

[Caution]
Output the output of the control side by an open collector or by TTL output.
Do not impress voltage of more than 5V to input signals.

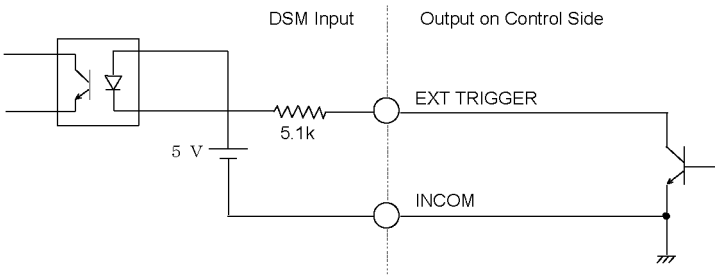


Fig. 9.3 Trigger Input Circuit

9.3 Interlock Terminal

The “INTERLOCK” connector on the rear.
Detecting open or closed state of the fixture lid, this terminal prohibits output of measuring voltage while the lid is open to safeguard operator safety.

When using the interlock function, set the interlock function to a “Use” state on the Setup screen.

9.3.1 Connector

Use a BNC connector.
When connecting this meter to an electrode for planar sample (SME-8310 or SME-8311) or a shielding box (SME-8350), the interlock connecting cable (DSM8104F) is necessary.

9.3.2 Electrical characteristics

The interlock signal is output by the cathode of an LED in the photocoupler through a current limiting resistance.
The anode side of the LED is connected to the 5V power source inside.
Output the control side output by an open collector or TTL output.
The common side (connector outer conductor) of the interlock signal is DC-isolated from the internal circuit. The common side is connected to the input-signal common terminals (Pins 2 and 20) of the handler interface.
An equivalent circuit of the input circuit is illustrated in Fig. 9.4.

(1) Signal logic level
Measuring voltage can be output when the interlock input is the LOW level.
Output of measuring voltage is prohibited when the interlock input is the HIGH level. (The [START] key is disabled)

(2) Electrical characteristics
Input Characteristics

Maximum Input Voltage		Maximum Input Current
LOW	HIGH	
0.5 V	5 V	1.2 mA

[Caution]
Output the output of the control side by an open collector or by TTL output.
Do not impress voltage of more than 5V to input signals.

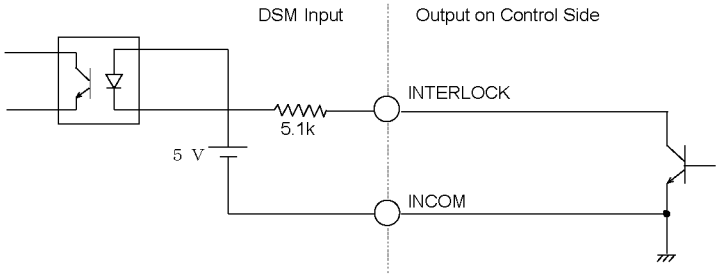
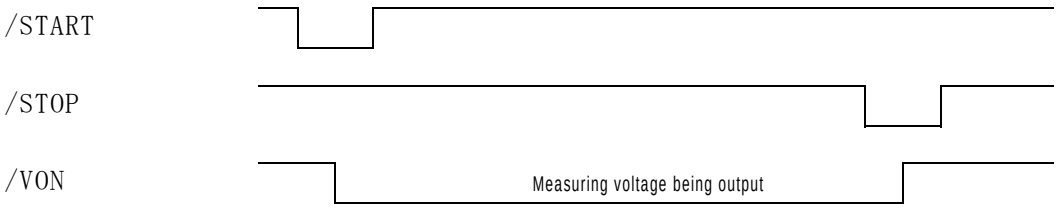


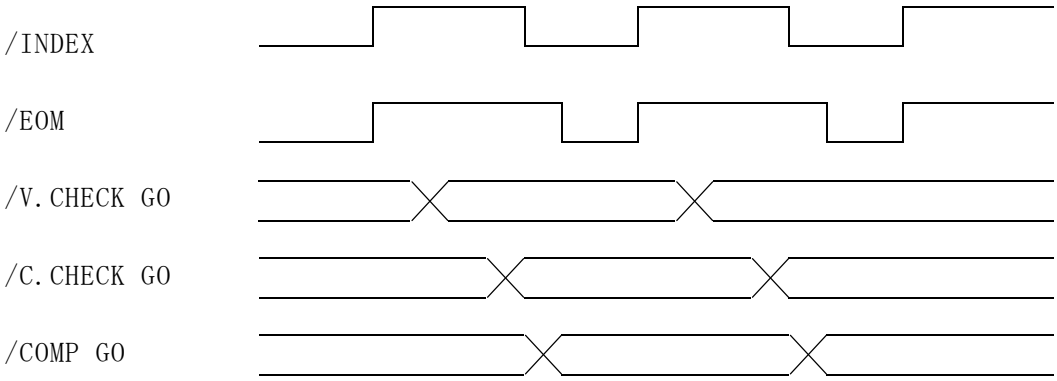
Fig. 9.4 Interlock Input Circuit

9.4 Signal Timing

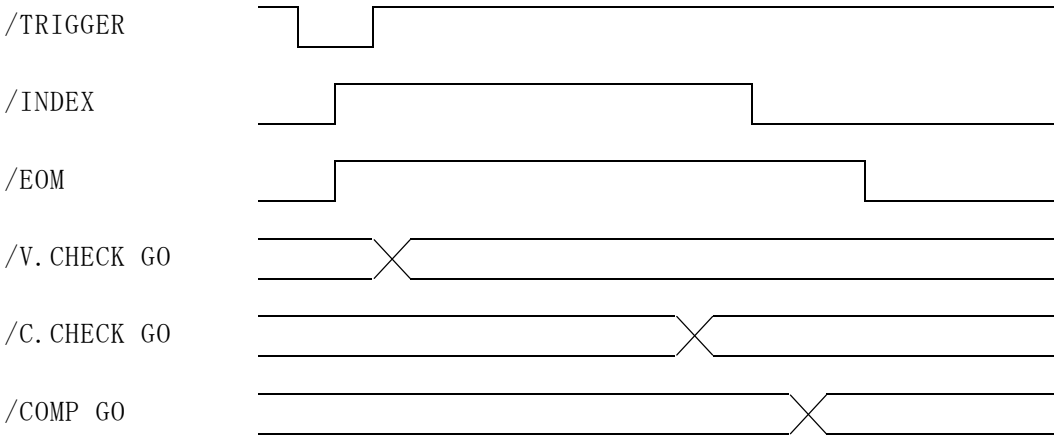
(1) Voltage output



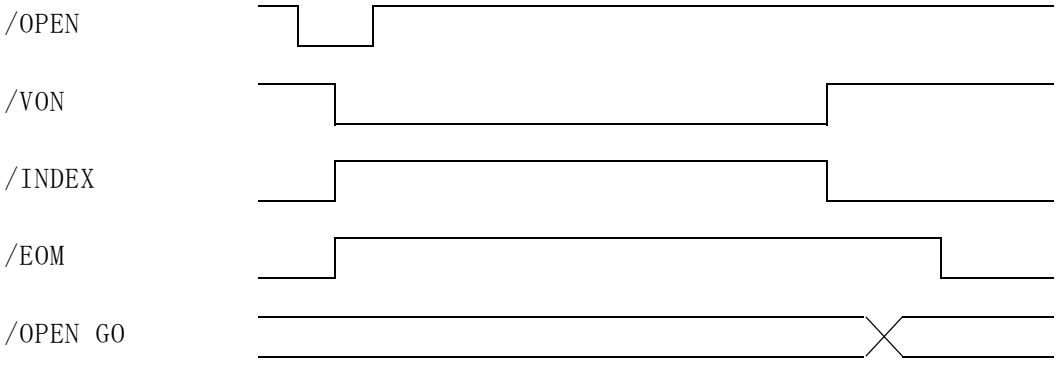
(2) Regular measurement (Internal trigger mode)



(3) Regular measurement (Sequence off, External Trigger mode)



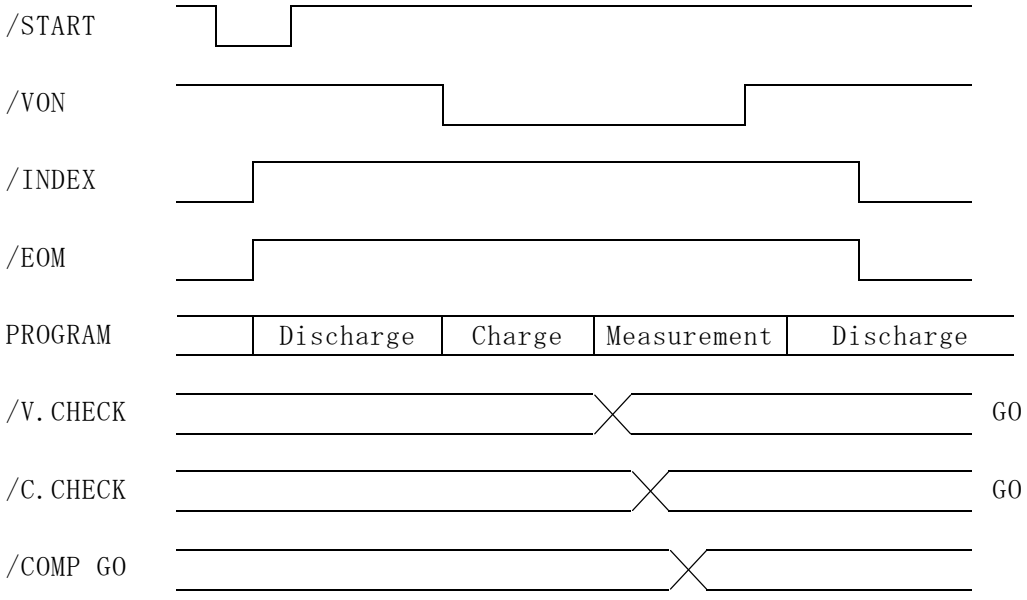
(4) Open correction



(5) Execution of voltage check only

(6) Execution of contact check only

(7) Sequential measurement



10. Maintenance

Periodical checks and calibrations are recommended to ensure reliability of test data of the meter and to prevent accidents.
HIOKI E. E. Corporation is on hand to make checks, repairs and calibrations of your meter.

10.1 Periodical Checks for Maintenance

(1) Visually check external damage such as on measuring terminals and panels. High voltage up to 1000V is impressed to the meter. A damaged measuring terminal or other part is hazardous and causes an accident.
(2) Clean the panel surfaces and areas around the terminals and connectors on the rear using a clean cloth.
(3) Visually check that the display screen is clear.
(4) Check that the keys, switches and other parts operate smoothly and correctly.
(5) Measure measuring voltage output using a voltmeter and check that voltage errors are within 3% of set values.
Measure the measuring voltage output between the “OUTPUT” terminal and “GUARD” terminal.

10.2 Calibration

This meter calculates the insulation resistance value of a sample based on measuring voltage impressed to the sample and on measured current value.
The resistance measurement accuracy of this meter is calibrated by calibrating the output voltage accuracy and current measurement accuracy.
First, calibrate the output voltage using a voltmeter with an accuracy of 0.01% or higher.
Then connect calibrated reference resistance and calibrate the current measurement accuracy.
In case calibration results are outside the DC current measurement accuracy mentioned in Paragraph 2.1.1, please contact HIOKI E. E. Corporation for adjustment of your meter.

10.2.1 Equipment needed for calibration

The following equipment is needed for calibration.

Voltmeter	Measurement accuracy 0.01% or higher
Reference resitances	1MΩ, 10MΩ, 100MΩ, 1GΩ, 10GΩ, 100GΩ, 100kΩ
Shielding box	

10.2.2 Calibration of measuring voltage

Measure voltage between the “OUTPUT” terminal and “GUARD” terminal.

10.2.3 Calibration of current measurement

Set an integral time of 300ms, Internal Trigger mode, averaging ON and self-calibration of 60s when measuring a current.
Place the reference resistance in the shielding box for shielding to reduce impacts by noise.

(1) Set the meter as follows.
- Integral time (SAMPL) 300ms
- Trigger mode (TRIG) Internal (INT)
- Averaging (AVE) ON
- Self-calibration (CALIBRATION) Auto execute (AUTO MODE: ON) (INTERVAL) 60s
- Measuring voltage (MES. V) 10V
- Measuring mode (MODE) Current measurement

(2) Connect reference resistance of 100kΩ between the “INPUT” and “OUTPUT” terminals.
(3) Connect a voltmeter between the “OUTPUT” terminal and “GUARD” terminal.
(4) Set the measuring voltage to 10V.
(5) Set the measuring mode to the Current Measuring mode.
(6) Set the current measuring range to the 100μA range (“HOLD 1”).
(7) Measure and calibrate the 100μA range.
(8) Change the reference resistance to 1MΩ, set the current measuring range to the 10μA range (“HOLD 2”) and similarly calibrate the 10μA range.
(9) Calibrate each range by the same method by changing the reference resistance and range. Calibrate the maximum sensitivity, 10pA range, at reference resistance of 100GΩ and measuring voltage of 1V.

The relationship between the reference resistance and current measuring range is shown below.

Measuring Voltage	Reference Resistance	Current Range
１０Ｖ	１００ｋΩ	１００μＡ（「HOLD1」）
１０Ｖ	１ＭΩ	１０μＡ（「HOLD2」）
１０Ｖ	１０ＭΩ	１μＡ（「HOLD3」）
１０Ｖ	１００ＭΩ	１００ｎＡ（「HOLD4」）
１０Ｖ	１ＧΩ	１０ｎＡ（「HOLD5」）
１０Ｖ	１０ＧΩ	１ｎＡ（「HOLD6」）
１０Ｖ	１００ＧΩ	１００ｐＡ（「HOLD7」）
１Ｖ	１００ＧΩ	１０ｐＡ（「HOLD8」）

[Caution] Note that the full-scale value of the current measuring range varies depending on the integral time. (See 5.1.5 “Setting measuring range”)

10.3 Self-calibration Function

This meter has a self-calibration function and can continue self-calibration at a preset interval by setting an interval. By setting this function ON, an accuracy can be maintained for a long time.
During a preshipment factory inspection, this meter is set to self-calibration function ON and 60s as a self-calibration interval.
Self-calibration is performed by measuring an offset current and gain of the current measuring unit and measured results are corrected by providing reference voltage and reference resistance inside.

Self-calibration requires about 2s to complete and this time sometimes presents a problem in automatic measurement. If such problem occurs, set the self-calibration function OFF

and execute a command from an interface or execute self-calibration by keying the keys on the panel periodically.

[Note]
When sequential measurement mode is set to ON, auto self-calibration function is not performed even if the self-calibration function is set to ON. When performing sequential measurement, periodically perform self-calibration by panel operation or by an interface command.

10.4 Self-diagnosis Function

The self-diagnosis function consists of a function, by which self-diagnosis is executed by a command by keying keys on the panel or by a command from an interface, and a function, by which internal operations are always monitored in a normal operating condition.
See Paragraph 6.7.3 “Self-diagnosis” for the self-diagnosis function executed by keying.
In case malfunction is detected by a function that monitors internal operations, the meter stops its operation and displays the following error message screen.
In this case, a component of the meter is faulty. Please contact the HIOKI sales office near your location.

Error message:

“ERROR: xxx Call Service Center”

“xxx” in error codes have the following meanings.

Error Code	Description
0 0 1	Data in the memory is destroyed
0 0 2	Memory write error.
0 0 3	Memory read/write error.
0 0 4	Poor calibration of current measuring unit.
0 0 5	Poor calibration of A/D converter.
0 0 6	Internal communication error with measuring unit.
0 0 7	Internal communication error with voltage output unit.
0 0 8	A/D data readout error.
0 0 9	Power source frequency detection error.
0 1 0	Malfunction of voltage output unit.

[Note] If meter operation is stopped by an error, pressing the [F3] SAVE key and then the “- MAN.T” key sometimes resets meter operation to a normal operation condition in about 60s.
Switching the power on again may return it to normal, but if an error persists, please contact the nearest HIOKI office for repair.

10.5 Service Organization of HIOKI

Please call HIOKI by dialing the toll-free-call telephone No. or the Services Section of HIOKI.

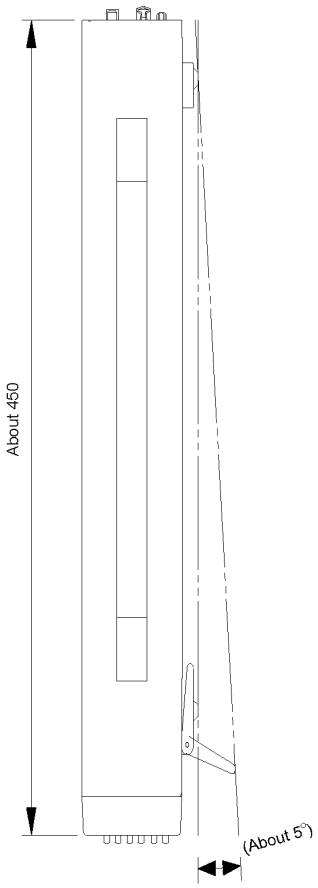
10.6 Storage and Moving

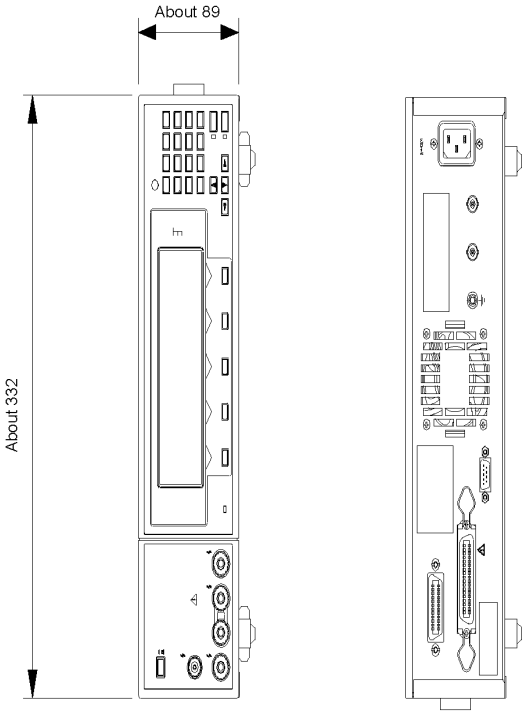
(1) Storage
When the meter is not intended to be used for a long time, disconnect the power plug and store the meter in a place free of a corrosive gas and vibration at an ambient temperature between -5 and 45°C and less than 85% RH covering it with sheeting to prevent dust and dirt.

(2) Moving and transporting
When moving or transporting the meter, please exercise caution to avoid shocks and vibration to the meter. When transporting over a long distance, please transport the meter by crating it in an anti-shock crate and labeling it with “handle with care” labels and by a method that avoids accidents caused by transportation.

(3) Discarding
The components of the meter are made of materials that are not harmful or hazardous. Nevertheless, the meter must be discarded as industrial waste when discarding it.

11. Product Full View





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