WT200

Digital Power Meter

USER'S MANUAL

YOKOGAWA
Yokogawa Electric Corporation

IM 253421-01E
1st Edition

Thank you for purchasing the YOKOGAWA WT200 Digital Power Meter.
This User's Manual contains useful information regarding the instrument's functions and operating procedures, as well as precautions that should be observed during use. To ensure proper use of the instrument, please read this manual thoroughly before operating it.
Keep the manual in a safe place for quick reference whenever a question arises.

Notes

- The contents of this manual are subject to change without prior notice.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your dealer or YOKOGAWA sales office.
- Copying or reproduction of all or any part of the contents of this manual without YOKOGAWA's permission is strictly prohibited.

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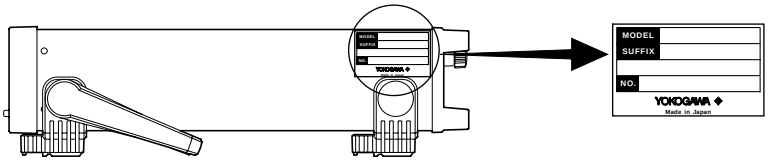
Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. In case the wrong instrument or accessories have been delivered, or if some accessories are not present, or if they seem abnormal, contact the dealer from which you purchased them.

WT200 Main Unit

Check that the model code and suffix code given on the name plate located at the right side of the main body are according to your order.

WT200 (model code: 253421)



Model and Suffix codes

Model code	Suffix code	Specifications
253421		WT200
Power cord	-D	UL,CSA Standard Power Cord (Part NO.: A1006WD) [Maximum rated voltage: 125 V; Maximum rated current: 7 A]
	-F	VDE Standard Power Cord (Part No.: A1009WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-R	SAA Standard Power Cord (Part No.: A1024WD) [Maximum rated voltage: 240 V; Maximum rated current: 10 A]
	-Q	BS Standard Power Cord (Part No.: A1054WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
Options		
Communication Interface (Select either one)	/C1	GP-IB interface
	/C2	RS-232-C interface
External sensor input function (Select either one)	/EX1	2.5/5/10 V range
	/EX2	50/100/200 mV range
Harmonic analysis function	/HRM	–
External input/output function (Select either one)	/DA4	4-channel D/A output
	/CMP	4-channel comparator, 4-channel D/A output

Ex: GP-IB interface, with UL/CSA power cord, with external sensor input 50/100/200 mV range, with harmonic analysis function, and 4 channels D/A output →253421-D/C1/EX2/HRM/DA4

NO. (instrument number)

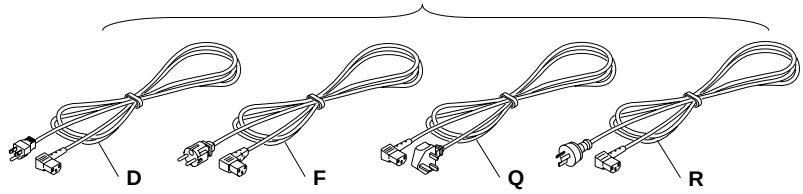
When contacting the dealer from which you purchased the instrument, please quote the instrument No.

Standard Accessories

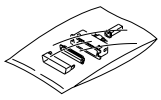
The following standard accessories are supplied with the instrument. Make sure that all items are present and undamaged.

Name	Part No.	Q'ty	Remarks
1 Power cord	see page ii	1	—
2 24-pin connector	A1004JD	1	For remote, D/A output (only provided with options /DA4 or /CMP)
3 Rubber feet	A9088ZM	1 set	
4 User's Manual	IM253421-01E	1	this manual

1. An appropriate power cord according to the instrument's suffix code is supplied.

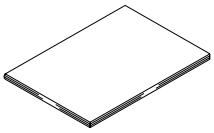


2.



3.

4.



Note

We recommend you keep the packing box. The box is useful when you need to transport the instrument.

Safety Precautions

This instrument is a IEC safety class I instrument (provided with terminal for protective grounding).
The following general safety precautions must be observed during all phases of operation, service and repair of this instrument. If this instrument is used in a manner not sepecified in this manual, the protection provided by this instrument may be impaired.
Also,YOKOGAWA Electric Corporation assumes no liability for the customer’s failure to comply with these requirements.

The following symbols are used on this instrument.


To avoid injury, death of personnel or damage to the instrument, the operator must refer to an explanation in the User's Manual or Service Manual.


Danger, risk of electric shock


Alternating current

ON (power)


OFF (power)


In-position of a bistable push control


Out-position of a bistable push control


Ground

Make sure to comply with the following safety precautions. Not complying might result in injury or death.

WARNING

Do not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable liquids or vapors. Operation of any electrical instrument in such an environment constitutes a safety hazard.

Protective Grounding

Make sure to connect the protective grounding to prevent an electric shock before turning ON the power.

Necessity of Protective Grounding

Never cut off the internal or external protective grounding wire or disconnect the wiring of protective grounding terminal. Doing so poses a potential shock hazard.

Defect of Protective Grounding

Do not operate the instrument when protective grounding or fuse might be defective.

Power Cord and Plug

To prevent an electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug must be plugged in an outlet with protective grounding terminal. Do no invalidate protection by using an extension cord without protective grounding.

Power Supply

Ensure the source voltage matches the voltage of the power supply before turning ON the power.

External Connection

To ground securely, connect the protective grounding before connecting to measurement or control unit.

Fuse

The power fuse of this instrument cannot be replaced by the user, because it is located inside the case. If you believe the fuse inside the case is blown, contact your nearest YOKOGAWA dealer as listed on the back cover of this manual.

Do not Remove any Covers

There are some areas with high voltage. Do not remove any cover if the power supply is connected. The cover should be removed by qualified personnel only.

Structure of this Manual

This User's Manual consists of the following 16 chapters and an index.

Chapter 1	**Functional Overview and Digital Display** Describes the input signal flow, functional overview, digital numbers/characters, initial menus that are displayed when a key is pressed, and other information..
Chapter 2	**Names and Uses of Parts and the Overrange and Error Displays** Gives the name of each part and each key, and describes how to use it. This chapter also gives the displays in case of overrange/error during measurement.
Chapter 3	**Before Starting Measurements** Describes points to watch during use and describes how to install the instrument, wire the measuring circuits, connect the power cord and switch the power ON/OFF.
Chapter 4	**Setting Measurement Conditions and Measurement Range** Explains settings such as measurement mode, filter ON/OFF, measurement range, scaling in case of external PT/CT or external sensor (such as shunt or clamp), averaging and measurement conditions.
Chapter 5	**Displaying the Results of the Measurement and Computation** Explains the procedures for displaying the voltage, current, active power, apparent power, reactive power, power factor, phase angle, frequency, peak value, value derived from four arithmetical operations, and crest factor.
Chapter 6	**Integration** Explains the procedures for integration of active power and current.
Chapter 7	**Using the Harmonic Analysis Function (Optional)** Explains the procedures when using the harmonic analysis function.
Chapter 8	**Storing/Recalling Measured Data and Setting Parameters from the Internal Memory** Explains the procedures when storing or recalling measured data or setting parameters from the internal memory.
Chapter 9	**Using External Input/Output** Explains the procedures for remote control, D/A output (option), external plotter/ printer output and comparator (option).
Chapter 10	**Using the GP-IB Interface (Optional)** Explains the procedures for controlling the instrument by personal computer and for sending measurement/computed data to a personal computer using the GP-IB interface.
Chapter 11	**Using the RS-232-C Interface (Optional)** Explains the procedures for controlling the instrument by personal computer/ controller and for sending measurement/computed data to a personal computer/ controller using the RS-232-C interface.
Chapter 12	**Initializing Setup Parameters and Performing Zero Level Compensation** Explains the procedures such as backing up setting parameter and initializing settings.
Chapter 13	**Communication Commands 1 (System of Commands before the IEEE 488.2-1987 Standard)** Describes communication commands and sample programs that follow the rules that existed before the establishment of the IEEE 488.2-1987 Standard.
Chapter 14	**Communication Commands 2 (System of Commands Complying to the IEEE 488.2-1987 Standard)** Describes communication commands and sample programs that comply with the IEEE 488.2-1987 Standard.
Chapter 15	**Adjustment, Calibration and Trouble-Shooting** Explains the procedures for calibration, adjustment, the way to verify trouble, the contents of error messages and the way to replace the fuse.
Chapter 16	**Specifications** Describes the specifications of the instrument.
Index	**Index of contents.**

Conventions Used in this Manual

Symbols Used

The following symbol marks are used throughout this manual to attract the operator's attention.

A symbol mark affixed to the instrument. Indicates danger to personnel or instrument and the operator must see the User's Manual. The symbol is used in the User's Manual to indicate the reference.

WARNING Describes precautions that should be observed to prevent the danger of serious injury or death to the user.

CAUTION Describes precautions that should be observed to prevent the danger of minor or moderate injury to the user, or the damage to the property.

Note Provides information that is important for proper operation of the instrument.

Displayed Characters on the 7-Segment LED

In order to display all numbers and alphabetic characters on the 7-segment LED, some of them are displayed in a slightly altered format. For details, see section 1.3.

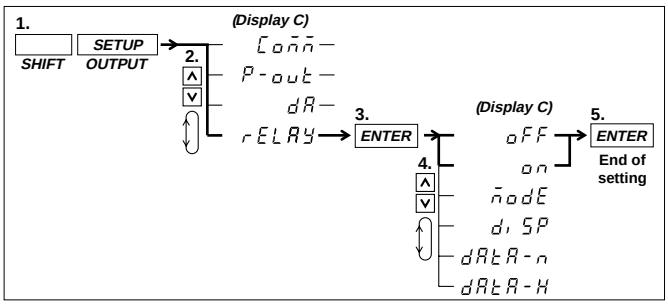
Markings used for Descriptions of Operations

Keys Indicates the relevant panel keys and indicators to carry out the operation.

Procedure The procedure is explained by a flow diagram. For the meaning of each operation, see the example below. The operating procedures are given with the assumption that you are not familiar with the operation. Thus, it may not be necessary to carry out all the steps when changing settings.

Explanation Describes settings and restrictions relating to the operation.

An example of an Operating Procedure



The items in this figure are obtained by the following setting procedures. The blinking part of the display can be set.

1. After pressing the SHIFT key and the SHIFT indicator is lit, press the SETUP (OUTPUT) key. The output setting menu will appear on display C.
2. Select *rELAY* using the up/down keys.
   Pressing either key, 4 selectable items will be displayed consecutively.
3. Verify the setting by pressing the ENTER key.
   The setting menu corresponding to the item selected at step 2 will appear at display
   C.
4. Select *oFF* or *on* using the up/down keys.
   Pressing either key, 6 selectable items will be displayed consecutively.
5. Verify the setting by pressing the ENTER key.

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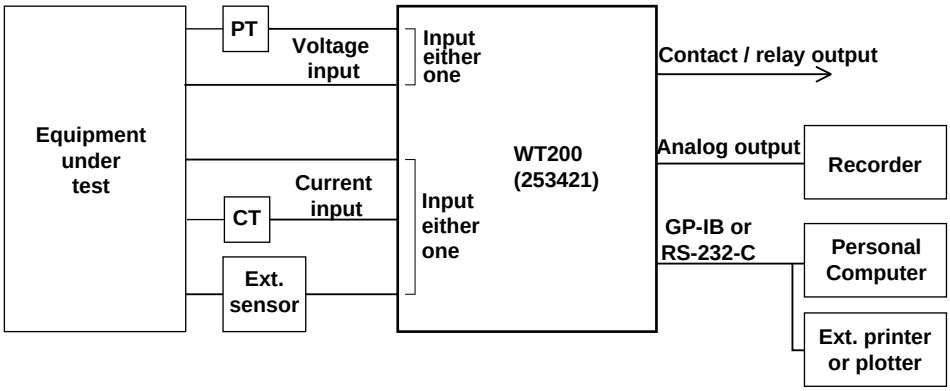
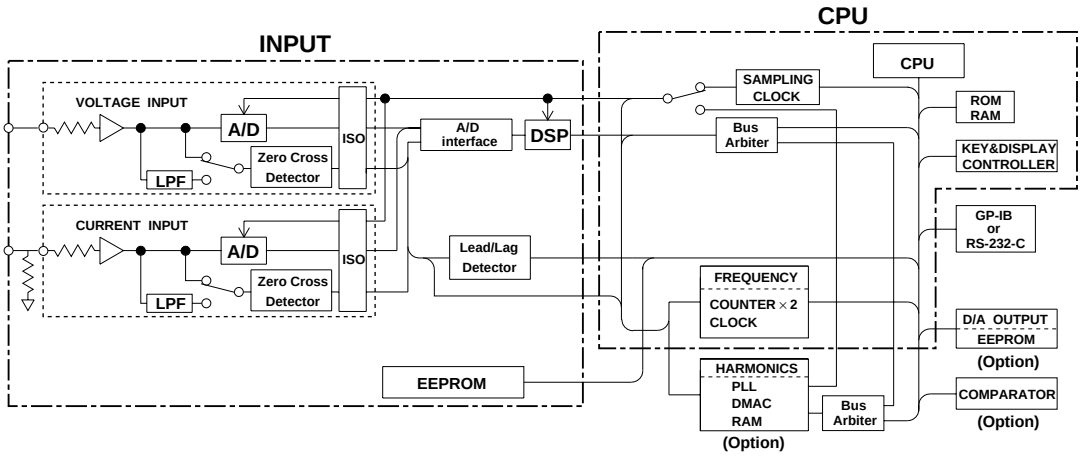
1.1 System Configuration and Block Diagram

System Configuration



Block Diagram



This instrument consists of various sections: input (voltage input and current input circuits), DSP, CPU, display and interface section.

In the voltage input circuit, the input voltage is formalized by a voltage divider and operational amplifier, then sent to the A/D converter.

In the current input circuit, the input current passes through a shunt resistor that forms a closed circuit. The voltage across shunt resistor is amplified and normalized and then input to the A/D converter. This method enables switching of the current range without opening the current measurement circuit, so the current range can be switched while electricitiy is supplied to the circuit. This also enables remote control via communications outputs.

The output from the A/D converter in the current input and voltage input circuits is sent to the DSP (Digital Signal Processor) via a photo-isolator, which is used to provide insulation between the current input circuit (or voltage circuit) and the DSP. One DSP is provided for each input element (current/voltage). For example, a total of 3 DSP's are used for the three-phase, four-wire model. The DSP performs averaging of voltage, current and active power for each sampled data sent from the A/D converter. After processing of a certain number of sets of data has been completed, computation of apparent power, reactive power, power factor and phase angle starts.

Computation results are then sent from the DSP to the CPU, where computation such as range conversion, and scaling is carried out. Control of display and outputs is also performed by the CPU.

1.2 Functions

Input Functions

Voltage and Current Input Sections
A voltage or current supplied to each input terminal is normalized then sent to the A/D converter, where the voltage or current is converted into digital signals. The digital signals are then sent via photo-isolator to a 16-bits high-speed DSP (Digital Signal Processor) or CPU, where computation of the measured value is carried out.

Frequency Measuring Range
Measurement of DC voltage, current and power as well as AC voltage and current in the frequency range 10 Hz to 50 kHz.

Filter
This instrument carries out various measurements after synchronizing the frequency of the input signals. Therefore, correct measurements are necessary. Thus, a filter is being applied to the frequency measurement circuit to eliminate noise of waveforms, such as inverted and distortion waveforms.

Wiring Method
The wiring method indicates the circuit configuration used to measure the voltage, current, and power. The WT200 uses a single-phase, two-wire (1ϕ2W) wiring method.

Display Functions

This function enables display of measured/computed values using three red high-intensity 7-segment LED displays. A total of three values can be displayed at once.

Peak Measurement Function

This function measures the peak values of the voltage and current. This value is used to compute the crest factor.

MAX Hold Function

This function holds the maximum values of the voltage, current, active power, apparent power, reactive power, voltage peak, and current peak. It holds the maximum value that exists while the MAX hold function is enabled.

Computing Functions

Apparent Power, Reactive Power, Power Factor and Phase Angle
Based on the measurement values of voltage, current and active power, the values of apparent power, reactive power, power factor and phase angle can be computed.

Scaling
When performing voltage or current measurements with an external PT, CT, shunt, external sensor (clamp) or such connected, you can set a scaling factor to the primary/secondary ratio. This is called scaling. This function enables display of the measured values of voltage, current, active power, reactive power, integrated current and integrated power factor in terms of primary-side values.

Averaging
This function is used to perform exponential or moving averaging on the measured values before displaying them in cases where the measured values are not stable.

Four Arithmetic Operation
Results from six types of arithmetic operations can be displayed. (A+B, A–B, A*B, A/B, A^2/B, A/B^2)

Crest Factor
This function determines the crest factor of the voltage and current using peak and RMS values.

Average active power during integration

This function computes the average active power within the integration period. It is derived by dividing the watt hour (integrated active power) by the elapsed time of integration.

Integrator Functions

This function enables integration of active power and current. All measurement values (and computed values) can be displayed, even when integration is in progress, except for the integrated values (watt hour and ampere hour) and elapsed integration time. Since also integrated values of negative polarity can be displayed, the consumed watt hour (ampere hour) value of the positive side and the watt hour value returning to the power supply of the negative side can be displayed seperately.

The following two integration methods are available:

- Standard type
  Integrates the active power or current that is obtained using the normal measurement method, which obtains the active power or current from the sampled data over the period that is synchronized to the input signal. Select the standard type for steady-state input signals that have a constant period such as a sinusoid.
- Advanced type
  Integrates the active power or current obtained over a fixed period of sampled data, irrespective of the period of the input signal. Select the advanced type for intermittent signals with a frequency of 50 or 60 Hz.

Frequency Measurement Function

This function measures the frequency of the voltage and current.
Measuring range is from 10 Hz to 50 kHz (however, depending on the internal timing of the instrument, measurement might be carried out in the range from 4 Hz to 10 Hz also).

Harmonic Analysis Function (optional)

This function enables computation of voltage, current, active power and so forth of up to the 50th order, the relative harmonic content of harmonic orders and the phase angle of each order compared to the fundamental (first order). Furthermore, the total rms value (fundamental + harmonic) of the voltage, current and active power, and the harmonic distortion factor (THD) can be calculated.

Storing/Recalling Measured Data and Setting Parameters

This function enables the storage of measured data and setting parameters into the internal memory. Furthermore, after recalling measured data or setting parameters, these data can be displayed or output by communication interface.

D/A Output Function (optional)

This function enables output of measured values of voltage, current, active power, apparent power, reactive power, power factor and phase angle as a DC analog signal with full scale of ±5 V. Output items of up to 4 channels can be selected.

Comparator Function (optional)

This function compares the measured values of voltage, current, active power, apparent power, reactive power, power factor and phase angle and such with preset limit values. When the measured values cross those preset limits, a contact output relay will be activated. Output items up to 4 channels can be set.

Remote Control Functions (optional)

External Input

This instrument can be controlled using the following TTL-level, low pulse, logic signals.

EXT HOLD (when options /DA4, /CMP are installed)
Holds updating of the displayed values or releases the hold status.

EXT TRIG (when option /DA4 is installed)
Updates the displayed values in hold mode.

EXT START (when option /DA4 is installed)
Starts integration.

EXT STOP (when option /DA4 is installed)
Stops integration.

EXT RESET (when option /DA4 is installed)
Resets the integration results.

External Output

This instrument can output the following TTL-level, low pulse, logic signals.

EXT BUSY (when option /DA4 is installed)
Outputs continuously from integration start through integration stop.

Communication Functions (Option)

Either a GP-IB or RS-232-C interface is provided as standard according to the custormer's preference. Measured/computed data of up to 14 channels can be output. It is also possible to control this instrument from the personal computer.

Output Function to an External Plotter and Printer

Measured/computed data can be printed on an external plotter or printer using the GP-IB or RS-232-C interface.

Other Useful Functions

Backup of Setting Parameters

This instrument backs up the setting parameters (including computed values) in case power is cut off accidentally as a result of a power failure or for any other reason.

Initializing Setting Parameters

This function enables you to reset the setting parameters to initial (factory) settings.

Zero-level compensation

Zero level compensation refers to creating a zero input condition inside the WT200 and setting the level at that point as the zero level. Zero level compensation must be performed in order to satisfy the specifications of this instrument. When the measurement range is changed, zero level compensation is performed automatically. However, if the measurement range is not changed for a long time, the zero level may shift due to environmental changes around the instrument. In such case, you can manually perform zero level compensation.

1.3 Digital Numbers/Characters, and Initial Menus

Digital Numbers/Characters

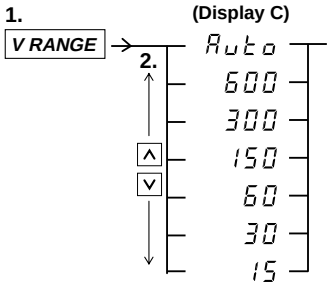
This instrument is equipped with a 7-segment LED which imposes some restrictions on the usable characters. The numbers/characters are styled as follows.

0 → 0	A → A	K → K	U → U	^(Exponent) → ^
1 → 1	B → b	L → L	V → V	
2 → 2	C → C Small c → c	M → M	W → W	
3 → 3	D → d	N → n	X → X	
4 → 4	E → E	O → o	Y → Y	
5 → 5	F → F	P → P	Z → Z	
6 → 6	G → G	Q → q	+ → +	
7 → 7	H → H Small h → h	R → r	− → −	
8 → 8	I → I	S → S	× → ×	
9 → 9	J → J	T → T	÷ → ÷	

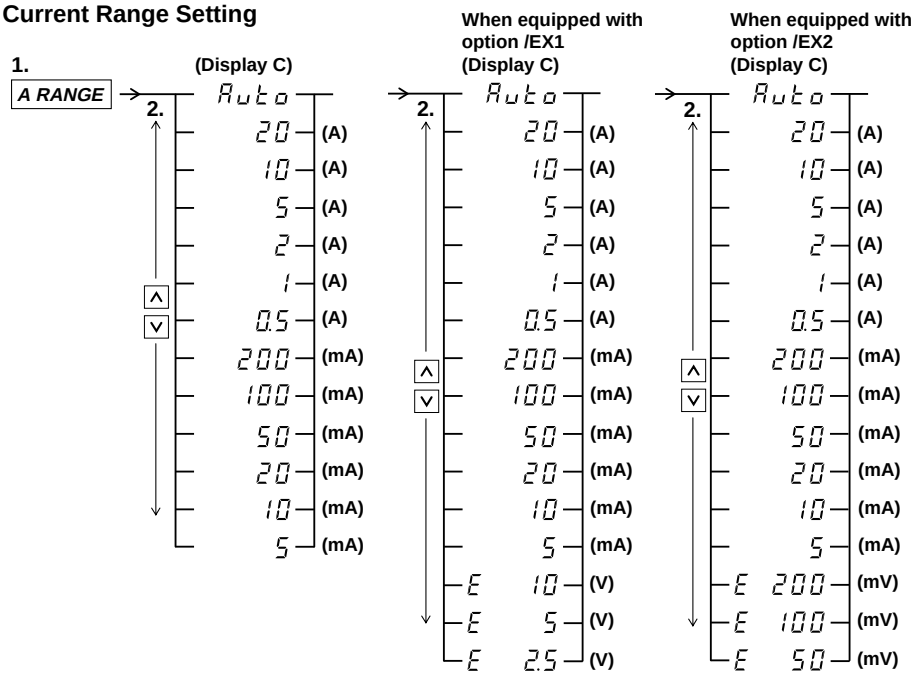
Initial Menus

Every function of this instrument can be set using the menus on the display. The initial displays which appear when the operation keys are pressed, are shown below.

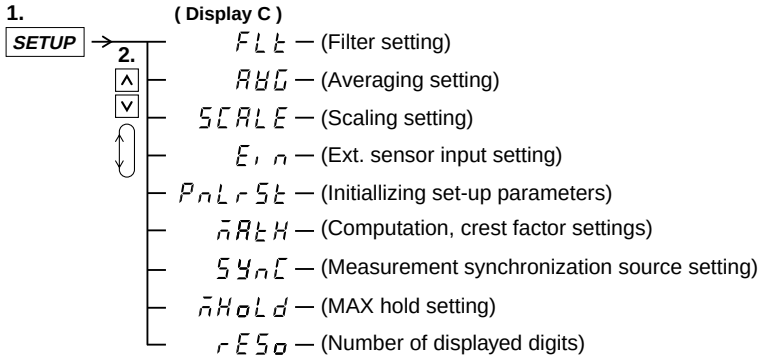
• Voltage Range Setting



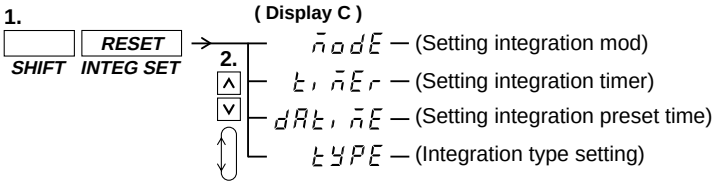
• Current Range Setting



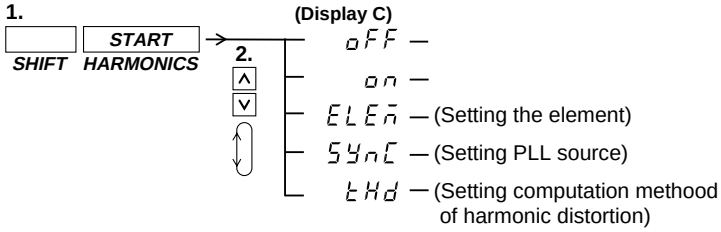
• Setting the Filter, Averaging, Scaling, Ext. Sensor Input, and Initializing Setting Parameters



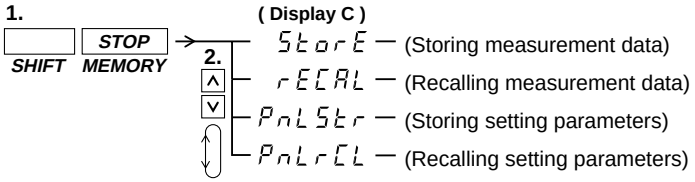
• Integration Setting



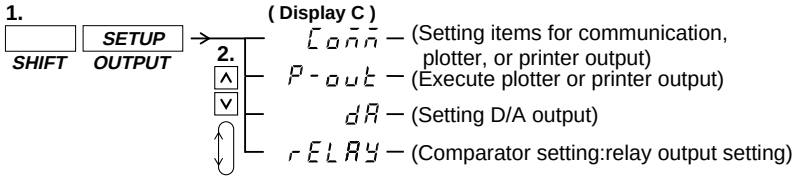
• Turning the Harmonic Analysis Function ON/OFF



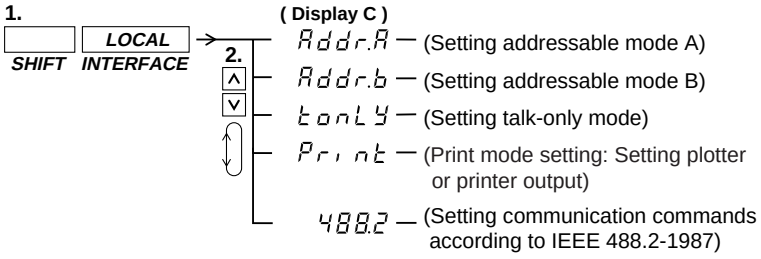
• Storing/Recalling to/from Internal Memory



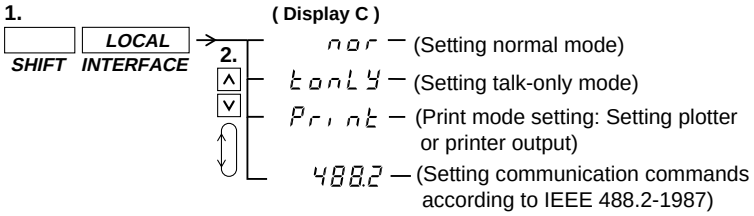
• Setting Output



• Setting Communication Interface (GP-IB)

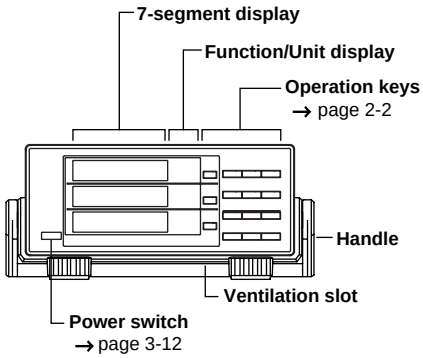


• Setting Communication Interface (RS-232-C)

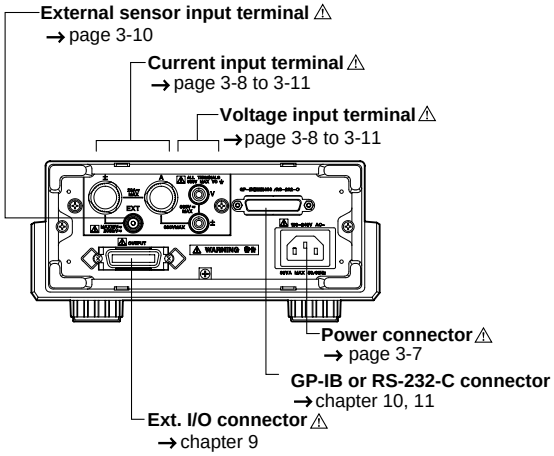


2.1 Front Panel, Rear Panel and Top View

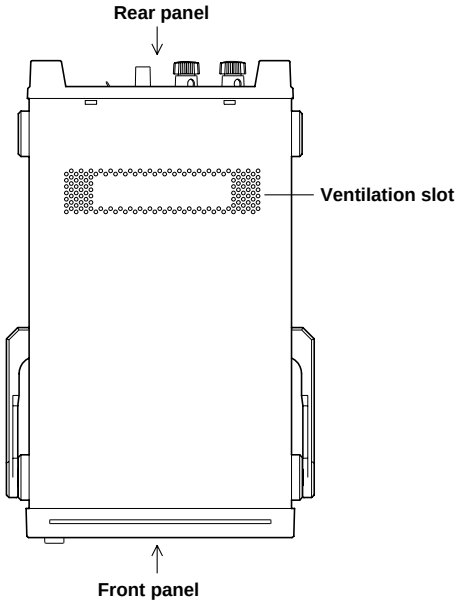
Front Panel



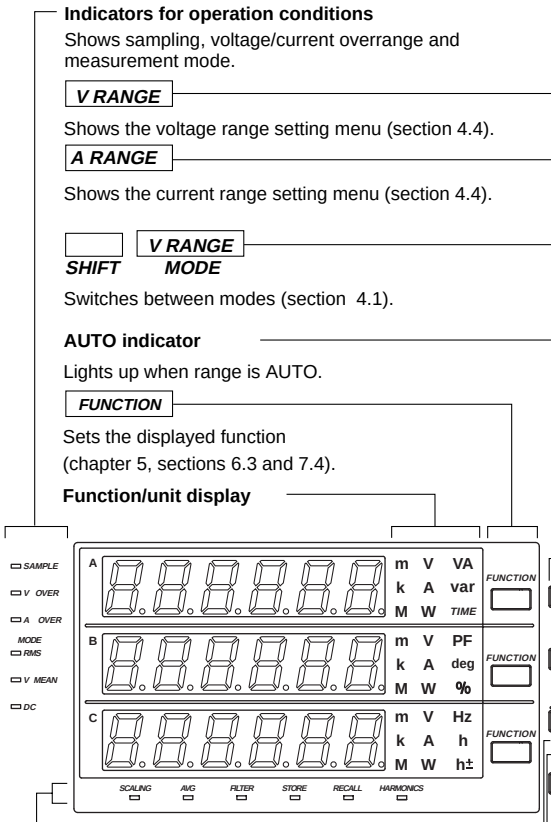
Rear Panel



Top View



2.2 Operation Keys and Function Display



Indicators for operation conditions

Shows sampling, voltage/current overrange and measurement mode.

V RANGE

Shows the voltage range setting menu (section 4.4).

A RANGE

Shows the current range setting menu (section 4.4).

SHIFT ***V RANGE*** ***MODE***

Switches between modes (section 4.1).

AUTO indicator

Lights up when range is AUTO.

FUNCTION

Sets the displayed function (chapter 5, sections 6.3 and 7.4).

Function/unit display

SHIFT ***A RANGE*** ***MAX HOLD***

Turns ON/OFF the MAX hold function. When turned ON, the MAX HOLD indicator lights. This is the same as the MAX hold setting under the SETUP key (section 4.8).

HOLD

Holds the displayed value. The HOLD indicator lights. Pressing the key again turns OFF the indicator and releases the hold.

SHIFT ***HOLD*** ***TRIG***

When in the HOLD condition this results in updating the displayed value.

V

For decreasing the voltage/current range, and for setting of functions/values.

^

For increasing the voltage/current range, and for setting of functions/values.

ENTER

For verifying the set range/function/value.

SHIFT ***V*** ***>***

Moves the cursor of a value from left to right.

SHIFT ***^*** ***.***

Moves the decimal point from left to right.

SHIFT ***ENTER*** ***CAL***

Performs zero level compensation (section 12.3).

START

Starts integration (see section 6.3).

STOP

Stops integration (see section 6.3).

RESET

Sets the integration value and elapsed time of integration to zero (0) (see section 6.3).

SHIFT ***RESET*** ***INTEG SET***

Shows the setting menu for integration mode/type/time, and rated integration time (see sections 6.2 and 9.3).

SHIFT ***START*** ***HARMONICS***

Shows the setting menu for harmonics ON/OFF, PLL source, and element selection (sections 7.2 and 7.3).

SHIFT ***STOP*** ***MEMORY***

Shows the setting menu for storing/recalling measurement data and set-up information (chapter 8).

LOCAL

When the REMOTE indicator is lit, the remote function will be canceled. When the REMOTE indicator is not lit, the setting menu for communication/printing will appear.

SHIFT ***LOCAL*** ***INTERFACE***

Shows the setting menu for communication/printing (sections 9.9, 10.5, and 11.3).

SHIFT ***SETUP*** ***OUTPUT***

Shows the setting menu for communication output items, D/A output, plotter/printer output and comparator output (sections 9.3, 9.5 to 9.9, and 10.6).

SETUP

Sets the filter, averaging, scaling, computation, external sensor input, measurement synchronization source, MAX hold, and the initialization of the set-up information (see sections 4.2, 4.3, 4.5 to 4.11, and 12.2).

Indicators for operating functions

When a function is set and in operation, this indicator will light up.

2.3 Displays in case of Overrange/Error during Measurement

Overrange display

Overrange occurs when the measured voltage or current exceeds 140% of the rated measurement range. In that case the range will automatically be increased, however up to 140% of the maximum range. When this level is exceeded, the overrange display wil appear, which looks as follows.

Computation over display

When the computed value becomes too high during the computation process, the following display will appear.

Peak over display

When the sampled data (instantaneous voltage or instantaneous current) exceed approx. 300% of the measurement range, the “V over” or “A over” indicators at the front panel will light up.

▭ ***V OVER***

▭ ***A OVER***

Note

The “V over” and “A over” indicators at the front panel will light up in case of overrange or peak-over of any signal.

Display in case the measurement value is too small

In case either the measured voltage or measured current drops below 0.5% of the measurement range, the display will indicate as follows. This is only in case the measurement mode is RMS or V MEAN (see section 4.1, “Selecting the Measurement Mode”).

Function	Display
V(voltage) A(current) var(reactive power)	displays zero
PF(power factor)	PFErr
deg(phase angle)	dEGEr

Interruption during measurement

If the measurement range or function is changed and the contents of the display changes, the display will indicate as follows.

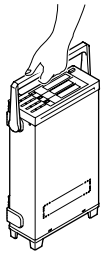
3.1 Usage Precautions

Safety Precautions

- Before using the instrument for the first time, make sure you have read the safety precautions on pages iv and v.
- Do not remove the case from the instrument. Some areas in the instrument use high voltages, which are extremely dangerous. When the instrument needs internal inspection or adjustment, contact your nearest YOKOGAWA representative. Addresses may be found on the back cover of this manual.
- If you notice smoke or unusual odors coming from the instrument, immediately turn OFF the power and unplug the power cord. Also turn OFF the power to all the objects being measured that are connected to the input terminals. If such an irregularity occurs, contact your nearest YOKOGAWA representative. Addresses may be found on the back cover of this manual.
- Do not place anything on the power cord and keep it away from any heat generating articles. When unplugging the power cord from the power outlet, always hold the plug and pull it, never pull the cord itself. If the power cord becomes damaged, contact your nearest YOKOGAWA representative. Addresses may be found on the back cover of this manual.Refer to page ii for the part number of the appropriate power cord when placing an order.

General Handling Precautions

- Never place anything on top of the instrument, especially objects containing water. Entry of water into the instrument may result in breakdowns.
- When Moving the Instrument, first turn off the power of the objects to be measured and disconnect the connected cables such as for measurement and communication. Then turn off the power switch and unplug the power cord from the power outlet. Always carry the instrument by the handles as shown below.



- To prevent internal temperature rise, do not block the vent holes in the instrument case.
- Keep input terminals away from electrically charged articles as they may damage internal circuits.
- Do not allow volatile chemicals to come into contact with the case or operation panel. Also do not leave any rubber or vinyl products in contact with them for prolonged periods. The operation panel is made of thermoplastic resin, so take care not to allow any heated articles such as a soldering iron to come in contact with it.
- For cleaning the case and the operation panel, unplug the power cord first, then gently wipe with a dry, soft and clean cloth. Do not use chemicals such as benzene or thinner, since these may cause discoloration or damage.
- If the instrument will not be used for a long period, unplug the power cord from the AC outlet.

3.2 Installing the Instrument

Installation Conditions

The instrument must be installed in a place where the following conditions are met.

Ambient temperature and humidity

- Ambient temperature: 5 to 40˚C
- Ambient humidity: 20 to 80% RH (no condensation)

Horizontal position

The instrument must be installed horizontally. A non-horizontal or inclining position can impede proper measurement of the instrument.

Well-ventilated location

Vent holes are provided on the top and bottom of the instrument. To prevent rise in internal temperature, do not block these vent holes.

In case you removed the feet for rack-mounting the instrument, make sure to keep a space of at least 20 mm as not to block the vent holes.

Never install the instrument in any of the following places

- In direct sunlight or near heat sources;
- Near noise sources such as high voltage equipment or power lines ;
- Where an excessive amount of soot, steam, dust or corrosive gases is present;
- Where the level of mechanical vibration is high;
- Near magnetic field sources;
- In an unstable place.

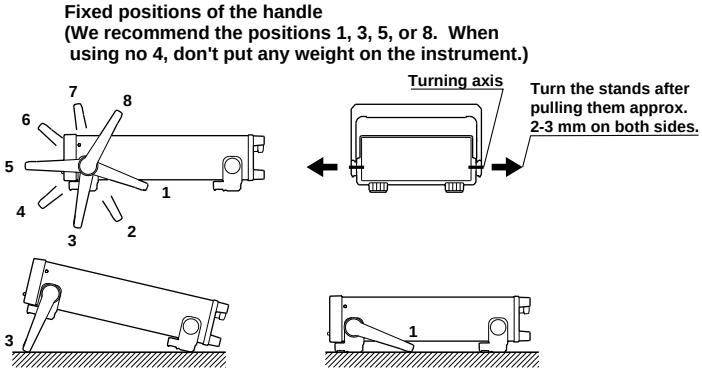
Note

- To ensure high measurement accuracy, the instrument should only be used under the following conditions.
  Ambient temperature: 23 ± 5˚C
  Ambient humidity: 30 to 75% RH (no condensation)
  When using the instrument in the temperature ranges of 5 to 18 or 28 to 40˚C, add the temperature coefficient to the accuracy as specified in chapter 16 “Specifications”.
- If the ambient humidity of the installation site is 30% or below, use an anti-static mat to prevent generation of static electricity.
- Internal condensation may occur if the instrument is moved to another place where both ambient temperature and humidity are higher, or if the room temperature changes rapidly. In such cases acclimatize the instrument to the new environment for at least one hour before starting operation.

Installation Position

Desktop

As shown below, place the instrument on a flat even surface. When using the handle for installation, check that the handle is in one of the fixed positions. To change the fixed position of the handle, pull the handle approximately 2 to 3 mm outward along the rotational axis and slowly move the handle.



Rack mount

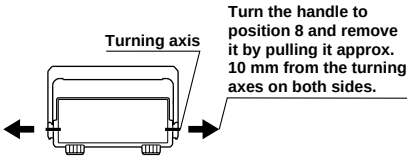
To install the instrument in a rack, use one of the following optional rack mount kits.

- **Rack mount kit (option)**

Specifications	Kit
EIA Standard (for single mount)	751533-E2
JIS Standard (for single mount)	751533-J2
EIA Standard (for multiple mount)	751534-E2
JIS Standard (for multiple mount)	751534-J2

- **Mounting procedure**

  1. Turn the handle to position 8 (see the figure on the previous page) and remove it by pulling the handle outward along the rotational axis approximately 10 mm.



  2. Remove the feet from the instrument.
  3. Remove the seals covering the mounting holes from the front side of the instrument.
  4. Mount the rack mount brackets.
  5. Mount the instrument in the rack.

  For more detailed information regarding the rack mount procedure, refer to the instruction manual accompanied with the rack mount kit.

Note

- When rack mounting the instrument, allow at least 20 mm of space around the vent holes to prevent internal overheating.
- Make sure to have adequate support for the bottom of the instrument. However, do not block the vent holes in the process.

3.3 Wiring Precautions

WARNING

- To prevent hazards, make sure to apply a ground protection before connecting the object being measured.
- Always turn OFF the power to the object being measured before connecting it to the instrument. Never connect or disconnect the measurement lead wires from the object while power is being supplied to it, otherwise a serious accident may result.
- When the power switch is ON, never apply a voltage or current exceeding the level specified in the table below to the voltage input or current input terminal. When the power switch is OFF, turn off the power of the instrument under measurement as well. For details regarding the other terminals, such as the external input terminal, refer to chapter 16 “Specifications.”

Max allowable input	Voltage input	Current input
Instantaneous max (for 1s)	Peak value of 2000 V or RMS value of 1500 V, whichever is less.	20 A to 0.5 A range Peak value of 150 A or RMS value of 40 A, whichever is less. 200 mA to 5 mA range Peak value of 30 A or RMS value of 20 A, whichever is less.
Continuous	Peak value of 1500 V or RMS valueof 1000 V, whichever is less.	20 A to 0.5 A range Peak value of 100 A or RMS value of 25 A, whichever is less. 200 mA to 5 mA range Peak value of 30 A or RMS value of 20 A, whichever is less.

- In case you are using an external potential transformer (PT) or current transformer (CT), use one which has a sufficient withstand voltage against the voltage to be measured (a withstand voltage of 2E + 1000 V is recommended, where E is the measurement voltage.) Also be sure not to allow the secondary side of the CT to go open-circuit while power is supplied, otherwise an extremely dangerous high voltage will be generated on the secondary side of the CT.
- If the instrument is used in a rack, provide a power switch so that power to the instrument can be shut off from the front of the rack in an emergency.
- For safety reasons, make sure that the bare end of the measurement lead wire connected to each input terminal does not protrude from the terminal.
  Also make sure that the measurement lead wires are connected to the terminals securely.
- The voltage rating across the input (voltage and current) and ground varies depending on the operating conditions.
  - When protective covers are used on GP-IB or RS-232-C and external input/output connectors;
    Voltage across each measuring input terminal and ground 600 Vrms max.
  - When protective covers are removed from GP-IB or RS-232-C and from external input/output connectors; or when connectors are used;
    Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
    Voltage across V terminal and ground 600 Vrms max.

CAUTION

Use lead wires that have sufficient margin in withstand voltage and current against the signal being measured. The lead wires must also have insulation resistance that is appropriate for the ratings.

Ex. If measurement is carried out on a current of 20 A, use copper wires with a conductor cross-sectional area of at least 4 mm^2.

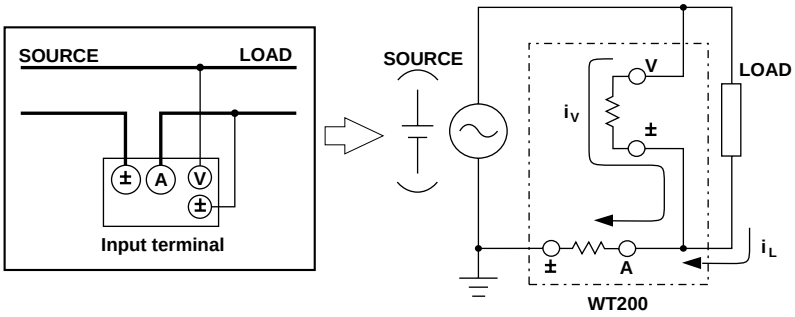
Note

- When measuring high currents, or currents or voltages that contain high-frequency components, wiring should be made with special attention paid to possible mutual interference and noise problems.
- Keep the lead wires short as possible.
- For current circuits indicated by thick lines in the wiring diagrams shown in section 3.4 and later, use thick lead wires appropriate for the current to be measured.
- The lead wire to the voltage input terminal should be connected as close to the load of the object under measurement as possible.
- To minimize stray capacitance to ground, route both lead wires and grounding wires so that they are as away from the instrument's case as possible.

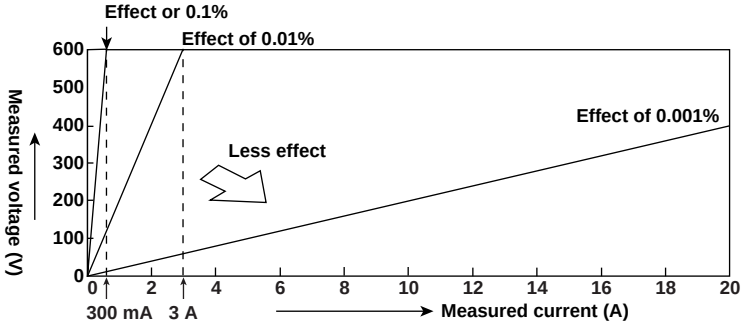
3.4 Improving the Measurement Accuracy

By wiring the circuit to match the load, you can minimize the effect of the power loss on the measurement accuracy. We will consider a circuit consisting of a current source (SOURCE) and load resistance (LOAD) below.

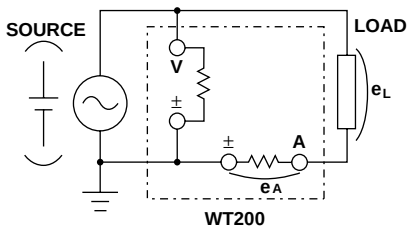
- **When the measurement current is relatively large**
  In this case, the voltage measurement circuit is connected to the load side. The current measurement circuit measures the sum of the current that flows through the load of the circuit under measurement (i_L) and the current that flows through the voltage measurement circuit (i_V). Since the current flowing through the circuit under measurement is i_L, i_V is the error. The input resistance of the voltage measurement circuit is approximately 2 MΩ. For a 600-V input signal, i_V is approximately 0.3 mA (600 V/2 MΩ). If the load current i_L is greater than or equal to 3 A (load resistance is 200 Ω or less), the effect of the voltage measurement circuit on the measurement accuracy is less than or equal to 0.01%. As another example, if the input signal is 200 V and 10 A, i_V = 0.1 mA (200 V/ 2 MΩ). The effect on the measurement accuracy is 0.001% (0.1 mA/10 A) in this case.



The following figure shows the relationship between the voltage and current that leads to 0.1%, 0.01%, and 0.001% errors.



- **When the measurement current is relatively small**
  Connect the current measurement circuit to the load side. In this case, the voltage measurement circuit measures the sum of the load voltage (e_L) and the voltage drop of the current measurement circuit (e_A). The voltage drop e_A is the error. The input resistance of the current measurement circuit is approximately 6 mΩ. If the load resistance is 600 Ω, for example, the effect on the measurement accuracy is approximately 0.001% (6 mΩ/600 Ω).



3.5 Connecting the Power Supply

Before Connecting the Power Supply

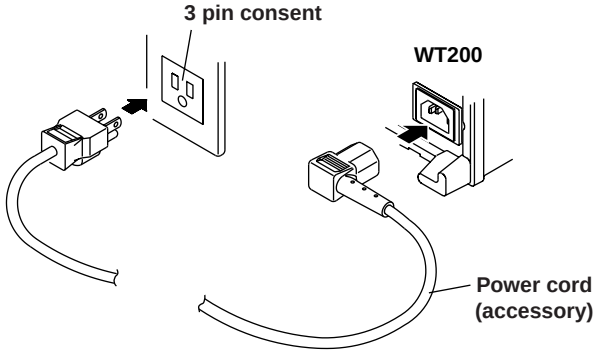
WARNING

- Ensure that the supply voltage matches the rated supply voltage of the instrument before connecting the power cable.
- Check that the power switch is turned OFF before connecting the power cord.
- Make sure to connect the protective earth to prevent electric shock. Connect the power cord to a three-pin power outlet with a protective earth terminal.
- Do not use an extension cord without protective earth ground. This act will invalidate the protection.

Connecting Procedure

1. Make sure that the power switch of the instrument is turned OFF.
2. Connect the accessory power cord to the power connector on the back of the instrument.
3. Insert the power cord to the power outlet which conforms to the following specifications.
   Make sure that you use an outlet with a protective grounding terminal only.

Item	Specifications
Rated supply voltage	100 to 240 VAC
Permitted supply voltage range	90 to 264 VAC
Rated supply voltage frequency	50/60 Hz
Permitted supply voltage frequency range	48 to 63 Hz
Maximum power consumption	25 VA (at 120 VAC) or 35 VA (at 240 VAC)



3.6 Wiring the Measurement Circuit

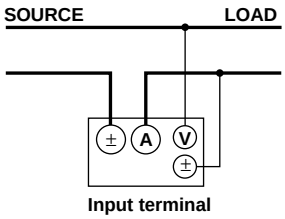
WARNING

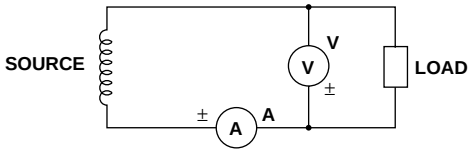
When applying a current to be measured directly to the input terminals of the instrument, disconnect the input cable of the external sensor. A voltage might be generated by the external sensor input terminal when connected.

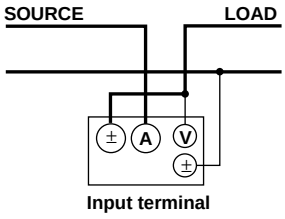
CAUTION

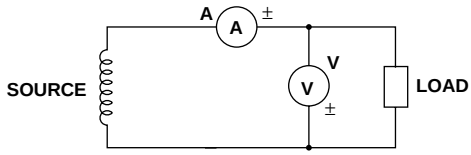
A load current flows in the thick lines show in the diagrams; therefore, a wire with sufficient current capacity must be used for these lines.

Wiring diagram









Note

The wire connected from the source the ± current terminal must be routed as close as possible to the ground potential in order to minimize measurement error.

3.7 Wiring the Measurement Circuit when Using External PT/CT

WARNING

When using an external CT, do not allow the secondary side of the CT to go open-circuit while power is supplied, otherwise an extremely high voltage will be generated on the secondary side of the CT.

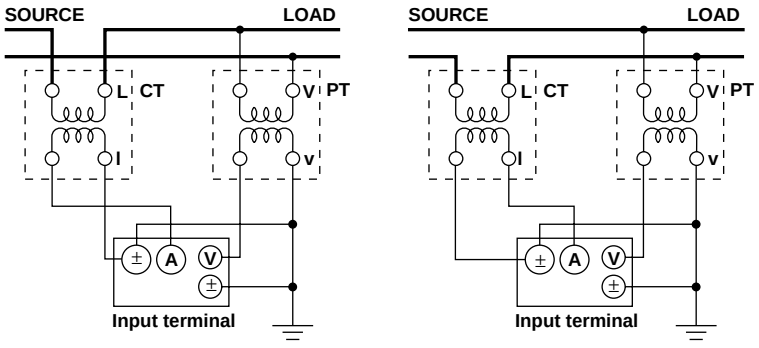
CAUTION

A load current flows in the thick lines shown in the diagrams; therefore, a wire with sufficient current capacity must be used for these lines.

Use of a PT (or CT) enables measurement of voltage or current even if the maximum voltage or maximum current of the object to be measured exceeds the maximum measuring range.

- If the maximum voltage of the object to be measured exceeds 600 V, connect an external potential transformer (PT), and connect the secondary side of the PT to the voltage input terminals.
- If the maximum current of the object to be measured exceeds 20 A, connect an external current transformer (CT), and connect the secondary side of the CT to the current input terminals.

Wiring diagram when using the PT and CT



Note

- Using the scaling function enables direct reading of measured values on the display. Refer to section 4.5, “Setting the Scaling Constant when External PT/CT is Used.”
- It must be noted that measured values are affected by the frequency and phase characteristics of PT and CT.

3.8 Wiring the Measurement Circuit when Using the External Sensor

WARNING

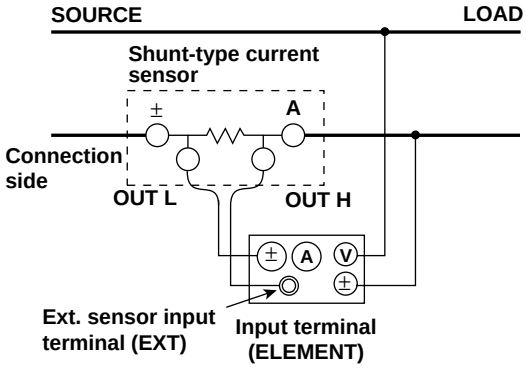
- Use an external sensor that is enclosed in a case which has sufficient withstand voltage against the voltages to be measured. Use of bare sensor may cause an electric shock if the sensor is touched accidentally.
- Before connecting an external shunt, make sure the power to the shunt is turned OFF. Always make sure to turn OFF the power switch of the source.
  When the power is supplied a voltage will be present at the shunt, so don't touch the shunt with your hands.
- When using the clamp sensor, make sure you have a thorough understanding of the specifications and handling of the voltage of the measurement circuit and the clamp sensor. Check that there are no hazards (places that may cause electric shock).
- When using the external sensor input terminal, do not touch the current input terminal or connect measurement leads. This act is dangerous, because when power is applied to the circuit under measurement (that is connected to the external sensor input terminal), the voltage of the circuit appears across the current input terminals.
- The connector to the input terminal for the external sensor should not have bare wires protruding; make sure to make connections to this terminal according to safety measures, since voltages will be present at the bare wires, which constitutes a hazard.

CAUTION

A load current flow in the thick lines shown in the diagrams; therefore, a wire with sufficient current capacity must be used for these lines.

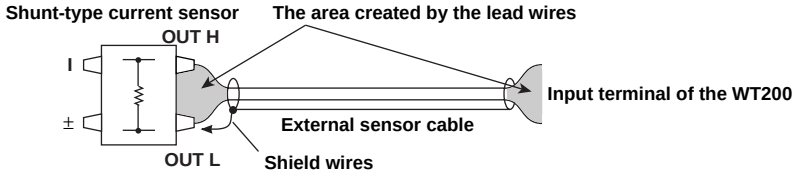
In cases where the maximum current of the object under measurement exceeds 20 A, measurement becomes possible by connecting an external sensor. The range for external sensor input is either 2.5/5/10 V or 50/100/200 mV. Either range is available as an option.
In the following wiring diagrams, the external shunt is grounded. When using the clamp sensor, replace the shunt with the clamp sensor.

Wiring diagram when using the external shunt

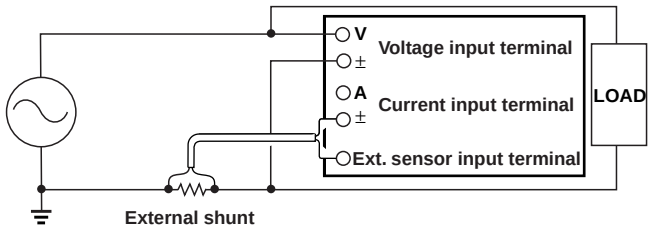


Note

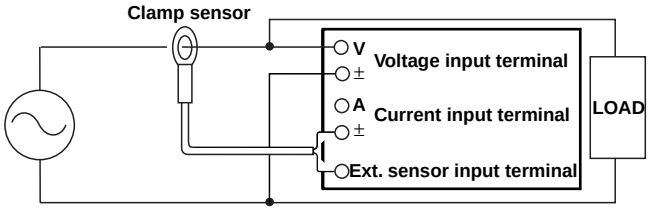
- The external sensor must be selected carefully, because the frequency and phase characteristics of the sensor affects the measured value.
- Make the lead wires between the external sensor and the instrument as short as possible to minimize measurement errors caused by stray capacitance and resistance of the lead wires.
- When using a shunt-type current sensor, note the following points when connecting the external sensor cable to minimize errors:
  - Connect the shield wire of the external sensor cable to the L side of the shunt output terminal (OUT).
  - Make the area that the lead wires create between the sensor and the external sensor cable as small as possible. This reduces the effects caused by field lines (caused by measurement current) entering this area and the external noise.



- As shown in the figure below, connect the shunt-type current sensor to the power grounding side. If you have to connect the sensor to the non-earth side, use a wire that is thicker than AWG18 (conductive cross-sectional area of approx. 1 mm^2) between the sensor and the instrument to reduce the effects of common mode voltage. Take safety and error reduction in consideration when constructing an external sensor cable.



- If the measurement circuit is not grounded and the measured signal is of high frequency or high power, the effects of inductance of the shunt-type current sensor cable become large. In this case, use an isolation sensor (CT, DC-CT, or clamp).



- Make sure you have the polarities correct when making the connections. Otherwise, the polarity of the measurement current will be reversed and correct measurements cannot be made. Be especially careful when connecting the clamp type current sensor, because it is easy to reverse the polarity.
- You can use the scaling function to directly read the measured values on the display. For the procedure, see section 4.6, “Selecting the Measurement Range and Setting the Scaling Constant when External Sensor is Used (option).”

3.9 Turning the Power ON/OFF, Opening Messages

Item to be Checked before Turning ON the Power

- Check that the instrument is installed correctly (see section 3.2, “Installing the Instrument”).
- Check that the power cord is connected properly (see section 3.5, “Connecting the Power Supply”).

Location of the Power Switch

The power switch is located in the lower left corner of the front panel.

Turning the Power ON

Turning the power ON will result in staring the test program, which checks each memory. When the results of these checks are all satisfactory, opening, messages will appear as described on the next page, after which the instrument will be ready for measurement. When the test program results in displaying error codes, proper operation of the instrument cannot be performed. Immediately turn OFF the power and contact you nearest representative.
Addresses may be found on the back cover of this manual. When contacting your representative, inform him of the name, suffix and No. code as on the right side panel, and of the displayed error code(s).

Note

- In case of an error code, refer to section 15.4, “Error Codes and Corrective Actions” , for a description and corrective action.
- A warm-up time of approx.30 minutes is required before all spesifications of the instrument can be met.

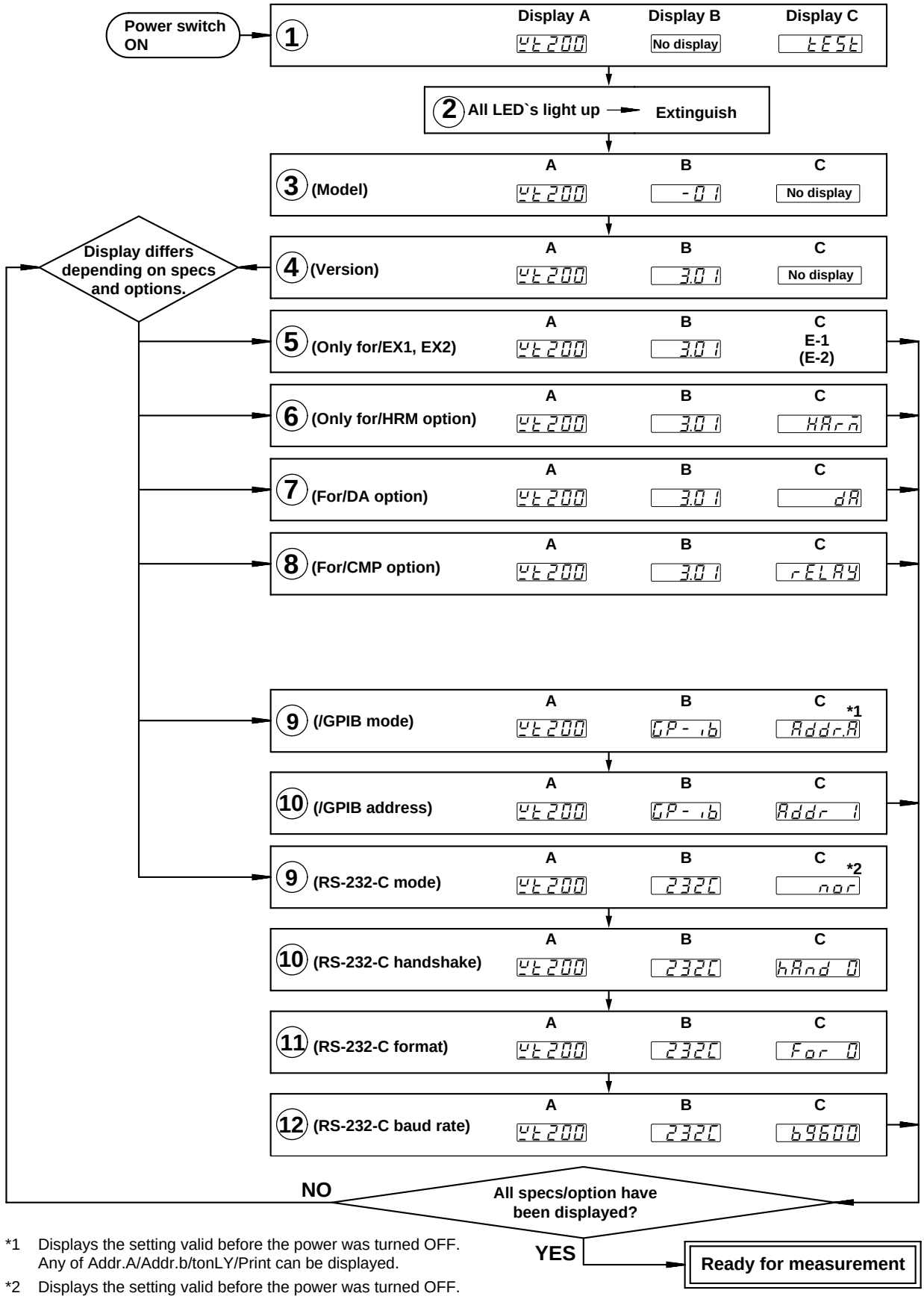
Turning the Power OFF

When turning the power OFF, the previous setting parameters will be kept. Consequently, turning the power ON again will result in the appearance of the setting condition of the previous measurements.

Note

The instrument uses a lithium battery to back up setting parameter. When the voltage level of the lithium battery falls below a certain value, an error code (see section 15.4, “Error Codes and Corrective Actions”) appears as the instrument is turned ON. When the battery life is exhausted, turning ON the power switch will result in an error code and the battery needs to be replaced. Never replace the battery yourself, but inform your nearest representative. Addresses may be found on the back cover of this manual.

Opening Messages

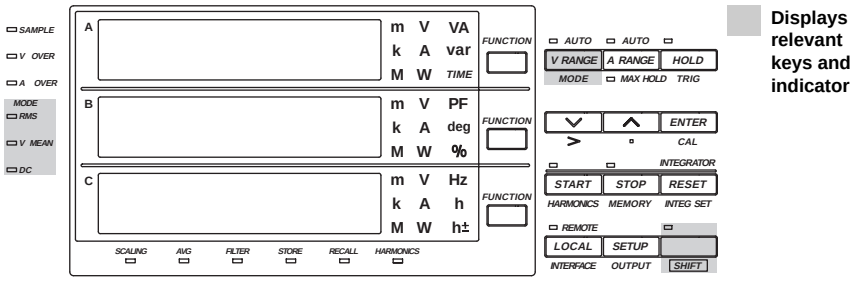


*1 Displays the setting valid before the power was turned OFF. Any of Addr.A/Addr.b/tonLY/Print can be displayed.

*2 Displays the setting valid before the power was turned OFF. Any of nor/tonly/Print can be displayed.

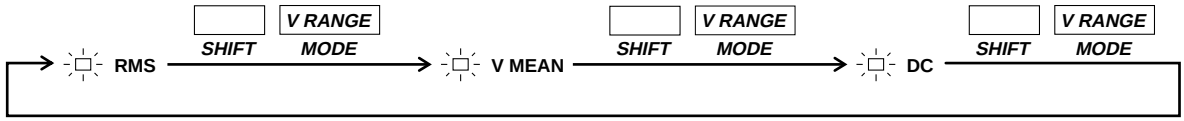
4.1 Selecting the Measurement Mode

Keys



Displays relevant keys and indicator

Procedure



Explanation

Measurement Mode

One of the following measurement modes can be selected for measurement of voltage and current. The initial value is “RMS”.

Indicator	Voltage	Current
RMS	Measures and displays true RMS value	Measures and displays true RMS value
V MEAN	Displays rectified mean value calibrated to the RMS value	Measures and displays true RMS value
DC	Displays DC value obtained by averaging the input signal	Displays DC value obtained by averaging the input signal

Theoretical Equations

- **RMS**

  This mode is selected to display input voltage or current as a true RMS value.

  $$\sqrt{\frac{1}{T}\int_0^T f(t)^2 dt}$$

  f (t): input signal
  T: one period of the input signal

- **V MEAN**

  This mode is selected to display input voltage or current as a rectified mean value calibrated to the RMS value. Since a sine wave is used for calibration, the value displayed will be the same as that obtained in RMS mode if a sine wave is measured. The value displayed will be different from that obtained in RMS mode if a distorted or DC waveform is measured.

  $$\frac{\pi}{2\sqrt{2}} \cdot \frac{1}{T}\int_1^T |f(t)|\,dt$$

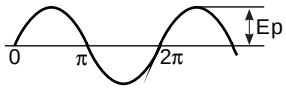
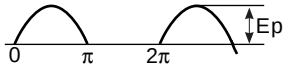
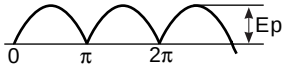
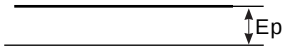
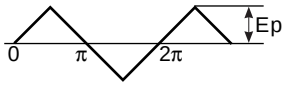
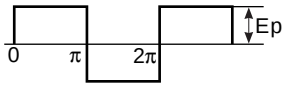
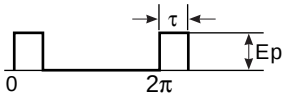
  f (t): input signal
  T: one period of the input signal

- **DC**

  This mode is selected when the input voltage or current is DC. The input signal is averaged and the result is displayed.

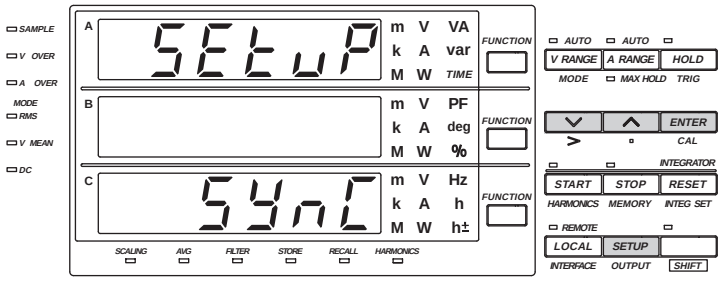
Typical Waveform Types and Differences in Measured Values between Measurement Modes

The WT200 does not support the mean value measurement mode in the following table.

Name	Measurement mode / Display / Waveform	RMS value	Mean value	Mean-value rectification	Linear averaging
		RMS	—	V MEAN	DC
Sinewave		$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$	$\frac{Ep}{\sqrt{2}}$	0
Half-wave rectification		$\frac{Ep}{2}$	$\frac{Ep}{\pi}$	$\frac{Ep}{2\sqrt{2}}$	$\frac{Ep}{\pi}$
Full-wave rectification		$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$	$\frac{Ep}{\sqrt{2}}$	$\frac{2}{\pi} \cdot Ep$
Direct current		Ep	Ep	$\frac{\pi}{2\sqrt{2}} \cdot Ep$	Ep
Triangular wave		$\frac{Ep}{\sqrt{3}}$	$\frac{Ep}{2}$	$\frac{\pi}{4\sqrt{2}} \cdot Ep$	0
Square wave Pulse		Ep	Ep	$\frac{\pi}{2\sqrt{2}} \cdot Ep$	0
Pulse		$\sqrt{\frac{\tau}{2\pi}} \cdot Ep$	$\frac{\tau}{2\pi} \cdot Ep$	$\frac{\pi\tau}{4\pi\sqrt{2}} \cdot Ep$	$\frac{\tau}{2\pi} \cdot Ep$
		When duty D ($=\frac{\tau}{2\pi}$) is applied.			
		$\sqrt{D} \cdot Ep$	$D \cdot Ep$	$\frac{\pi D}{2\sqrt{2}} \cdot Ep$	$D \cdot Ep$

4.2 Selecting the Measurement Synchronization Source

Keys

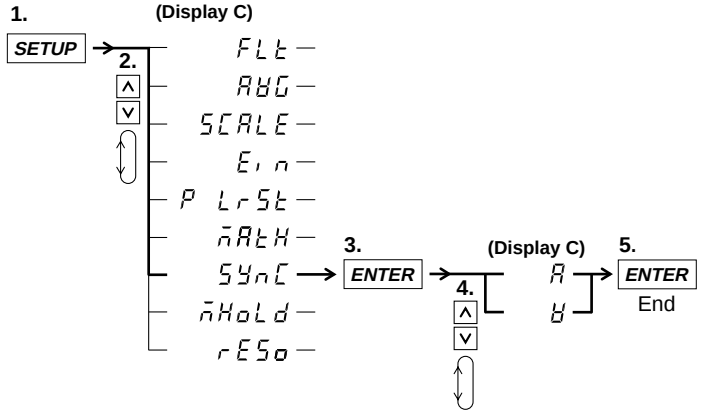


Displays relevant keys

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

Select the measurement synchronization source.



Explanation

Function used to select the measurement synchronization source

The instrument determines the measured value by averaging the sampled data (averaging process) over the period synchronized to the input signal period. The input signal period is detected from the voltage and current signals and you can select which signal period to use to perform the averaging process. The initial setting is A.

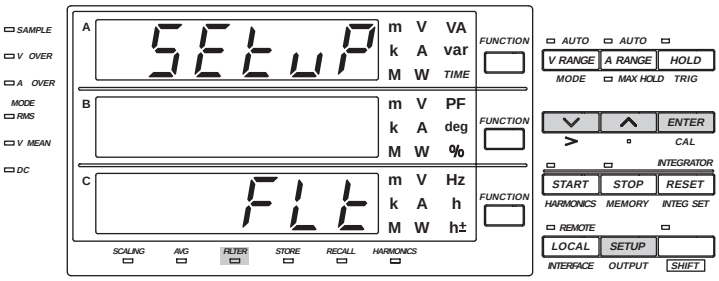
- A
  Priority is placed in detecting the current period to be used as the synchronization source. When the current input is less than 30% of the measurement range, the voltage is used as the synchronization source.
- V
  Priority is placed in detecting the voltage period to be used as the synchronization source. When the voltage input is less than 30% of the measurement range, the current is used as the synchronization source.

Note

- Select an input signal with stable input level and frequency (with little distortion) for the synchronization source.
- If both the voltage and current inputs are less than 30% of the range, a fixed period of 240 ms is used to sample and average the data.

4.3 Turning the Filter ON/OFF

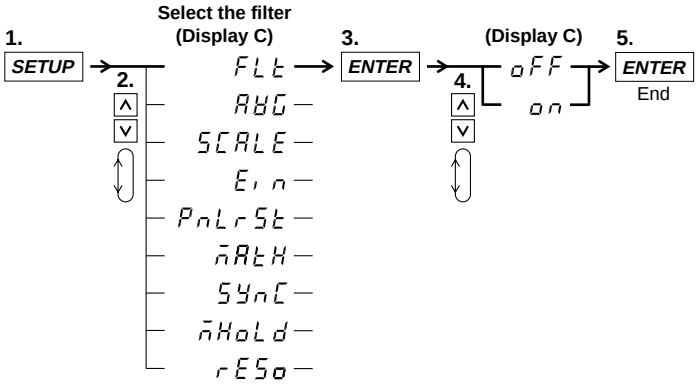
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Filter Function

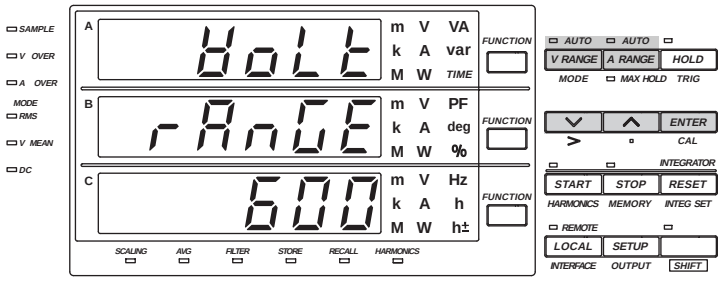
The instrument will perform measurements after synchronizing to the cycle of the input signal. Consequently, the frequency of the input signal can be measured properly. The filter, at a cut-off frequency of 300 Hz, will only be applied to the frequency measurement circuit and will remove noise from distorted and inverted waves, etc. This allows the frequency to be measured correctly which improves the accuracy of each measurement value. The filter will not be applied to the voltage and current circuit. The initial value is oFF.

Note

The filter setting cannot be changed while integration is being carried out.

4.4 Selecting the Measurement Range in case of Direct Input

Keys

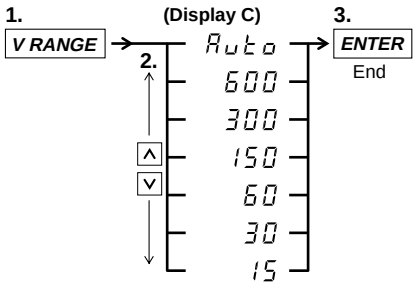


Displays relevant keys and indicator

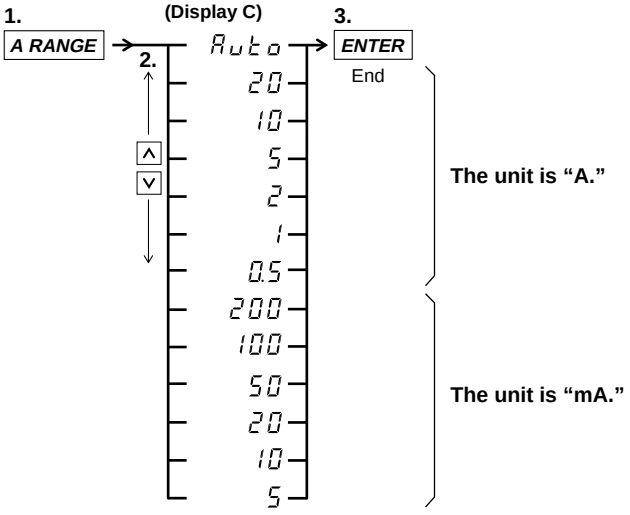
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Voltage Range Setting



• Current Range Setting



Explanation

Manual Range (fixed) versus Automatic Range (auto)

The measurement range can be of one of the following types. The initial setting is Auto range ON.

- **Manual range**
  Voltage range: Select from 600 V, 300 V, 150 V, 60 V, 30 V, and 15 V.
  Current range: Select from 20 A, 10 A, 5 A, 2 A, 1 A, 0.5 A, 200 mA, 100 mA, 50 mA, 20 mA, 10 mA, and 5 mA.
- **Auto range: Auto**
  The measuring range is adjusted automatically according to the input voltage or current as follows. Overrange is handled the same way as for the manually selected range.
  Range up:
  A higher range is selected immediately if the instantaneous input voltage or current exceeds approx. 300% of the rated value during sampling. If the meaured voltage or current exceeds 110% of the rated value, a higher range will be selected at the end of the current measurement cycle.
  Range down:
  A lower range is selected if the measured voltage or current drops below 30% of the rated value. However, even when the measured voltage or current drops below 30% of the rated value, range down will not be done when this would result in waveforms with a high crest factor causing peak over.

Verifying the Range

To verify the current range setting press the V RANGE key or the A RANGE key. The result will be shown at display C. In order to return to the measurement status, press the same key again.

Note

- When the range is set to auto, you cannot move to the minimum range by pressing the ∧ key. On the other hand, when the range is set to the minimum, you cannot move to auto range by pressing the ∨ key.
- When the range is set to auto, the range may be adjusted frequently if a waveform such as a pulse is input. In such a case, set the range manually.

Power Range

The measuring range for active power, apparent power and reactive power is determined as follows.

Wiring Method	Power Range
Single-phase, two-wire (1Φ2W)	voltage range × current range

The maximum display is 99999 (when the number of displayed digits is 5).
When the result of "voltage range × current range" exceeds 1000 W (VA or var), the unit on the display will change to "kW (kVA or kvar)".

Power range table

- A list of the combination of voltage and current ranges and the power range are shown below. The table shows the active power range (unit: W). The range for apparent power (unit: VA) and reactive power (unit: var) will have the same magnitude as the active power. Read the unit as VA or var for apparent power and reactive power, respectively.
- The following table shows the case when the number of displayed digits is four. When the number of displayed digits is set to five, one digit is added to the lowest digit of the values in the table. For selecting the number of displayed digits, see section 4.12.

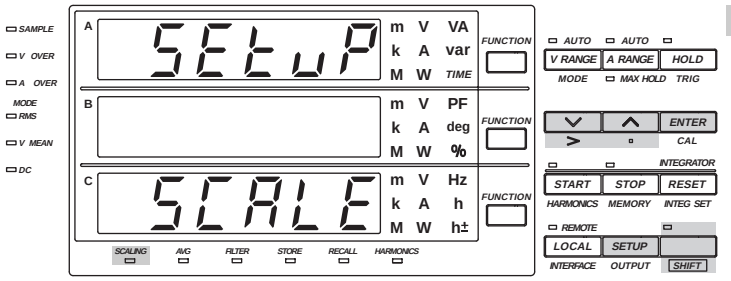
	Voltage Range					
Current Range	15 V (15.00 V)	30 V (30.00 V)	60 V (60.00 V)	150 V (150.0 V)	300 V (300.0 V)	600 V (600.0 V)
5 mA (5.000 mA)	75.00 mW	150.0 mW	300.0 mW	750.0 mW	1.500 W	3.000 W
10 mA (10.00 mA)	150.0 mW	300.0 mW	600.0 mW	1.500 W	3.000 W	6.000 W
20 mA (20.00 mA)	300.0 mW	600.0 mW	1.200 W	3.000 W	6.000 W	12.00 W
50 mA (50.00 mA)	750.0 mW	1.500 W	3.000 W	7.500 W	15.00 W	30.00 W
100 mA (100.0 mA)	1.500 W	3.000 W	6.000 W	15.00 W	30.00 W	60.00 W
200 mA (200.0 mA)	3.000 W	6.000 W	12.00 W	30.00 W	60.00 W	120.0 W
0.5 A (500.0 mA)	7.500 W	15.00 W	30.00 W	75.00 W	150.0 W	300.0 W
1 A (1.000 A)	15.00 W	30.00 W	60.00 W	150.0 W	300.0 W	600.0 W
2 A (2.000 A)	30.00 W	60.00 W	120.0 W	300.0 W	600.0 W	1.200 kW
5 A (5.000 A)	75.00 W	150.0 W	300.0 W	750.0 W	1.500 kW	3.000 kW
10 A (10.00 A)	150.0 W	300.0 W	600.0 W	1.500 kW	3.000 kW	6.000 kW
20 A (20.00 A)	300.0 W	600.0 W	1.200 kW	3.000 kW	6.000 kW	12.00 kW

Note

When the range is set to auto, the measuring range switches according to range up/range down conditions. Therefore, the range may vary even if the measured values remain the same.

4.5 Setting the Scaling Constant when External PT/CT is Used

Keys

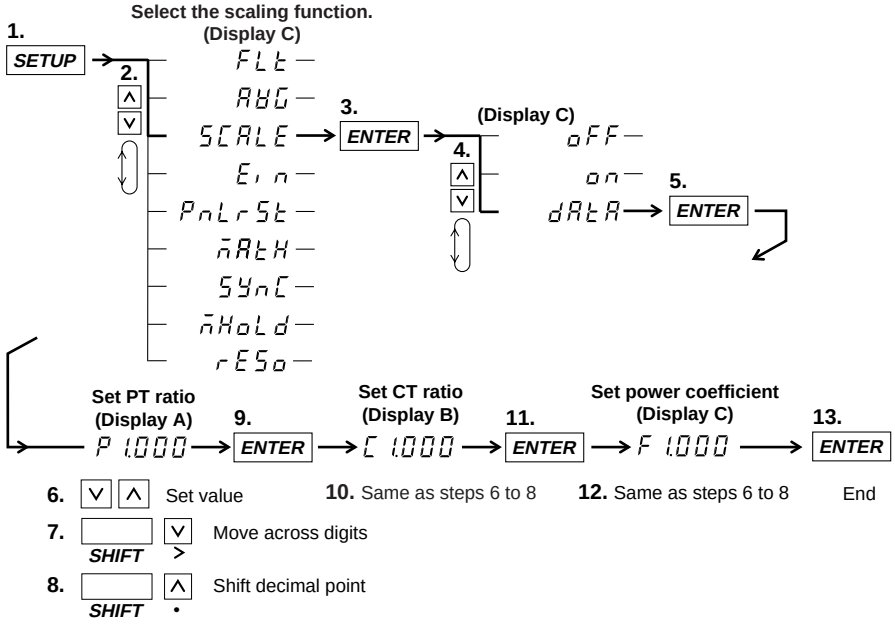


Displays relevant keys and indicator

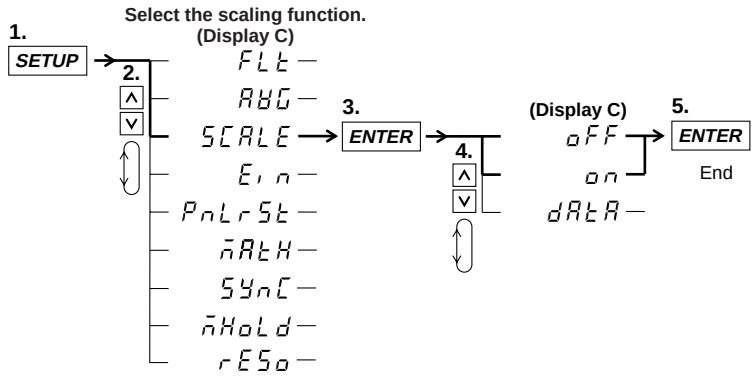
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting the Scaling Value



• Selecting Scaling ON/OFF



Explanation

About the Scaling Function

This function is useful when measuring parameters such as voltage, current, and power by using an external transformer such as a potential transformer (PT) or a current transformer (CT). In this case, the output from the secondary side of the transformer is applied to the input terminals of the instrument. You can specify the PT ratio, CT ratio, or power coefficient as the scaling constant on this instrument.

Measured/computed value	Scaled result	
Voltage V	P × V	P: Voltage scaling constant (PT ratio)
Current A	C × A	C: Current scaling constant (CT ratio)
Active power W	F × P × C × W	F: Power scaling constant
Reactive power var	F × P × C × var	
Apparent power VA	F × P × C × VA	

Setting the Scaling Constant

The scaling constants are set in the following order. The setting ranges from 0.001 to 9999. The initial value is 1.000.

- P: Sets the PT ratio on display A
- C: Sets the CT ratio on display B
- F: Sets the power coefficient on display C

Turning Scaling ON/OFF

Select the scaling menu once again after having set the scaling constants. The initial value is oFF.

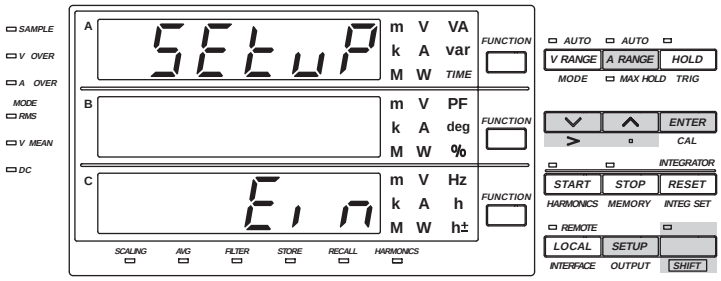
- on: When this setting is selected, pressing the ENTER key will start scaling and the SCALING indicator will light.
- oFF: When this setting is selected, pressing the ENTER key will stop scaling and SCALING indicator will extinguish.

Note

When the scaling constant × measurement range exceeds 9999M(10^6), the computation over display will appear (see section 2.3).

4.6 Selecting the Measurement Range and Setting the Scaling Constant when External Sensor is Used (option)

Keys

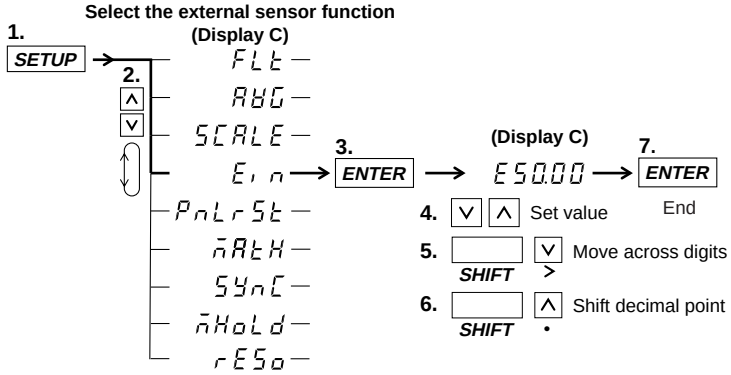


Displays relevant keys and indicator

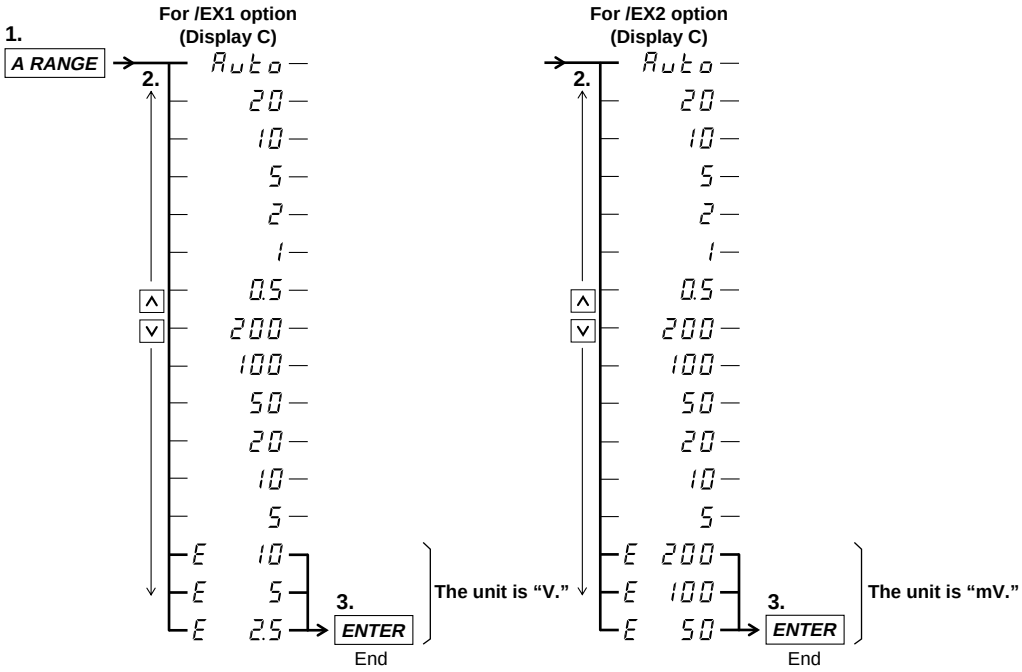
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting the Scaling Value of the External Sensor Input



• Selecting the Measurement Range (Current, with Scaling function ON)



Explanation

Scaling Function in combination with External Sensor Input

This function is useful for measuring current, power and such when you are using an external sensor, and have connected their output to the input connector. You set the scaling constant to the current or power value, computed from the sensor. When the scaling function is turned ON, measured values which have been converted to the corresponding values for the transformer primary sides, can been displayed or otherwise output. This function is exactly the same as the one described previously for use with PT/CT.

Measured/computed value	Scaled result	
Current A	E × A	E: External sensor scaling constant
Active power W	E × W	
Reactive power var	E × var	
Apparent power VA	E × VA	

Selecting the Setting Format of the Scaling Constant

The range is from 0.001 to 9999. The initial value is 50.00. The scaling constant is specified using display C.

Selecting the Measurement Range (Current, with Scaling function ON)

After having set the scaling constants, select the menu for the current measurement range. Select the rated output of the external sensor from this menu (see the Operating Procedure on the previous page). Scaling of the external sensor input will start as soon as you press the ENTER key after selecting. Scaling will stop as soon as you select a measurement range other than external sensor input from the menu.

Setting Example of Scaling Constants for External Sensor Input

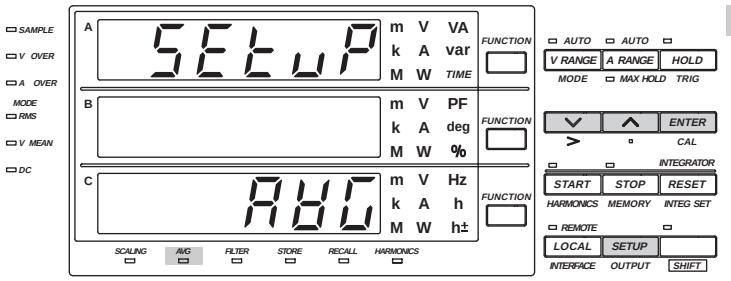
- In case the rated specs of the external sensor are 50 A/50 mV, measurement range is 50 mV, then
  50 A/50 mV × 50 mV = 50 A: scaling constant is 50.00
- In case the rated specs of the external sensor are 100 A/50 mV, measurement range is 50 mV, then
  100 A/50 mV × 50 mV = 100 A: scaling constant is 100.00
- In case the rated specs of the external sensor are 50 A/80 mV, measurement range is 50 mV, then
  50 A/80 mV × 50 mV = 31.25 A: scaling constant is 31.25
  However, since the setting range is 50 mV, use a setting within the 0 to 50 mV range.

Note

- When performing measurements using the external sensor, make sure to turn off the scaling function for the external PT/CT. When this function is ON, the scaling constant of the CT ratio will interfere.
- The input range for the external sensor can only be of the manual type.
- When you switch from external sensor input to direct, auto range input, an error will appear. First, select manual range for direct input and afterwards select auto range. (same goes for setting by communication interface.)

4.7 Using the Averaging Function

Keys

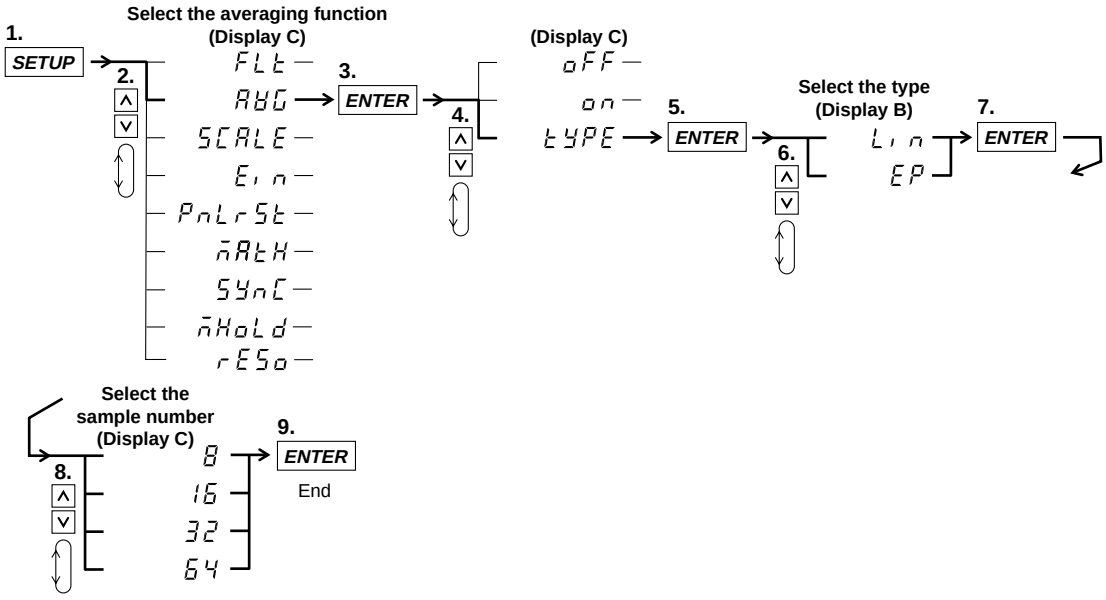


Displays relevant keys and indicator

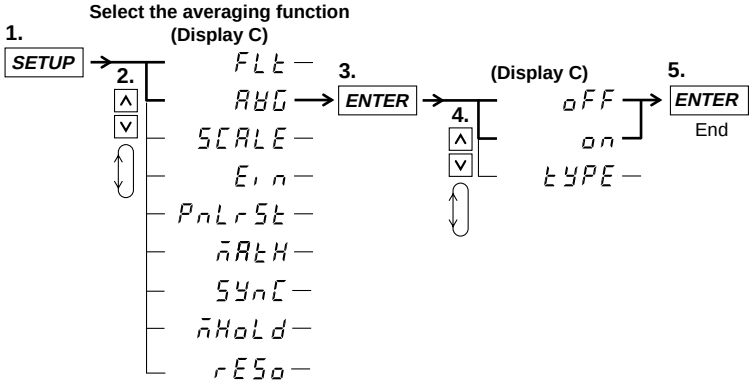
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting Averaging



• Averaging ON/OFF



Explanation

About the Averaging Function

This function performs exponential averaging or moving averaging on measurement values. When the displayed values are unsteady due to big fluctuations in power source or load, or due to the low frequency of the input signal, this function is useful to stabilize the displayed values for easier reading.

Selecting the Type of Averaging

The following two selections are available. The initial value is “Lin”.

- Exponential Averaging: EP
  Exponential averaging is expressed by the following equation.
  $D_n = D_{n-1} + (M_n - D_{n-1})/K$
  where
  D_n: the exponentially averaged value at the “n”th display;
  D_{n-1}: the exponentially averaged value at the “n–1”th display;
  M_n: the measurement value at the “n”th display;
  K: attenuation constant

- Moving Averaging: Lin
  Moving averaging is expressed by the following equation.
  $D_n = (M_{n-(m-1)} + M_{n-(m-2)} + \ldots M_{n-2} + M_{n-1} + M_n)/m$
  where
  D_n: the value at the “n”th display;
  $M_{n-(m-1)}$: the measurement value at (m–1) display before the “n”th display;
  $M_{n-(m-2)}$: the measurement value at (m–2) display before the “n”th display;
  :
  M_{n-2}: the measurement value at two displays before the “n”th display;
  M_{n-1}: the measurement value at one display before the “n”th display;
  M_n: the measurement value at the “n”th display;
  m: sample number

Setting the Averaging Sample Number/Attenuation Constant

The following selections are available. The attenuation constant (for exponential averaging) and the sample number (for moving averaging) are set and saved seperately. The initial value is “8”.
8, 16, 32, 64

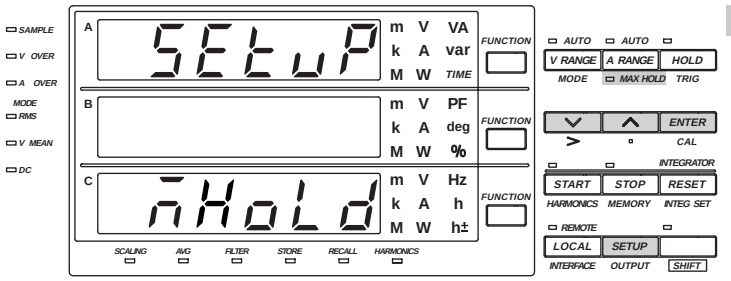
Setting Averaging ON/OFF

Select the averaging menu once again after having set the averaging values. The initial value is oFF.

- on: When this setting is selected, pressing the ENTER key will start averaging and the AVG indicator will light.
- oFF: When this setting is selected, pressing the ENTER key will stop averaging and the AVG indicator will extinguish.

4.8 Using the MAX Hold Function

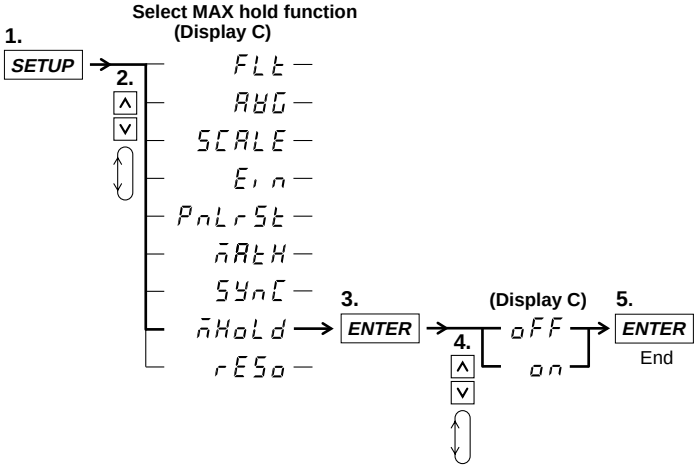
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

MAX hold function

The maximum values (MAX) of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak) can be held while the MAX hold function is enabled. The initial setting is oFF.

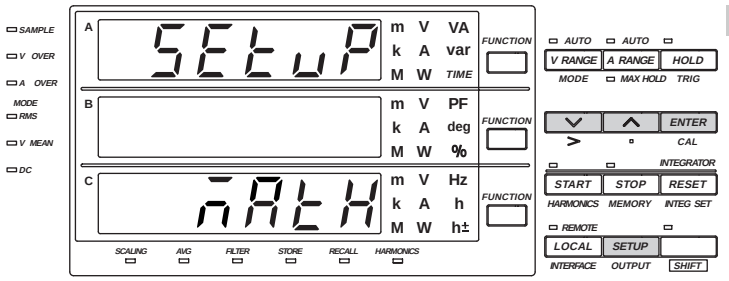
- on: The MAX hold function is activated.
- oFF: The MAX hold function is deactivated.

Note

The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak) while the MAX hold function is enabled will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held.

4.9 Using the Four Arithmetical Operation Function

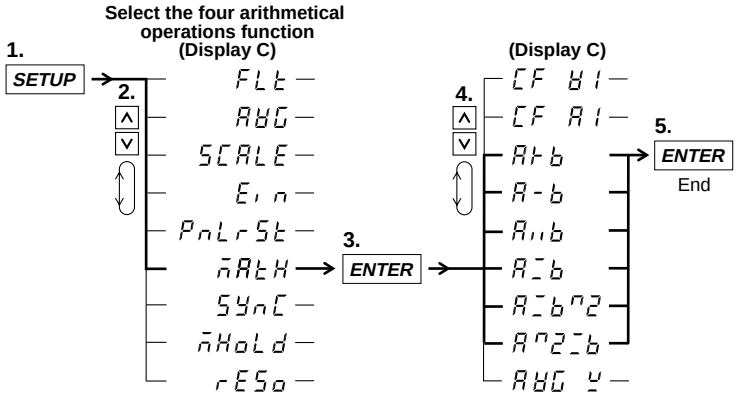
Keys



Displays relevant keys

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Four Arithmetical Operations Function

Displays the following computation results on display C. "$\bar{n}$" is displayed at the front when the computation results are being displayed.

- A+b : **A+B**
- A-b : **A–B**
- A,,b : **A×B**
- A/b : **A÷B**
- A/bn2 : **A÷B^2**
- An2/b : **A^2÷B**

A, B indicates display A, B respectively.

Note

- The meanings of the displayed symbols are as follows:

  + : + **(Addition)**
  - : – **(Subtraction)**
  ,, : × **(Multiplication)**
  / : ÷ **(Division)**
  n : ^ **(Exponent)**

- If the display A function is displaying INTEG TIME (elapsed time of integration), the computation result displays "- - - - - -" (no data).
- If the value of display B function is less than 0.0001% of the rating, the computation result displays "- - oF - -".

Application Example

A,,b : Displays the result of display A × display B.

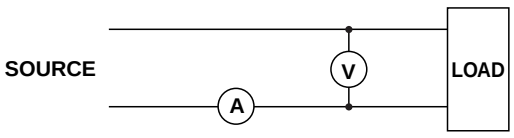
Computation example: This function is valid when display A is set to some function other than VA (apparent power) and you wish to display VA on Display C.

Display A	Display B	Display C
Vrms	Arms	Vrms × Arms

A/b : Displays the result of display A ÷ display B.

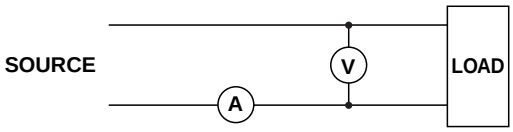
Computation example: The absolute value of the impedance can be computed.

Display A	Display B	Display C
Vrms	Arms	$\lvert Z\rvert = \frac{\text{Vrms}}{\text{Arms}}$



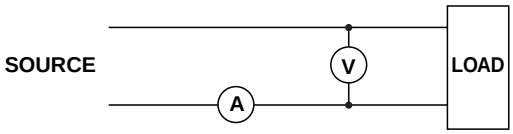
A-bn2: Displays the result of display A ÷ (display B)^2
Computation example: The impedance (Z), resistance (R), and reactance (X) can be computed.

Display A	Display B	Display C
VA	Arms	$\|Z\| = \frac{VA}{(Arms)^2}$
W	Arms	$R = \frac{W}{(Arms)^2}$
Var	Arms	$\|X\| = \frac{Var}{(Arms)^2}$



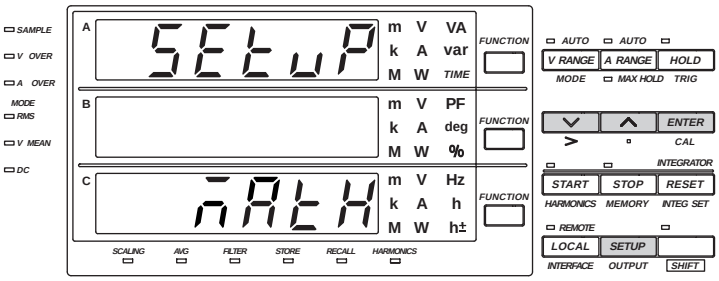
An2-b: Displays the result of (display A)^2 ÷ display B
Computation example: The resistance can be computed.

Display A	Display B	Display C
Vrms	W	$R = \frac{(Vrms)^2}{W}$



4.10 Computing the Crest Factor

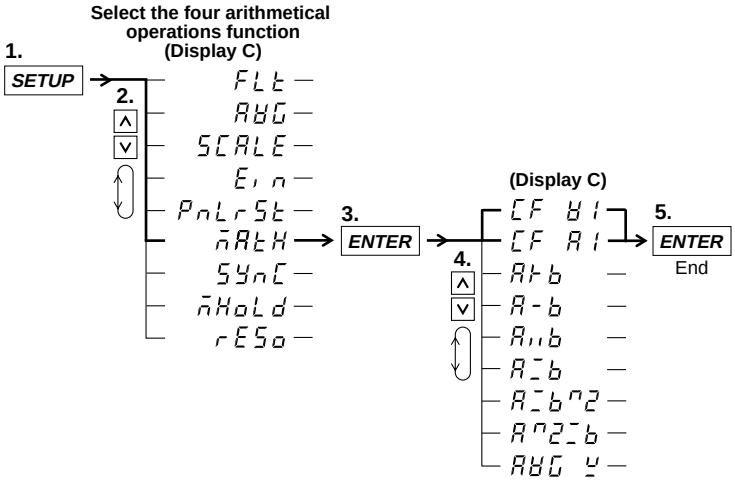
Keys



Displays relevant keys

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Crest factor computation

The crest factor is determined by peak value/rms value. When displaying the crest factor, " cf " is displayed at the front.

Computing equation for the crest factor and display

CF V: Displays the result of (Vpeak)/(Vrms).

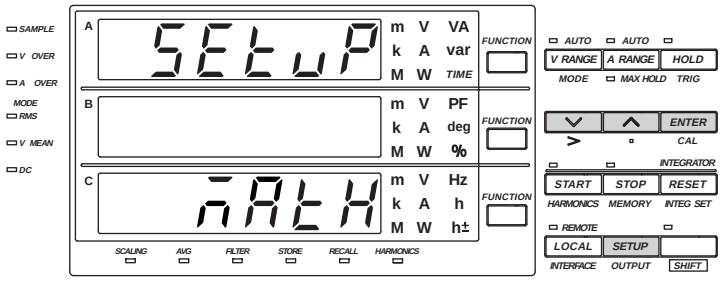
CF A: Displays the result of (Apeak)/(Arms).

Note

- Definition of crest factor: $\frac{\text{PEAK value}}{\text{RMS value}}$
- If the measurement mode is V MEAN or DC, "- - - - - -" is displayed.

4.11 Computing the Average Active Power during Integration

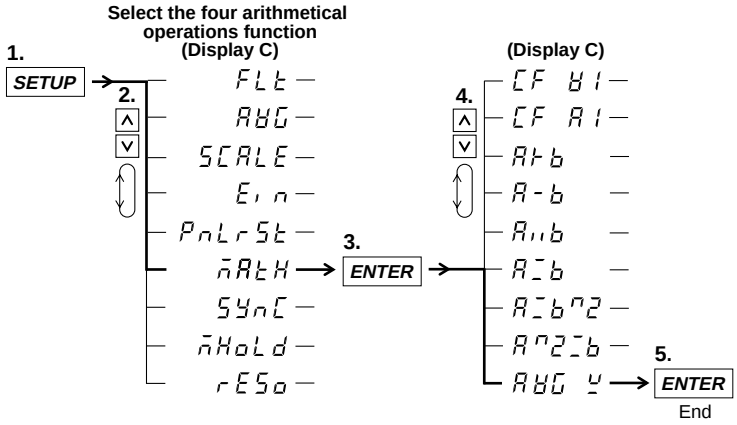
Keys



Displays relevant keys

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Function used to compute the average active power during integration

This function computes the average active power within the integration period. It is derived by dividing the watt hour (integrated active power) by the elapsed time of integration.

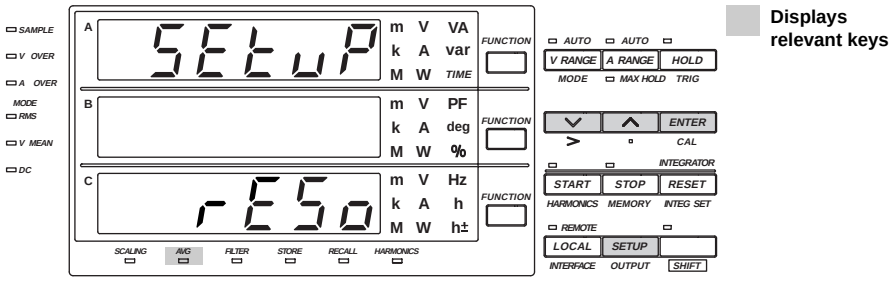
$$\text{Average active power during integration (W)} = \frac{\text{Watt hour (Wh)}}{\text{Elapsed time of integration(h)}}$$

Note

This computation function is enabled during integration (while the integration is in progress or while the integration is suspended). If the integration is reset, the watt hour and the elapsed time of integration become zero, and the display shows "n- - - - -." For details on integrator functions, see chapter 6.

4.12 Selecting the Number of Displayed Digits

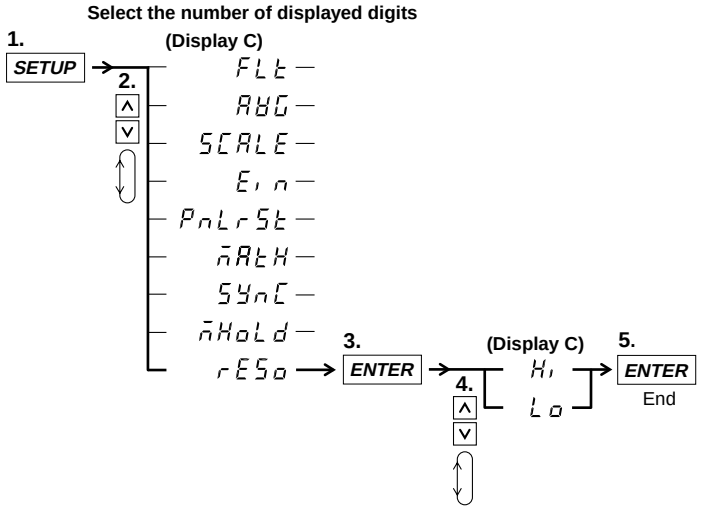
Keys



Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

Select the number of displayed digits



Explanation

Function used to select the number of displayed digits

You can select the maximum number of displayed digits for values such as V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), Apk (current peak), PF (power factor), VHz (voltage frequency), AHz (current frequency), four arithmetical operation values, crest factor, and harmonic analysis values (voltage, current, and active power). The initial value is Lo.

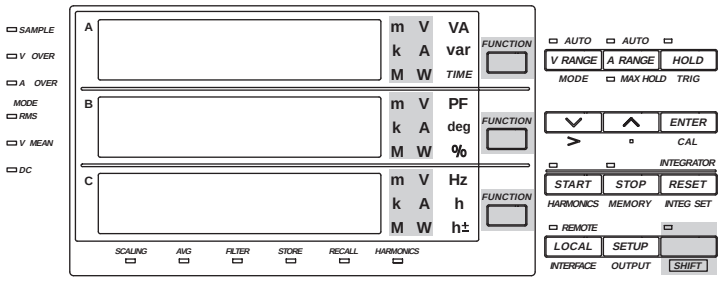
- Hi
  The number of displayed digits is set to 5 (99999).
- Lo
  The number of displayed digits is set to 4 (9999).

Note

- The actual number of displayed digits may be smaller than the maximum number of displayed digits depending on the combination of the voltage range and current range and the automatic digit carrying operation.
- Some items such as the phase angle, integrated value, integration time, and relative harmonic content are not affected by the maximum number of displayed digits specified in this section. For details, see the sections describing each item.

5.1 Displaying Voltage, Current, and Active Power

Keys

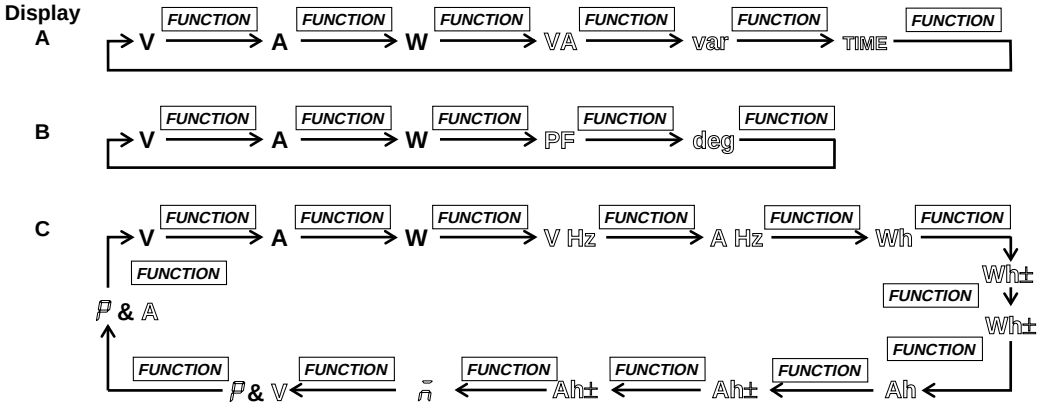


Displays relevant keys and indicator

Procedure

1. Selecting the Display Function

Select either V (voltage), A (current) or W (power) by pressing the FUNCTION key.



Wh± and Ah± will light twice. $\bar{n}$ and P are displayed on the top of display C.
You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Continuous Maximum Allowable Input

- Voltage
  Up to a peak value of 1.5 kV or RMS value of 1.0 kV, whichever is less.
- Current
  - 20 A to 0.5 A range
    Up to a peak value of 100 A or RMS value of 25 A, whichever is less.
  - 200 mA to 5 mA range
    Up to a peak value of 30 A or RMS value of 20 A, whichever is less.
  - External sensor input
    Up to five times the measurement range.

Maximum Reading of the Display and Units

- Maximum reading : for voltage, current and power, each 99999 (when the number of displayed digits is 5)
- Units: V (voltage), A (current), W (power)
- Prefix: m, k, or M

Selecting the Display Function

The following selections are available.

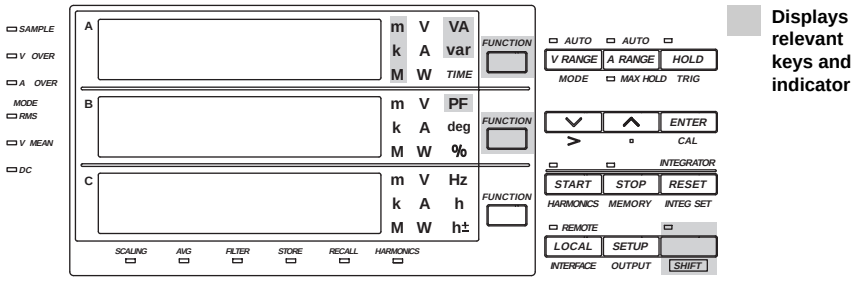
- V: voltage will be displayed
- A: current will be displayed
- W: power will be displayed

Note

- The measurement results may differ even on a same signal if the measurement mode is changed. For details related to the measurement mode, see section 4.1.
- The displayed values of V (voltage), A (current), and W (active power), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held.

5.2 Displaying Apparent Power, Reactive Power, and Power Factor

Keys



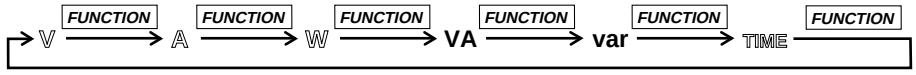
Displays relevant keys and indicator

Procedure

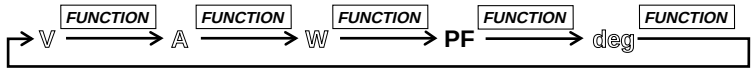
1. Selecting the Display Function

Select either VA (apparant power), var (reactive power) or PF (power factor) by pressing the FUNCTION key of display A or B.

Display A



B



You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Maximum Reading of the Display and Units

- Maximum reading of apparent and reactive power: 99999 (when the number of displayed digits is 5)
- Display range of power factor: –1.0000 to 1.0000 (1.0000 if the computed result between 1.0001 and 2.0000; PFErr if it is greater than 2.0000; –1.0000 if it is between –1.0001 and –2.0000; PFErr if it is less than –2.0000.)
- Units: VA (apparent power), var (reactive power), power factor (no unit)
- Prefix: m, k, or M

Selecting the Display Function

The following selections are available.

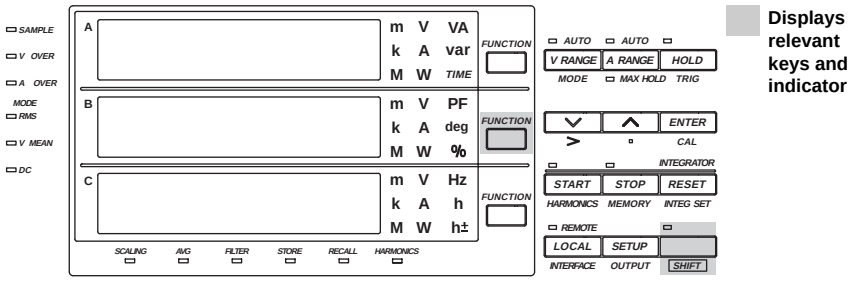
- VA: apparent power will be displayed
- var: reactive power will be displayed
- PF: power factor will be displayed

Note

- Changing the measurement mode might result in different computed results, even when the input signal is the same. For details on the measurement mode, refer to section 4.1.
- When either the voltage or current drops below 0.5% of the measurement range, PFErr will be displayed.
- The displayed values of VA (apparent power) and var (reactive power), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held.

5.3 Displaying the Phase Angle

Keys



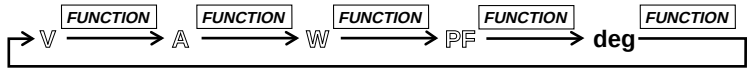
Displays relevant keys and indicator

Procedure

Selecting the Display Function

Select deg (phase angle) by pressing the FUNCTION key of display B.

Display B



You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Display Range and Units

Display range: G180.0 to d180.0 (G meaning phase lag, d meaning phase lead)
Unit: deg

Selecting the Display Function

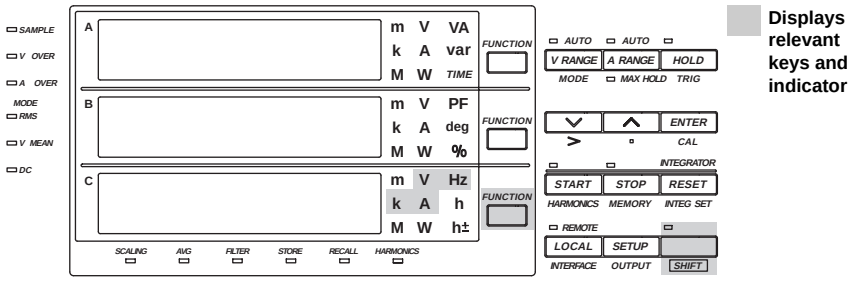
When you select deg, the phase angle will be displayed.

Note

- Changing the measurement mode might result in different computed results, even when the input signal is the same. For details on the measurement mode, refer to section 4.1.
- When either the voltage or current drops below 0.5% of the measurement range, dEGEr will be displayed.
- Distinction between phase lag and lead can be made properly, only when both voltage and current are sine waves, and when the percentage of voltage or current input relating to the measurement range does not fluctuate much.
- If the computed result of the power factor exceeds 1, the display will be as follows.
  - When the power factor is between 1.0001 and 2.0000 or between –1.0001 and –2.0000: phase angle display is 0.0.
  - When the power factor is greater than 2.0000 or less than 2.0000: phase angle display is dEGEr.

5.4 Displaying the Frequency

Keys

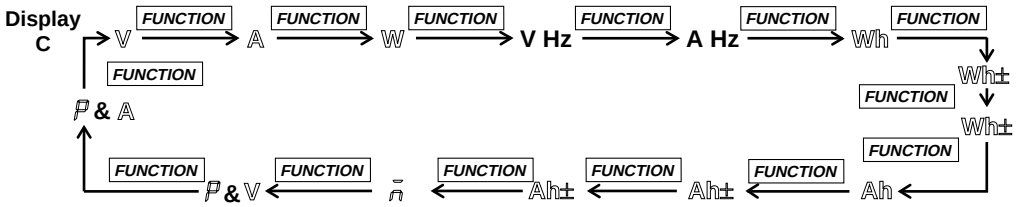


Displays relevant keys and indicator

Procedure

Selecting the Display Function

Select either V Hz (voltage frequency) or A Hz (current frequency) by pressing the FUNCTION key of display C.



Wh± and Ah± will light twice. $\bar{n}$ and $\bar{P}$ are displayed on the top of display C.
You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Measurement Range

The measurement range lies from 10 to 50 kHz. Depending on the internal timing, however, measurements can be done in the range from 4 to 10 Hz. At 100 Hz, 1 kHz, 10 kHz, 100 kHz, the measurement range is auto range.

Maximum Reading of the Display and Units

- Maximum reading: 99999 (when the number of displayed digits is 5)
- Units: Hz
- Prefix: k

Selecting the Display Function

The following selections are available.

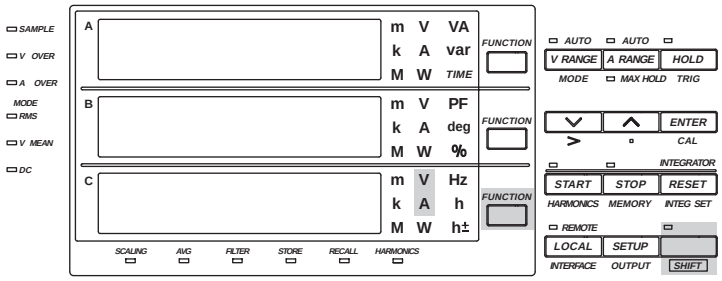
- V Hz: voltage frequency will be displayed
- A Hz: current frequency will be displayed

Note

- In case the level of the input signal is low (below approx. 7%), or when the frequency is smaller than the measurement range, the display will show “ErrLo.” When the frequency is larger than the measurement range, the display will show “ErrHi.”
- This instrument measures the frequency after synchronizing to the cycle of the input signal. We recommend to turn ON the filter when measuring an inverted waveform or a waveform with high noise. However, depending on the signal’s frequency and level, “ErrLo” might appear on the display. Since the filter’s cutoff frequency is 300 Hz, the signal attenuates and no signal will be detected.
- Even when the filter is set OFF but the frequency exceeds the measurement range, “ErrLo” might appear since no signal will be detected anymore due to the internal circuit’s attenuation.

5.5 Displaying Peak Value, Four Arithmetic Operation Value, and Crest Factor

Keys

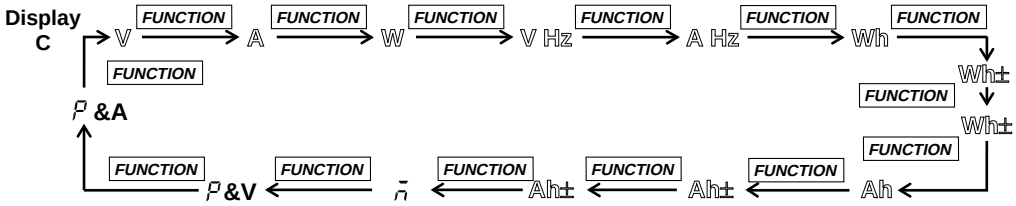


Displays relevant keys and indicator

Procedure

Selecting the display Function

Select either $\bar{n}$ (four arithmetical operations, crest factor), P (voltage peak value) or P (current peak value) by pressing the FUNCTION key.



Wh± and Ah± will light twice. $\bar{n}$ and P are displayed on the top of display C.
You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Displaying the peak value

P is displayed first on display C followed by the value. If the unit display shows V, the value is a voltage peak. If it shows A, the value is a current peak.

Displaying the result of the four arithmetical operation abd the crest factor

When display C is set to $\bar{n}$, the result of the computing equation specified in Section 4.9 or the crest factor specified in Section 4.10 is displayed.

However, if the value of display B function is less than 0.0001% of the rating, "- - oF - -" is displayed for the computation result.

Note

The displayed values of Vpk (voltage peak) and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held.

6.1 Integrator Functions

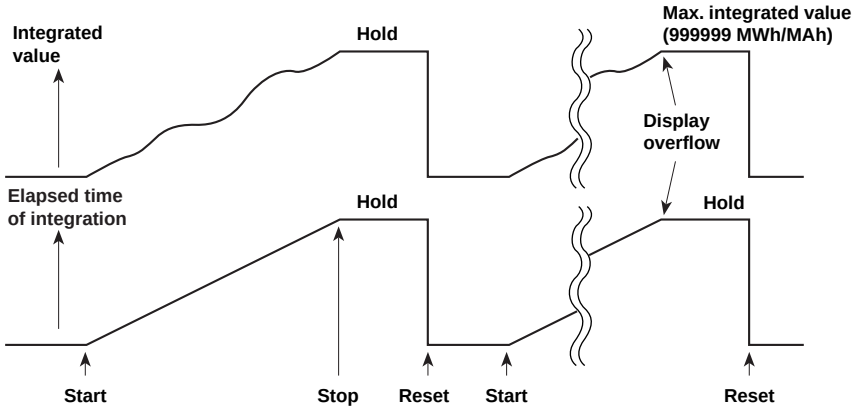
Active power integration and current integration can be carried out. All measurement values (and computed values) can be displayed, even when integration is in progress, except for the integrated values (watt hour or ampere hour) and elapsed time of integration. Since integrated values of negative polarity can be also displayed, the consumed watt hour (ampere hour: only when the measurement mode is DC) value of the positive side and the watt hour value returning to the power supply of the negative side (ampere hour: only when the measurement mode is DC), can be displayed seperately.

Integration Modes

The following three modes are available as integration modes.

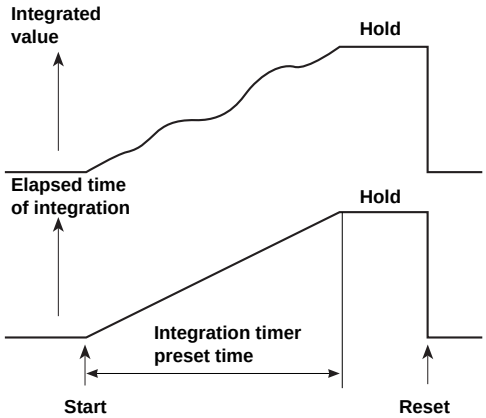
Manual Integration Mode

- Integration starts: after having pressed the START key
- Integration stops:
  - after having pressed the STOP key;
  - when the integrated value reaches the maximum of 999999 MWh/MAh, or when the integrated value of negative polarity reaches –99999 MWh/MAh;
  - when the elapsed time of integration reaches the maximum of 10000 hours 00 minutes 00 seconds.
- Integration holds: the elapsed time of integration and integrated values at the point where integration stopped will be held until the RESET key is pressed.



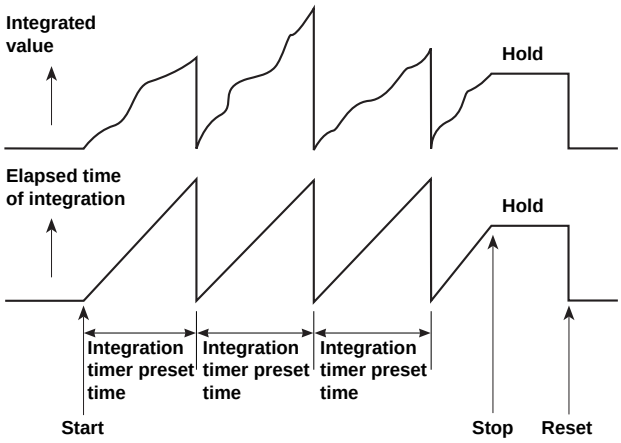
Standard Integration Mode

- Integration starts: after having pressed the START key
- Integration stops:
  - when the elapsed time of integration reaches the integration timer preset time;
  - when the integrated value reaches the maximum of 999999 MWh/MAh, or when the integrated value of negative polarity reaches –99999 MWh/MAh.
- Integration holds: the elapsed time of integration and integrated values at the point where integration stopped will be held until the RESET key is pressed.



Continous Integration Mode (Repeat Integration)

- Integration starts:
  - after having pressed the START key;
  - when the elapsed time of integration reaches the integration timer preset time, the integrated value and elapsed time of integration are reset automatically and restarted immediately.
- Integration stops:
  - when the elapsed time of integration reaches the integration timer preset time ; however, the integrated value and elapsed time of integration are reset automatically and restarted immediately;
  - after having pressed the STOP key;
  - when the integrated value reaches the maximum of 999999 MWh/MAh, or when the integrated value of negative polarity reaches –99999 MWh/MAh;
- Integration holds: the elapsed time of integration and integrated values at the point where they reached the maximum or at the point where the STOP key was pressed will be held until the RESET key is pressed.



Integration Methods

Each display update interval (250 ms) the apparent power values or current values are added to the integrated values, and will be time converted. The integration equations are as follows.

Power integration

$$\sum_{T=0}^{t} \frac{Wi}{4 \times 3600}$$

Wi: Active power between display update interval
t: Elapsed time of integration

Current integration

$$\sum_{T=0}^{t} \frac{Ai}{4 \times 3600}$$

Ai: Current value between display update interval
t: Elapsed time of integration

Display Resolution during Integration

The display resolution for integrated values is 100000 counts. When the integrated value reaches 100000 counts, the decimal point shifts automatically. For example, if 0.00001 mWh is added to 9.99999 mWh, the display shows "10.0000 mWh. "

Display Function of Integrator Values

By selecting the display function, you can display the polarity of the integrator values.

Display function	Measurement mode	Display contents
Wh	RMS,VMEAN,DC	both positive and negative watt hour values
Wh±*1	RMS,VMEAN,DC	positive watt hour value
Wh±*1	RMS,VMEAN,DC	negative watt hour value
Ah	RMS,VMEAN	total ampere hour values
	DC	both positive and negative ampere hour values
Ah±*2	RMS,VMEAN	total ampere hour values (same as Ah)
	DC	positive ampere hour value
Ah±*2	RMS,VMEAN	–0
	DC	negative ampere hour value

*1 When the Wh function is selected, pressing the FUNCTION key once or twice will result in Wh±. Pressing the FUNCTION key once will result in displaying the positive watt hour value, whereas pressing the FUNCTION key twice will result in displaying the negative watt hour value. In case of the negative watt hour value, "–" will appear in front of the value.

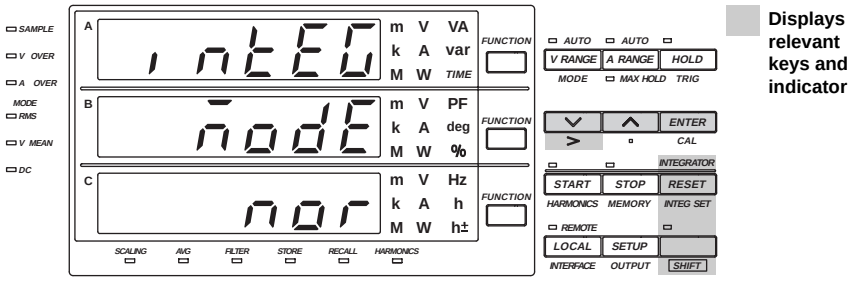
*2 When the Ah function is selected, pressing the FUNCTION key once or twice will result in Ah±. Pressing the FUNCTION key once will result in displaying the positive ampere hour value, whereas pressing the FUNCTION key twice will result in displaying the negative ampere hour value. In case of the negative ampere hour value, "–" will appear in front of the value.

Note

- When negative integrated values are displayed, the maximum display reading will become –99999 MWh/MAh because of the added minus character.
- When the measurement mode is RMS/VMEAN and the current input drops below 0.5% of the rated range, the ampere hour value will become zero (0).
- During integration is in progress (until being reset), operation of other functions are restricted. For details, see section 6.4.

6.2 Setting Integration Mode, Integration Type, and Integration Timer

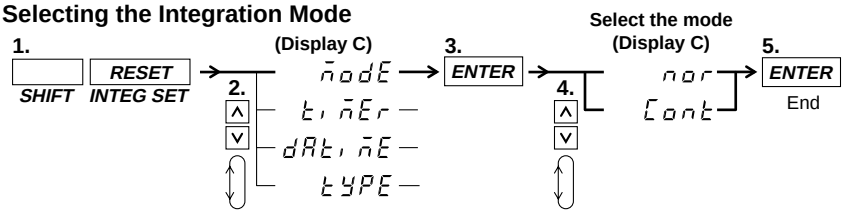
Keys



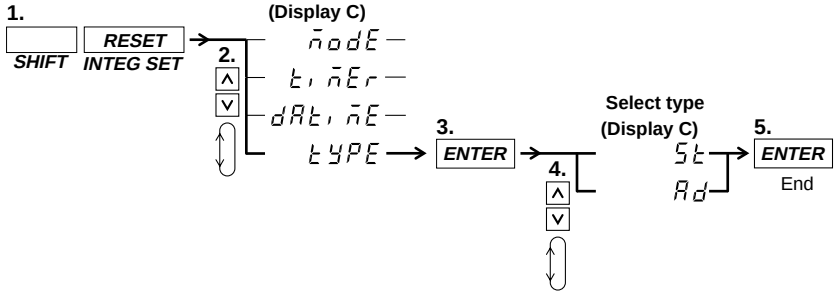
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

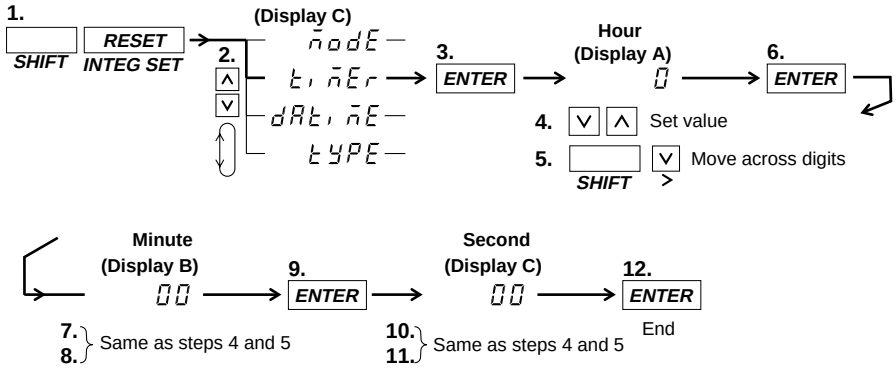
• Selecting the Integration Mode



• Setting the integration type



• Setting the Integration Timer



Explanation

Selecting the Integration Mode

The following selections are available. The initial value is nor.

- nor: Select this for manual or standard integration mode. Depending on the integration timer, this instrument will automatically decide the appropriate mode.
- Cont: Select this for the continuous integration mode.

Selecting the Integration Type

The following selections are available. The initial value is St.

- St: Standard type. Integrates the active power or current that is obtained using the normal measurement method, which obtains the active power or current from the sampled data over the period that is synchronized to the input signal. Select the standard type for steady-state input signals that have a constant period such as a sinusoid.
- Ad: Advanced type. Integrates the active power or current obtained over a fixed period of sampled data, irrespective of the period of the input signal. Select the advanced type for intermittent signals with a frequency of 50 or 60 Hz.

Note

Select integration type Ad when integrating the power of devices that are controlled through intermittent signals or devices on which the amplitude of the voltage or current changes drastically. If the load fluctuation is large, the value obtained on this instrument may differ from that obtained on other instruments using a different integration method.

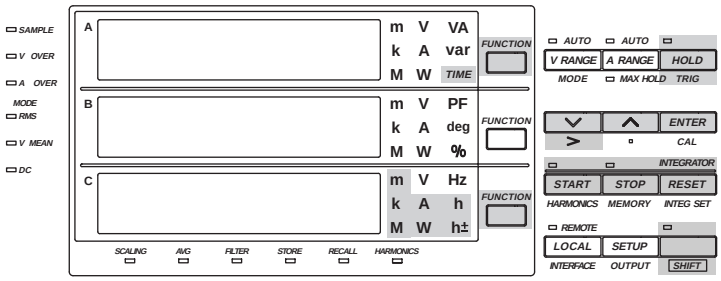
Selecting the Integration Timer

Specify how many hours, minutes, and seconds to perform the integration. The selectable range is from 0.00.00 (0 hours 0 minutes 0 seconds) to 10000.00.00 (10000 hours, 0 minutes, 0 seconds). The initial value is 0.00.00.

- 0.00.00: When nor is selected in the integration mode menu, integration is performed in the manual integration mode. If Cont is selected, an error code is displayed and the integration is not performed.
- 0.00.01 to 10000.00.00: The time during which integration is to be performed when using the standard or continuous integration mode. The standard or continuous integration mode is specified in the integration mode menu.

6.3 Displaying Integrated Values

Keys



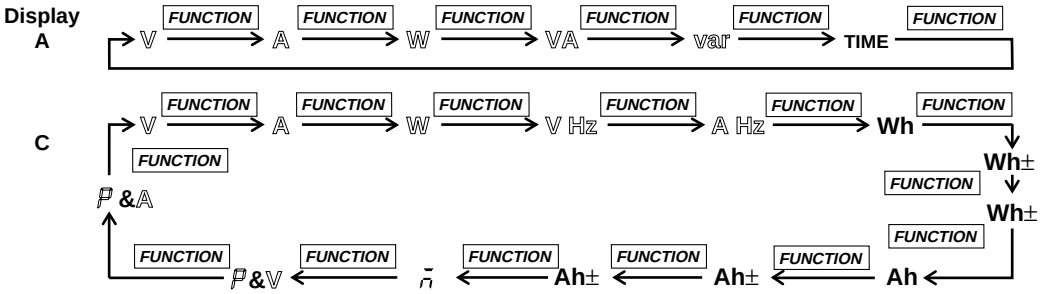
Displays relevant keys and indicator

Procedure

1. Selecting the Display Function

Pressing the FUNCTION key on display A will select TIME (elapsed time of integration).

Pressing the FUNCTION key on display C will select either Wh/Wh± (power) or Ah/Ah± (current), $\bar{n}$. (average active power during integration).



Wh± and Ah± will light twice. $\bar{n}$ and P are displayed on the top of display C.
You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

2. Starting Integration

Press the START key. The START indicator lights, the integrated value appears on display C, and the elapsed time of integration appears on display A. $\bar{n}$ is displayed first on display C. It is followed by the average active power during integration, if the function is specified in the computation settings (see section 4.11).

START

3. Holding Integration

Press the HOLD key. The HOLD indicator will light, and the displayed values will be held.

HOLD

4. Cancelling HOLD, and Updating the Integration

Press the HOLD key while the values are held. The HOLD indicator turns off, and the display values are updated. You can also update the display by activating a trigger (press the SHIFT key followed by the HOLD (TRIG) key) while the values are held.

HOLD
TRIG

5. Stopping Integration

Press the STOP key. The START indicator will extinguish and the STOP indicator will light. The displayed values will be held.

STOP

6. Resetting Integration

Press the RESET key. The STOP indicator will extinguish and the values on display A will be reset to 0.00.00.

RESET

Explanation

Maximum Reading of the Display and Units

Maximum reading

- Integrated value: 999999 (–99999 in case of minus display)
- Elapsed time of integration: 10000
- Units: Wh (power integration: watt hour value), Ah(current integration: ampere hour value)
- Prefix: m, k, or M

Selecting the Display Function

The following selections are available.

- Wh: displays both the positive and negative watt hour values
- Wh±: displays the positive and negative watt hour values separately
- Ah: displays the total ampere hour values
- Ah±: displays the total ampere hour values, or the positive and negative ampere hour values separataly
- $\bar{P}$: The average active power during integration is displayed, if the function is specified in the computation settings (see section 4.11).

Update Hold Function

Although the held values will not be updated, integration continues. When hold is being cancelled, the integration results (values and time) corresponding to the point of cancellation, will be displayed.

For details regarding the relation with the START/STOP key, refer to the following section.

Integration Reset

Resetting will result in returning the integration results to the status before integration started.

Pressing the RESET key is useful after integration has been stopped.

For details regarding the relation with the START/STOP key, refer to the following section.

Display in case of Integration Over

When the maximum integration value has been reached (999999 MWh/MAh or –99999 MWh/MAh), integration will stop and that result will be held on the display.

When the maximum integration time has been reached (up to 10000 hrs), integration will stop and that result will be held on the display.

Note

- The maximum number of digits used to display the elapsed time of integration is nine (when the hour, minute, and second digits are added together). The WT200 displays the elapsed time of integration on display A. However, because the maximum number of digits that can be displayed on display A is five, all the digits of the elapsed time of integration may not be displayed in certain cases. Therefore, the number of digits that are displayed varies depending on the elapsed time of integration as follows:

Elapsed Time of Integration	Display on Display A	Display Resolution
0 to 9 hours 59 minutes 59 seconds	0.00.00 to 9.59.59	1 s
10 hours to 99 hours 59 minutes 59 seconds	10.00.0 to 99.59.5	10 s
100 hours to 999 hours 59 minutes 59 seconds	100.00 to 999.59	1 min
1000 hours to 9999 hours 59 minutes 59 seconds	1000.0 to 9999.5	10 min
10000 hours	10000	1 hour

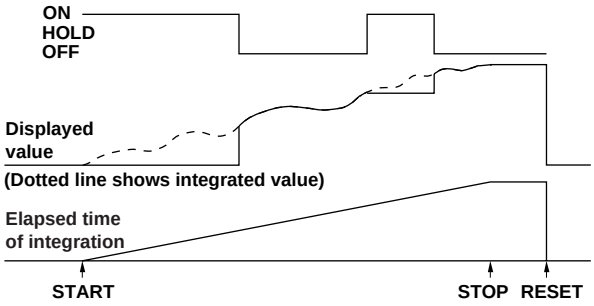
- For details related to Wh, Wh±, Ah, and Ah±, see page 6-3. For details related to the average active power during integration, see section 4.11.
- The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held. The integrated value is determined and displayed by summing the value that is measured at every display update rate, irrespective of the MAX hold function.

6.4 Precautions Regarding Use of Integrator Function

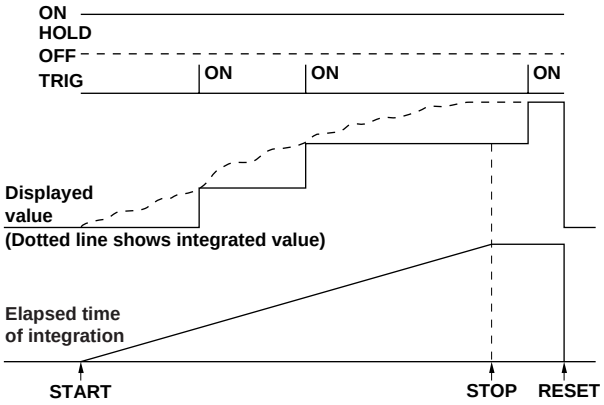
Relation between Integration Hold and the START/STOP key

When the HOLD key is pressed, the display and communication output of the integrated results is being held while integration continues. The relation between this hold function and the START/STOP key is as follows.

- Even when starting integration while the hold function is on, the display and communication output will remain unchanged. Only canceling the hold function or activating a trigger (pressing the SHIFT key followed by the HOLD (TRIG) key) will result in displaying or outputting the integrated results of the time of cancellation.

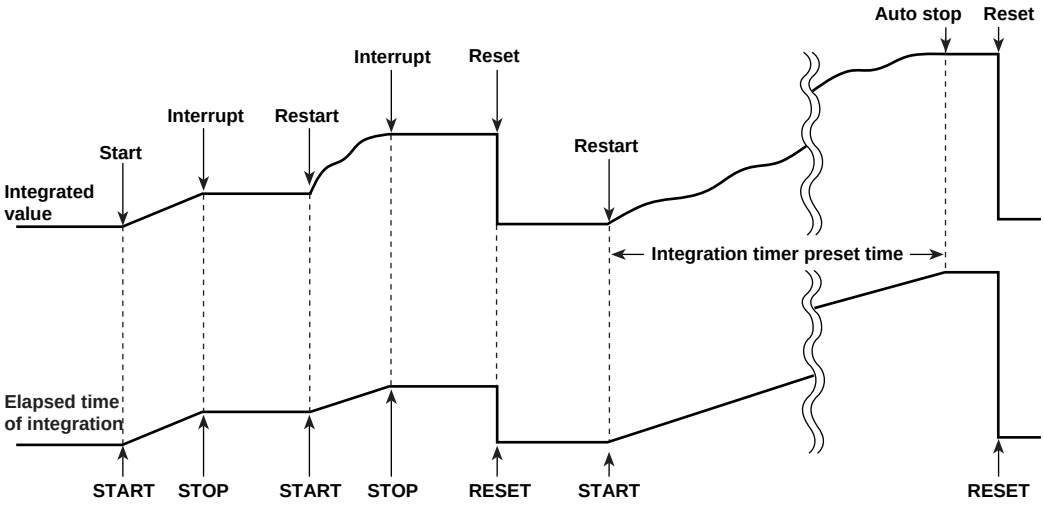


- Even when stopping integration while the hold function is on, the displayed integrated value will remain unchanged. However, as soon the hold function is turned off or a trigger is activated, the integrated results of the time when integration was stopped will be displayed or output.



Relation between Integration Reset and the START/STOP key

The relation between integration reset and the start/stop key is as follows.



Backup During Power Failures

- If there is a power failure while integration is in progress, the integrated value and elapsed time of integration will be backed up. When the power is restored, the display will show the integrated results up to the time the power failure occurred.
- To start integration after the power is restored, it is necessary to reset integration first.

Operating Restrictions during Integration

Certain key operations are restricted during integration, and are shown below.

		Integration status	
	Integration reset	**Integration in progress**	**Integration interrupted**
(START Indicator)	**Not lit**	**Lit**	**Not lit**
(STOP Indicator)	**Not lit**	**Not lit**	**Lit**
Function			
Measurement mode	yes	no	no
Measurement synchronization source	yes	no	no
Filter	yes	no	no
Measurement range	yes	no	no
Scaling	yes	yes	yes
Averaging	yes	no	no
MAX hold	yes	yes	yes
Display function	yes	yes	yes
Number of displayed digits	yes	yes	yes
Hold	yes	yes	yes
Trigger	yes	yes	yes
Integration mode	yes	Settings cannot be changed, but can be displayed	
Integration type	yes	Settings cannot be changed, but can be displayed	
Integration timer	yes	Settings cannot be changed, but can be displayed	
Integration start	yes	no	yes
Integration stop	no	yes	no
Integration reset	yes	no	yes
Harmonic analysis function (option)	yes	no	no
Store/recall	yes	no (Store possible)	no (Store possible)
Comparator	yes	yes	yes
Plotter and printer	yes	yes	yes
Zero level compensation	yes	no	no

- yes: Settings can be changed
- no: Settings cannot be changed. Attempts will result in an error code.
- When integration is started during auto range, the measurement range will change to manual range.

Integration Computation when the Measured Value Exceeds Measurement Limits

When the active power, measurement current, instantaneous voltage or current exceeds the measurement range, the integration computation will be handled as follows.

- When the active power or measurement current exceeds the measurement range by 163.84%, their integrated values become 163.84% of the measurement range.
- When the instantaneous voltage or current exceeds the measurement range by 300%, their integrated values become 300% of the measurement range.

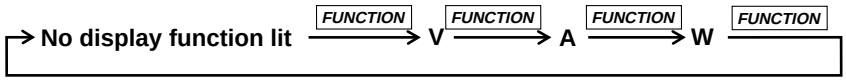
7.1 Harmonic Analysis Function

This chapter explains the harmonics analysis function which can be applied to normal measurements of voltage, current and power.

Analyzed/Displayed Items

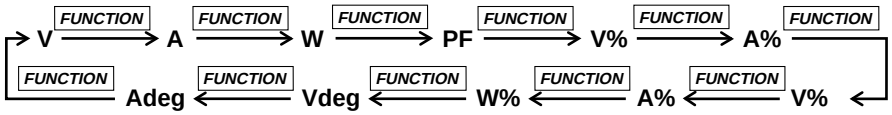
After having set the harmonic analysis function to ON, the harmonic component of voltage, current, or active power, will be analyzed and displayed for one of the input elements. Depending on the setting of the display function, the display changes as follows.

Display A



No display function lit : Displays the harmonic order (1 to 50)
Display function **V, A, W** : Displays all rms values (computed values) of 1up to 50 components of voltage, current or active power

Display B



Display function **V** : Displays the voltage analysis value of the order shown on display A
A : Displays the current analysis value of the order shown on display A
W : Displays the active power analysis value of the order shown on display A
PF : Displays the power factor of the fundamental (1st order)
V % : Displays the voltage harmonic distortion, proceeded by "t" on display B
A % : Displays the current harmonic distortion, proceeded by "t" on display B
V % : Displays the relative harmonic content of the voltage of the order shown on display A
A % : Displays the relative harmonic content of the current of the order shown on display A
W % : Displays the relative harmonic content of the active power of the order shown on display A
V deg : ・In case the 1st order (fundamental) is shown on display A:
Displays the phase angle between the voltage of the first order and the current of the first order
・In case the order 2 to 50 is shown on display A:
Displays the phase angle between the voltage of the first order and each voltage of the 2nd to 50th order
A deg : ・In case the 1st order (fundamental) is shown on display A:
Displays the phase angle between the voltage of the first order and the current of the first order (same as V deg)
・In case the order 2 to 50 is shown on display A:
Displays the phase angle between the current of the first order and each current of the 2nd to 50th order

Display C

Display function **V, A, W** : Displays all rms values (computed values) of 1 up to 50 components of voltage, current or active power.
V Hz : Displays the fundamental frequency of the voltage for PLL synchronization (displays the measurement value for only the selected voltage input)
A Hz : Displays the fundamental frequency of the current for PLL synchronization (displays the measurement value for only the selected current input)

Auto Range Operation

The up/down operation of the measurement range is the same as for normal measurement.

Note

When the range changes, the PLL synchronization will be re-established. Therefore, correct measurement values might not be obtained which might result in an unstable range. If this is the case, set the measurement range to a fixed range.

Display Renewal Rate

Harmonic analysis data will be updated approx. every 3 seconds.

Holding the Display

When you use the display hold function and change the order or display function while the harmonic analysis function is ON, you can display the harmonic data analyzed at the corresponding time.

Updating the Displayed Data

The display can be updated in the same way as for normal measurement.

Overrange/Error Displays

In case the fundamental frequency of the PLL synchronization signal lies outside the measurement range. Display B will show “FrqEr”.

Note

The measurement range of the fundamental frequency of the harmonic analysis function is different from the frequency measurement range of normal measurement. For details, see chapter 16, “Specifications.”

Display in case of Overrange

The overrange display (being the same as for normal measurement) will appear when all rms values of the 1st to 50th order reach the following value:

- 140% of the rated range for the 600 V voltage range, or 20 A current range
- 200% of the rated range for voltage ranges except 600 V, or current ranges except 20 A

The relative harmonic content and harmonic distortion are related to voltage and current.

Error Display

The power factor or phase angle will show PFErr or dEGEr when either the voltage, range or power exceeds 200% of the range.

Computation Over Display

Appears in the same way as for normal measurement.

Dot Display

The display will show dots in any of the following cases.

- When there are no more analysis data to be displayed during harmonic analysis;
- Soon after the harmonic analysis function has been turned ON;
- When the PLL synchronization is being re-established;
- Until the initial analysis data are obtained, after having changed the settings;
- When the analysis order which depends on the fundamental frequency, exceeds the upper limit, after having set the order at display A;
- When the display function is set to relative harmonic content (%) and the order at display A is set to 1;
- When the PLL source is set to voltage, and an attempt is made to display the current frequency (AHz); or when the PLL source is set to current, and an attempt is made to display the voltage frequency (VHz);

Averaging Function

Exponential averaging is performed with an attenuation constant of 8.

Output to an External Plotter

Using the GP-IB or RS-232-C interface, harmonic analysis data can be printed as value or graph on an external plotter.

Effect of Aliasing

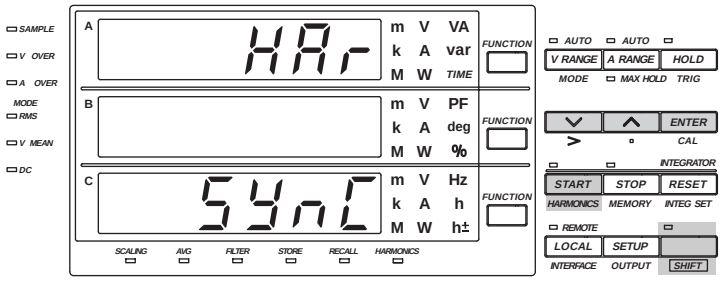
This instrument is not equipped with an internal aliasing filter. Due to aliasing accidental errors may occur under the following circumstances.

Fundamental frequency f in Hz

40≤f<70 errors may occur in case of harmonic components of the 256th or higher;
70≤f<130 errors may occur in case of harmonic components of the 128th or higher;
130≤f<250 errors may occur in case of harmonic components of the 64th or higher;
250≤f≤440 errors may occur in case of harmonic components of the 32nd or higher.

7.2 Setting the PLL Source and Harmonic Distortion Method

Keys

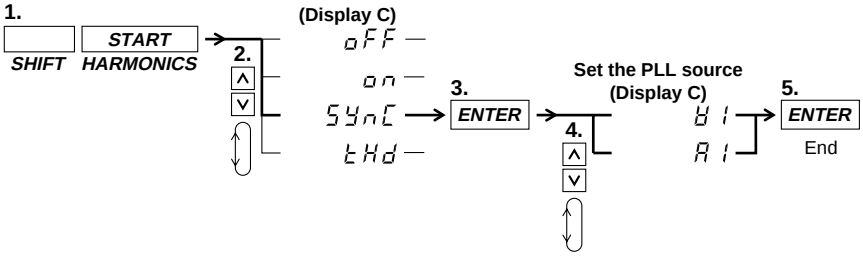


Displays relevant keys and indicator

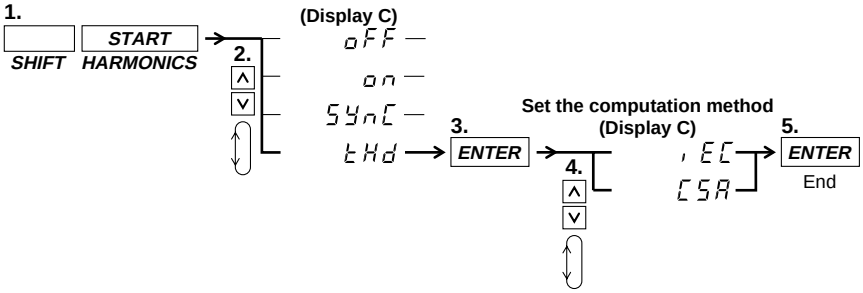
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting the PLL source



• Setting the Computation Method of the Harmonic Distortion



Explanation

Setting the PLL source

For harmonic analysis, it is necessary to select the input to be used as the fundamental frequency (PLL source) for synchronization. (PLL stands for Phase Locked Loop.)

- V1: Sets the voltage as the PLL source.
- A1: Sets the current as the PLL source.

Note

- If the fundamental frequency of the PLL source cannot be measured due to fluctuations or distortion, it is not possible to obtain correct measurement results. In this case, it is suggested that voltage with relatively small distortion be selected as the PLL source.
- It is recommended to turn ON the filter in cases where the fundamental frequency is 300 Hz or less and high frequency components are present.
- If the amplitude of the input signal selected as the PLL source is smaller than the rated range value, PLL synchronization may sometimes fail. In this case, it is suggested that a suitable measurement range be selected so that the input level exceeds 30% of the rated range value.

Setting the Computation Method of Harmonic Distortion

The computation method of harmonic distortion can be selected from the following two. In the following explanation a maximum of 50 analysis orders is assumed. In case of a maximum less than 50, computation/display will be performed up to that order.

- iEC: Computes the ratio of the rms value of the 2nd to 50th order component to that of the fundamental (1st order).
- CSA: Computes the ratio of the rms value of the 2nd to 50th order component to that of the rms value of the 1st to 50th component.

Computation Equation

In case of iEC

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right] / C_1$$

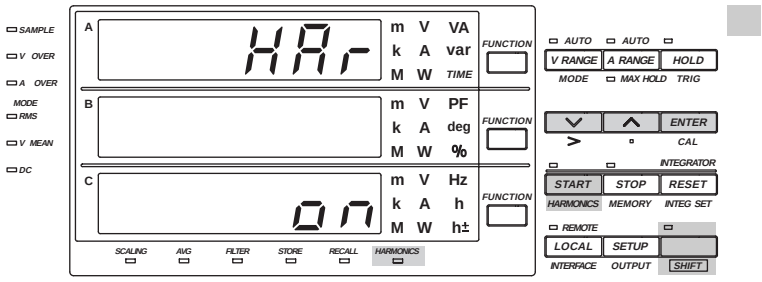
In case of CSA

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right] / \left[\sqrt{\sum_{k=1}^{n}(C_k)^2}\right]$$

C1: Fundamental component (1st order)
Ck: Fundamental or harmonic component
k: Analysis order
n: Maximum order. The maximum order depends on the fundamental frequency of the input set as the PLL source. For details, see chapter 16, “Specifications.”

7.3 Switching the Harmonic Analysis Function ON/OFF

Keys

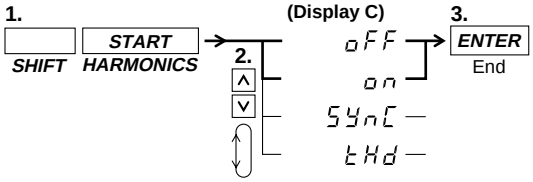


Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Turning the Harmonic Analysis Function ON/OFF



Explanation

Turning the Harmonic Analysis Function ON/OFF

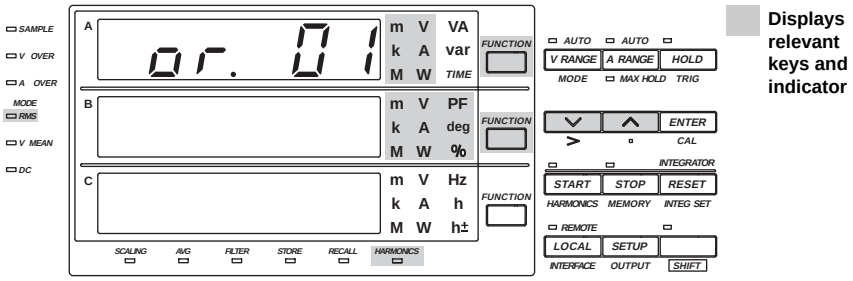
- on : Pressing the ENTER key after selecting on will result in starting of the harmonic analysis and the HARMONICS indicator will light up. The harmonic order will be displayed on display A.
- oFF: Pressing the ENTER key after selecing off will result in stopping of the harmonic analysis and the HARMONICS indicator will extinguish.

Note

- When the harmonic analysis function is turned ON, the measurement mode will automatically change to RMS mode. When the harmonic analysis function is turned OFF, the measurement mode will stay the RMS mode.
- When the harmonic analysis function is ON, integration cannot be started. And accordingly, when the integration is in progress, the harmonic analysis function cannot be started (see page 6-10).

7.4 Setting the Harmonic Order and Displaying the Results of Harmonic Analysis

Keys

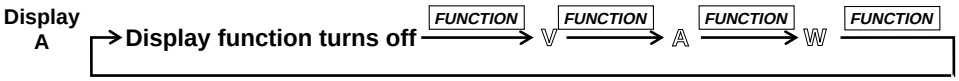


Procedure

The following operations assume that the harmonic analysis function is turned ON.

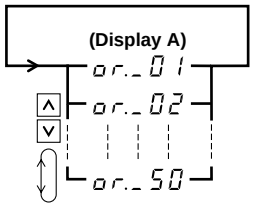
Setting the Harmonics Order

1. Turn off the display function indicator of display A.



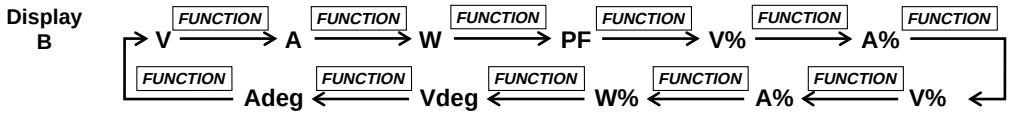
You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

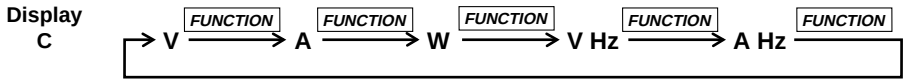
2. Set the harmonics order.



Displaying the Values of Harmonic Analysis

Displays each analysis value after having set the display function of either display B or C.





You can reverse the order by first pressing the SHIFT key followed by the FUNCTION key.

Explanation

Setting the Order of Harmonics

The maximum order for which analysis results can be displayed varies depending on the frequency of the fundamental.

Example

- When the fundamental frequency is 50 Hz, up to 50 orders can be displayed;
- When the fundamental frequency is 400 Hz, up to 30 orders can be displayed.

When an order is set exceeding the maximum order, display B will change to the dot display. For details related to the upper limit of the order of analysis, see chapter 16, "Specifications."

Displaying the Results of Harmonic Analysis

Depending on the setting of display function of display B and C, the analyzed items will appear on the display as follows. In the following explanation a maximum of 50 analysis orders is assumed. In case of a maximum less than 50, computation/display will be performed up to that order.

Display B

- V: Shows the analysis value of the voltage corresponding to the order shown on display A;
- A: Shows the analysis value of the current corresponding to the order shown on display A;
- W: Shows the analysis value of the active power corresponding to the order shown on display A;
- PF: Shows the power factor of the fundamental (1st order);
- V%: Shows the harmonic distortion of the voltage followed by the character "t"; Two computation methods are available; See section 7.2 for details. The display range is 0.00 to 99.99 and 100.0 to 999.9%.
- A%: Shows the harmonic distortion of the current followed by the character "t"; Two computation methods are available; See section 7.2 for details. The display range is 0.00 to 99.99 and 100.0 to 999.9%.
- V%: Shows the relative harmonic content of the voltage corresponding to the order shown on display A; The display range is 0.00 to 99.99 and 100.0 to 999.9%.
- A%: Shows the relative harmonic content of the current corresponding to the order shown on display A; The display range is 0.00 to 99.99 and 100.0 to 999.9%.
- W%: Shows the relative harmonic content of the active power corresponding to the order shown on display A; The display range is 0.00 to ±99.99 and ±100.0 to ±999.9%.
- V deg: When the fundamental (1st order) is shown on display A
  Shows the phase angle between the 1st order of the current and the 1st order of the voltage. G (phase lag) or d (phase lead) will also be displayed.
  When the 2nd to 50th order is shown on display A
  Shows the phase angle between the 1st order of the voltage and the 2nd to 50th order of each voltage. A – (minus) will be displayed in front of the order only when the 2nd to 50th order is phase-lagged. The display range is –180.0 to 180.0 deg.
- A deg: When the fundamental (1st order) is shown on display A
  Shows the same as in case of V deg.
  When the 2nd to 50th order is shown on display A
  Shows the phase angle between the 1st order of the current and the 2nd to 50th order of each current. A – (minus) will be displayed in front of the order only when the 2nd to 50th order is phase-lagged. The display range is –180.0 to 180.0 deg.

Display C

V: Shows each rms (computed) value of the 1st to 50th harmonic component of the voltage;

A: Shows each rms (computed) value of the 1st to 50th harmonic component of the current;

W: Shows each rms (computed) value of the 1st to 50th harmonic component of the active power;

Computation Equation

$$V=\sqrt{\sum_{k=1}^{n}(V_k)^2}$$

$$A=\sqrt{\sum_{k=1}^{n}(A_k)^2}$$

$$W=\sum_{k=1}^{n}W_k$$

Vk, Ak, Wk: Each component of 1st to 50th order of voltage, current and active power;

k: Analysis order

n: Maximum order. The maximum order depends on the fundamental frequency of the input set as the PLL source. For details, see chapter 16, “Specifications.”

V Hz: Shows the fundamental frequency of the voltage of the PLL source. This frequency applies only to the element selected as PLL source. For details regarding the PLL source setting, see section 7.2. The measurement range is the same as in case of normal measurement.
The range of fundamental frequencies in case of harmonic analysis is 40 to 440 Hz. However, depending on internal timing, there are cases where measurements in the 20 to 700 Hz range can be performed.

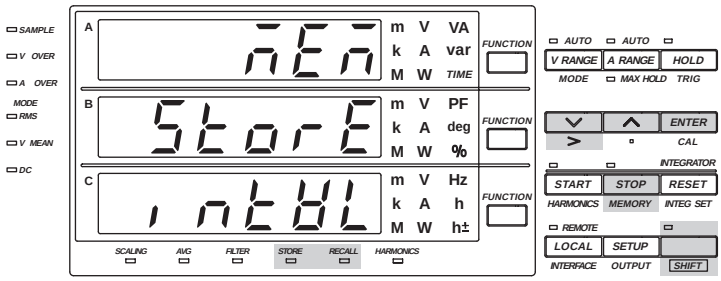
A Hz: Shows the fundamental frequency of the current of the PLL source. The rest is the same as in case of V Hz.

Note

- A bar display appears if you select a display function that is not being analyzed or measured.
- When pressing the FUNCTION key on display A, and the display function becomes V, A or W, then display A will show the same analysis items as the V, A or W shown on display C.
- Characteristics such as maximum reading, display range, units, etc. which are not described on the previous page, are not different from the characteristics of normal measurement.

8.1 Storing/Recalling Measured Data

Keys

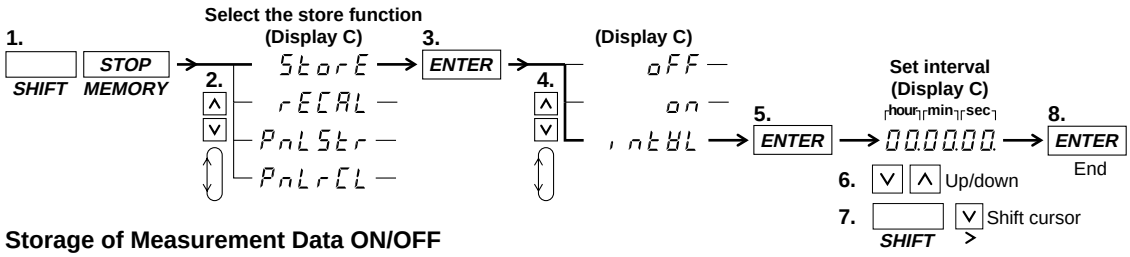


Displays relevant keys and indicator

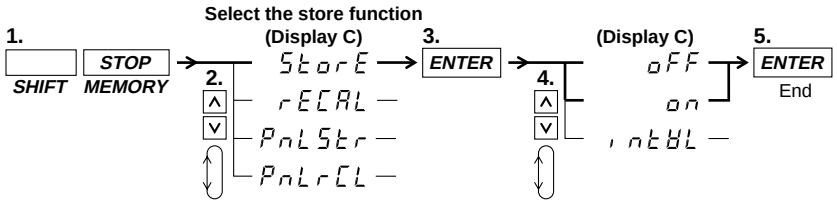
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

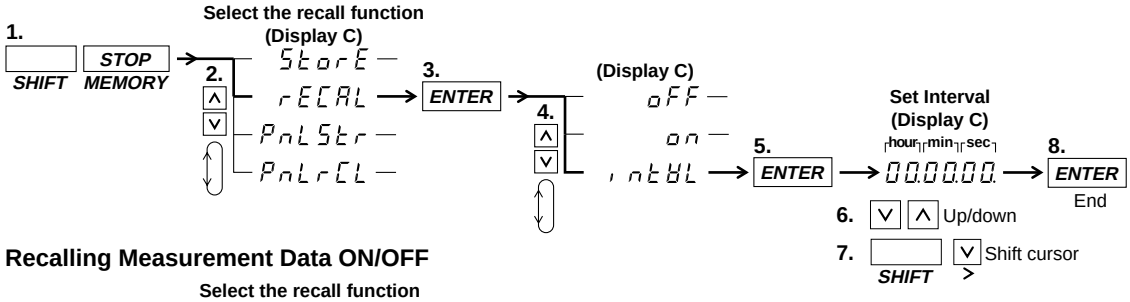
• Setting the Storage Interval for Measurement Data



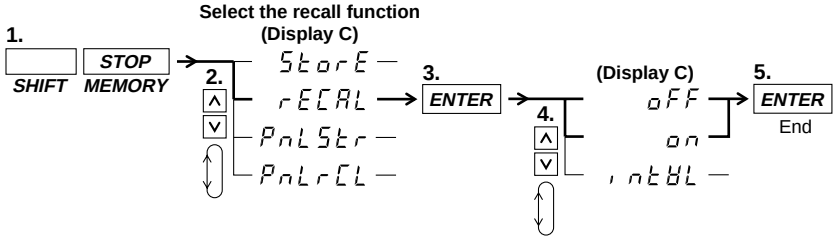
• Storage of Measurement Data ON/OFF



• Setting the Recall Interval for Measurement Data



• Recalling Measurement Data ON/OFF



Explanation

Storing Measured Data (Storing into Internal Memory)

The number of blocks which can be stored into the internal memory is as follows.

During Normal Measurement	During Harmonic Analysis
600 blocks	30 blocks

Items which can be stored

All the data that are obtained while the display is updated once are stored as one block of data. The data number increases by the number of used input elements and therefore the number of blocks that can be stored depends on the model as described above.

- When storing normal measured data (harmonic analysis function is turned OFF)
  Each measured/integrated data of normal measurement will be stored.
  However, only either the voltage frequency or current frequency will be stored *.
  * When either the V Hz or A Hz display function is lit, the frequency of that function will be stored. When neither is lit, the frequency of the latest lit display function will be stored. Regarding the element, the frequency of the latest set element will be stored.
- When storing harmonic analysis data (harmonic analysis function is turned ON)
  Normal measurement data are not stored. All analyzed data are stored.

Aborting Storage

- When all the above described blocks are full;
- When during the storage process “oFF” is selected at the store ON/OFF setting.

Setting the Storage Interval

Sets the time during which storage will be carried out.

- When storing normal measured data (harmonic analysis function is turned OFF)
  - Setting range: 00.00.00 (0 hrs, 0 min, 0 sec) to 99.59.59 (99 hrs, 59 min, 59 sec)
  - Initial value: 00.00.00
    When the setting is 00.00.00, the interval will become 250 ms.
- When storing harmonic analysis data (harmonic analysis function is turned ON)
  - Setting range: 00.00.00 (0 hrs, 0 min, 0 sec) to 99.59.59 (99 hrs, 59 min, 59 sec)
  - Initial value: 00.00.00
    When the setting ranges from 00.00.00 to 00.00.03, the interval will become 3s; from 00.00.04 to 00.00.06, the interval will become 6 s; from 00.00.07 to 00.00.09, the interval will become 9 s; in other cases, the set interval will be valid.

Note

The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output, output to external plotter and printer, and communication output are also set to the maximum values (MAX) that are held. The measured data that are stored are values that are measured at every display update rate, irrespective of the MAX hold function.

Storage ON/OFF

After having set the storage interval, select the store menu once again. The initial value is oFF.

- on: Storing will start by pressing the ENTER key after selecting “on”; the STORE indicator will light while storage is in progress.
- oFF: Storing will stop by pressing the ENTER key after selecting “oFF”; the STORE indicator will extinguish.

Note

- After storing has been stopped and storing is restarted, the existing data in the memory will be overwritten. Previous data will therefore be lost.
- Stored data will be kept even after the power has been turned OFF because of the internal lithium battery.
- When integrated values are not present, the dot display will be stored as data, whereas 0.00.00 will be stored as integration preset time.
- When the fundamental frequency is high and up to 50 windows of harmonic analysis data are not present, the dot display will be stored as data.
- While storage is in progress, several settings cannot be changed, such as switching the harmonic analysis function ON/OFF, changing the related input element, the PLL source, the harmonic distortion factor computation method, nor can scaling, averaging and filter settings be changed, nor integration mode, integration time and storage interval.
- If you press the HOLD key while storing data, the measurement operation and the counting operation of the store interval are suspended. The storage operation itself is also suspended. However, if integration is in progress, measurement and integration continues internally.

Recalling Measured Data (Retrieving Data from the Internal Memory)

After displaying data stored in the internal memory on the panel, you can use all display functions and carry out integration and display these data. Furthermore, by using the communication function, data can be output.

Items which can be recalled

all data which can be stored.

Aborting Recalling

when all stored data are retrieved;

when during the recall process “oFF” is selected at the store ON/OFF setting.

Setting the Recalling Interval

Sets the time during which recalling will be carried out.

Setting range: 00.00.00 (0 hrs, 0 min, 0 sec) to 99.59.59 (99 hrs, 59 min, 59 sec)

Initial value: 00.00.00

When recalling normal measured data, the interval will become 250 ms when the setting is 00.00.00.

When recalling harmonic analysis data, the interval will become 1s when the setting is 00.00.00.

Recalling ON/OFF

After having set the recalling interval, select the recall menu once again. The initial value is oFF.

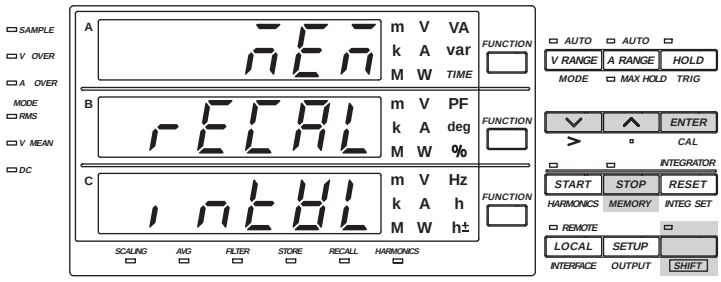
- on: Recalling will start by pressing the ENTER key after selecting “on”; the RECALL indicator will light while recalling is in progress.
- oFF: Recalling will stop by pressing the ENTER key after selecting “oFF”; the RECALL indicator will extinguish

Note

- During recalling, the measurement conditions and range* will become as those of the data being recalled. After recalling finishes, the original measurement conditions will return.
  * Measurement range, measurement mode, filter ON/OFF, scaling ON/OFF, scaling constants, averaging ON/OFF, averaging mode, averaging constants, integration mode, integration type, integration time, harmonic analysis function ON/OFF, PLL source, computation method of harmonic distortion factor, etc.
- When recalling data to a personal computer by communication interface, data might be cut due to the data length or used personal computer. In such a case, increase the recalling interval.

8.2 Storing/Recalling Setting Parameters

Keys

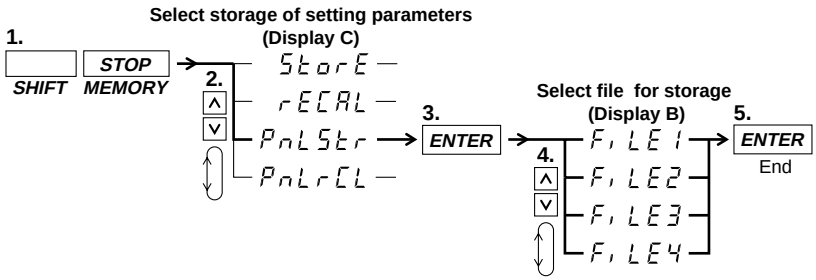


Displays relevant keys and indicator

Procedure

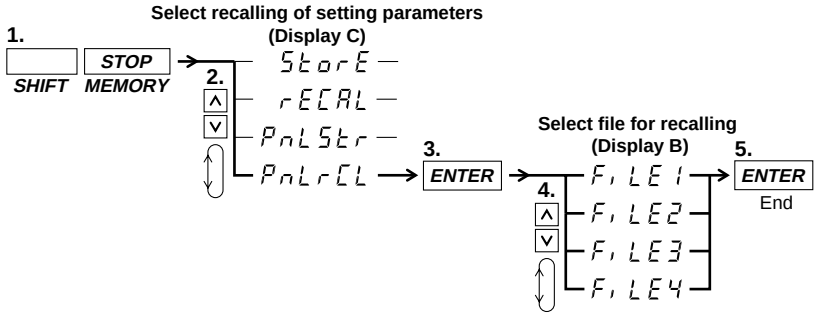
- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Storing Setting Parameters



When setting parameters are stored to a file, display C will show "SAVEd"
When no data are stored yet, display C will show "FrEE"

• Recalling Setting Parameters



When setting parameters are stored to a file, display C will show "SAVEd"
When no data are stored yet, display C will show "FrEE"

Explanation

Storing Setting Parameters

Stores the current setting parameters which consist of the following. Four destinations (FiLE1/FilE2/FiLE3/FiLE4) are available.

Measurement range, measurement mode, scaling settings, averaging settings, filter settings, integration settings, harmonic settings, plotter output settings, store/recall settings, and communication settings.

When data are saved in a file and you want to save data in the same file, display C will show “SAVEd”. Pressing the ENTER key will result in overwriting the previously saved data.

Setting parameters are saved in another internal memory than measured data.

Saved setting parameters are backed up by the lithium battery in the same way as measured data.

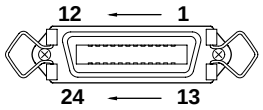
Recalling Setting Parameters

When setting parameters are being retrieved, all setting parameters are being set accordingly. After that, measurements can be carried out.

9.1 Remote Control and D/A Output Connector (optional)

Using the remote control and the D/A output connector, this instrument can be remotely controlled and D/A output can be done. The connector's pin sequence and signal assignment is as follows.

Connector's Pin Sequence



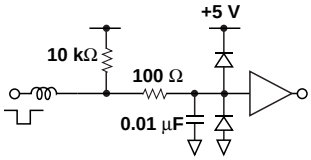
(Rear panel)

Pin Assignment

remote control, 4 channel D/A output

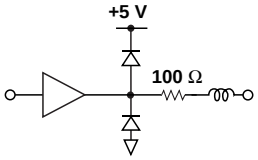
Pin No.	Signal	Pin No.	Signal
1	DIGITAL COM	13	DIGITAL COM
2	$\overline{\text{EXT HOLD}}$ (Input)	14	$\overline{\text{EXT TRIG}}$ (Input)
3	$\overline{\text{EXT START}}$ (Input)	15	$\overline{\text{EXT STOP}}$ (Input)
4	$\overline{\text{EXT RESET}}$ (Input)	16	$\overline{\text{INTEG BUSY}}$ (Output)
5	No Connection	17	No Connection
6	No Connection	18	No Connection
7	No Connection	19	No Connection
8	No Connection	20	No Connection
9	No Connection	21	No Connection
10	DA 3ch (Output)	22	DA 4ch (Output)
11	DA 1ch (Output)	23	DA 2ch (Output)
12	DA COM	24	DA COM

Remote control: input circuit



TTL level
L: 0 to 0.8 V
H: 2.0 to 5 V

Remote control: output circuit



TTL level
L: 0 to 0.4 V(8 mA)
H: 2.4 to 5 V(–400 μA)

WARNING

The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:

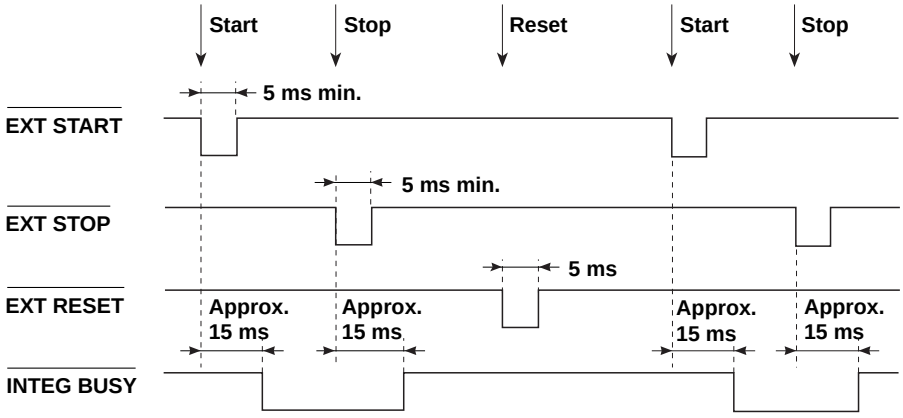
Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
Voltage across V terminal and ground 600 Vrms max.

Put the protective cover on the connector when this function is not used.

9.2 Remote Control (optional)

Controlling Integration

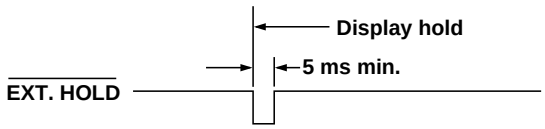
To control integration, apply timing signals according to the timing chart below.



As shown in the timing chart, the **INTEG BUSY** output signal level goes low while integration is in progress. The signal can be used to monitor integration, etc.

Holding Display Data Update (same function as HOLD key)

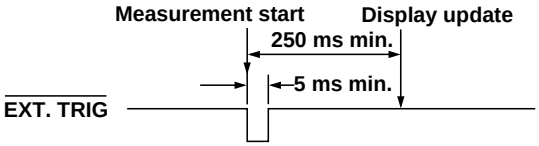
To hold the display update, apply the **EXT. HOLD** signal according to the timing chart below.



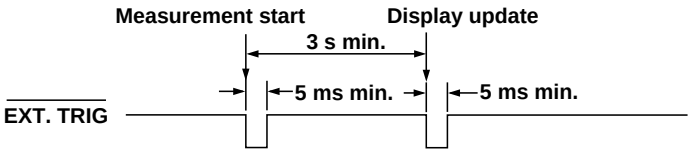
Updating Display Data which has been held (same function as TRIG key)

Applying an **EXT.TRIG** signal when the display is on hold updates the display data.

·**Update timing during normal measurement/integration**



·**Update timing while harmonic analysis function is in progress**

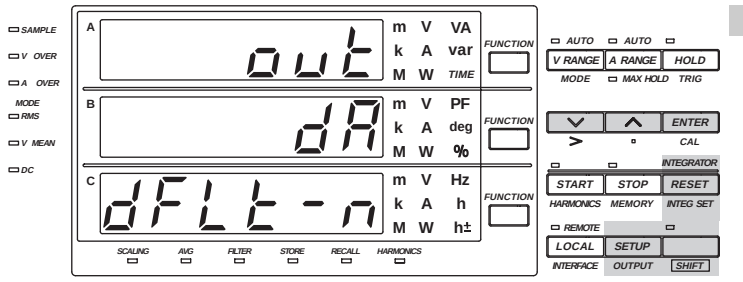


CAUTION

Do not apply a voltage which exceeds the TTL level to the remote controller pin. Also, do not short the output pins nor apply a voltage to them. The instrument might be damaged.

9.3 D/A Output (optional)

Keys

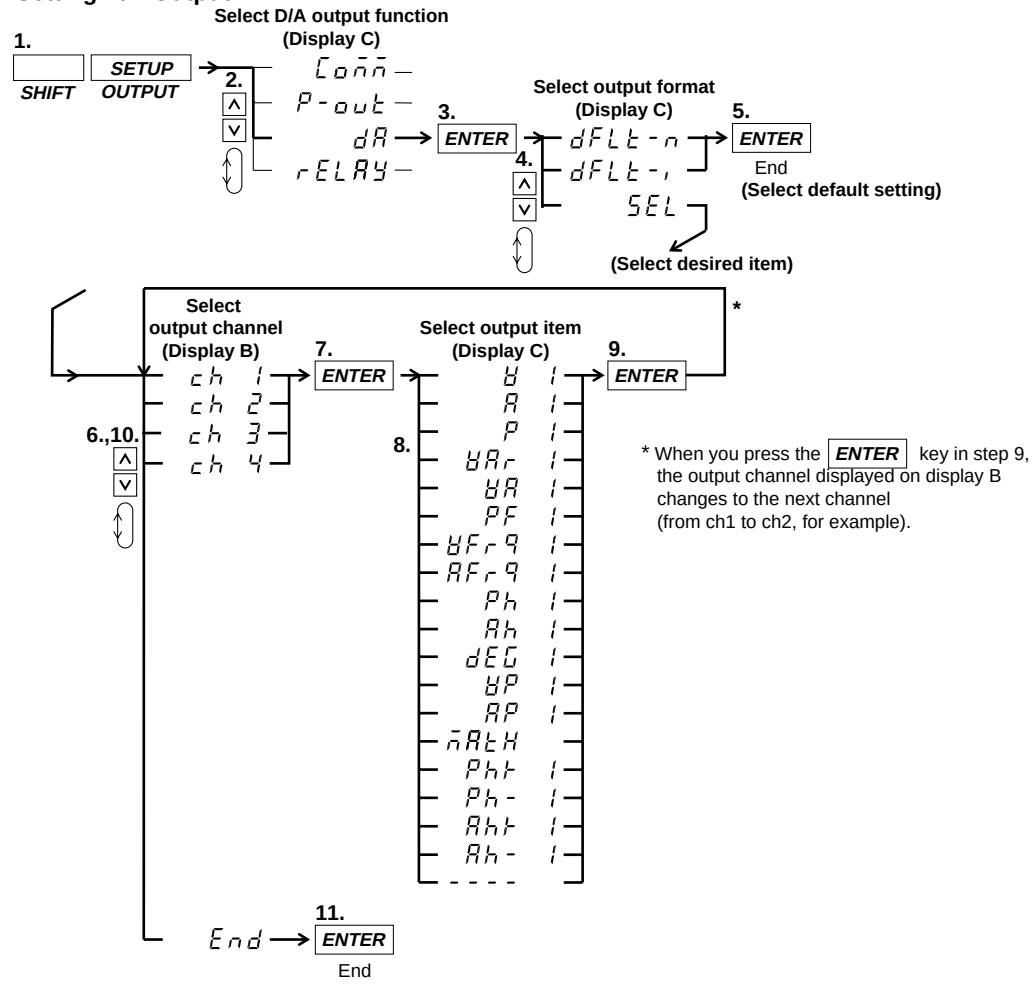


Displays relevant keys and indicator

Procedure

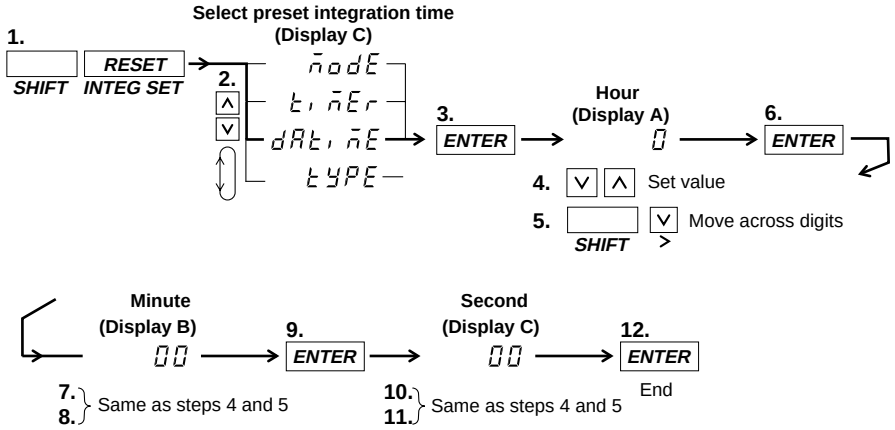
- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting D/A Output



* When you press the **ENTER** key in step 9, the output channel displayed on display B changes to the next channel (from ch1 to ch2, for example).

• Setting Preset Integration Time



Explanation

D/A Output

Voltage, current, active power, apparent power, reactive power, power factor, phase angle, harmonic analysis data and integrated data values will be output as a 5V FS analog voltage.

Default Setting of the Output Format

The default items which will be output can be selected as follows.

- **dFLt-n (normal measurement values are set as default)**
  Select this when you want to output normal measurement values. Which items are output to which channel is described below.

Output Channel	Output Item
ch1	V
ch2	A
ch3	W
ch4	Hz*

* If either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.

- **dFLt-i (integration measurement values are set as default)**
  Select this when you want to output integration measurement values. Which items are output to which channel is described below.

Output Channel	Output Item
ch1	W
ch2	Wh
ch3	Ah
ch4	Hz*

* If either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.

Selecting the Desired Item of the Output Format

The items to be output are set per each output channel.

- **Setting the output channel**
  The number of channels is 4. You can select the channel that will output each item.
- **Setting the output item (corresponds to column A in the procedure)**
  The output item can be set to any of the following.
  V (voltage), A (current), P (active power), VAr (reactive power), VA (apparent power), PF (power factor), VFrq (voltage frequency)*1, AFrq (current frequency)*1, Ph (total Watt-hour Wh), Ah (total Ampere-hour), dEG (phase angle), VP(peak value of voltage), AP(peak value of current), MATH(computation), Ph+ (positive watt hour value Wh+), Ph– (negative watt hour value Wh–), Ah+ (positive ampere hour value*2), Ah– (negative ampere hour value*2),
  – – – – (D/A output 0 V; no further elements can be set)

*1 If either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.

*2 For details concerning the positive value of the ampere hour, see page 6-3.

Setting the Integration Preset Time

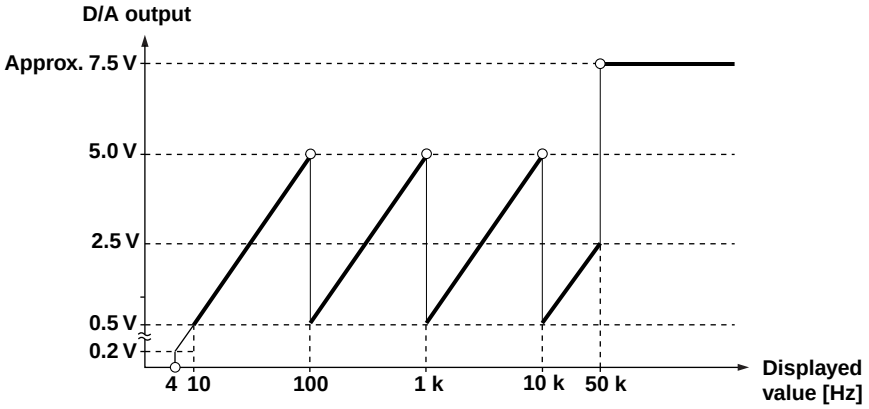
The D/A output of integrated values will be 5.0 V FS when the rated range has been input consequently during the preset integration time (rated integration time).
Setting range: 0.00.00 (0 hrs 0 min 0 sec) to 10000.00.00 (10000 hrs 0 min 0 sec)
The initial value is 1.00. When 0.00.00 is set, the D/A output value will be 0 V.

Note

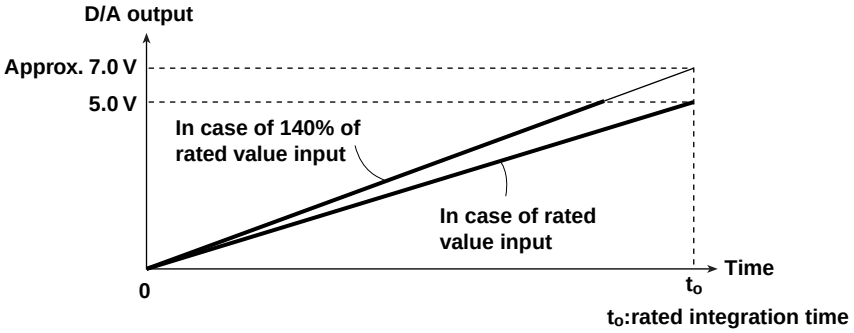
- The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be the maximum values (MAX) that are held. The values for D/A output are also set to the maximum values (MAX) that are held.
- The D/A output of each output item is adjusted so that 5.0 V is output when the value corresponding to the range rating of the voltage, current, or power is applied.
- Even when scaling constants for voltage, current, and power are specified, the D/A output is adjusted so that 5.0 V is output when the value corresponding to the range rating is applied.
- When MAtH (computation) is specified, the D/A output is 0 V.

Relation between the output item and the D/A output voltage

- **Frequency**

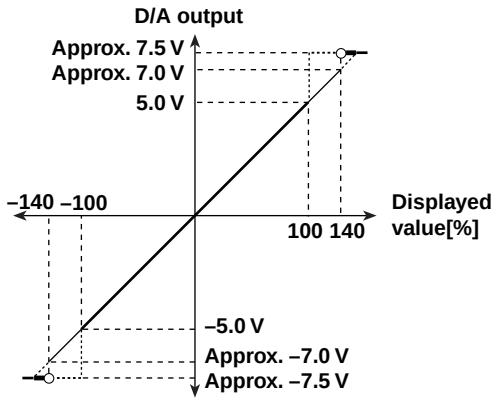


- **Integrated value**



- **Other items**

Displayed value	Output
140%	Approx. 7.0 V
100%	5.0 V
0%	0 V
–100%	–5.0 V
–140%	Approx. –7.0 V



However, for PF and deg, points in the range from +5 to +7 V and from –5 to –7 V are not output.
If there is an error, the output will be about ±7.5 V.
For Vp and Ap, the output will be ±5 V when the value is three times the range rating. In addition, output will not be ±7.5 V when Vp and Ap are over the range.

9.4 Comparator Function (optional)

When the instrument is equipped with option /CMP you can compare the measured, computed, integrated, and analysis values with previously set limits and these results can be output by contact relay.

Contact Relay Output

This instrument is equipped with four contact relays (4ch) as follows. If the relay is not operating, the NC (Normally Closed) contact is closed. If the relay is operating, the NC contact is opened and the NO (Normally Open) contact is closed.

Relay specifications

- Contact capacity: rated 24 V/0.5 A (max. 30 V/0.5 A)
- Minimum load: 10 mV/10 μA
- Electric switching life: approx. 500000 times (at contact rating)
- Mechanical life: approx. one hundred million times
- Contact Response time: less than 500 ms

Note

Since this relay is subject to wear, it is excluded from the 3-year warranty.

CAUTION

Damage to the relays may occur when a voltage or current exceeding the specified range is applied to the contact output terminal.

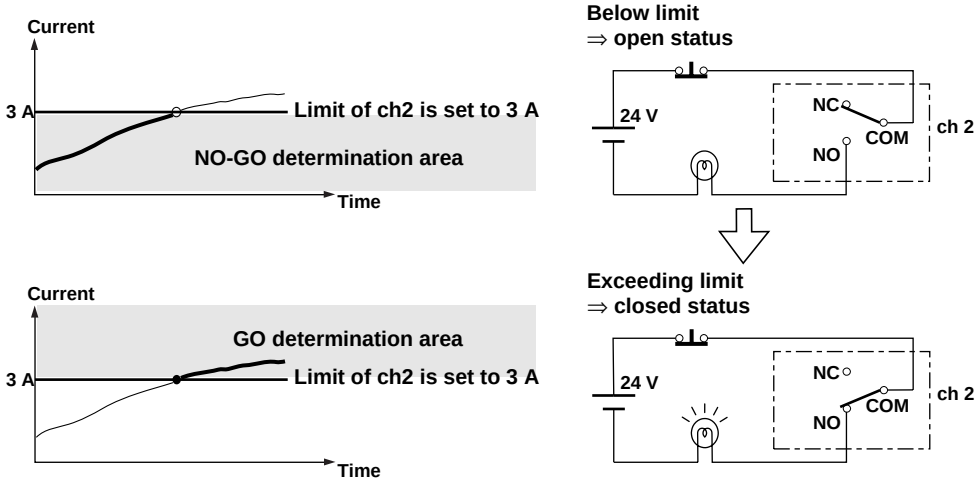
Comparator Mode

The following two comparator modes are available.

Single Mode

If the measured/computed/integrated/analysis values exceed the previously set limits, the relay contact will become NO. This mode is useful when you want to assign each of the four relays individually. See the figure below.

When the current value is less than 3 A: NO-GO will be determined and the circuit becomes open.
When the current value is 3 A or more: GO will be determined and the circuit becomes closed.

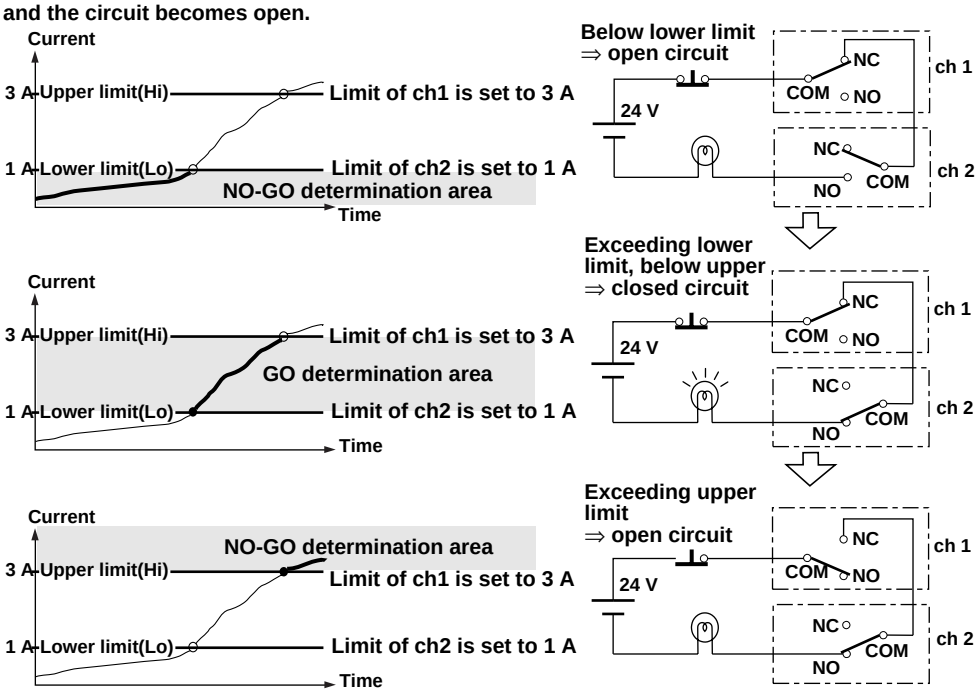


Dual Mode

This mode allows you to combine the limit values of two relays (e.g. the upper value (Hi) and the lower value (Lo)) to determine the contact status. The four relays will be fixed as two pairs of ch1 & ch2 and ch3 & ch4. Setting the limit values of a pair of relays (e.g. ch1 & ch2) can only be done at the same display function. The setting method, relay operation, etc. are the same as in the single mode, and when the measured/computed/integrated/analysis values exceed the preset limits, the contact status will become NO.

The following shows an example.

When the current value exceeds 1 A, but is less then 3 A: GO will be ditermined and the circuit becomes closed.
When the current value lies below 1 A, or exceeds3 A:NO-GO will be determined and the circuit becomes open.



Note

- In the dual mode, the combinations ch1&ch2, and ch3&ch4 are fixed. The combinations ch1&ch3 and ch2&ch4 are not possible.
- Within a pair you can set either channel as upper or lower limit.
- The values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be displayed according to the maximum values (MAX) that are held. The values that are compared against the limit values are also the maximum values (MAX) that are held.

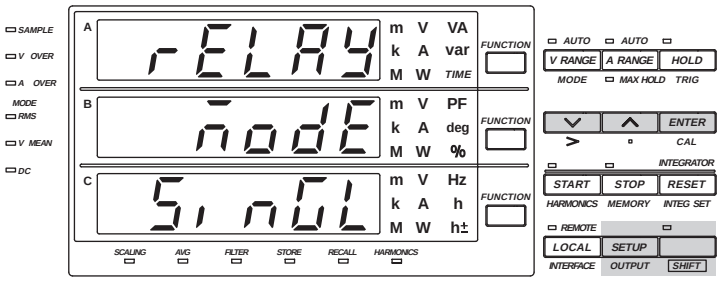
CAUTION

Make sure not to greatly vary the input signal when using the comparator function. Depending on the input signal used for determination, the instrument may display error codes (i.e. overrange) and this will change the output relays as follows. When using the output relay as a control signal, make sure to match these control signals with other equipments to eliminate erroneuous control.

Displayed error	Relay status
oL (over range)	The NC contact is closed.
oF (over flow)	The NC contact is closed.
dEGEr (phase angle error)	The NC contact is closed.
PFErr (power factor error)	The NC contact is closed.
ErrLo (frequency error)	The NC contact is closed.
ErrHi (frequency error)	The NO contact is closed for this case only.
FrqEr (frequency error in case of harmonic analysis)	The NC contact is closed.
- - - - - (error when no data are present)	The NC contact is closed.

9.5 Setting the Comparator Mode (optional)

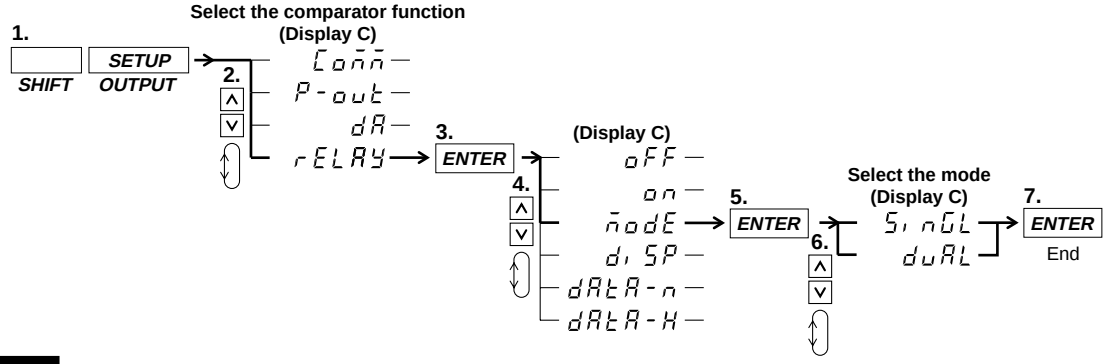
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Setting the Comparator Mode

The following two settings are available. For details related to the mode, see section 9.4. The initial value is SinGL.

- SinGL: the comparator mode will be set to single mode;
- duAL: the comparator mode will be set to dual mode.

Note

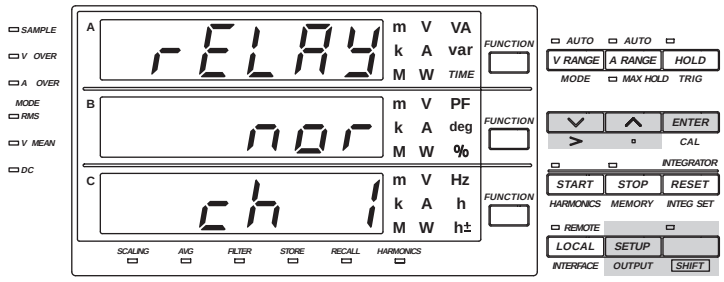
- When you change the comparator mode after having set the comparator limit (See section 9.6 and the following sections), the situation will change as follows. Also verify the comparator limits again.
- When you change the mode to dual mode after setting the limits in the single mode, the limit item (see section 9.6) for ch2 and ch4 are set to those for ch1 and ch3, respectively. When the mode is set back to the single mode, the limit item of each channel returns to its original value.

CAUTION

Do not change the comparator mode, measurement mode or harmonic analysis ON/OFF, while the comparator function is turned ON (see section 9.8). Similar to the Note above, changing the limit item might result in unexpected statuses of the output relay.

9.6 Setting the Comparator Limit Values (optional)

Keys

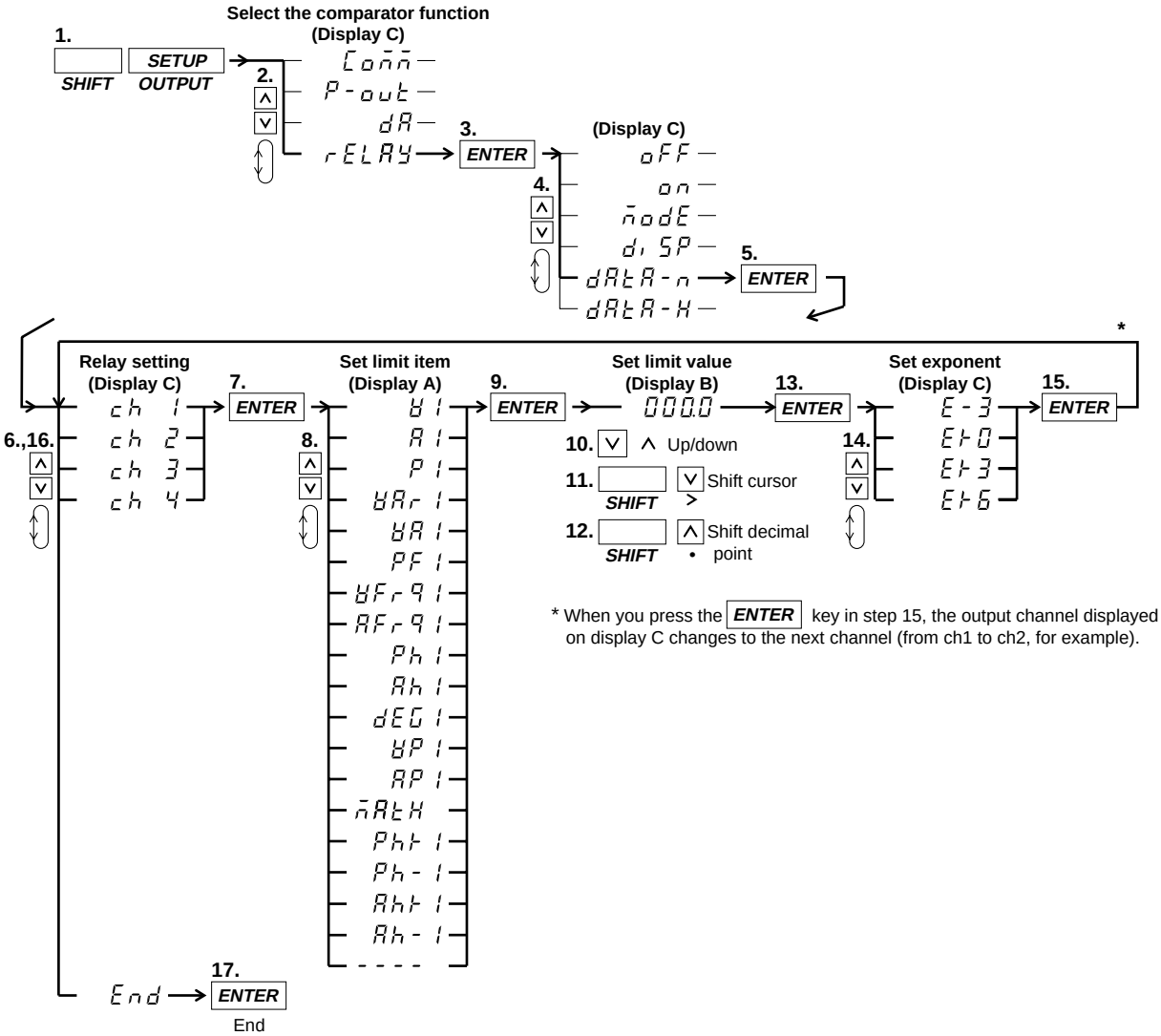


Displays relevant keys and indicator

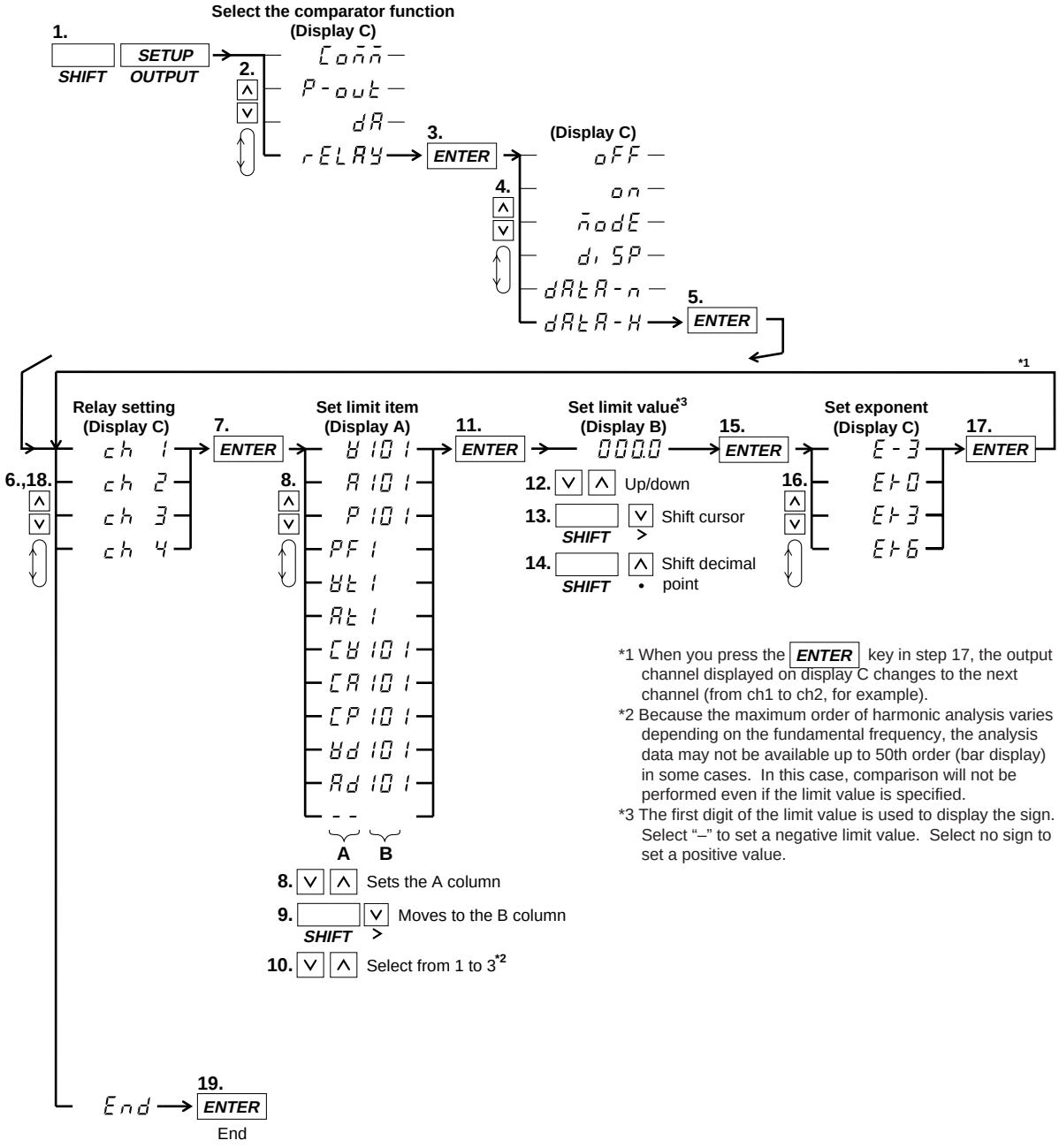
Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting the Comparator Limit Values in case of Normal Measurement



• Setting the Comparator Limit Values in case of Harmonic Anaiysis



*1 When you press the **ENTER** key in step 17, the output channel displayed on display C changes to the next channel (from ch1 to ch2, for example).

*2 Because the maximum order of harmonic analysis varies depending on the fundamental frequency, the analysis data may not be available up to 50th order (bar display) in some cases. In this case, comparison will not be performed even if the limit value is specified.

*3 The first digit of the limit value is used to display the sign. Select "–" to set a negative limit value. Select no sign to set a positive value.

Explanation

Setting the Comparator Limit Values in case of Normal Measurement

You can set the type of the limit and its value for each relay seperately.

- **Relay setting**
  Selects the relay (ch1 to ch4) for which the limit item and its value will be set.
- **Setting the limit item**
  The following sections are available. When the comparator mode is dual, ch1&ch2 and ch3&ch4 are pairs and the same limit item should be set for the channels of one pair.
  V (voltage), A (current), P (active power), VAr (reactive power), VA (apparent power), PF (power factor), VFrq (voltage frequency)*1, AFrq (current frequency)*1, Ph (total Watt-hour Wh), Ah (total Ampere-hour), dEG (phase angle), VP(peak value of voltage), AP(peak value of current), MATH(computation), Ph+ (positive watt hour value Wh+), Ph– (negative watt hour value Wh–), Ah+ (positive ampere hour value*2), Ah– (negative ampere hour value*2),
  – – – – (no data)
  *1 If either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.
  *2 For details related to the positive and negative directions of the ampere hour, see page 6-3.
- **Setting the limit value**
  Setting range: 0.000 to ±9999
  Initial setting: The limit item: limit value: exponent of the limit value (see next section) are initialized for each channel.
  ch1 : V1 : 600.0 : E+0 (set 600 V of voltage to ch1)
  ch2 : A1 : 20.00 : E+0 (set 20.00 A of current to ch2)
  ch3 : P1 : 1.200 : E+3 (set 1.2 kW of active power to ch3)
  ch4 : PF1 : 1.000 : E+0 (set a power factor of 1 to ch4)
- **Setting the exponent**
  The following selections are available. The initial value is as described above.
  E–3 (10^{-3}), E+0 (10^{0}), E+3 (10^{3}), E+6 (10^{6})

Setting the Comparator Limit Values in case of Harmonic Analysis

You can set the type of the limit and its value for each relay seperately.

- **Relay setting**
  Selects the relay (ch1 to ch4) for which the limit item and its value will be set.
- **Setting the limit item(corresponding to column A in the procedure)**
  The following selections are available. When the comparator mode is dual, ch1&ch2 and ch3&ch4 are pairs and the same limit item should be set for the channels of one pair.
  V (voltage), A (current), P (active power), PF (power factor),
  Vt (harmonic distortion of voltage), At (harmonic distortion of current),
  CV (relative harmonic content of each voltage harmonic order),
  CA (relative harmonic content of each current harmonic order),
  CP (relative harmonic content of each active power harmonic order),
  Vd (voltage phase angle of each order), Ad (current phase angle of each order),
  – – – – (no data)
  * For the meanings of the harmonic analysis values, see chapter 7, “Using the Harmonic Analysis Function (Optional).”

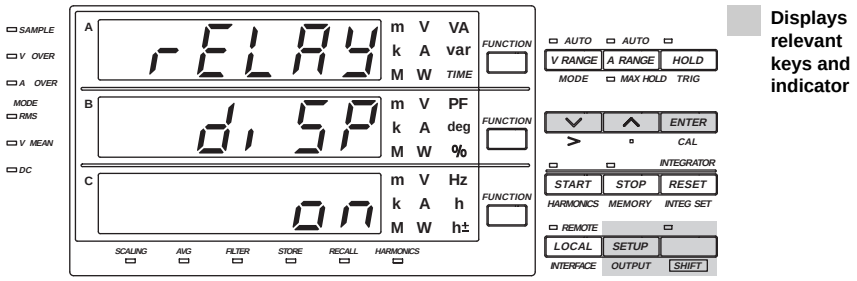
- **Setting the harmonic order (corresponds to column B in the procedure)**
  Setting range: 01 to 50
  Initial value: see the following.
  The maximum order of harmonic analysis data varies by the fundamental frequency. Therefore, there might be cases where no analysis data are present up to the 50th order (and the display will show bars). In such a case, even if you set an harmonic order, determination will not be carried out. Therefore, before setting, verify the maximum order (chapter 16 “Specifications”) and the fundamental frequency of the object of measurement.
- **Setting the limit value**
  Setting range: 0.000 to ±9999
  Initial setting: The limit item: analysis order: limit value: exponent of the limit value (see next section) are initialized for each channel.
  ch1 : V1 : 01 : 600.0 : E+0 (set 600 V of voltage of the fundamental component to ch1)
  ch2 : A1 : 01 : 20.00 : E+0 (set 20.00 A of current of the fundamental component to ch2)
  ch3 : P1 : 01 : 1.200 : E+3 (set 1.2 kW of active power of the fundamental component to ch3)
  ch4 : PF1 : 01 : 1.000 : E+0 (set a power factor of 1 of the fundamental component to ch4)
- **Setting the exponent**
  The following selections are available. The initial value is as described above.
  E–3 (10^{-3}), E+0 (10^{0}), E+3 (10^{3}), E+6 (10^{6})

Note

- The values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled will be displayed, according to the maximum values (MAX) that are held. The values that are compared against the limit values are also the maximum values (MAX) that are held.
- When you use limit values based on harmonic analysis data, make sure to set the harmonic analysis function to ON (see section 9.8) before you set the comparator function ON .
- Although the four relays used in case of normal measurement and in case of harmonic analysis are the same, the contents of the settings will be kept for both seperately. For example, even after setting a limit for ch1 in case of harmonic analysis after previously having set a limit for ch1 in case of normal measurement, will result in keeping both values.
- The determination method does not change as a result of – (minus) limit values. For example, if a limit of –1 is set, the relay will not be activated when the input signal value reaches –2 coming from an even lower value, but will be activated when the input signal value becomes 0.
- Make sure to set the polarity of the phase angle as well, + for phase lead (and can be ignored), – for phase lag.

9.7 Comparator Display (optional)

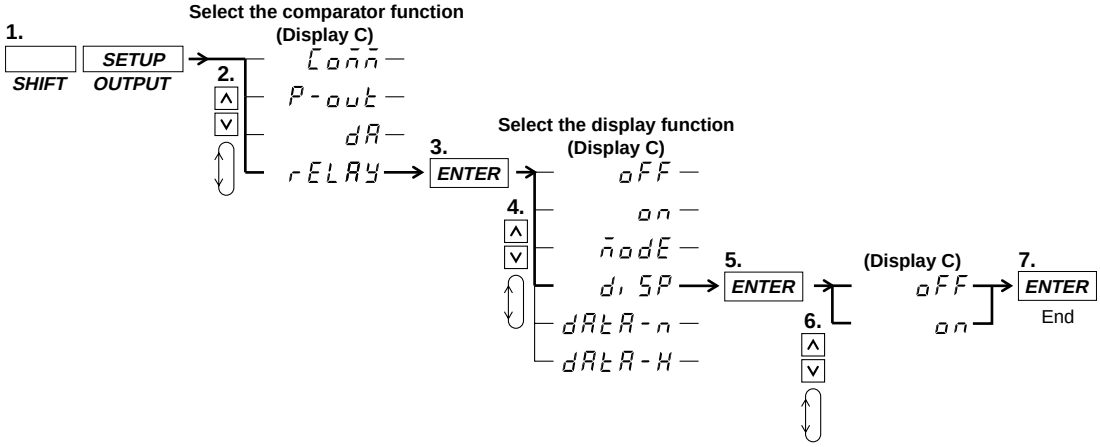
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

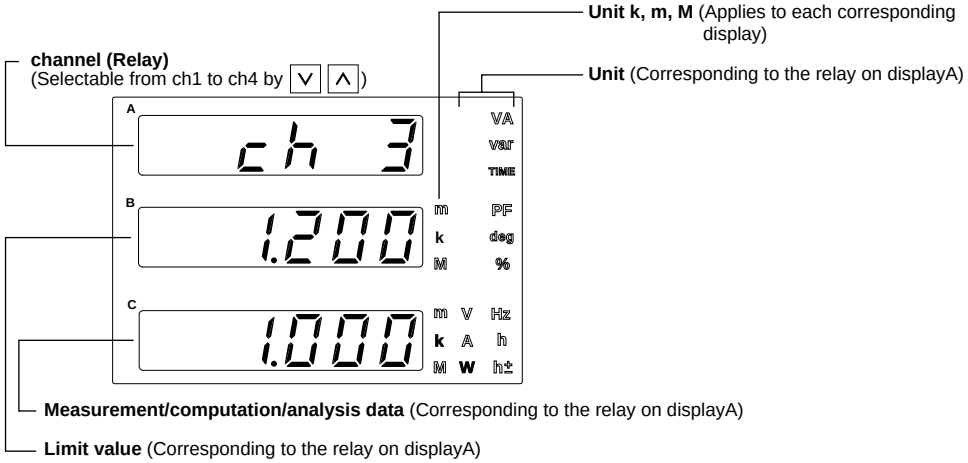


Explanation

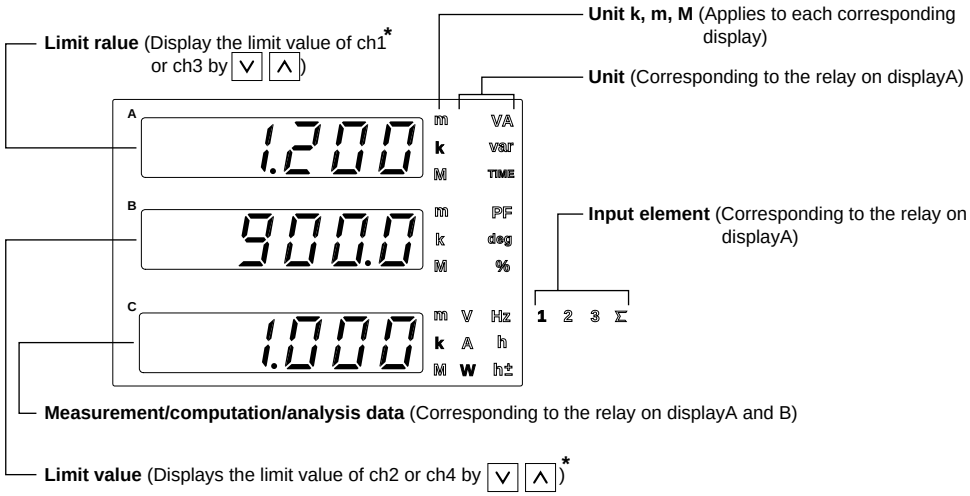
Comparator Display Function

This function allows you to verify the set limits together with measurement/computation/ analysis data on the display when using the comparator function. The display is as follows, depending on whether the comparator function is set to single or dual mode.

- **Display in case the comparator function is set to single mode**



- **Display in case the comparator function is set to dual mode**



* The limit values on display A and B will show the pairs of ch1&ch2 and ch3&ch4 alternately by pressing the ∨ ∧ keys.

Comparator Display Function ON/OFF

This setting allows you to turn the above described display function ON or OFF.

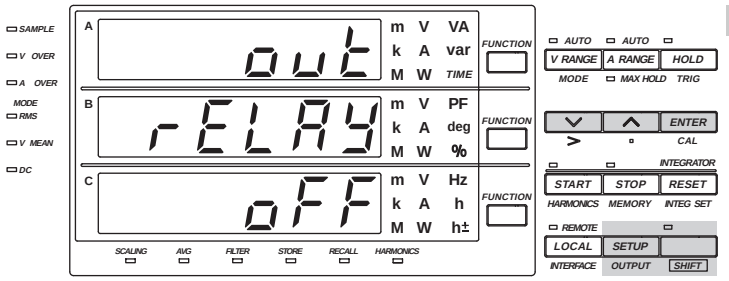
- oN: The comparator display will appear by pressing the ENTER key after selecting “on”;
- oFF: The normal measurement or harmonic analysis display will appear by pressing the ENTER key after selecting “oFF”.

Note

- Pressing the FUNCTION or ELEMENT key will result in an error. Other keys can be operated.
- The values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak), while the MAX hold function (see section 4.8) is enabled, will be displayed according to the maximum values (MAX) that are held. The values that are compared against the limit values are also the maximum values (MAX) that are held.
- Determination is done by internal data of the input signal, and not by displayed data. For example, when the limit is set to 10.00 and the internal data of the input signal coming from a lower value reaches 9.999, the relay will not be activated. Only when the internal data reaches a value of 10.000, the relay will be activated.

9.8 Turning the Comparator Function ON/OFF (optional)

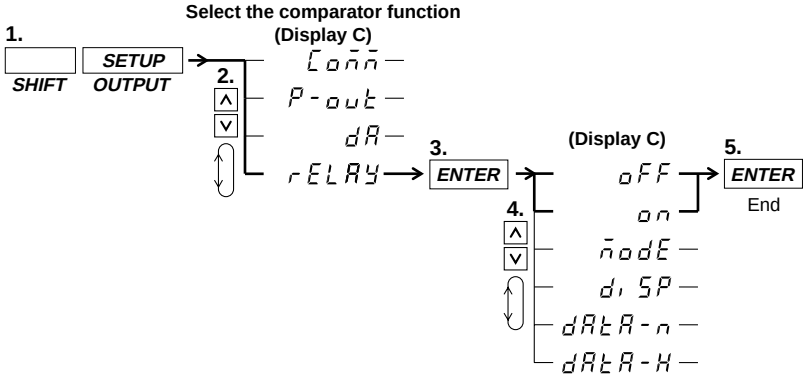
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Turning the Comparator Function ON/OFF

After having set all the items described on the previous pages, turn the comparator function ON.

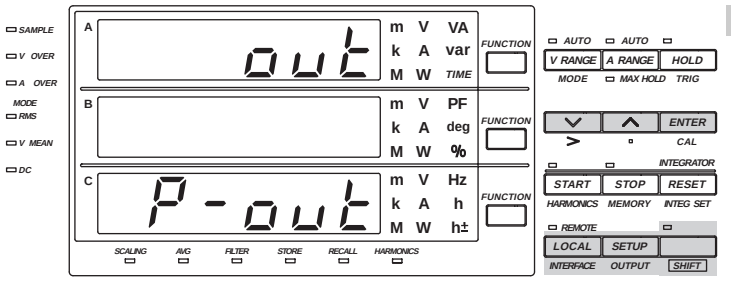
- on: The comparator function will start by pressing the ENTER key after selecting “on”;
- oFF: The comparator function will stop by pressing the ENTER key after selecting “oFF”.

CAUTION

- After having turned ON the comparator function, do not change the comparator mode. Changing the limit item might result in unexpected statuses of the output relay.
- Make sure not to greatly vary the input signal before turning the comparator function ON. Depending on the input signal used for determination, the instrument may display error codes (i.e. overrange) and this will change the output relays as described in section 9.4. When using the output relay as a control signal, make sure to match these control signals with other equipments to eliminate erroneuous control.

9.9 Outputting to an External Plotter or Printer

Keys

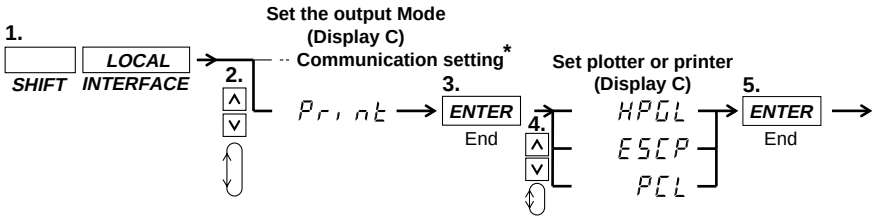


Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

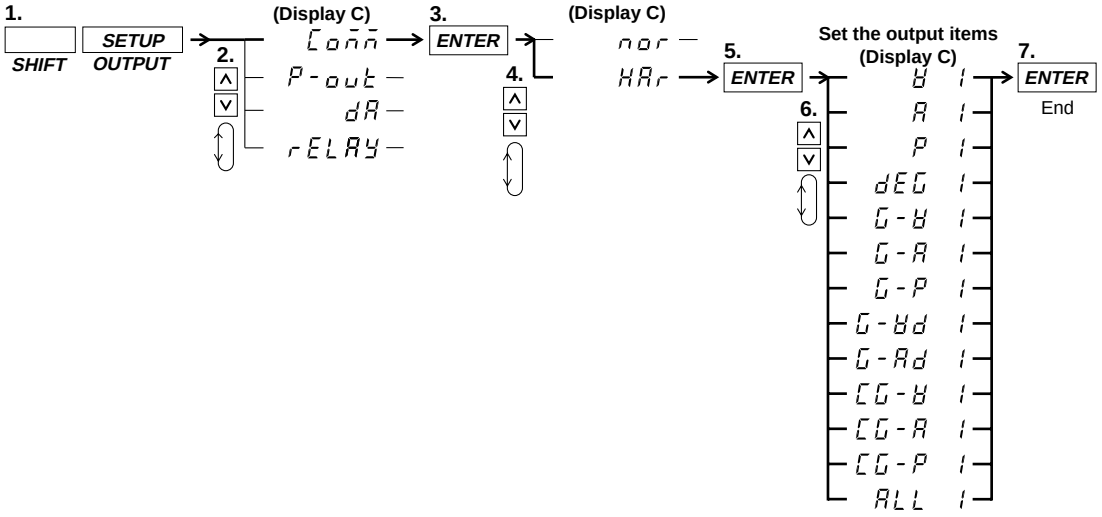
• Setting the Output Mode



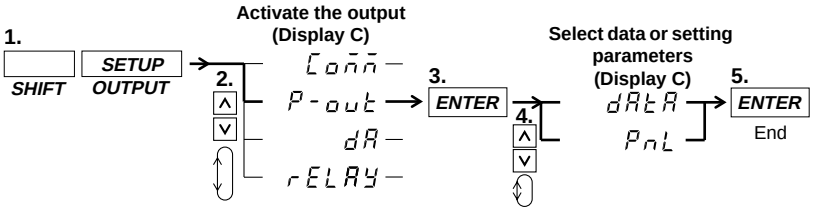
If the communication interface that you purchased is an RS-232-C, the menu proceeds to the "Selecting handshaking method" menu of page 11-3. Set the relevant parameters such as the handshaking method, format, and baud rate, then press the ENTER key to complete the settings. If the communication interface is a GP-IB, the procedure ends at step 5.

*** The communication settings vary depending on the communication interface you purchased. For details on the menus, see chapters 10 and 11.**

• Setting the Output Items



• Activating the Output



Explanation

Setting the Output (Printing) Mode

This setting is to select whether you are printing out on a plotter or a printer.
HPGL: For printing on an external, HPGL - compatible plotter.
ESCP: For printing on an external, ESC/P - compatible printer.
PCL: For printing on an external, PCL5 (printer language of HP) - compatible printer.

Setting the Output Contents in case of Normal Measurement

All measured/computed data will be output. All measured and computed data are output. However, for frequency, if either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.

Setting the Output Items and the Element in case of Harmonic Analysis

- **Setting the Output Item**
  Set one of the following items. The selected item is printed on the external plotter or printer. The initial value is V.
  - V: Prints the numerical values of the analysis value and relative harmonic content of the voltage;
  - A: Prints the numerical values of the analysis value and relative harmonic content of the current;
  - P: Prints the numerical values of the analysis value and relative harmonic content of the active power;
  - dEG: Prints the numerical values of the phase angle;
  - G-V: Prints the numerical values* and the graph of the analyzed voltage values;
  - G-A: Prints the numerical values* and the graph of the analyzed current values;
  - G-P: Prints the numerical values* and the graph of the analyzed active power values;
  - G-Vd: Prints the numerical values* and the graph of the phase angle between each voltage of the 2nd to 50th order and the fundamental (1st order);
  - G-Ad: Prints the numerical values* and the graph of the phase angle between each current of the 2nd to 50th order and the fundamental (1st order);
  - CG-V: Prints the numerical values* and the graph of the relative harmonic content of voltage;
  - CG-A: Prints the numerical values* and the graph of the relative harmonic content of current;
  - CG-P: Prints the numerical values* and the graph of the relative harmonic content of active power;
  - ALL: Prints the numerical values* and the graph of the analysis values and relative harmonic content of voltage and current (V and A are both printed).

* HPGL/PCL plotters print both numerical values and the graph, but ESCP printers only print the graph.

- **Executing Output**
  After having connected the external plotter or printer to this instrument, execute the output of data.
  dATA: All data selected as output items will be output.
  PnL: All setting parameters will be output.

Note

- When the output items are to be sent by communication interface and they are set to V, A, P or dEG, these items are then output. When the output item to be sent by communication is set to ALL, not only the V and A data are output, but P and dEG data as well. When the output item to be sent by communication is set to G-V to CG-P, the output data will not be the graph, but the numerical values.
- The orders are printed up to the maximum analysis order.
- When the fundamental frequency lies outside the measurement range of the harmonic analysis (display B will show FrqEr), an attempt to output will result in an error code.
- When no analysis data are present, "- - - -" will be printed.
- There are cases where the active power value becomes negative. The corresponding bargraph will be printed in thin print.
- When no plotter is connected, output time-out will result in an error code.

Example of Output to an External Plotter

(Slight differences may exist due to used plotter, etc.)

Output example in case of output item G-V of harmonic analysis data

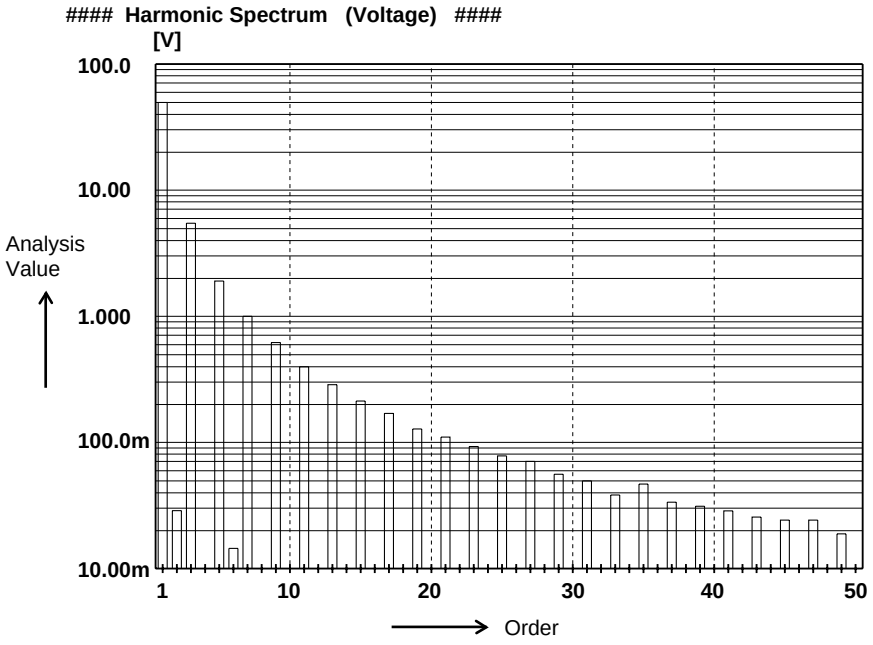
Voltage range
Current range
Function
PLL source
Frequency of PLL source
Rms value of 1st to 50th order of voltage
Rms value of 1st to 50th order of current
Rms value of 1st to 50th order of active power
Phase angle between the fundamental current and fundamental voltage
Power factor of the fundamental (1st order)
Harmonic distortion of the voltage
Harmonic distortion of the current
Averaging
Scaling

```
Model          :  M/253421/HRM
V  Range       :  60V
A  Range       :   1A
Function       :    V  1
Sync           :  PLL  V1
Freq  V1       =     60.00  Hz
V1  rms        =     49.98  V
A1  rms        =     0.002  A
W1             =      0.02  W
DEG1 =  LEAD             50.1  deg
PF1            =      0.641
V1  THD(IEC)   =     12.01  %
A1  THD(IEC)   =     95.58  %
AVg(EXP 8)     =  OFF
Scaling        =  OFF
```

Order — Analysis Value — Relative Harmonic Content

######## Harmonic Voltage List ########

Or	Volt [V]	Cont [%]	Or	Volt [V]	Cont [%]
1	49.62		2	0.03	0.06
3	5.50	11.09	4	0.01	0.02
5	1.99	4.01	6	0.02	0.03
7	1.01	2.03	8	0.01	0.01
9	0.62	1.24	10	0.00	0.01
11	0.41	0.82	12	0.00	0.01
13	0.30	0.60	14	0.00	0.00
15	0.22	0.45	16	0.00	0.01
17	0.17	0.35	18	0.00	0.01
19	0.14	0.28	20	0.00	0.00
21	0.12	0.23	22	0.00	0.01
23	0.09	0.19	24	0.00	0.01
25	0.08	0.16	26	0.00	0.01
27	0.07	0.14	28	0.01	0.01
29	0.06	0.11	30	0.00	0.01
31	0.05	0.10	32	0.00	0.01
33	0.04	0.08	34	0.00	0.01
35	0.05	0.09	36	0.00	0.01
37	0.03	0.07	38	0.00	0.00
39	0.03	0.06	40	0.01	0.01
41	0.03	0.06	42	0.00	0.01
43	0.03	0.05	44	0.00	0.01
45	0.02	0.05	46	0.00	0.01
47	0.02	0.05	48	0.00	0.01
49	0.02	0.04	50	0.00	0.01



Output example of setting parameters

```
                                WT200 Setup Lists
Voltage range                   Rev.          : 3.01
                                Model         : 253421-D/C2/EX2/HRM/CMP
Current range
                                V Range       :  15   Vrms  Manual
External sensor                 A Range       :  0.5  Arms  Manual
scaling values
                                Ext. Sensor (Elem 1)     = 50.00A
Items shown
                                Display A     : V  Element 1
Wiring method                   Display B     : A  Element 1
                                Display C     : W  Element 1
Filter ON/OFF                   Mathematics : Crest Factor V1
Hold ON/OFF                     Wiring        : 1 Phase 2 Wire
                                Filter        : Off
Scaling ON/OFF                  Hold          : Off
                                Scaling       : Off
Voltage(PT)ratio
Current(CT)ratio                PT Ratio          (Elem 1) =1.000
Power coefficient               CT Ratio          (Elem 1) =1.000
                                Scaling Factor    (Elem 1) =1.000

Averaging ON/OFF                Averaging              : Off
  Type                          Averaging Type         : Linear
  Coefficient                   Averaging Coefficient  :  8
Integration mode
Integration timer               Integrate Mode    : Manual
preset time                     Integrate Timer   : 00000: 00: 00
Integration type                Integrate Type    : Standard
Rated Integration time
Storage ON/OFF                  Rated Time (DA)   : 001: 00
  Interval                      Store             :  Off
                                Store Interval    : 00:00:00
Recall ON/OFF                   Recall            :  Off
  Interval                      Recall Interval   : 00:00:00

Measurement
synchronization source          Sync. Source          :  V1
MAX hold ON/OFF                 Max Hold              :  Off
PLL source                      Harmonics Sync.       :  Off
Harmonics                       Harmonics             :  Off
function ON/OFF                 Display A Order       :  01
  Order                         Harmonics Element     :  Element 1
  Element                       Distortion Formula    :  IEC
  Distortion
  formula                       Comparator            :  Off
                                Comparator Mode       :  Single
Comparator                      Comparator Display    :  Off
function ON/OFF
                                Comparator Channel    :  1
  Mode
                                Communication Command :  0
  Display
  ON/OFF
  Channel
Comm.command
```

Output example of normal measurement data

```
                                Element 1
Element                         V          0.00
Voltage                         A          0.0m
Current                         W          -0.000
Active power                    VA         0.000
Apparent power                  Var        0.000
Reactive power                  PF         0.953
Power factor                    DEG        17.7
Phase angle                     Vpk        0.27
Voltage peak                    Apk        -0.006
Current peak                    AVGW       581.3m
Average active power            HzV        60.30
(of integration)
                                Integrator: Start
Frequency                       Integrator Time: 00000: 00: 14
Integration status
Elapsed time of integration
                                Element 1
Watt-hour                       Wh+   0.000m
                                Wh-   -0.002m
                                Wh    -0.002m
Ampere-hour                     Ah+   0.0000m
                                Ah-   0.0000m
                                Ah    0.0000m
```

Output example of harmonic analysis data

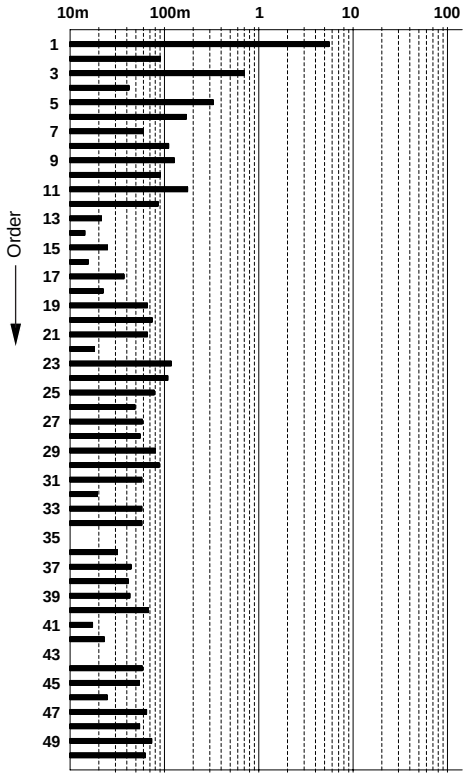
Refer to the previous page for a description

```
Model        : M/253421/HRM
V Range      : 15 V
A Range      : 0.5A
Function     : V 1
Sync         : PLL  V1
Freq V1      =      60.00 Hz
V1 rms       =       5.76 V
A1 rms       =       1.4  mA
W1           =    -0.001  W
DEG1   = LEAD  153.8  deg
PF1            =  -0.897
V1 THD (IEC)   =   15.71%
A1 THD (IEC)   = - - - oF - - -
Avg    (EXP 8 ) = OFF
Scaling        = OFF

####### Harmonic Voltage List #######
```

Or	Volt [V]	Cont [%]	Or	Volt [V]	Cont [%]
1	5.69		2	0.09	1.60
3	0.68	12.02	4	0.04	0.74
5	0.32	5.63	6	0.16	2.77
7	0.06	1.05	8	0.11	2.01
9	0.12	2.15	10	0.09	1.65
11	0.17	2.96	12	0.08	1.47
13	0.02	0.39	14	0.01	0.25
15	0.02	0.43	16	0.01	0.25
17	0.04	0.63	18	0.02	0.41
19	0.07	1.15	20	0.07	1.31
21	0.07	1.15	22	0.02	0.31
23	0.11	1.93	24	0.10	1.84
25	0.08	1.39	26	0.05	0.85
27	0.06	1.04	28	0.06	0.97
29	0.08	1.44	30	0.09	1.59
31	0.06	1.03	32	0.02	0.36
33	0.06	1.08	34	0.06	1.06
35	0.00	0.02	36	0.03	0.57
37	0.04	0.77	38	0.04	0.72
39	0.04	0.74	40	0.07	1.24
41	0.01	0.26	42	0.02	0.40
43	0.01	0.14	44	0.06	1.04
45	0.05	0.94	46	0.02	0.43
47	0.07	1.18	48	0.05	0.94
49	0.07	1.30	50	0.06	1.09

Analysis Value

Harmonic Spectrum (Voltage)



10.1 GP-IB Interface Functions and Specifications

This instrument is equipped with a GP-IB interface in accordance with your preference. This interface permits remote control from a controller such as a personal computer, and output of various data.

GP-IB Interface functions

The table below shows functions that are available in each mode.

Mode	Function	
Addressable mode (mode A and mode B), 488.2 mode	Listener	Functions performed by key operations (except for LOCAL key and power ON/OFF) measure, computed, and analysis data setting parameters output request error code output request
	Talker	measure, computed, and analysis data setting parameters output error code output status byte output
Talk-only mode	Talker	measured/computed/analysis data output

Addressable Mode A

Data is output when the data output request command “OD” is received. This mode enables transmission of data at a specified time.

Addressable Mode B

This mode does not require a measured data inquiry command. When data is requested by the controller (personal computer, etc.), the data is output as the display is updated when measurement is completed. Therefore, if an attempt is made to transmit data at intervals shorter than the display intervals, the controller is forced to wait until the next display interval.

488.2 Mode

This mode allows commands conforming to the IEEE St'd 488.2-1987 protocol to be used.

Talk-only Mode

This mode does not require a controller. Data is output at certain intervals. This interval can be set to any length. This mode is useful when the instrument is connected to a listener-only device such as a printer.

Print Mode

This mode is useful when harmonic analysis data are output to the external plotter/printer. For details, see section 9.9.

GP-IB Interface Specifications

- Electrical & mechanical specifications: conforms to IEEE St'd 488-1978
- Functional specifications: see the table below
- Code: ISO (ASCII) code
- Address setting: Address can be set in the range from 0 to 30 using the front panel keys.
- Remote mode clear: remote mode can be cleared by pressing the LOCAL key on the front panel. However, this is not possible when Local Lockout has been set by the controller.

Function	Subset name	Description
source handshake	SH1	full source handshake capability
acceptor handshake	AH1	full acceptor handshake capability
talker	T5	basic talker capability, serial polling, nontalker on MLA (My Listen Address), talk-only capability
listener	L4	Basic listener capability, nonlistener to MTA (My Talk Address), no listen-only capability
service request	SR1	full service request capability
remote local	RL1	full remote/local capability
parallel poll	PP0	no parallel polling capability
device clear	DC1	full device clear capability
device trigger	DT1	full device trigger capability
controller	C0	no controller function

CAUTION

The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:

Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.

Voltage across V terminal and ground 600 Vrms max.

Put the protective cover on the connector when this function is not used.

10.2 Responses to Interface Messages

Responses to Interface Messages

IFC (Interface Clear)

Unaddresses talker and listener.

REN (Remote Enable)

Transfers the instrument from local control to remote control.

GTL (Go To Local)

Transfers the instrument from remote control to local control.

SDC (Selective Device Clear), DCL (Device Clear)

Cleasrs GP-IB input/output buffer, and resets an error. The setting parameter and measurement state are not affected. DCL is applicable to all devices on the bus, whilst DSC is applicable to designated devices only.

GET (Group Execute Trigger)

Same function as the TRIG key.

LLO (Local Lockout)

Invalidates the LOCAL key on the front panel to inhibit transfer from remote control to local control.

Switching between Remote and Local Mode

When switched from local to remote mode

The REMOTE indicator will light up, and all panel keys except the LOCAL key cannot be operated. Setting parameters entered in the local mode will be retained.

When switched from remote to local mode

The REMOTE indicator will extinguish and all panel keys can be operated. Setting parameters entered in the remote mode will be retained.

Valid keys for remote control

Pressing the LOCAL key in remote control will switch the instrument to local control. However, this is not possible in case the Local Lockout has been set by the controller.

10.3 Status Byte Format (before the IEEE 488.2-1987 Standard)

DIO 8	DIO 7	DIO 6	DIO 5	DIO 4	DIO 3	DIO 2	DIO 1
Integration BUSY	**SRQ**	**ERROR**	**STORE/ RECALL BUSY**	**OVER**	**Syntax ERROR**	**Integration END**	**Computation END**

Integration BUSY (DIO 8)

This bit is set to “1” when integration is in progress. This bit cannot be disabled by the IM command since it is a status bit. Even if this bit is set to “1”, SRQ will not be affected.

SRQ (DIO 7)

This bit is set to “1” when computation End (DIO 1), integration End (DIO 2), OVER (DIO 4) or Syntax error (DIO 3) occurs. When RQS is set to “1”, SRQ is set to True, issuing a service request to the controller. This bit is reset to “0” when a response is sent to the serial poll. To prevent the SRQ and status byte being affected by computation End, integration End, Over or Syntax error, this bit must be disabled by the IM command.

After an “IM15”, SRQ is affected by a computation End, integration End, Over, or Syntax error.

After an “IM1”, SRQ is affected only by a computation End.

In case of “IM4”, SRQ is affected only by a Syntax error.

ERROR (DIO 6)

When a Syntax error or Over occurs, this bit is set to “1” and the SRQ is set to True.

STORE/RECALL BUSY (DIO 5)

This bit is set to “1” when storing/recalling of data is in progress. This bit cannot be disabled by the IM command since it is a status bit. Even if this bit is set to “1”, SRQ will not be affected.

OVER (DIO 4)

This bit is set to “1” and SRQ is set to True when an overrange occurs in the measured data. However, this is not valid if the bit has been disabled by the IM command. This bit is reset after a response is made to the serial poll. The nature of Over can by identified by the OE command.

Syntax ERROR (DIO 3)

This bit is set to “1” when a command error, parameter error or execution error occurs. The error No. can be identified by the OE command. This bit is reset after a response is made to the serial poll. However, this is not valid if the bit has been disabled be the IM command.

Integration END (DIO 2)

This bit is set to “1” when integration has been completed. The bit is reset when a response is made to the serial poll. However, this is not valid if the bit has been disabled by the IM command.

Computation END (DIO1)

This bit is set to “1” when computation has been completed and the display is updated. The bit is reset when a response is made to the serial poll. However, this is not valid if the bit has been disabled by the IM command.

10.4 Output Format

Output Format of Normal Measured/Computed Data

Data Format

Measured data normally consists of a 6-byte header and 11 bytes of data

Header	Data

Header Section

The header section consists of 6 bytes (h1 to h6).

h1	h2	h3	h4	h5	h6

h1 to h3: data type

V_ _: voltage	A_ _: Current	W_ _: Active power
VA_: Apparent power	Var: Reactive power	PF_: Power factor
HzV: Voltage frequency	HzA: Current frequency	Wh_: Watt hour
Ah_: Ampere hour	DEG: Phase angle	Vpk: Peak voltage value
Apk: Peak current value		
Wh+: Positive watt hour	Wh–: Negative watt-hour	
Ah+: Positive ampere hour	Ah–: Negative ampere hour	
HMS: Elapsed time of integration	MEM: Data number in case of recalling	
CV1: V1 crest factor	CA1: A1 crest factor	
A+B: (display A)+(display B)		
A–B: (display A)–(display B)		
A*B: (display A)*(display B)		
A/B: (display A)/(display B)		

h4: Element

1: Element 1

h1–h4: data type (only when the computing equation is A/B^2, A^2/B, or average active power)

A/B^2: (display A)/(display B)^2

A^2/B: (display A)^2/(display B)

AVGW: average active power (correct values output only while the integration is in progress)

h5: Data state

N: normal I: Overrange O: Computation overflow P: Peak overflow

E: No data

h6: Indicates data lag/lead in case of DEG data type. In case of other data types, _ (space) will occur.

G: Lag D: Lead _: Not detectable

Data Section

The data section consists of 11 bytes.

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11

d1: polarity; _ (space) or – (minus)
d2 to d8: mantissa, floating-point number of the maximum six digits
d9 to d11: exponent; E–3→m, E+0, E+3 → k, E+6 → M

Data state in case of an overrange (oL is being displayed)

h1	h2	h3	h4	I	_	_	9	9	9	9	9	9	.	E	+	3

Data state in case of a computation overflow

(oF, PFErr, dEGEr, ErrLo, ErrH, is being displayed)

h1	h2	h3	h4	O	_	_	8	8	8	8	8	8	.	E	+	0

Data state in case of no data (when the display is - - - - -)

"I" becomes "E" for data during overrange.

Elapsed time of integration

H	M	S	_	_	_	d1	d2	d3	d4	d5	:	d7	d8	:	d10	d11

d1 to d5: Hour
d7 to d8: Minute
d10 to d11: Second

Output Format when Self Selected

Up to 14 normal measured/computed data can be output simultaneously, and the user is allowed to choose any output information type for those 14 data. Each output block is of the following format.

Line 1	Data number	Terminator	(The data number will only be output in case of recall)						
Line 2	ch.1	,	ch.2	,	ch.3	,	ch.4	Terminator	
Line 3	ch.5	,	ch.6	,	ch.7	,	ch.8	Terminator	
Line 4	ch.9	,	ch.10	,	ch.11	,	ch.12	Terminator	
Line 5	ch.13	,	ch.14	Terminator					
Line 6	END	Terminator							

Each output block usually consists of five lines (six in case of recall) including the block end line “END”. However, if all output types on a line are set to “no output”, this line will be omitted, reducing the number of output lines by one. For example, if all output items of ch.9 to ch.12 are set to “no output”, line 4 in the above example will be omitted.

Furthermore, if any channel on a line is set to “no output”, all data following this channel on the line will be shifted forward. For example, if the ch.2 on line 1 is set to “no output”, data of ch.1 will be followed by data of ch.3.

Output Format in case of Normal Measurement

Line 1	Data number	Terminator	(The data number will only be output in case of recall)	
Line 2	V1 data	Terminator		
Line 3	A1 data	Terminator		
Line 4	W1 data	Terminator		
Line 5	Frequency	,	Display C	Terminator
Line 6	END	Terminator		

Note

- When the frequency is set by either of the following methods, only one value is measured, and that value will be output.
  - by panel keys: FUNCTION key on display C.
  - by communication command: by the “DC” or “EC” command.

  After setting the measurement object of frequency, even changing the display C to something different than VHz or AHz will not result in changing the object of measurement of frequency. When selecting the output items yourself and you set a frequency item which is not object of measurement, “999999.E+03” will be output.
- The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak) while the MAX hold function (see section 4.8) is enabled will be the maximum values (MAX) that are held. The values output via communications are also set to the maximum values (MAX) that are held.

Default Output Format in case Integration Measurement

Line 1	Data number	Terminator			(The data number will only be output in case of recall)
Line 2	W1 data	Terminator			
Line 3	Wh1data	Terminator			
Line 4	Ah1data	Terminator			
Line 5	Frequency	,	Elapsed integration time	Terminator	
Line 6	END	Terminator			

Note

- When the frequency is set by either of the following methods, only one value is measured, and that value will be output.
  - by panel keys: FUNCTION key on display C.
  - by communication command: by the “DC” or “EC” command.

  After setting the measurement object of frequency, even changing the display C to something different than VHz or AHz will not result in changing the object of measurement of frequency. When selecting the output items yourself and you set a frequency item which is not object of measurement, “999999.E+03” will be output.
- The displayed values of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Vpk (voltage peak), and Apk (current peak) while the MAX hold function (see section 4.8) is enabled will be the maximum values (MAX) that are held. The values output via communications are also set to the maximum values (MAX) that are held.

Output Format of Harmonic Analysis Data

Data Format

Harmonic analysis data normally consists of a 8-byte header and 11 bytes of data

Header	Data

Header Section

The header section consists of 8 bytes (h1 to h8).

h1	h2	h3	h4	h5	h6	h7	h8

h1 to h3: data type

V__: voltage A__: Current W__: Active power

DEG: Phase angle between the 1st order voltage and 1st order current

DGV: Phase angle between the 1st order voltage and the 2nd to 50st order voltage

DGA: Phase angle between the 1st order current and the 2nd to 50st order current

PF_: Fundamental power factor (1st order)

HzV: Fundamental frequency of the voltage of the PLL source

HzA: Fundamental frequency of the current of the PLL source

THD: Harmonic distortion (either IEC or CSA)

CNT: Relative harmonic content

MEM: Data number in case of recalling

h4: Element

1: Element 1

h5: Data state

N: normal I: Overrange O: Computation overflow P: Peak overflow

E: No data

h6, h7: Order

01 to 50: Order of fundamental or higher harmonic (up to the maximum analysis order).

"__" (space) will be assigned in case of frequency, harmonic distortion, power factor or in case of all computed values of the 1st to 50th order.

h8: Indicates data lag/lead in case of DEG data type. In case of other data types, __ (space) will occur.

G: Lag D: Lead _: Not detectable

Data Section

The data section consists of 11 bytes.

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11

d1: polarity; __ (space) or – (minus)

d2 to d8: mantissa, floating-point number of the maximum six digits

In case of harmonic distortion and relative harmonic content :

d9: %

d10 to d11: __ (space)

In other cases:

d9 to d11: exponent; E–3 → m, E+0, E+3 → k, E+6 → M

Output Format

The output format depends on the selected output items which can be selected by the "OH" command.

In case of voltage and current

Line 1	All computed values of the 1st to 50th order	,	harmonic distortion	Terminator
Line 2	Analysis value for fundamental (1st order)	,	Frequency	Terminator
Line 3	Analysis value for 2nd harmonic	,	Relative harmonic content for 2nd harmonic	Terminator
⋮	⋮	⋮	⋮	⋮
Line 51	Analysis value for 50th harmonic	,	Relative harmonic content for 50th harmonic	Terminator
Line 52	END	Terminator		

In case of active power

Line 1	All computed values of the 1st to 50th order	,	Power factor	Terminator
Line 2	Analysis value for fundamental (1st order)	,	Frequency	Terminator
Line 3	Analysis value for 2nd harmonic	,	Relative harmonic content for 2nd harmonic	Terminator
⋮	⋮	⋮	⋮	⋮
Line 51	Analysis value for 50th harmonic	,	Relative harmonic content for 50th harmonic	Terminator
Line 52	END	Terminator		

In case of phase angle

Line 1	Phase angle between fundamentals of voltage and current	,	Frequency	Terminator
Line 2	Phase angle between fundamental and 2nd harmonic of voltage	,	Phase angle between fundamental and 2nd harmonic of current	Terminator
Line 3	Phase angle between fundamental and 3rd harmonic of voltage	,	Phase angle between fundamental and 3rd harmonic of current	Terminator
⋮	⋮	⋮	⋮	⋮
Line 50	Phase angle between fundamental and 50th harmonic of voltage	,	Phase angle between fundamental and 50th harmonic of current	Terminator
Line 51	END	Terminator		

In case of ALL setting

The data will be output in the sequence voltage → current → active power → phase angle → END <terminator>

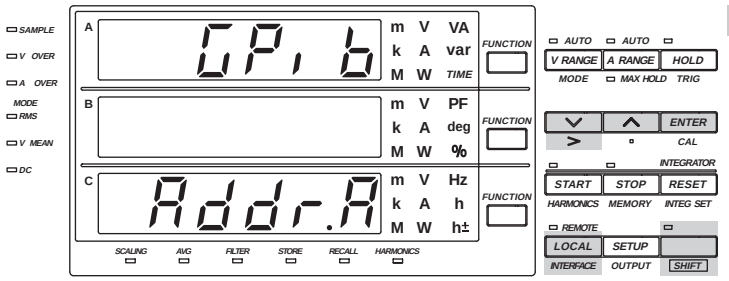
- The output format of each item is as described for each item above;
- The END line is not output for each item, but after finishing the entire output operation.

Output Format of Setting Parameters and Error Codes

See the explanations and examples of the "OS" or the "OE" commands described in section 13.1.

10.5 Setting the Address/Addressable Mode

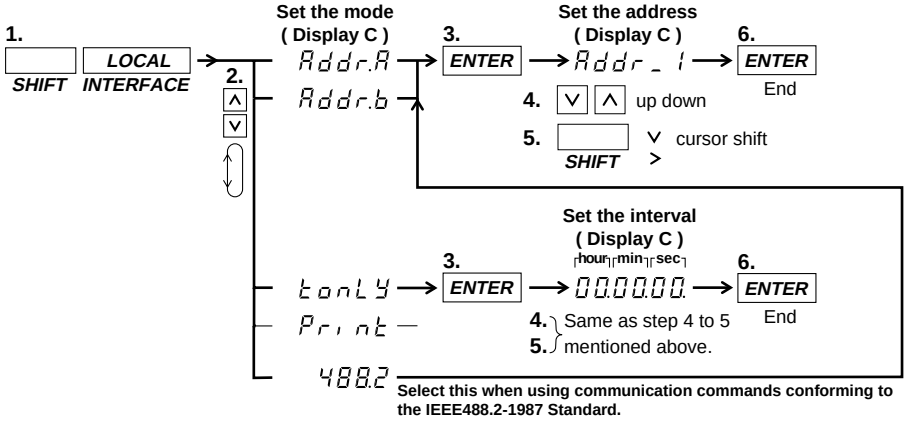
keys



Displays relevant keys and indicators

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Mode Setting

For details, see section 10.1.

Address Setting

A particular address is assigned to each device connected to the GP-IB interface so that each device can be recognized by every device. Therefore, an address must be assigned to this instrument when it is connected to a personal computer.
Address setting range: 0 to 30
The initial value is “1”. Initializating the instrument will not result in changing the address setting.

Talk-only Function

This function only allows the instrument to send data to other devices. If talk-only is off, the instrument can both send and receive data. In talk-only mode, the instrument cannot be controlled by the controller.

Terminator

When this instrument is used as a listener

Use “CR+LF”, “LF” or “EOI” as the receiving terminator.

When this instrument is used as a talker

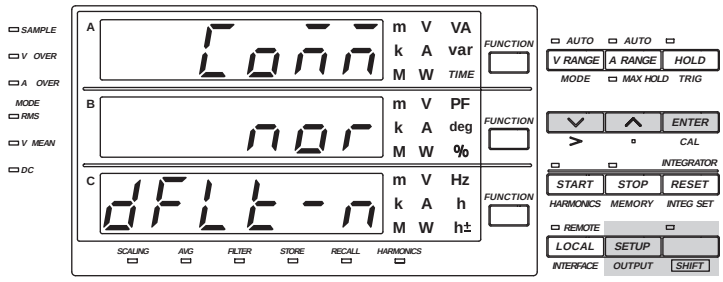
The sending terminator is set using the DL command. The initial setting is “CR+LF+EOI”.

Note

It is not possible for this instrument to receive data if the “CR” terminator is sent from the controller. It is also not possible to set “CR” as the terminator which is to be sent from this instrument.

10.6 Setting the Output Items

keys

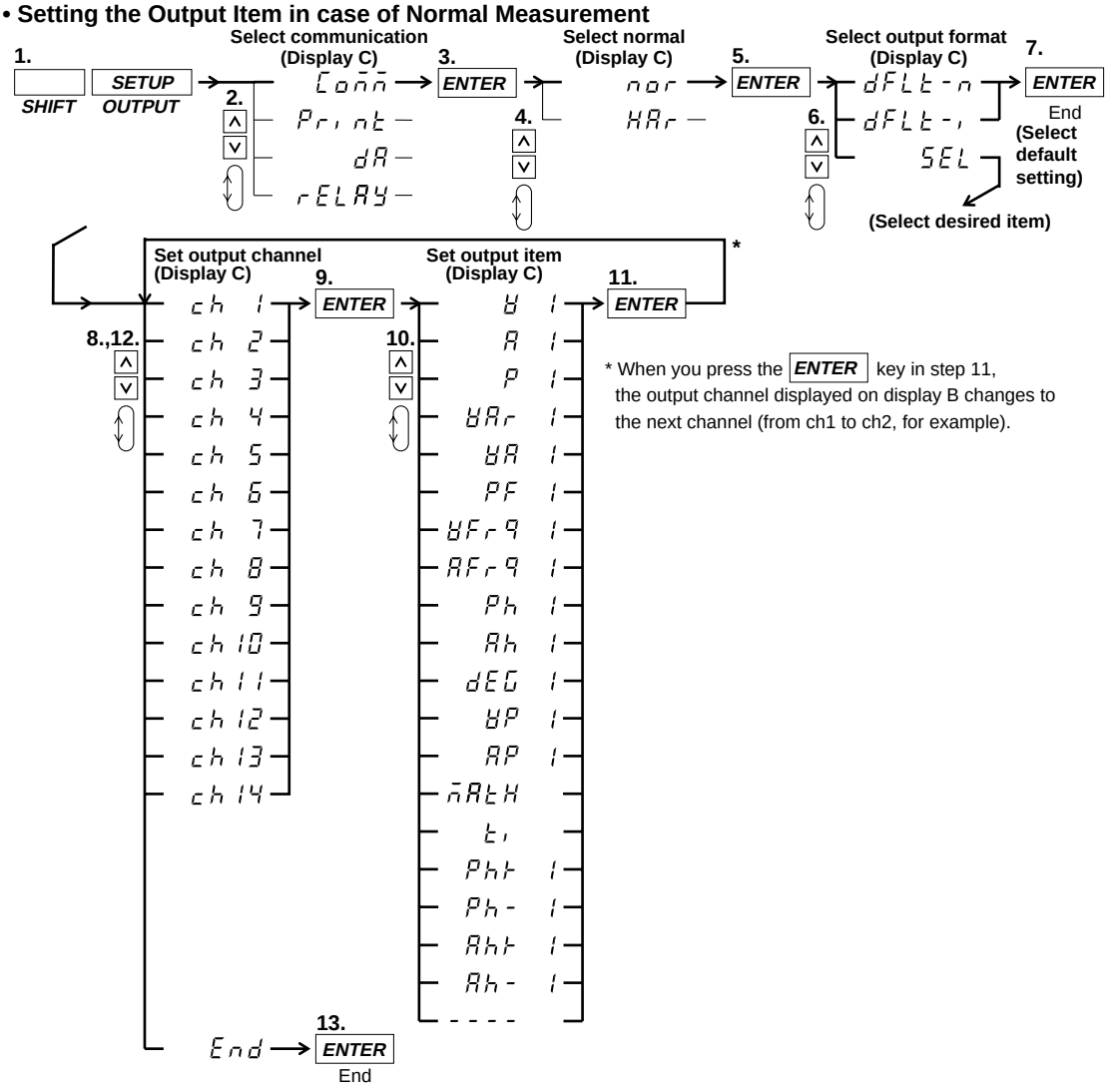


Displays relevant keys and indicator

Procedure

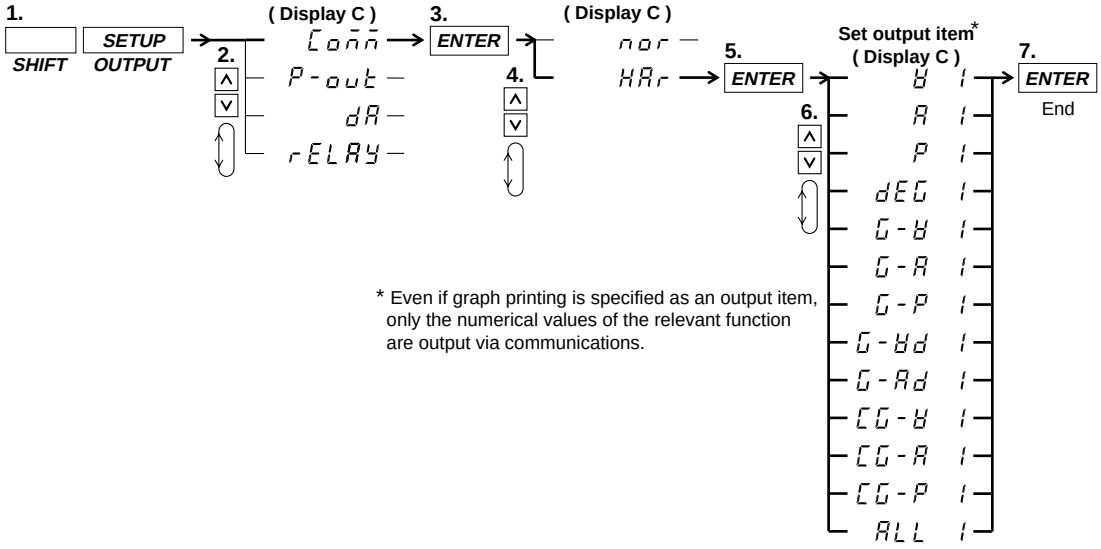
- Operate the instrument by following the thick lines in the menu below
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

• Setting the Output Item in case of Normal Measurement



* When you press the **ENTER** key in step 11, the output channel displayed on display B changes to the next channel (from ch1 to ch2, for example).

Setting the Output Item in case of Harmonic Analysis



* Even if graph printing is specified as an output item, only the numerical values of the relevant function are output via communications.

Explanation

Setting the Output Item in case of Normal Measurement

- **Selecting the Default Setting**
  Predefined items will be output by the communication function. The following types of default settings exist and they depend on the model. For details, see section 10.4.
  - Normal default setting : dFLt-n
    Consists of V (voltage), A (current), W (active power, the above menu shows P), frequency and displayed data of display C.
  - Integration default setting : dFLt-i
    Consists of W (active power, the above menu shows P), Wh (watt hour), Ah (ampere hour), frequency, and integration time.

- **Selecting yourself**
  You can set any item to each of ch1 to ch14 output channels.
  - Setting the channel
    Sets which channel (ch1 to ch14) will output the item.
  - Setting the output item (corresponds to column A in the operating procedure)
    Any of the following items can be selected. The initial value is V.
    V (voltage), A (current), P (active power), VAr (reactive power), VA (apparent power), PF (power factor), VFrq (voltage frequency)*1, AFrq (current frequency)*1, Ph (total watt hour Wh), Ah (total ampere hour), dEG (phase angle),VP(peak value of voltage), AP(peak value of current), MATH(computation), t1 (elapsed integration time), Ph+ (positive watt hour Wh+), Ph– (negative watt hour Wh–), Ah+ (positive ampere hour*2), Ah– (negative ampere hour*2), – – – – (no output)
    *1 If either one of the display functions, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both functions are turned OFF, the frequency of the function that was lighted last will be output.
    *2 For details related to the positive and negative directions of the ampere hour, see page 6-3.

Setting the Output Item in case of Harmonic Analysis

The procedure to set the output item is the same as the procedure described in section 9.9, "Outputting to an External Plotter or Printer."
For details, see section 9.9.

10.7 System of Commands before the IEEE 488.2-1987 Standard

For a detailed description of each command, see section 13.1.

	Command	Description
Voltage range	RV m (Range Voltage)	sets voltage range
	AV m(Auto Voltage range)	sets voltage auto range
Current range	RA m(Range current(A))	sets current range
	AA m(Auto current(A) range)	sets current auto range
	SA m(Sensor Ampere)	sets external sensor
Display range	DR(Display Range)	displays the current range
Measurement mode	MN m(MeaN)	sets RMS/V and MEAN/DC
Filter	FL m(FiLter)	sets filter ON/OFF
Hold	HD m(sampling HolD)	holds display and output data
Trigger	E or ST or <GET>	trigger
Display	DA m(Display A function)	selects function to be displayed on display A
	DB m(Display B function)	selects function to be displayed on display B
	DC m(Display C function)	selects function to be displayed on display C
Scaling	SC m(SCaling)	sets scaling ON/OFF
	KV m(K*Voltage)	sets the scaling constant
	KA m(K*Ampere)	
	KW m(K*Wattage)	
Averaging	AG m(AveraGing)	sets averaging ON/OFF
	AT m(Averaging Type)	selects exponential averaging or moving averaging
	AC m(Averaging Coefficient)	sets attenuation constant or averaging number
MATH	MT m(MaThematics)	sets computing equation
Measurement synchronization source	SN m	sets measurement synchronization source
MAX hold	KH m	sets MAX hold
Number of displayed digits	DS m (Display reSolution)	sets number of displayed digits
Zero level compensation	ZC (Zero Calibration)	performs zero level compensation
Integration	IS(Integrate Start)	starts integration
	IP(Integrate stoP)	stops integration
	IR(Integrate Reset)	resets integration
	IC m(Integrate Continuous)	sets integration mode
	IG m	sets integration type
	TM m1,m2,m3(integrate TiMer)	sets integration preset time
Data storage	SO m(Store On)	starts storage
	SR m1,m2,m3(Store inteRval)	sets storage interval
Data recalling	RO m(Recall On)	starts recalling
	RR m1,m2,m3(recall inteRval)	sets recalling interval
Setting parameters	SL m(panel Setting Load)	recalling setting parameters
	SS m(panel Setting Save)	storing setting parameters
	RC(Reset Command)	initialize setting parameters
Communication commands	CM m(Communication coMmand)	sets command group to be used
	OD(Output Data)	requests output of measured data
	OF m1,m2,m3(Output Function)	sets output items
	OFD m(Output Function Default)	sets default output items
	OS(Output panal Setting)	requests output of setting parameters
	OE(Output Error code)	requests output of error code
	H m(Header)	sets output data header
	DL m(DeLimiter)	sets output data delimiter
	IM m(Interrupt Mask)	sets status byte interrupt mask

Option	Command	Description
/HRM	HA m(Harmonics Analize)	sets harmonic analysis ON/OFF
	HE m (Harmonics Element)	sets the element for harmonic analysis
	OR(harmonics ORder)	sets harmonics order
	OH m1,m2(Output Harmonics function)	sets output item
	PS m(Pll Source)	sets PLL source
	DF m(Distortion Formula)	sets the computation method for THD
/DA	OA m1,m2,m3(Output Analog)	sets output items yourself
	OAD m(Output Analog Default)	sets default output items
	RT m1,m2,m3(integrate Rated Time)	sets integration time
/CMP	YO m(relaY On)	sets comparator function ON/OFF
	YM m(relaY Mode)	sets comparator mode
	DY m(Display relaY)	sets display relay ON/OFF for comparator
	YC m(relaY Channel)	sets the relay channel
	OY m1,m2,m3,m4,m5 (Output relaY function)	sets the output relay function for normal measurement
	OYH m1,m2,m3,m4,m5,m6 (Output relaY Harmonic function)	sets the output relay function for harmonic analysis

Note

If commands relating to options are used on instruments which do not have the options installed, “Error 11” is displayed. Also, there are no responses to inquiries.

11.1 RS-232-C Interface Functions and Specifications

This instrument is equipped with a RS-232-C interface in accordance with your preference. This interface permits remote control from a controller such as a personal computer, and output of various data.

Overview of the RS-232-C Interface

The table below shows functions that are available in each mode.

Mode	Function	
Normal mode	Reception	Functions performed by key operations (except for LOCAL key and power ON/OFF) measured, computed, and analysis data output request setting parameter output request error code output request
	Transmission	measured, computed, and analysis data output setting parameter output error code output status byte output
Talk-only mode	Transmission	measured, computed, and analysis data output

Normal Mode

This mode is equivalent to the the addressable mode A of the GP-IB function, and enables reception of commands and transmission of data. Measured data is output on reception of the “OD” command.

488.2 Mode

This mode allows receiving of commands conforming to the IEEE St'd 488.2-1987 protocol.

Talk-only Mode

This mode is equivalent to the Talk-only mode of the GP-IB function. Only measured data can be output and commands cannot be received.

There is no equivalent to the addressable mode B of the GP-IB function.

Print Mode

This mode is used to output harmonic analysis data to an external plotter or printer. For details, see section 9.9.

RS-232-C Interface Specifications

Electrical characteristics:	conforms to EIA RS-232-C
Connection:	point-to-point
Communications:	full-duplex
Synchronization:	start-stop system
Baud rate:	75, 150, 300, 600, 1200, 2400, 4800, 9600
Start bit:	1 bit
Data length (word length):	7 or 8 bits
Parity:	Even, odd or no parity
Stop bit:	1 or 2 bits
Hardware handshaking:	User can select whether CA, CB, CC and CD signals will always be True, or be used for control.
Software handshaking:	User can select whether to control only transmission or both transmission and reception using X-on and X-off signals. X-on (ASCII 11H) X-off (ASCII 13H)
Receive buffer size:	64 bytes

WARNING

The connectors used in this function have protective covers. When the covers are removed or when using connectors, the voltage ratings across the measuring input and the ground become as follows:

Voltage across A, ±(V and A side) input terminals and ground 400 Vrms max.
Voltage across V terminal and ground 600 Vrms max.

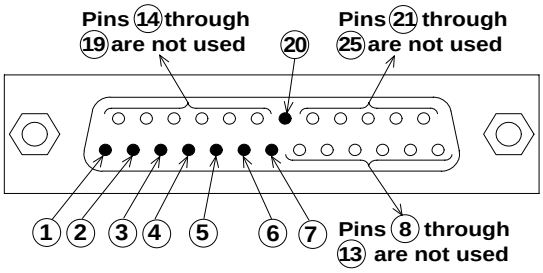
Put the protective cover on the connector when this function is not used.

11.2 Connecting the Interface Cable

When connecting this instrument to a personal computer, make sure that the handshaking method, data transmission rate and data format selected for the instrument match those selected fro the computer. For details, see the following pages. Also make sure that the correct interface cable is used.

Connector and Signal Names

Numbers in the figure represent the Pin Nos.



RS-232-C Connector : DBSP-JB25S or equivalent

1	AA(GND: Protective Ground)	Grounded to the case of this instrument
2	BA(TXD: Transmitted Data)	Data transmitted to personal computer Signal direction: output
3	BB(RXD: Received Data)	Data received from personal computer Signal direction: input
4	CA(RTS: Request to Send)	Signal used to handshake when receiving data from personal computer Signal direction: output
5	CB(CTS: Clear to Send)	Signal used to handshake when transmitting data to personal computer Signal direction: input
6	CC(DSR: Data Set Ready)	Signal used to handshake when transmitting data to personal computer Signal direction: input
7	AB(GND: Signal Ground)	Ground for signals
20	CD(DTR: Data Terminal Ready)	Signal used to handshake when receiving data from personal computer Signal direction: output

Note

Pins 8 to 19 and 21 to 25 are not used.

Signal Direction

The figure below shows the direction of the signals used by the RS-232-C interface.

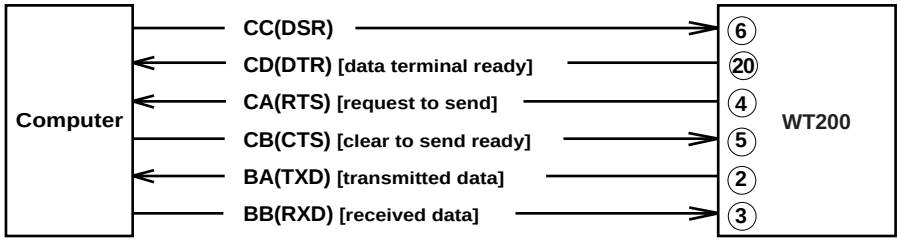


Table of RS-232-C Standard Signals and their JIS and CCITT Abbreviations

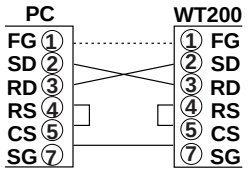
Pin No. (25-pin connector)	Abbreviations			Name
	RS-232-C	CCITT	JIS	
①	AA(GND)	101	FG	Protective ground
⑦	AB(GND)	102	SG	Signal ground
②	BA(TXD)	103	SD	Transmitted data
③	BB(RXD)	104	RD	Received data
④	CA(RTS)	105	RS	Request to send
⑤	CB(CTS)	106	CS	Clear to send
⑥	CC(DSR)	107	DR	Data set ready
⑳	CD(DTR)	108/2	ER	Data terminal ready
22	CE(RI)	125	CI	Ring indicator
8	CF(DCD)	109	CD	Data channel received carrier detect
21	CG(-)	110	SQD	Data signal quality detect
23	CH/CI(-)	111	SRS	Data signal rate select
24/15	DA/DB(TXC)	113/114	ST_1/ST_2	Transmitter signal element timing
17	DD(RXC)	115	RT	Receiver signal element timing
14	SBA(-)	118	BSD	Secondary transmitted data
16	SBB(-)	119	BRD	Secondary received data
19	SCA(-)	120	BRS	Secondary request to send
13	SCB(-)	121	BCS	Secondary clear to send
12	SCF(-)	122	BCD	Secondary received carrier detect

Circles indicate pins used for the RS-232-C interface of this instrument

Signal Wiring Example

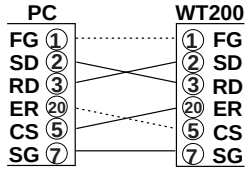
In general, use a cross cable.

1. OFF-OFF/XON-XON



Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

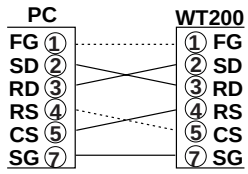
2. XON-DTR(XON-ER)



Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

The wiring of PC (ER) and WT200 (CS) are not necessary. However, we recommend that you wire so that the cable can be used in either direction.

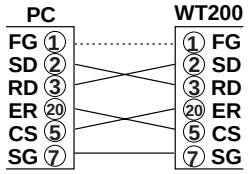
3. XON-RTS(XON-RS)



Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

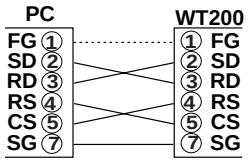
The wiring of PC (ER) and WT200 (CS) are not necessary. However, we recommend that you wire so that the cable can be used in either direction.

4. CTS-DTR(CS-ER)



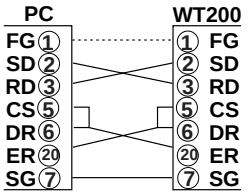
Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

5. CTS-RTS(CS-RS)



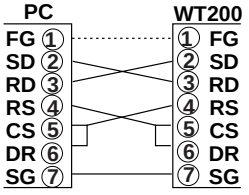
Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

6. DSR-DTR(DR-ER)



Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

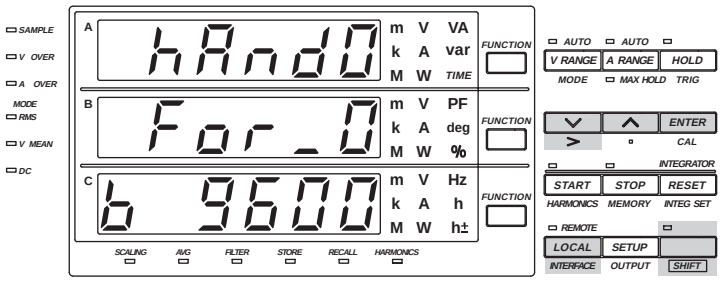
7. DSR-RTS(DR-RS)



Remove the wiring from FG (①), when erroneous operation occurs due to noise or other interference.

11.3 Setting the Mode, Handshaking Method, Data Format and Baud Rate

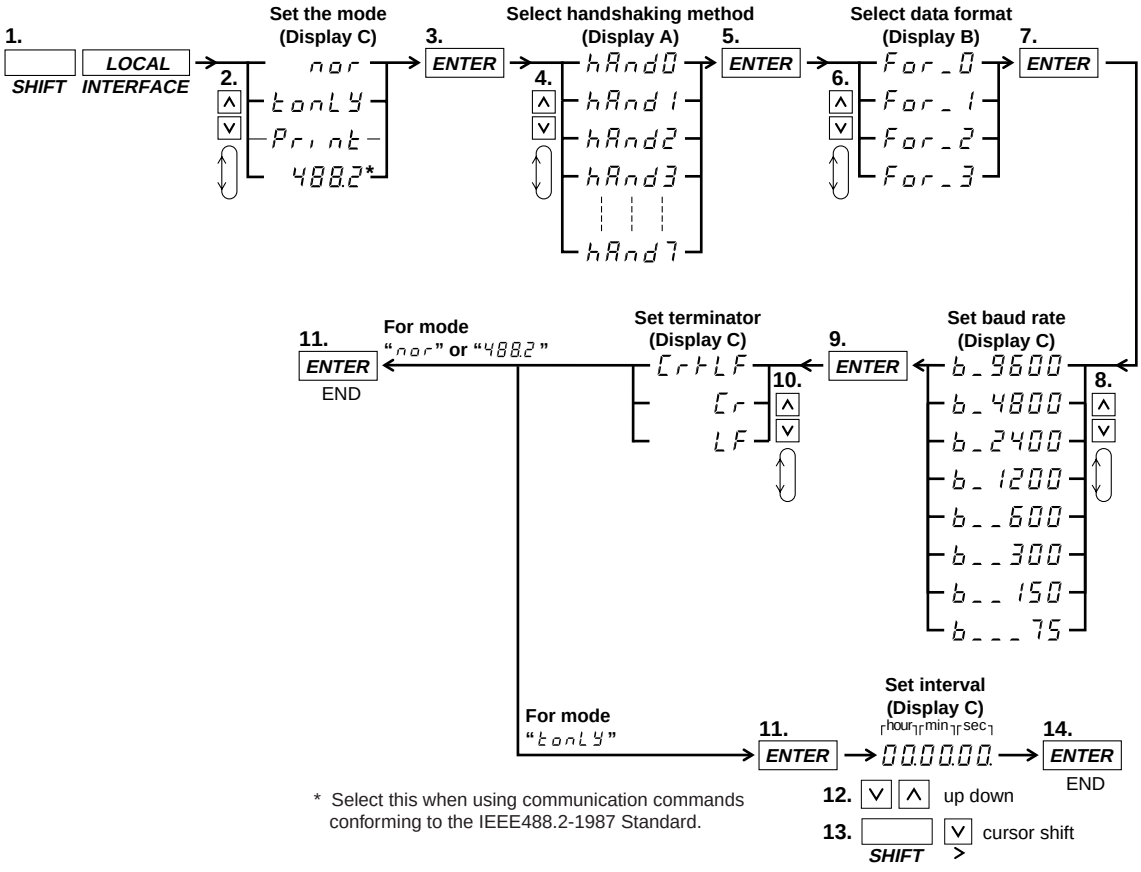
Relevant keys



Displays relevant keys and indicator

Operating Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



* Select this when using communication commands conforming to the IEEE488.2-1987 Standard.

Explanation

Mode Setting

For details, see section 11.1.

Handshaking

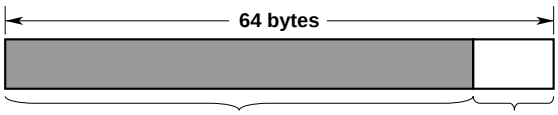
To use an RS-232-C interface to transfer data between this instrument and a computer, it is necessary to use certain procedures by mutual agreement to ensure the proper transfer of data. These procedures are called “handshaking”. Various handshaking systems are available depending on the computer to be used; the same handshaking system must be used for both computer and this instrument. This instrument allows you to choose any handshaking method from the following eight using the panel keys.

Handshaking method combinations (a circle indicates that the function is available)

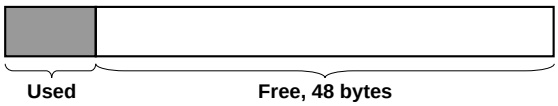
Mode selection no.	Data sending control (Control method when sending data to computer)				Data receiving control (Control method when receiving data from computer)			
	Software handshake	Hardware handshake		No handshake	Software handshake	Hardware handshake		No handshake
	Sending stops when X-off is received, and sending is resumed when X-on is received.	Sending stops when CB (CTS) is False, and sending is resumed when CB is True.	Sending stops when CC (DSR) is False,and sending is resumed when CC is True.		X-off is sent when received data buffer becomes 3/4-full, and X-on is sent when received data buffer becomes 1/4-full.	CD(DTR) is set to False when received data buffer becomes 3/4-full, and is set to True when received data buffer becomes 1/4-full.	CA(RTS) is set to False when received data buffer becomes 3/4-full, and is set to True when received data buffer becomes 1/4-full.	
0	—	—	—	yes	—	—	—	yes
1	yes	—	—	—	yes	—	—	—
2	yes	—	—	—	—	yes	—	—
3	yes	—	—	—	—	—	yes	—
4	—	yes	—	—	—	yes	—	—
5	—	yes	—	—	—	—	yes	—
6	—	—	yes	—	—	yes	—	—
7	—	—	yes	—	—	—	yes	—

Precautions Regarding Data Receiving Control

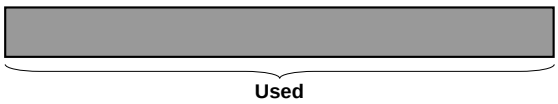
When handshaking is used to control received data, data may still be sent from the computer even if the free space in the receive buffer drops below 16 bytes. In this case, after the receive buffer becomes full, the excess data will be lost, whether handshaking is in use or not. Data storage to the buffer will start again when there is free space in the buffer.



When handshaking is in use,reception of data will stop when the free space in the buffer drops to 16 bytes since data cannot be passed to the main program fast enough to keep up with the transmission.



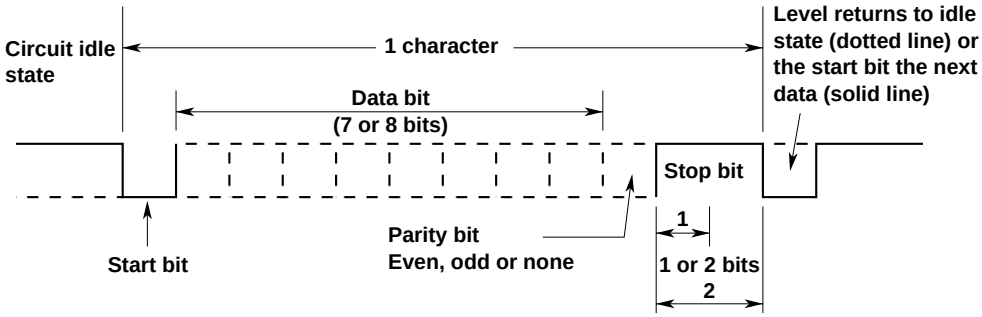
After reception of data stops, data continues to be passed to the internal program. Reception of data starts again when the free space in the buffer inceases to 48 bytes.



Whether handshaking is in use or not, if the buffer becomes full, any additional data received is no longer stored and is lost.

Data Format

The RS-232-C interface of this instrument performs communications using start-stop synchronization. In start-stop synchronization, one character is transmitted at a time. Each character consists of a start bit, data bits, a parity bit, and a stop bit. See the figure below.



The table below shows the data format combinations supported.

Preset value	Start bit	Data length	Parity	Stop bit
0	1	8	No	1
1	1	7	Odd	1
2	1	7	Even	1
3	1	7	No	2

Baud Rate

The baud rate can be selected from 75, 150, 300, 600, 1200, 2400, 4800 or 9600.

About the Terminator

Data can be received with either “CR+LF” or “LF” terminator. For transmission terminator, you can select from “CR+LF,” “LF,” and “CR.”

Interval

In case of the talk-only mode, this setting specifies the interval to send data.
Setting range: 00.00.00 (0 hr 0 min 0 sec) to 99.59.59 (99 hrs 59 min 59 sec)
Initial value: 00.00.00

Note

The error code 390 may appear depending on the status of this instrument. In such a case, lower the baud rate.

11.4 Format and Commands of Output Data (before the IEEE 488.2-1987 Standard)

Output Format

The format of output data is the same as for the GP-IB interface. For details, see section 10.4.

Commands

The commands used for the RS-232-C interface are identical to those used for the GP-IB interface, except for the following commands.

DL/DL?<terminator>

Sets or inquires about output data terminator.

Syntax DLm <terminator>
"m" indicates terminator
m= 0: CR + LF
1: LF
2: CR

Query DL?<terminator>

Example DL1

Note

If a value outside the setting range is set, an error code will appear.

The interface message function of the GP-IB interface is assigned to the following commands at the RS-232-C interface.

<ESC>S<terminator>

Equivalent to GP-IB's serial poll function. Status byte is output when the S command is received following reception of the <ESC> code (1BH).

<ESC>R<terminator>

Equivalent to GP-IB's remote/local control function. The instrument is placed in remote status and panel keys become invalid when the R command is received following reception of the <ESC> code (1BH). Press the LOCAL key to exit from the remote status.

<ESC>L<terminator>

Equivalent to GP-IB's remote/local control function. When the instrument is in remote status, the instrument will be placed in local status when the L command is received following reception of the <ESC> code (1BH).

<ESC>C<terminator>

Equivalent to GP-IB's device clear function. The communication devices of this instrument are initialized when the C command is received following reception of the <ESC> code (1BH).

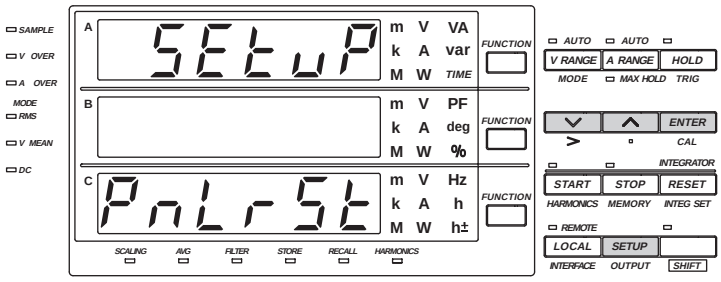
12.1 Back-up of Setting Parameters

In order to protect setting parameters in case of a power failure and such, this instrument is equipped with a lithium battery which protects these parameters. The following setting parameters are being kept.

Voltage range
Current range
Measurement mode of voltage and current
Data hold
Filter ON/OFF
Measurement synchronization source
Scaling ON/OFF
MAX hold function ON/OFF
PT/CT scaling constant
External sensor scaling constant
Averaging ON/OFF
Averaging type
Averaging sample number/attenuation constant
Computing Equation of MATH function
Display function for each display
Number of displayed digits
Integration mode
Integration type
Integration timer preset time
Integration value
Elapsed time of integration
Data stored in internal memory
Storage interval
Recalling interval
Output items for plotter/communication
Harmonic analysis ON/OFF (only when equipped with the harmonic analysis option)
PLL source (only when equipped with the harmonic analysis option)
D/A output items (only when equipped with the D/A output option)
D/A rated integration time (only when equipped with the D/A output option)
Comparator determination function (only when equipped with the comparator option)
Comparator determination limit value (only when equipped with the comparator option)
Communication output mode
Delimiter
Header
Output interval in case of talk-only
GP-IB address (when GP-IB (optional) is installed)
Handshaking method (when RS-232-C (optional) is installed)
Data format (when RS-232-C (optional) is installed)
Baud rate (when RS-232-C (optional) is installed)

12.2 Initializing Setting Parameters

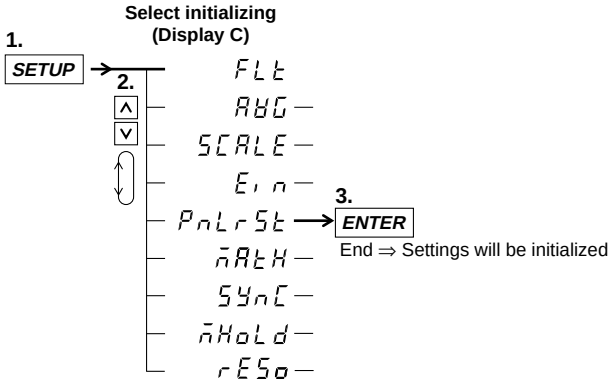
Keys



Displays relevant keys and indicator

Procedure

- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.



Explanation

Initializing Setting Parameters

Setting parameters will be initialized as soon as the ENTER key is being pressed in the procedure described above. The initial settings are as follows.

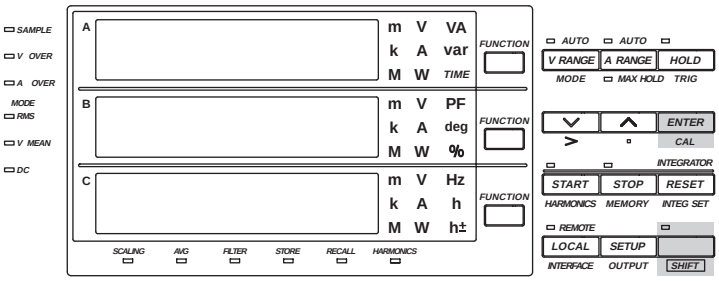
Item	Initial setting
Display A	Display function: V
Display B	Display function: A
Display C	Display function: W
Number of displayed digits	Lo (4 digits)
Number of displayed digits	4 digits
Filter	OFF
Measurement synchronization source	A
Measurement range	Auto range
Measurement mode	RMS
Hold	OFF
MAX hold	OFF
PC/CT scaling constant	P: 1.000, C: 1.000, F: 1.000 scaling ON/OFF: OFF
External sensor scaling constant	50.00A
Averaging	Averaging type: exponential, attenuation constant: 8 Averaging ON/OFF: OFF
MATH computing equation	WT200: Voltage crest factor
Frequency	VHz
Integration	Reset condition, integration mode: manual, integration type: standard Integration preset time: 0 hr, 0 min, 0 s
Harmonic analysis (option)	PLL source: V1, harmonic distortion factor computation format: IEC, Harmonic analysis function ON/OFF: OFF
Storage/recalling	Interval: 0hr 0min 0sec, storage/recalling ON/OFF: OFF
D/A output (option)	Output items: normal measurement items, rated integration time: 1 hr, 0 min, 0 sec
Comparator (option)	Mode: single, limit item: (V1, A1, P1, PF1), limit value: section 9.6, display function ON/OFF: OFF
Data output	Communication, item: normal measurement setting
GP-IB	Addressable mode: A, address: 1, status byte:15, delimiter: 0
RS-232-C	Normal mode, handshaking mode: 0, format: 0, Baud rate: 9600, delimiter: 0, status byte: 15

Note

Be careful since measurement data will be lost when initializing. However, measurement data or setting parameters stored in the internal memory will be kept.

12.3 Performing Zero Level Compensation

Keys



Displays relevant keys and indicator

Procedure

[ ] [ENTER] (Execute zero level compensation)
SHIFT CAL

Explanation

Zero level compensation

This function is used to create a zero input condition using the internal circuit of the instrument and setting the level at that point to zero level. Zero level compensation must be performed to meet the specifications of this instrument (see chapter 16).

- Press the SHIFT key to turn ON the indicator to the left of the SHIFT key and then press the ENTER key to perform zero level compensation.
- Zero compensation is also performed the first time a measurement is made after changing the measurement range.

Note

- For making accurate measurements, we recommend zero level compensation to be performed after warming up the instrument for at least 30 minutes. In addition, the ambient temperature need to be within the specifications (see chapter 16) and stable.
- If the measurement mode, measurement range, and input filter are not changed over a long period of time, the zero level may change due to the changes in the environment surrounding the instrument. We recommend zero level compensation to be performed in this case.

13.1 Commands

AA/AA? Sets the current auto range ON or OFF or queries the current setting.

Syntax AA m<terminator>
"m" indicates auto range ON/OFF
m=0 :auto range OFF (fixed range)
1 :auto range ON
Query AA?<terminator>
Example AA0
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- Auto range is not allowed while integration is in progress; execution error 13 will occur.
- If the range is changed during auto range mode, manual range mode will be validated instead of auto range mode.
- If integration is started during auto range mode, auto range mode will be invalidated.
- Auto range mode is not allowed if the external sensor range is selected; execution error 14 will occur.
- While recalling is in progress, execution error 19 will occur.

AC/AC? Sets attenuation constant or queries the current setting. The constant set is used as the attenuation constant for exponential averaging, or as the number of data for moving averaging.

Syntax AC m<terminator>
"m" indicates attenuation constant
m= 1:8
2:16
3:32
4:64
Query AC?<terminator>
Example AC1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

AG/AG? Determines whether or not averaging should be performed or queries the current setting.

Syntax AG m<terminator>
"m" indicates if averaging is ON or OFF
m= 0:OFF
1:ON
Query AG?<terminator>
Example AG1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- Averaging cannot be set to ON while integration is in progress; Error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

AT/AT? Sets averaging type (exponential or moving) or queries the current setting.

Syntax AT m<terminator>
"m" indicates averaging type
m= 0:Exponential averaging
1:Moving averaging
Query AT?<terminator>
Example AT1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

AV/AV? Sets the voltage auto range ON or OFF or queries the voltage setting

Syntax AV m<terminator>
"m" indicates auto range ON/OFF
m= 0:auto range OFF (fixed range)
1:auto range ON
Query AV?<terminator>
Example AV0
Description
- Auto range is not allowed while integration is in progress; execution error 13 will occur.
- If the range is changed during auto range mode, manual range mode will be validated instead of auto range mode.
- If integration is started during auto range mode, auto range mode will be invalidated.
- While recalling is in progress, execution error 19 will occur.

CM/CM? Selects scaling constants simultaneously, individual setting command group, or 2533E setting command group for command data which come after this command or queries the current setting.

Syntax CM m<terminator>
"m" indicates command group used.
m= 0: Command/output format group (scaling constant simultaneous setting command group)
1: Command/output format group by element (scaling constant individual setting command group)
2: 2533E command/output group
Query CM?<terminator>
Example CM1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- The output format of the WT200 is the same for m=0 or 1.

DA/DA? Sets the function for display A or queries the current setting.

Syntax
DA m<terminator>
"m" indicates one of the following functions.
• During normal measurement
m= 1:voltage (V)
2:current (A)
3:power (W)
4:reactive power (var)
5:apparent power (VA)
15:Integration time (TIME)
• During harmonic analysis
m= 1: Each relative harmonic content of 1st to 50 (or 30) th order of voltage (V)
2: Each relative harmonic content of 1st to 50 (or 30) th order of current (A)
3: Each relative harmonic content of 1st to 50 (or 30) th order of active power (W)
28: harmonic analysis order (order)

Query
DA?<terminator>

Example
DA1

Description
Parameter error 12 will occur if "m" is set to an illegal value.

DB/DB? Sets the function for display B or queries the current setting.

Syntax
DB m<terminator>
"m" indicates one of the following functions.
• During normal measurement
m= 1:voltage (V)
2:current (A)
3:power (W)
6:power factor (PF)
11:phase angle (deg)
• During harmonic analysis
m= 1: Analysis value of each component of voltage (V)
2: Analysis value of each component of current (A)
3: Analysis value of each component of active power (W)
6: power factor (PF)
16: harmonic distortion factor of voltage (V THD)
17: harmonic distortion factor of current (A THD)
19: Relative harmonic content of each voltage component (V %)
20: Relative harmonic content of each current component (A %)
21: Relative harmonic content of each active power component (W %)
22: Phase angle between each voltage of the 2nd to 50 (or 30) th order and the fundamental (1st order) voltage.
23: Phase angle between each current of the 2nd to 50 (or 30) th order and the fundamental (1st order) current.

Query
DB?<terminator>

Example
DB1

Description
Parameter error 12 will occur if "m" is set to an illegal value.

DC/DC? Sets the function for display C/inquires about the current setting

Syntax
DC m<terminator>
"m" indicates one of the following functions.
• During normal measurement
m= 1:voltage (V)
2:current (A)
3:power (W)
7:Input voltage frequency (V Hz)
8:Input current frequency (A Hz)
9:watt hour (Wh)
10:ampere hour (Ah)
12:Peak voltage value (Vpk)*
13:Peak current value (Apk)*
14:Computation result (MATH)*
24:positive watt hour (Wh+)
25:negative watt hour (Wh−)
26:positive ampere hour (Ah+)
27:negative ampere hour (Ah−)
• During harmonic analysis
m= 1: Rms value of the 1st to 50 (or 30) th order of voltage (V)
2: Rms value of the 1st to 50 (or 30) th order of current (A)
3: Rms value of the 1st to 50 (or 30) th order of active power (W)
7: Input voltage frequency (V Hz)
8: Input current frequency (A Hz)

Query
DC?<terminator>

Example
DC1

Description
Parameter error 12 will occur if "m" is set to an illegal value.

DF/DF? Sets the computation method for harmonic distortion (THD) or queries the current setting.

Syntax
DF m<terminator>
"m" indicates the computation method for harmonic distortion (see to section 7.2)
m= 0:IEC
1:CSA

Query
DF?<terminator>

Example
DF0

Description
• Parameter error 12 will occur if "m" is set to an illegal value.
• While recalling or storing is in progress, execution error 19 will occur.

DL/DL? Sets the terminator for communication output data or queries the current setting.

Syntax
DL<terminator>
"m" indicates terminator

		GP-IB	RS-232-C
m=	0:	CR+LF+EOI	CR+LF
	1:	LF	LF
	2:	EOI	CR

Query
DL?<terminator>

Example
DL0

Description Parameter error 12 will occur if “m” is set to an illegal value.

DR/DR? Displays the current range.

Syntax DR m<terminator>
“m” indicates the range.
m= 0: cancels the range display and returns to measurement display
1: displays voltage, current and shunt value of element 1 on display A, B and C respectively.
Query DR?<terminator>
Example DR0
Description Parameter error 12 will occur if “m” is set to an illegal value.

DS/DS? Sets the number of displayed digits or queries the current setting.

Syntax DS m<terminator>
m indicates the number of digits.
m= 0: 4 digits
1: 5 digits
Query DS?<terminator>
Example DS0
Description Parameter error 12 will occur if “m” is set to an illegal value.

DY/DY? Sets the display for comparator ON/OFF, or inquires about the current setting.

Syntax DY m<terminator>
“m” indicates display for comparator ON/OFF
m= 0:cancels the display for comparator
1:sets the display for comparator ON
Query DY?<terminator>
Example DY1
Description Parameter error 12 will occur if “m” is set to an illegal value.

EA/EA? Sets the element for display A or queries the current setting.

Syntax EA m<terminator>
“m” indicates element.
m= 1:Element 1
Query EA?<terminator>
Example EA1
Description Parameter error 12 will occur if “m” is set to an illegal value.

EB/EB? Sets the element for display B or queries the current setting.

Syntax EB m<terminator>
“m” indicates element.
m= 1:Element 1
Query EB?<terminator>
Example EB1
Description Parameter error 12 will occur if “m” is set to an illegal value.

EC/EC? Sets the element for display C or queries the current setting.

Syntax EC m<terminator>
“m” indicates element.
m= 1:Element 1
Query EC?<terminator>
Example EC1
Description Parameter error 12 will occur if “m” is set to an illegal value.

E,ST,<interface message GET> Generates a trigger.

Syntax E<terminator>
ST<terminator>
<interface message GET>
Description This command is valid only during sample hold mode.

FL/FL? Determines whether or not filter is used or queries the current setting.

Syntax FL m<terminator>
“m” indicates whether filter is ON or OFF.
m= 0:OFF
1:ON
Query FL?<terminator>
Example FL1
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- Filter cannot be switched ON or OFF while integration is in progress; error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

HD/HD? Determines whether or not output data should be updated or queries the current setting.

Syntax HD m<terminator>
“m” indicates the sampling mode.
m= 0: Updates the data at each sampling rate.
1: Hold
Query HD?<terminator>
Example HD0
Description Parameter error 12 will occur if “m” is set to an illegal value.

H/H? Determines whether or not to add a head to measured data output via communication or queries the current setting.

Syntax H m<terminator>
“m” indicates whether a header is added or not.
m= 0:No header added
1:Header added
Query H?<terminator>
Example H0
Description Parameter error 12 will occur if “m” is set to an illegal value.

HA/HA? Determines whether or not to turn ON the harmonic analysis function or queries the current setting.

Syntax HA m<terminator>
"m" indicates whether the harmonic analysis function or normal measurement function is set.
m= 0:Normal measurement
1:Harmonic analysis
Query HA?<terminator>
Example HA1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- When integration is in progress or being aborted, harmonic analysis cannot be performed; error 13 will occur.
- Integration cannot be started when the harmonic analysis function is in progress; error 16 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

HE/HE? Determines the element of the harmonic analysis function or queries the current setting.

Syntax HE m<terminator>
m= 1:Element 1
Query HE?<terminator>
Example HE1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

IC/IC? Sets the integration mode or queries the current setting.

Syntax IC m<terminator>
"m" indicates one of the following integration modes.
m= 0:Normal integration mode
1:Continuous integration mode
Query IC?<terminator>
Example IC1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- Changing the integration mode is not allowed while integration is in progress; execution error 13 will occur.
- If continuous integration mode is selected, make sure that the timer preset time is set to a value larger than "0".
- If normal integration mode is selected, set the timer preset time to any desired value.
- While recalling or storing is in progress, execution error 19 will occur.

IG/IG? Sets the integration type or queries the current setting.

Syntax IG m<terminator>
"m" indicates the integration type.
m= 0:Standard
1:Advanced
Query IG?<terminator>
Example IG0
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- Cannot be changed while integration is in progress. Execution error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

IM/IM? Specifies which causes will be allowed to generate a status byte or queries the current setting.

Syntax IM m<terminator>
"m" is assigned as follows (0 ≤ m ≤ 15).
m= 1:Computation end
2:Integration end
4:Syntax error
8:OVER
Query IM?<terminator>
Example IM15
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- If more than one of these causes is to be allowed, set "m" to the sum of their individual "m" values. For instance, if all causes are to be allowed, set "m" to 15 (=1+2+4+8).

IP Stops integration.

Syntax IP<terminator>
Description
- If an attempt is made to stop integration when integration has already been interrupted (stopped), execution error 44 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

IR Resets integration.

Syntax IR<terminator>
Description
- If an attempt is made to reset integration while integration is in progress, execution error 45 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

IS Starts integration.

Syntax IS<terminator>
Description
- If an attempt is made to start integration when integration is already in progress, execution error 42 will occur.
- If a voltage or current peak overflow, or overrange takes place when an attempt is made to start integration, execution error 46 will occur, and integration will not be started.
- While recalling or storing is in progress, execution error 19 will occur.

KH/KH? Sets MAX hold function or queries the current setting.

Syntax KH m<terminator>
"m" indicates whether the MAX hold function is ON or OFF.
m= 0:OFF
1:ON

Query KH?<terminator>
Example KH0
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- While recalling is in progress, execution error 19 will occur.
- Cannot be changed in the harmonic analysis mode. Execution error 16 will occur.

KV/KV?, KA/KA?, KW/KW?

Sets the scaling constant or queries the current setting.KV is used for voltage measurement, KA for current measurement, and KW for power measurement.

Syntax When CM0 is set:
KVn<terminator>
KAn<terminator>
KWn<terminator>
When CM1 is set:
KVm,n<terminator>
KAm,n<terminator>
KWm,n<terminator>
“m” indicates element.
m= 1: Element 1
“n” indicates scaling constant.
0.001 ≤ n ≤ 9999.

Query When CM0 is set:
KV?<terminator>
KA?<terminator>
KW?<terminator>
When CM1 is set:
KV1?<terminator>
KA1?<terminator>
KW1?<terminator>

Example When CM0 is set:
KV1.000
KA1.000
KW1.000
When CM1 is set:
KV1,1.000
KA1,1.000
KW1,1.000

Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- “n” must be floating-point or integer.
- While recalling or storing is in progress, execution error 19 will occur.

MN/MN?

Sets the measurement mode for voltage and current or queries the current setting.

Syntax MN m<terminator>
“m1” indicates the measurement mode.
m1= 0: RMS
1: V MEAN (MEAN for voltage, RMS for current)
2: DC

Query MN?<terminator>
Example MN0
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- Changing of the measurement mode is not allowed while integration is in progress; execution error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

MT/MT?

Sets the computing equation of MATH function or queries the current setting.

Syntax MT m<terminator>
m indicates the computing equation.
m= 1: Crest factor of the voltage input waveform of input element 1
4: Crest factor of the current input waveform of input element 1
7: display A + display B
8: display A − display B
9: display A X display B
10: display A / display B
11: display A / (display B)^2
12: (display A)^2 / display B
13: Average power during integration

Query MT?<terminator>
Example MT1
Description The value for the average power (m=13) is displayed only when the integration is in progress.

OA/OA?

Sets D/A output items or queries the current settings. Up to 4 measured data can be selected and output as analog signal from the D/A converter.

Syntax OA m1,m2,m3<terminator>
“m1” indicates D/A output channel, and must be set within the following range.
1 ≤ m1 ≤ 4
“m2” indicates output item no.
m2= 0:No output
1:Voltage (V)
2:Current (A)
3:Power (W)
4:Reactive power (var)
5:Apparent power (VA)
6:Power factor (PF)
7:Input voltage frequency (V Hz)
8:Input current frequency (A Hz)
9:Watt-hour (Wh)
10:Ampere-hour (Ah)
11:Phase angle (deg)
12:Peak voltage value (Vpk)*
13:Peak current value (Apk)*
14:Computation result (MATH)*
24:Positive watt-hour (Wh+)
25:Negative watt-hour (Wh−)
26:Positive ampere-hour (Ah+)
27:Negative ampere-hour (Ah−)
“m3” indicates element.
m= 1:Element 1

Query OA1?<terminator>
Example OA1,3,2
Description
- Parameter error 12 will occur if any of “m1”, “m2” and “m3” is set to an illegal value.
- If computation result is selected and the MATH computing equation is set to anything other than efficiency (MT0),the D/A output is fixed to 0 (V).

OAD/OAD?

Initializes D/A output items or queries the current settings. Two sets of default settings are available: one is for normal measurement and the other is for integration. The same initialization can also be performed using a key operation.

Syntax OAD m<terminator>
“m” indicates default no.
m= 2:Select mode
0:Default for normal measurement
1:Default for integration
Query OAD?<terminator>
Example OAD1
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- Select mode (OAD2) is validated when the OA command is executed if “m” has been set to “0” (default for normal measurement) or “1” (default for integration).

OD

Requests output of measurement data.

Syntax OD<terminator>
Description The OD command should be used only in addressable mode A. If the OD command is used in addressable mode B, execution error 11 will occur. Setting the addressable mode should be done using a key operation.

OE

Requests output of error codes via communications.

Syntax OE<terminator>
Example ERR011<terminator>

Error code	Description
011	Command error
012	Parameter error
013	Attempted to change settings which cannot be changed while integration was in progress.
014	Attempted to set auto range mode while external sensor range was selected.
015	Attempted to execute a command that was protected.
016	Attempted to execute a command that was protected while harmonic analysis was being performed.
017	Time-out in print output.
018	Not in printing mode, or no data available.
019	Attempted to execute commands while recalling/storing is in progress.
030	File data failure
031	File is damaged.
032	Not stored in internal memory.
033	No data to be stored in internal memory.
041	Attempted to start integration when integration had been stopped due to an irregularity.
042	Attempt made to start integration during integration.
043	Measurement stopped due to overflow during integration or due to a power failure.
044	Attempt made to stop integration while integration was interrupted.
045	Attempt made to reset integration while integration was in progress.
046	Attempt made to start integration when peak overflow was detected.
051	Measurement data overflow occurred. “-oL” is displayed.
052	Voltage peak overflow occurred
053	Current peak overflow occurred
054	Power factor exceeded “2”. “PFErr” is displayed.
055	“degErr” was displayed.
056	Frequency input level was too low or below measurement range. “ErrLo” is displayed.
057	Frequency was above the measurement range. “ErrHi,” is displayed.
058	Computation overflow occurred. “–oF–” is displayed.
059	When harmonic analysis is carried out, “FrqEr” is displayed

OF/OF?

Sets communication output information types or queries the current settings. Up to 14 measured data can be selected and output.

Syntax OF m1,m2,m3<terminator>
“m1” indicates communication output channel, and must be set within the following range.
1 ≤ m1 ≤ 14
“m2” indicates output type no.
m2= 0 :No output
1: Voltage (V)
2: Current (A)
3: Power (W)
4: Reactive power (var)
5: Apparent power (VA)
6: Power factor (PF)
7: Input voltage frequency (V Hz)
8: Input current frequency (A Hz)
9: Watt-hour (Wh)
10: Ampere-hour (Ah)
11: Phase angle (deg)
12: Peak voltage value (Vpk)*
13: Peak current value (Apk)*
14: Computation result (MATH)*
15: Elapsed time of integration
24: Positive watt-hour (Wh+)
25: Negative watt-hour (Wh–)
26: Positive ampere-hour (Ah+)
27: Negative ampere-hour (Ah–)
“m3” indicates element.
m3= 1: Element 1

Query OF1?<terminator>
Example OF1,3,2
Description • Parameter error 12 will occur if “m1”, “m2” or “m3” is set to an illegal value.

OFD/OFD?

Initializes communication output information type or queries the current settings. Two sets of default setting are available.

Syntax OFD m<terminator>
“m” indicates default no.
m= 2: Select mode (valid only for the inquiry command)
0: Default for normal measurement
1: Default for integration
Query OFD?<terminator>
Example OFD1
Description • Parameter error 12 will occur if “m” is set to an illegal value.
• Select mode (OFD2) is validated when the OF command is executed if “m” is set to “0” (default for normal measurement) or “1” (default for integration).
• If you select default for normal measurement, the output of channel 13 is the information on the frequency target function that is currently measured, and the output of channel 14 is the information displayed on display C. If you change either the frequency measurement target or display information of display C, the output also changes.

OH/OH?

Sets communication output items during harmonic analysis or queries the current settings.

Syntax OH m1,m2<terminator>
“m1” indicates output type no.
• During print mode
m1= 1: (V) outputs voltage analysis value and relative harmonic content as a numerical value
2: (A) outputs current analysis value and relative harmonic content as a numerical value
3: (W) outputs active power analysis value and relative harmonic content as a numerical value
4: (deg) outputs the phase angle as a numerical value
5: (GV) outputs voltage analysis value as numerical value and graph
6: (GA) outputs current analysis value as numerical value and graph
7: (GW) outputs active power analysis value as numerical value and graph
8: (GVD) outputs the phase angle between the 2nd to 50 (or 30) th order voltage and the fundamental (1st order) as numerical value and graph
9: (GAD) outputs the phase angle between the 2nd to 50 (or 30) th order current and the fundamental (1st order) as numerical value and graph
10: (CGV) outputs the relative harmonic content of voltage as numerical value and graph
11: (CGA) outputs the relative harmonic content of current as numerical value and graph
12: (CGW) outputs the relative harmonic content of active power as numerical value and graph
13: (ALL) outputs the relative harmonic content and analysis value of both voltage and current
• During any other mode
m1= 1 :(V) outputs voltage analysis value and relative harmonic content as a numerical value
2 :(A) outputs current analysis value and relative harmonic content as a numerical value
3 :(W) outputs active power analysis value and relative harmonic content as a numerical value
4 :(deg) outputs the phase angle between the first order voltage(current) and the 2nd to 50 (or 30) th voltage(current) as a numerical value
5 :(GV) outputs voltage analysis value and relative harmonic content as numerical value
6: (GA) outputs current analysis value and relative harmonic content as numerical value
7: (GW) outputs active power analysis value and relative harmonic content as numerical value
8: (GVD) outputs the phase angle between the first order voltage(current) and the 2nd to 50 (or 30) th voltage(current) as a numerical value
9: (GAD) outputs the phase angle between the first order voltage(current) and the 2nd to 50 (or 30) th voltage(current) as a numerical value
10: (CGV) outputs the analysis value of voltage and relative harmonic content as numerical value
11: (CGA) outputs the analysis value of current and relative harmonic content as numerical value
12: (CGW) outputs the analysis value of active power and relative harmonic content as numerical value
13: (ALL) outputs the relative harmonic content and analysis value of both voltage and current

"m2" indicates element
m2= 1: Element 1

Query OH?<terminator>

Example OH13,1

Description Parameter error 12 will occur if "m1" or "m2" is set to an illegal value.

OR/OR? Designates the harmonic order of the harmonic component shown on display B (V,A,W,V %, A%, W%, V deg, A deg) or queries the current settings.

Syntax OR m<terminator>
"m" indicates the harmonic order
m=any number between 1 to 50 (or 30)

Query OR?<terminator>

Example OR50

Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- Depending on the fundamental frequency of the PLL source set as the input, the maximum number of orders varies.
- When an order exceeding the maximum has been set, display B will show [——].

OS Requests output of setting parameters via communications.

Syntax OS<terminator>

Example

Line 1: Model name
MODEL253421<terminator>
Line 2: Voltage range
RV9;AV1<terminator>
Line 3: Current range
When CM0 is set:
RA9;AA1;SA50.00<terminator>
When CM1 is set:
RA9;AA1;SA1,50.00<terminator>
Line 4: Display function
DA1;DB2;DC3<terminator>
Line 5: Element
EA1;EB1;EC1<terminator>
Line 6: Measurement condition
WR2;FL0;SC0;AG0;HD0;MT1
<terminator>
Line 7: Measurement mode
MN0<terminator>
Line 8: Scaling constant
When CM0 is set:
KV1.000;KA1.000;KW1.000
<terminator>
When CM1 is set:
KV1,1.000;KA1,1.000;KW1,1.000
KV2,1.000;KA2,1.000;KW2,1.000;
KV3,1.000;KA3,1.000;KW3,1.000
<terminator>
Line 9: Averaging setting
AT1;AC1<terminator>
Line 10: Integration setting
IC0;TM0,0<terminator>
Line 11: Storing/recalling setting
SO0;SR0,0,0;RO0;RR0,0,0<terminator>
Line 12: Command group used
CM0<terminator>
Line 13: Measurement synchronization source, integration type, MAX hold
SN0;IG0;KH0;DS1<terminator>
Line 14: Output end
END<terminator>

Description
- The number of lines varies depending on the options used.
- When the harmonic analysis option is used, the following line must be installed before the used command group.
PS1;HA0;OR1;HE1;DF0<terminator>
- When the D/A output option is used, the following line must be inserted before the used command group.
RT1,0,0<terminator>
- When the comparator option is used, the following line must be inserted before the used command group.
YO0;YM1;DY0;YC1<terminator>

OY/OY? Sets the relay output items during normal measurement or queries the current setting. Up to four items can be set.

Syntax OY m1,m2,m3,m4,m5<terminator>
"m1" indicates the output relay channel
1 ≤ m1 ≤ 4
"m2" indicates the output item number
m2= 0: no output
1: Voltage (V)
2: Current (A)
3: Power (W)
4: Reactive power (var)
5: Apparent power (VA)
6: Power factor (PF)
7: Input voltage frequency (V Hz)
8: Input current frequency (A Hz)
9: Watt-hour (Wh)
10: Ampere-hour (Ah)
11: Phase angle (deg)
12: Peak voltage value (Vpk)*
13: Peak current value (Apk)*
14: Computation result (MATH)*
24: Positive watt-hour (Wh+)
25: Negative watt-hour (Wh−)
26: Positive ampere-hour (Ah+)
27: Negative ampere-hour (Ah−)
"m3" indicates element.
m= 1: Element 1
"m4" indicates setting value.
0.000 ≤ m4 ≤ ±9999
"m5" indicates prefix
m5= 0: m(E-3)
1: (E+0)
2: k(E+3)
3: M(E+6)

Query OY1?<terminator>
Example OY1,1,1,600.0,1
Description Parameter error 12 will occur if “m” is set to an illegal value.

OYH/OYH? Sets the relay output items during harmonic analysis or queries the current setting. Up to four items can be set.

Syntax OYH m1,m2,m3,m4,m5,m6<terminator>
“m1” indicates the output relay channel
1 ≤ m1 ≤ 4
“m2” indicates the output item number
m2= 0: no output
1: Voltage (V)
2: Current (A)
3: Power (W)
6: Power factor (PF)
16: harmonic distortion factor of voltage (V THD)
17: harmonic distortion factor of current (A THD)
19: Relative harmonic content of each voltage component (V %)
20: Relative harmonic content of each current component (A %)
21: Relative harmonic content of each active power component (W %)
22: Phase angle between each voltage of the 2nd to 50 (or 30) th order and the fundamental (1st order) voltage (V deg)
23: Phase angle between each current of the 2nd to 50 (or 30) th order and the fundamental (1st order) current (A deg)
“m3” indicates element.
m= 1: Element 1
“m4” indicates order of the harmonic.
m4 =any number between 1 and 50 (or 30)
“m5” indicates setting value.
0.000 ≤ m5 ≤ ±9999
“m6” indicates prefix.
m6= 0: m(E-3)
1: (E+0)
2: k(E+3)
3: M(E+6)
Query OYH3?<terminator>
Example OYH3,3,1,1,1,200,2
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- “No output” is not related to any element, order or setting value, so in case the OYH command is set, set these all to 1 as a dummy.
- “PF”, “VTHD” and “ATHD” are not related to any order, so in case the OYH command is used, set 1 as a dummy.

PS/PS? Sets the input as the PLL source or queries the current setting.

Syntax PS m<terminator>
“m” indicates the input as the PLL source
m= 1: V1
2: A1
Query PS?<terminator>
Example PS1
Description
- Parameter error 12 will occur if any illegal value is set.
- While recalling or storing is in progress, execution error 19 will occur.

RA/RA? Sets current range or queries the current setting.

Syntax RA m<terminator>
“m” indicates current range.
m= 4: 0.5 A range
5: 1 A range
6: 2 A range
7: 5 A range
8: 10 A range
9: 20 A range
15: 50 mV range (only when equipped with option /EX2)
16: 100 mV range (only when equipped with option /EX2)
17: 200 mV range (only when equipped with option /EX2)
18: 2.5 V range (only when equipped with option /EX1)
19: 5 V range (only when equipped with option /EX1)
20: 10 V range (only when equipped with option /EX1)
21: 5 mV
22: 10 mV
23: 20 mV
24: 50 mV
25: 100 mV
26: 200 mV
Query RA?<terminator>
Example RA9
Description
- Parameter error 12 will occur if “m” is set to an illegal value.
- Changing of the current range is not allowed while integration is in progress; execution error 13 will occur.
- The 50 mV, 100 mV and 200 mV or 2.5 V, 5 V and 10 V ranges are for the external sensor. When using any of these ranges, be sure to set a valid sensor value using the SA command.
- While recalling or storing is in progress, execution error 19 will occur.

RC Initializes setting parameters.

Syntax RC<terminator>

RO/RO? Sets the recall function ON/OFF or inquires about the current setting.

Syntax
```
RO m<terminator>
"m" indicates recall ON or OFF.
 m=  0:  recall OFF
     1:  recall ON
```
Query
```
RO?<terminator>
```
Example
```
RO1
```
Description
- Parameter error 12 will occur if "m" is set to an illegal value.

RR/RR? Sets the recall interval or queries the current setting.

Syntax
```
RR m1,m2,m3<terminator>
"m1" indicates the hour
 0 ≤ m1 ≤ 99
"m2" indicates the minutes
 0 ≤ m2 ≤ 59
"m3" indicates the seconds
 0 ≤ m3 ≤ 59
```
Query
```
RR?<terminator>
```
Example
```
RR0,0,0
```
Description
- Parameter error 12 will occur if an illegal value is set.
- When the recall interval is set to 0 hrs, 0 min, 0 sec, the interval will be 250 msec during normal measurement and 1s during harmonic analysis.
- While recalling or storing is in progress, execution error 19 will occur.

RT/RT? Sets the rated integration time when integrated values are to be output as an analog signal or queries the current setting.

Syntax
```
RT m1,m2,m3<terminator>
"m1" indicates hour, and must be set
within the following range.
 0 ≤ m1 ≤ 10000
"m2" indicates minute, and must be set
within the following range.
 0 ≤ m2 ≤ 59
"m3" indicates second, and must be set
within the following range.
 0 ≤ m3 ≤ 59
```
Query
```
RT?<terminator>
```
Example
```
RT1,0,0
```
Description
- Parameter error 12 will occur if an illegal value is set.
- The maximum selectable time is 10000 (hours).

RV/RV? Sets voltage range or queries the current setting.

Syntax
```
RV m<terminator>
"m" indicates voltage range.
 m=  3:  15V range
     4:  30 V range
     5:  60 V range
     7:  150 V range
     8:  300 V range
     9:  600 V range
```
Query
```
RV?<terminator>
```
Example
```
RV9
```
Description
- Parameter error 12 will occur if an illegal value is set.
- Changing of the voltage range is not allowed while integration is in progress; execution error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

SA/SA? Sets the external sensor scaling constant or queries the current setting.

Syntax
```
When CM0 is set:
  SA n<terminator>
When CM1 is set:
  SA m,n<terminator>
"m" indicates element.
 m=  1:  Element 1
"n" indicates external sensor scaling
constant.
 0.001 ≤ n ≤ 9999.
```
Query
```
When CM0 is set:
 SA?<terminator>
When CM1 is set:
 SAm?<terminator>
```
Example
```
When CM0 is set:
 SA50.00
When CM1 is set:
 SA1,50.00
```
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

SC/SC? Determines whether or not to use the scaling function or queries the current setting.

Syntax
```
SC m<terminator>
"m" indicates whether scaling is ON or
OFF.
 m=  0:  OFF
     1:  ON
```
Query
```
SC?<terminator>
```
Example
```
SC1
```
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

SL Recalls setting parameters from a selected file.

Syntax
```
SL m<terminator>
"m" indicates file no., and must be set
within the following range.
 1 ≤ m ≤ 4
```
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- It is not possible to recall communications-related information (communication mode, address etc.) using this command.
- While recalling or storing is in progress, execution error 19 will occur.

SN/SN? Sets the measurement synchronization source or queries the current setting.

Syntax SN m<terminator>
"m" indicates the type of measurement synchronization source.
m= 0: V (voltage)
1: A (current)
Query SN?<terminator>
Example SN0
Description Parameter error 12 will occur if "m" is set to an illegal value.

SO/SO? Sets the store function ON/OFF or inquires about the current setting.

Syntax SO m<terminator>
"m" indicates whether storage is ON or OFF.
m= 0:OFF
1:ON
Query SO?<terminator>
Example SO1
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- While recalling or storing is in progress, execution error 19 will occur.

SR/SR? Sets the storage interval or queries the current setting.

Syntax SR m1,m2,m3<terminator>
"m1" indicates the hour
0 ≤ m1 ≤ 99
"m2" indicates the minutes
0 ≤ m2 ≤ 59
"m3" indicates the seconds
0 ≤ m3 ≤ 59
Query SR?<terminator>
Example SR0,0,0
Description
- Parameter error 12 will occur if an illegal value is set.
- When the storage interval is set to 0hrs, 0min, 0sec, see page 8-2.
- While recalling or storing is in progress, execution error 19 will occur.

SS Stores setting parameters into a selected file.

Syntax SS m<terminator>
"m" indicates file no., and must be set within the following range.
1 ≤ m ≤ 4
Description
- Parameter error 12 will occur if "m" is set to an illegal value.
- The following setting parameters can be stored:
  All setting parameters which can be output by the OS command
  Information related to communications (GP-IB, RS-232-C etc.)
- While recalling or storing is in progress, execution error 19 will occur.

TM/TM? Sets integration preset time or queries the current setting.

Syntax TM m1,m2,m3<terminator>
"m1" indicates hour, and must be set within the following range.
0 ≤ m1 ≤ 10000
"m2" indicates minute, and must be set within the following range.
0 ≤ m2 ≤ 59
"m3" indicates second, and must be set within the following range.
0 ≤ m3 ≤ 59
Query TM?<terminator>
Example TM0,0,0
Description
- Parameter error 12 will occur if an illegal value is set.
- While recalling or storing is in progress, execution error 19 will occur.
- The maximum selectable time is 10000 (hours).

WR/WR? Sets the wiring system or queries the current setting.

Syntax WR m<terminator>
m= 1: 1Φ2W
Query WR?<terminator>
Example WR1
Description Parameter error 12 will occur if an illegal value is set.

YC/YC? Sets the display channel while the comparator function is ON or queries the current setting.

Syntax YC m<terminator>
"m" indicates the channel number for display
• During single mode
m= 1: Displays limit and measurement value on display 1
2: Displays limit and measurement value on display 2
3: Displays limit and measurement value on display 3
4: Displays limit and measurement value on display 4
• During dual mode
m= 1,2:Displays limit and measurement value on display 1 and 2 respectively
m= 3,4:Displays limit and measurement value on display 3 and 4 respectively
Query YC?<terminator>
Example YC1
Description Parameter error 12 will occur if "m" is set to an illegal value.

YM/YM? Sets the mode of the comparator function or queries the current setting.

Syntax YM m<terminator>
"m" indicates the display mode
m= 0: Single mode
1: Dual mode
Query YM?<terminator>
Example YM0

Description Parameter error 12 will occur if “m” is set to an illegal value.

YO/YO? Sets the comparator function ON/OFF or inquires about the current setting.

Syntax `YO m<terminator>`
“m” indicates whether the comparator function is ON/OFF
m= 0: OFF
1: ON

Query `YO?<terminator>`

Example `YO1`

Description Parameter error 12 will occur if “m” is set to an illegal value.

ZC Performs zero level compensation.

Description
- When integration is in progress, execution error 13 will occur.
- While recalling is in progress, execution error 19 will occur.

13.2 Sample Program

Before Programming

This section describes sample programs for a IBM PC/AT and compatible system with National Instruments GPIB-PCIIA board installed. Sample programs in this manual are written in Quick BASIC version 4.0/4.5

Programming Format

The programming format for this instrument is as follows.

Command + Parameter + Terminator

The used codes are ASCII codes.

Example	**DA**	**2**	**CR LF**
	command	parameter	terminator

Commands

One to three capital characters are used to designate a command.

Parameters

Characters or numericals are in ASCII code.

Terminator

- **For GP-IB:**
  When this instrument is set to listener mode, either [CR+LF], [LF], or [EOI] can be used as the terminator.
  When this instrument is set to talker mode, the terminator set using the DL command becomes valid. See page 13-2.
- **For RS-232-C:**
  See page 11-8 and 13-2.

Sending Several Commands

You can express several commands on one line. In such a case, enter a ";" (semicolon) between two commands (command + parameter).

Note

It makes no difference whether a space, tab or similar is entered between command and parameter.

Query

A command followed by a "?" (question mark) is called a query command. When such a command is sent, the current data will appear.

Query		Current data
DA?	⇒	**DA1**

Parameter Values

Up to 5 digits after the decimal point will be recognized.

Sample Program

```
'*************************************************************************
'*                                                                       *
'*      WT200 DIGITAL POWER METER                                        *
'*                                                                       *
'*  Used to set measurement condition/ranges for normal mesurement mode, *
'*  and read and display the following data each time measured/computed data  *
'*  is updated.                                                          *
'*                                                                       *
'*************************************************************************

    REM $INCLUDE: 'qbdecl.bas'

    DECLARE SUB gpiberr (msg$)

    PRINT ""

    CALL IBDEV(0, 1, 0, T10s, 1, 0, DEV%)
    IF (DEV% <= 0) THEN CALL gpiberr("Ibdev error")

' interface clear
    CALL IBCLR(DEV%)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr error")

' set measurement condition
' hold off , filter off , scaling off , averaging off
    WRT$ = "HD0;FL0;SC0;AG0"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set displaying data
    WRT$ = "DA1;DB2;DC3"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set voltage range
    WRT$ = "RV7"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set current range
    WRT$ = "RA7"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set measurement mode
    WRT$ = "MN0"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set the communication output function (normal),
' and output delimitter (CR+LF+EOI)
    WRT$ = "OFD0;DL0"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' read measurement data
    FOR I = 1 TO 5
        MASK% = &H4800
        CALL IBWAIT(DEV%, MASK%)
        IF (ibsta% AND (EERR OR TIMO)) THEN CALL gpiberr("Ibwait error")
        WRT$ = "OD"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
RDDAT:
        RD$ = SPACE$(255)
        CALL IBRD(DEV%, RD$)
```

```
        IF (ibsta% AND EERR) THEN
            CALL gpiberr("Ibrd error")
        ELSE
            RD$ = LEFT$(RD$, ibcnt% - 2)
            PRINT RD$
            IF (RD$ <> "END") GOTO RDDAT
        END IF
    NEXT I

'STOP
'END
'
'
'*******************************************************
'*  read measurement data used service request         *
'*                                                     *
'*******************************************************

    PRINT ""

' interface clear
    CALL IBCLR(DEV%)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr error")

' SRQ interrupt enable
    WRT$ = "IM1"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' statusbyte initialize
    CALL IBRSP(DEV%, SPR%)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrsp error")

    FOR J = 1 TO 10
SBWAIT:
        MASK% = &H4800
        CALL IBWAIT(DEV%, MASK%)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwait error")

' read status byte
        CALL IBRSP(DEV%, SPR%)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrsp error")
        IF (SPR% <> &H41) GOTO SBWAIT

' read mesurement data
        WRT$ = "OD"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
RDDAT2:
        RD$ = SPACE$(255)
        CALL IBRD(DEV%, RD$)
        IF (ibsta% AND EERR) THEN
            CALL gpiberr("Ibrd error")
        ELSE
            RD$ = LEFT$(RD$, ibcnt% - 2)
            PRINT RD$
            IF (RD$ <> "END") GOTO RDDAT2
        END IF
    NEXT J

'  Call the IBONL function to disable the hardware and software.
    CALL IBONL(DEV%, 0)
END
```

```
'*************************************************************
'*                                                           *
'* WT200 range adjust program                                *
'* [SHIFT] + power on                                        *
'*                                                           *
'*************************************************************

    REM $INCLUDE: 'qbdecl.bas'

    DECLARE SUB gpiberr (msg$)

    PRINT ""

    CALL IBDEV(0, 1, 0, T10s, 1, 0, DEV%)
    IF (DEV% <= 0) THEN CALL gpiberr("Ibdev error")

' interface clear
    CALL IBCLR(DEV%)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr error")
    IO = 0
    RTN = 0

' display main menu
MENU:
    CLS
    PRINT "main menu of range adjust"
    PRINT ""
    PRINT "1: adjust normal mesurement range"
    PRINT "2: adjust sensor range"
    PRINT "0: end"
    PRINT "Command >> "; : LINE INPUT C$
    IF C$ = "1" THEN GOSUB RANGE: GOTO RESTART
    IF C$ = "2" THEN GOSUB SHUNT: GOTO RESTART
    IF C$ = "0" THEN END
RESTART:
    GOTO MENU
END:
    STOP: END

' display measured data for adjust normal mesurement range
ODDISP:
    PRINT "1: refresh adjusted data"
    PRINT "0: back to previous display"
WRTDATA:
    WRT$ = "OD"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
    LOCATE 15, 1
RDDATA:
    RD$ = SPACE$(255)
    CALL IBRD(DEV%, RD$)
    IF (ibsta% AND EERR) THEN
        CALL gpiberr("Ibrd error")
        GOTO ENDODDISP
    ELSE
        RD$ = LEFT$(RD$, ibcnt% - 2)
        PRINT RD$
        IF (RD$ <> "END") GOTO RDDATA
    END IF
    GOSUB WAITING
    IF C$ = "1" THEN
        WRT$ = "ENT"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        RTN = 0: GOTO ENDODDISP
    ELSE IF C$ = "0" THEN RTN = 0: GOTO ENDODDISP
    END IF
    GOTO WRTDATA
```

```
ENDODDISP:
    RETURN

' display measured data for adjust sensor range
ODDISPEX:
    PRINT "S: refresh and save adjusted data"
    PRINT "C: cancel (not save)"
WRTDATAEX:
    WRT$ = "OD"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
    LOCATE 15, 1
RDDATAEX:
    RD$ = SPACE$(255)
    CALL IBRD(DEV%, RD$)
    IF (ibsta% AND EERR) THEN
        CALL gpiberr("Ibrd error")
        GOTO ENDODDISPEX
    ELSE
        RD$ = LEFT$(RD$, ibcnt% - 2)
        PRINT RD$
        IF (RD$ <> "END") GOTO RDDATAEX
    END IF
    GOSUB WAITING
    IF C$ = "S" THEN
        WRT$ = "ENT"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        WRT$ = "END"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        RTN = 1: GOTO ENDODDISPEX
    ELSEIF C$ = "C" THEN
        WRT$ = "CAN"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        RTN = 1: GOTO ENDODDISPEX
    END IF
    GOTO WRTDATAEX
ENDODDISPEX:
    RETURN

' adjust normal mesurement range
RANGE:
    WRT$ = "CAL1"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
RANGESEL:
    CLS
    PRINT "range adjust"
    PRINT ""
    PRINT "1: 30.00 V range"
    PRINT "2: 300.0 V range"
    PRINT "3: 1.000 A range"
    PRINT "4: 10.00 A range"
    PRINT "5: 100.0mA range"
    PRINT "S: save adjusted data"
    PRINT "C: cancel(not save)"
    PRINT "Command >> "; : LINE INPUT C$
    IF C$ = "1" THEN
        WRT$ = "CR0"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO DISPDATA
    ELSEIF C$ = "2" THEN
        WRT$ = "CR1"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
```

```
        GOTO DISPDATA
    ELSEIF C$ = "3" THEN
        WRT$ = "CR2"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO DISPDATA
    ELSEIF C$ = "4" THEN
        WRT$ = "CR3"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO DISPDATA
    ELSEIF C$ = "5" THEN
        WRT$ = "CR6"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO DISPDATA
    ELSEIF C$ = "S" THEN
        WRT$ = "END"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO ENDRANGE
    ELSEIF C$ = "C" THEN
        WRT$ = "CAN"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO ENDRANGE
    END IF
    GOTO RANGESEL
DISPDATA:
    GOSUB ODDISP
    IF RTN = 0 THEN GOTO RANGESEL
    IF RTN = 1 THEN GOTO ENDRANGE
ENDRANGE:
    RETURN

' adjust sensor range
SHUNT:
CAL2WRT:
    WRT$ = "CAL2"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
    GOSUB ODDISPEX
    IF RTN = 0 THEN GOTO CAL2WRT
    IF RTN = 1 THEN GOTO ENDSHUNT
ENDSHUNT:
    RETURN

' wait input from keyboard
WAITING:
    C$ = ""
    FOR J = 0 TO 500
    C$ = INKEY$: IF C$ <> "" THEN GOTO PRTCOMMAND
    NEXT J
PRTCOMMAND:
    IF C$ <> "" THEN PRINT C$
    RETURN
```

```
'*************************************************************
'*                                                           *
'* WT200 DA output adjust program                            *
'* [SHIFT] + power on                                        *
'*                                                           *
'*************************************************************

    REM $INCLUDE: 'qbdecl.bas'

    DECLARE SUB gpiberr (MSG$)

    PRINT ""

    CALL IBDEV(0, 1, 0, T10s, 1, 0, DEV%)
    IF (DEV% <= 0) THEN CALL gpiberr("Ibdev error")

' interface clear
    CALL IBCLR(DEV%)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr error")
    IO = 0
    RTN = 0

    GOSUB DACAL
    STOP: END

' subroutine to adjust DA output
DACAL:
    WRT$ = "CAL3"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

' display main menu
RESTART:
    CLS
    CH$ = ""
    PRINT "DA output adjust"
    PRINT ""
    PRINT "1-12 : Specify DA channel"
    PRINT "S    : Save adjusted data"
    PRINT "C    : Cancel(Not save adjusted data)"
    PRINT "Command >> "; : LINE INPUT CH$
    IF CH$ = "S" THEN
        WRT$ = "END"
        CALL IBWRT(DEV%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO ENDDACAL
    ELSEIF CH$ = "C" THEN
        WRT$ = "CAN"
        CALL IBWRT(DEV%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")
        GOTO ENDDACAL
    END IF
    CH = VAL(CH$)
    IF CH < 1 OR CH > 12 THEN GOTO RESTART
    CH$ = STR$(CH)
```

```
' +5V output on selected channel
    WRT$ = "CH" + CH$
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "DO0"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    PRINT ""
    PRINT "+5V output on channel"; CH$
    PRINT "Please measure voltage of channel"; CH$
    PRINT "measurement data = "; : LINE INPUT D$

    WRT$ = "CD" + CH$ + "," + D$
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    FOR I = 0 TO 2000: NEXT I

    WRT$ = "ENT"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

' -5V output on selected channel
    WRT$ = "DO1"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    PRINT ""
    PRINT "-5V output is doing on channel"; CH$
    PRINT "Please measure voltage of channel"; CH$
    PRINT "measurement data = "; : LINE INPUT D$

    WRT$ = "CD" + CH$ + "," + D$
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    FOR I = 0 TO 2000: NEXT I
    WRT$ = "ENT"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

    GOTO RESTART
ENDDACAL:
    RETURN
```

13.3 For Users Using Communication Commands of Digital Power Meter 2533E

The WT200 differ from the 2533E in communication commands and data format. The WT200 has a function which enables the user to use communication programs created for the 2533E. This function is described below.

Communication Commands

Under usual conditions, the 2533E commands cannot be used. The “CM” command should be set to CM2 to be able to use the 2533E commands (for details about the CM command, see section 13.1, “Commands” (page 13-1)).

Description is given below in alphabetical order of those commands which differ from the WT200 when the 2533E group is selected.

Note

- For addressable mode setting method, see pages 10-1 and 10-11.
- WT200 code format is used for error code and status byte. For details, see to page 10-4 and 15-12. The WT200 code format differs from 2533E code format.
- To read harmonic analysis data via RS-232-C interface, select a value other than “0” for handshake mode since harmonics analysis data consists of a number of output bytes.

DS **Sets the delimiter EOI output timing. This command is used with the 2533E, but cannot be used with the WT200 even if the 2533E group is selected by the “CM” command.**

MN/MN? **Sets the measurement mode/inquires about the current setting.**

Syntax
```
MN m<terminator>
m stands for measurement mode.
 m=  0:RMS
     1:V MEAN
     2:DC
```
Query
```
MN?<terminator>
```
Example
```
MN0
```
Description Parameter error 12 will occur if “m” is set to an illegal value.

OL **Requests output of setting parameters. Output format differs from that of the 2533E**

Syntax
```
OL<terminator>
```
Example
```
MODEL253421<terminator>
RV9;AV1<terminator>
RV9;AA1;SA50.00<terminator>
DA1;DB2;DC3<terminator>
EA1;EB1;EC1<terminator>
WR2;FL0;SC0;AG0;HD0;MT0<terminator>
MN0<terminator>
KV1.000;KA1.000;KW1.000<terminator>
AT1;AC1<terminator>
IC0;TM0,0,0<terminator>
SO0;SR0,0,0;RO0;RR0,0,0<terminator>
PS1;HA0;OR1;HE1;DF0<terminator>
RT1,0,0<terminator>
YO0;YM1;DY0;YC1<terminator>
CM2<terminator>
SN1;IG0;KH0;DS1<terminator>
END<terminator>
```

OS **Requests output of setting parameters. This command cannot be used if 2533E command group is selected by the “CM” command. However, in this case the “OL” command can be used instead.**

WR/WR? **Sets the wiring system/inquires about the current setting.**

Syntax
```
WR m<terminator>
m stands for the wiring system.
m=    2:  1Φ2W
```
Query
```
WR?<terminator>
```
Example
```
WR0
```
Description Parameter error 12 will occur if “m” is set to an illegal value.

Output Items

To read measurement data using the 2533E communication program, the WT200 addressable mode B must be set. Output items do no match those displayed on each display as in the WT200, but match those set for ch.1 to ch.3 in output function setting for the WT200. Select output items according to the 2533E communication programs.

Note

- WT200 output items for ch.4 and subsequent ch. nos. are not output.
- For details regarding the setting of output items, see section 10.4.

Data Output Format

Data consists of a 12-byte header and 12 bytes of data.

The entire data output format is shown below.

ch.1 header	ch.1 data	,	ch.2 header	ch.2 data	,	ch.3 header	ch.3 data

- **Header Section**

h1	h2	h3	h4	h5	h6	h7	h8	h9	h10	h11	h12

h1 to h2: Output channel

DA: ch1 DB: ch2 DC: ch3

h3 to h4: Data type

1: V (voltage)	7 : HzV (voltage frequency)	13: Peak current value (Apk)*
2: A (current)	8 : HzA (current frequency)	14: Computation result (MATH)*
3: W (power)	9 : Wh (watt hour)	15: HMS (elapsed time of integration)
4: var (reactive power)	10: Ah (ampere hour)	24: Wh+ (positive watt hour)
5: VA (apparent power)	11: DEG (phase angle)	25: Wh– (negative watt hour)
6 : PF (power factor)	12: Peak voltage value (Vpk)*	26: Ah+ (positive ampere hour)
		27: Ah– (negative ampere hour)

Note

If “15” is set to h3 and h4 while “DB” is set to h1 and h2, “DB4_” is output to h1 through h4. This is done to conform to 2533E format.

h5 to h6: Output channel

EA: ch1 EB: ch2 EC: ch3

h7: Element

1: element 1 _: no element

h8: Data state

N: normal I: overrange/no data O: computation overflow

h9 to h11: Unit

V_ _: V VA_: VA DEG: DEG Ah_: Ah Ah+: Ah+ Ah–: Ah–

A_ _: A HZ_: Hz Vpk: Vpk HM_: elapsed time of integration

W_ _: W Wh_: Wh Wh+: Wh+ Wh–: Wh– Apk: Apk

VAR: var Computation result*

* CV1, CA1, A+B, A–B, A*B, A/B, A/2(meaning A/B^2), A2/(meaning A^2/B)

h12: fixed to “,”

- **Output Section**

d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12

d1: Polarity: _ (space) or – (minus)
d2 to d9: Mantissa, floating decimal of max. 7 digits
d10 to d12: Exponent

E-3 ⇒ m
E+0
E+3 ⇒ k
E+6 ⇒ M
% – – for efficiency(EFF)

14.1 Overview of IEEE 488.2-1987

The GP-IB interface provided with this instrument conforms to IEEE 488.2-1987. This standard requires the following 23 points be stated in this document. This chapter describes these points.

(1) Subsets supported by IEEE 488.1 interface functions
See the specifications on page 10-2.

(2) Operation of device when the device is assigned to an address other than one of the addresses 0 to 30
This instrument does not allow assignment to an address other than 0 to 30.

(3) Reaction when the user initializes address settings.
Change of the current address is acknowledged when a new address is set using the INTERFACE key menu (see page 10-11). The newly set address is valid until another new address is set.

(4) Device set-up at power ON. Commands which can be used at power ON
Basically, the previous settings (i.e. the settings which were valid when power was turned OFF) are valid. All commands are available at power ON.

(5) Message transmission options

(a) Input buffer size and operation
The input buffer's capacity is 1024 bytes.

(b) Types of queries which return multiple response messages
See the examples of each command in section 14.3.

(c) Types of queries which generate response data during analysis of the syntax
Every query generates response data when analysis of the syntax is performed.

(d) Types of queries which generate response data during reception
No query generates response data when it is received by the controller.

(e) Types of commands which have pairs of parameters.
No such commands.

(6) List of function elements which configure commands used for the device. All those which are included in elements of composite command program headers
See sections 14.2 and 14.3.

(7) Buffer size which affects transmission of block data
Block data are not supported.

(8) List of program data elements which can be used in equations and nesting limit
Cannot be used.

(9) Syntax of response data to queries
See the examples of each command in section 14.3.

(10) Communication between devices which do not follow the rules regarding response data
No other modes than conforming to IEEE 488.2-1987 are supported (see section 10.1).

(11) Size of data block of response data
Block data are not supported.

(12) List of supported common commands
See section 14.3.15, "Common Command Group."

(13) Condition of device when calibration is successfully completed
Enters a measurement-in-progress condition.

(14) Maximum length of block data which can be used for definition of trigger macro when *DDT is used
*DDT is not supported.

(15) Maximum length of macro label if macro definition is used; maximum length of block data which can be used for definition of macro; processing when recursion is used in definition of macro
Macro functions are not supported.

(16) Response to *IDN?
See section 14.3.15, "Common Command Group."

(17) Size of storage area for protected user data if PUD and *PUD? are used.
*PUD and *PUD? are not supported.

(18) Length of resource name if *RDT and *RDT? are used.
*RDT and *RDT? are not supported.

(19) Change in status if *RST, *LRN?, *RCL and *SAV are used.
*RST
See section 14.3.15, "Common Command Group."
*LRN?, *RCL, *SAV
These commands are not supported.

(20) Execution range of self-test using *TST?
See section 14.3.15, "Common Command Group."

(21) Structure of extended return status
See section 14.4.

(22) To find out whether each command is performed in parallel or sequentially
See section 14.2.6, “Synchronization with the Controller” and section 14.3.

(23) Functions performed until a message indicating completion of the command is displayed
See the function description of each command in section 14.3 and the corresponding chapters.

14.2 Program Format

14.2.1 Symbols Used in Syntax Descriptions

Symbols which are used in the syntax descriptions in section 14.3 are shown below. These symbols are referred to as BNF notation (Backus-Naur Form). For detailed information, see pages 14-7 and 14-8.

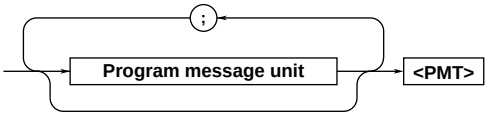
Symbol	Description	Example	Example
< >	Defined value	DISPLAY<x> <x>=1, 2	DISPLAY2
{}	One of the options in {} is selected.	MODE {RMS|VMEan|DC}	MODE RMS
|	Exclusive OR	MODE {RMS|VMEan|DC}	MODE RMS
[ ]	Abbreviated	SCALing[:STATe] {<Boolean>}	
...	may be repeated		

14.2.2 Messages

Blocks of message data are transferred between the controller and this instrument during communications. Messages sent from the controller to this instrument are called program messages, and messages sent back from this instrument to the controller are called response messages.
If a program message contains a query command, i.e. a command which requests a response, this instrument returns a response message. A single response message is always returned in reply to a program message.

Program Messages

As explained above, the data (message) sent from the controller to this instrument is called a program message. The format of a program message is shown below.



<Program message unit>

A program message consists of one or more program message units; each unit corresponds to one command. This instrument executes commbìts one by one according to the order in which they are received.
Program message units are delimited by a ";".
For a description of the format of the program message unit, see the explanation given further below.

Example :CONFIGURE:MODE RMS;FILTER ON<PMT>

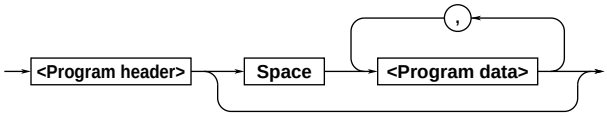
Unit Unit

<PMT>

PMT is a terminator used to terminate each program message. The following three types of terminator are available.
NL (New Line): Same as LF (Line Feed). ASCII code "0AH" is used.
^END: END message defined in IEEE488.1. (EOI signal)
(The data byte sent with an END message will be the final item of the program message unit.)
NL^END: NL with an END message attached
(NL is not included in the program message unit.)

Program message unit format

The format of a program message unit is shown below.



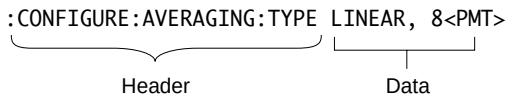
<Program header>

A program header is used to indicate the command type. For details, see page 14-5.

<Program data>

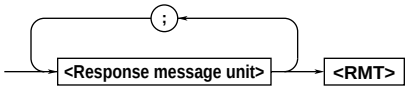
If certain conditions are required for the execution of a command, program data must be added. Program data must be separated from the header by a space (ASCII code “20H”). If multiple items of program data are included, they must be separated by a “,” (comma).

Example



Response Messages

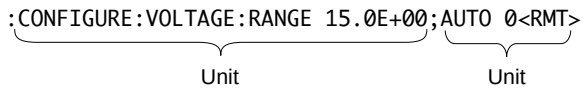
The data returned by this instrument to the controller is called a response message. The format of a response message is shown below.



<Response message units>

A response message consists of one or more response message units: each response message unit corresponds to one response.
Response message units are delimited by a “;”.
For the response message format, see the next item.

Example

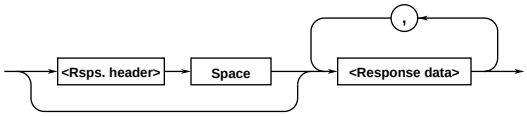


<RMT>

RMT is the terminator used for every response message. Only one type of response message is available; NL^END.

Response message unit format

The format of a program message unit is shown below.



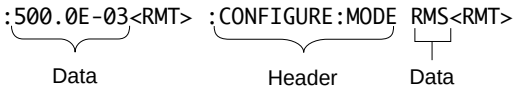
<Response header>

A response header sometimes precedes the response data. Response data must be separated from the header by a space. For details, see page 14-7.

<Response data>

Response data is used to define a response. If multiple items of response data are used, they must be separated by a “,” (comma).

Example



If a program message contains more than one query, responses are made in the same order as the queries. Normally, each query returns only one response message unit, but there are some queries which return more than one response message unit. The first response message unit always responds to the first query, but it is not always true that the ‘n‘th unit always responds to the ‘n‘th query. Therefore, if you want to make sure that a response is made to each query, the program message must be divided up into individual messages.

Points to Note concerning Message Transmission

- It is always possible to send a program message if the previous message which was sent did not contain any queries.
- If the previous message contained a query, it is not possible to send another program message until a response message has been received. An error will occur if a program message is sent before a response message has been received in its entirety. A response message which has not been received will be discarded.
- If an attempt is made by the controller to receive a response message, even if there it no response message, an error will occur. An error will also occur if the controller makes an attempt to receive a response message before transmission of a program message has been completed.
- If a program message of more than one unit is sent and some of the units are incomplete, this instrument receives program message units which the instrument thinks complete and attempts to execute them. However, these attempts may not always be successful and a response may not always be returned, even if the program message contains queries.

Dead Lock

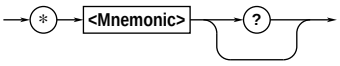
This instrument has a buffer memory in which both program and response messages of 1024 bytes or more can be stored. (The number of bytes available will vary depending on the operating state of the instrument.) If both buffer memories become full at the same time, this instrument becomes inoperative. This state is called dead lock. In this case, operation can be resumed by discarding the response message.
No dead lock will occur, if the size of the program message including the PMT is kept below 1024 bytes. Furthermore, no dead lock will occur if the program message does not contain a query.

14.2.3 Commands

There are two types of command (program header) which can be sent from the controller to this instrument. They differ in the format of their program headers.

Common Command Header

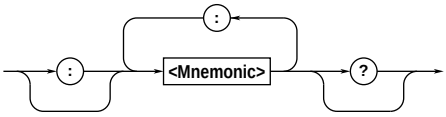
Commands defined in IEEE 488.2-1987 are called common commands. The header format of a common command is shown below. An asterisk (*) must always be attached to the beginning of a command.



An example of a common command: `*CLS`

Compound Header

Commands designed to be used only with this instrument are classified and arranged in a hierarchy according to their function. The format of a compound header is illustrated below. A colon (:) must be used when specifying a lower-level header.



An example of a compound header: `CONFIGURE:MODE RMS`

Note

A mnemonic is a character string made up of alphanumeric characters.

Consecutive Commands

Command Group

A command group is a group of commands which have the same compound header. A command group may contain sub-groups.

Example Commands relating to integration

```
INTEGrate?
INTEGrate:MODE
INTEGrate:TIMer
INTEGrate:TYPE
INTEGrate:STARt
INTEGrate:STOP
INTEGrate:RESet
```

When Consecutive Commands are in the Same Group

This instrument stores the hierarchical level of the command which is currently being executed, and performs analysis on the assumption that the next command to be sent will also belong to the same level. Therefore, it is possible to omit the header if the commands belong to the same group.

Example `DISPLAY1:FUNCTION V;ELEMENT 1<PMT>`

When Consecutive Commands are in Different Groups

A colon (:) must be included before the header of a command, if the command does not belong to the same group as the preceding command.

Example

```
DISPLAY1:FUNCTION V;:SAMPLE:HOLD ON<PMT>
```

In Case of Consecutive Common Commands

Common commands defined in IEEE 488.2-1987 are independent of hierarchical level. Thus, it is not necessary to add a colon (:) before a common command.

Example

```
DISPLAY1:FUNCTION V;*CLS;ELEMENT 1<PMT>
```

When Separating Commands by <PMT>

If a terminator is used to separate two commands, each command is a separate message. Therefore, the common header must be typed in for each command even when commands of the same command group are being sent.

Example

```
DISPLAY1:FUNCTION V<PMT>DISPLAY1:ELEMENT 1<PMT>
```

Upper-level Query

An upper-level query is a compound header to which a question mark is appended. Execution of an upper-level query allows all settings of one group to be output at once. Some query groups comprising more than three hierarchical levels can output all their lower level settings.

Example

```
INTEGRATE?<PMT>→
:INTEGRATE:MODE NORMAL;TIMER 0,0,0
```

In reply to a query, a response can be returned as a program message to this instrument.

Header Interpretation Rules

This instrument interprets the header received according to the following rules.

- Mnemonics are not case sensitive.
  Example "FUNCtion" can also be written as "function" or "Function".
- The lower-case part of a header can be omitted.
  Example "FUNCtion" can also be written as "FUNCT" or "FUNC".
- If the header ends with a question mark, the command is a query. It is not possible to omit the question mark.
  Example "FUNCtion?" cannot be abbreviated to anything shorter than "FUNC?".
- If the "x" at the end of a mnemonic is omitted, it is assumed to be "1".
  Example If "ELEMent<x>" is written as "ELEM", this represents "ELEMent1".
- Any part of a command enclosed by [ ] can be omitted.
  Example [CONFigure]:SCALing[:STATe] ON can be written as "SCAL ON".
- However, a part enclosed by [ ] cannot be omitted if is located at the end of an upper-level query.
  Example "SCALing?" and "SCALing:STATe?" belong to different upper-level query levels.

14.2.4 Responses

On receiving a query from the controller, this instrument returns a response message to the controller. A response message is sent in one of the following two forms.

- Response consisting of a header and data
  If the query can be used as a program message without any change, a command header is attached to the query, which is then returned.

  Example `INTEGRATE:MODE?<PMT>→`
  `:INTEGRATE:MODE NORMAL<RMT>`

- Response consisting of data only
  If the query cannot be used as a program message unless changes are made to it (i.e. it is a query-only command), no header is attached and only the data is returned. Some query-only commands can be returned after a header is attached to them.

  Example `STATUS:ERROR?<PMT>→`
  `0,"NO ERROR"<RMT>`

When returning a response without a header
It is possible to remove the header from a response consisting of a header and data. The "COMMunicate:HEADer" command is used to do this.

Abbreviated form
Normally, the lower-case part is removed from a response header before the response is returned to the controller. Naturally, the full form of the header can also be used. For this, the "COMMunicate:VERBose" command is used. The part enclosed by [ ] is also omitted in the abbreviated form.

14.2.5 Data

A data section comes after the header. A space must be included between the header and the data. The data contains conditions and values. Data is classified as below.

Data	Description
<Decimal>	Value expressed as a decimal number (Example: PT setting →CONFigure:SCALing PT:ELEMENT1 100)
<Voltage><Current>	Physical value (Example: Voltage range →CONFigure:VOLTage:RANge 150V)
<Register>	Register value expressed as either binary, octal, decimal or hexadecimal (Example: Extended event register value →STATus:EESE #HFE)
<Character data>	Specified character string (mnemonic). Can be selected from { } (Example: Selecting measurement mode →CONFigure:MODE {RMS|VMEan|DC})
<Boolean>	Indicates ON/OFF. Set to ON, OFF or value (Example: Averaging ON →[CONFigure]:AVERaging[:STATe] ON)
<Character string data>	Arbitrary character string (Example: Timer →INTEGrate:TIMer "100.00:00")

<Decimal>
<Decimal> indicates a value expressed as a decimal number, as shown in the table below. Decimal values are given in the NR form specified in ANSI X3. 42-1975.

Symbol	Description	Example
<NR1>	Integer	125 -1 +1000
<NR2>	Fixed point number	125.0 -.90 +001.
<NR3>	Floating point number	125.0E+0 -9E-1 +.1E4
<NRf>	Any of the forms <NR1> to <NR3> is allowed.	

- Decimal values which are sent from the controller to this instrument can be sent in any of the forms to <NR3>. In this case, <NRf> appears.
- For response messages which are returned from this instrument to the controller, the form (<NR1> to <NR3> to be used) is determined by the query. The same form is used, irrespective of whether the value is large or small.
- In the case of <NR3>, the "+" after the "E" can be omitted, but the "–" cannot.
- If a value outside the setting range is entered, the value will be normalized so that it is just inside the range.
- If the value has more than the significant number of digits, the value will be rounded.

<Voltage>, <Current>
<Voltage> and <Current> indicate decimal values which have physical significance. <Multiplier> or <Unit> can be attached to <NRf>. They can be entered in any of the following forms.

Form	Example
<NRf><Multiplier><Unit>	5MV
<NRf><Unit>	5E-3V
<NRf><Multiplier>	5M
<NRf>	5E-3

<Multiplier>

Multipliers which can be used are shown below.

Symbol	Word	Description
EX	Exa	10^{18}
PE	Peta	10^{15}
T	Tera	10^{12}
G	Giga	10^{9}
MA	Mega	10^{6}
K	Kilo	10^{3}
M	Mili	10^{-3}
U	Micro	10^{-6}
N	Nano	10^{-9}
P	Pico	10^{-12}
F	Femto	10^{-15}

<Unit>

Units which can be used are shown below.

Symbol	Word	Description
V	Volt	Voltage
A	Ampere	Current

- <Multiplier> and <Unit> are not case sensitive.
- “U” is used to indicate “μ”.
- “MA” is used for Mega (M) to distinguish it from Mili. However, when using “MA” for current, Mili-ampere will be valid; therefore use “MAA” to assign Mega-ampere.
- If both <Multiplier> and <Unit> are omitted, the default unit will be used.
- Response messages are always expressed in <NR3> form. Neither <Multiplier> nor <Unit> is used, therefore the default unit is used.

<Register>

<Register> indicates an integer, and can be expressed in hexadecimal, octal or binary as well as as a decimal number. <Register> is used when each bit of a value has a particular meaning. <Register> is expressed in one of the following forms.

Form	Example
<NRf>	1
#H<Hexadecimal value made up of the digits 0 to 9, and A to F>	#H0F
#Q<Octal value made up of the digits 0 to 7>	#q777
#B<Binary value made up of the digits 0 and 1>	#B001100

- <Register> is not case sensitive.
- Response messages are always expressed as <NR1>.

<Character Data>

<Character data> is a specified string of character data (a mnemonic). It is mainly used to indicate options, and is chosen from the character strings given in { }. For interpretation rules, see “Header Interpretation Rules” on page 14-6.

Form	Example
{RMS|VMEan|DC}	RMS

- As with a header, the “COMMunicate:VERBose” command can be used to return a response message in its full form. Alternatively, the abbreviated form can be used.
- The “COMMunicate:HEADer” command does not affect <character data>.

<Boolean>

<Boolean> is data which indicates ON or OFF, and is expressed in one of the following forms.

Form	Example
{ON|OFF|<NRf>}	ON OFF 1 0

- When <Boolean> is expressed in <NRf> form, OFF is selected if the rounded integer value is “0” and ON is selected if the rounded integer is “Not 0”.
- A response message is always “1” if the value is ON and “0” if it is OFF.

<Character String Data>

<Character string data> is not a specified character string like <Character data>. It is an arbitrary character string. A character string must be enclosed in single quotation marks (') or double quotation marks (").

Form	Example
<Character string data>	'ABC' "IEEE488.2-1987"

- Response messages are always enclosed in double quotation marks.
- If a character string contains a double quotation mark ("), the double quotation mark will be replaced by two concatenated double quotation marks (""). This rule also applies to a single quotation mark within a character string.
- <Character string data> is an arbitrary character string, therefore this instrument assumes that the remaining program message units are part of the character string if no single (') or double quotation mark (") is encountered. As a result, no error will be detected if a quotation mark is omitted.

14.2.6 Synchronization with the Controller

There are two kinds of command; overlap commands and sequential commands. Execution of an overlap command may start before execution of the previously sent command is completed.

For example, if the next program message is transmitted after the measurement range has been changed and an query is made about the measurement data, it may occur that regardless whether the measurement data have been updated, MEASure[:NORMal]:VALue? will be executed. The display becomes "——" (no data) and "9.91E+37 (Not a number)" will be output.

```
[CONFigure:]VOLTage:RANGe 60V;:
MEASure[:NORMal:VALue?<PMT>
```

In this case, synchronization with the time at which the update of measurement data is completed must be accomplished, as shown next.

Using STATus:CONDition? query

A "STATus:CONDition?" query is used to make an inquiry about the contents of the condition register (section 14.4). It is possible to judge whether updating measurement data is in progress or not by reading bit 0 of the condition register. Bit 0 is "1" if updating is in progress, and "0" if updating is stopped.

Using the extended event register

Changes in the condition register are reflected in the extended event register (section 14.4).

```
Example   STATus:FILTer1 FALL;:STATus:
          EESE 1;EESR?;
          *SRE8;[:CONFigure]:VOLTage:
          RANGe 60V<PMT>
          (Service request is awaited.)
          MEASure[:NORMal]:VALue?<PMT>
```

"STATus:FILTer1 FALL" indicates that the transit filter is set so that bit 0 is set to "1" when bit 0 (FILTer 1) of the condition register is changed from "1" to "0".

"STATus:EESE 1" is a command used only to reflect the status of bit 0 of the extended event register in the status byte.
"STATus:EESR?" is used to clear the extended event register.
The "*SRE" command is used to generate a service request caused solely by the extended event register.
"MEASure[:NORMal]:VALue?" will not be executed until a service request is generated.

Using the COMMunicate:WAIT command

The "COMMunicate:WAIT" command halts communications until a specific event is generated.

```
Example   STATus:FILTer1 FALL;:STATus:
          EESE 1;EESR?;
          [:CONFigure]:VOLTage:RANGe 60V<PMT>
          (Response to STATus:EESR? is decoded.)
          COMMunicate:WAIT 1;:
          MEASure[:NORMal] :VALue?<PMT>
```

For a description of "STATus:FILTer 1 FALL" and "STATus:EESR?", see "Using the extended event register" on this page.
"COMMunicate:WAIT 1" means that communications is halted until bit 0 of the extended event register is set to "1".
"MEASure[:NORMal]:VALue?" will not be executed until bit 0 of the extended event register is set to "1".

14.3 Commands

14.3.1 Command List

Command	Description	Page
AOUTput Group		
:AOUTput?	Queries all settings related to D/A output.	14-14
:AOUTput:CHANnel<x>	Sets/queries the D/A output item.	14-14
:AOUTput:IRTime	Sets/queries the preset integration time for D/A output of integrated values.	14-14
:AOUTput:PRESet	Sets the default value as D/A output items.	14-14
COMMunicateG roup		
:COMMunicate?	Queries all settings related to communication.	14-15
:COMMunicate:HEADer	Sets/queries whether a header is to be added.	14-15
:COMMunicate:LOCKout	Sets/cancels local lockout.	14-15
:COMMunicate:REMote	Sets remote/local condition.	14-15
:COMMunicate:STATus?	Queries the status of a specified circuit.	14-15
:COMMunicate:VERBose	Sets/queries the response to be in full or abbreviated form.	14-16
:COMMunicate:WAIT	Waits until one of the specified extended event occurs.	14-16
:COMMunicate:WAIT?	Generates a response when on of the specified extended events occurs.	14-16
CONFigure Group		
:CONFigure?	Queries all settings related to the measurement conditions.	14-18
[:CONFigure]:AVERaging?	Queries all settings related to the averaging function.	14-18
[:CONFigure]:AVERaging[:STATe]	Sets/queries averaging ON/OFF.	14-18
[:CONFigure]:AVERaging:TYPE	Sets/queries averaging type and constant.	14-18
[:CONFigure]:CURRent?	Queries all settings related to the current range.	14-18
[:CONFigure]:CURRent:AUTO	Sets/queries the current auto range ON/OFF.	14-18
[:CONFigure]:CURRent:ESCaling?	Queries all settings related to the external sensor.	14-18
[:CONFigure]:CURRent:ESCaling:ELEMent<x>	Sets/queries the scaling constants for the external sensor.	14-18
[:CONFigure]:CURRent:RANGe	Sets/queries the current range.	14-19
[:CONFigure]:FILTer	Sets/queries the filter ON/OFF.	14-19
[:CONFigure]:MHold[:STATe]	Sets/queries the MAX hold function.	14-19
[:CONFigure]:MODE	Sets/queries the measurement mode.	14-19
[:CONFigure]:SCALing?	Queries all settings related to the scaling function.	14-19
[:CONFigure]:SCALing:{PT|CT|SFACtor}?	Queries all settings related to scaling constant for {voltage|current|power}.	14-19
[:CONFigure]:SCALing:{PT|CT|SFACtor}:ELEMent<x>	Sets the scaling constants of {voltage|current|power}.	14-19
[:CONFigure]:SCALing[:STATe]	Sets/queries the scaling function ON/OFF.	14-19
[:CONFigure]:SYNChronize	Sets/queries the measurement synchronization source.	14-19
[:CONFigure]:VOLTage?	Queries all settings related to the voltage range.	14-19
[:CONFigure]:VOLTage:AUTO	Sets/queries the voltage auto range ON/OFF.	14-19
[:CONFigure]:VOLTage:RANGe	Sets/queries the voltage range.	14-20
[:CONFigure]:WIRing	Sets/queries the wiring method.	14-20
DISPlay Group		
:DISPlay<x>?	Queries all the display settings.	14-21
:DISPlay<x>:ELEMent	Sets/queries the element to be displayed.	14-21
:DISPlay<x>:FUNCtion	Sets/queries the function to be displayed.	14-21
:DISPlay<x>:MODE	Sets/queries the contents of the display.	14-21
:DISPlay<x>:RESolution	Sets/queries the number of displayed digits.	14-21

Command	Description	Page
HARMonics Group		
:HARMonics?	Queries all settings related to harmonic analysis.	14-22
:HARMonics:DISPlay?	Queries all settings related to the display in case of harmonic analysis.	14-22
:HARMonics:DISPlay:ORDer	Sets/queries the order of the harmonic component to be shown on display B.	14-22
:HARMonics:ELEMent	Sets/queries the element for harmonic analysis.	14-22
:HARMonics[:STATe]	Sets/queries the harmonic analysis mode ON/OFF.	14-22
:HARMonics:SYNChronize	Sets/queries the input to be used as PLL source.	14-22
:HARMonics:THD	Sets/queries the computation method for harmonic distortion.	14-23
INTEGrate Group		
:INTEGrate?	Queries all settings related to integration.	14-23
:INTEGrate:MODE	Sets/queries the integration mode.	14-23
:INTEGrate:RESet	Resets the integration values.	14-23
:INTEGrate:STARt	Starts integration.	14-23
:INTEGrate:STOP	Stops integration.	14-23
:INTEGrate:TIMer	Sets/queries the integration timer.	14-23
:INTEGrate:TYPE	Sets/queries the integration type.	14-23
MATH Group		
:MATH?	Queries all settings related to the computing function.	14-24
:MATH:ARIThmetic	Sets/queries the computing equation of the four arithmetic operations.	14-24
:MATH:AVERage	Sets/queries the average power computation during integration.	14-24
:MATH:CFACtor	Sets/queries the computing equation of the crest factor.	14-24
:MATH:TYPE	Sets/queries the computing equation.	14-24
MEASure Group		
:MEASure?	Queries all settings related to measurement/computation data.	14-26
:MEASure:HARMonics?	Queries all settings related to harmonic analysis data.	14-26
:MEASure:HARMonics:ITEM?	Queries all settings related to the output items of harmonic analysis data.	14-26
:MEASure:HARMonics:ITEM:PRESet	Sets the ON/OFF pattern for all communication outputs of the harmonic analysis function.	14-26
:MEASure:HARMonics:ITEM:{SYNChronize|<harmonic analysis function>}	Sets/queries the communication output item of harmonic analysis ON/OFF.	14-27
:MEASure:HARMonics:VALue?	Queries harmonic analysis data set by commands other than "MEASure:HARMonics:ITEM".	14-27
:MEASure:NORMal?	Queries all settings related to normal measured/computed data.	14-27
:MEASure[:NORMal]:ITEM?	Queries all settings related to the output items of normal measured/computed data.	14-27
:MEASure[:NORMal]:ITEM:PRESet	Sets the ON/OFF pattern for all communication outputs of the normal measurement function.	14-27
:MEASure[:NORMal]:ITEM:{TIME|MATH}	Sets/queries the ON/OFF state of the communication output of {integration time|MATH}.	14-27
:MEASure[:NORMal]:ITEM:<normal measurement function>?	Queries communication output settings of the normal measurement function.	14-27
:MEASure[:NORMal]:ITEM:<normal measurement function>:ELEMent<x>	Turns ON/OFF the communication output of the specified normal measurement function.	14-28
:MEASure[:NORMal]:VALue?	Queries normal measured/computed data set by commands other than "MEASure[:NORMal]:ITEM"	14-28

Command	Description	Page
RECall Group		
:RECall?	Queries all settings related to recalling data.	14-32
:RECall:INTerval	Sets/queries the recalling interval.	14-32
:RECall:PANel	Retrieves the setting parameters file.	14-32
:RECall[:STATe]	Sets/queries recalling ON/OFF.	14-32
RELay Group		
:RELay?	Queries all settings related to the comparator function.	14-33
:RELay:DISPLay	Sets/queries the comparator display OFF, or in case of ON, the channel to be displayed.	14-33
:RELay:HCHannel<x>?	Queries all settings related to relay output items in case of harmonic analysis.	14-33
:RELay:HCHannel<x>:FUNCtion	Sets/queries function of the relay output item in case of harmonic analysis.	14-34
:RELay:HCHannel<x>:THReshold	Sets/queries the threshold level for the relay output item.	14-34
:RELay:MODE	Sets/queries the mode of the comparator function.	14-34
:RELay:NCHannel<x>?	Queries all settings related to the relay output items in case of normal measurement.	14-34
:RELay:NCHannel<x>:FUNCtion	Sets/queries the function of the relay output in case of normal measurement.	14-34
:RELay:NCHannel<x>:THReshold	Sets/queries the threshold level for the relay output item.	14-34
:RELay:STATe	Sets/queries the comparator function ON/OFF.	14-34
SAMPle Group		
:SAMPle?	Queries all settings related to sampling.	14-35
:SAMPle:HOLD	Sets/queries to hold the output of data (display, communication).	14-35
STATus Group		
:STATus?	Queries all settings related to the status of communication.	14-36
:STATus:CONDition?	Queries the contents of the condition filter and clears it at the same time.	14-36
:STATus:EESE	Sets/queries the extended event register.	14-36
:STATus:EESR?	Queries the contents of the extended event register and clears it.	14-36
:STATus:ERRor?	Queries the occurred error code and message.	14-36
:STATus:FILTer<x>	Sets/queries the transit filter.	14-37
:STATus:QMESsage	Sets/queries whether or not to apply the corresponding message to the query “STATus:ERRor?”.	14-37
:STATus:SPOLl?(Serial Poll)	Executes serial polling.	14-37
STORe Group		
:STORe?	Queries all settings related to storing data.	14-37
:STORe:INTerval	Sets/queries the interval for storing data.	14-37
:STORe:PANel	Saves the setting parameters to a file.	14-37
:STORe[:STATe]	Sets/queries the store function ON/OFF.	14-37

Command	Description	Page
Common Command Group		
*CAL?	Performs zero level compensation and queries the result.	14-38
*CLS	Clears the standard event register, extended event register and error queue.	14-38
*ESE	Sets/queries the value of the standard event enable register.	14-38
*ESR?	Sets/queries the value of the standard event register and clears it.	14-39
*IDN?	Queries the instrument model.	14-39
*OPC	This command is not supported by this instrument.	14-39
*OPC?	This command is not supported by this instrument, and is always “1”.	14-39
*OPT?	Queries installed options.	14-39
*PSC	Sets/queries whether or not to clear some registers at power ON.	14-39
*RST	Initializes the present settings.	14-39
*SRE	Sets/queries the value of the service request enable register.	14-39
*STB?	Queries the value of the status byte register.	14-40
*TRG	Executes the same operation as the TRIG(SHIFT+HOLD) key.	14-40
*TST?	Executes a self-test and queries the results.	14-40
*WAI	This command is not supported by this instrument.	14-40

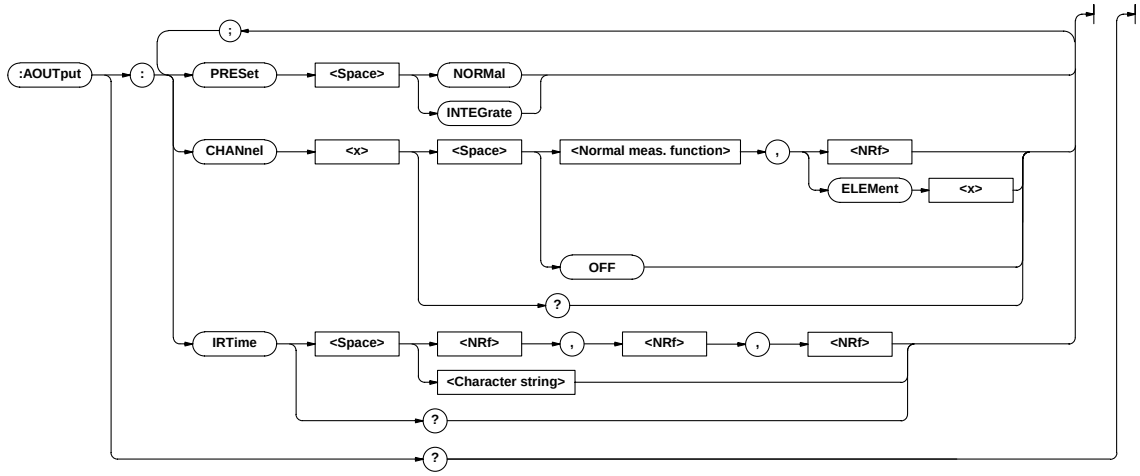
Note

In the following pages, the character strings used in the descriptions of the <normal measurement function> or the <harmonic analysis function> indicate the following data.

- <Normal measurement function>
  V: voltage, A: current, W: active power, VA: apparent power, VAR: reactive power, PF: power factor, DEGRee: phase angle, VHZ: voltage frequency, AHZ: current frequency, WH: watt hour, WHP: positive watt hour, WHM: negative watt hour, AH: ampere hour, AHP: positive ampere hour, AHM: negative ampere hour, MATH: MATH computation result, VPK: peak voltage, APK: peak current.
- <Harmonic analysis function>
  See page 14-30.
- Other
  TIME: integration time, ORDer: harmonic order

14.3.2 AOUTput Group

The commands in the AOUTput group are used to make settings relating to, and inquires about D/A output. This allows you to make the same settings and inquiries as can be set using the lower menus of [OUTPUT]-“dA” or [INTEG SET]-“dAtimE”. The commands in this group are available only if the /D4 option is installed.



AOUTput?

Function Queries all the settings relating to D/A output.
Syntax AOUTput?
Example AOUTPUT?→:AOUTPUT:CHANNEL1 V,1;
CHANNEL2 A,1;CHANNEL3 W,1;
CHANNEL4 VHZ,1;IRTIME 1,0,0

AOUTput:CHANnel<x>

Function Sets the D/A output item, or queries the current setting.
Syntax AOUTput:CHANnel<x> {<normal measurement function>,(<NRf>|ELEMent<1>)|OFF}
<x>=1 to 4 (for /DA4)
<normal measurement function>={V|A|W|VA|VAR|PF|DEGRee|VHZ|AHZ|WH|WHP|WHM|AH|AHP|AHM|MATH|VPK|APK}
Example AOUTPUT:CHANNEL1 V,1
AOUTPUT:CHANNEL1?→:AOUTPUT:CHANNEL1V,1
AOUTPUT:CHANNEL2?→:AOUTPUT:CHANNEL2 OFF

AOUTput:IRTime

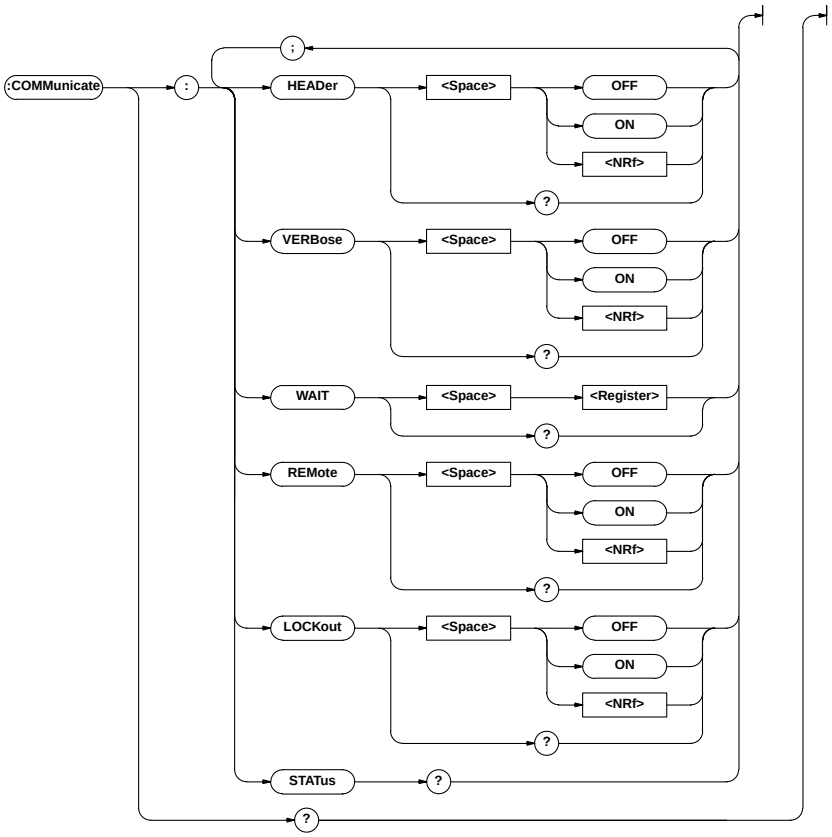
Function Sets the preset integration time for D/A output of integrated values, or queries the current setting.
Syntax AOUTput:IRTime {<NRf>,<NRf>,<NRf>|<String>}
{<NRf>,<NRf>,<NRf>}=0,0,0 to 10000,0,0
{<String>}=HHHHH:MM:SS
HHHHH hours
MM minutes
SS seconds
Example AOUTPUT:IRTIME 1,0,0
AOUTPUT:IRTIME "1:00:00"
AOUTPUT:IRTIME?→:AOUTPUT:IRTIME 1,0,0

AOUTput:PRESet

Function Initializes the output items for D/A output.
Syntax AOUTput:PREset {NORMal|INTEGrate}
NORMal=default for normal measurement
INTEGrate=default for integration
Example AOUTPUT:PRESET NORMAL
Description See section 9.3 for a description of default D/A output items for normal measurement and integration.

14.3.3 COMMunicate Group

The commands in the COMMunicate group are used to make settings relating to, and inquires about communications. There is no front panel key for this function.



COMMunicate?

Function Queries all the communication settings.
Syntax `COMMunicate?`
Example `COMMUNICATE? →:COMMUNICATE:HEADER 1; VERBOSE 1`

COMMunicate:HEADer

Function Determines whether a header is to be added (for example: "CONFIGURE:VOLTAGE:RANGE 150.0E+00"") or not (for example:150.0E+00) when sending a response to a query, or queries the current setting.
Syntax `COMMunicate:HEADer {<Boolean>}`
`COMMunicate:HEADer?`
Example `COMMUNICATE:HEADER ON`
`COMMUNICATE:HEADER? →:COMMUNICATE: HEADER 1`

COMMunicate:LOCKout

Function Sets local lockout ON or OFF.
Syntax `COMMunicate:LOCKout {<Boolean>}`
`COMMunicate:LOCKout?`
Example `COMMUNICATE:LOCKOUT ON`
`COMMUNICATE:LOCKOUT? →:COMMUNICATE: LOCKOUT 1`
Description This command is dedicated to the RS-232-C interface. An interface message is available for the GP-IB interface.

COMMunicate:REMote

Function Sets remote (ON) or local mode (OFF).
Syntax `COMMunicate:REMote {<Boolean>}`
`COMMunicate:REMote?`
Example `COMMUNICATE:REMOTE ON`
`COMMUNICATE:REMOTE?→:COMMUNICATE: REMOTE 1`
Description This command is dedicated to the RS-232-C interface. An interface message is available for the GP-IB interface.

COMMunicate:STATus?

Function Queries the status of a specified circuit.
Syntax `COMMunicate:STATus?`
Example `COMMUNICATE:STATUS?→:COMMUNICATE: STATUS 0`
Description The status condition for each bit is as follows.

bit	GP-IB	RS-232-C
0	permanent comm. error	Parity error
1	always 0	framing error
2	always 0	break character occurrence
3 and up	always 0	always 0

When a status occurs which results in changing of the bits, reading it will clear the error.

COMMunicate:VERBose

Function Determines whether a response to a query is to be returned in full form (for example:CONFIGURE: VOLTAGE:RANGE 150.0E+00), or in abbreviated form (for example: VOLT:RANG 150.0E+00), or queries the current setting.

Syntax
```
COMMunicate:VERBose {<Boolean>}
COMMunicate:VERBose?
```

Example
```
COMMUNICATE:VERBOSE ON
COMMUNICATE:VERBOSE?
→:COMMUNICATE:VERBOSE 1
```

COMMunicate:WAIT

Function Waits until one of the specified extended event occurs.

Syntax
```
COMMunicate:WAIT <Register>
<Register>= 0 to 65535 (For a
description of the extended event
register, see page 14-41.)
```

Example
```
COMMUNICATE:WAIT 65535
```

Description For a description of synchronization using "COMMunicate:WAIT", see page 14-9.

COMMunicate:WAIT?

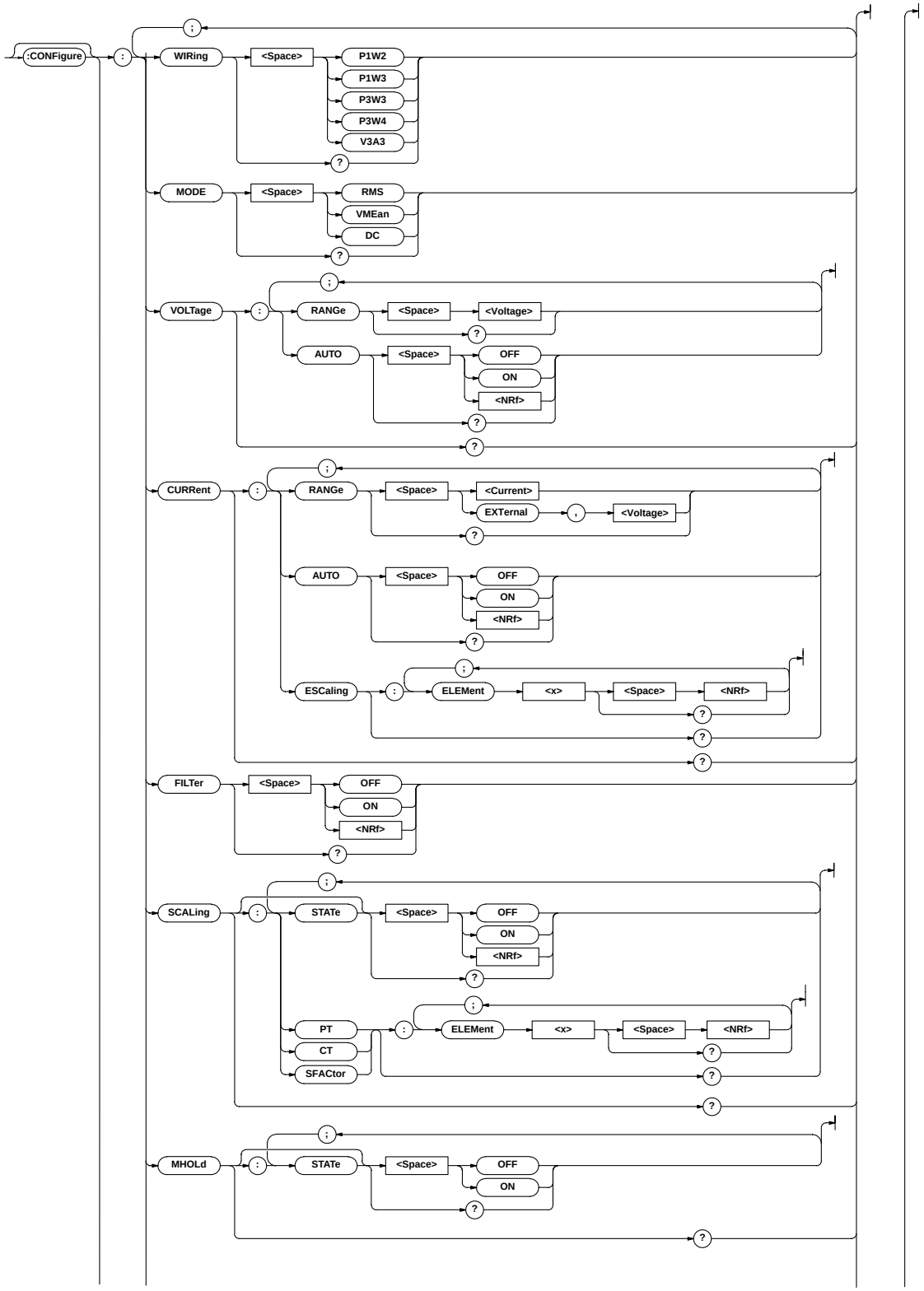
Function Generates a response when one of the specified extended events occurs.

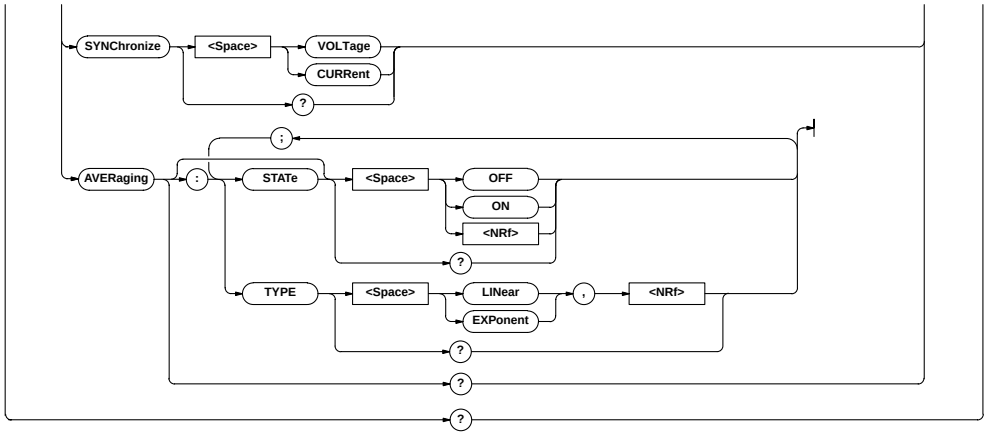
Syntax
```
COMMunicate:WAIT? <Register>
<Register>= 0 to 65535 (For a
description of the extended event
register, see section 14.4.)
```

Example
```
COMMUNICATE:WAIT? 65535→1
```

14.3.4 CONFigure Group

The CONFigure group relates to the measurement settings. The same function can be performed using the WIRING key, V RANGE key, A RANGE key, MODE (SHIFT + V RANGE) key and SETUP key (except for “PnLrSt”) on the front panel. The external sensor input range and external sensor scaling constants are only vald if equipped with the external sensor option (/EX1 or /EX2).





CONFigure?

Function Queries all the settings related to the measurement conditions.

Syntax `CONFigure?`

Example
```
CONFIGURE?Æ:CONFIGURE:WIRING P1W2;
MODE RMS;VOLTAGE:RANGE 600.0E+00;
AUTO 1;:CONFIGURE:CURRENT:
RANGE 20.0E+00;AUTO 1;ESCALING:
ELEMENT1 50.00E+00;:CONFIGURE:FILTER 0;
SCALING:STATE 0;PT:ELEMENT1 1.000E+00;:
CONFIGURE:SCALING:CT:
ELEMENT1 1.000E+00;:CONFIGURE:SCALING:
SFACTOR:ELEMENT1 1.000E+00;:CONFIGURE:
AVERAGING:STATE 0;TYPE LINEAR,8;
:CONFIGURE:SYNCHRONIZE
CURRENT;MHOLD:STATE 0
```

[CONFigure]:AVERaging?

Function Queries all the setting values related to the averaging function.

Syntax `[CONFigure]:AVERaging?`

Example
```
[CONFIGURE]:AVERAGING?→:CONFIGURE:
AVERAGING:STATE 0;TYPE LINEAR,8
```

[CONFigure]:AVERaging[:STATe]

Function Sets averaging ON/OFF, or queries the current status.

Syntax
```
[CONFigure]:AVERaging[:STATe]
{<Boolean>}
[CONFigure]:AVERaging:STATe?
```

Example
```
[CONFIGURE]:AVERAGING:STATE OFF
[CONFIGURE]:AVERAGING:STATE?→
:CONFIGURE:AVERAGING:STATE 0
```

[CONFigure]:AVERaging:TYPE

Function Sets the averaging type and constant, queries the current setting.

Syntax
```
[CONFigure]:AVERaging:TYPE {LINear|
EXPonent},{<NRf>}
[CONFigure]:AVERaging:TYPE?
```
{<NRf>}=8, 16, 32, 64 (averaging constant)

Example
```
[CONFIGURE]:AVERAGING:TYPE LINEAR,8
[CONFIGURE]:AVERAGING:TYPE?→:CONFIGURE:
AVERAGING:TYPE LINEAR,8
```

[CONFigure]:CURRent?

Function Queries all setting values relating to the current range (external sensor range)

Syntax `[CONFigure]:CURRent?`

Example
```
[CONFIGURE]:CURRENT?→:CONFIGURE:
CURRENT:RANGE 20.0E+00;AUTO 1;ESCALING:
ELEMENT1 50.00E+00
```

[CONFigure]:CURRent:AUTO

Function Sets the current auto range ON/OFF, or queries the current setting.

Syntax
```
[CONFigure]:CURRent:AUTO {<Boolean>}
[CONFigure]:CURRent:AUTO?
```

Example
```
[CONFIGURE]:CURRENT:AUTO ON
[CONFIGURE]:CURRENT:AUTO?→:CONFIGURE:
CURRENT:AUTO 1
```

[CONFigure]:CURRent:ESCaling?

Function Queries all scaling constants for the external sensor.

Syntax `[CONFigure]:CURRent:ESCaling?`

Example
```
[CONFIGURE]:CURRENT:ESCALING?
→:CONFIGURE:CURRENT:ESCALING:
ELEMENT 50.00E+00
```

[CONFigure]:CURRent:ESCaling:ELEMent<x>

Function Sets the scaling constants for the external sensor for each element separately, queries the current setting.

Syntax
```
[CONFigure]:CURRent:ESCaling:
ELEMent<x> {<NRf>}
[CONFigure]:CURRent:ESCaling:ELEMent<x>?
```
<x>= 1
{<NRf>}=0.001 to 1000

Example
```
[CONFIGURE]:CURRENT:ESCALING:
ELEMENT1 50.00
[CONFIGURE]:CURRENT:ESCALING:ELEMENT1?→
:CONFIGURE:CURRENT:ESCALING:
ELEMENT1 50.00E+00
```

Description The values are rounded as follows:
Less than 1.000: Rounded to three decimal places.
1.000 to 1000: Rounded to four significant digits.

[CONFigure]:CURRent:RANGe

Function Sets the current range (external sensor input range), queries the current setting.

Syntax
```
[CONFigure]:CURRent:RANGe
{<current>|(EXTernal,<voltage>)}
[CONFigure]:CURRent:RANGe?
<current>=5mA to 20A (5m, 10m, 20m, 50m,
100m, 200m, 0.5, 1, 2, 5, 10, 20A)
<voltage>=50mV to 200mV (50, 100, 200mV,
for /EX2 option)
          =2.5V to 10V (2.5, 5, 10V, for
/EX1 option)
```

Example
```
Setting of current range/query
[CONFIGURE]:CURRENT:RANGE 20A
[CONFIGURE]:CURRENT:RANGE?→:CONFIGURE:
CURRENT:RANGE 20.0E+00
Setting of external sensor input range/
query (for /EX2 option)
[CONFIGURE]:CURRENT:RANGE EXTERNAL,50MV
[CONFIGURE]:CURRENT:RANGE?→:CONFIGURE:
CURRENT:RANGE EXTERNAL,50.0E-03
```

[CONFigure]:FILTer

Function Sets the filter ON/OFF, queries the current setting.

Syntax
```
[CONFigure]:FILTer {<Boolean>}
[CONFigure]:FILTer?
```

Example
```
[CONFIGURE]:FILTER OFF
[CONFIGURE]:FILTER?→:CONFIGURE:FILTER 0
```

[CONFigure]:MHOLd[:STATe]

Function Sets/queries the MAX hold function.

Syntax
```
[CONFigure]:MHOLd[:STATe] {<Boolean>}
[CONFigure]:MHOLd[:STATe]?
```

Example
```
[CONFIGURE]:MHOLD:STATE OFF
[CONFIGURE]:MHOLD:STATE?→:CONFIGURE:
MHOLD:STATE 0
```

[CONFigure]:MODE

Function Sets the measurement mode of current and voltage, queries the current setting.

Syntax
```
[CONFigure]:MODE {RMS|VMEan|DC}
[CONFigure]:MODE?
```

Example
```
[CONFIGURE]:MODE RMS
[CONFIGURE]:MODE?→:CONFIGURE:
MODE RMS
```

[CONFigure]:SCALing?

Function Queries all settings relating to the scaling function.

Syntax
```
[CONFigure]:SCALing?
```

Example
```
[CONFIGURE]:SCALING?→:CONFIGURE:
SCALING:STATE 0;PT:ELEMENT1 1.000E+00;:
CONFIGURE:SCALING:CT:
ELEMENT1 1.000E+00;:
CONFIGURE:SCALING:SFACTOR:
ELEMENT1 1.000E+00
```

[CONFigure]:SCALing:{PT|CT|SFACtor}?

Function Queries all scaling constants related to {voltage|current|power}.

Syntax
```
[CONFigure]:SCALing:{PT|CT|SFACtor}?
```

Example
```
[CONFIGURE]:SCALING:PT?→:CONFIGURE:
SCALING:PT:ELEMENT1 1.000E+00
```

[CONFigure]:SCALing:{PT|CT|SFACtor}:ELEMent<x>

Function Sets the scaling constant for {voltage|current|power} of each element, queries the current setting.

Syntax
```
[CONFigure]:SCALing:{PT|CT|SFACtor}:
ELEMent<x> {<NRf>}
[CONFigure]:SCALing:{PT|CT|SFACtor}:
ELEMent<x>?
<x>= 1
{<NRf>}=0.001 to 9999
```

Example
```
[CONFIGURE]:SCALING:PT:ELEMENT1 1.000
[CONFIGURE]:SCALING:PT:ELEMENT1?→:
CONFIGURE:SCALING:PT:ELEMENT1 1.000E+00
```

Description The values are rounded as follows:
Less than 1.000: Rounded to three decimal places.
1.000 to 9999: Rounded to four significant digits.

[CONFigure]:SCALing[:STATe]

Function Sets scaling ON/OFF, queries the current setting.

Syntax
```
[CONFigure]:SCALing[:STATe] {<Boolean>}
[CONFigure]:SCALing:STATe?
```

Example
```
[CONFIGURE]:SCALING:STATE OFF
[CONFIGURE]:SCALING:STATE?→:CONFIGURE:
SCALING:STATE 0
```

[CONFigure]:SYNChronize

Function Sets/queries the measurement synchronization source.

Syntax
```
[CONFigure]:SYNChronize {VOLTage|
CURRent}
[CONFigure]:SYNChronize?
```

Example
```
[CONFIGURE]:SYNCHRONIZE VOLTAGE
[CONFIGURE]:SYNCHRONIZE?→:CONFIGURE:
SYNCHRONIZE VOLTAGE
```

[CONFigure]:VOLTage?

Function Queries all settings relating to voltage range.

Syntax
```
[CONFigure]:VOLTage?
```

Example
```
[CONFIGURE]:VOLTAGE?Æ:CONFIGURE:VOLTAGE:
RANGE 600.0E+00;AUTO 1
```

[CONFigure]:VOLTage:AUTO

Function Sets the voltage auto range ON/OFF, queries the current setting.

Syntax
```
[CONFigure]:VOLTage:AUTO {<Boolean>}
[CONFigure]:VOLTage:AUTO?
```

Example
```
[CONFigure]:VOLTage:AUTO ON
[CONFIGURE]:VOLTAGE:AUTO?Æ:CONFIGURE:
VOLTAGE:AUTO 1
```

[CONFigure]:VOLTage:RANGe

Function Sets the voltage range/queries the current setting.

Syntax
```
[CONFigure]:VOLTage:RANGe {<voltage>}
[CONFigure]:VOLTage:RANGe?
```
<voltage>=15V to 600V (15, 30, 60, 150, 300, 600V)

Example
```
[CONFIGURE]:VOLTAGE:RANGE 600V
[CONFIGURE]:VOLTAGE:RANGE?Æ:CONFIGURE:
VOLTAGE:RANGE 600.0E+00
```

[CONFigure]:WIRing

Function Sets the wiring method/queries the current setting.

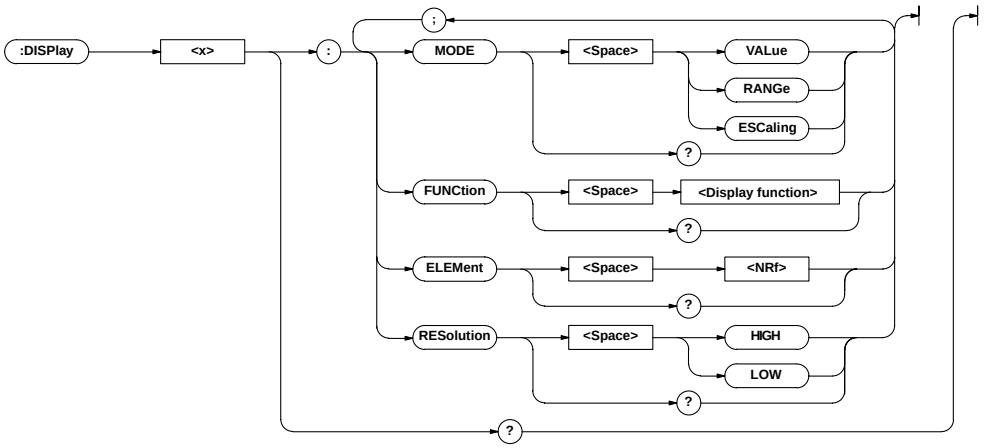
Syntax
```
[CONFigure]:WIRing {P1W2}
[CONFigure]:WIRing?
```

Example
```
[CONFIGURE]:WIRING P1W3
[CONFIGURE]:WIRING?Æ:CONFIGURE:WIRING
P1W3
```

Description The wiring method is as follows.
P1W2 : Single-phase two-wire method.

14.3.5 DISPlay Group

The commands in the DISPlay group are used to make settings relating to, and inquiries about display. This allows you to make the same settings and queries as when using the FUNCTION key or ELEMENT key on the front panel.



DISPlay<x>?

Function Queries all the display settings.

Syntax
```
DISPlay<x>?
<x>= 1 to 3
     1:Display A, 2:Display B,
     3:Display C
```

Example
```
DISPlay1?→:DISPLAY1:MODE VALUE;FUNCTION
V;ELEMENT 1
```

DISPlay<x>:ELEMent

Function Sets the element to be displayed/queries the current setting.

Syntax
```
DISPlay<x>:ELEMent {<NRf>}
DISPlay<x>:ELEMent?
<x>= 1 to 3
     1:Display A, 2:Display B
     3:Display C
{<NRf>}= 1 (WT110E single-phase model)
         1, 3 (WT130 three-phase, three-
         wire model)
         1 to 3 (WT130 three-phase,
         four-wire model)
```

Example
```
DISPLAY1:ELEMENT 1
DISPLAY1:ELEMENT?→:DISPLAY1:ELEMENT 1
```

DISPlay<x>:FUNCtion

Function Sets the function to be displayed/queries the current setting.

Syntax
```
DISPlay<x>:FUNCtion {<display function>}
DISPlay<x>:FUNCtion?
<x>= 1 to 3
     1:Display A, 2:Display B,
     3:Display C
For normal measurement
<display function>= {V|A|W|VA|VAR|
PF|DEGRee|VHZ|AHZ|WH|WHP|WHM|AH|AHP|AHM|
MATH|VPK|APK|TIME}
For harmonic analysis
<display function>= {V|A|W|PF|VHZ|AHZ|
VTHD|ATHD|VCON|ACON|WCON|VDEG|ADEG|ORDer}
```

Example
```
DISPLAY1:FUNCTION V
DISPLAY1:FUNCTION?→:DISPLAY1:FUNCTION V
```

DISPlay<x>:MODE

Function Sets the contents of the display/queries the current setting.

Syntax
```
DISPlay<x>:MODE {VALue|RANGe|ESCaling}
DISPlay<x>:MODE?
<x>= 1 to 3
     1:Display A, 2:Display B,
     3:Display C
VALue: displays measurement data
RANGe: displays the present range of
voltage and current, or the scaling
constants of the external sensor of
element 1.
ESCaling: displays the scaling constants
of the current external sensor
```

Example
```
DISPLAY1:MODE VALUE
DISPLAY1:MODE?→:DISPLAY1:MODE VALUE
```

Description <x> will be ignored. The contents of all the displays A to C will be received.

DISPlay<x>:RESolution

Function Sets the number of displayed digits or queries the current setting.

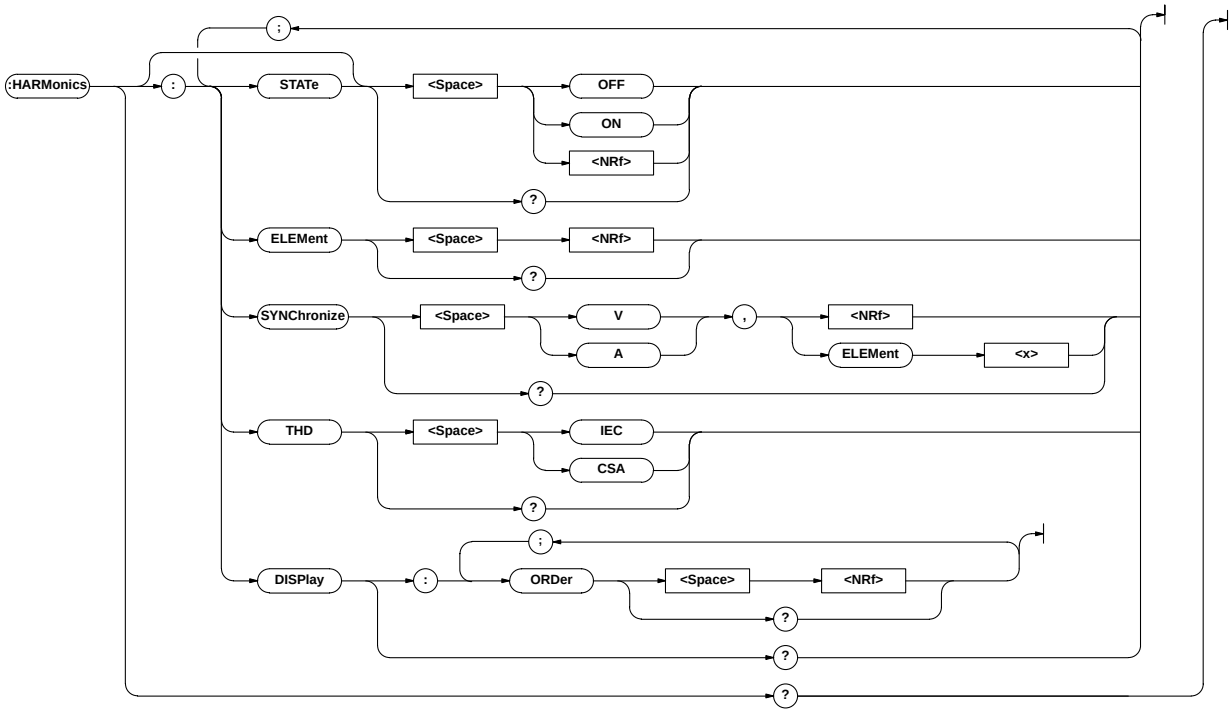
Syntax
```
DISPlay<x>:RESolution {HIGH|Low}
DISPlay<x>:RESolution?
<x>= 1 to 3
     1: Display A, 2: Display B,
     3: Display C
```

Example
```
DISPLAY1:RESOLUTION LOW
DISPLAY1:RESOLUTION?→:DISPLAY1:
RESOLUTION LOW
```

Description <x> will be ignored.
The contents of all the displays A to C will be received.

14.3.6 HARMonics Group

The commands in the HARMonics group relate to the harmonic analysis function. This allow you to make the same settings and inquiries as when using the HARMONICS key on the front panel and the corresponding menus. This group is only useful in case your instrument is equipped with the /HRM option.



HARMonics?

Function Queries all settings relating to harmonic analysis.

Syntax `HARMonics?`

Example
```
HARMONICS?→:HARMONICS:STATE 0;
ELEMENT 1;SYNCHRONIZE V,1;THD IEC;
DISPLAY:ORDER 1
```

HARMonics:DISPlay?

Function Queries all settings concerning the display in case of harmonic analysis.

Syntax `HARMonics:DISPlay?`

Example
```
HARMONICS:DISPLAY?
HARMONICS:DISPLAY?→:HARMONICS:
DISPLAY:ORDER 1
```

HARMonics:DISPlay:ORDer

Function Sets the order of the harmonic component to be shown on display B, queries the current setting.

Syntax
```
HARMonics:DISPlay:ORDer {<NRf>}
HARMonics:DISPlay:ORDer?
```
`{<NRf>}=1 to 50`

Example
```
HARMONICS:DISPLAY:ORDER 1
HARMONICS:DISPLAY:ORDER?→:HARMONICS:
DISPLAY:ORDER 1
```

HARMonics:ELEMent

Function Sets the element for harmonic analysis/queries the current setting.

Syntax
```
HARMonics:ELEMent {<NRf>}
HARMonics:ELEMent?
```
`{<NRf>}= 1`

Example
```
HARMONICS:ELEMENT 1
HARMONICS:ELEMENT?→:HARMONICS:ELEMENT 1
```

HARMonics[:STATe]

Function Sets the harmonic analysis mode ON/OFF, queries the current setting.

Syntax
```
HARMonics[:STATe] {<Boolean>}
HARMonics[:STATe]?
```

Example
```
HARMONICS:STATE ON
HARMONICS:STATE?→:HARMONICS:STATE 1
```

HARMonics:SYNChronize

Function Sets the fundamental frequency for PLL synchronization (PLL source)/queries the current setting.

Syntax
```
HARMonics:SYNChronize
{(V|A),(<NRf>|ELEMent<1>)}
HARMonics:SYNChronize?
```

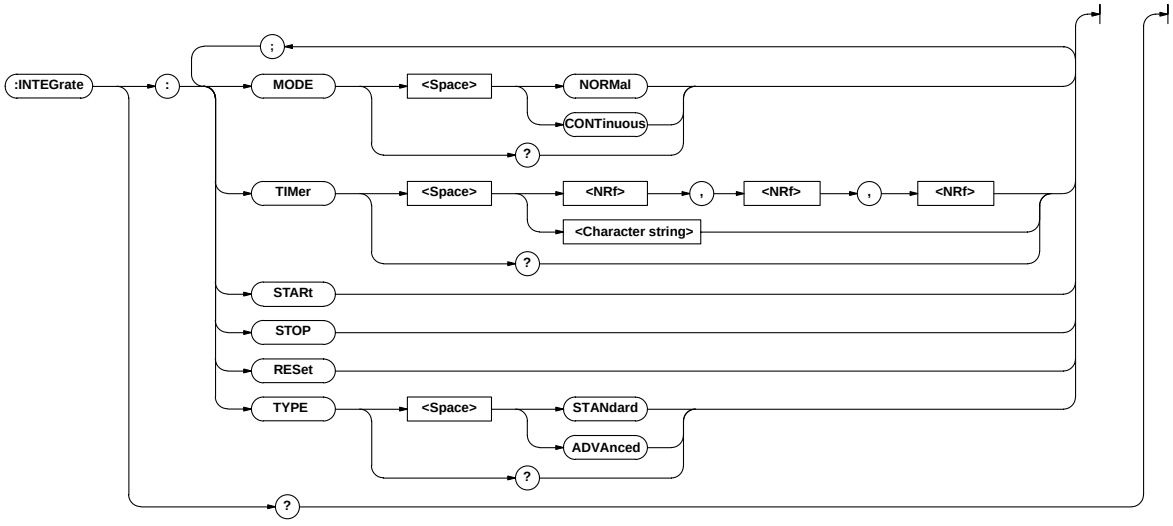
Example
```
HARMONICS:SYNCHRONIZE V,1
HARMONICS:SYNCHRONIZE?→:HARMONICS:
SYNCHRONIZE V,1
```

HARMonics:THD

Function Sets the computation method for harmonic distortion (THD) for harmonic analysis/queries the current setting.
Syntax `HARMonics:THD {IEC|CSA}`
`HARMonics:THD?`
Example `HARMONICS:THD IEC`
`HARMONICS:THD?→:HARMONICS:THD IEC`

14.3.7 INTEGrate Group

The commands in the INTEGrate group are used to make settings relating to, and inquiries about integration. This allows you to make the same settings and inquiries as when using the START key, STOP key, RESET key, INTEG SET key and their corresponding menus.



INTEGrate?

Function Queries all settings relating to integration.
Syntax `INTEGrate?`
Example `INTEGRATE?→:INTEGRATE:MODE NORMAL;`
`TIMER 0,0,0:TYPE STANDARD`

INTEGrate:MODE

Function Sets the integration mode/queries the current setting.
Syntax `INTEGrate:MODE {NORMal|CONTinuous}`
`INTEGrate:MODE?`
Example `INTEGRATE:MODE NORMAL`
`INTEGRATE:MODE?→:INTEGRATE:MODE NORMAL`

INTEGrate:RESet

Function Resets the integrated values.
Syntax `INTEGrate:RESet`
Example `INTEGRATE:RESET`

INTEGrate:STARt

Function Starts integration.
Syntax `INTEGrate:STARt`
Example `INTEGRATE:START`

INTEGrate:STOP

Function Stops integration.
Syntax `INTEGrate:STOP`
Example `INTEGRATE:STOP`

INTEGrate:TIMer

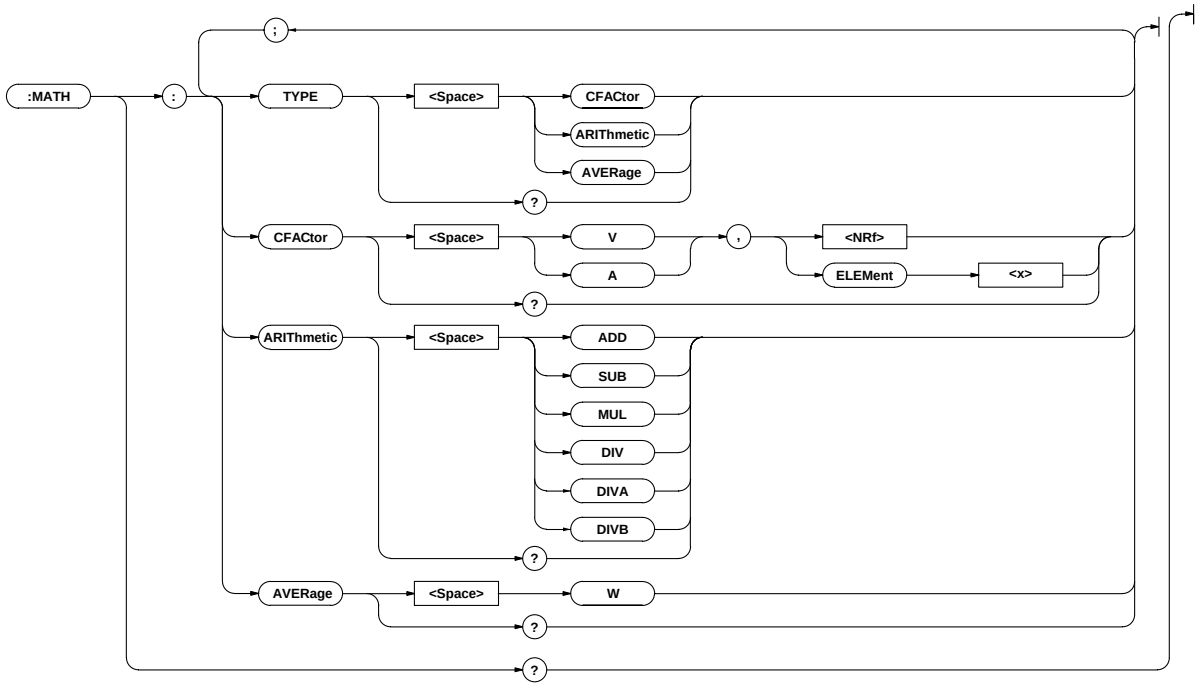
Function Sets the integration timer/queries the current setting.
Syntax `INTEGrate:TIMer {<NRf>,<NRf>,<NRf>|<String>}`
`{<NRf>,<NRf>,<NRf>}=0,0,0 to 10000,0,0`
`{<String>}=HHHHH:MM:SS`
`HHHHH hours`
`MM minutes`
`SS seconds`
Example `INTEGRATE:TIMER 10,0,0`
`INTEGRATE:TIMER "10:00:00"`
`INTEGRATE:TIMER?→:INTEGRATE:`
`TIMER 10,0,0`

INTEGrate:TYPE

Function Sets/queries the integration type.
Syntax `INTEGrate:TYPE {STANdard|ADVAnced}`
`INTEGrate:TYPE?`
Example `INTEGRATE:TYPE STANDARD`
`INTEGRATE:TYPE?→:INTEGRATE:TYPE`
`STANDARD`

14.3.8 MATH

The commands in the MATH group are used to make settings relating to, and to make inquiries about the computing function. The same function can be performed using the “MATH” menu of the [SETUP] key of the front panel.



MATH?

Function Queries all settings related to the computing function

Syntax `MATH?`

Example `MATH?→:MATH:TYPE ARITHMETIC;`
`ARITHMETIC ADD`

MATH:ARIThmetic

Function Sets/queries the computing equation of the four arithmetic operations.

Syntax `MATH:ARIThmetic {ADD|SUB|MUL|DIV|DIVA|DIVB}`
`MATH:ARIThmetic?`

Example `MATH:ARITHMETIC ADD`
`MATH:ARITHMETIC?→:MATH:ARITHMETIC ADD`

Description If [MATH:TYPE] is not set to [ARIThmetic], this command will be meaningless. The computing equation selections are as follows:
ADD : display A + display B
SUB : display A – display B
MUL : display A ∗ display B
DIV : display A / display B
DIVA : display A / (display B)^2
DIVB : (display A)^2 / display B

MATH:AVERage

Function Sets/queries the average power computation.

Syntax `MATH:AVERage {W}`
`MATH:AVERage?`

Example `MATH:AVERAGE W`
`MATH:AVERAGE?→:MATH:AVERAGE W`

Description This command is void if “MATH:TYPE AVERage” is not specified.

MATH:CFACtor

Function Sets/queries the computing equation of the crest factor

Syntax `MATH:CFACtor {(V|A),(<NRf>|ELEMent<x>)}`
`<x>=1`
`MATH:CFACtor?`

Example `MATH:CFACTOR V,1`
`MATH:CFACTOR?→:MATH:CFACTOR V,1`

Description If [MATH:TYPE] is not set to [CFACtor], this command will be meaningless.

MATH:TYPE

Function Sets/queries the computing equation

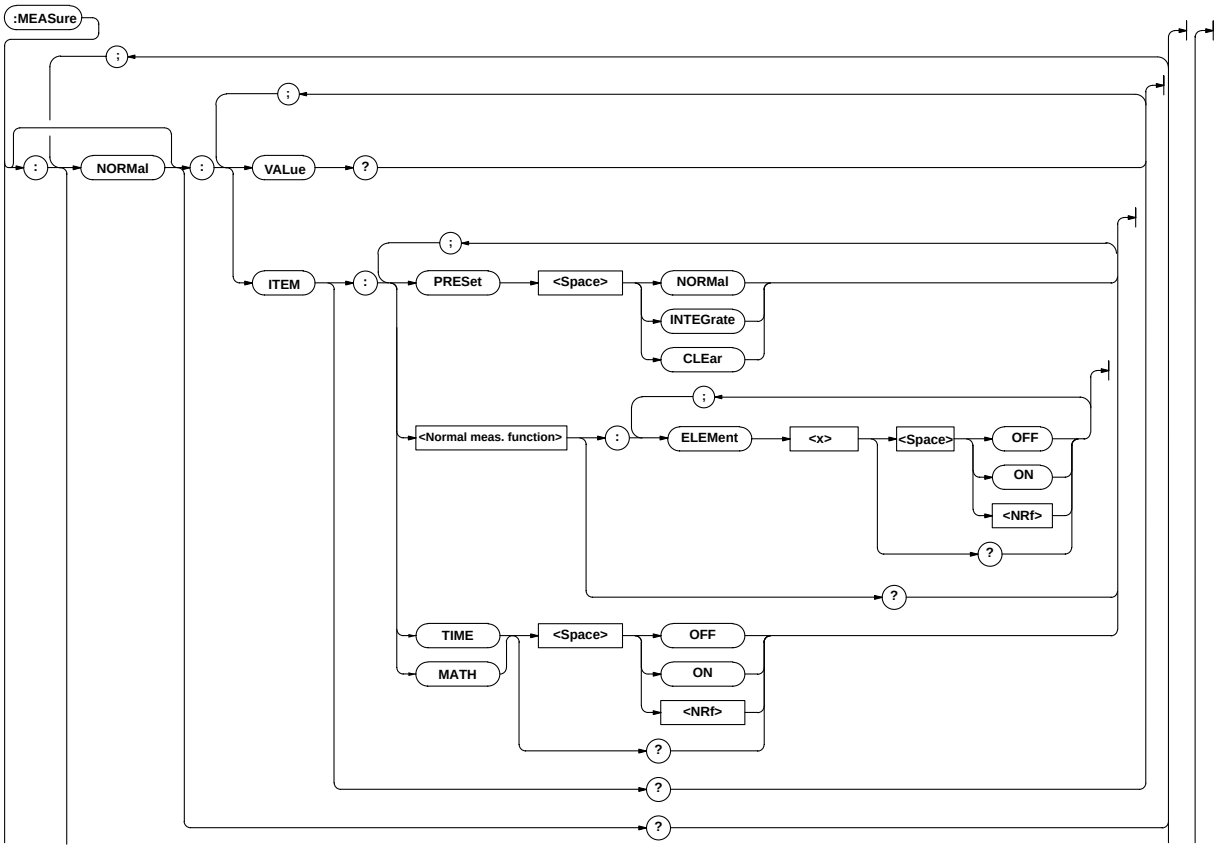
Syntax `MATH:TYPE {CFACtor|ARIThmetic|AVERage}`
`MATH:TYPE?`

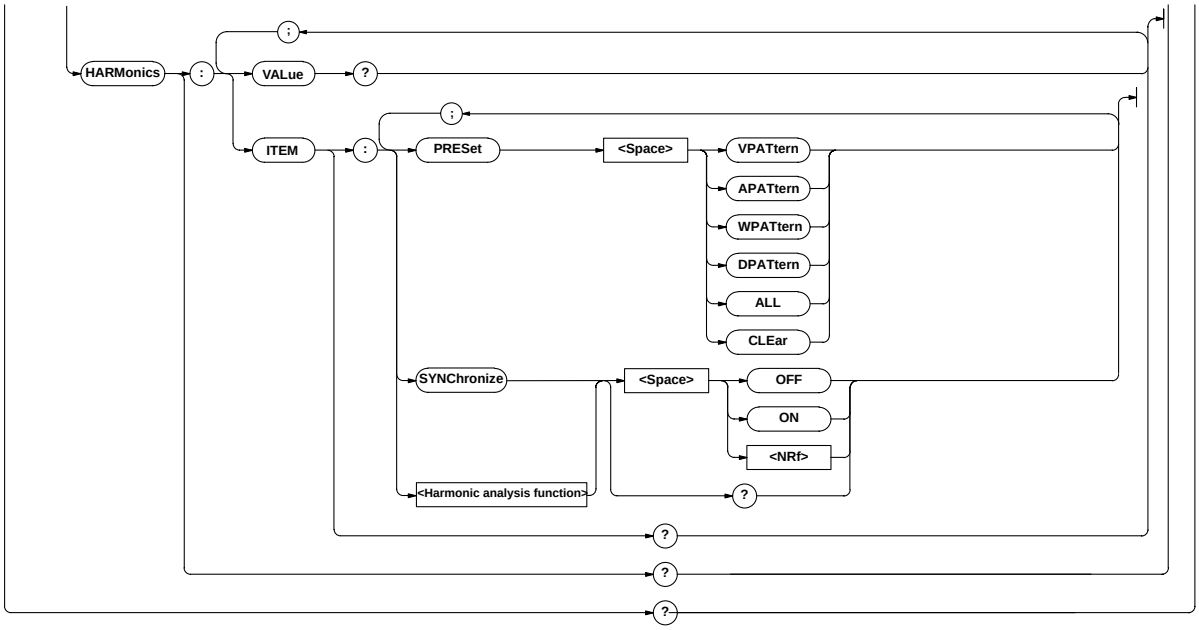
Example `MATH:TYPE CFACTOR`
`MATH:TYPE?→:MATH:TYPE CFACTOR`

Description The equation method selections are as follows:
CFACtor : Crest factor
ARIThmetic : Four arithmetic operations
AVERage : Average power computation during integration

14.3.9 MEASure Group

The MEASure group relates to measurement/computation data. There are no front panel keys for these functions. Also, your instrument must be equipped with the /HRM (harmonic analysis function) to be able to use the related commands. Settings related to the measurement/computation data output items and the data format/output format are valid only when the communication mode is set to “488.2.” The settings related to the communication output items of measurement and computation data are retained independently from the settings of items used when the communication mode is set to some other mode than “488.2.”





MEASure?

Function Queries all the settings related to measurement/computation data.

Syntax `MEASure?`

Example
```
MEASURE?→:MEASURE:NORMAL:ITEM:V:
ELEMENT1 1;:MEASURE:NORMAL:ITEM:A:
ELEMENT1 1;:MEASURE:NORMAL:ITEM:W:
ELEMENT1 1;:MEASURE:NORMAL:ITEM:VA:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VAR:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:PF:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:DEGREE:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VHZ:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHZ:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WH:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WHP:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WHM:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AH:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHP:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHM:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VPK:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:APK:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:TIME 0;
MATH 0;:MEASURE:HARMONICS:ITEM:
SYNCHRONIZE 1;VTHD 1;V 1;VCON 1;ATHD 0;
A 0;ACON 0;PF 0;W 0;WCON 0;VDEG 0;ADEG 0
```

MEASure:HARMonics?

Function Queries all settings related to harmonic analysis data.

Syntax `MEASure:HARMonics?`

Example
```
MEASURE:HARMONICS?→:MEASURE:HARMONICS:
ITEM:SYNCHRONIZE 1;VTHD 1;V 1;VCON 1;
ATHD 0;A 0;ACON 0;PF 0;W 0;WCON 0;
VDEG 0;ADEG 0
```

MEASure:HARMonics:ITEM?

Function Queries all settings related to the communication output items of harmonic analysis data.

Syntax `MEASure:HARMonics:ITEM?`

Example `MEASURE:HARMONICS:ITEM?→(Same result as for MEASure:HARMonics?)`

MEASure:HARMonics:ITEM:PRESet

Function Sets the ON/OFF pattern for all communication outputs of the harmonic analysis function.

Syntax `MEASure:HARMonics:ITEM:PRESet {VPATtern|APATtern|WPATtern|DPATtern|ALL|CLEar}`

Example `MEASURE:HARMONICS:ITEM:PRESET VPATTERN`

Description The following six patterns can be selected.
VPATtern : SYNChronize/VTHD/V/VCON→ON, others→ OFF
APATtern : SYNChronize/ATHD/A/ACON→ON, others→ OFF
WPATtern : SYNChronize/PF/W/WCON→ON, others→ OFF
DPATtern : SYNChronize/VDEG/ADEG→ON, others→ OFF
ALL : all items→ ON
CLEar : all items→ OFF

MEASure:HARMonics:ITEM:{SYNChronize|<harmonic analysis function>}

Function Sets the communication output item of harmonic analysis ON/OFF, queries the current setting.

Syntax
```
MEASure:HARMonics:ITEM:{SYNChronize|
<harmonic analysis
function>} {<Boolean>}
MEASure:HARMonics:ITEM:{SYNChronize|
<harmonic analysis function>}?
SYNChronize=PLL source
<harmonic analysis function>={VTHD|V|
VCON|ATHD|A|ACON|PF|W|WCON|VDEG|ADEG}
```

Example
```
MEASURE:HARMONICS:ITEM:VTHD ON
MEASURE:HARMONICS:ITEM:VTHD?→:MEASURE:
HARMONICS:ITEM:VTHD 1
```

Description The selection SYNChronize is for outputting the frequency of the PLL source.
You can query the PLL source input by the command HARMonics:SYNChronize?

MEASure:HARMonics:VALue?

Function Queries harmonic analysis data set by commands other than"MEASure:HARMonics:ITEM".

Syntax
```
MEASure:HARMonics:VALue?
```

Example
```
MEASURE:HARMONICS:VALUE?→60.00E+00,
12.01E+00,49.98E+00,49.62E+00,0.03E+00,
5.50E+00,.....
```

Description
- The renewal of harmonic analysis data output here occurs when bit0 (UPD) of the condition register (see section 14.4) changes from high to low. For details, see section 14.2.6, “Synchronization with the Controller.”
- For the output format of harmonic analysis data, see page 14-30.

MEASure:NORMal?

Function Queries all settings related to normal measured/computed data.

Syntax
```
MEASure:NORMal?
```

Example
```
MEASURE:NORMAL?→:MEASURE:NORMAL:ITEM:
V:ELEMENT1 1;:MEASURE:NORMAL:ITEM:A:
ELEMENT1 1;:MEASURE:NORMAL:ITEM:W:
ELEMENT1 1;:MEASURE:NORMAL:ITEM:VA:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VAR:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:PF:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:DEGREE:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VHZ:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHZ:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WH:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WHP:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:WHM:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AH:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHP:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:AHM:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:VPK:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:APK:
ELEMENT1 0;:MEASURE:NORMAL:ITEM:TIME 0;
MATH 0
```

MEASure[:NORMal]:ITEM?

Function Queries all settings related to the communication output items of normal measured/computed data.

Syntax
```
MEASure[:NORMal]:ITEM?
```

Example
```
MEASURE:NORMAL:ITEM?→(Results are the same
```
as for MEASure:NORMal?)

MEASure[:NORMal]:ITEM:PRESet

Function Sets the ON/OFF pattern for all communication outputs of the normal measurement function.

Syntax
```
MEASure[:NORMal]:ITEM:PRESet {NORMal|
INTEGrate|CLEar}
```

Example
```
MEASURE:NORMAL:ITEM:PRESET NORMAL
```

Description The following three patterns can be selected.
NORMal: V/A/W→ON, others→OFF
INTEGrate: W/WH/AH/TIME→ON, others→OFF
CLEar: all items→OFF

MEASure[:NORMal]:ITEM:{TIME|MATH}

Function Sets the communication output of {elapsed time of integration|MATH} ON/OFF, queries about the current setting.

Syntax
```
MEASure[:NORMal]:ITEM:{TIME|
MATH} {<Boolean>}
MEASure[:NORMal]:ITEM:{TIME|MATH}?
```

Example
```
MEASURE:NORMAL:ITEM:TIME OFF
MEASURE:NORMAL:ITEM:TIME?→:MEASURE:
NORMAL:ITEM:TIME 0
```

MEASure[:NORMal]:ITEM:<normal measurement function>?

Function Queries communication output settings of the normal measurement function.

Syntax
```
MEASure[:NORMal]:ITEM:<normal
measurement function>?
<normal measurement
function>={V|A|W|VA|VAR|PF|DEGRee|VHZ|AHZ|
WH|WHP|WHM|AH|AHP|AHM|VPK|APK}
```

Example
```
MEASURE:NORMAL:ITEM:V?→:MEASURE:NORMAL:
ITEM:V:ELEMENT1 1
```

MEASure[:NORMal]:ITEM:<normal measurement function>:ELEMent<x>

Function Sets the communication output concerning each element ON/OFF, queries the current setting.

Syntax
```
MEASure[:NORMal]:ITEM:<normal measurement function>:ELEMent<x> {<Boolean>}
MEASure[:NORMal]:ITEM:<normal measurement function>:ELEMent<x>? <x>=1
```

Example
```
MEASURE:NORMAL:ITEM:V:ELEMENT1 ON
MEASURE:NORMAL:ITEM:V:ELEMENT?→
:MEASURE:NORMAL:ITEM:V:ELEMENT1 1
```

MEASure[:NORMal]:VALue?

Function Queries normal measured/computed data set by commands other than "MEASure[:NORMal]:ITEM".

Syntax
```
MEASure[:NORMal]:VALue?
```

Example
```
MEASURE:NORMAL:VALUE?→10.04E+00,
10.02E+00, 10.03E+00,49.41E+00,...
```

Description
- The renewal of normal measured/computed data output here occures when bit0 (UPD) of the condition register (see section 14.4) changes from high to low. For details, see 14.2.6, "Synchronization with the Controller."
- For the output format of normal measured/computed data, see page 14-29.
- When the harmonic analysis function is ON, harmonic analysis data will be returned. (Results are the same as for MEASure:HARMonics:VALue?)

Output Format/Data Format of Normal Measured/Computed Data and Harmonic Analysis Data

The output format/data format of normal measured/computed data and harmonic analysis data which is requested by `MEASure[:NORMal]:VALue?` or `MEASure:HARMonics:VALue?`, is as follows.

Data Format of Normal Measured/Computed Data

- All data of the <harmonic analysis function> are output in the <NR3> format.
  (Example) 99.99E+00
  V,A,W,VA,VAR,PF,DEGR,VHZ,AHZ,VPK,APK,MATH → mantissa: max. 4 digits + exponent: 2 digits
  WH,WHP,WHM,AH,AHP,AHM → mantissa: max. 6 digits + exponent: 2 digits (max. 5 digits in case of negative value)
- The sign of the mantissa will only be applied in case of negative values. However, phase lead and lag (in case of phase angle (DEG)) will be shown as follows.
  LEAD → +180.0E+00
  LAG → –180.0E+00
  in phase → 0.0E+00 (The mantissa will be proceeded by a space)
- In case of overrange or computation over, “9.9E+37”(+•) will be output.
  (i.e. in case the display shows –oL–, –oF–, PFErr, dEGEr, ErrLo, or ErrHi)
- In case no data is present (i.e. the display shows – – – – –), “9.91E+37” (NAN) will be output.
- The elapsed time of integration is output as hours, minutes, seconds in the <NR1> format. (Example) 999,59,59

Output Format of Normal Measured/Computed Data

The communication output is set ON by any of the commands starting with “`MEASure[:NORMal]:ITEM`” and the normal measured/computed data or elapsed time of integration are output according to the following order of priority. Besides, in case of recalling normal measurement or integration data, the data number will be output in <NR1> format as well. Data will be output in the following order corresponding to each element. However, only element 1 will be valid for WT200 (model: 253421).

(0. Data number in case of recalling)
1. V1
2. A1
3. W1
4. VA1
5. VAR1
6. PF1
7. DEGR1
8. VHZ1
9. AHZ1
10. WH1
11. WHP1
12. WHM1
13. AH1
14. AHP1
15. AHM1
16. VPK1
17. APK1
18. TIME (elapsed time of integration)
19. MATH

Each data is divided by a comma”,” and is ended by the terminator <RMT>.

Output example of normal measured/computed data

- **Output example for WT200 (model: 253421) after having sent the following commands.**

```
(Sent)          MEASURE:NORMAL:ITEM:PRESET NORMAL
                MEASURE:NORMAL:VALUE?
(Received data) 10.04E+00,49.41E+00,429.0E+00
(Data contents) V1:10.04E+00
                A1:49.41E+00
                W1:429.0E+00
```

- **Output example for WT200 (model: 253421) where measurement data first have been stored during integration, and while recalling these data, the following commands have been sent.**

```
(Sent)          MEASURE:NORMAL:ITEM:PRESET INTEGRATE
                MEASURE:NORMAL:VALUE?
(Received data) 10,428.6E+00,71.45E+00,8.2342E+00,0,10,0
(Data contents)
    Recalled data number: 10
    W1:10.428E+00
    WH1:71.45E+00
    AH1:8.2342E+00
    Elapsed time of integration: 0 (hours), 10 (minutes), 0 (seconds)
```

Data Format of Harmonic Analysis

All data will be output in the <NR3> format. (mantissa: max. 4 digits + exponent: 2 digits)

Output Format of Harmonic Analysis

The communication output is set ON by any of the commands starting with "MEASure:HARMonics:ITEM" and the harmonic measurement data or frequency of PLL source (SYNChronize) are output according to the following order of priority. Besides, in case of recalling normal measurement or integration data, the data number will be output in <NR1> format as well.

```
(0.Data number in case of recalling)
1.Frequency of PLL source (SYNChronize)
2.VTHD     3.V      4.VCON     5.ATHD     6.A        7.ACON
8.PF       9.W      10.WCON    11.VDEG    12.ADEG
```

Harmonic analysis data will be output for all applicable elements. To find out to which element the data correspond, use the HARMonics:ELEMent? command.

- Frequency of PLL Source (SYNChronize) : 1 data
  Outputs the fundamental frequency (VHZ/AHZ) of the voltage/current for which the PLL source has been set. The input of the PLL source can be found out using HARMonics:SYNChronize?.
- VTHD,ATHD : 1 data
  Outputs the harmonic distortion factor of voltage/current. (for either iEC or CSA). The used computation method can be found out using the HARMonics:THD? command.
- V,A,W : 51(or 31) data
  Rms values of the 1st to 50(or 30)th order→fundamental analysis value (1st order)→harmonic analysis value (2nd order)→ · · ·→harmonic analysis value (50(or 30)th order)
- VCON,ACON,WCON : 49(or 29) data
  Harmonic relative content (2nd order)→ · · ·→harmonic relative content (50(or 30)th order)

- PF : 1 data
  Outputs the power factor of the fundamental (1st order).
- VDEG : 50(or 30) data
  Phase angle between the1st order voltage and 1st order current→Phase angle between the 2nd order voltage and 1st order voltage→ · · ·→Phase angle between the 50(or 30)th order voltage and the 1st order voltage.
- ADEG : 50(or 30) data
  Phase angle between the1st order voltage and 1st order current→Phase angle between the 2nd order current and 1st order current→ · · ·→Phase angle between the 50(or 30)th order current and the 1st order current.
  Each data is divided by a comma "," and ended by the terminator <RMT>.

Output Example of Harmonic Analysis Data

- Output example for WT200 (model: 253421), after having sent the following commands. (Refer also to page 9-19 for output example of external plotter).

(Sent)
```
MEASURE:HARMONICS:ITEM:PRESET VPATTERN
MEASURE:HARMONICS:VALUE?
```

(Received data)
```
60.00E+00,12.01E+00,49.98E+00,49.62E+00,0.03E+00,
5.50E+00,0.01E+00,1.99E+00,0.02E+00,1.01E+00,0.01E+00,
0.62E+00,0.00E+00,0.41E+00,0.00E+00,0.30E+00,0.00E+00,
0.22E+00,0.00E+00,0.17E+00,0.00E+00,0.14E+00,0.00E+00,
0.12E+00,0.00E+00,0.09E+00,0.00E+00,0.08E+00,0.00E+00,
0.07E+00,0.01E+00,0.06E+00,0.00E+00,0.05E+00,0.00E+00,
0.04E+00,0.00E+00,0.05E+00,0.00E+00,0.03E+00,0.00E+00,
0.03E+00,0.01E+00,0.03E+00,0.00E+00,0.03E+00,0.00E+00,
0.02E+00,0.00E+00,0.02E+00,0.00E+00,0.02E+00,0.00E+00,
0.06E+00,11.09E+00,0.02E+00,4.01E+00,0.03E+00,2.03E+00,
0.01E+00,1.24E+00,0.01E+00,0.82E+00,0.01E+00,0.60E+00,
0.00E+00,0.45E+00,0.01E+00,0.35E+00,0.01E+00,0.28E+00,
0.00E+00,0.23E+00,0.01E+00,0.19E+00,0.01E+00,0.16E+00,
0.01E+00,0.14E+00,0.01E+00,0.11E+00,0.01E+00,0.10E+00,
0.01E+00,0.08E+00,0.01E+00,0.09E+00,0.01E+00,0.07E+00,
0.00E+00,0.06E+00,0.01E+00,0.06E+00,0.01E+00,0.05E+00,
0.01E+00,0.05E+00,0.01E+00,0.05E+00,0.01E+00,0.04E+00,
0.01E+00
```

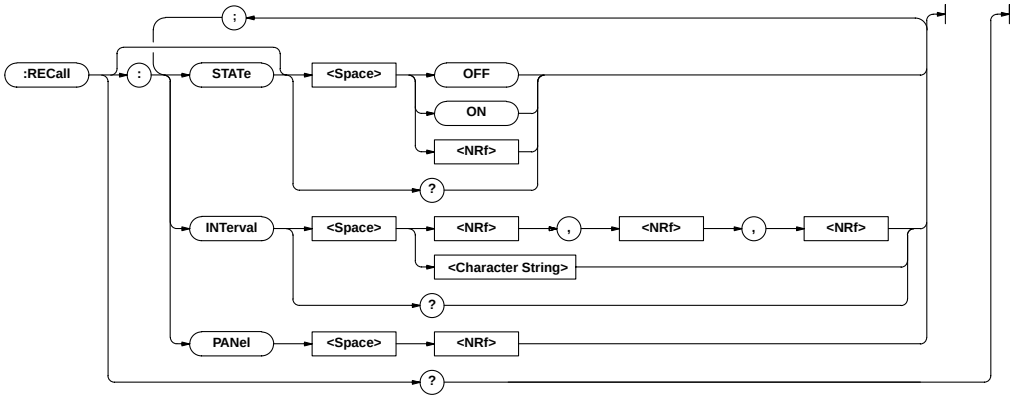
(Data contents)

Frequency of PLL source	: 60.00E+00 (Hz)
Harmonic distortion factor of voltage	: 12.01E+00 (%)
Rms value of 1st to 50th order	: 49.98E+00 (V)
Fundamental analysis value (1st order)	: 49.62E+00 (V)
Harmonic analysis value (2nd order)	: 0.03E+00 (V)
:	:
Harmonic analysis value (50th order)	: 0.00E+00 (V)
Harmonic relative content (2nd order)	: 0.06E+00 (%)
:	:
Harmonic relative content (50th order)	: 0.01E+00 (%)

The data consist of 102 items in total.

14.3.10 RECall Group

The commands in the RECall group are used to make settings relating to, and inquires about recalling data. This allows you to make the same settings and inquiries as can be set using the lower menus of [MEMORY]-“rECAL” or [MEMORY]-“PnLrC”.



RECall?

Function Queries all the settings relating to recalling data.

Syntax `RECall?`

Example `RECALL?→:RECALL:STATE 0;INTERVAL 0,0,0`

RECall:INTerval

Function Sets the recalling interval/queries the current setting.

Syntax
```
RECall:INTerval
{<NRf>,<NRf>,<NRf>|<String>}
RECall:INTerval?
```
{<NRf>,<NRf>,<NRf>}=0,0,0 to 99,59,59
{<String>}=HH:MM:SS HH hour MM minutes SS seconds

Example
```
RECALL:INTERVAL 0,0,0
RECALL:INTERVAL "00:00:00"
RECALL:INTERVAL?→:RECALL:INTERVAL 0,0,0
```

Description Even when the interval has been set to 0,0,0, the interval becomes 250ms in case of normal measurement and 1s in case of harmonic analysis.

RECall:PANel

Function Retrieves the setting parameters file.

Syntax
```
RECall:PANel {<NRf>}
```
{<NRf>}=1 to 4 : file number

Example
```
RECALL:PANEL 1
```

RECall[:STATe]

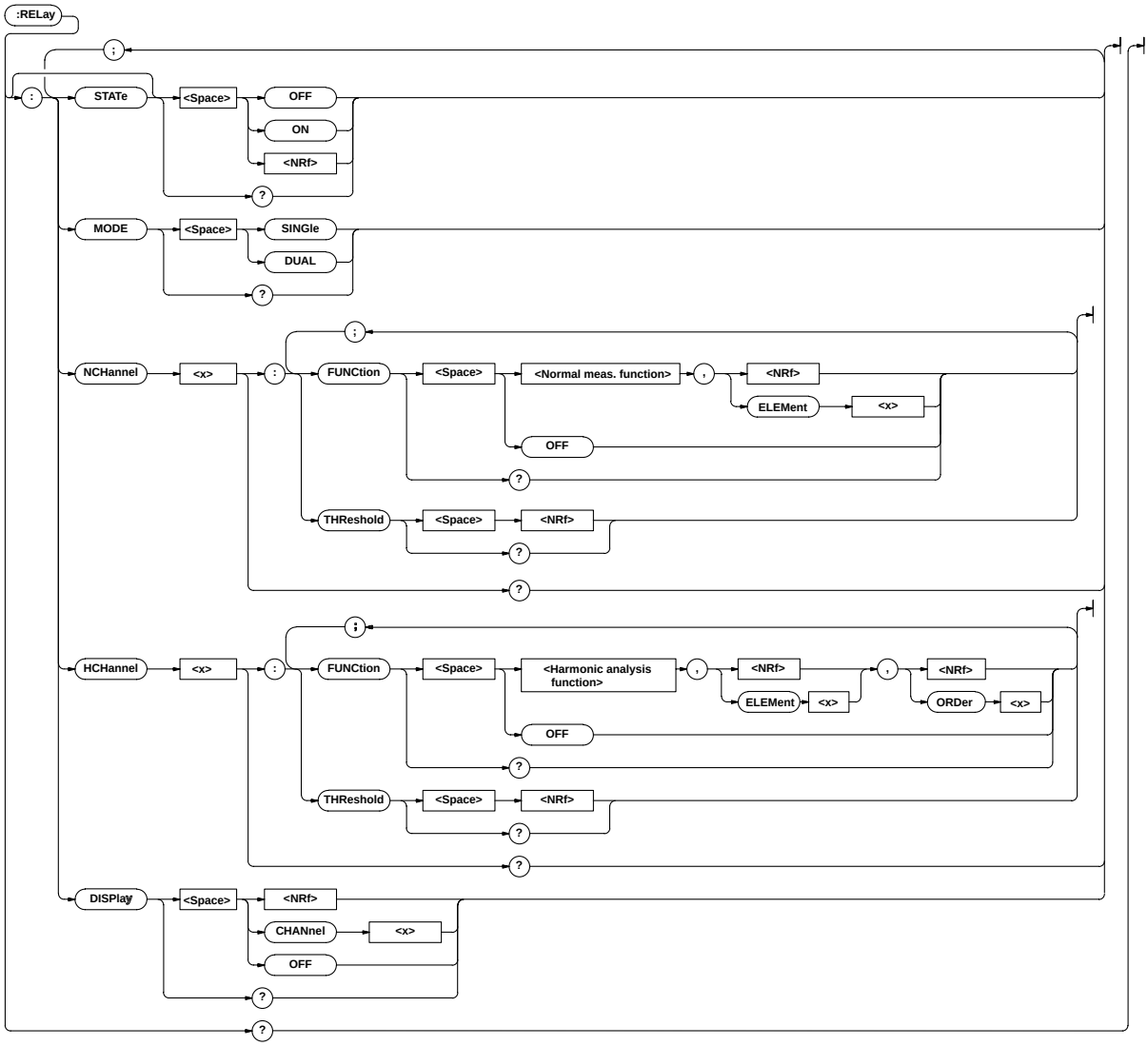
Function Turns recalling ON/OFF, queries the current setting.

Syntax
```
RECall[:STATe] {<Boolean>}
RECall:STATe?
```

Example
```
RECALL:STATE ON
RECALL:STATE?→:RECALL:STATE 1
```

14.3.11 RELay Group

The commands in the RELay group are used to make settings relating to, and inquiries about the comparator function. This allows you to make the same settings and inquiries as when using the lower menus of [OUTPUT]-"rELAY". This group is only useful in case your instrument is equipped with the /CMP option.



RELay?

Function Queries all settings relating to the comparator function.

Syntax `RELay?`

Example
```
RELAY?→:RELAY:STATE 0;MODE SINGLE;
NCHANNEL1:FUNCTION V,1;
THRESHOLD 600.0E+00;:RELAY:NCHANNEL2:
FUNCTION A,1;THRESHOLD 20.00E+00;:RELAY:
NCHANNEL3:FUNCTION W,1;
THRESHOLD 1.200E+03;:RELAY:NCHANNEL4:
FUNCTION PF,1;THRESHOLD1.000E+00;:RELAY:
HCHANNEL1:FUNCTION V,1,1;
THRESHOLD 600.0E+00;:RELAY:HCHANNEL2:
FUNCTION A,1,1;THRESHOLD 20.00E+00;:
RELAY:HCHANNEL3:FUNCTION W,1,1;
THRESHOLD 1.200E+03;:RELAY:HCHANNEL4:
FUNCTION PF,1;THRESHOLD 1.000E+00;:
RELAY:DISPLAY OFF
```

RELay:DISPlay

Function Sets the comparator display OFF, or, in case of ON, the channel to be displayed/queries the current setting.

Syntax
```
RELay:DISPlay {<NRf>|CHANnel<1-4>|OFF}
RELay:DISPlay?
{<NRf>}=1 to 4:channel
```

Example
```
RELAY:DISPLAY 1
RELAY:DISPLAY?→:RELAY:DISPLAY 1
```

RELay:HCHannel<x>?

Function Queries all settings related to relay output items in case of harmonic analysis.

Syntax
```
RELay:HCHannel<x>?
<x>= 1 to 4
```

Example
```
RELAY:HCHANNEL1?→:RELAY:HCHANNEL1:
FUNCTION V,1,1;THRESHOLD 600.0E+00
```

RELay:HCHannel<x>:FUNCtion

Function Sets the function of the relay output item in case of harmonic analysis/queries the current setting.

Syntax
```
RELay:HCHannel<x>:FUNCtion {<harmonic analysis function>,(<NRf>|ELEMent<1>),(<NRf>|ORDer<1-50>)|OFF}
<harmonic analysis function>={VTHD|V|VCON|ATHD|A|ACON|PF|W|WCON|VDEG|ADEG}
```

Example
```
RELAY:HCHANNEL1:FUNCTION V,1,1
RELAY:HCHANNEL1?→:RELAY:HCHANNEL1:FUNCTION V,1,1
RELAY:HCHANNEL2?→:RELAY:HCHANNEL2:FUNCTION OFF
RELAY:HCHANNEL4?→:RELAY:HCHANNEL4:FUNCTION PF,1
```

Description
- Except for the case when it is OFF, you will specify <harmonic analysis function>, <element>, and <order> for the relay output item. However, if the <normal measurement function> is set to VTHD, ATHD, or PF, <element> is ignored. <element> can be omitted in this case. (The response to the query will have the <element> omitted.)
- Even if V,A or W has been selected, the rms value of the 1st to 50th order does not become the corresponding relay output item. Also, even if VDEG or ADEG has been selected, the phase angle between the 1st order voltage and 1st order current does not become the corresponding relay output item.

RELay:HCHannel<x>:THReshold

Function Sets the threshold level for the relay output item in case of harmonic analysis/queries the current setting.

Syntax
```
RELay:HCHannel<x>:THReshold {<NRf>}
<x>=1 to 4
<NRf>=0.000E+00 to ±9.999E+09
```

Example
```
RELAY:HCHANNEL1:THRESHOLD 600.0E+00
RELAY:HCHANNEL1:THRESHHOLD?→:RELAY:HCHANNEL1:THRESHOLD 600.0E+00
```

Description The mantissa of the setting value is rounded a follows.
Less than 1.000: Rounded to three decimal places.
1.000 to 9999: Rounded to four significant digits.

RELay:MODE

Function Sets the mode of the comparator function/ queries the current setting.

Syntax
```
RELay:MODE {SINGle|DUAL}
RELay:MODE?
```

Example
```
RELAY:MODE DUAL
RELAY:MODE?→:RELAY:MODE DUAL
```

RELay:NCHannel<x>?

Function Queries all settings related to the relay output items in case of normal measurement.

Syntax
```
RELay:NCHannel<x>?
<x>=1 to 4
```

Example
```
RELAY:NCHANNEL2?→:RELAY:NCHANNEL2:FUNCTION A,1;
THRESHOLD 20.00E+00
```

RELay:NCHannel<x>:FUNCtion

Function Sets the function of the relay output item in case of normal measurement/ queries the current setting.

Syntax
```
RELay:NCHannel<x>:FUNCtion {<normal measurement function>,(<NRf>|ELEMent<1>|OFF}
<x>=1 to 4
<normal measurement function>={V|A|W|VA|VAR|PF|DEGRee|VHZ|AHZ|WH|WHP|WHM|AH|AHP|AHM|MATH|VPK|APK}
```

Example
```
RELAY:NCHANNEL3:FUNCTION W,1
RELAY:NCHANNEL3?→:RELAY:NCHANNEL3:FUNCTION W,1
```

Description
- Except for the case when it is OFF, you will specify <normal measurement function> and <element> for the relay output item. However, if the <normal measurement function> is set to MATH, <element> is ignored. (The response to the query will have the <element> omitted.)

RELay:NCHannel<x>:THReshold

Function Sets the threshold level for the relay output item in case of normal measurement/queries the current setting.

Syntax
```
RELay:NCHannel<x>:THReshold {<NRf>}
<x>=1 to 4
<NRf>=0.000E+00 to ±9.999E+09
```

Example
```
RELAY:NCHANNEL3:THRESHOLD 1.200E+03
RELAY:NCHANNEL3:THRESHHOLD?→:RELAY:NCHANNEL3:THRESHOLD 1.200E+03
```

Description The mantissa of the setting value is rounded a follows.
Less than 1.000: Rounded to three decimal places.
1.000 to 9999: Rounded to four significant digits.

RELay:STATe

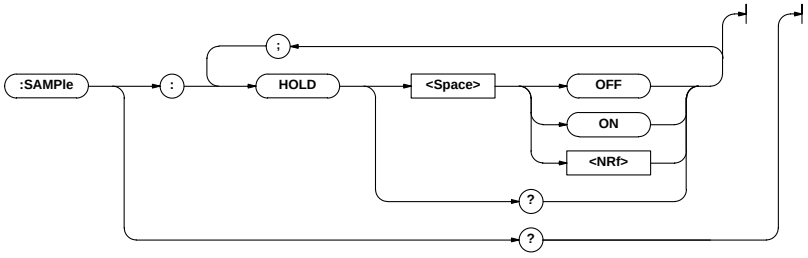
Function Sets the comparator function ON/OFF, queries the current setting.

Syntax
```
RELay[:STATe] {<Boolean>}
RELay:STATe?
```

Example
```
RELAY ON
RELAY:STATE ON
RELAY:STATE?→:RELAY:STATE 1
```

14.3.12 SAMPle Group

The commands in the SAMPle group are used to make settings relating to, and inquiries about sampling. You can make the same settings as when using the [HOLD] key on fhe front panel.



SAMPle?

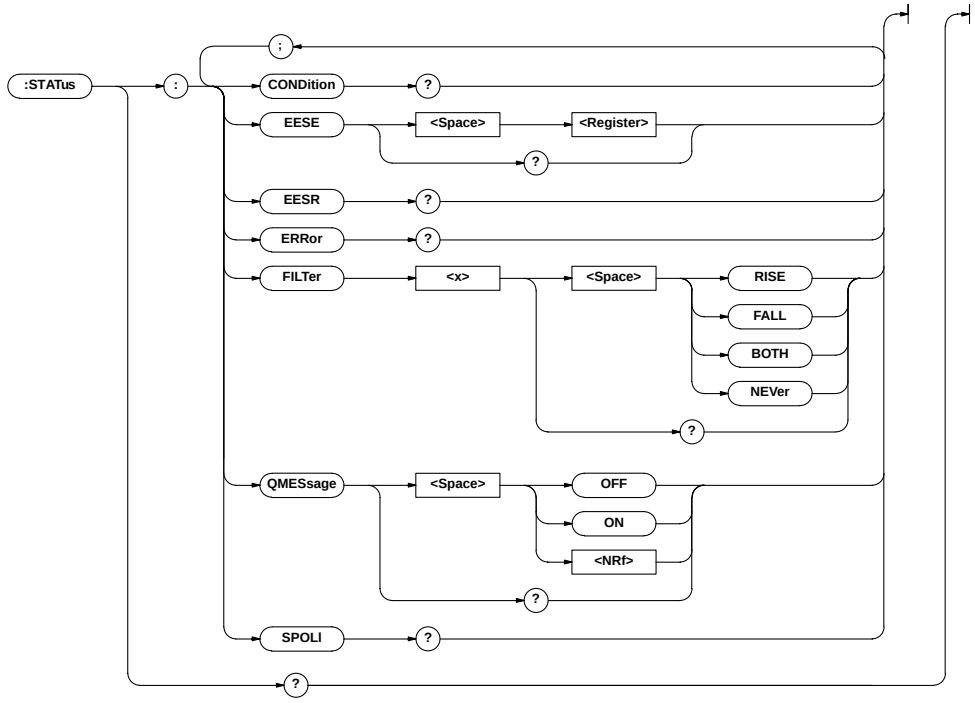
Function Queries all settings related to sampling.
Syntax SAMPle?
Example SAMPLE?→:SAMPLE:HOLD 0

SAMPle:HOLD

Function Sets to hold the output of data (display, communication)/queries the current setting.
Syntax SAMPle:HOLD {<Boolean>}
SAMPle:HOLD?
Example SAMPLE:HOLD ON
SAMPLE:HOLD?→:SAMPLE:HOLD 1

14.3.13 STATus Group

The commands in the STATus group are used to make settings relating to, and inquiries about the communication status. There is no corresponding operation using the front panel. See sectiono 14.4 for status reports.



STATus?

Function Queries all settings related to the status of communication.

Syntax `STATus?`

Example
```
STATUS?→:STATUS:EESE 0;FILTER1 NEVER;
FILTER2 NEVER;FILTER3 NEVER;
FILTER4 NEVER;FILTER5 NEVER;
FILTER6 NEVER;FILTER7 NEVER;
FILTER8 NEVER;FILTER9 NEVER;
FILTER10 NEVER;FILTER11 NEVER;
FILTER12 NEVER;FILTER13 NEVER;
FILTER14 NEVER;FILTER15 NEVER;
FILTER16 NEVER;QMESSAGE 1
```

STATus:CONDition?

Function Queries the contents of the condition filter, and clears it at the same time.

Syntax `STATus:CONDition?`

Example `STATUS:CONDITION→16`

Description See section 14.4, “Status Report” for details on the condition filter.

STATus:EESE

Function Sets the extended event register/queries the current setting.

Syntax
```
STATus:EESE <Register>
STATus:EESE?
<Register>=0 to 65535
```

Example
```
STATUS:EESE 257
STATUS:EESE?→:STATUS:EESE 257
```

Description See section 14.4, “Status Report” for details on the extended event register.

STATus:EESR?

Function Queries the contents of the extended event register, and clears it.

Syntax `STATus:EESR?`

Example `STATUS:EESR?→1`

Description See section 14.4, “Status Report” for details on the extended event register.

STATus:ERRor?

Function Queries the occurred error code and message.

Syntax `STATus:ERRor?`

Example `STATUS:ERROR?→113,"Undefined header"`

STATus:FILTer<x>

Function Sets the transit filter/queries the current setting.
Syntax `STATus:FILTer<x> {RISE|FALL|BOTH|NEVer}`
`STATus:FILTer<x>?`
`<x>=1 to 16`
Example `STATUS:FILTER2 RISE`
`STATUS:FILTER2?→:STATUS:FILTER2 RISE`
Description See section 14.4, "Status Report" for details on the condition filter.

STATus:QMESsage

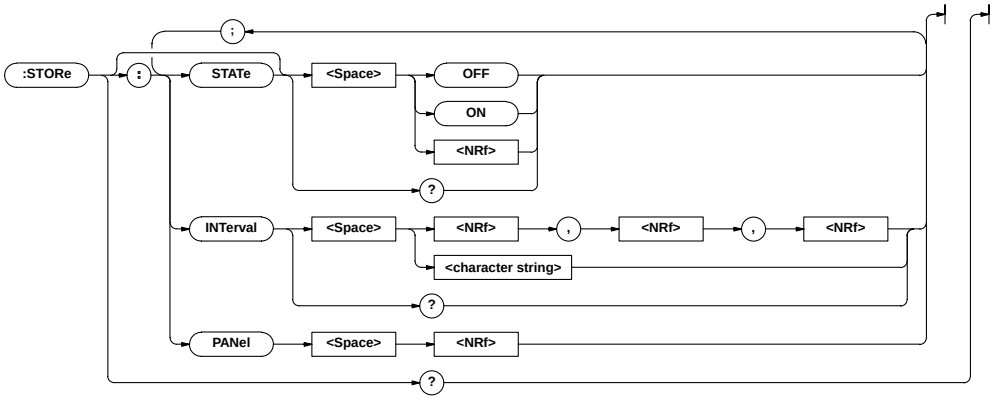
Function Sets whether or not to apply the corresponding message to the query "STATus:ERRor?" / queries the current setting.
Syntax `STATus:QMESsage {<Boolean>}`
`STATus:QMESsage?`
Example `STATUS:QMESSAGE OFF`
`STATUS:QMESSAGE?→:STATUS:QMESSAGE 0`

STATus:SPOLL?(Serial Poll)

Function Executes serial polling.
Syntax `STATus:SPOLL?`
Example `STATUS:SPOLL?→STATUS:SPOLL 0`
Description This command is dedicated to the RS-232-C interface. An interface message is available for the GP-IB interface.

14.3.14 STORe Group

The commands in the STORe group are used to make settings relating to and inquiries about storing data. This allows you to make the same settings as when using the lower menus of [MEMORY]-"StorE" or [MEMORY]-"PnLSt".



STORe?

Function Queries all settings related to storing data.
Syntax `STORe?`
Example `STORE?→:STORE:STATE 0;INTERVAL 0,0,0`

STORe:INTerval

Function Sets the interval for storage/queries the current setting.
Syntax `STORe:INTerval`
`{<NRf>,<NRf>,<NRf>|<String>}`
`STORe:INTerval?`
`{<NRf>,<NRf>,<NRf>}=0,0,0 to 99,59,59`
`{<String>}=HH:MM:SS`
`HH hour MM min SS sec`
Example `STORE:INTERVAL 0,0,0`
`STORE:INTERVAL "00:00:00"`
`STORE:INTERVAL?→:STORE:INTERVAL 0,0,0`
Description
- If the storage interval is set to 0,0,0, the storage interval becomes 250 ms in case of normal measurement.
- For the storage interval in case of harmonic analysis, see page 8-2.

STORe:PANel

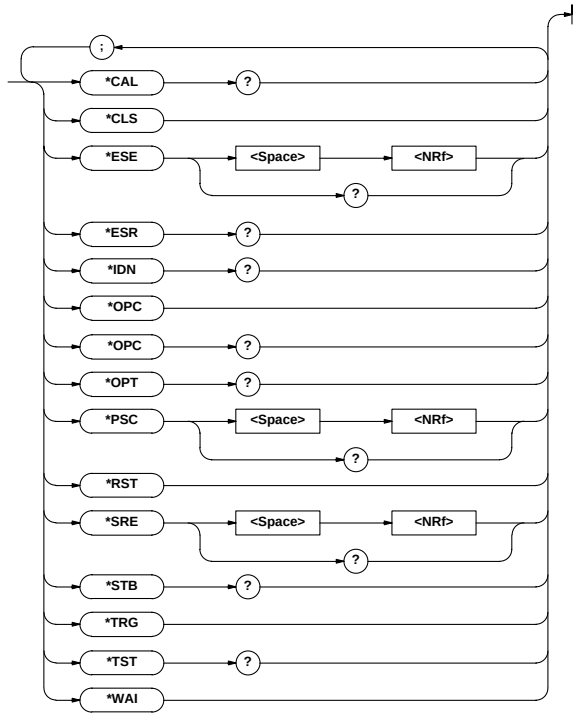
Function Saves the setting parameters to a file.
Syntax `STORe:PANel {<NRf>}`
`{<NRf>}=1 to 4:file number`
Example `STORE:PANEL 1`

STORe[:STATe]

Function Sets store ON/OFF, queries the current setting.
Syntax `STORe[:STATe] {<Boolean>}`
`STORe:STATe?`
Example `STORE:STATE ON`
`STORE:STATE?→:STORE:STATE 1`

14.3.15 Common Command Group

The commands in the common command group are independent of the instrument's functions, and are specified in IEEE 488.2-1987. There is no front panel key that corresponds to this group.



*CAL?

Function Performs zero level compensation and queries the result.

Syntax `*CAL?`

Example `*CAL?→0`

Description "0" is returned when the zero level compensation completes properly. Otherwise, "1" is returned.

*CLS

Function Clears the standard event register, extended event register and error queue.

Syntax `*CLS`

Example `*CLS`

Description
- The output will also be cleared if a `*CLS` command is appended after the program message terminator.
- For details on the registers and queues, see section 14.4.

*ESE

Function Sets the value for the standard event enable register, or queries the current setting.

Syntax `*ESE {<NRf>}`
`*ESE?`
`{<NRf>}=0 to 255`

Example `*ESE 253`
`*ESE?→253`

Description
- Each bit is expressed as a decimal number.
- For example, if "`*ESE 253`" is set, the standard enable register will be set to "11111101". This means that bit 2 of the standard event register is disabled so that bit 5 (ESB) of the status byte register will not be set to "1", even if a query error occurs.
- Default is "`*ESE 255`" , i.e. all bits are enabled.
- The standard event enable register will be cleared when an inquiry is made using `*ESE?`.
- For details referring the standard event enable register, see section 14.4.

*ESR?

Function Queries the value of the standard event register and clears it at the same time.
Syntax *ESR?
Example *ESR?→32
Description
- Each bit is expressed as a decimal number.
- It is possible to ascertain the type of event which has occurred, while SRQ is occuring.
- For example, if "*ESR 32" is returned, this means that the standard event register is "00100000" , i.e. the SRQ has occurred due to a command syntax error.
- If a query is made using *ESR?, the standard event register will be cleared.
- For details referring the standard event enable register, see section 14.4.

*IDN?

Function Queries the instrument model.
Syntax *IDN?
Example *IDN?→YOKOGAWA,253421,0,F3.11
Description A reply consists of the following information: <Model>,<Type>,<Serial No.> and <Firmware version>

*OPC

Function When *OPC is sent, this command sets bit 0 (the OPC bit) of the standard event register to "1". This command is not supported by this instrument.
Syntax *OPC

*OPC?

Function When *OPC? is sent, "1" in (ASCII code) will be returned. This command is not supported by this instrument.
Syntax *OPC?

*OPT?

Function Queries installed options.
Syntax *OPT?
Example *OPT?→EXT1, HARM, DA4, CMP
Description
- "NONE" will be attached to the reply if no options are installed.
- "OPT?" must always be the last query in program message. If there is another query after this, an error will occur.

*PSC

Function Selects whether or not to clear the following registers when turning ON the power, or queries the current setting. The registers are the standard event enable register, the extended event enable register and the transition filter. However, they cannot be cleared if the parameter is "0".
Syntax *PSC {<NRf>}
*PSC?
{<NRf>}=0(no clearance), other than 0(clearance)
Example *PSC 1
*PSC?→1
Description See section 14.4 for details on the registers.

*RST

Function Resets (initializes) the present settings.
Syntax *RST
Example *RST
Description See section 12.2, "Initializing Setting Parameters" for initial settings.

*SRE

Function Sets the value of the service request enable register, or queries the current setting.
Syntax *SRE {<NRf>}
*SRE?
{<NRf>}=0 to 255
Example *SRE 239
*SRE?→239
Description
- Each bit is expressed as a decimal number.
- For example, if "*SRE 239" is set, the service request enable register will be set to "11101111". This means that bit 4 of the service request enable register is disabled, so that bit 5 (ESB0 of the status byte register will not be set to "1", even if the output queue is not empty.
- However, bit 6 (MSS) of the status byte register is the MSS bit, so it will be ignored.
- Default is "*SRE 255", i.e. all bits are enabled.
- The service request enable register will not be cleared, even if a query is made using *SRE?.
- For details of the service request enable register, see section 14.4.

*STB?

Function Queries the value of the status byte register.

Syntax `*STB?`

Example `*STB?→4`

Description
- Each bit is expressed as a decimal number.
- Bit 6 is RQS and not MSS because the register is read without serial polling.
- For example, if "`*STB 4`" is returned, the status byte register is set to "00000100", i.e. the error queue is not empty (an error has occurred).
- The status byte register will not be cleared, even if a query is made using `*STB?`.
- For details of the status byte register, see section 14.4.

*TRG

Function Executes the same operation as the TRIG (SHIFT+HOLD) key on the front panel.

Syntax `*TRG`

Description
- Executes the same operation as when using the multi line message GET (Group Execute Trigger).

*TST?

Function Executes a self-test and queries the result. All internal memory boards are tested.

Syntax `*TST?`

Example `*TST?→0`

Description
- "`0`" will be returned when the result are satisfactory. If an abnormality is detected, "`1`" will be returned.

*WAI

Function Waits for the command following `*WAI` until execution of the designated overlap command has been completed. This command is not supported by this instrument.

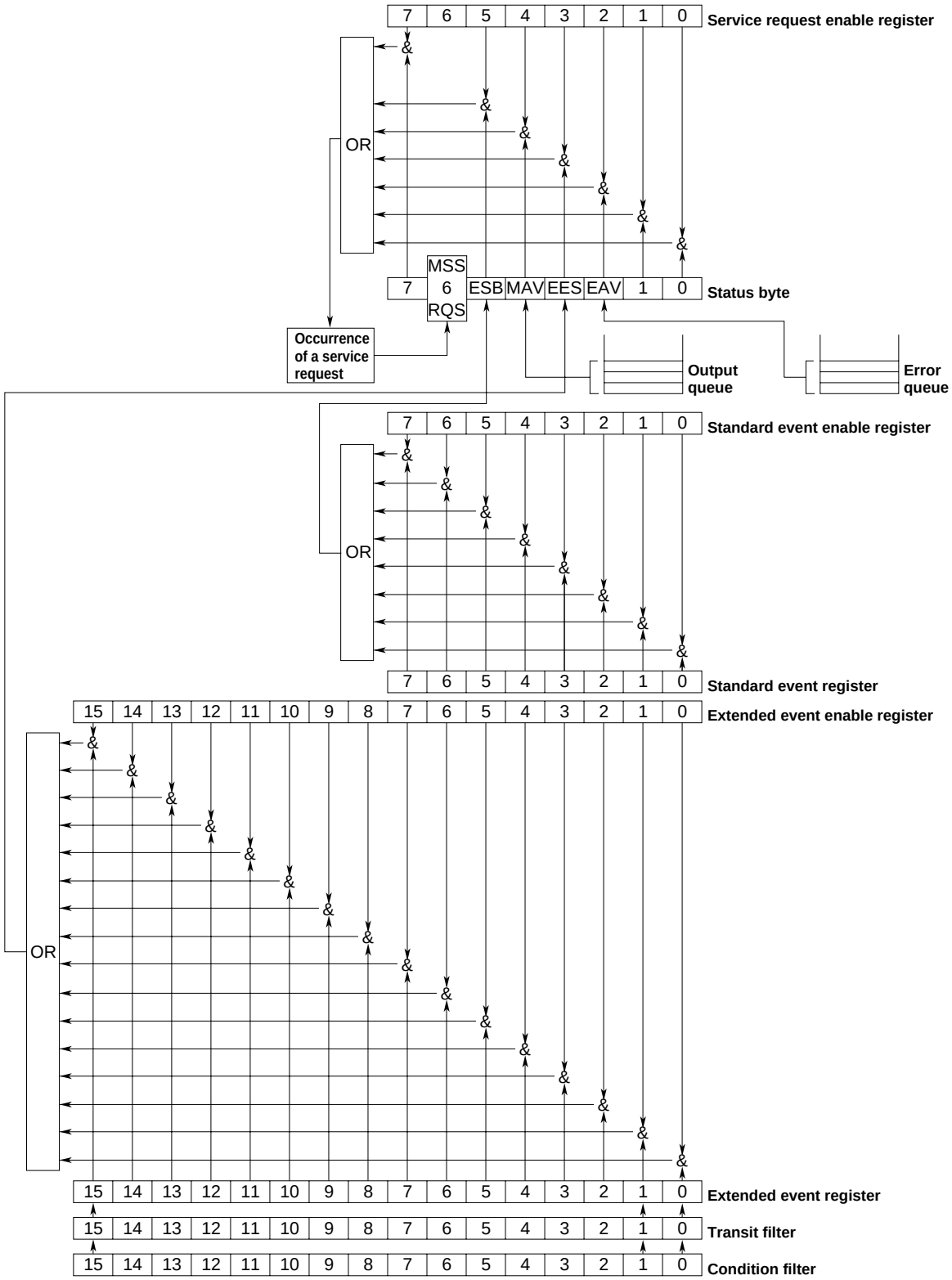
Syntax `*WAI`

14.4 Status Report

14.4.1 Overview of the Status Report

Status Report

The figure below shows the status report which is read by a serial poll. This is an extended version of the one specified in IEEE 488.2-1987.



Overview of Registers and Queues

Name	Function	Writing	Reading
Status byte		—	Serial poll (RQS), *STB?(MSS)
Service request enable register	Masks status byte.	*SRE	*SRE?
Standard event register	Event in the instrument (1)	—	*ESR?
Standard event enable register	Masks standard event register.	*ESE	*ESE?
Extended event register	Event in the instrument (2)	—	STATus:EESR?
Extended event enable register	Masks extended event register.	STATus:EESE	STATus:EESE?
Condition register	Current instrument status	—	STATus:CONDition?
Transition filter	Extended event occurrence conditions	STATus:FILTer <x>	STATus:FILTer <x>
Output queue	Stores response message to a query.	All executable queues	
Error queue	Stores error Nos. and messages.	—	STATus:ERRor?

Registers and Queues which Affect the Status Byte

Registers which affect each bit of the status byte are shown below.

Standard event register: Sets bit 5 (ESB) of status byte to “1” or “0”.
Output queue: Sets bit 4 (MAV) of status byte to “1” or “0”.
Extended event register: Sets bit 3 (EES) of status byte to “1” or “0”.
Error queue: Sets bit 2 (EAV) of status byte to “1” or “0”.

Enable Registers

Registers which mask a bit so that the bit does not affect the status byte, even if the bit is set to “1”, are shown below.

Status byte: Masks bits using the service request enable register.
Standard event register: Masks bits using the standard event enable register.
Extended event register: Masks bits using the extended event enable register.

Writing/Reading from Registers

The *ESE command is used to set bits in the standard event enable register to “1” or “0”, and the *ESR? query is used to check whether bits in that register are set to “1” or “0”. For details of these commands, see section 14.3.

14.4.2 Status Byte

Overview of Status Byte

Bits 0, 1 and 7

Not used (always “0”)

Bit 2 EAV (Error Available)

Set to “1” when the error queue is not empty, i.e. when an error occurs. For details, see page 14-45.

Bit 3 EES (Extended Event Summary Bit)

Set to “1” when a logical AND of the extended event register and the corresponding enable register is “1”, i.e. when an event takes place in the instrument. See page 14-44.

Bit 4 MAV (Message Available)

Set to “1” when the output queue is not empty, i.e. when there is data which is to be output when an inquiry is made. See page 14-45.

Bit 5 ESB (Event Summary Bit)

Set to “1” when a logical AND of the standard event register and the corresponding enable register is “1”, i.e. when an event takes place in the instrument. See page 14-43.

Bit 6 RQS (Request Status)/MSS (Master Summary Status)

MSS is set to “1” when a logical AND of the status byte (except for bit 6) and the service request enable register is not “0”, i.e. when the instrument is requesting service from the controller.
RQS is set to “1” when MSS changes from “0” to “1”, and is cleared when a serial poll is performed or when MSS changes to “0”.

Bit Masking

To mask a bit in the status byte so that it does not cause an SRQ, set the corresponding bit of the service request enable register to “0”.
For example, to mask bit 2 (EAV) so that no service will be requested, even if an error occurs, set bit 2 of the service request enable register to “0”. This can be done using the *SRE command. To query whether each bit of the service request enable register is “1” or “0”, use *SRE?. For details of the *SRE command, see section 14.3.

Operation of the Status Byte

A service request is issued when bit 6 of the status byte becomes “1”. Bit 6 becomes “1” when any of the other bits becomes “1” (or when the corresponding bit in the service request enable register becomes “1”). For example, if an event takes place and the logical OR of each bit of the standard event register and the corresponding bit in the enable register is “1”, bit 5 (ESB) will be set to “1”. In this case, if bit 5 of the service request enable register is “1”, bit 6 (MSS) will be set to “1”, thus requesting service from the controller.
It is also possible to check what type of event has occurred by reading the contents of the status byte.

Reading from the Status Byte

The following two methods are provided for reading the status byte.

- **Inquiry using the *STB? query**
  Making an inquiry using the *STB? query sets bit 6 to MSS. This causes the MSS to be read. After completion of the read-out, none of the bits in the status byte will be cleared.
- **Serial poll**
  Execution of a serial poll changes bit 6 to RQS. This causes RQS to be read. After completion of the read-out, only RQS is cleared. Using a serial poll, it is not possible to read MSS.

Clearing the Status Byte

No method is provided for forcibly clearing all the bits in the status byte. Bits which are cleared are shown below.

- **When an inquiry is made using the *STB? query**
  No bit is cleared.
- **When a serial poll is performed**
  Only the RQS bit is cleared.
- **When the *CLS command is received**
  When the *CLS command is received, the status byte itself is not cleared, but the contents of the standard event register (which affects the bits in the status byte) are cleared. As a result, the corresponding bits in the status byte are cleared, except bit 4 (MAV), since the output queue cannot be emptied by the *CLS command. However, the output queue will also be cleared if the *CLS command is received just after a program message terminator.

14.4.3 Standard Event Register

Overview of the Standard Event Register

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

Bit 7 PON (Power ON)

Bit 7 PON (Power ON) Set to “1” when power is turned ON

Bit 6 URQ (User Request)

Not used (always “0”)

Bit 5 CME (Command Error)

Set to “1” when the command syntax is incorrect.
Examples: Incorrectly spelled command name; “9” used in octal data.

Bit 4 EXE (Execution Error)

Set to “1” when the command syntax is correct but the command cannot be executed in the current state.
Examples: Parameters are outside the setting range: an attempt is made to make a hard copy during acquisition.

Bit 3 DDE (Device Dependent Error)

Set to “1” when execution of the command is not possible due to an internal problem in the instrument that is not a command error or an execution error.

Bit 2 QYE (Query Error)

Set to “1” if the output queue is empty or if the data is missing even after a query has been sent.
Examples: No response data; data is lost due to an overflow in the output queue.

Bit 1 RQC (Request Control)

Not used (always “0”)

Bit 0 OPC (Operation Complete)

Set to “1” when the operation designated by the *OPC? command has been completed.

Bit Masking

To mask a bit in the standard event register so that it does not cause bit 5 (ESB) of the status byte to change, set the corresponding bit in the standard event enable register to “0”.
For example, to mask bit 2 (QYE) so that ESB will not be set to “1”, even if a query error occurs, set bit 2 of the standard event enable register to “0”. This can be done using the *ESE? command. To inquire whether each bit of the standard event enable register is “1” or “0”, use the *ESE?. For details of the *ESE? command, see section 14.3.

Operation of the Standard Event Register

The standard event register is provided for eight different kinds of event which can occur inside the instrument. Bit 5 (ESB) of the status byte is set to “1” when any of the bits in this register becomes “1” (or when the corresponding bit of the standard event enable register becomes “1”).

Examples

1. A query error occurs.
2. Bit 2 (QYE) is set to “1”.
3. Bit 5 (ESB) of the status byte is set to “1” if bit 2 of the standard event enable register is “1”.

It is also possible to check what type of event has occurred inside the instrument by reading the contents of the standard event register.

Reading from the Standard Event Register

The contents of the standard event register can be read by the `*ESR` command. After completion of the read-out, the register will be cleared.

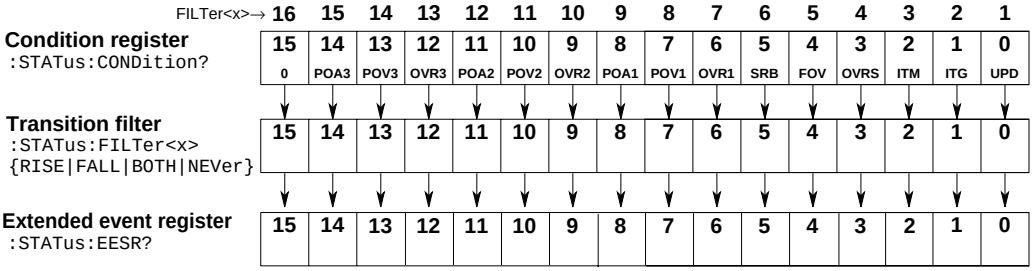
Clearing the Standard Event Register

The standard event register is cleared in the following three cases.

- When the contents of the standard event register are read using `*ESR?`
- When the `*CLS` command is received
- When power is turned ON again

14.4.4 Extended Event Register

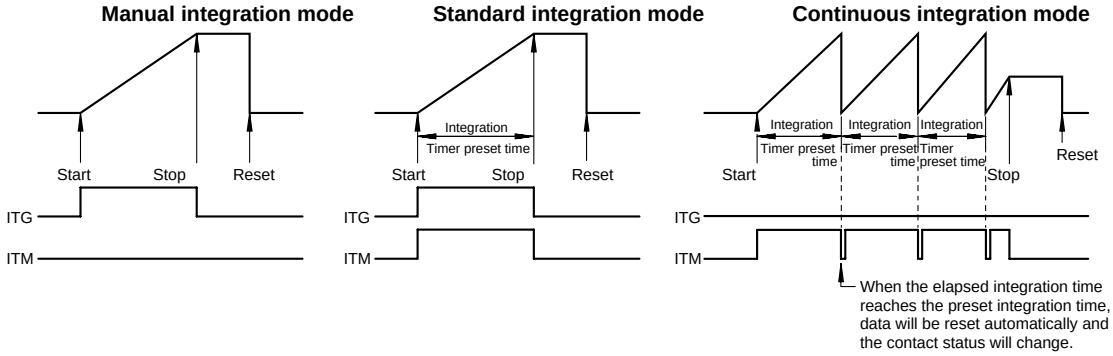
Reading the extended event register tells you whether changes in the condition register (reflecting internal conditions) have occurred. A transition filter can be applied which allows you to decide which events are reported to the extended event register.



The meaning of each bit of the condition register is as follows.

Bit 0 UPD (Updating)	Set to “1” during updating of measurement data.
Bit 1 ITG (Integrate busy)	Set to “1” during integration. (See figure on the next page.)
Bit 2 ITM (Integrate timer busy)	Set to “1” during the integration timer is being operated. (See figure on the next page.)
Bit 3 OVRS (Σ results overflow)	Set to “1” when the integration results of Σ overflow. (Display shows “—oF—”)
Bit 4 FOV (Frequency over)	Set to “1” when the frequency lies outside the measurement range (Display shows “ErrLo” , “ErrHi” or “FrqEr” .
Bit 5 SRB (Store/Recall busy)	Set to “1” while storing or recalling is in progress.
Bit 6 OVR1 (Element 1; measured data over)	Set to “1” when the measurement/computed data of element 1 overflow, or when an error occurs. (Display shown “—oF—” , “—oL—” , “PFErr” or “dEGEr”)
Bit 7 POV1 (Element 1; voltage peak over)	Set to “1” when the voltage value of element 1 exceeds the peak value.
Bit 8 POA1 (Element 1; current peak over)	Set to “1” when the current value of element 1 exceeds the peak value.
Bit 9 OVR2 (Element 2; measured data over)	Set to “1” when the measurement/computed data of element 2 overflow, or when an error occurs. (Display shown “—oF—” , “—oL—” , “PFErr” or “dEGEr”)
Bit 10 POV2 (Element 2; voltage peak over)	Set to “1” when the voltage value of element 2 exceeds the peak value.
Bit 11 POA2 (Element 2; current peak over)	Set to “1” when the current value of element 2 exceeds the peak value.
Bit 12 OVR3 (Element 3; measured data over)	Set to “1” when the measurement/computed data of element 3 overflow, or when an error occurs. (Display shown “—oF—” , “—oL—” , “PFErr” or “dEGEr”)
Bit 13 POV3 (Element 3; voltage peak over)	Set to “1” when the voltage value of element 3 exceeds the peak value.
Bit 14 POA3 (Element 1; current peak over)	Set to “1” when the current value of element 3 exceeds the peak value.

The transition filter is applied to each bit of the condition register seperately, and can be selected from the following. Note that the numbering of the bits used in the filter setting differs from the actual bit number (1 to 16 vs. 0 to 15).



Rise	The bit of the extended event register becomes “1” when the bit of the condition register changes from “0” to “1”.
Fall	The bit of the extended event register becomes “1” when the bit of the condition register changes from “1” to “0”.
Both	The bit of the extended event register becomes “1” when the bit of the condition register changes from “0” to “1”, or from “1” to “0”.
Never	The bit of the extended event register is disabled and always “0”.

14.4.5 Output Queue and Error Queue

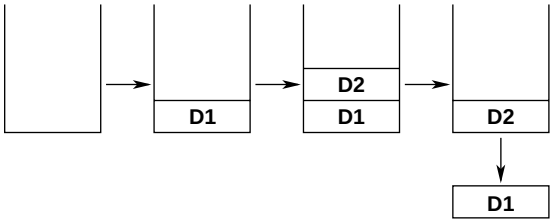
Overview of the Output Queue

The output queue is provided to store response messages to queries. For example, when the WAVeform:SEND? query is sent to request output of the acquired waveform, the response data will be stored in the output queue until it is read out.

The example below shows that data is stored record by record in the output queue, and is read out oldest item first, newest item last. The output queue is emptied in the following cases (in addition to when read-out is performed):

- When a new message is received from the controller.
- When dead lock occurs (page 14-5).
- When a device clear command (DCL or SDC) is received.
- When power is turned ON again.

The output queue cannot be emptied using the *CLS command. To see whether the output queue is empty or not, check bit 4 (MAV) of the status byte.



Overview of the Error Queue

The error queue stores the error No. and message when an error occurs. For example, when the built-in battery has run out, an error occurs and its error No. (901) and message “Backup Failure” will be stored in the error queue.

The contents of the error queue can be read using the STATus:ERRor? query. As with the output queue, messages are read oldest first, newest last (see the previous page).

If the error queue becomes full, the final message will be replaced by message 350, “Queue overflow”.

The error queue is emptied in the following cases (in addition to when read-out is performed).

- When the *CLS command is received
- When power is turned ON again

To see whether the error queue is empty or not, check bit 2 (EAV) of the status byte.

14.5 Sample Program

This section describes sample programs for a IBM PC/AT and compatible system with National Instruments AT-GPIB/TNTIEEE-488.2 board. Sample programs in this manual are written in Quick BASIC version 4.0/4.5.

```
'*************************************************************************
'*                                                                       *
'*  sample program 1 for the WT200                                       *
'*                                                                       *
'*************************************************************************
'*                                                                       *
'*  Used to set measurement condition/ranges for normal mesurement mode, *
'*  and read and display the following data each time measured/computed  *
'*  data is updated.                                                     *
'*                                                                       *
'*  Voltage(V), current(A), active power(W), voltage frequency(VHz)      *
'*                                                                       *
'*************************************************************************

    REM $INCLUDE: 'qbdecl.bas'

    DECLARE SUB gpiberr (msg$)
    DIM D$(4)

    CALL IBDEV(0, 1, 0, T10s, 1, 0, DEV%)
    IF (DEV% <= 0) THEN CALL gpiberr("Ibdev error")

' interface clear
    CALL IBCLR(DEV%)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibclr error")

' set measurement condition
    WRT$ = "SAMPLE:HOLD OFF"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "MODE RMS"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "FILTER OFF"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "SCALING OFF;AVERAGING OFF"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set measurement range
    WRT$ = "VOLTAGE:RANGE 150V"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "CURRENT:RANGE 5A"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set function/element of display C to measure frequency of element 1
    WRT$ = "DISPLAY3:FUNCTION VHZ;ELEMENT 1"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set communication output items
' 1. V, A, W -> ON, others -> OFF
' 2. VHz -> ON
    WRT$ = "MEASURE:ITEM:PRESET NORMAL"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

    WRT$ = "MEASURE:ITEM:VHZ:ELEMENT1 ON"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set filter to detect completion of refreshing data
    WRT$ = "STATUS:FILTER1 FALL"
    CALL IBWRT(DEV%, WRT$)
    IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
```

```
' read/display measured data
    PRINT ""
    FOR I = 1 TO 10
        'clear extended event register
        WRT$ = "STATUS:EESR?"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")
        RD$ = SPACE$(512)
        CALL IBRD(DEV%, RD$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrd error")

        'wait for completion of refreshing data
        WRT$ = "COMMUNICATE:WAIT 1"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

        'request output of measured data
        WRT$ = "MEASURE:VALUE?"
        CALL IBWRT(DEV%, WRT$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibwrt error")

        'read measured data
        RD$ = SPACE$(128)
        CALL IBRD(DEV%, RD$)
        IF (ibsta% AND EERR) THEN CALL gpiberr("Ibrd error")
        C$ = RD$
        FOR J = 0 TO 3
            L = INSTR(C$, " ")
            B = INSTR(C$, ",")
            IF B = 0 THEN B = INSTR(C$, CHR$(10))       'LF
            D$(J) = LEFT$(C$, (B - 1))
            C$ = MID$(C$, (B + 1), L)
        NEXT J

        'display measured data
        PRINT "V", D$(0)
        PRINT "A", D$(1)
        PRINT "W", D$(2)
        PRINT "VHZ", D$(3)
    NEXT I

'  Call the IBONL function to disable the hardware and software.
    CALL IBONL(DEV%, 0)
END
```

```
'*************************************************************************
'*                                                                       *
'*  sample program 2 for the WT200                                       *
'*                                                                       *
'*************************************************************************
'*                                                                       *
'*  used to read and display the following data in harmonic analysis mode. *
'*                                                                       *
'*  PLL source (voltage) frequency                                       *
'*  harmonic distortion of current                                       *
'*  total rms value of each harmonic from 1st to 50th of current         *
'*  analysis value of fundamental (1st) of current, analysis value of    *
'*  each harmonic (2nd to 50th)                                          *
'*                                                                       *
'*************************************************************************

    REM $INCLUDE: 'qbdecl.bas'

    DECLARE SUB gpiberr (msg$)
    DIM D$(53)

    CALL IBDEV(0, 1, 0, T10s, 1, 0, DEV%)
    IF (DEV% <= 0) THEN CALL gpiberr("Ibdev error")

' interface clear
    CALL IBCLR(DEV%)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibclr error")

' set measurement condition
    WRT$ = "HARMONICS:STATE ON;ELEMENT 1;SYNCHRONIZE V,1;THD IEC"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set communication output items
' 1. set all function off
' 2. set necessary function on
    WRT$ = "MEASURE:HARMONICS:ITEM:PRESET CLEAR"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")
    WRT$ = "MEASURE:HARMONICS:ITEM:SYNCHRONIZE ON;ATHD ON;A ON"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

' set filter to detect completion of refreshing data
    WRT$ = "STATUS:FILTER1 FALL"
    CALL IBWRT(DEV%, WRT$)
    IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

' read/display measured data
    PRINT ""
    FOR I = 1 TO 10
        'clear extended event register
        WRT$ = "STATUS:EESR?"
        CALL IBWRT(DEV%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")
        RD$ = SPACE$(255)
        CALL IBRD(DEV%, RD$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd error")

        'wait for completion of refreshing data
        WRT$ = "COMMUNICATE:WAIT 1"
        CALL IBWRT(DEV%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

        'request output of measured data
        WRT$ = "MEASURE:HARMONICS:VALUE?"
        CALL IBWRT(DEV%, WRT$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibwrt error")

        'read analyzed data
        RD$ = SPACE$(1024)
        CALL IBRD(DEV%, RD$)
        IF (IBSTA% AND EERR) THEN CALL gpiberr("Ibrd error")

        C$ = LEFT$(RD$, ibcnt%)
        FOR J = 0 TO 52
            L = LEN(C$)
            B = INSTR(C$, ",")
            IF B = 0 THEN B = INSTR(C$, CHR$(10))
            D$(J) = LEFT$(C$, B - 1)
            C$ = MID$(C$, (B + 1), L)
        NEXT J
```

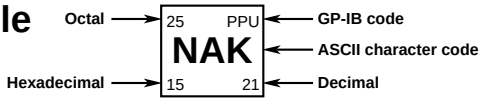
```
            'display analyzed data
            PRINT "V1 FREQ", D$(0)
            PRINT "A1 THD(IEC)", D$(1)
            PRINT "A1 RMS", D$(2)
            FOR J = 1 TO 50 STEP 2
                PRINT "A1 Order" + STR$(J), D$(J + 2),
                PRINT "A1 Order" + STR$(J + 1), D$(J + 3)
            NEXT J
        PRINT ""
        NEXT I

'   Call the IBONL function to disable the hardware and software.
    CALL IBONL(DEV%, 0)
END
```

14.6 ASCII Character Codes

ASCII chracter codes are given below.

	0	1	2	3	4	5	6	7
0	0 **NUL** 0 0	20 **DEL** 10 16	40 0 **SP** 20 32	60 16 **0** 30 48	100 0 **@** 40 64	120 16 **P** 50 80	140 0 **‘** 60 96	160 16 **p** 70 112
1	1 GTL **SOH** 1 1	21 LLO **DC1** 11 17	41 1 **!** 21 33	61 17 **1** 31 49	101 1 **A** 41 65	121 17 **Q** 51 81	141 1 **a** 61 97	161 17 **q** 71 113
2	2 **STX** 2 2	22 **DC2** 12 18	42 2 **”** 22 34	62 18 **2** 32 50	102 2 **B** 42 66	122 18 **R** 52 82	142 2 **b** 62 98	162 18 **r** 72 114
3	3 **ETX** 3 3	23 **DC3** 13 19	43 3 **#** 23 35	63 19 **3** 33 51	103 3 **C** 43 67	123 19 **S** 53 83	143 3 **c** 63 99	163 19 **s** 73 115
4	4 SDC **EOT** 4 4	24 DCL **DC4** 14 20	44 4 **$** 24 36	64 20 **4** 34 52	104 4 **D** 44 68	124 20 **T** 54 84	144 4 **d** 64 100	164 20 **t** 74 116
5	5 PPC **ENQ** 5 5	25 PPU **NAK** 15 21	45 5 **%** 25 37	65 21 **5** 35 53	105 5 **E** 45 69	125 21 **U** 55 85	145 5 **e** 65 101	165 21 **u** 75 117
6	6 **ACK** 6 6	26 **SYN** 16 22	46 6 **&** 26 38	66 22 **6** 36 54	106 6 **F** 46 70	126 22 **V** 56 86	146 6 **f** 66 102	166 22 **v** 76 118
7	7 **BEL** 7 7	27 **ETB** 17 23	47 7 **’** 27 39	67 23 **7** 37 55	107 7 **G** 47 71	127 23 **W** 57 87	147 7 **g** 67 103	167 23 **w** 77 119
8	10 GET **BS** 8 8	30 SPE **CAN** 18 24	50 8 **(** 28 40	70 24 **8** 38 56	110 8 **H** 48 72	130 24 **X** 58 88	150 8 **h** 68 104	170 24 **x** 78 120
9	11 TCT **HT** 9 9	31 SPD **EM** 19 25	51 9 **)** 29 41	71 25 **9** 39 57	111 9 **I** 49 73	131 25 **Y** 59 89	151 9 **i** 69 105	171 25 **y** 79 121
A	12 **LF** A 10	32 **SUB** 1A 26	52 10 ***** 2A 42	72 26 **:** 3A 58	112 10 **J** 4A 74	132 26 **Z** 5A 90	152 10 **j** 6A 106	172 26 **z** 7A 122
B	13 **VT** B 11	33 **ESC** 1B 27	53 11 **+** 2B 43	73 27 **;** 3B 59	113 11 **K** 4B 75	133 27 **[** 5B 91	153 11 **k** 6B 107	173 27 **{** 7B 123
C	14 **FF** C 12	34 **FS** 1C 28	54 12 **,** 2C 44	74 28 **<** 3C 60	114 12 **L** 4C 76	134 28 **** 5C 92	154 12 **l** 6C 108	174 28 **|** 7C 124
D	15 **CR** D 13	35 **GS** 1D 29	55 13 **-** 2D 45	75 29 **=** 3D 61	115 13 **M** 4D 77	135 29 **]** 5D 93	155 13 **m** 6D 109	175 29 **}** 7D 125
E	16 **SO** E 14	36 **RS** 1E 30	56 14 **.** 2E 46	76 30 **>** 3E 62	116 14 **N** 4E 78	136 30 **^** 5E 94	156 14 **n** 6E 110	176 30 **~** 7E 126
F	17 **SI** F 15	37 **US** 1F 31	57 15 **/** 2F 47	77 UNL **?** 3F 63	117 15 **O** 4F 79	137 UNT **_** 5F 95	157 15 **o** 6F 111	177 **DEL (RUBOUT)** 7F 127
	Address Command	**Universal Command**	**Listener Address**		**Talker Address**		**Secondary Command**	

Example



14.7 Communication-related Error Messages

Error messages related to communications are given below.

When servicing is required, contact your nearest YOKOGAWA representative, as given on the back cover of this manual.

Only error messages relating to the communication mode 488.2 are given here. For other error messages, see chapter 13 and section 15.4, “Error Codes and Corrective Actions.”

Errors in communications commands (100 to 199)

Code	Message	Action	Reference Page or Section
102	Syntax error	Incorrect syntax	Section 14.2, 14.3
103	Invalid separator	Insert a comma between data items to separate them.	14-4
104	Data type error	See pages 14-7 and 14-8 and enter data using the correct data format.	14-7, 14-8
105	GET not allowed	GET is not supported as a response to an interface message.	—
108	Parameter not allowed	Check the number of parameters.	14-7, Section 14.3
109	Missing parameter	Enter the required number of parameters.	14-7, Section14.3
111	Header separator error	Insert a space between the header and the data to separate them.	14-4
112	Program mnemonic too long	Check the mnemonic (character string consisting of letters and numbers).	Section 14.3
113	Undefined header	Check the header.	Section 14.3
114	Header suffix out of range	Check the header.	Section 14.3
120	Numeric data error	Mantissa must be entered before the numeric value in <NRf> format.	14-7
123	Exponent too large	Use a smaller exponent in <NR3> format.	14-8, Section 14.3
124	Too many digits	Limit the number of digits to 255 or less.	14-8, Section 14.3
128	Numeric data not allowed	Enter in a format other than <NRf> format.	14-8, Section 14.3
131	Invalid suffix	Check the units for <Voltage> and <Current>.	14-8
134	Suffix too long	Check the units for <Voltage> and <Current>.	14-8
138	Suffix not allowed	No units are allowed other than <Voltage> and <Current>.	14-8
141	Invalid character data	Enter one of the character strings in {...|...|...}.	Section 14.3
144	Character data too long	Check the character strings in {...|...|...}.	Section 14.3
148	Character data not allowed	Enter in a format other than one of those in {...|...|...}.	Section 14.3
150	String data error	<Character string> must be enclosed by double quotation marks or single quotation marks.	14-8
151	Invalid string data	<Character string> is too long or contains characters which cannot be used.	Section 14.3
158	String data not allowed	Enter in a data format other than <Character string>.	Section 14.3
161	Invalid block data	<Block data> is not allowed.	—
168	Block data not allowed	<Block data> is not allowed.	—
171	Invalid expression	Equation is not allowed.	Section 14.3
178	Expression data not allowed	Equation is not allowed.	Section 14.3
181	Invalid outside macro definition	Does not conform to the macro definition specified in IEEE488.2.	—

Errors in communications execution (200 to 299)

Code	Message	Action	Reference Section
221	Setting conflict	Check the relevant setting.	Section 14.3
222	Data out of range	Check the setting range.	Section 14.3
223	Too much data	Check the data byte length.	Section 14.3
224	Illegal parameter value	Check the setting range.	Section 14.3
241	Hardware missing	Check availability of options.	—
260	Expression error	Equation is not allowed.	—
270	Macro error	Does not conform to the macro definition specified in IEEE488.2.	—
272	Macro execution error	Does not conform to the macro definition specified in IEEE488.2.	—
273	Illegal macro label	Does not conform to the macro definition specified in IEEE488.2.	—
275	Macro definition too long	Does not conform to the macro definition specified in IEEE488.2.	—
276	Macro recursion error	Does not conform to the macro function specified in IEEE488.2.	—
277	Macro redefinition not allowed	Does not conform to the macro definition specified in IEEE488.2.	—
278	Macro header not found	Does not conform to the macro definition specified in IEEE488.2.	—

Error in communication query(400 to 499)

Code	Message	Action	Reference Page
410	Query INTERRUPTED	Check transmission/reception order.	14-4
420	Query UNTERMINATED	Check transmission/reception order.	14-4
430	Query DEADLOCKED	Limit the length of the program message including <PMT> to 1024 bytes or less.	14-5
440	Query UNTERMINATED after indefinite response	Do not enter any query after `*IDN?` and `*OPT?`.	—

Errors in execution (800 to 899)

Codes	Message	Action	Reference Page
813 to 819		Invalid operation	15-12
830 to 833		Internal memory access error	15-12
841 to 847		Integrator execute error	15-12

Error in system operation (912)

Code	Message	Action	Reference Page
912	Fatal error in Communication driver	Service is required.	—

Warnings (350, 390)

Code	Message	Action	Reference Page
350	Queue overflow	Read out the queue.	14-45
390	Overrun error (only for RS-232C)	Adjust the baud rate.	11-6

Note

The warning code 350 only appears in case of an overflow of the error queue. The error which occurs in case of clearing the `STATus:ERRor?` will not appear on the screen.

15.1 Adjustments

When the measurement values are erroneous, adjust this instrument using the following procedures.

Required Equipments

AC Voltage/Current Standard (0.02%, 30 to 300 V, 1 to 10 A/60 Hz)
recommended: Yokogawa 9100
or 2558 (if you want to carry out adjustments with an accuracy higher than the one 2558 is providing, fine adjust the output using the Digital Multi Meter (DMM) 1271)

DMM (0.05%)
recommended: Yokogawa 7552

Adjusting

Preparations

- **Preparing this instrument**

1. Turn ON the power while pressing the SHIFT key. Release the SHIFT key after all LED's have lit up.
2. Press the ENTER key.
   "rAnGE" will appear on display C. Press the ∧ or ∨ key and the display will change to "Ein" (in case of the external input option), "dA" (in case of the D/A option) or "End". The "rAnGE" mode is for adjustments of voltages or currents, while the "dA" mode is for adjustments of the D/A output. This instrument has no need for adjustment of power.
3. Select "rAnGE" and press the ENTER key. Then let the instrument warm up for at least 30 minutes.

- **Preparing the AC voltage/current standard and DMM**

4. Allow a warm-up time of at least one hour for the AC voltage/current standard and, if necessary, DMM.

Operating Keys

The keys to be used for carrying out adjustments, are as follows.

ENTER:	Press this key to confirm every adjustment of each range.
SHIFT:	Returns to the previous screen when aborting adjustment. However, since the adjustments will not be displayed, turn the power OFF and ON again.
RESET:	Returns to normal measurement. However, all adjusted data will become invalid.
A RANGE:	Press this key to proceed to the following range without adjusting the current range. When adjusting the D/A output, press this key to move the new input value to the right.
V RANGE:	Press this key to return to the previous range without adjusting the current range. When adjusting the D/A output, press this key to move the new input value to the left.

Adjusting the Voltage Range

1. Select "rAnGE" as described in the preparation above, press the ENTER key, and the display will become as follows.
   Display A rAnGE
   Display B 30.00 V
   Display C displays measurement value for five seconds.

2. Connect the voltage output of the AC voltage/current standard to the voltage input terminal of this instrument. Connect the H terminal of the standard to the V terminal of this instrument, and connect the L terminal of the standard to the ± terminal of this instrument.
3. Set the output voltage of the standard to 30.00 V and output this voltage.
4. Press the ENTER key after the value on display C stabilizes.
5. Display B will change to “300.0” V.
6. Set the output voltage of the standard to 300.0 V.
7. Press the ENTER key after the value on display C stabilizes.
8. Turn the output of the standard OFF.
   This completes the adjustment of the voltage range. The current range will be adjusted next. If the current range is not to be adjusted, press the SHIFT key here.

Adjusting the Current Range

1. After having completed adjusting the 300 V voltage range, display B will show “100.0” A.
2. Connect the current output of the AC voltage/current standard to the current input terminal of this instrument. Connect the H terminal of the standard to the A terminal of this instrument, and connect the L terminal of the standard to the ± terminal of this instrument.
3. Set the output of the standard to 100 mA and output this current.
4. Press the ENTER key after the value on display C stabilizes.
5. Display B will change to “1.000” A.
6. Set the output of the standard to 1.000 A.
7. Press the ENTER key after the value on Display C stabilizes.
8. Display B will change to “10.00” A.
9. Set the output of the standard to 10.000 A.
10. Press the ENTER key after the value on display C stabilizes.
11. Turn the output of the standard OFF.
12. Press the SHIFT key and display C will change to “rAnGE”. This completes the range adjustments. When you press the RESET key instead of the SHIFT key, the carried out adjustments will become invalid.

- **In case the External Input Option is installed (/EX1 or /EX2)**
  1. Select “Ein” in step 2 of Preparing this instrument (see previous page) and press the ENTER key.
  2. Display B will change to “10.00” V (or “200.0” mV).
  3. Connect the voltage output of the AC voltage/current standard to the voltage input terminal of this instrument. Connect the H terminal of the standard to the EXT terminal of this instrument, and connect the L terminal of the standard to the ± terminal of this instrument.
  4. Set the output voltage of the standard to 10.000 V (or 200.00 mV) and output this voltage.
  5. Press the ENTER key after the value on display C stabilizes.
  6. Press the SHIFT key and display C will change to “Ein”. This completes the external input adjustments. When you press the RESET key instead of the SHIFT key, the carried out adjustments will become invalid.

Note

The displayed value of the external input will become 50.000 A by the rated range.

Adjusting the D/A Output

- **Preparations**
  1. Connect the pin No. of the output connector corresponding to the channel to be adjusted to the H terminal of the DMM, and connect pin No. 12 and 24 of the output connector to the L terminal.
  2. Set the range of the DMM to 20 V.
  3. After “dA” appears on display C (using the ∧ or ∨ key), press the ENTER key.

- **Adjusting**

  After having carried out the above described preparations, the displays will show the following. Display A will be blinking.

  display A: ch 1
  display B: 5.000
  display C: 5.0000

  1. Select the channel to be adjusted on display A by pressing the ∧ or ∨ key, and then press the ENTER key. The head digit of display C will start blinking. From that point a voltage of approx. +5 V will be output from the connector.
  2. Press the V RANGE or A RANGE key to move the blinking digit of display C. Then, using the ∧ or ∨ key, adjust the blinking value to the value displayed at the DMM.
  3. After having adjusted all digits of display C, press the ENTER key. “–5.000 V” will appear on display C, and a voltage of approx. –5 V will be output from the connector.
  4. Carry out step 2 once again.
  5. After having adjusted all digits of display C, press the ENTER key.
  6. Change the channel indication on display A from “ch1” to “ch2”. Carry out steps 1 to 5 to adjust channel 2.
  7. Carry out steps 1 to 5 to adjust all channels.
  8. Press the SHIFT key and display C will change to “dA”. This completes the D/A output adjustments. When you press the RESET key instead of the SHIFT key, the carried out adjustments will become invalid.

After Finishing Adjustments

After having finished all adjustments, turn the power OFF and ON again.

Communication Commands to Carry Out Adjustments

Command	Description
CAL1	Enters the range adjustment mode.
CAL2	Enters the external input range adjustment mode.
CAL3	Enters the D/A output adjustment mode.
CAL0	Finishes adjustment (and returns to normal measurement mode).
CR0	Switches to 30 V range in range adjustment mode.
CR1	Switches to 300 V range in range adjustment mode.
CR2	Switches to 1 A range in range adjustment mode.
CR3	Switches to 10 A range in range adjustment mode.
CR6	Switches to 100 mA range in range adjustment mode.
CHm	Switches the channel in D/A output adjustment mode. m = 1 to 4
CDm,n	Enters the actual output value in D/A output adjustment mode. m = 1 to 4, n = actual output value
DO0	Outputs +5 V in D/A output adjustment mode.
DO1	Outputs –5 V in D/A output adjustment mode.
OD	Requests the output of measurement data, and sets the output format to normal measurement default.
ENT	Corresponds to the ENTER key operation, confirming the adjustment value.
CAN	Corresponds to the RESET key operation, ignoring the adjustments.
END	Corresponds to the SHIFT key operation, keeping the adjustments.

Note

- In case of D/A adjustment, change the channel using the CHm command, then carry out DO0 or DO1 command, and the request output using the CDm,n command. After the CDm,n command is being executed by +5 V or –5 V, make sure to confirm by the ENT command.
- After the display has been stabilized in the range adjustment mode or external input range adjustment mode, execute the ENT command.

15.2 Calibration

Required Equipment

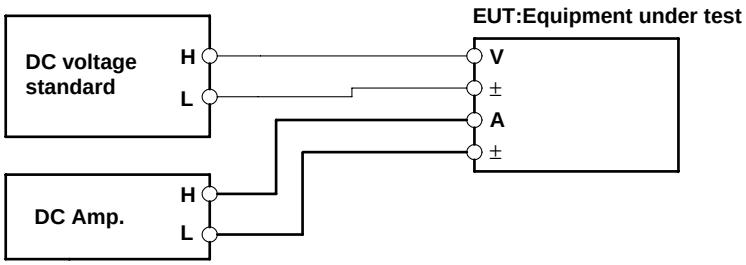
DC Voltage/Current Standard
  recommended: Yokogawa 2552, 2550
AC Voltage/Current Standard
  recommended: Yokogawa 2558, 2558-S7
    or 9100 (up to 400 Hz)
    or Fluke 5200A + 5215A or 5200A + 5220A
Digital Power Meter
  recommended: Yokogawa WT2000 or 2531
2ch Synchronizer
  recommended: Yokogawa FG120

Calibration of DC Voltage, Current and Power

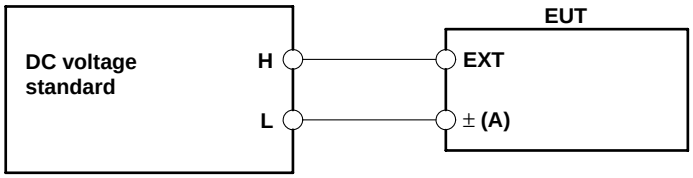
Wiring

Connect the DC voltage and DC current standard as follows.

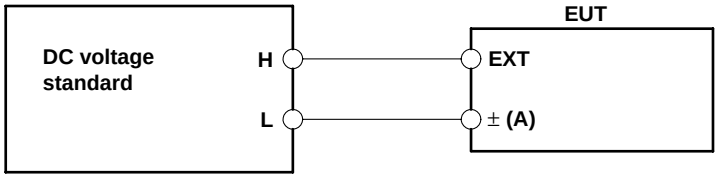
• Direct input



• External sensor input (equipped with option /EX1)



• External sensor input (equipped with option /EX2)



Calibration

Regarding the combination of voltage and current ranges, we recommend applying the following.

- Test the current ranges with the voltage range set to 150 V;
- Test the voltage ranges with the current range set to 5 A.

Of course testing can be carried out using other combinations as well.

1. Set the voltage or current range of this instrument to the testing range.
2. Set the output voltage of the DC voltage standard to the rated range value of this instrument, and output the voltage.
3. Set the output current of the DC current standard to the rated range value of this instrument, and output the current.
4. Fine adjust the output setting value of the voltage standard so that the voltage or current value displayed on this instrument shows the rated range.
5. Read the output voltage or current setting value of the voltage standard and treat this as the reference.
6. Verify that the power factor value displayed on this instrument shows the rated value. The product of the voltage setting value and the current setting value of the voltage standard is the calibrated power factor value.

Note

Before carrying out the calibration described above, verify that this instrument performs within its accuracy specifications.

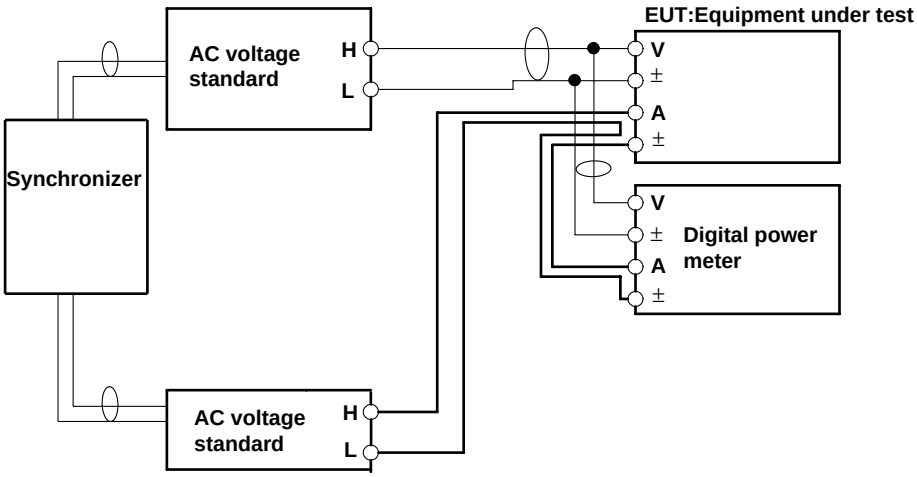
- Set the output of the DC voltage standard to the rated range of this instrument, read this voltage or current value on the display on this instrument and verify that this value lies within this instrument's accuracy.
- Set the output of the DC voltage standard to the rated range of this instrument, read the power factor value on the display on this instrument and verify that this value lies within this instrument's accuracy.

Calibration of AC Voltage, Current and Power

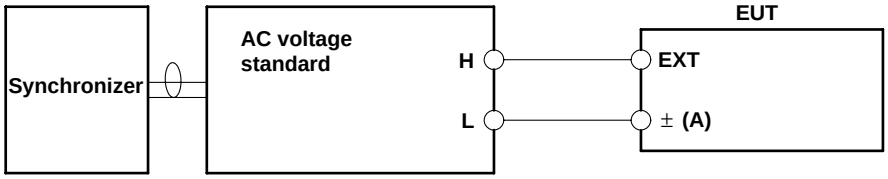
Wiring

Connect the Digital Power meter, Synchronizer and the AC voltage and AC current standard as follows.

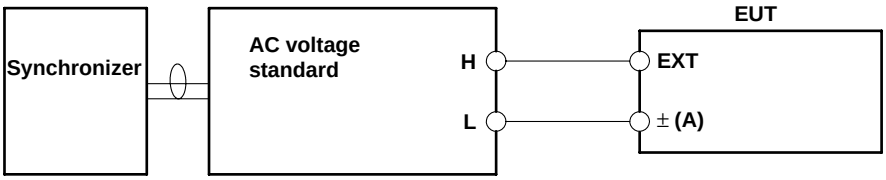
- **Direct input**



- **External sensor input (equipped with option /EX1)**
  Change as follows for wiring currents only.



- **External sensor input (equipped with option /EX2)**
  Change as follows for wiring currents only.



Preparation

Set the frequency of the AC voltage standard and of each channel of the synchronizer to 60 Hz. Then, while not exceeding the maximum values of the external synchronization inputs of the voltage and current standard, rise the output level of the synchronizer until the standards are synchronized. Make sure that the phase angle between each channel of the synchronizer is 0 degrees.

Calibrating

1. Set the voltage or current range of this instrument to the range to be calibrated.
2. Set the output voltage of the AC voltage standard to the rated range of this instrument, and output the voltage.
3. Set the output current of the AC current standard to the rated range of this instrument, and output the current.
4. Fine adjust the output values of the standard so that the displayed voltage or current value on this instrument show the rated range.
5. Read the output voltage or current value, and keep it as a reference.
6. Verify that the displayed power value corresponds to the rated value. The product of the voltage value and the current value is the reference value of the power.

Note

- Before starting the above described calibration, verify that the accuracy of this instrument lies within the specifications.
  - Adjust the output of the standard to the rated range value of this instrument, then read the displayed voltage or current value on this instrument and verify that this value lies within the specifications.
  - Slightly change the phase angle of ch2 of the synchronizer (current signal) so that the displayed power value becomes the rated value. Then read the displayed power value on this instrument and verify that this value lies within the specifications (power factor = 1).
  - Change the phase of ch2 of the synchronizer so that the displayed power value becomes zero. Then read the displayed power value on this instrument and verify that this value lies within the specifications (power factor = 0).
- When calibrating the harmonic analysis, match the phase so that the displayed power value becomes the calibrated value.
- When calibrating using a frequency of more than 60 Hz, set the same frequency for the synchronizer and the standard. In such a case, use a voltage/current standard which surely has a sufficient accuracy regarding the output frequency. This means to use measuring equipment with an accuracy of 3 to 4 times the specified higher accuracy of this instrument.

Calibration of D/A Output

Preparation

1. Connect the AC voltage standard to the voltage terminal of this instrument. The wiring method is the same as when adjustments are carried out (see page 15-3).
2. Set the D/A output of this instrument to V1 for each channel.

Calibrating

1. Connect the DMM to ch1 of the output terminal in the same way as when carrying out adjustments.
2. Set the voltage range of this instrument to a suitable range.
3. Set the output voltage of the voltage standard so that positive rated values are generated.
4. Then read the value of the DMM and verify that this value lies within the specifications.
5. Connect the DMM to ch2 of D/A output and carry out steps 3 and 4. Repeat this for all D/A channels.
6. Set the output voltage of the voltage standard so that negative rated values are generated.
7. Repeat steps 4 and 5 and verify all channels.
8. Turn the output of the voltage standard OFF.

Verifying the Comparator Output Function

Preparation

1. Connect the voltage standard to the voltage terminal of this instrument.
2. Set the range of this instrument to 15 V.
3. Set the comparator output to V1 for each channel.
4. Set the comparator setting value to 10V for each channel.

Calibrating

1. Set the output of the voltage standard so that the displayed value on this instrument becomes 9.99 V, and output this voltage.
2. Measure the resistance values between all terminals of the comparator output (between NO and COM or between NC and COM) using the DMM. Verify that the resistance between NO and COM is at least 50 MΩ, and that the resistance between NC and COM is at most 0.1 Ω.
3. Set the output of the voltage standard so that the displayed value on this instrument becomes 10.01 V, and output this voltage.
4. Measure the resistance values between all terminals of the comparator output (between NO and COM or between NC and COM) using the DMM. Verify that the resistance between NO and COM is at most 0.1 Ω, and that the resistance between NC and COM is at least 50 MΩ.
5. Turn the output of the voltage standard OFF.

Calibration of the Harmonic Analysis Function

Connection

Use the same instruments as those used for AC power measurement. The wiring diagrams are the same as those given in “Calibration of AC Voltage, Current, and Power” (see pages 15-7 and 15-8).

Preparation

1. Set the voltage range of this instrument to 15 V, and the current range to 1 A.
2. Turn the harmonic analysis function ON.

Calibrating Currents

1. Set the ch1 of the synchronizer to 60 Hz, ch 2 to 900 Hz (15 times) and output these frequencies.
2. Set the frequency of the voltage standard to 60 Hz, the output voltage to 15 V and output the voltage.
3. Set the frequency of the current standard to 900 Hz, the output current to 1 A and output the current.
4. Set the displayed number on display A of this instrument to 15.
5. Set the display function of display B to A and verify that the displayed value lies within the specifications.
6. If required, change the ch2 setting of the synchronizer and the frequency of the current standard, and verify another number.
7. Turn the output of the voltage and current standard OFF.

Calibrating Voltages

1. Set the ch1 of the synchronizer to 900 Hz (15 times), ch 2 to 60 Hz and output these frequencies.
2. Set the frequency of the current standard to 60 Hz, the output current to 1 A and output the current.
3. Set the frequency of the voltage standard to 900 Hz, the output voltage to 15 V and output the voltage.
4. Set the displayed number on display A of this instrument to 15.
5. Set the display function of display B to V and verify that the displayed value lies within the specifications.
6. If required, change the ch1 setting of the synchronizer and the frequency of the current standard, and verify another number.
7. Turn the output of the voltage and current standard OFF.

Verification of Functions

Auto Range Operation

1. Set the voltage or current range of this instrument to Auto range. In case of no voltage or current input, the voltage range will become 15 V, and the current range will become 0.5 A automatically.
2. Press the V RANGE key to verify the 15 V range and then press this key once more.
3. Press the A RANGE key to verify the 0.5 A range and then press this key once more.
4. Connect the output terminal of the voltage standard (either AC or DC) to the voltage input terminal of this instrument, and connect the current standard to the current input terminal.
5. Set the output voltage of the voltage standard to 600 V and output this voltage.
6. Verify that the display shows “- - - - -” as the measured voltage value for approx. 1.5 seconds and then changes to 600 V.
7. Turn the output of the voltage standard OFF.
8. Set the output current of the current standard to 20 A and output this current.
9. Verify that the display shows “- - - - -” as the measured current value for approx. 1.5 seconds and then changes to 20 A.
10. Turn the output of the current standard OFF.

15.3 In Case of Malfunctioning

Check These Items First

If the instrument does not operate properly even if the actions given in the table below are performed, contact your nearest sales representative. Addresses may be found on the back cover of this manual. When contacting your representative, inform the ROM version No. which is displayed on display B on power-up.

Symptom	Items to check	Reference page
Nothing is displayed when the power is turned ON.	• Is the power cord properly connected to the power connector of this instrument and the AC outlet? • Is the input power voltage within the allowed range?	3-5
Displayed data is odd.	• Is there a possibility of noise? • Are measurement leads connected correctly? • Is the filter OFF? • Are the ambient temperature and humidity within the allowed range?	3-2 3-3 to 3-8 4-3 16-2
Keys do not function properly.	• Is the REMOTE indicator LED off?	10-2
Instrument cannot be controlled via GP-IB interface.	• Does the GP-IB address specified in the program match the address set up in the instrument? • Does the interface meet the IEEE standard 488-1978 electrical and mechanical requirements?	10-1,10-5
Instrument cannot be controlled via the RS-232-C interface.	• Are the instrument and controller using the same communication settings?	11-1 to 11-3

15.4 Error Codes and Corrective Actions

Error Codes for Operation and Measurement

Error Code	Description	Corrective Action	Reference page
11	Received a command not used by this instrument.	Check for error in the command sent.	10-7
12	Parameter value specified is outside the allowed range.	Correct the value.	Ch. 13,Ch. 14
13	Attempted to execute a key operation or received a communications command, while integration was running or was interrupted, that cannot be executed or received in such a state.	Check whether integration is in progress or is interrupted.	6-4, 10-7
14	Attempted to set auto range while external sensor range is selected.	It is not possible to set auto range while external sensor range is selected.	4-4
15	Attempted to execute a command or key operation that was protected.	Check whether the command or key operation is correct.	–
16	Attempted to execute a key operation or received a communications command, while harmonic analysis was being performed or was interrupted, that cannot be executed or received in such a state.	Check whether harmonic analysis is in progress or is interrupted.	7-3
17	Print output time-out.		9-9
18	No data to be printed or not in the printing mode.		9-9
19	Attempted to execute a key operation or received a communications command, while storing/recalling of data being performed.		–
30	Invalid file data.		–
31	File is damaged.		–
32	No data stored in the internal memory.	Store data in the internal memory or select the proper file to be stored.	Ch. 8
33	No space to store data in the internal memory.		8-1
41	• Attempted to start integration while there is an overflow condition. • Attempted to start integration after integration time has reached its preset value.	Reset integration.	6-3
42	Attempted to start integration while integration is in progress.		6-4
43	Measurement stopped due to overflow during integration or due to a power failure.		6-4
44	Attempted to stop integration even though integration was not in progress.		6-4
45	Attempted to reset integration even though integration was not in progress or integration mode was not selected.		6-4
46	Attempted to start integration while measurement of peak overflow was in progress or during an overrange condition.		6-4
47	Attempted to start integration in continuous integration mode when integration preset time was set to “0”.	Set a correct preset time.	6-2
50	A/D conversion time-out.		–
51	Measurement data overflow occurred. “oL” is displayed.		2-3
52	Voltage peak overflow occurred. V OVER indicator lights up.		2-3
53	Current peak overflow occurred. A OVER indicator lights up.		2-3
54	Power factor exceeded “2” during measurement of power factor.		5-2
55	“PFErr” was displayed at the end of power factor computation during measurement of phase angle.		5-2, 5-3
56	Input level was too low or below measurement range during measurement of frequency. “ErrLo” is displayed.		5-4
57	Measured frequency exceeded the measurement range. “ErrHi” is displayed.		5-4
58	Computation overflow occurred. “oF” is displayed.		2-3
59	Harmonic analysis becomes “FrqEr”.		7-1
390	Overrun error.	Lower the baud rate.	11-3

Error Codes regarding Self Diagnosis

Error Code	Description	Corrective Action
60	Data failure of setting parameters backup. (setting parameters are set to default)	–
61*	EEPROM (element 1) failure.	Service is required.
62*	EEPROM (element 2) failure.	Service is required.
63*	EEPROM (element 3) failure.	Service is required.
64	EEPROM (D/A board) failure.	Service is required.
65	A/D converter (element 1) failure.	Service is required.
66	A/D converter (element 2) failure.	Service is required.
67	A/D converter (element 3) failure.	Service is required.
68	Data file failure (measurement data, setting parameter file failure)	File will be initialized automatically.
69	Lithium battery voltage drop.	Service is required.
71	DSP communications failure.	Service is required.
75	DSP1 program RAM failure.	Service is required.
76	DSP2 program RAM failure.	Service is required.
77	DSP3 program RAM failure.	Service is required.
79	ROM checksum error.	Service is required.
80	RAM read/write check error.	Service is required.
81	DSP1 data RAM error.	Service is required.
82	DSP2 data RAM error.	Service is required.
83	DSP3 data RAM error.	Service is required.
84	DSP1 sample clock failure.	Service is required.
85	DSP2 sample clock failure.	Service is required.
86	DSP3 sample clock failure.	Service is required.
90	Incorrect board combination.	Service is required.
91	Incorrect board combination.	Service is required.

* Redundancy is provided for EPROMs that handle errors 61, 62, and 63. If one of the errors 61, 62, or 63 appears when the instrument is turned ON, turn OFF the instrument and turn it back ON. If no errors occur on the second attempt, servicing is not necessary.

15.5 Replacing the Fuse

The power fuse of this instrument cannot be replaced by the user, because it is located inside the case. If you believe the fuse inside the case is blown, contact your nearest YOKOGAWA dealer as listed on the back cover of this manual.

The ratings of the fuse that is used inside the case are shown below.

Location	Max. Rated Voltage	Max. Rated Current	Type	Approved Standard	Part No.
Main board	250 V	1 A	Time lag	UL/VDE	S9564VK

15.6 Recommended Replacement Parts

The three-year warranty applies only to the main unit of the instrument (starting from the day of delivery) and does not cover any other items nor expendable items (items which wear out). The replacement period for expendable items varies depending on the conditions of use. Refer to the table below as a general guideline. Contact your nearest YOKOGAWA dealer for replacement parts.

Parts Name	Specifications and Recommended Replacement Period
Current input relay	This is the relay used to switch the current input circuit. The specifications of the relay are as follows: • Rated contact capacity: 250 VAC/25 A (resistive load). • Electric switching life: Approx. 100,000 times (at rated capacity). • Mechanical life: Approx. 5,000,000 times.
Comparator function relay	This relay operates in the comparator mode. It is provided only on models with the /CMP option. The specifications of the relay are as follows: • Rated contact capacity: 24 V/0.5 A. • Electric switching life: Approx. 500,000 times (at rated capacity). • Mechanical life: Approx. 10,000,000 times.
Backup battery (Lithium)	3 years.

16.1 Input

Voltage

Item	Specification
Input circuit type	Floating input Resistive voltage divider
Rated inputs (range rms)	600, 300, 150, 60, 30, 15 V
Input impedance	Input resistance approx.2 MΩ, Input capacitance approx.13 pF
Instantaneous maximum allowable input for 20 ms, 1 cycle	The peak is 2.8 kV or the RMS value is 2.0 kV, whichever is less.
Instantaneous maximum allowable input for 1 s	The peak is 2.0 kV or the RMS value is 1.5 kV, whichever is less.
Continuous maximum allowable input	The peak is 1.5 kV or the RMS value is 1.0 kV, whichever is less.
Continuous maximum common mode voltage (at 50/60 Hz)	600 Vrms (when the protective cover for the output connector is used) CAT II, 400 Vrms (when the protective cover for the output connector is removed) CAT II
Common mode rejection ratio at 600 Vrms between input terminals and case	50/60 Hz, better than -80 dB (±0.01% of range maximum) Voltage input terminals : short Reference value: 50 kHz max. ±{(maximum range rating)/(range rating) × 0.001 × f% of range} or less; 0.01% or more; the unit f: kHz
Input terminals	Binding posts
A/D conversion	Simultaneous sampling of voltage and current inputs; Resolution: 12 bits; Maximum conversion rate: approx. 22 µs (approx. 45 kHz)
Range switching	Range can be selected manually, automatically or by communication control.
Automatic range switching	Range up: When the measured value exceeds 110% of the rated range or the peak value exceeds approximately 300% of the rated range Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than approximately 300% of the subordinate range
Measurement mode switching	The following modes can be set manually or by communication control: RMS: True RMS measurement for both voltage and current; V MEAN: Rectified Mean Calibrated to an RMS sine wave measurement for voltage, and true RMS measurement for current; DC: Mean value measurement for voltage and current

Current

Item	Specification
Input circuit type	Floating input Shunt input
Rated inputs (range rms)	Direct input: 20 A, 10 A, 5 A, 2 A, 1 A, 0.5 A, 200 mA, 100 mA, 50 mA, 20 mA, 10 mA, 5 mA External sensor input (optional): (10 V, 5 V, 2.5 V), or (200 mV, 100 mV, 50 mV)
Input impedance	Direct input: Approx. 6 mΩ + approx. 0.1 μH in the 20 A to 0.5 A range. Approx. 500 mΩ in the 200 mA to 5 mA range. External sensor input: 2.5/5/10 V - approx. 100 kΩ; 50/100/200 mV - approx. 20 kΩ
Instantaneous maximum allowable input for 20 ms, 1 cycle	20 A to 0.5 A range: Peak current of 450 A or RMS value of 300 A, whichever is less. 200 mA to 5 mA range: Peak current of 150 A or RMS value of 100 A, whichever is less. External sensor input: Peak value is 10 times the range or less.
Instantaneous maximum allowable input for 1 s	20 A to 0.5 A range: Peak current of 150 A or RMS value of 40 A, whichever is less. 200 mA to 5 mA range: Peak current of 30 A or RMS value of 20 A, whichever is less. External sensor input: Peak value is 10 times the range or less.
Continuous maximum allowable input	20 A to 0.5 A range: Peak current of 100 A or RMS value of 25 A, whichever is less. 200 mA to 5 mA range: Peak current of 30 A or RMS value of 20 A, whichever is less. External sensor input: Peak value is 5 times the range or less.
Continuous maximum common mode voltage (at 50/60 Hz)	600 Vrms (when the protective cover for the output connector is used) CAT II, 400 Vrms (when the protective cover for the output connector is removed) CAT II
Common mode rejection ratio at 600 Vrms between input terminals and case	50/60 Hz, better than -80 dB (±0.01% of range maximum) Current input terminals : open Reference value: 50 kHz max. $\pm\left\{\frac{\text{Maximum range rating}}{\text{Range rating}}\times 0.001\times f\%\text{ of rng}\right\}$ (other than the 200 mA to 5 mA range) $\pm\left\{\frac{\text{Maximum range rating}}{\text{Range rating}}\times 0.0002\times f\%\text{ of rng}\right\}$ (200 mA to 5 mA range) ; 0.01% or more; the unit f: kHz
Input terminals	Direct input: Large binding posts, External sensor input: Safety terminals
A/D conversion	Simultaneous sampling of voltage and current inputs; Resolution: 12 bits; Maximum conversion rate: approx. 26 μs (approx. 38 kHz)
Range switching	Range can be selected manually, automatically or by communication control.
Automatic range switching	Range up: When the measured value exceeds 110% of the rated range or the peak value exceeds approximately 300% of the rated range Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than approximately 300% of the subordinate range
Measurement mode switching	The following modes can be set manually or by communication control: RMS: True RMS measurement for both voltage and current; V MEAN: Rectified Mean Calibrated to an RMS sine wave measurement for voltage, and true RMS measurement for current; DC: Mean value measurement for voltage and current

16.2 Measurement Functions

Voltage/Current

Item	Specification	
Method	Digital sampling method, summation averaging method	
Frequency range	DC, 10 Hz to 50 kHz	
Crest factor	“3” at rated input	
Display accuracy (within 3 months after calibration) (Conditions) Temperature: 23 ±5°C Humidity: 30% to 75% R.H. Supply voltage: Specified Voltage ±5% Input waveform: Sine wave Common mode voltage: 0 VDC Filter: ON at 200 Hz or less Scaling: OFF This accuracy are guaranteed by YOKOGAWA calibration system.	DC : 10 Hz ≤ f < 45 Hz : 45 Hz ≤ f ≤ 66 Hz : 66 Hz < f ≤ 1 kHz : 1 kHz < f ≤ 10 kHz : 10 kHz < f ≤ 20 kHz : Reference value 20 kHz < f ≤ 50 kHz :	±(0.2 % of rdg + 0.2% of rng) ±(0.3% of rdg + 0.2% of rng) ±(0.15% of rdg + 0.1% of rng) ±(0.3% of rdg + 0.2% of rng) ±(0.2% of rdg + 0.3% of rng)±{(0.05 × f)% of rdg} ±(0.5% of rdg + 0.5% of rng)±[{0.15 × (f–10)}% of rdg] ±(0.5% of rdg + 0.5% of rng) ±[{0.15 × (f–10)}% of rdg]
Note: The unit f in accuracy expressions is kHz.		
Effective input range	With the input range at 10% to 110%, the above specified accuracy is valid. With the input range at 110% to 130%, the above specified reading accuracy increased 0.5 times is added to the accuracy.	
Accuracy (within 12 months after calibration)	The above specified reading accuracy increased 0.5 times is added to the accuracy (within 3 months after calibration).	
Temperature coefficient	±0.03% of range/°C at 5 to 18°C, 28 to 40°C	
Display update rate	4 times/s	

Effective Power

Item	Specification	
Method	Digital sampling method, summation averaging method	
Frequency range	DC, 10 Hz to 50 kHz	
Display accuracy (within 3 months after calibration) (Conditions) Temperature: 23 ±5°C Humidity: 30% to 75% R.H. Supply voltage: Specified Voltage ±5% Input waveform: Sine wave Common mode voltage: 0 VDC Filter: ON at 200 Hz or less Scaling: OFF This accuracy are guaranteed by YOKOGAWA calibration system.	DC : 10 Hz ≤ f < 45 Hz : 45 Hz ≤ f ≤ 66 Hz : 66Hz < f ≤ 1 kHz : 1 kHz < f ≤ 10 kHz : 10 kHz < f ≤ 20 kHz : Reference value 20 kHz < f ≤ 50 kHz :	±(0.3% of rdg + 0.3% of rng) ±(0.5% of rdg + 0.3% of rng) ±(0.2% of rdg + 0.1% of rng) ±(0.5% of rdg + 0.3% of rng) ±(0.3% of rdg + 0.5% of rng)±{(0.08 × f)% of rdg} ±(0.8% of rdg + 0.8% of rng)±[{0.19 × (f–10)}% of rdg] ±(0.8% of rdg + 0.8 % of rng)±[{0.25 × (f–10)}% of rdg]
Note: The unit f in accuracy expressions is kHz.		
Effect of power factor	cosφ = 0 45 Hz ≤ f ≤ 66 Hz:add ±0.25% of range Reference data (up to 50 kHz): add ±{(0.23 + 0.4 × f kHz)% of range} 1 > cosφ > 0 add the product of tanφ and the effect on cosφ = 0.	
Note: The φ is the phase angle between the voltage and current, and the f is frequency.		
Effective input range	With the input range at 10% to 110%, the above specified accuracy is valid. With the input range at 110% to 130%, the above specified reading accuracy increased 0.5 times is added to the accuracy.	
Accuracy (within 12 months after calibration)	The above specified reading accuracy increased 0.5 times is added to the accuracy (within 3 months after calibration).	
Temperature coefficient	±0.03% of range/°C at 5 to 18°C, 28 to 40°C	
Display update rate	4 times/s	

16.3 Frequency Measurement

Item	Specification
Input	V, A
Operating principle	Reciprocal counting method
Frequency ranges	10 Hz to 50 kHz (100 Hz, 1 kHz, 10 kHz, 100 kHz, Auto range)
Accuracy	±(0.1% of rdg + 1 digit) Minimum input is more than 30% of rated range. When an input frequency is less than 200Hz, FILTER must be ON to obtain the specification accuracy. Minimum input frequency is more than 20% of frequency measurement range.

16.4 Communication (optional)

Item	Specification	
GP-IB	Electrical specifications: Mechanical specifications: Interface function:	IEEE St'd 488.2-1987 IEEE St'd 488.2-1987 SH1, AH1, T5, L4, SR1, RL1, PP0, DC1,DT1, C0
RS-232-C	Transmission mode: Start stop synchronization Baud rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps	

16.5 Computing Functions

	Effective Power (W)	Apparent Power (VA)	Reactive Power (var)	Power Factor (PF)	Phase Angle (deg)
1-phase 2-wire	W	VA=V×A	$\sqrt{(VA)^2-W^2}$	$\frac{W}{VA}$	$\cos^{-1}(\frac{W}{VA})$
Computating range	Depends on the selected V and A ranges	Depends on the selected V and A ranges	Same as apparent power (var ≤ 0)	–1 to 0 to 1	–180 to 0 to 180
Display resolution (when the number of displayed digits is 5)	99999	99999	99999	±1.0000	±180.0
Computing accuracy (for the value operated from the measured value)	–	±0.005% of VA range	±0.005% of var range	±0.0005	Resolution (power factor ±0.0005)

Note

- The apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) measurements in this instrument are computed digitally from the voltage, current and effective power. If the input is non-sinusoidal, the measured values may differ from those obtained with instruments employing different measurement principles.
- When the current or voltage is less than 0.5% of the range, the VA and var will be displayed as 0, and PF/deg will be displayed as an error.
- The Lead and Lag are displayed for V and A input at 50% or more. The detected lead/lag accuracy is ±5 degrees over the frequency range of 20 Hz to 2 kHz.

16.6 Display Functions

Item	Specification
Display type	7-segment LED
Number of displays	3

DISPLAY	Displayed Value	Maximum Reading
A	V, A, W, VA, var, elapsed integration time	V, A, W: 99999
B	V, A, W, PF, deg, % (contents ratio in %, THD)	Wh, Ah: 999999
C	V, A, W, V•AHz, ±Wh, ±Ah Vpk, Apk, MATH	V, AHz: 99999

Number of displayed digits	Select Hi (5 digits) or Lo (4 digits).
Unit	m, k, M, V, A, W, VA, var, Hz, h±, deg, %
Display update rate	4 times/s
Response time	Approximately 0.5 s (time for displayed value to settle within accuracy specifications of final value after step change from 0% to 100% or 100% to 0% of rated range)
Display scaling function	Significant digits: Selected automatically according to significant digits in the voltage and current ranges Reassign ratio:0.001 to 9999
Averaging function	The following two algorithms can be selected: Exponential averaging Moving averaging Response can be set; for exponential averaging, the attenuation constant can be selected and for moving averaging, the number of averages (N) can be set to 8, 16, 32, or 64.
Peak over range display	The alarm LED will light up when the RMS value is greater than 140% of the range or the peak value is greater than 300% of the range.

16.7 Integrator Function

Item	Specification
Display resolution	Depending on elapsed time value, the resolution will be changed.
Maximum display	–99999 to 999999 MWh (or MAh)
Modes	Standard integration mode (timer mode) Continuous integration mode (repeat mode) Manual integration mode
Timer	When the timer is set, integration will be stopped automatically. Setting range: 0 h:00 min:0 sec to 10000 h:00 min:00 sec (0 h:00 min:00 sec will be shown when manual integration mode is selected automatically.)
Count overflow	If the integration count flows above 999999 MWh (or MAh) or below –99999 MWh (or MAh), integration stops and the elapsed time is held on the display.
Accuracy	±(display accuracy + 0.2% of rdg) However, only when the input signal is continuous.
Timer accuracy	±0.02%
Remote control	Start, stop, and reset can be remotely controlled by external contact signals. However, the /DA4 option must be installed.

16.8 Internal Memory Function

Item	Specification
Measurement data	Number of data that can be stored: 600 blocks Writing intervals: 250 ms and 1 s to 99 h: 59 min: 59 s Reading intervals: 250 ms and 1 s to 99 h: 59 min: 59 s (both intervals can be set on a second basis)
Panel setup information	Four-pattern information can be written/read.

16.9 D/A Converter (optional)

Item	Specification
Output voltage	±5 VDC FS (approximately ±7.5 V maximum) at rated value or range Number of output channels: 4 when the /DA4 option is installed
Output current	±1 mA
Output data selection	Can be selected for each channel.
Accuracy	±(Display accuracy + 0.2% of range)
Update rate	Identical to display update interval
Temperature coefficient	±0.05% of rng/ °C

16.10 External Input (optional)

Item	Specification
Either /EX1 or /EX2 can be selected as a voltage-output-type current sensor.	/EX1: 10 V, 5 V, 2.5 V /EX2: 200 mV, 100 mV, 50 mV Specifications: Refer to section “Input.”

16.11 Comparator Output (optional)

Item	Specification
Output method	Normally open and normally closed relay contact outputs (one pair)
Number of output channels	4 (Can be set for each channel.)
Contact capacity	24 V/0.5 A
D/A output (4 channels)	Refer to section “D/A Converter (Optional).”

16.12 External Contorol and Input Signals (in combination with the D/A converter and comparator options)

Item	Specification
External Control and Input/Output signals	EXT-HOLD, EXT-TRIG, EXT-START, EXT-STOP, EXT-RESET, INTEG-BUSY (However, the /DA4 option must be installed. Only EXT-HOLD and EXT-TRIG are available if the /CMP option is installed.)
Input level	TTL negative pulse

16.13 Total Harmonic Analysis Function (optional)

Item	Specification
Method:	synchronization to the fundamental frequency by using a phase locked loop (PLL) circuit
Frequency range:	Fundamental frequency between 40 Hz and 440 Hz
Maximum reading:	9999
Items to be analyzed:	V, A, W, deg Each harmonic components, Total Vrms, Total Arms, Total effective power, PF of the fundamental, Phase-angle of fundamental, For each harmonic phase-angle related to the fundamental, Total harmonic distortion ratio in %, and contents ratio in %. However, a simultaneous analysis can be made for a specified input module.
Sampling speed/method:	The sampling speed depends on the fundamental frequency to be input:

Input frequency range	Sampling frequency	Window up to the n'th harmonic	Order
40≤f<70 Hz	f×512 Hz	1 period of f	50
70≤f<130 Hz	f×256 Hz	2 period of f	50
130≤f<250 Hz	f×128 Hz	4 period of f	50
250≤f<440 Hz	f×64 Hz	8 period of f	30

FFT number of points :	512 points FFT
FFT calculation accuracy:	32 bits
Window:	Rectangular window
Display update interval:	Approx. 3 s
Accuracy:	±0.2% of range is added to the normal display accuracy.

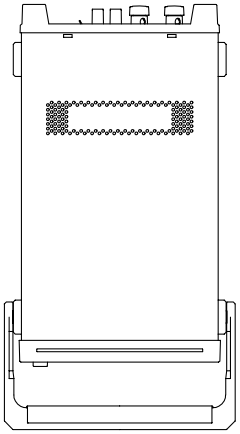
16.14 General Specifications

Item	Specification
Warm-up time	Approx. 30 min.
Ambient temperature and humidity range	5 to 40°C, 20% to 80% R.H. (no condensation)
Operating altitude	2000m or below
Storage temperature	–25 to 60°C (no condensation)
Insulation resistance	Between voltage input terminals and case Between current input terminals and output terminals Between voltage input terminals and current input terminals Between voltage input terminals and power plug Between current input terminals and power plug Between case and power plug Above: 50 MΩ or more at 500 V DC
Withstanding voltage	Between voltage input terminals and case Between current input terminals and output terminals Between voltage input terminals and current input terminals Between voltage input terminals and power plug Between current input terminals and power plug Above: AC 3700 V for 1 minute at 50/60 Hz Between case and power plug: AC 1500 V for 1 minute at 50/60 Hz
Power supply	100 to 240 V; frequency: 50/60 Hz
Vibration test condition	Sweep test - Frequency: 8 to 150 Hz sweep, all 3 directions for 1 minute Endurance test - Frequency: 16.7 Hz, all 3 directions; amplitude of 4 mm for 2 h
Impact condition	Impact test: Acceleration at 490 m/s^2, all 3 directions Free-fall test - Height: 100 mm, 1 time for each 4 sides
Power consumption	25 VA maximum (Power supply: 120 VAC) 35 VA maximum (Power supply: 240 VAC)
External dimensions	Approx. W × H × D : 213 × 88 × 350 (mm), 8-3/8 × 3-1/2 × 13-3/4 (inch), excluding projections.
Weight	Approx. 3.0 (kg), 6.6 (lbs)
Accessories	Power cord: UL/CSA, VDE, SAA or BS standard 1 pc 24-pin connector User's Manual Rubber feed
Emission	Complying Standard: EN55011-Group1, Class A This is a Class A product for industrial environment. In a domestic environment, this product may cause radio interference in which cause the user may be required to take adequate measures. Cable Condition: External Senser Input (installed /EX1 or /EX2 option) 500 mm max External Input/Output Signals (installed /DA4, /CMP option) To use shielded wires
Immunity	Complying Standard: EN50082-2:1995
Safety standard	Complying Standard: EN61010 Overvoltage Category II Pollution degree 2

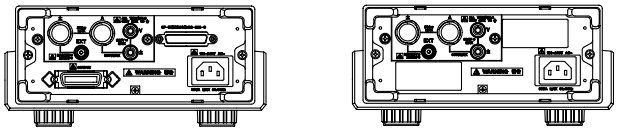
* Equipment that is connected to the WT200 through the GP-IB, RS-232-C, or Ext. I/O connector must comply with applicable safety standards (IEC60950 or IEC61010-1, for example) or some equivalent standard.

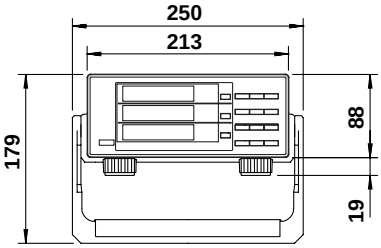
16.15 External Dimensions

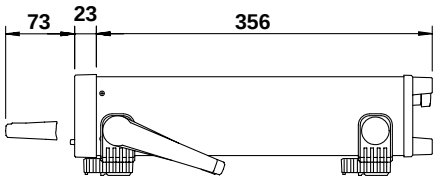
Unit: mm



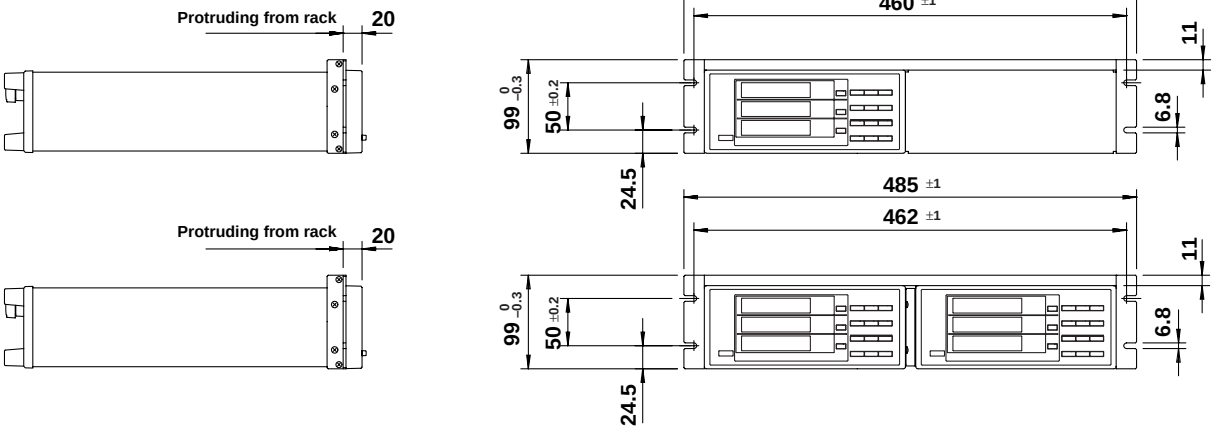
Rear



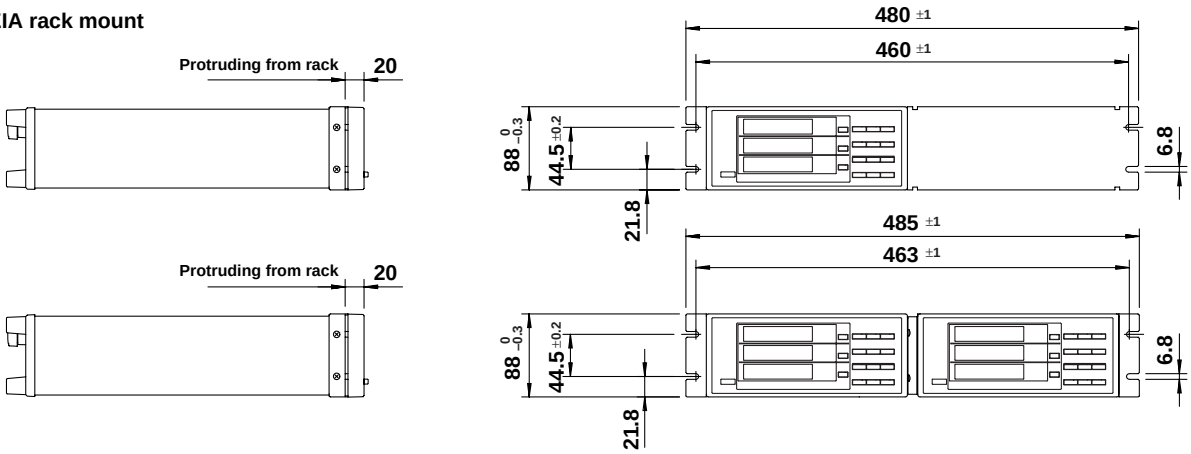




JIS rack mount



EIA rack mount



Unless other wise spcified, tolerance is ±3% (However, tolerance is ±0.3 mm when below 10 mm)

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