HIOKI

INSTRUCTION MANUAL

8855 MEMORY HiCORDER

9549

FUNCTION UP DISK (POWER MONITOR)

HIOKI E. E. CORPORATION

Contents

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Introduction

Thank you for purchasing the HIOKI "9549 FUNCTION UP DISK (POWER MONITOR)."
To obtain maximum performance from the product, please read this manual first, and keep it handy for future reference.

Safety Notes

This manual contains information and warnings essential for safe operation of the 8855 MEMORY HiCORDER and for maintaining it in safe operating condition. Before using the product, be sure to carefully read the following safety notes.

⚠ DANGER

The 8855 MEMORY HiCORDER that this software is installed are designed to conform to IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the product. Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from product defects.

Safety symbols

- The ⚠ symbol printed on the product indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
- In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the product.

Indicates a grounding terminal.

Indicates AC (Alternating Current).

Indicates DC (Direct Current).

Indicates both DC (Direct Current) and AC (Alternating Current).

Indicates the ON side of the power switch.

Indicates the OFF side of the power switch.

Conventions used in this manual

The following symbols in this manual indicate the relative importance of cautions and warnings.

⚠ DANGER	Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.
⚠ WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠ CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the product.
NOTE	Advisory items related to performance or correct operation of the product.

Notes on Use

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

Inspection

- When you receive the software, inspect it carefully to ensure that no damage occurred during shipping.
- If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.

Accessories

Instruction Manual 1

(1) Installation environment

⚠ WARNING

Do not use the product where it may be exposed to corrosive or combustible gases. The product may be damaged or cause an explosion.

⚠ CAUTION

- This product should be installed and operated indoors only, between 5 and 40℃ and 30 to 80% RH.
- Do not store or use the product where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the product may be damaged and insulation may deteriorate so that it no longer meets specifications.

(2) Power supply connections

⚠ DANGER

Before turning the product on, make sure the supply voltage matches that indicated on the its power connector. Connection to an improper supply voltage may damage the product and present an electrical hazard. (The AC fuse is integrated in the unit.)

(3) Grounding the unit

⚠ WARNING

To avoid electric shock and ensure safe operation, connect the power cord to a grounded (3-contact) outlet.

(4) Probe Connection, Measurement Voltage Input

⚠ DANGER

- **Maximum input voltage ratings for the input unit and the input terminals of the product are shown below. To avoid the risk of electric shock and damage to the product, take care not to exceed these ratings.**
- **The maximum rated voltage to earth of the input unit (voltage between input terminals and main product frame ground, and between inputs of other analog units) is shown below. To avoid the risk of electric shock and damage to the product, take care that voltage between channels and between a channel and ground does not exceed these ratings.**
- **The maximum rated voltage to earth rating applies also if an input attenuator or similar is used. Ensure that voltage does not exceed these ratings.**
- **When measuring power line voltages with the 8950, 8952 or 8953-10, always connect the probe to the secondary side of the circuit breaker, so the breaker can prevent an accident if a short circuit occurs. Connection to the primary side involves the risk of electric shock and damage to the product.**
- **Before using the product, make sure that the insulation on the connection cords is undamaged and that no bare conductors are improperly exposed. Using the product under such conditions could result in electrocution. Replace the test leads and probes with the specified Hioki Model 9197, 9198.**

Input/output terminal	Maximum input voltage	Maximum rated voltage to earth
8950 (input)	400 VDC max.	370 V AC/DC
8951 (input)	30 Vrms or 60 VDC	30 Vrms or 60 VDC
8952 (input)	400 VDC max.	370 V AC/DC
8953-10 (input)	400 VDC max.	370 V AC/DC
8954 (input)	30 Vrms or 60 VDC	370 V AC/DC
8955 (input)	30 Vrms or 60 VDC	30 Vrms or 60 VDC
9322	2000 VDC, 1000 VAC (CAT II) 600 VDC/AC (CAT III)	When using grabber clips 1500 VDC/AC (CAT II), 600 V DC/AC (CAT III) When using alligator clips 1000 VDC/AC (CAT II), 600 V DC/AC (CAT III)
EXT TRIG/ START • STOP/ EXT SMPL	-5 to +10 VDC	Not insulated
TRIG OUT/ GO/ NG/ EXT.OUT	-20 V to +30 VDC 500 mA max./ 200 mW max.	

⚠ DANGER

- **A common GND is used for the external I/O terminals (START, STOP, GO, NG, EXT_OUT, EXT_TRIG, EXT_OUT, and EXT_SMPL terminals) and the 8855 unit. The terminals are not isolated. To prevent damage to the object connected to the external I/O terminals and the 8855 unit, wire the terminals so that there is no difference in electrical potential between the GND for the external I/O terminals and the GND for the connected object.**
- **The logic input and 8855 Product share a common ground. Therefore, if power is supplied to the measurement object of the logic probe and to the 8855 from different sources, an electric shock or damage to the equipment may result. Even if power is supplied from the same system, if the wiring is such that a potential difference is present between the grounds, current will flow through the logic probe so that the measurement object and 8855 could be damaged. We therefore recommend the following connection method to avoid this kind of result. Refer to 8855' Quick Start Manual Section 2.5, "Logic Probe Connection" for details.**
- **When using grabber clips, the 9322's maximum rated voltage to earth is 1500 V AC or DC (CAT II) / 600 V AC or DC (CAT III); when using alligator clips, it is 1000 V AC or DC (CAT II) / 600 V AC or DC (CAT III). To avoid electrical shock and possible damage to the unit, never apply voltage greater than these limits between the input channel terminals and chassis, or across the input of two 9322s.**
- **Maximum input voltage is 1000 VAC/2000 VDC (CAT II) / 600 V AC or DC (CAT III). Attempting to measure voltage in excess of the maximum rating could destroy the product and result in personal injury or death.**
- **Refer to 8855' Quick Start Manual Chapter 2, "Installation and Preparation" for details of the probes, clamp on sensor/probe, differential probe, 10:1 and 100:1 probe, and logic probe.**

(6) Replacing the input units

⚠ DANGER

- **To avoid electric shock accident, before removing or replacing an input module, confirm that the instrument is turned off and that the connection cables are disconnected.**
- **To avoid the danger of electric shock, never operate the product with an input module removed. To use the product after removing an input module, install a blank panel over the opening of the removed module.**

Chapter Summary

Chapter 1 Product Overview
Contains an overview of the software and its features.

Chapter 2 Installation Procedure
Contains about the installation method of 9549 FUNCTION UP DISK (POWER MONITOR)

Chapter 3 Preparation Before Measurement
Contains the explanation with regard to matters of inspection and connection method of in measurement.

Chapter 4 Basic Settings (Procedure for Setting the 8855)
Contains about the common basis setting of the power monitor function.

Chapter 5 Power Value Calculations
Contains about the setting method of the power value Calculations function.

Chapter 6 Power Waveform Calculations
Contains about the setting method of the power Waveform Calculations function.

Chapter 7 Specifications

Chapter 8 Appendix
Contains information that is necessary for using this unit.

Chapter 1
Product Overview

1.1 Outline

The 9549 FUNCTION UP DISK (POWER MONITOR) is provided exclusively for use in updating the 8855 MEMORY HiCORDER. Installation is easy using the provided floppy.

1.2 Functions Added by the 9549 FUNCTION UP DISK (POWER MONITOR)

The 9549 function upgrade disk adds the power monitor function.
Hereafter, this function is referred to as the 9549 power monitor function.
The 9549 power monitor function performs several functions.

■ Power value calculation function

This function allows you to calculate numerical values using acquired waveforms.
The following types of calculations can be performed:
RMS (Urms, Irms), average (Umn, Imn), simple average (Udc, Idc), peak (Umax, Umin, Imax, Imin), frequency (Uf, If), effective power (P), apparent power (S), reactive power (Q), power factor (λ), and phase (ϕ) calculations.

■ Power waveform calculation function

In addition to the input signal (voltage/current), you can display the following internally calculated waveforms:
Instantaneous power, voltage fluctuation, current fluctuation, and power fluctuation waveforms.

The above items are explained in the various chapters of this manual.

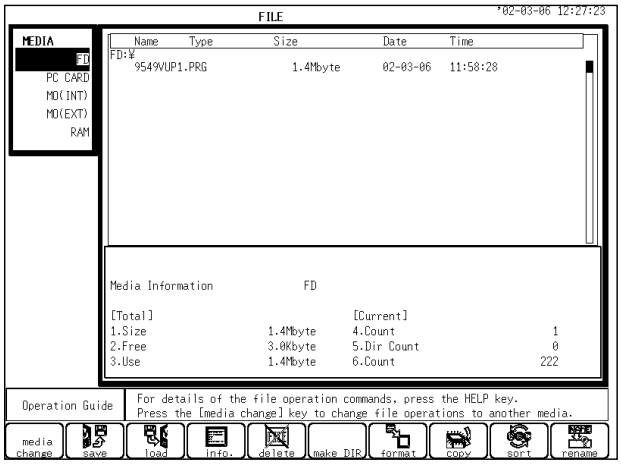
Chapter 2
Installation Procedure

2.1 Installation Procedure

Functional update can be accomplished using the functional update disk.

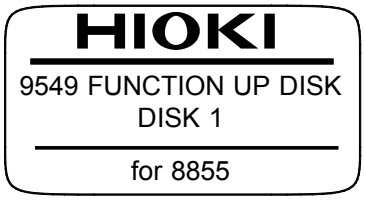
NOTE

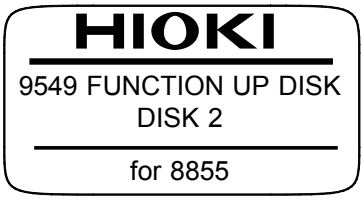
Never turn off the power during upgrade of the ROM version; the program becomes unusable.



1. Insert the FUNCTION UP DISK1.
2. Press the FILE key to call up the FILE screen.
3. Select "FD" as the media type.
4. Load the file named "9549VUP1.PRG".
5. When "Insert Disk 2 and press any key" appears, insert "FUNCTION UP DISK2" and press any key.
6. After loading program file, message is displayed -Version is updated. and the display screen appears.
   Installation is successful.

Functional update floppy disks





Chapter 3
Preparation Before Measurement

3.1 Notes

⚠ DANGER

- **Maximum input voltage ratings for the input unit and the input terminals of the product are shown below. To avoid the risk of electric shock and damage to the product, take care not to exceed these ratings.**
- **The maximum rated voltage to earth of the input unit (voltage between input terminals and main product frame ground, and between inputs of other analog units) is shown below. To avoid the risk of electric shock and damage to the product, take care that voltage between channels and between a channel and ground does not exceed these ratings.**
- **The maximum rated voltage to earth rating applies also if an input attenuator or similar is used. Ensure that voltage does not exceed these ratings.**
- **When measuring power line voltages with the 8950, 8952 or 8953-10, always connect the probe to the secondary side of the circuit breaker, so the breaker can prevent an accident if a short circuit occurs. Connection to the primary side involves the risk of electric shock and damage to the product.**
- **Before using the product, make sure that the insulation on the connection cords is undamaged and that no bare conductors are improperly exposed. Using the product under such conditions could result in electrocution. Replace the test leads and probes with the specified Hioki Model 9197, 9198.**

Input/output terminal	Maximum input voltage	Maximum rated voltage to earth
8950 (input)	400 VDC max.	370 V AC/DC
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8952 (input)	400 VDC max.	370 V AC/DC
8953-10 (input)	400 VDC max.	370 V AC/DC
8954 (input)	30 Vrms or 60 VDC	370 V AC/DC
8955 (input)	30 Vrms or 60 VDC	30 Vrms or 60 VDC
9322	2000 VDC, 1000 VAC (CAT II) 600 VDC/AC (CAT III)	When using grabber clips 1500 VDC/AC (CAT II), 600 V DC/AC (CAT III) When using alligator clips 1000 VDC/AC (CAT II), 600 V DC/AC (CAT III)
EXT TRIG/ START • STOP/ EXT SMPL	-5 to +10 VDC	Not insulated
TRIG OUT/ GO/ NG/ EXT.OUT	-20 V to +30 VDC 500 mA max./ 200 mW max.	

⚠ DANGER

- **A common GND is used for the external I/O terminals (START, STOP, GO, NG, EXT_OUT, EXT_TRIG, EXT_OUT, and EXT_SMPL terminals) and the 8855 unit. The terminals are not isolated. To prevent damage to the object connected to the external I/O terminals and the 8855 unit, wire the terminals so that there is no difference in electrical potential between the GND for the external I/O terminals and the GND for the connected object.**
- **The logic input and 8855 Product share a common ground. Therefore, if power is supplied to the measurement object of the logic probe and to the 8855 from different sources, an electric shock or damage to the equipment may result. Even if power is supplied from the same system, if the wiring is such that a potential difference is present between the grounds, current will flow through the logic probe so that the measurement object and 8855 could be damaged. We therefore recommend the following connection method to avoid this kind of result. Refer to 8855' manual Section 2.5, "Logic Probe Connection" for details.**
- **When using grabber clips, the 9322's maximum rated voltage to earth is 1500 V AC or DC (CAT II) / 600 V AC or DC (CAT III); when using alligator clips, it is 1000 V AC or DC (CAT II) / 600 V AC or DC (CAT III). To avoid electrical shock and possible damage to the unit, never apply voltage greater than these limits between the input channel terminals and chassis, or across the input of two 9322s.**
- **Maximum input voltage is 1000 VAC/2000 VDC (CAT II) / 600 V AC or DC (CAT III). Attempting to measure voltage in excess of the maximum rating could destroy the product and result in personal injury or death.**
- **Refer to 8855' manual Chapter 2, "Installation and Preparation" for details of the probes, clamp on sensor/probe, differential probe, 10:1 and 100:1 probe, and logic probe.**

3.2 Measuring

Unit limitations

- Units that can be used for power calculation with the 9549 power monitor function include the 8950 analog unit, 8951 voltage/current unit, and 8952 DC/RMS unit. Calculations are performed using the following fixed relationship between channels and units. If the input unit is not installed as shown below, power calculations cannot be performed, and you must change the unit.

Channel	Unit capable of calculations	Measurement mode
CH 1 to 4	8950 ANALOG UNIT	Voltage
	8952 DC/RMS UNIT	DC
CH 5 to 8	8951 VOLTAGE/CURRENT UNIT	Current (clamp-on probe/sensor)

  In addition to the above units, measurement can be performed using the 8953-10, 8954, and 8955, but power calculations cannot be performed using these units. Further, power calculations cannot be performed if measurement is performed in Voltage Mode using the 8951, or in RMS mode using the 8952.
- When using a combination of voltage measurement units (8950 and 8952) in the same connection mode, or two different clamp-on probes/sensors for current measurement, calculations are possible, but accuracy is not guaranteed. In this case, the confirmation for the connection check is displayed as "WARN". If possible, use the same unit or clamp-on probe/sensor when performing calculations.

Unit settings

- When making voltage axis range or filter settings, settings for units in the same connection mode are linked, and are therefore set to the same value.
- When making filter or coupling settings, the phase changes and the calculated value differs. Make sure that settings for units in the same connection mode are the same.

Number of usable clamps

The number of clamps that can be used with the 8855 is limited according to clamp type. The clamps that can be used for the relevant clamp type is shown to the list shown below.
In the case that the relevant clamp type is used the clamp total use number is confirmed and please do not exceed the number of the list shown below.

Clamp	Number
3274 CLAMP ON PROBE	
Continuous 150 A	8
Non-continuous 300 A	4
3273-50, 3275, 3276 CLAMP ON PROBE	4
9278 UNIVERSAL CLAMP ON CT	7
9279 UNIVERSAL CLAMP ON CT	7

Calculations

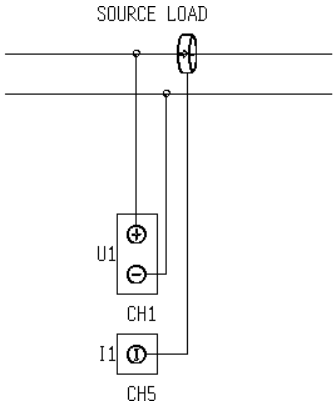
- Once the input signal crosses the zero point, it takes one whole cycle before it crosses the zero point in the same direction (rise/fall) again. Power calculations are performed when zero cross zero (one cycle) is detected. If much noise occurs near the zero cross point, the point cannot be detected and an incorrect calculation result may be displayed.
- When using cursors A and B to perform calculations, place the cursors on the points where the input signal crosses zero, and then perform calculations. Even if the calculation range is specified as the whole data range, set the recording length to an integral multiple of the cycle, and perform calculations. By doing this, you can display a more accurate calculation result. If the calculation range is less than a single cycle, or is not an integral multiple of the cycle, the calculation result when the cursors are not placed on the points where the input signal crosses zero is less than the normal measurement result.

NOTE

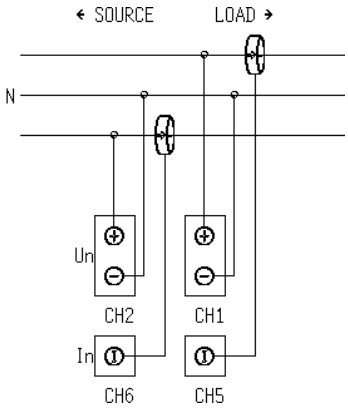
Measurement data calculated using the 9549 power monitor function may not match measurement data acquired using another measurement device such as a power meter. This is because the measurement principle, unit accuracy, or frequency characteristics differ. The measurement result acquired differs depending on range, filter, and coupling settings. Make sure you consider the characteristics of the differential probe or clamp-on probe/sensor you are using when performing measurement.

3.3 Connection Methods

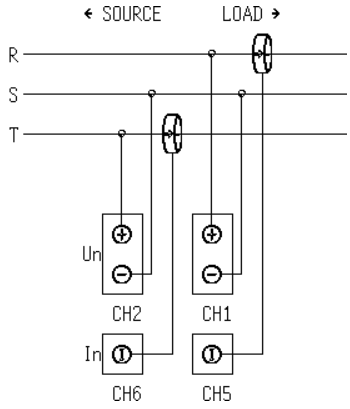
This section describes the connection methods for the various measurement lines. All connection modes are supported.
For details about the relationship between connection modes and channels, see 5.2.2 "Setting the Connection Mode."



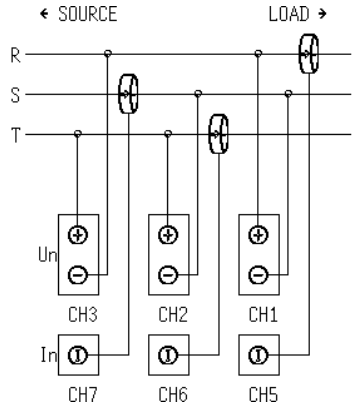
Single phase 2-wire (1P2W) connection method



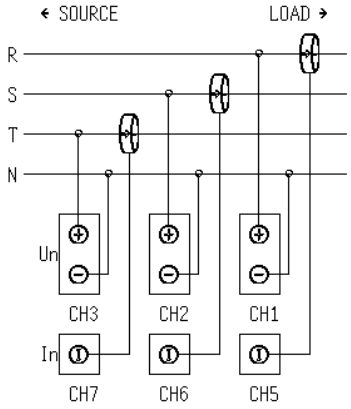
Single phase 3-wire (1P3W) connection method



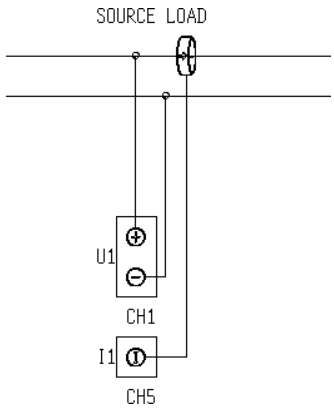
Three phase 3-wire (3P3W) connection method



Three phase 3-wire (3V3A) connection method



Three phase 4-wire (3P4W) connection method



Direct current (DC) connection method

3.4 Connection Check

Before you start measurement, carry out a connection check. Connection checks involve the following:

■ Voltage settings check

- Checks whether the unit (8950 or 8952) specified by U1 (CH1) to U4 (CH4) is installed.
- Checks whether the measurement mode is set to voltage.
- Checks whether the measurement range is correct.

■ Current settings check

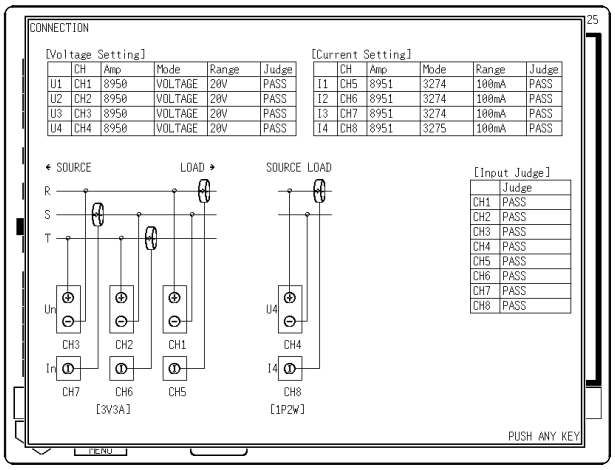
- Checks whether the unit (8951) specified by I1 (CH5) to I4 (CH8) is installed.
- Checks the measurement mode (clamp-on sensor/clamp-on probe).
- Checks whether the measurement range is correct.

■ Input confirmation check

- Checks whether the connection mode and unit are compatible.
- Checks whether the current is flowing in the right direction.
- Over input check (checks whether the input signal falls within the range +/- 20 divisions)
- Under input check (checks whether the input signal is larger than +/-1 division)

(Ex.) A connection check is carried out when the connection mode is 3P4W.

- Checks whether U1 to U3 and I1 to I3 are set to the same range.
- Checks whether the same clamp-on sensor/clamp-on probe is being used.



Procedure Screen: STATUS

1. Press the STATUS key to display the waveform processing screen, then turn on power value processing, and make the necessary settings.
2. Move the flashing cursor to the CONNECTION item.
3. Press the F4 (Execute) key.
   The connection check is performed automatically, and the results displayed.
   If all of the results returned are "PASS", you can proceed with measurement.

■ Input confirmation results

An confirmation result is returned for each signal that is input by the various units. The contents of the confirmation results are as follows:
No error: The signal was input correctly.
Over input: A signal larger than +/-20 divisions was input on the screen.
Under input: A signal less than +/-1 division was input on the screen.
No connection: The input polarity does not match.
No confirmation possible: When a lot of noise occurs near the point where the input signal crosses zero and the point cannot be easily detected, or when the polarity cannot be evaluated due to an error on the voltage side of the current channel.

NOTE

- The connection check performed here is a simplified check.
  Because it is not possible to check all of the connections in this manner, make sure that you check all other connections and settings to ensure that they are correct before starting measurement.
- If you carry out a connection check, the waveform data stored in the unit's memory is erased, and the waveform at the time of checking is stored in the memory. Use this data to confirm whether a connection error has occurred.
- If both the 8950 and 8952 are used in the same connection mode when performing the voltage settings check, the result "WARN" is returned. Further, if a combination of clamp-on probes/clamp-on sensors are used in the same connection mode when performing the current settings and voltage settings checks, the result "WARN" is returned. In this case, calculations are possible, but the accuracy of the measurement results cannot be guaranteed.
- The accuracy of connection checks cannot be guaranteed when measuring inverter waveforms.

Chapter 4
Basic Settings
(Procedure for Setting the 8855)

This section describes the basic settings that are required in order to use the 9549 upgrade functions (hereafter referred to as the power monitor function). Common settings shared with the 8855 when using the power monitor function to perform measurements are as follows:

- Input channel settings
- Trigger settings
- System screen settings

For details on the above setting procedures, refer to the user's guide supplied with the 8855.

4.1 Power Monitor Function

The power monitor function has the following features:

(1) All of the input channels and calculated waveforms can be observed simultaneously.

(2) Up to 16 waveforms (8 input channels and 8 waveforms after calculations) can be displayed simultaneously, and then printed.

(3) Time axis settings are from 5 μs/division to 5 s/division in 19 steps.

(4) The time axis analysis function allows analysis at 100 points/division.

(5) Instantaneous power waveforms can be displayed in real time (faster than 10 ms/division).

(6) Recording capacity (when a specified recording length is set)

- For 32 MW of recording capacity (standard): 10,000 divisions max.
- For 128 MW of recording capacity (with the 9645 installed): 40,000 divisions max.
- For 512 MW of recording capacity (with the 9645-01 installed): 160,000 divisions max.

(7) Input waveforms and calculated waveforms can be enlarged or reduced, and then printed.
- The time axis is between 10 and 1/10,000 in 16 steps.
- The voltage axis is between 100 and 1/2 (a single screen) in 8 steps.
- Variable and zoom functions are available.

(8) Display layout
- Single, dual, quad, and oct display layouts are available.

(9) Logging function: Prints measurement data as numerical values.

(10) Power value calculations
- Displays each voltage and current value, such as the various RMS values, various averages, and effective power as a single block.

(11) Power waveform calculations
- Calculates each voltage and current value as a single block for up to 4 blocks.
- Displays instantaneous power, voltage fluctuation, current fluctuation, and power fluctuation waveforms.

(12) A variety of 8855 function triggers are available.

4.2 Power Monitor Function Settings

The 8855 comes equipped with four functions, but when you install the 9549 power monitor, another function is added to those already available. In order to use the power monitor function to display, set, or calculate power waveforms, you must first make the necessary settings in the power monitor function.

Procedure

Screen: STATUS, CHANNEL, Waveform display, TRIGGER, SYSTEM

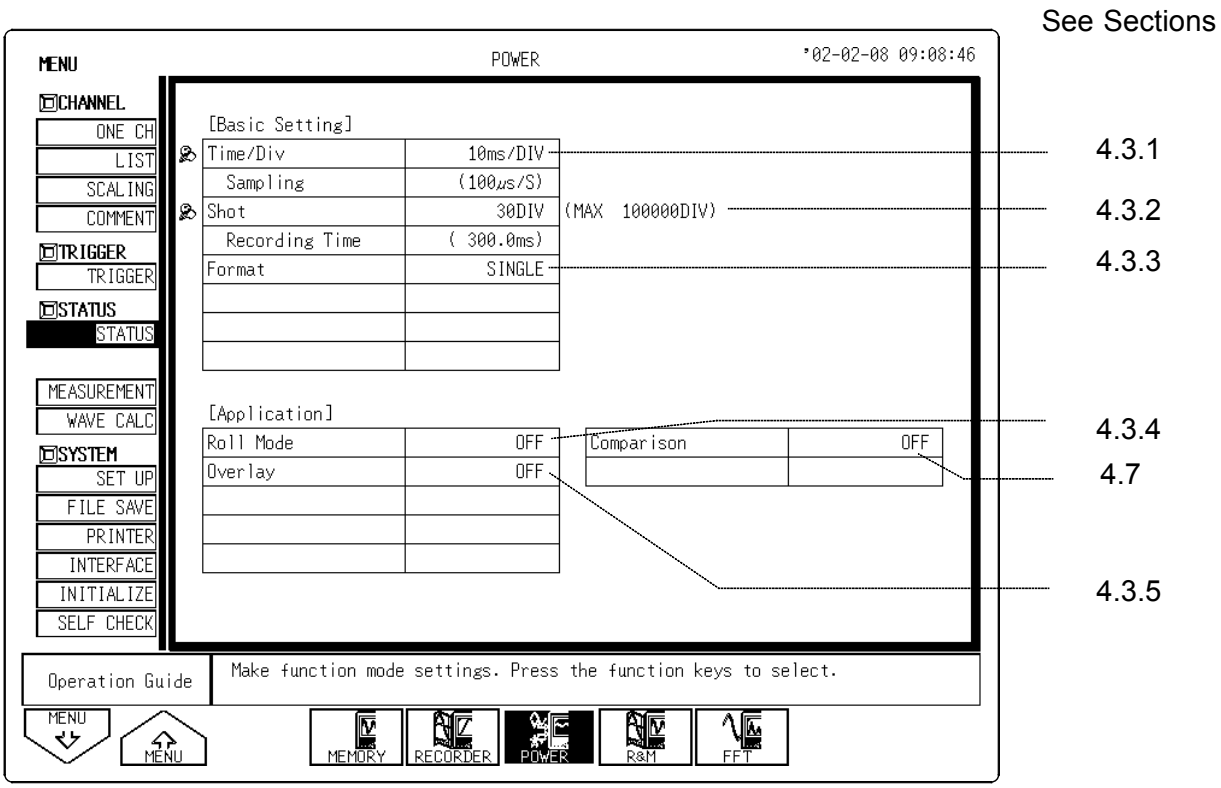
1. Move the flashing cursor to the uppermost position on the function display for the various screens.
2. Select **POWER** using the function key display.

Function display	Meaning
	: Selects the power monitor function.

NOTE Only the 8950 analog unit, 8951 voltage/current unit, and 8952 DC/RMS unit can be used with the power monitor function. Install the 8950 or 8952 on channels 1 to 4, and the 8951 on channels 5 to 8. The channels are fixed according to the connection method used. For details, see 5.2.2 "Setting the Connection Mode."

4.3 STATUS Settings

Press the **STATUS** key to access the Status screen.



4.3.1 Setting the Time Axis Range

Set the speed (sampling) for inputting and storing the waveform of the input signal. Time axis range setting expresses the time for 1 division.

Procedure

Screen: STATUS, Waveform display

1. Use the Menu keys to display the desired screen.
2. Set the value using the **TIME/DIV** knob.
   You can also move the flashing cursor to **Time/Div**, and make settings using the function keys or jog.

• When external sampling is set:

When you set the time axis range to "**EXT.**", the external sampling can be used.

Data points per division are set when external sampling is selected.

1. Move the flashing cursor to the **samples/DIV** item.
2. Use the **JOG/SHUTTLE** control or the function keys to make the selection. Setting range is 10 to 1000.

4.3.2 Setting the Recording Length

The length of recording for one measurement operation (number of DIV) can be set.

FIXED SHOT Select the recording length.
USER SHOT Variable recording length can be selected by the user.

Procedure 1 Constant recording length mode

Screen: STATUS, Waveform display

1. Use the Menu keys to display the desired screen.
2. Move the flashing cursor to the **Shot** item and select **FIXED SHOT** or **USER SHOT**.
3. Use the **JOG/SHUTTLE** control or the function keys to make a setting.

NOTE

If you change the recording length during measurement, measurement restarts, and continues for the newly set recording length.

Relationship between memory capacity and maximum recording length (with optional recording lengths)

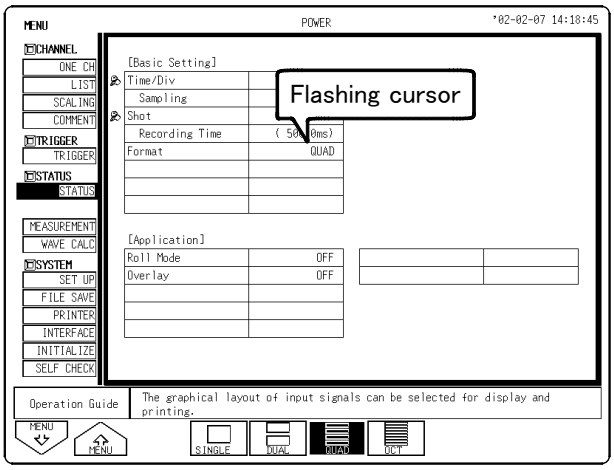
Memory capacity (words)	Maximum recording length (DIV)
32 M 128 M 512 M	10000DIV 40000DIV 160000DIV

About recording lengths and data items

A recording length of 1 DIV contains 100 data items. (External sampling excepted.)
The number of data items for the total set recording length is as follows:
Set recording length (number of DIV) x 100 data items + 1

4.3.3 Setting the Display Format

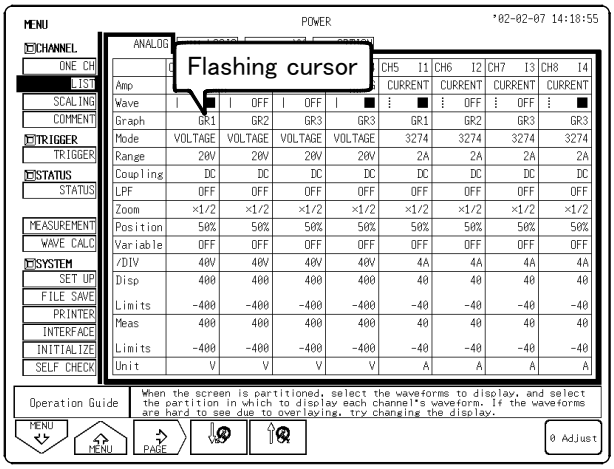
Displays acquired waveforms on the display screen, or sets the display layout for printing.
Select from single, dual, quad, and oct display layouts.
If you change the display layout, vertical axis divisions are automatically changed.



Procedure Screen: STATUS

1. Press the **STATUS** key to display the Status screen.
2. Move the flashing cursor to the **Format** item, as shown in the figure on the left and use the function keys to select the display format.

Function display	Meaning (When using waveforms stored in the unit's memory)
SINGLE	: Data is displayed on one graph.
DUAL	: The screen is split into two and data displayed on two graphs.
QUAD	: The screen is split into four and data displayed on four graphs.
OCT	: The screen is split into eight and data displayed on eight graphs.



3. When the dual, quad, or oct display layout is selected, set which channel is to be displayed on each screen.
4. Press the **CHAN** key to display the CHANNEL screen (Various Channels, List).
5. Move the cursor to the **Graph** position in the figure, and make settings for the screen on which the waveform is displayed.

4.3.4 Setting the Roll Mode

- This mode can be used at a time axis range setting of 10 ms/DIV or slower.
- In normal recording, the waveform is displayed only after all data of the recording length have been captured. At low sampling speed settings, this will cause a considerable delay between the start of measurement and the appearance of the waveform on the display.
- When roll mode is set to ON, the waveform is displayed immediately at the start of recording (the screen scrolls).
- When the time axis range of 10 ms/DIV or faster is set, normal recording is carried out even if roll mode is set to **ON**.

Procedure

Screen: STATUS

1. Press the **STATUS** key to display the Status screen.
2. Move the flashing cursor to the **Roll Mode** item and use the function keys to make a setting.

Function display	Meaning
	: Normal recording is carried out.
	: The waveform is displayed immediately at the start of recording.

NOTE

- Roll mode cannot be set together with the external sampling.
- When Roll Mode is set to ON, the settings for Overlay, Averaging, Sequential Saving, Calculating Waveform data, and Waveform evaluation are automatically turned OFF.
- Roll Mode is selected as the default setting.

4.3.5 Setting the Overlay Function

- Overlay is performed without clearing the currently displayed waveform (if trigger mode is **REPEAT** or **AUTO**). This allows comparison to the immediately preceding waveform.
- If trigger mode is **SINGLE**, measurement terminates after one set of data has been collected. Therefore the overlay setting is invalid.

Procedure

Screen: STATUS

1. Press the **STATUS** key to display the Status screen.
2. Move the flashing cursor to the **Overlay** item and use the function keys to make a setting.

Function display	Meaning
	: Overlay is not performed.
	: Overlay is performed.

NOTE

- While overlay is being executed, operations on the Waveform display screen (waveform scrolling, change in time-axis magnification/compression ratio, change in zero position) are disabled.
- When manual printing or trace cursor reading carried out, only the last waveform will be done.
- If one of the following settings is changed, the overlay waveform display terminates and only the last waveform is shown:
  (1) The display format of the STATUS screen is changed.
  (2) The CHANNEL screen settings are changed. (The graph display, waveform magnification/compression, or zero point is changed.)
- The overlay function cannot be set together with roll mode.

4.4 Setting the Input Unit

The following units can perform calculations using the 9549 power monitor function.
Units not listed below can perform measurement, but are unable to perform power calculations.

- 8950 ANALOG UNIT
- 8951 VOLTAGE/CURRENT UNIT (in Current Mode)
- 8952 DC/RMS UNIT (in DC Mode)

For details on the input settings for the various units, refer to chapter 6 "Input Channel Settings" in the Quick Start Manual and chapter 5 "Input Channel Settings" in the Instruction Manual supplied with the 8855.

■ Combining input units

In order to perform calculations using the 9549 power monitor function, installed units are fixed to a particular channel.
Install the input units as follows:
Channels 1 to 4: Install the 8950 analog unit or 8952 DC/RMS unit.
Channels 5 to 8: Install the 8951 voltage/current unit.
Voltage and current combinations for performing power calculations are fixed as follows.
For details on connection procedures, see 5.2.2 "Setting the Connection Mode."

Calculation block (P)	Voltage input channel (U)	Current input channel (I)
Calculation 1 (P1)	Channel 1 (U1)	Channel 5 (I1)
Calculation 2 (P2)	Channel 2 (U2)	Channel 6 (I2)
Calculation 3 (P3)	Channel 3 (U3)	Channel 7 (I3)
Calculation 4 (P4)	Channel 4 (U4)	Channel 8 (I4)

4.5 Setting Triggers

Triggers can be set to occur for input signals. A specific input signal starts recording.
The following triggers can be used with the 9549 power monitor function.

- Level trigger
- Window in/out trigger
- Period trigger
- Glitch trigger
- Event trigger
- Logic pattern trigger
- External trigger
- Timer trigger

For details on setting triggers, refer to chapter 7 "Trigger Functions" in the Quick Start Manual supplied with the 8855.

4.6 Setting the System Screen

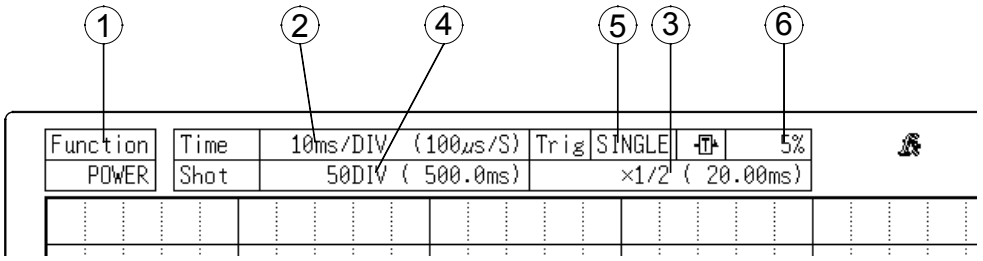
On the system screen a variety of settings (such as displaying a grid or comments on the screen), file storage settings (auto save and save power calculation settings), print settings (auto print and power calculation result settings), and communication settings are possible.
For details, refer to chapter 9 "SYSTEM Screen Settings" in the Quick Start Manual supplied with the 8855.

4.7 Setting Waveform Evaluation

The 9549 power monitor function can be used to perform waveform evaluations.
GO/NG (pass/fail) evaluations can be performed for input signals in the waveform evaluation area that you created.
All displayed channels and calculated waveforms are subject to evaluation.
For details on setting procedures, refer to chapter 9 "Waveform Evaluation Function" in the Instruction Manual supplied with the 8855.

4.8 Settings on the Waveform Display Screen (Power Monitor Function)

Explains the setting items on the Waveform display screen. For details on setting, refer to Section 4.3. When want to use the **JOG/SHUTTLE** control, press the **VALUE** select key. (The selection window is not displayed.)



Setting items	Selection	Explanation
1. Function	MEM, REC	Select function.
2. Time Axis Range	5 µs/DIV to 5 min/DIV (24 steps), EXT	Set the speed for inputting and storing the waveform of the input signal. Time axis range setting expresses the time for 1 DIV.
3. Magnification/ compression along the time axis	x 10 to x 1/100000 (19 steps)	By magnifying the waveform, detailed observations can be made. By compressing the waveform, an entire change can be promptly apprehended. To use the zoom function, press the **F4** function key. You can change the magnification to a value between x 10 and x 50000.
4. Recording Length	FIXED SHOT: 30 DIV to 20000 DIV USER SHOT: 1 DIV to 40000 DIV	Using channels: 8 ch Capacity: 32 M words The length of recording for one measurement operation (the number of DIV) can be set.
5. Trigger mode	SINGLE, REPEAT, AUTO	Select trigger mode.
6. Pre-trigger	0 to 100%, -95% (19 steps)	Set the Pre-trigger.
Input channel settings	Analog input Logic input Analog trigger Comment X, Y axis (X-Y format)	Press the **F9** (**CH.SET**) key on the Waveform display screen, enables the measurement conditions for each channel to be set or changed. See 8855's Instruction Manual Section 5.5.
Level monitor function		Press the **F8** (**MONITOR**) key on the Waveform display screen. See 8855's Quick Start Manual Section 8.5.
VIEW function		Press the **F7** (**SEARCH**) key on the Waveform display screen. See 8855's Instruction Manual Section 8.1.

Chapter 5
Power Value Calculations

Power value calculations are performed for acquired voltage and current waveforms, and the results displayed as numerical values.
The following ten types of value calculation are possible:

(1) RMS voltage value (Urms), RMS current value (Irms):
Calculates the true effective value from the voltage or current waveform.

(2) Average voltage value (Umn), average current value (Imn):
Calculates the average value (corrected average rectified RMS value) from the voltage or current waveform.

(3) Simple average voltage value (Udc), simple average current value (Idc):
Calculates the average value from the voltage or current waveform.

(4) Peak voltage value (Umax, Umin), peak current value (Imax, Imin):
Calculates the maximum and minimum values from the voltage or current waveform.

(5) Voltage frequency (Uf), current frequency (If):
Calculates the frequency from the voltage or current waveform.

(6) Effective power (P):
Calculates the instantaneous power and effective power from the voltage or current waveform.

(7) Apparent power (S):
Calculates the apparent power from the RMS voltage and RMS current values.

(8) Reactive power (Q):
Calculates the reactive power from the values for apparent power and effective power.

(9) Power factor (λ):
Calculates the power factor from the values for apparent power and effective power.

(10) Phase (ϕ):
Calculates the phase from the values for apparent power and effective power.

NOTE

- 9549 power monitor power value calculations are performed for all acquired waveform data.
  If you want to calculate each waveform separately, separate the data using the A and B cursors, then perform calculations.
- Measurement data calculated using the 9549 power monitor function may not match measurement data acquired using another measurement device such as a power meter. This is because the measurement principle, unit accuracy, or frequency characteristics differ.
  Make sure you consider the characteristics of the differential probe or clamp-on sensor you are using when performing measurement.
- For details on the various equations, see 8.1 "Power Value Calculation Details."
- When calculating frequency, waveforms that contain multiple waveforms, such as inverter output waveforms, and waveforms that contain a lot of noise may not be calculated correctly.

5.1 Operation Sequence

Preparation

- Installation of the Product
- Turn on the power
- Connect the inputs

See 8855's manual Chapter 2

Settings on the STATUS screen

See Chapter 4

Press the **STATUS** key to display the STATUS screen.

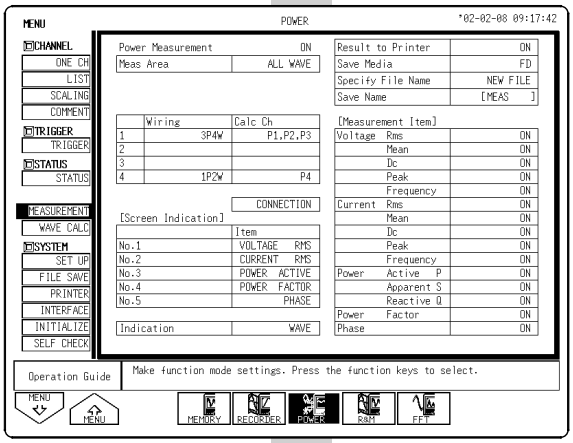
Setting the trigger function

- Trigger mode
- Trigger source
- Pre-trigger
- Trigger selection

See 8855's Quick Start Manual Chapter 7

Settings the power value calculation

Press the **STATUS** key to display the MEASUREMENT screen.



- **Select power value calculation settings** — Sets whether power value calculations are performed.
- **Set calculation range** — Sets all of the data or only the data between the cursors to be calculated.
- **Select connection** — Selects a connection type, such as single phase or three phase 3-wire, depending on the input.
- **Set items for calculation** — Sets the items for calculation.
- **Set calculated value screen display** — Selects whether the calculated values are displayed on the screen.
- **Set screen display** — Selects whether a waveform or the numerical calculation results are displayed on the display screen.
- **Set the following when outputting the calculation results to an external device:**
  - **Select print settings for calculation results** — Sets whether the calculation results are printed.
  - **Save calculation results** — Sets where the calculation results are saved.

Connection check

Checks whether the specified connection method is correct.

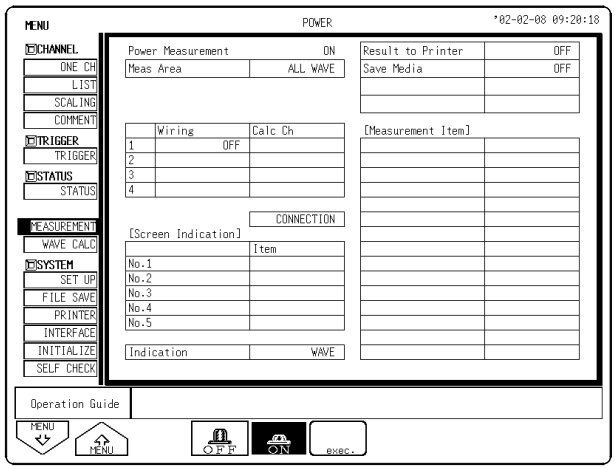
Start measurement/calculation

Measurement/calculation starts when the **START** key is pressed.
When calculating existing waveforms, press the Execute (**F6**) key to start calculation.

5.2 Power Value Calculation Settings Screen

Press the **STATUS** key to display the numerical calculation screen.
Here you can make the various settings for power value calculations.

5.2.1 Setting Power Value Calculations



Procedure

(1) Setting numerical calculations

Sets whether numerical calculations are performed.

1. Move the flashing cursor to **MEASUREMENT**.
2. Make selections using the function key display.

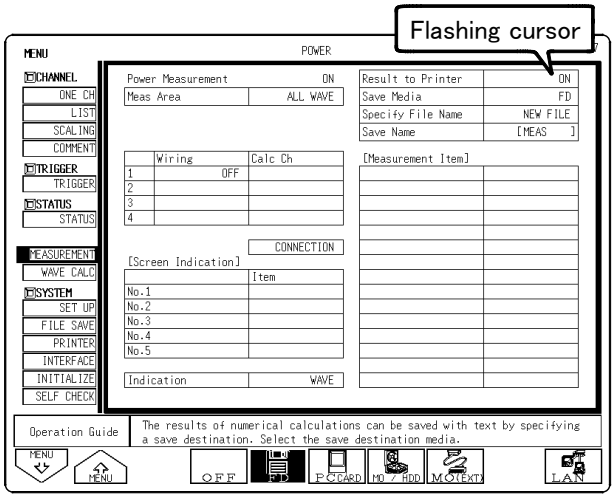
Function display	Meaning
OFF	: Numerical calculations are disabled.
ON	: Numerical calculations are enabled. If numerical calculation is selected, the various setting items are enabled.
exec.	: Calculates the numerical values for the waveform read from the media or the values between the A and B cursors.

(2) Setting the numerical calculation range

Sets the range for numerical calculation.

1. Move the flashing cursor to **Meas Area**.
2. Use the function key display to specify the calculation range.

Function display	Meaning
ALL WAVE	: Performs numerical calculation on all waveforms.
A-B WAVE	: Performs numerical calculation only on the waveform between cursors A and B.



(3) Setting waveform numerical calculation results to be printed or saved

Numerical calculation results can be printed using the built-in printer (when the 8994 printer unit is installed). Further, you can save the results on a variety of media.

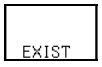
1. Move the flashing cursor to **Result to Printer**.
2. Make selections using the function key display.

Function display	Meaning
OFF	: Prints the waveform numerical calculation results.
ON	: Does not print the waveform numerical calculation results.

3. Move the flashing cursor to **Save Calculation Results**.
4. Make a selection using the function key display.

Function display	Meaning
	: Does not save waveform numerical calculation results.
	: Saves the waveform numerical calculation results on a floppy disk.
	: Saves the waveform numerical calculation results on a PC card.
	: Saves the waveform numerical calculation results on the internal MO/HD.
	: Saves the waveform numerical calculation results on the external MO.
	: Saves the waveform numerical calculation results on a device connected through a LAN.

5. Move the flashing cursor to the item for saving the calculation results file. Calculation results can be saved to a new file each time calculations are executed, or appended to an existing file.

Function display	Meaning
	: Calculation results are saved to a new file.
	: Calculation results are appended to an existing file.

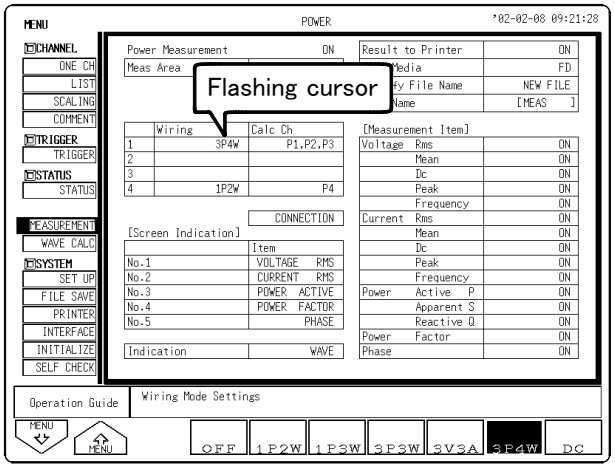
6. Move the flashing cursor to File Name. This allows you to set the file name under which the calculation results are saved. For details on how to set the file name, refer to 8855's Instruction Manual 5.4.3.

NOTE

- When performing numerical calculations while acquiring a waveform, the calculation results are not displayed if you stop numerical calculations before they are finished. In this case, press the Execute function key once more, and restart numerical calculations.
- When specifying the cursors between which you want to perform numerical calculations, make sure you set them at least one cycle apart so that the cycle can be calculated. When performing other types of calculations, place the cursors on the points where the input signal crosses zero. If you set the cursors less than one cycle apart, or on a point other than where the input signal crosses zero, calculation results will not be calculated properly.
- When only the A cursor is enabled, numerical calculations are performed for the data that comes after the cursor. It is recommended that you enable both the A and B cursors and place them on the points where the input signal crosses zero when performing numerical calculations.
- When using horizontal line cursors, all waveforms are subject to numerical calculations.

5.2.2 Setting the Connection Mode

Because four voltage and four current units can be installed on the 8855, a single unit can measure from four single phase 2-wire systems to one three phase 4-wire system + one single phase 2-wire system.
For details on connection procedures, see 3.3 "Connection Methods."



Procedure

1. Press the **STATUS** key to display the numerical calculation screen, and select **Power Measurement**.
2. Move the flashing cursor to **Wiring**.
3. Use the function key display to select a connect mode. When you select a connection mode, the numerical calculation items are displayed.

Function display	Meaning
OFF	: Does not calculate.
1P2W	: Measures/calculates single phase 2-wire (1P2W) connections.
1P3W	: Measures/calculates single phase 3-wire (1P3W) connections.
3P3W	: Measures/calculates three phase 3-wire (3P3W) connections.
3V3A	: Measures/calculates three phase 3-wire (3V3A) connections.
3P4W	: Measures/calculates three phase 4-wire (3P4W) connections.
DC	: Measures/calculates DC lines.

4. When you select a connection type, the calculated channel is displayed automatically.

Relationship between connection modes and channels

- Calculations can only be performed using the following input units: the 8950 ANALOG UNIT, 8951 VOLTAGE/CURRENT UNIT, and 8952 DC/RMS UNIT.
- The possible unit and channel combinations, as well as the connection modes you can select from are as follows:

	Calculated channel 1 (P1)	Calculated channel 2 (P2)	Calculated channel 3 (P3)	Calculated channel 4 (P4)
	CH1 voltage unit (U1) CH5 current unit (I1)	CH2 voltage unit (U2) CH6 current unit (I2)	CH3 voltage unit (U3) CH7 current unit (I3)	CH4 voltage unit (U4) CH8 current unit (I4)
Measurement 1	1P2W / DC	1P2W / DC	1P2W / DC	1P2W / DC
Measurement 2	1P3W / 3P3W		1P2W / DC	1P2W / DC
Measurement 3	1P3W / 3P3W		1P3W / 3P3W	
Measurement 4	3V3A / 3P4W			1P2W / DC

- Voltage units: 8950 ANALOG UNIT and 8952 DC/RMS UNIT
- Current unit: 8951 VOLTAGE/CURRENT UNIT

Connection modes and numerical calculation settings

- Numerical calculation settings for the various connection modes are as follows:

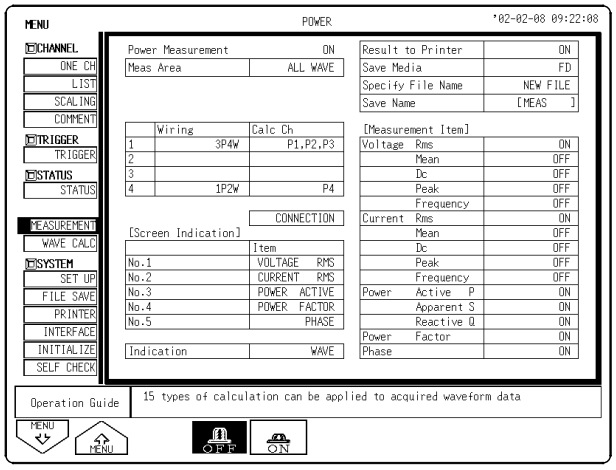
Measured line	Connection mode	Numerical calculation setting
Direct current	DC	P, Umax, Umin, Imax, Imin, Udc, Idc
Single phase 2-wire	1P2W	Urms, Umn, Udc, Umax, Umin, Uf, Irms, Imn, Idc, Imax, Imin, If, P, S, Q, λ, ϕ
Single phase 3-wire	1P3W	Urms, Umn, Udc, Umax, Umin, and Uf for each channel Irms, Imn, Idc, Imax, Imin, If, P12, S12, Q12, λ12, and ϕ12 for each channel
Three phase 3-wire	3P3W (2 voltage, 2 current, 2 power computation)	Urms, Umn, Udc, Umax, Umin, and Uf for each channel Irms, Imn, Idc, Imax, Imin, If, P12, S12, Q12, λ12, and ϕ12 for each channel
	3V3A (3 voltage, 3 current, 2 power computation)	Urms, Umn, Udc, Umax, Umin, and Uf for each channel Irms, Imn, Idc, Imax, Imin, If, P123, S123, Q123, λ123, and ϕ123 for each channel
Three phase 4-wire	3P4W	Urms, Umn, Udc, Umax, Umin, and Uf for each channel Irms, Imn, Idc, Imax, Imin, If, P123, S123, Q123, λ123, and ϕ123 for each channel

NOTE

- When a unit other than the 8950 ANALOG UNIT, 8951 VOLTAGE/CURRENT UNIT, or 8952 DC/RMS UNIT is installed, waveforms can be acquired, but numerical calculations cannot be performed. Further, numerical calculations cannot be performed when the 8950 ANALOG UNIT or 8952 DC/RMS UNIT is installed on a channel other than channels 1 to 4, or the 8951 VOLTAGE/CURRENT UNIT is installed on a channel other than channels 5 to 8.
- Before performing measurement, check the input and connection mode for the unit. If the connection is incorrect, measurement and calculation processes cannot be performed correctly.
- The effective power measurement is the same whether 3P3W mode or 3V3A mode is selected when performing three phase 3-wire measurement, since the measurement method for effective power (P) is the same.

5.2.3 Setting Calculated Items

Sets whether calculations are performed for the various settings.



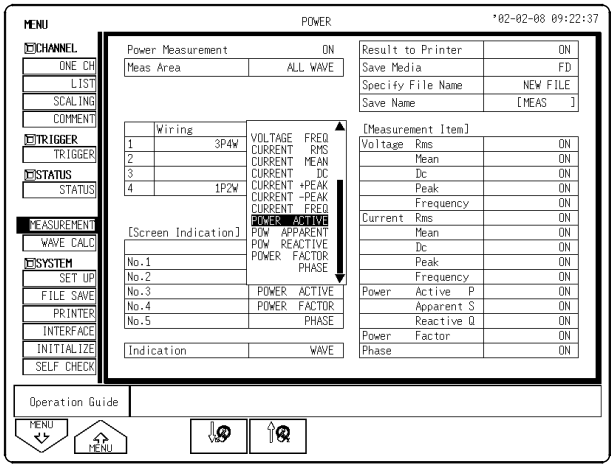
Procedure

1. Press the **STATUS** key to display the numerical calculation screen, and select **Power Measurement**.
2. Move the flashing cursor to Set **Measurement Item**.
3. Use the function key display to select whether calculation is performed.

Function display	Meaning
OFF	: This item is not calculated.
ON	: Numerical calculation is performed for this item.

5.2.4 Setting the Calculated Value Screen Display

Up to five types of calculation results and twenty items can be displayed together with the waveform on the display screen.
Here you can select the calculation items you want to display together with the waveform on the screen.



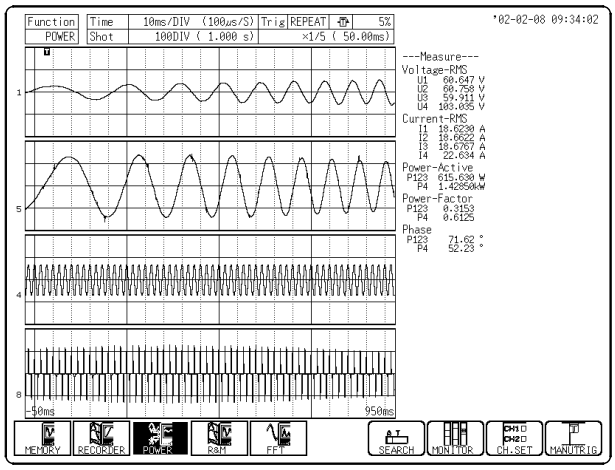
Procedure

1. Press the **STATUS** key to display the numerical calculation screen, and select **Power Measurement**.
2. Move the flashing cursor to the various items for **Screen Indication**. The display item selection window appears.
3. Use the function keys to select items 1 through 5.

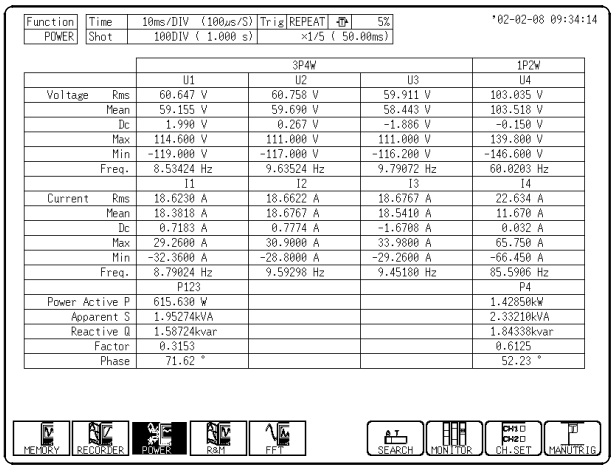
(2) Setting the screen display
Selects whether the waveform or all of the waveform numerical calculation results are displayed on the display screen.

4. Move the flashing cursor to **Indication**.
5. Make a selection using the function key display.

Function display	Meaning
WAVE	: Waveforms are displayed.
NUMBER	: Waveform numerical calculation results only are displayed.



Waveform display screen



Waveform numerical calculation result display screen

Screen display for the Waveform display screen

On the Waveform display screen, move the flashing cursor to Function, and switch the display by pressing the **F3** (Power) key on the GUI.

Chapter 6
Power Waveform Calculations

The 9549 power monitor function allows you to calculate and display acquired voltage and current waveforms. In addition to displaying eight channels for input waveforms, you can display eight graphs for calculated waveforms (a total of 16 waveforms) on a single screen.

(1) Voltage fluctuation waveform (U)
The RMS value is calculated each time the input signal crosses zero and the voltage waveform displayed as a graph.
Fluctuations in voltage can be observed for each waveform.

(2) Current fluctuation waveform (I)
The RMS value is calculated each time the input signal crosses zero and the current waveform displayed as a graph.
Fluctuations in current can be observed for each waveform.

(3) Instantaneous power waveform (p)
The product of the input voltage and current for the waveform are displayed in a graph.
The instantaneous power for these points are graphed.
When using a three phase connection, the graphs for the various other phases as well as the graph for the three phase connection can be displayed.

(4) Power fluctuation waveform (P)
Calculates the points where the voltage and current input signals cross zero, then calculates the average for instantaneous power (p) each time zero is crossed, and displays the waveform as a graph. When using a three phase connection, the graphs for the various other phases as well as the graph for the three phase connection can be displayed.

NOTE

- Measurement data calculated using the 9549 power monitor function may not match measurement data acquired using another measurement device such as a power meter. This is because the measurement principle, unit accuracy, or frequency characteristics differ. Make sure you consider the characteristics of the differential probe or clamp-on sensor you are using when performing measurement.
- For details on the various equations, see 8.2 "Power Waveform Calculation Details."

6.1 Operation Sequence

Preparation

- Installation of the Product
- Turn on the power
- Connect the inputs

See 8855's manual Chapter 2

Settings on the STATUS screen — See Chapter 4

Press the **STATUS** key to display the STATUS screen.

Setting the trigger function

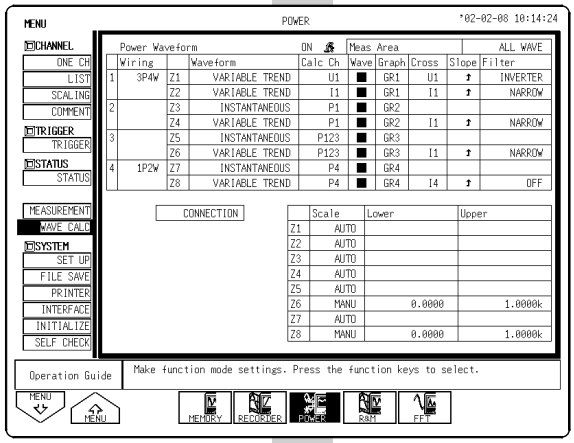
- Trigger mode
- Trigger source
- Pre-trigger
- Trigger selection

See 8855's Quick Start Manual Chapter 7

Settings the power waveform calculation

- Select power waveform calculation settings — Sets whether power waveform calculations are performed.
- Set calculation range — Sets all of the data stored in the memory or only the data between the cursors to be calculated.
- Select connection — Selects a connection type, such as single phase or three phase 3-wire, depending on the input.
- Select power calculated waveform — Selects the type of power calculation performed.
- Set power calculation channel — Sets the channel to be calculated.
- Select power waveform calculation display settings — Turns the display on and off, and switches the display color.
- Select power waveform calculation display graph settings — Sets the graph for displaying the calculation results.
- Set zero cross detection — Selects the channel for detecting the points where the input signal crosses zero.
- Select slope — Sets the slope for zero cross detection.
- Set filter — Sets the zero cross filter.
- Set scale — Sets the display scale for calculated waveforms.

Press the **STATUS** key to display the WAVE Calculation screen.



Connection check

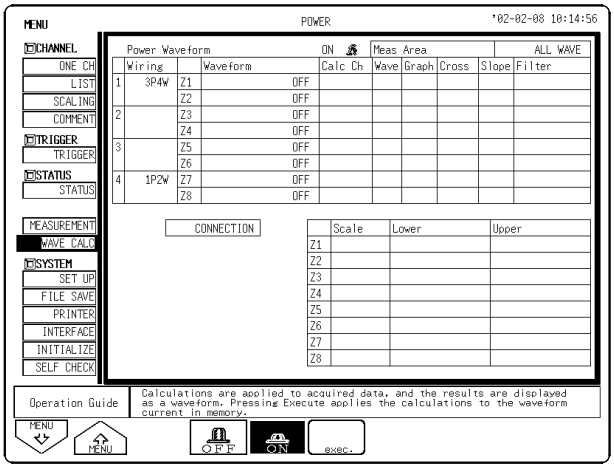
Checks whether the specified connection method is correct.

Starts measuring.

6.2 Power Waveform Calculation Settings Screen

Press the **STATUS** key to display the waveform processing screen.

6.2.1 Making Power Waveform Calculations Settings



Procedure

(1) Setting waveform calculations

1. Move the flashing cursor to **Power Waveform**.
2. Make selections using the function key display.

Function display	Meaning
OFF	: Waveform processing is disabled.
ON	: Waveform processing is enabled. If waveform calculation is selected, the various setting items are enabled.
exec.	: Calculates the waveform values for the waveform read from the media or the values between the A and B cursors.

(2) Setting the waveform calculation range

1. Move the flashing cursor to **Meas Area**.
2. Use the function key display to specify the calculation range.

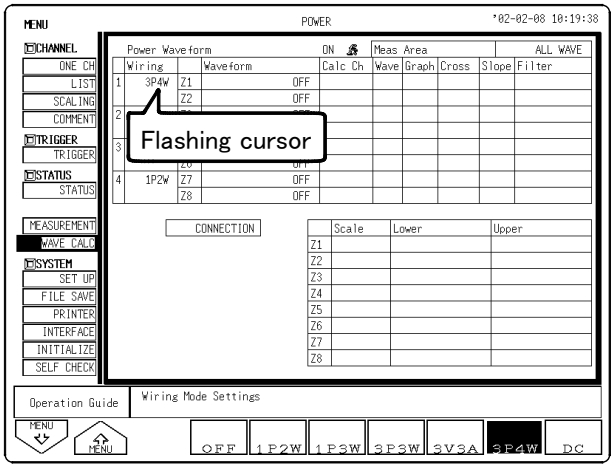
Function display	Meaning
ALL WAVE	: Performs power waveform calculation on all waveforms.
A-B WAVE	: Performs power waveform calculation only on the waveform between cursors A and B.

NOTE

- When performing power waveform calculations while acquiring a waveform, the calculation results are not displayed if you stop calculations before they are finished. In this case, press the Execute function key once more, and restart power waveform calculations.
- When specifying the cursors between which you want to perform power waveform calculations, make sure you set them at least one cycle apart. If you set them less than one cycle apart, power waveform calculations cannot be performed.
- When only the A cursor is enabled, power waveform calculations are performed for the data that comes after the cursor.
  In this case, check that one waveform cycle or more comes after the A cursor, and then perform power waveform calculations.
- When using horizontal line cursors, all waveforms are subject to power waveform calculations.

6.2.2 Setting the Connection Mode

Because four voltage and four current units can be installed on the 8855, a single unit can measure from four single phase 2-wire systems to one three phase 4-wire system + one single phase 2-wire system.
For details on connection procedures, see 3.3 "Connection Methods."



Procedure

1. Press the **STATUS** key to display the waveform processing screen, and select **Power Waveform**.
2. Move the flashing cursor to **Wiring**.
3. Use the function key display to select a connect mode. When you select a connection mode, the numerical calculation items are displayed.

Function display	Meaning
OFF	: Does not calculate.
1P2W	: Measures/calculates single phase 2-wire (1P2W) connections.
1P3W	: Measures/calculates single phase 3-wire (1P3W) connections.
3P3W	: Measures/calculates three phase 3-wire (3P3W) connections.
3V3A	: Measures/calculates three phase 3-wire (3V3A) connections.
3P4W	: Measures/calculates three phase 4-wire (3P4W) connections.
DC	: Measures/calculates DC lines.

Relationship between connection modes and channels

- Calculations can only be performed using the following input units: the 8950 ANALOG UNIT, 8951 VOLTAGE/CURRENT UNIT, and 8952 DC/RMS UNIT.
- The possible unit and channel combinations, as well as the connection modes you can select from are as follows:

	Calculated channel 1 (P1)	Calculated channel 2 (P2)	Calculated channel 3 (P3)	Calculated channel 4 (P4)
	CH1 voltage unit (U1) CH5 current unit (I1)	CH2 voltage unit (U2) CH6 current unit (I2)	CH3 voltage unit (U3) CH7 current unit (I3)	CH4 voltage unit (U4) CH8 current unit (I4)
Measurement 1	1P2W / DC	1P2W / DC	1P2W / DC	1P2W / DC
Measurement 2	1P3W / 3P3W		1P2W / DC	1P2W / DC
Measurement 3	1P3W / 3P3W		1P3W / 3P3W	
Measurement 4	3V3A / 3P4W			1P2W / DC

- Voltage units: 8950 ANALOG UNIT and 8952 DC/RMS UNIT
- Current unit: 8951 VOLTAGE/CURRENT UNIT

Connection modes and waveform calculation settings

- Waveform calculation settings for the various connection modes are as follows:

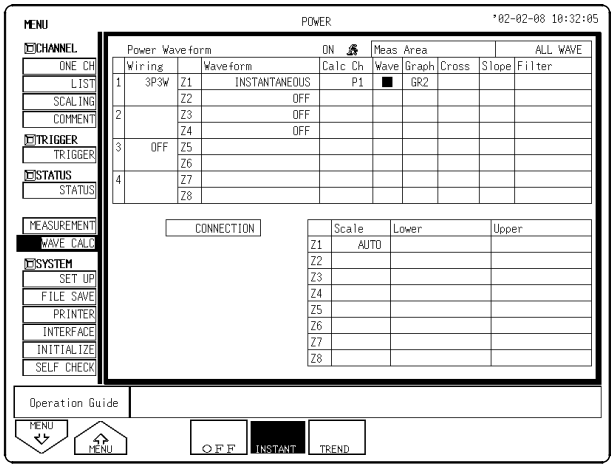
Measured line	Connection mode	Calculated waveform display setting
Direct current	DC	Instantaneous power waveform P
Single phase 2-wire	1P2W	Voltage fluctuation waveform U, current fluctuation waveform I Instantaneous power waveform p, power fluctuation waveform P
Single phase 3-wire	1P3W	Voltage fluctuation waveforms U1, U2 Current fluctuation waveforms I1, I2 Instantaneous power waveforms p1, p2, p12 Power fluctuation waveform P12
Three phase 3-wire	3P3W (2 voltage, 2 current, 2 power computation)	Voltage fluctuation waveforms U1, U2 Current fluctuation waveforms I1, I2 Instantaneous power waveforms p1, p2, p12 Power fluctuation waveform P12
	3V3A (3 voltage, 3 current, 2 power computation)	Voltage fluctuation waveforms U1, U2, U3 Current fluctuation waveforms I1, I2, I3 Instantaneous power waveforms p1, p2, p3, p123 Power fluctuation waveform P123
Three phase 4-wire	3P4W	Voltage fluctuation waveforms U1, U2, U3 Current fluctuation waveforms I1, I2, I3 Instantaneous power waveforms p1, p2, p3, p123 Power fluctuation waveform P123

NOTE

- When a unit other than the 8950 ANALOG UNIT, 8951 VOLTAGE/CURRENT UNIT, or 8952 DC/RMS UNIT is installed, waveforms can be acquired, but numerical calculations cannot be performed. Further, numerical calculations cannot be performed when the 8950 ANALOG UNIT or 8952 DC/RMS UNIT is installed on a channel other than channels 1 to 4, or the 8951 VOLTAGE/CURRENT UNIT is installed on a channel other than channels 5 to 8.
- Before performing measurement, check the input and connection mode for the unit. If the connection is incorrect, measurement and calculation processes cannot be performed correctly.
- The power fluctuation waveform (P) is the same whether 3P3W mode or 3V3A mode is selected when performing three phase 3-wire measurement, since the measurement method for the power fluctuation waveform is the same.

6.2.3 Setting Calculated Waveforms

Sets the type of calculated waveform and the calculated channel.



Procedure

Here, "Z1" is set in the following example.

(1) Setting the waveform calculation type

1. Press the **STATUS** key to display the waveform processing screen, and select **Power Waveform**.
2. Move the flashing cursor to **Waveform** in Z1.
3. Use the function key display to select the type of calculation required.

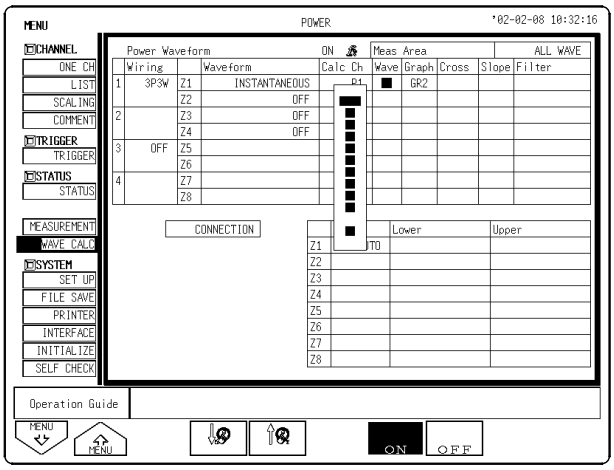
Function display	Meaning
OFF	: Waveform processing is disabled.
INSTANT	: Instantaneous waveform processing is enabled.
TREND	: Fluctuation waveform processing is enabled.

(2) Setting calculated channels

4. Move the flashing cursor to **Calc Ch** in Z1.
5. Use the function key display to set the channel (U/I/P) to be calculated.
6. Set Z2 to Z8 in the same manner.

6.2.4 Setting the Calculated Waveform Display

Turns the calculated waveform display on and off, selects the color of the waveform, and sets the graph to be displayed.



Procedure

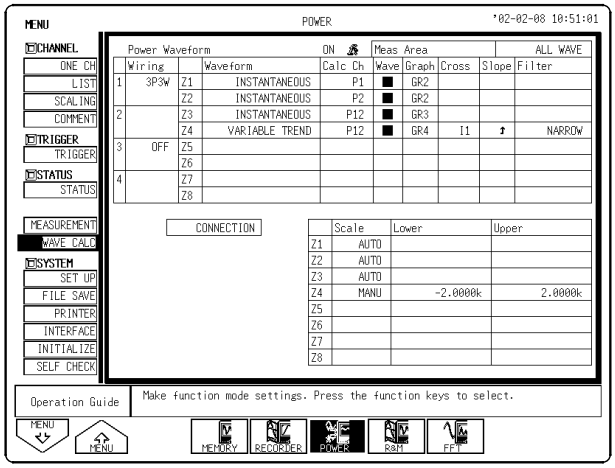
(1) Setting the display

1. Press the **STATUS** key to display the waveform processing screen, and select **Power Waveform**.
2. Move the flashing cursor to **Wave**.
3. Use the function key display to turn the display on and off, and select the color of the waveform.

(2) Setting the display graph

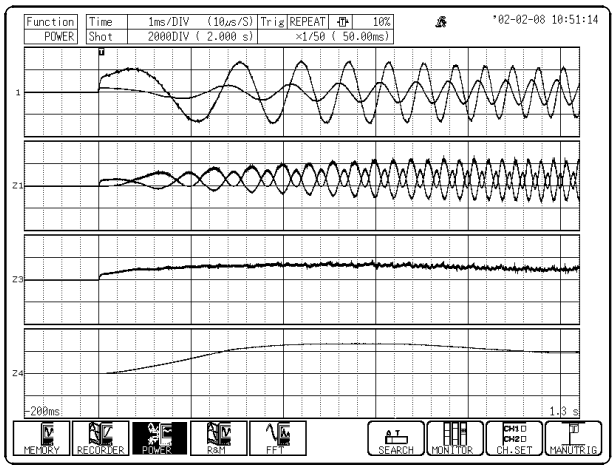
4. If double, quad, or octo is set for the display layout, move the flashing cursor to **Graph**.
5. Use the function keys to set the display graph.

Setting example: When calculations are performed in 3P3W connection mode



Settings screen

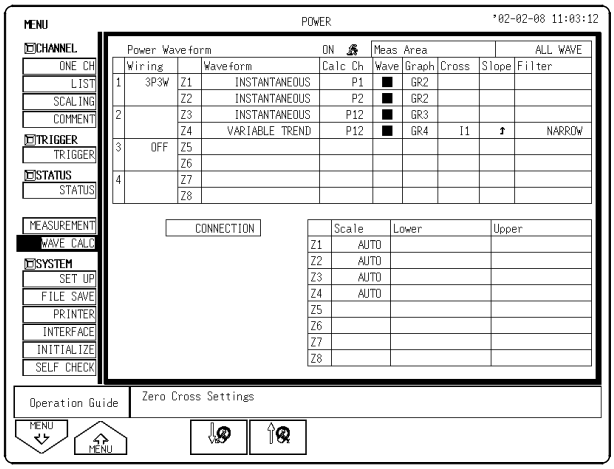
	Calculated waveform	Calculated channel	
Z1	Instantaneous waveform	P1	Graph 2
Z2	Instantaneous waveform	P2	Graph 2
Z3	Instantaneous waveform	P12	Graph 3
Z4	Fluctuating waveform	P12	Graph 4



Calculated waveform

6.2.5 Setting the Zero Cross

Sets the zero cross detection channel reference for calculations, as well as the slope and filter.
Calculates from the first zero cross point to the last zero cross point for the acquired waveform.
When the calculation range is specified using the A and B cursors, the area between the first zero cross point and last zero cross point within the specified range is calculated.



Procedure

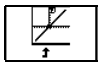
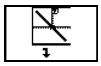
Here, "Z1" is set in the following example.

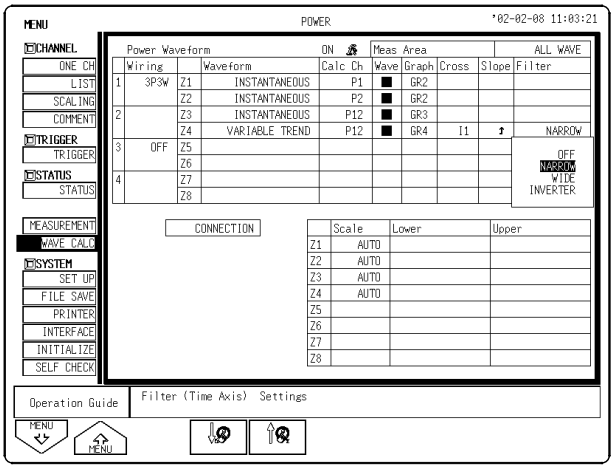
(1) Setting the zero cross detection channel

1. Press the **STATUS** key to display the waveform processing screen, and select **Power Waveform**.
2. Move the flashing cursor to **Cross** in Z1.
3. Use the function keys to select which channel is to be used to search for the zero cross during Z1 calculations.

(2) Setting the detection slope

4. Move the flashing cursor to **Slope** in Z1.
5. Use the function key display to set whether you want to detect a rising or falling zero cross for Z1.

Function display	Meaning
	: Detects a rising zero cross.
	: Detects a falling zero cross.



(3) Setting the filter

If noise occurs as the input signal nears zero, set the filter.

6. Move the flashing cursor to **Filter** in Z17.
7. Use the function keys to select a filter from the selection screen.

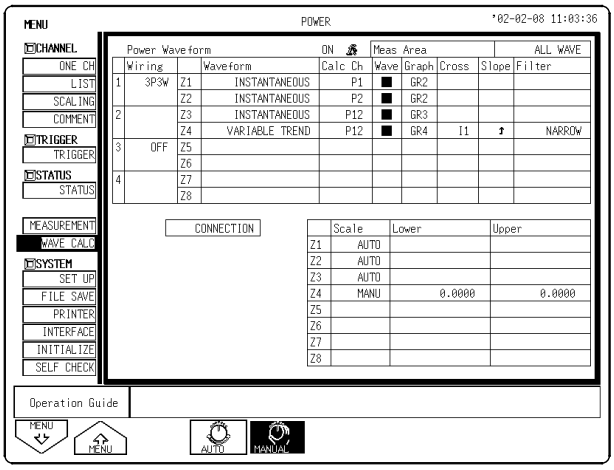
   Set Z2 to Z8 in the same manner.

About the zero cross and zero cross filter

The condition whereby the input signal crosses the zero level is called the "zero cross." A single power waveform cycle lasts from the point where zero is crossed to the next point where zero is crossed in the same direction, and calculations are performed per cycle. If noise occurs as the input signal nears zero (the "zero cross"), the cycle cannot be detected properly. To calculate the components that contain noise, the filter must be set. Three types of filters can be set when using the power monitor: Narrow, Wide, and Inverter.If Narrow is selected, the average movement for five samples is searched, and if Wide is selected, the average movement for 51 samples is searched. If the average movement is anything other than zero, the zero cross is searched.??When Inverter is selected, if more than half of the maximum (minimum) value of the waveform is crossed from zero, the zero cross is searched.??Setting the zero cross filter prevents miscalculations caused by noise as the input signal nears zero.

6.2.6 Setting the Display Scale

Selects Automatic or Manual as the display scale setting.
When Manual is selected, enter the upper and lower threshold values.



Procedure

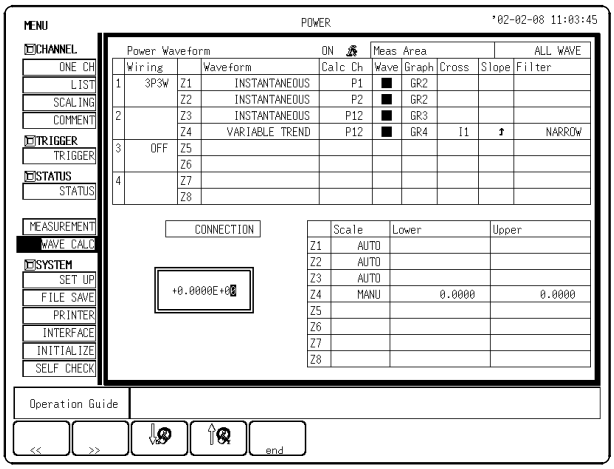
1. Press the **STATUS** key to display the waveform processing screen, and select **Power Waveform**.
2. Move the flashing cursor to **Scale**.
3. Make a selection using the function key display.

Function display	Meaning
AUTO	: Sets the scale automatically.
MANUAL	: The scale can be set manually.

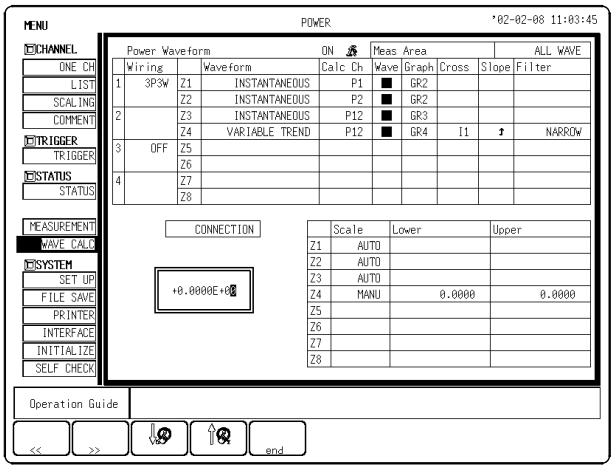
When the scale is set manually:

4. Move the flashing cursor to Lower or Upper.
5. Make a selection using the function key display.

Function display	Meaning
1.0 input	: Makes settings in the numerical value input screen.
reset	: Resets to the default values.
undo	: Returns to the previous setting.
UP-DOWN	: Enters a numerical value for each digit.



Numerical value input screen



Input screen for the various digits

When Automatic is set

- The upper and lower limits for voltage and current fluctuation waveforms are determined by the voltage/current range of the input unit.
- When voltage and current waveforms are displayed in full span on the screen in 1 x, the upper and lower limits are determined so that the power waveform can be displayed in full span.

Overflow calculation results

When Numerical Value is set for the value displayed by the A and B cursors or printer recording layout, Over and Under are displayed.

Chapter 7
Specifications

7.1 General Specifications

Media supplied	3.5 inch 2HD floppy disk (Function upgrade disk x 2)
	User's manual x 1

7.2 Basic Specifications

Measurement function	Power waveform monitor
Compatible units	8950 ANALOG UNIT, 8951 VOLTAGE/CURRENT UNIT, and 8952 DC/RMS UNIT
Time axis	5, 10, 20, 50, 100, 200, or 500 μ s/division 1, 2, 5, 10, 20, 50, 200, or 500 ms/division 1, 2, or 5 s/division, external
Time axis analysis function	100 points/division
Sampling cycle	1/100 of time axis
Recording length	With fixed setting: 30, 50, 100, 200, 500, 1000, 2000, 5000 or 10000 divisions 20000(*1), 50000(*2), or 100000(*2) divisions With optional setting: 1 to 10000 (standard), 1 to 40000(*1), or 1 to 160000(*2) divisions (*1: with 128 MW *2: with 512 MW)
Input channels	8 channels (4 voltage channels + 4 current channels)
Accuracy of numerical calculation(*3)	$\pm$2.0% rdg. (when using the 3273, 3273-50, 3274, 3275, or 3276 CLAMP ON PROBE) (*3: sine wave input (50% f.s. RMS value input), power factor = 1, frequency: 55 Hz, DC coupling, filter: OFF, single phase 2-wire, I1 waveform calculation, after clamp-on sensor offset adjustment is performed)
Waveform magnification and compression	(time axis) x 10, x 5, x 2, x 1, x 1/2, x 1/5, x 1/10, x 1/20, x 1/50, x 1/100, x 1/200, x 1/500, x 1/1000, x 1/2000, x 1/5000, x 1/10000 (voltage axis) x 100, x 50, x 20, x 10, x 5, x 2, x 1 , x 1/2
Screen display	(Waveform display) waveform storage (analog, logic), power waveform calculations (Numerical display) parameter values, cursor read values
Screen and print settings	Single, double, quad, or octo screen display layout
Recording line assignment	12 colors (4 colors when printing)
Overlay function	Yes
Waveform scrolling	Scrolling left and right is possible using the jog or shuttle.

Zoom function	Yes
Logging function	Records measurement data numerically.
Variable display function	Yes
Waveform evaluation	Yes Conforms to 8855 unit specifications.

7.3 Power Value Calculations

Calculated channels	Fixed to a maximum of 4 blocks CH1 (voltage) to CH5 (current) CH2 (voltage) to CH6 (current) CH3 (voltage) to CH7 (current) CH4 (voltage) to CH8 (current)
Parameter calculations	Displays each voltage and current value as a single block. Urms: RMS voltage value — Irms: RMS current value Umn: Average voltage value — Imn: Average current value Udc: Simple average voltage value — Idc: Simple average current value Umax: Maximum voltage value — Imax: Maximum current value Umin: Minimum voltage value — Imin: Minimum current value Uf: Voltage frequency — If: Current frequency P: Effective power S: Apparent power Q: Reactive power λ: Power factor ϕ: Phase
Calculation area	All stored memory, between the A and B cursors

7.4 Power Waveform Processing

Calculated channels	Fixed to a maximum of 4 blocks CH1 (voltage) to CH5 (current) CH2 (voltage) to CH6 (current) CH3 (voltage) to CH7 (current) CH4 (voltage) to CH8 (current)
Display channel	A total of 16 channels can be displayed (8 input waveforms and 8 calculated waveforms).
Waveform processing	Instantaneous power waveform (with time axis range settings of 10 ms/division (10 kS/s) or slower for real-time display) Effective power fluctuation waveform for each zero cross (after data is saved) Voltage fluctuation and current fluctuation waveforms (RMS value fluctuations)
Calculation amounts	When using standard memory: Up to 10,000 divisions (1 MW) regardless of the number of channels used When using 128 MW: Up to 40,000 divisions (4 MW) regardless of the number of channels used When using 512 MW: Up to 160,000 divisions (16 MW) regardless of the number of channels used

7.5 Triggers

Trigger types	Level, window in, window out, period, glitch, event, logic pattern (conforms to 8855 unit specifications)
Zero cross	Detected by the software
Zero cross filter	OFF, Narrow, Wide, Inverter

Chapter 8
Appendix

8.1 Power Value Calculation Details

9549 power monitor function power value calculations are performed for all acquired waveform data.
When the calculation range is delimited using the A and B cursors, calculations are performed for data in that area only.
Note that the calculation range is not measured in waveform cycles.
Power value calculations are performed using the following equations:

RMS voltage value (Urms), RMS current value (Irms)

Calculates the true RMS value for voltage or current.

$$Urms = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(u(t)^2)}$$

$$Irms = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(i(t)^2)}$$

n: Number of data samples
u(t): Voltage input waveform
i(t): Current input waveform

Average voltage value (Umn), average current value (Imn)

Calculates the corrected average rectified RMS value for voltage or current.

$$Umn = \frac{\pi}{2\sqrt{2}} \cdot \frac{1}{n}\sum_{t=1}^{n} |u(t)|$$

$$Imn = \frac{\pi}{2\sqrt{2}} \cdot \frac{1}{n}\sum_{t=1}^{n} |i(t)|$$

n: Number of data samples
u(t): Voltage input waveform
i(t): Current input waveform

Simple average voltage value (Udc), simple average current value (Idc)

Calculates the simple average value for voltage or current.

$$Udc = \frac{1}{n}\sum_{t=1}^{n} u(t)$$

$$Idc = \frac{1}{n}\sum_{t=1}^{n} i(t)$$

n: Number of data samples
u(t): Voltage input waveform
i(t): Current input waveform

Peak voltage value, peak current value

Calculates the maximum (Umax, Imax) and minimum (Umin, Imin) values for voltage or current waveform data.

Voltage frequency (Uf), current frequency (If)

Calculates frequency from voltage or current waveform data.
Calculates frequency using the time difference average from the point where the input signal crosses zero to the next point where it crosses zero.
Note: Frequency may not be able to be calculated for waveforms where large amounts of noise occur when the input signal nears zero (such as inverter waveforms).

Effective power (P)

Calculates the effective power value using the average obtained from the product of the voltage waveform u(t) and current waveform i(t).

$$P = \frac{1}{n}\sum_{t=1}^{n} (u(t) \cdot i(t))$$

n: Number of data samples
u(t): Voltage input waveform
i(t): Current input waveform

Apparent power (S)

Calculates the apparent power value from the RMS voltage value (Urms) and RMS current value (Irms).

$$S = Urms \cdot Irms$$

Depending on miscalculations and unbalanced loads, when the equation is $S < |P|$, the apparent power value is calculated so that $S = |P|$, $Q = 0$, $\lambda = 1$, $\phi = 0$.

Reactive power (Q)

Calculates the reactive power value using the effective power (P) and apparent power (S) values.

$$Q = \sqrt{(S^2 - P^2)}$$

Power factor (λ)

Calculates the power factor using the effective power (P) and apparent power (S) values.

$$\lambda = \frac{P}{S}$$

Phase (ϕ)

Calculates the phase using the effective power (P) and apparent power (S) values.

$$\phi = \cos^{-1}\left(\frac{P}{S}\right)$$

Connection modes and processing equations

Connection modes and their corresponding processing equations are shown below.

Connection mode	DC	Single phase 2-wire	Single phase 3-wire
RMS voltage value (Urms)	-	U	U1, U2
RMS current value (Irms)	-	I	I1, I2
Effective power (P)	U ▪ I	P	P12=P1+P2
Apparent power (S)	-	S	S12=S1+S2
Reactive power (Q)	-	Q	$Q12 = \sqrt{S12^2 - P12^2}$
Power factor (λ)	-	λ	λ12=P12/S12
Phase (ϕ)	-	ϕ	ϕ12=cos^{-1}(λ12)

Connection mode	Three phase 3-wire		Three phase 4-wire
	3P3W	3V3A	
RMS voltage value (Urms)	U1, U2	U1, U2, U3	U1, U2, U3
RMS current value (Irms)	I1, I2	I1, I2, I3	I1, I2, U3
Effective power (P)	P12=P1+P2	P123=P1+P2	P123=P1+P2+P3
Apparent power (S)	$S12 = \frac{\sqrt{3}}{2}(S1 + S2)$	$S123 = \frac{\sqrt{3}}{3}(S1 + S2 + S3)$	S123=S1+S2+S3
Reactive power (Q)	$Q12 = \sqrt{S12^2 - P12^2}$	$Q12 = \sqrt{S12^2 - P12^2}$	$Q123 = \sqrt{S123^2 - P123^2}$
Power factor (λ)	λ12=P12/S12	λ123=P123/S123	λ123=P123/S123
Phase (ϕ)	ϕ12=cos^{-1}(λ12)	ϕ123=cos^{-1}(λ123)	ϕ123=cos^{-1}(λ123)

8.2 Power Waveform Calculation Details

9549 power monitor function fluctuation waveforms are calculated for each cycle of acquired waveform data.
When the calculation range is delimited using the A and B cursors, calculations are performed for each cycle of the data in that area only.
If the data for the acquired waveform is less than a single cycle of data, or if less than a single cycle is selected using the A and B cursors, calculations cannot be performed.

Power waveform calculations are performed using the following equations:

Voltage fluctuation waveform (U(n)), current fluctuation waveform (I(n))

Calculates the RMS values for each cycle using voltage or current waveform data, sets the average movement, and then displays the results in a graph.

$$U(n) = \sqrt{\frac{1}{T}\sum_{t=n-T}^{n}(u(t)^2)}$$

$$I(n) = \sqrt{\frac{1}{T}\sum_{t=n-T}^{n}(i(t)^2)}$$

n: nth number of data in the voltage or current input waveform
T: A single cycle on the input waveform
u(t): Voltage input waveform
i(t): Current input waveform

Instantaneous power waveform (p(t))

Calculates the product of the voltage input waveform and current input waveform, and then displays the results in a graph.

$$P(t) = u(t) \cdot i(t)$$

u(t): Voltage input waveform
i(t): Current input waveform

Power fluctuation waveform

Calculates the average movement per cycle using the data for the instantaneous power waveform, and then displays the results in a graph.

$$P(n) = \frac{1}{T}\sum_{t=n-T}^{n} p(t)$$

n: nth number of data in the instantaneous power waveform
T: A single cycle on the input waveform
p(t): Instantaneous power waveform

Connection modes and processing equations

Connection modes and their corresponding processing equations are shown below.

Connection mode	DC	Single phase 2-wire	Single phase 3-wire
Voltage fluctuation waveform (U(t))	U(n)	U(n)	U1(n), U2(n)
Current fluctuation waveform (I(t))	I(n)	I(n)	I1(n), I2(n)
Instantaneous power waveform (p(t))	p(t)	p(t)	p12(t)=p1(t)+p2(t)
Instantaneous fluctuation waveform (P(t))	p(t)	P(n)	$P(n) = \frac{1}{T} \sum_{t=n-T}^{n} p12(t)$

Connection mode	Three phase 3-wire		Three phase 4-wire
	3P3W	3V3A	
Voltage fluctuation waveform (U(t))	U1(n), U2(n)	U1(n), U2(n), U3(n)	U1(n), U2(n), U3(n)
Current fluctuation waveform (I(t))	I1(n), I2(n)	I1(n), I2(n), I3(n)	I1(n), I2(n), I3(n)
Instantaneous power waveform (p(t))	p12(t)=p1(t)+p2(t)	p123(t)=p1(t)+p2(t)	p123(t)=p1(t)+p2(t)+p3(t)
Instantaneous fluctuation waveform (P(t))	$P(n) = \frac{1}{T} \sum_{t=n-T}^{n} p12(t)$	$P(n) = \frac{1}{T} \sum_{t=n-T}^{n} p123(t)$	$P(n) = \frac{1}{T} \sum_{t=n-T}^{n} p123(t)$

8.3 Numerical Calculation Errors

The 8951 voltage/current unit that uses the 9549 power monitor function can be combined with a variety of clamp-on sensors. Numerical processing results acquired using the various clamp-on sensors are used as reference data when logical and read value errors occur.

Numerical processing read value errors (rdg) (comparison/reference data for logical values)
Including the clamp-on sensor

Clamp	AC coupling		DC coupling	
	Filter OFF	Filter 500Hz	Filter OFF	Filter 500Hz
9270	+/-3.5%	+/-5%	-	-
9271	+/-2%	+/-3%	-	-
9272 (20A)	+/-3.5%	+/-5%	-	-
9272 (200A)	+/-2%	+/-3.5%	-	-
9277	+/-2.5%	+/-4%	+/-2%	+/-2%
9278	+/-2.5%	+/-4%	+/-2%	+/-2.5%
9279	+/-2.5%	+/-3.5%	+/-2%	+/-2%

Measurement conditions	23±5℃ 80% RH or less
Input voltage	100 V (50% f.s.)
Input current	50% f.s. input for each range
Input frequency	55 Hz
Input waveform	Sine wave
Connection mode	Single phase 2-wire
Power factor	1
Calculated waveform	11 waveforms

NOTE

- Make sure you warm up the clamp-on sensor/probe before using it.
  For details, refer to the user's manual for the clamp-on sensor/probe you are using.
- Depending on the coupling method and filter used with the input unit, results may fall outside the reference data given above.
  In order to achieve accurate measurement results, make sure you use a clamp-on sensor/probe that is suitable for the current being measured.

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HIOKI 9549 FUNCTION UP DISK (POWER MONITOR)

Instruction Manual

Publication date: October 2004 Revised Edition 2

Edited and published by HIOKI E.E. CORPORATION
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Printed in Japan 9549A981-02

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9549A981-02 04-10H

Printed on recycled paper