

WT210/WT230
Digital Power Meter

USER'S MANUAL

Product Registration

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Thank you for purchasing the YOKOGAWA WT210 or WT230 Digital Power Meter. This user's manual contains useful information about the functions, operating procedures, and handling precautions of the instrument. To ensure correct use, please read this manual thoroughly before beginning operation.

After reading the manual, keep it in a convenient location for quick reference whenever a question arises during operation.

Notes

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functions. The figures given in this manual may differ from the actual screen.
- 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 nearest YOKOGAWA dealer.
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Functional Comparison of the WT210/WT230 and WT200/WT110E/WT130

This section summarizes the functional differences between the WT210/WT230 and the conventional models WT200/WT110E/WT130. For more details on the functions and performance of the WT210/WT230, see the following sections.

Item	WT210/WT230	WT200/WT110E/WT130 (Conventional Models)
Voltage input terminal	Plug-in terminal (safety terminal structure)	Binding post
External sensor input terminal	BNC connector	Plug-in terminal (safety terminal structure)
Basic voltage and current accuracy	0.1% of reading +0.1% of range	0.15% of reading +0.1% of range
Basic power accuracy	0.1% of reading +0.1% of range	0.2% of reading +0.1% of range
Frequency range	DC, 0.5 Hz to 100 kHz	DC, 10 Hz to 20 kHz
Effective input range	1 to 130% of the rated range	10 to 130% of the rated range
Measurement synchronization source	Select from "voltage," "current," and "entire period of the display"	WT200: Select voltage or current and "entire period of the display" WT110E/WT130: No update rate."
Line filter	Yes (cutoff frequency 500 Hz)	None
Frequency filter	Yes (cutoff frequency 500 Hz)	Yes (cutoff frequency 300 Hz)
MAX hold	Yes	WT200: Yes WT110E/WT130: No
Peak value display	Yes	WT200: Yes, WT110E: Option WT130: Yes
Average active power during integration	Yes	WT200: Yes WT110E/WT130: No
Display update rate	Select 0.1, 0.25, 0.5, 1, 2, or 5 s	Fixed to 0.25 s
Number of displayed digits	Select 4 or 5 digits	WT200: Select 4 or 5 digits WT110E/WT130: Fixed to 4 digits
Integration timer time	10000 hours maximum Resolution 1 s	WT200: 10000 hours maximum Resolution 1 s WT110E/WT130: 999 hours 59 minutes maximum Resolution 1 min
Display update during harmonic measurement	Select 0.25, 0.5, 1, 2, or 5 s	Approx. 3 s
Remote control I/O signal when equipped with the comparator function (/CMP option)	EXT HOLD, EXT TRIG, EXT START, EXT STOP, EXT RESET, INTEG BUSY	EXT HOLD, EXT TRIG
Communication Commands	All communication commands for conventional models can be used except the commands for the 2533E.	
Communication data format	ASCII and binary	ASCII
Addressable mode B of GP-IB communications	No	Yes
Baud rate of serial (RS-232-C) communications	1200 to 9600 bps	75 to 9600 bps
Zero-level compensation	Yes	WT200: Yes, WT110E/WT130: No
Key lock	Yes	No
Power fuse	Yes, part number A1347EF	WT200: No, WT110E: No WT130: Yes, part number A1346EF

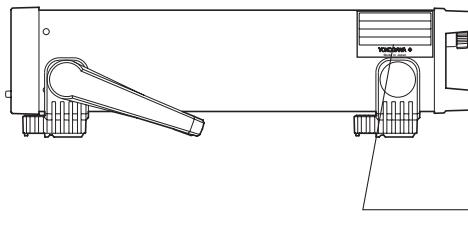
Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If some of the contents are not correct or missing or if there is physical damage, contact the dealer from which you purchased them.

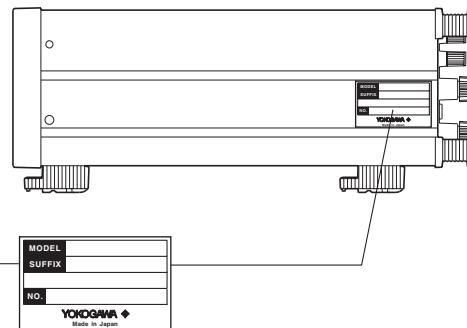
WT210/WT230

Check that the model name and suffix code given on the name plate on the right side panel when facing the front panel match those on the order.

WT210 (model: 760401)



WT230 (model code: 760502, 760503)



MODEL and SUFFIX codes

Model	SUFFIX	Description
760401	WT210 Single-phase model (single input element model)
760502	WT230 Three-phase, three-wire model (two input element model)
760503	WT230 Three-phase, four-wire model (three input element model)
Supply Voltage	100-120 VAC/200-240 VAC
Communication interface (One of the two is built-in (applies to the WT230))	-C1 -C2	GP-IB interface Serial (RS-232-C) interface
Power cord	-D -F -Q -R -H	UL/CSA Standard power cord (Part No.: A1006WD) [Maximum rated voltage: 125 V; Maximum rated current: 7 A] VDE Standard Power Cord (Part No.: A1009WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A] BS Standard Power Cord (Part No.: A1054WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A] AS Standard Power Cord (Part No.: A1024WD) [Maximum rated voltage: 240 V; Maximum rated current: 10 A] GB Standard Power Cord (complies with the CCC) (Part No.: A1064WD) [Maximum rated voltage : 250 V, Maximum rated current : 10 A]

Checking the Contents of the Package

Options			
Communication interface (One of the two is provided (applies to the WT210))	/C1	GP-IB interface	
	/C2	Serial (RS-232-C) interface	
External sensor input function (One of the two is provided.)	/EX1	2.5, 5, and 10 V range	
	/EX2	50, 100, and 200 mV range	
Harmonic measurement function	/HRM	—	
External I/O function (One of the three is provided.)	/DA4	4-channel D/A output (applies to the WT210)	
	/DA12	12-channel D/A output (applies to the WT230)	
	/CMP	4-channel comparator, 4-channel D/A output	

Ex: Three-phase, three-wire model, GP-IB interface, UL/CSA Standard power cord, external sensor input for 50, 100, and 200 mV range, harmonic measurement function, and 12-channel D/A output → 760502-C1-D/EX2/HRM/DA12

NO. (Instrument Number)

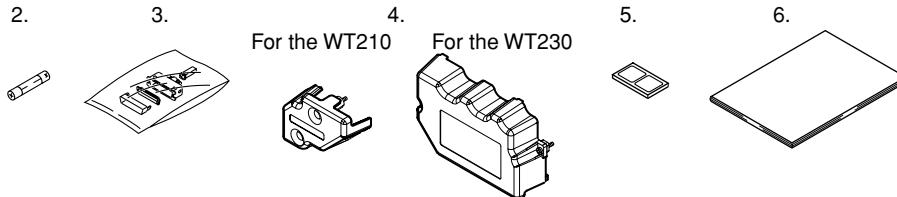
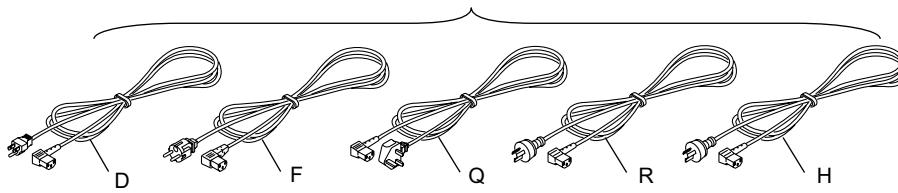
When contacting the dealer from which you purchased the instrument, please give them the instrument number.

Standard Accessories

The standard accessories below are supplied with the instrument. Check that all contents are present and that they are undamaged.

Name	Part No.	Q'ty	Description
1. Power cord previous page	See the	1	—
2. Power fuse	A1347EF	1	250 V, 1 A, time lag (attached to the fuse holder)
3. 24-pin connector	A1004JD	1	For remote control and D/A output (provided only on options /DA4, DA12, and / CMP)
4. Current input protective cover B9317CY B9317GY	1 1	For the WT210 For the WT230 (cover appropriate for the model provided)	
5. Rubber feet for the hind feet	A9088ZM	1	Two pieces in one set. One set provided.
6. User's Manual	IM760401E-011		This manual

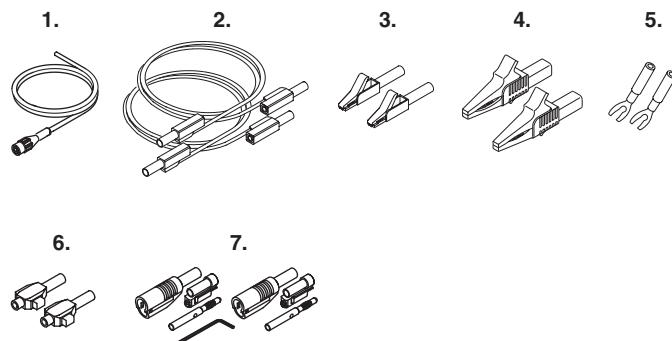
1. (One of the following power cords is supplied according to the instrument's suffix codes.)



Optional Accessories (Sold Separately)

The optional accessories below are available for purchase separately.

Name	Model	Q'ty	Description
1. External sensor cable	B9284LK	1	For connecting the current sensor input connector of the WT210/WT230, length 0.5 m
2. Measurement lead	758917	1	Two leads in one set, used with the separately sold 758922 or 758929 adapter, length 0.75 m, ratings 1000 V
3. Alligator clip adapter set	758922	1	Two pieces in one set, for the 758917 measurement lead. Rated voltage 300 V
4. Alligator clip adapter set	758929	1	Two pieces in one set, for the 758917 measurement lead. Rated voltage 1000 V
5. Fork terminal adapter set	758921	1	Two pieces in one set, for the 758917 measurement lead. Rated current 25 A
6. Safety terminal adapter set	758923	1	Two pieces in one set. This type holds measurement wires in place using springs.
7. Safety terminal adapter set	758931	1	Two pieces in one set. This type holds the measurement wires using screws.
8. Rack mount kit	—	—	For details, see section 3.2.

**Spare Parts (Sold Separately)**

The spare parts below are available for purchase separately.

Name	Model	Q'ty	Description
Power fuse	A1347EF	2	250 V, 1 A, time lag

Safety Precautions

This instrument is an IEC safety class I instrument (provided with terminal for protective earth grounding).

The following general safety precautions must be observed during all phases of operation. If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. Yokogawa Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

For your safety, the following symbols and signal words are used on this instrument.



"Handle with care." (To avoid injury, death of personnel or damage to the instrument, the operator must refer to the explanation in the user's manual or service manual.)



Protective earth terminal. To ensure safe operation, if the current to be measured exceeds 7 A (rms value), use a cable or conductor that is capable of running a current higher than the current to be measured, and be sure to connect the protective earth before operating the instrument. The protective earth terminal is provided on the rear panel of products shipped in January 2004 and later.



Electric shock, danger



Alternating current



Both direct and alternating current



ON (power)



OFF (power)



ON (power) state



OFF (power) state



Earth

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

WARNING

- **Power Supply**

Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the WT210/WT230 and that it is within the maximum rated voltage of the provided power cord.

- **Power Cord and Plug**

To prevent the possibility of electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug must be plugged into an outlet with a protective earth terminal. Do not invalidate this protection by using an extension cord without protective earth grounding.

- **Protective Grounding**

Make sure to connect the protective earth to prevent electric shock before turning ON the power. The power cord that comes with the instrument is a three-pin type power cord. Connect the power cord to a properly grounded three-pin outlet.

- **Necessity of Protective Grounding**

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

- **Defect of Protective Grounding**

Do not operate the instrument if the protective earth or fuse might be defective. Also, make sure to check them before operation.

- **Fuse**

To avoid the possibility of fire, only use a fuse that has a rating (voltage, current, and type) that is specified by the instrument. When replacing a fuse, turn OFF the power switch and unplug the power cord. Never short the fuse holder.

- **Do Not Operate in an Explosive Atmosphere**

Do not operate the instrument in the presence of flammable liquids or vapors. Operation in such environments constitutes a safety hazard.

- **Do Not Remove Covers**

The cover should be removed by YOKOGAWA's qualified personnel only. Opening the cover is dangerous, because some areas inside the instrument have high voltages.

- **External Connection**

Securely connect the protective grounding before connecting to the item under measurement or to an external control unit. If you are going to touch the circuit, make sure to turn OFF the circuit and check that no voltage is present.

See below for operating environmental limitations.

CAUTION

This product is a Class A (for industrial environments) product. Operation of this product in a residential area may cause radio interference in which case the user will be required to correct the interference.

Structure of the Manual

This user's manual consists of the following sections:

Startup Guide

Using an example of measuring the "inverter efficiency," the setup procedure from wiring the circuit to performing measurements and computation is explained.

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 Functions of Parts and Auto range Monitor, OVERRANGE, and Error Displays

Describes the names of each part of the instrument and keys on the front panel.

Chapter 3 Before Starting Measurements

Describes precautions to be taken when using the instrument, how to install the instrument, how to connect the power supply, how to turn ON/OFF the power switch, and how to wire the measurement circuit.

Chapter 4 Setting Measurement Conditions and Measurement Range

Describes how to set measurement conditions such as the measurement mode, filter ON/OFF, measurement range, external PT/CT, scaling when using external sensors (shut, clamp, etc.), averaging, and crest factor.

Chapter 5 Displaying Measurement Results and Computation Results

Explains the procedures for displaying parameters such as the voltage, current, active power, apparent power, reactive power, power factor, phase angle, frequency, efficiency, crest factor, value derived from four arithmetical operations, average active power during integration, and peak value.

Chapter 6 Integration

Explains the procedures for integrating active power and current.

Chapter 7 Harmonic Measurement Function (Option)

Explains the procedures for performing harmonic measurement.

Chapter 8 Store/Recall Function of Measured/Computed Data and Setup Parameters

Describes how to store/recall measured/computed data and setup parameters to/from the internal memory.

Chapter 9 External I/O Function

Describes how to use the remote control (option), D/A output (option), and comparator (option) functions, and how to output to external plotters and printers.

Chapter 10 GP-IB Interface (Option)

Describes how to control the WT210/WT230 from a PC and how to retrieve measured/computed data on the WT210/WT230 to a PC using the GP-IB interface.

Chapter 11 Serial Interface (Option)

Describes how to control the WT210/WT230 from a controller such as a PC and how to retrieve measured/computed data on the WT210/WT230 to a controller using the serial (RS-232-C) interface.

Chapter 12 Initializing Setup Parameters, Zero-level Compensation, and Key Lock

Describes the setup parameters that are backed up and how to initialize the settings.

Chapter 13 Communication Commands 1 (System of Commands before the IEEE 488.2 Standard)

Describes communication commands and sample programs that follow the rules that existed before the establishment of the IEEE 488.2 Standard.

Chapter 14 Communication Commands 2 (System of Commands Complying to the IEEE 488.2-1992 Standard)

Describes communication commands and sample programs that comply with the IEEE 488.2-1992 Standard.

Chapter 15 Maintenance and Troubleshooting

Describes how to calibrate and adjust the instrument, how to troubleshoot problems, the error code information and corrective action, and how to replace the power fuse.

Chapter 16 Specifications

Summarizes the main specifications of the WT210/WT230 in a table.

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Conventions Used in This Manual

Symbol Markings

The following markings are used in this manual.



Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING

Calls attention to actions or conditions that could cause serious injury or death to the user, and precautions that can be taken to prevent such occurrences.

CAUTION

Calls attention to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

Tips, Note

Calls attention to information that is important for proper operation of the instrument.

Characters Displayed on the 7-Segment LED

Because alphanumeric characters are displayed on a 7-segment LED, some of the characters are displayed using special formats. For details, see section 1.3, "Digital Numbers and Characters and Initial Menus" (page 1-6).

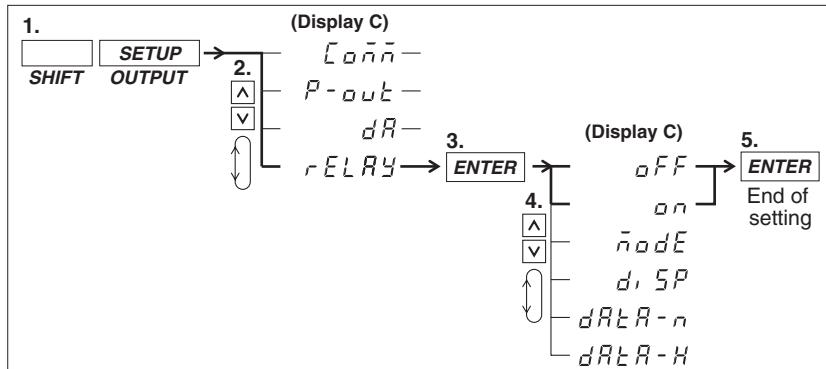
Conventions Used in This Manual

Symbols Used on Pages Describing Operating Procedures

The following symbols are used to distinguish the contents of the explanations.

Keys	Indicates the keys and indicators related to the settings.
Procedure	The procedure is explained using a flow diagram. For the meaning of each operation, see the example below. All procedures are written with inexperienced users in mind; experienced users may not need to carry out all the steps.

Example



The flow diagram above indicates the following setup procedure.
You can set up the display that is blinking.

1. Press the **SHIFT** key to illuminate the **SHIFT** indicator and then press the **SETUP(OUTPUT)** key.
The output setup menu appears on display **C**.
2. Press the **▲** or **▼** key to select **rELAY**.
The four selectable items appear repetitively by pressing either key.
3. Press the **ENTER** key to confirm the settings.
The setup menu corresponding to the function selected in step 2 appears on display **C**.
4. Press the **▲** or **▼** key to select **oFF** or **on**.
The six selectable items appear repetitively by pressing either key.
5. Press the **ENTER** key to confirm the settings.

When entering a sign or a value, an under bar blinks at the corresponding entry digit if the digit is blank (space).

Explanation This section describes the setup parameters and the limitations regarding the procedures.

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Displaying the Active Power on the Secondary Side of the Inverter on Display C ...	S-17
Displaying the Efficiency	S-18
Setting the Efficiency Computation	S-18
Displaying the Efficiency	S-20
Confirming the Displayed Efficiency	S-21

Wiring the Circuit

<<For details, see section 3.3.>>

To prevent the possibility of electric shock and damage to the instrument, follow the warnings below.



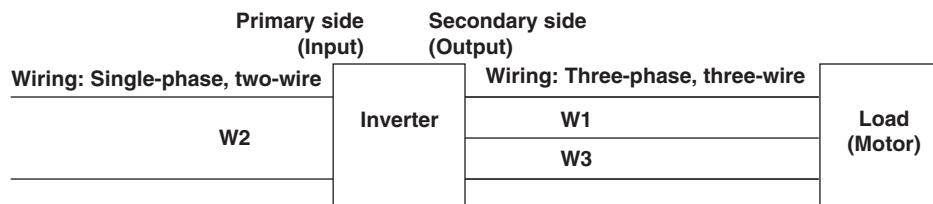
WARNING

- Employ protective earth ground before wiring measurement cables. The power cord that comes with the instrument is a three-pin type power cord. Connect the power cord to a properly grounded three-pin outlet.
- Turn OFF the power to the circuit under measurement, when wiring the circuit. Connecting or removing measurement cables while the power is turned ON is dangerous.
- Take special caution not to wire a current measurement circuit to the voltage input terminal or a voltage measurement circuit to the current input terminal.
- Strip the insulation cover of the measurement cable so that when it is wired to the input terminal, the conductive parts (bare wires) do not protrude from the terminal. Also, make sure to fasten the input terminal screws securely so that the cable does not come loose.
- Use cables with safety terminals that cover the conductive parts for connecting to the voltage input terminals. Using a terminal with bare conductive parts (such as a banana plug) is dangerous when the terminal comes loose.
- After connecting the measurement cable, attach the current input protection cover for your safety. Make sure that the conductive parts are not exposed from the protection cover.
- To make the protective functions effective, check the following items before applying the voltage or current of the circuit under measurement.
 - The power cable provided with the instrument is used to connect to the power supply and the instrument is grounded.
 - The power switch of the instrument is turned ON.
 - The current input protective cover provided with the instrument is being used.

Other important items concerning the safety when wiring the circuit are described in section 3.3. Read and understand the information before wiring the circuit.

Wiring the Circuit

Below is a wiring example of a circuit used to measure the efficiency of an inverter using the WT230 Digital Power Meter (760503, three-phase, four-wire model). To compute the efficiency on the WT230 (760503, three-phase, four-wire model) when the primary side of the inverter is a single-phase, two-wire system and the secondary side is a three-phase, three-wire system, wiring must be furnished to input elements 1 and 3 using a three-phase, three-wire system.



W2: Active power measured by input element 2 of the WT230

W1: Active power measured by input element 1 of the WT230

W3: Active power measured by input element 3 of the WT230

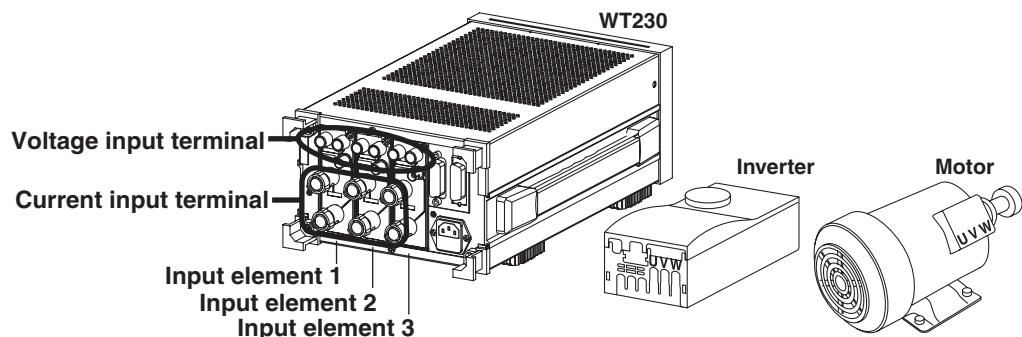
$$\text{Efficiency} = \frac{\text{Power consumed by the load } (= W1 + W3)}{\text{Power supplied by the source } (= W2)} \times 100(\%)$$

Installing the WT230

<<For details, see section 3.2.>>

1. Install the WT230 (760503, three-phase, four-wire model).

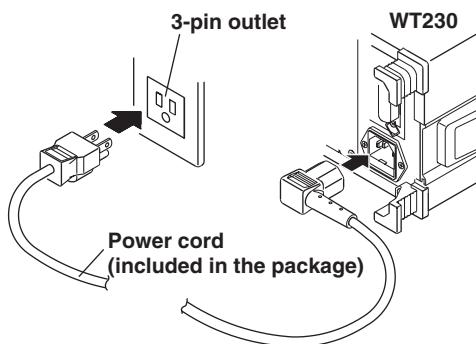
Install the inverter to be measured and the motor also.



Connecting the WT230 Power Supply

<<For details, see section 3.5.>>

2. Check that the power switch on the WT230 (760503, three-phase, four-wire model) is OFF.
3. Connect the power cord plug to the power connector on the rear panel of the WT230. (Use the power cord that came with the package.)
4. Plug the other end of the power cord into a power outlet.

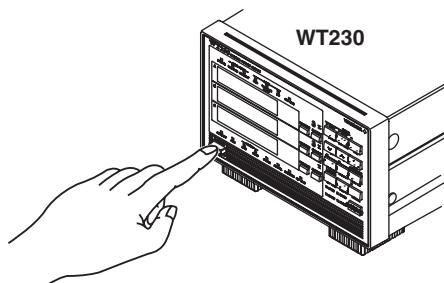


Turning ON the Power to the WT230

<<For details, see section 3.6.>>

5. Press the power switch at the lower left corner of the front panel.

A test program starts when the power switch is turned ON. After an opening message appears, the WT230 is ready to make measurements. To suppress the error in the measured value that occurs as time progresses after power-up, warm up the WT230 for at least 30 minutes before starting measurements.

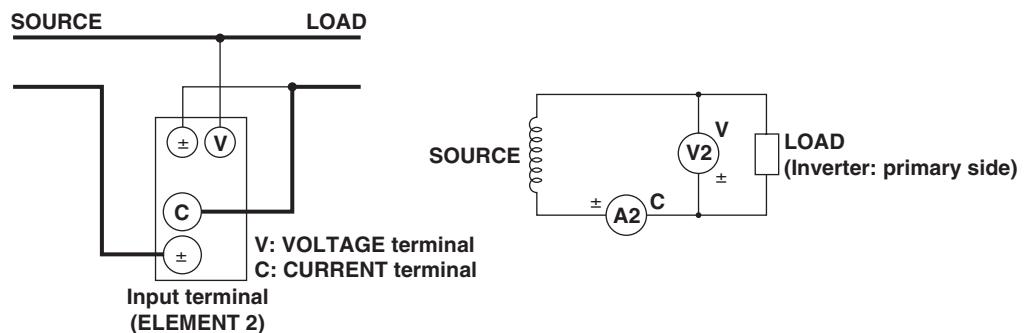


Wiring the Circuit on the Primary Side of the Inverter (Wiring a Single-Phase, Two-Wire System)

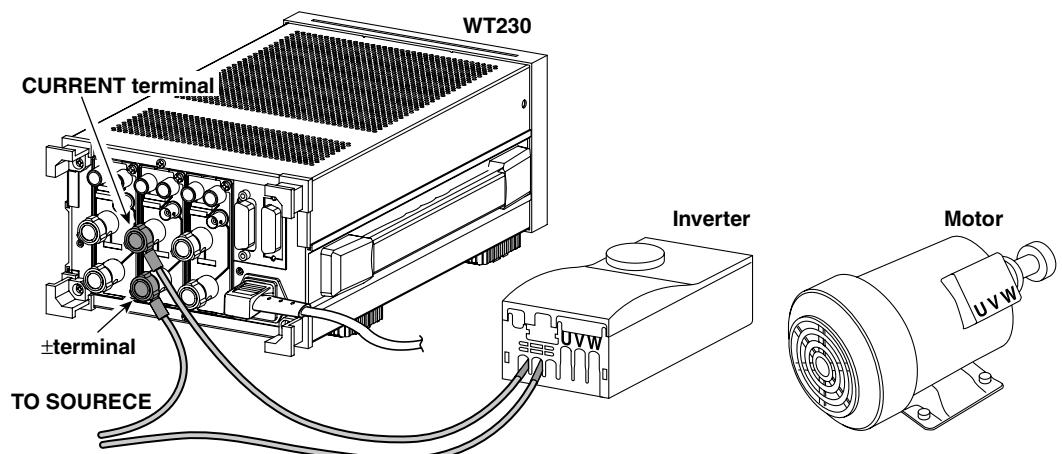
<<For details, see section 3.7.>>

6. Connect the voltage and current input terminals of input element 2 on the rear panel of the WT230 (760503, three-phase, four-wire model) and the current measurement circuit and voltage measurement circuit on the primary side of the inverter.

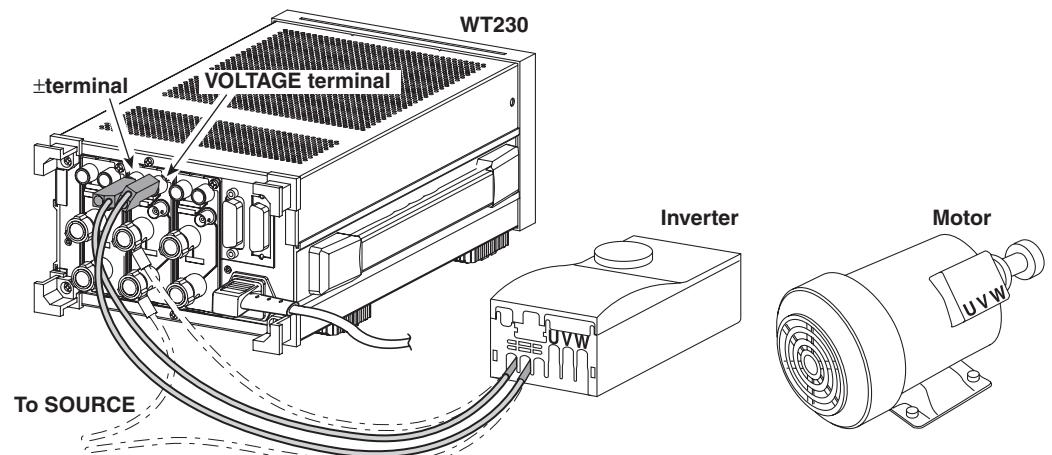
Wiring Diagram



Wiring Example of a Current Measurement Circuit



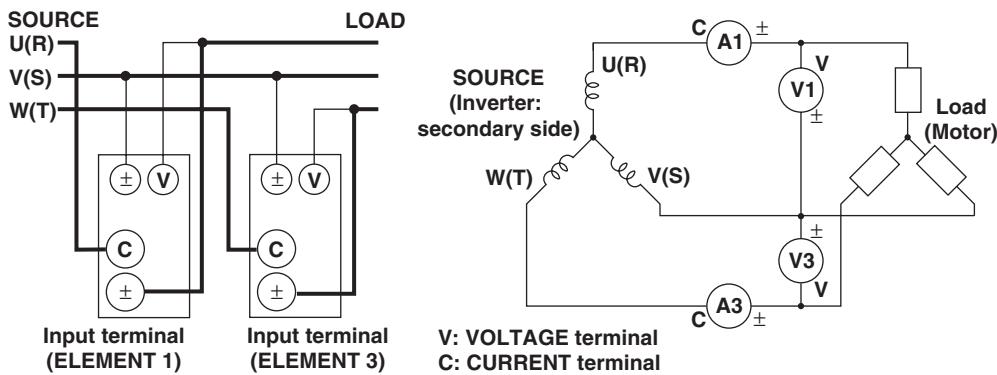
Wiring Example of a Voltage Measurement Circuit



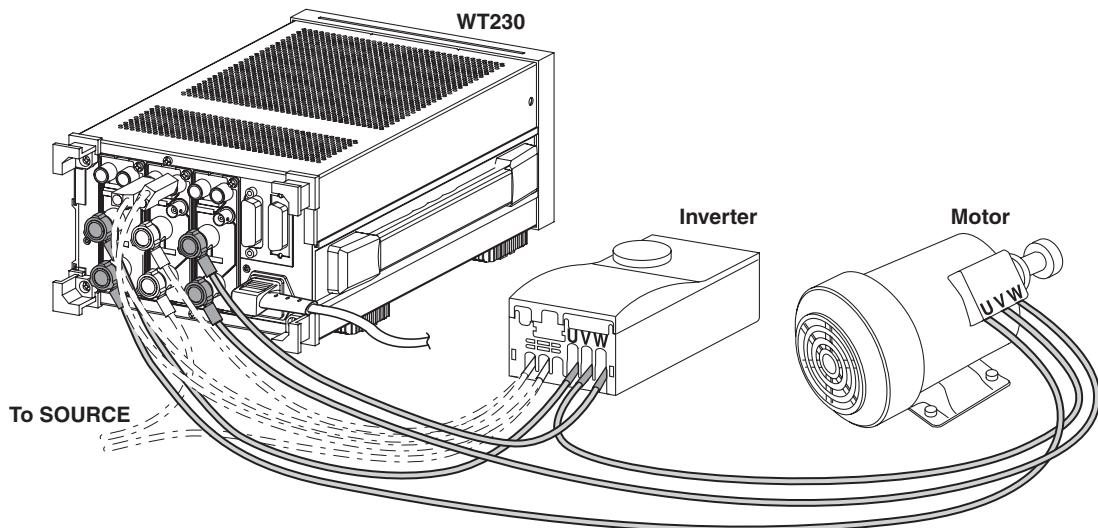
Wiring the Circuit on the Secondary Side of the Inverter (Wiring a Three-Phase, Three-Wire System)

7. Connect the voltage and current input terminals of input elements 1 and 3 on the rear panel of the WT230 (760503) and the current measurement circuit and voltage measurement circuit of the secondary side of the inverter and the motor.

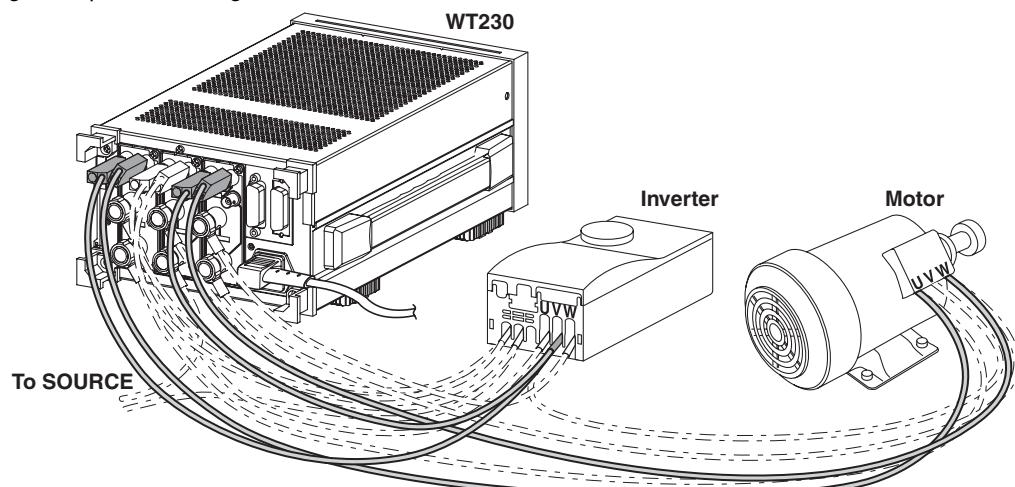
Wiring Diagram



Wiring Example of a Current Measurement Circuit

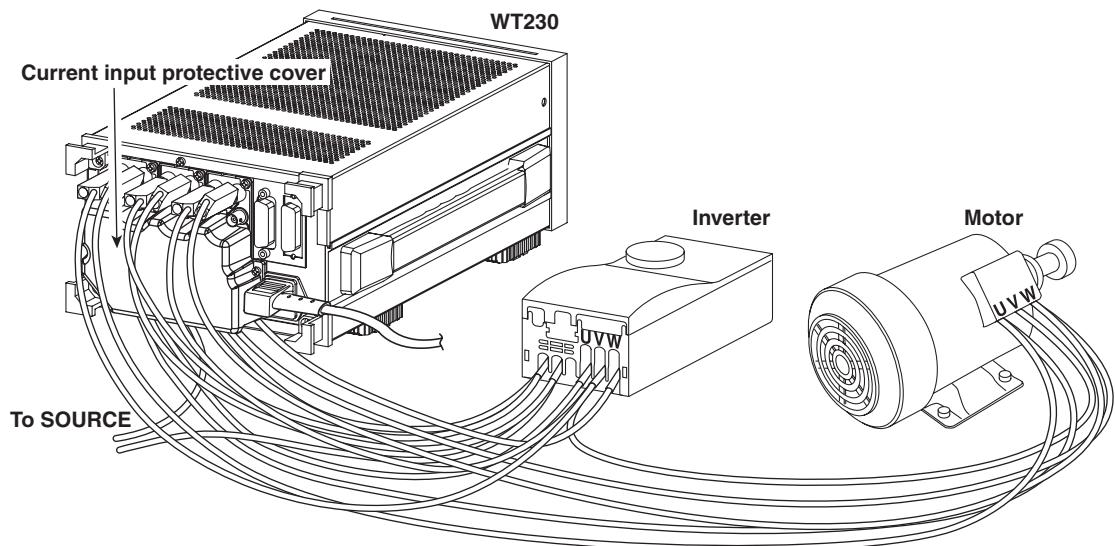


Wiring Example of a Voltage Measurement Circuit



8. Attach the current input protection cover.

Before attaching the current input protection cover, check that the input terminal screws are securely fastened.



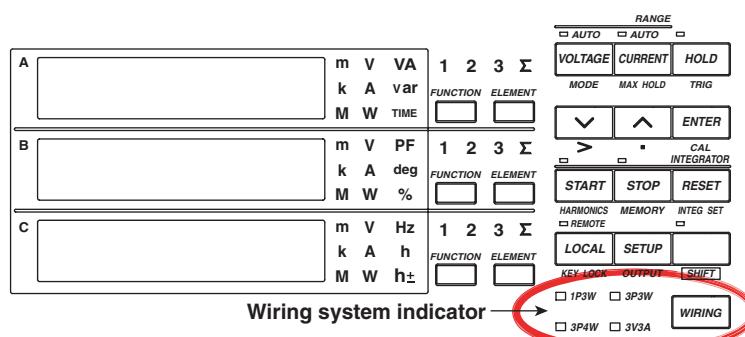
Selecting the Wiring System

<<For details, see section 3.10.>>

After wiring the circuit, select the wiring circuit. Select the wiring system to match the circuit under measurement that is actually wired. When input element Σ is selected, the average voltage or current of each input element that corresponds to the selected wiring system and the sum of powers of each input element are displayed.

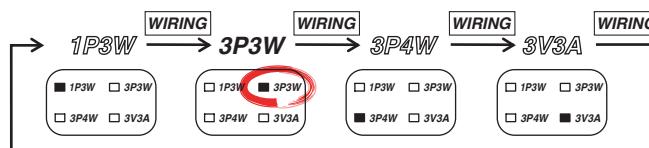
For the computing equation of the sum of powers, see section 16.3.

For the procedure of selecting input element Σ , see pages S-15 to S-17.



Press **[WIRING]** to select wiring system 3P3W.

Each time **[WIRING]** is pressed, the wiring system indicator illuminates in the order shown in the figure below. Since the example in this guide uses input element 1 and 3 of the WT230 (760503, three-phase, four-wire model) with the wiring system of the secondary side of the inverter set to three-phase, three-wire, wiring system 3P3W is selected.

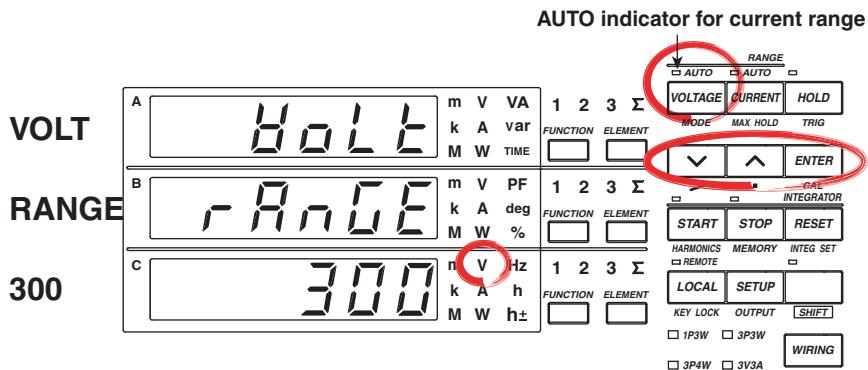


Selecting the Measurement Range

<<For details, see section 4.4.>>

After selecting the writing system, select the measurement range (voltage and current ranges). When you select and confirm the measurement range, the measured values are indicated on the WT230 displays.

Selecting the Voltage Range



For a description of the other digital numbers and characters that are displayed on the 7-segment LED of each display, see section 1.3.

1. Press **VOLTAGE.**

The voltage range selection menu appears.

Display C shows the voltage range selection with blinking indication.

If the voltage range had been set to "RuLo" before this step (AUTO indicator for the voltage range is illuminated), the voltage range that is automatically selected from the measured voltage is displayed blinking.

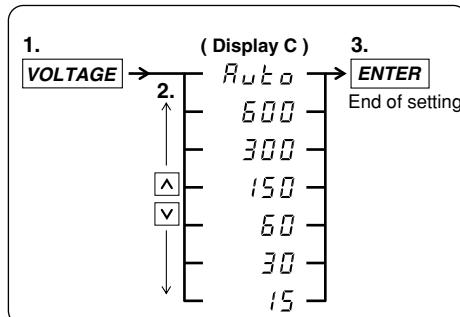
2. Press **▲ or **▼** to show the desired voltage range on display C.**

3. Press **ENTER.**

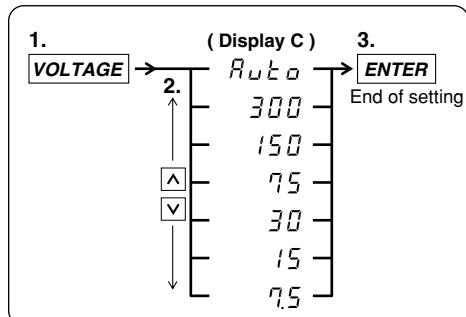
The voltage range is confirmed. Each display shows the measured values.

The following flow chart illustrates steps 1 to 3. In the procedural explanation in chapter 4 and beyond, similar flow diagrams are used.

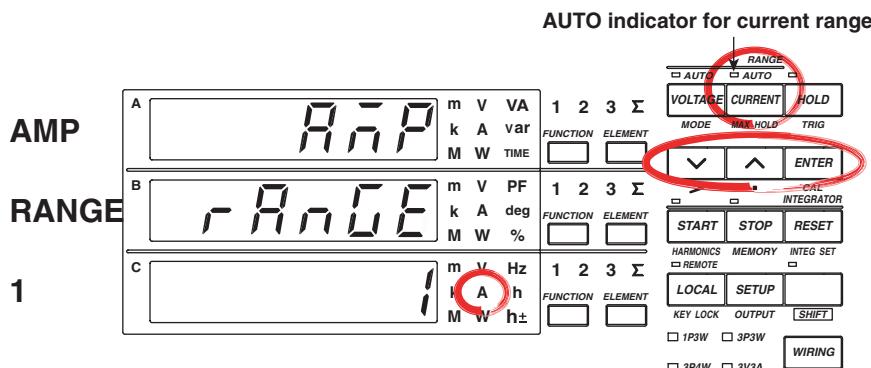
When the crest factor is set to 3



When the crest factor is set to 6



Selecting the Current Range



For a description of the other digital numbers and characters that are displayed on the 7-segment LED of each display, see section 1.3.

4. Press **CURRENT**.

The current range selection menu appears.

Display C shows the current range selection with blinking indication.

If the current range had been set to "Ruto" before this step (AUTO indicator for the current range is illuminated), the current range that is automatically selected from the measured current is displayed blinking.

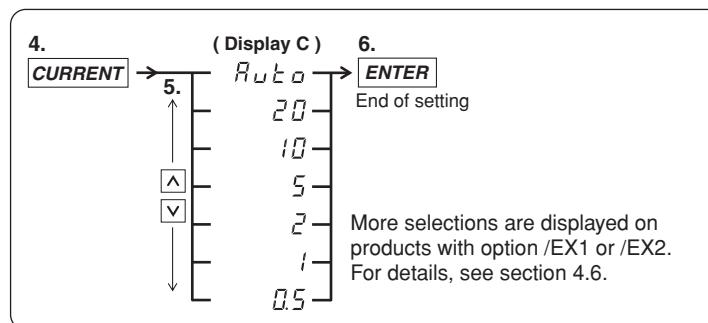
5. Press **^** or **▼** to show the desired current range on display C.

6. Press **ENTER**.

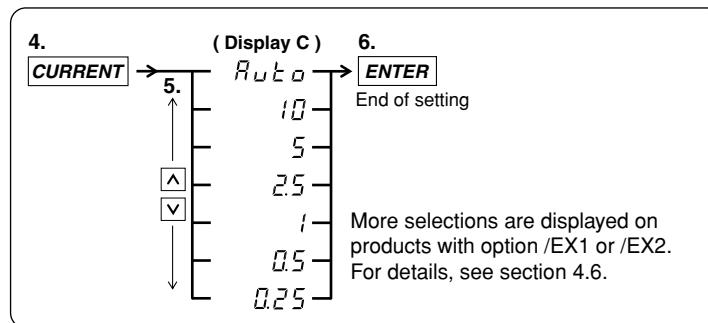
The current range is confirmed. Each display shows the measured values.

The following flow chart illustrates steps 4 to 6.

When the crest factor is set to 3



When the crest factor is set to 6



Turning ON the Power to the Circuit under Measurement

Check the following items before turning on the power to the circuit under measurement.

- The power supply of the WT230 is connected.
- Input terminal screws are securely fastened.
- The current input protection covers are attached.
- The power to the WT230 is ON and it is ready to make measurements.

- 7. Turn ON the power to the circuit under measurement.**
- 8. Operate the inverter to rotate the motor.**

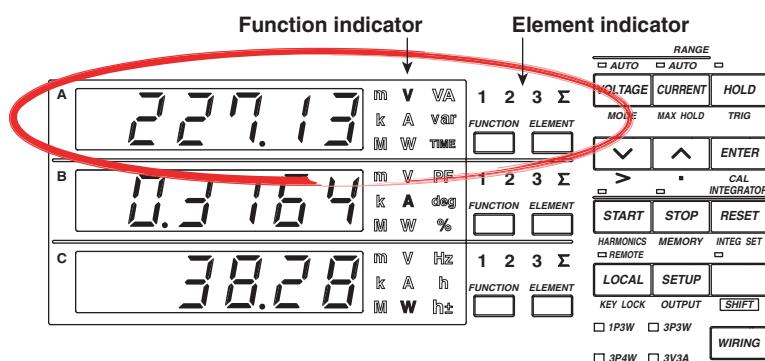
Displaying Voltage, Current, and Active Power

<<For details, see section 5.1.>>

After selecting the measurement range (voltage and current ranges), select the measured items to be displayed in each display.

Displaying the Voltage on the Primary Side of the Inverter on Display A

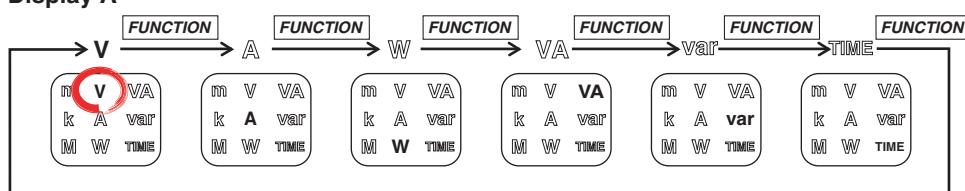
Carry out the following procedure to display the voltage of the primary side of the inverter on display A.



1. Press **FUNCTION** of display A to select function V.

Each time **FUNCTION** is pressed the function indicator character of display A illuminates in the order shown below. To show the measured voltage on display A, we illuminate function V.

Display A

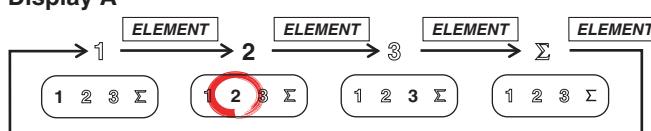


The decimal point position moves so that the measured value can be displayed within the number of digits available on display A. The appropriate prefix symbol ($m(10^{-3})$, $k(10^3)$, or $M(10^6)$) of the unit illuminates accordingly.

2. Press **ELEMENT** of display A to select input element 2.

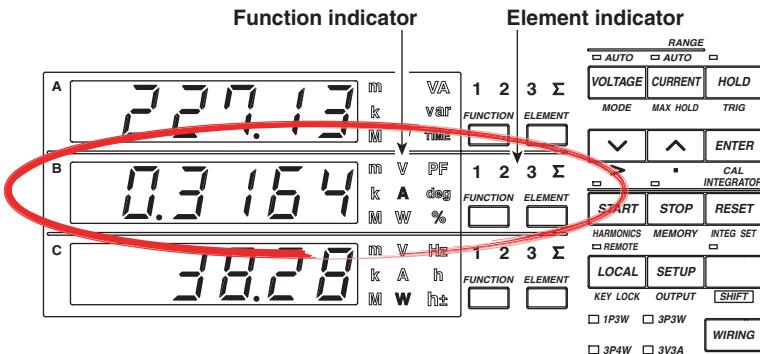
Each time **ELEMENT** is pressed the element indicator character of display A illuminates in the order shown below. The wiring system of the circuit on the primary side of the inverter is single-phase, two-wire, and the circuit is connected to input element 2 of the WT230. To show the measured value of input element 2 on display A, we illuminate input element 2.

Display A



Displaying the Current on the Primary Side of the Inverter on Display B

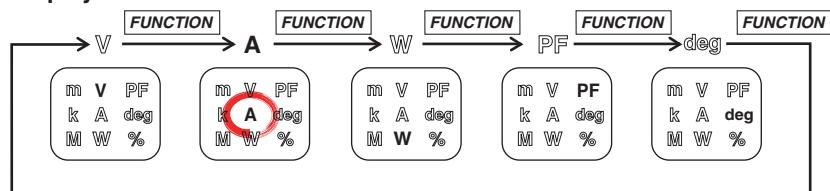
Carry out the following procedure to display the current of the primary side of the inverter on display B.



3. Press **FUNCTION** of display B to select function A.

Each time **FUNCTION** is pressed the function indicator character of display B illuminates in the order shown below. To show the measured voltage on display B, we illuminate function A.

Display B

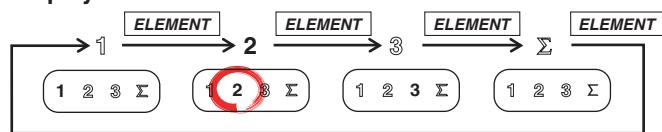


- The decimal point position moves so that the measured value can be displayed within the number of digits available on display B. The appropriate prefix symbol ($m(10^{-3})$, $k(10^3)$, or $M(10^6)$) of the unit illuminates accordingly.
- Function indicator % illuminates only during harmonic measurement.

4. Press **ELEMENT** of display B to select input element 2.

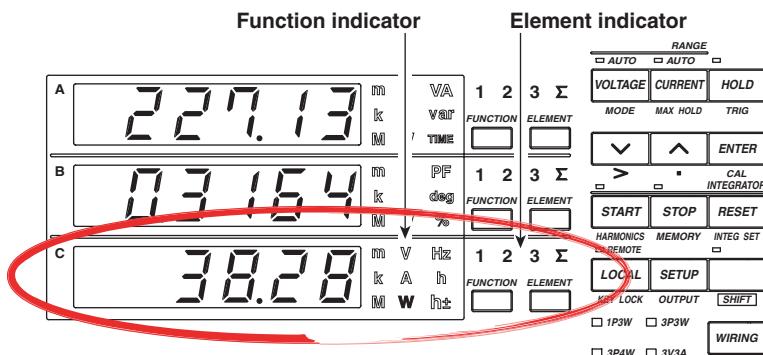
Each time **ELEMENT** is pressed the element indicator character of display B illuminates in the order shown below. The wiring system of the circuit on the primary side of the inverter is single-phase, two-wire, and the circuit is connected to input element 2 of the WT230. To show the measured value of input element 2 on display B, we illuminate input element 2.

Display B



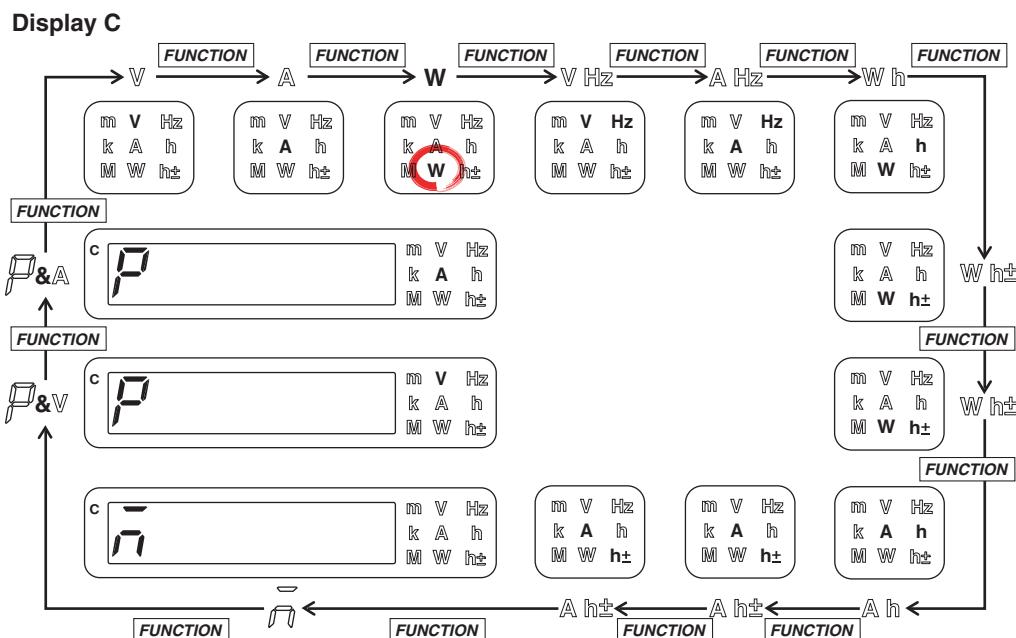
Displaying the Active Power on the Primary Side of the Inverter on Display C

Carry out the following procedure to display the active power of the primary side of the inverter on display C.



5. Press **FUNCTION** of display C to select function W.

Each time **FUNCTION** is pressed the function indicator character of display C illuminates in the order shown below. To show the measured active power on display C, we illuminate function W.

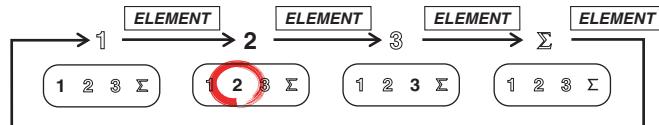


- The decimal point position moves so that the measured value can be displayed within the number of digits available on display C. The appropriate prefix symbol ($m(10^{-3})$, $k(10^3)$, or $M(10^6)$) of the unit illuminates accordingly.
- Indicators "W h±" and "A h±" illuminate twice consecutively. For a description of these items, see page 6-3.
- If the first digit of display C shows "ñ" (M), the result of computations such as the efficiency, crest factor, and four arithmetic operations is displayed.
- If the first digit of display C shows \bar{P} and function V is illuminated, the peak voltage is displayed. If the first digit of display C shows \bar{P} and function A is illuminated, the peak current is displayed.

6. Press $\boxed{\text{ELEMENT}}$ of display C to select input element 2.

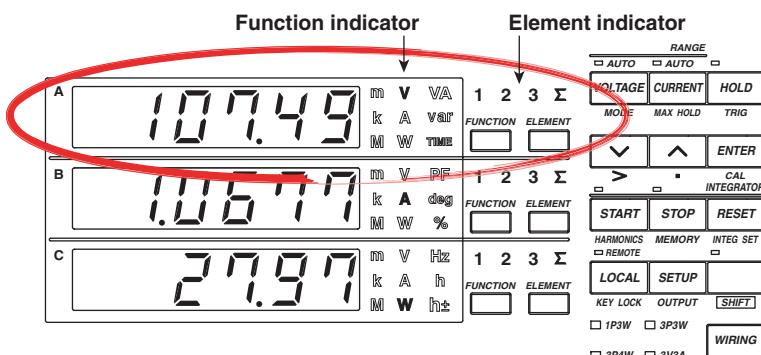
Each time $\boxed{\text{ELEMENT}}$ is pressed the element indicator character of display C illuminates in the order shown below. The wiring system of the circuit on the primary side of the inverter is single-phase, two-wire, and the circuit is connected to input element 2 of the WT230. To show the measured value of input element 2 on display C, we illuminate input element 2.

Display C



Displaying the Voltage of the Secondary Side of the Inverter on Display A

Carry out the following procedure to display the voltage of the secondary side of the inverter on display A.



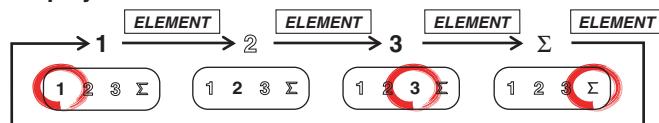
7. Press $\boxed{\text{FUNCTION}}$ of display A to select function V.

For details, see step 1 of page S-10.

8. Press $\boxed{\text{ELEMENT}}$ of display A to select input element 1, 3 or Σ .

Each time $\boxed{\text{ELEMENT}}$ is pressed the element indicator character of display A illuminates in the order shown below. The wiring system of the circuit on the secondary side of the inverter is three-phase, three-wire, and the circuit is connected to input elements 1 and 3 of the WT230. To show the measured value of input element 1, 3, or Σ on display A, we illuminate input element 1, 3, or Σ .

Display A



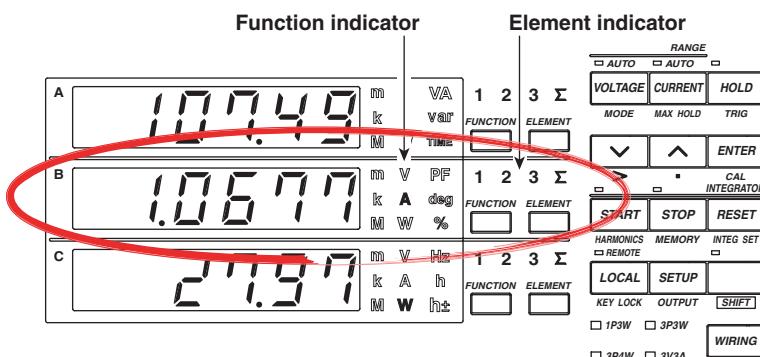
- When input element 1 is illuminated, the line voltage across phases U and V (see page S-5) on the secondary side of the inverter is indicated.
- When input element 3 is illuminated, the line voltage across phases W and V (see page S-5) on the secondary side of the inverter is indicated.
- When input element Σ is illuminated, the average of the line voltage across phases U and V and the voltage across phases W and V on the secondary side of the inverter is indicated. However, this value does not have any physical meaning.

Tips

There are cases when we wish to measure, as a voltage on the secondary side of the inverter, the converted rms voltage (rectified mean value calibrated to the rms value) that is derived by summing the absolute values of the voltage over a single period, dividing the result by the time of one period, and making a conversion. The WT230 provides a function for measuring the rectified mean value calibrated to the rms value of only the voltage. For the setup procedure, see section 4.1, "Selecting the Measurement Mode."

Displaying the Current on the Secondary Side of the Inverter on Display B

Carry out the following procedure to display the current of the secondary side of the inverter on display B.



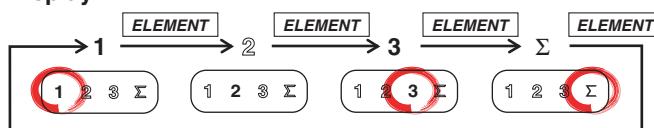
9. Press ^{FUNCTION} of display B to select function A.

For details, see step 3 of page S-11.

10. Press ^{ELEMENT} of display B to select input element 1, 3 or Σ .

Each time ^{ELEMENT} is pressed the element indicator character of display B illuminates in the order shown below. The wiring system of the circuit on the secondary side of the inverter is three-phase, three-wire, and the circuit is connected to input elements 1 and 3 of the WT230. To show the measured value of input element 1, 3, or Σ on display B, we illuminate input element 1, 3, or Σ .

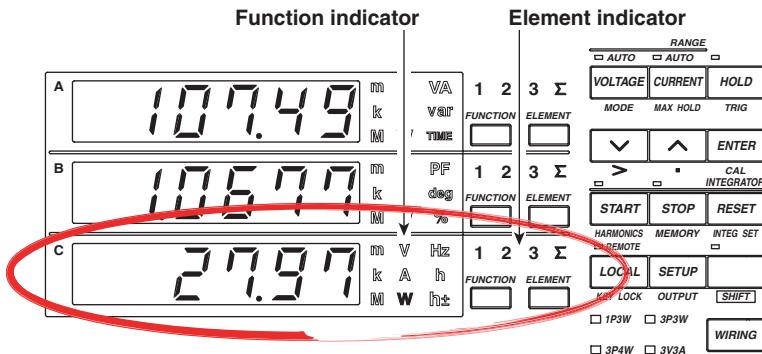
Display B



- When input element 1 is illuminated, the line current of phase U (see page S-6) on the secondary side of the inverter is indicated.
- When input element 3 is illuminated, the line current of the W phase (see page S-6) on the secondary side of the inverter is indicated.
- When input element Σ is illuminated, the average of the line current of phase U and W on the secondary side of the inverter is indicated. However, this value does not have any physical meaning.

Displaying the Active Power on the Secondary Side of the Inverter on Display C

Carry out the following procedure to display the active power of the secondary side of the inverter on display C.



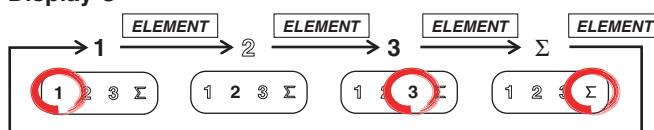
11. Press ^{FUNCTION} of display C to select function W.

For details, see step 5 of page S-14.

12. Press ^{ELEMENT} of display C to select input element 1, 3 or Σ. When input element Σ is illuminated, the sum of active powers measured on input element 1 and 3 is displayed. This value is the “power consumed by the load” when computing the efficiency.

Each time ^{ELEMENT} is pressed the element indicator character of display C illuminates in the order shown below. The wiring system of the circuit on the secondary side of the inverter is three-phase, three-wire, and the circuit is connected to input elements 1 and 3 of the WT230. To show the measured value of input element 1, 3, or Σ on display C, we illuminate input element 1, 3, or Σ.

Display C



- When input element 1 is illuminated, the active power measured on input element 1 is displayed.
- When input element 3 is illuminated, the active power measured on input element 3 is displayed.
- When input element Σ is illuminated, the sum of active powers measured on input element 1 and 3 is displayed. This value is the “power consumed by the load” when computing the efficiency.

Tips

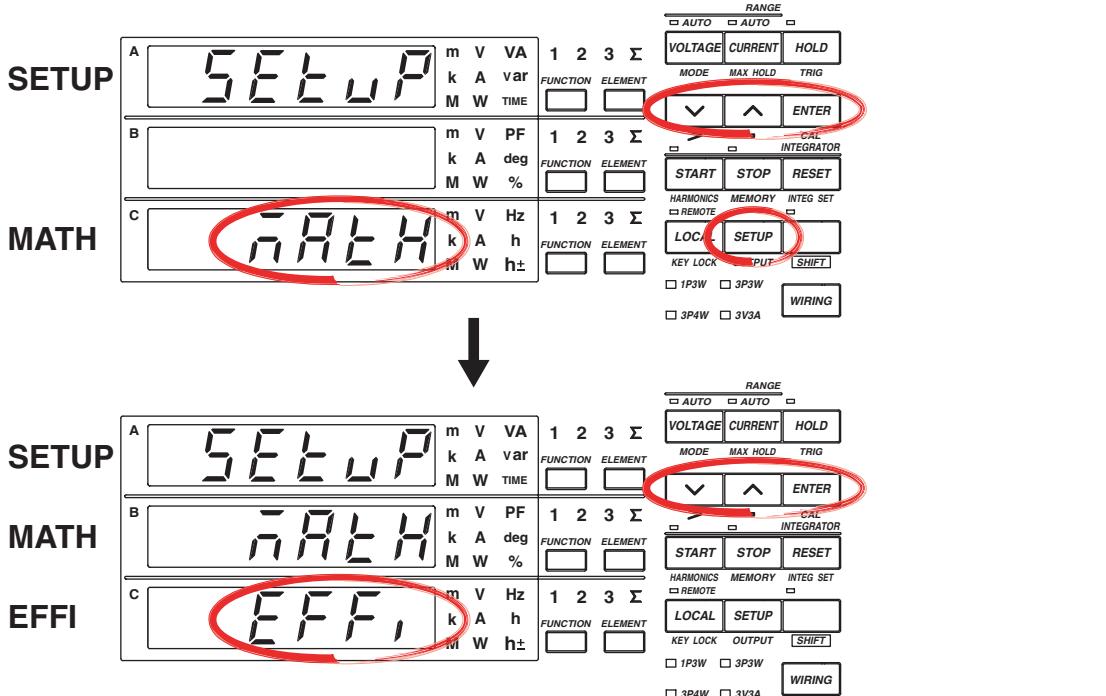
- The WT210/WT230 is equipped with an input filter function for eliminating noise on the measured signal and more accurately measuring the frequency of the measured signal. For the setup procedure, see section 4.3, “Turning ON/OFF the Input Filter.”
- The WT230 has a function that is used to perform exponential or moving averaging on the measured values before displaying them when the measured values are not stable. For the setup procedure, see section 4.7, “Using the Averaging Function.”

Displaying the Efficiency

After wiring the circuit, selecting the wiring system, and selecting the measurement range (voltage and current ranges), set the efficiency computation. The computed results of efficiency can be shown on display C.

Setting the Efficiency Computation

<<For details, see section 4.9.>>

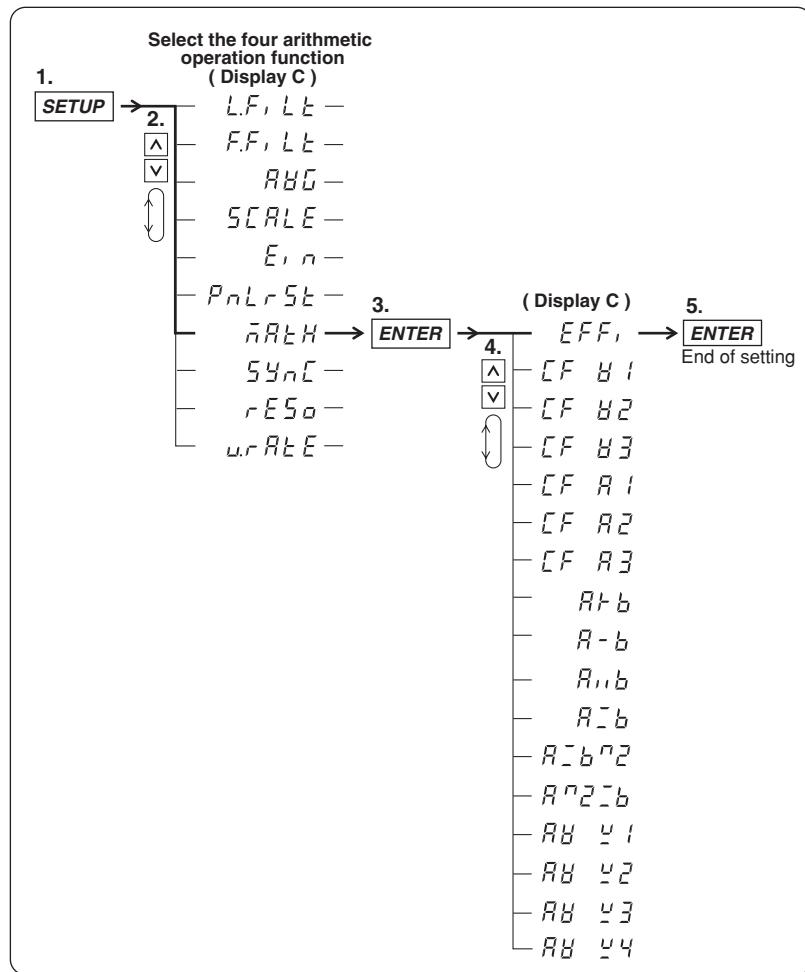


For a description of the other digital numbers and characters that are displayed on the 7-segment LED of each display, see section 1.3.

1. Press **SETUP**.
The setup menu is displayed.
2. Press **^** or **▼** to show **ñRÆH** (MATH) on display C.
3. Press **ENTER**.
The selection of the computation function is confirmed, and a menu used to select the computed items is shown on display C. **ñRÆH** (MATH) moves to display B.
4. Press **^** or **▼** to show **EFF**, (EFFI, efficiency) on display C.
5. Press **ENTER**.
Efficiency computation is confirmed as a computed item. Each display returns to the condition in which the measured values are displayed.

Displaying the Efficiency

The following flow chart illustrates steps 1 to 5. In the procedural explanation in chapter 4 and beyond, similar flow diagrams are used.

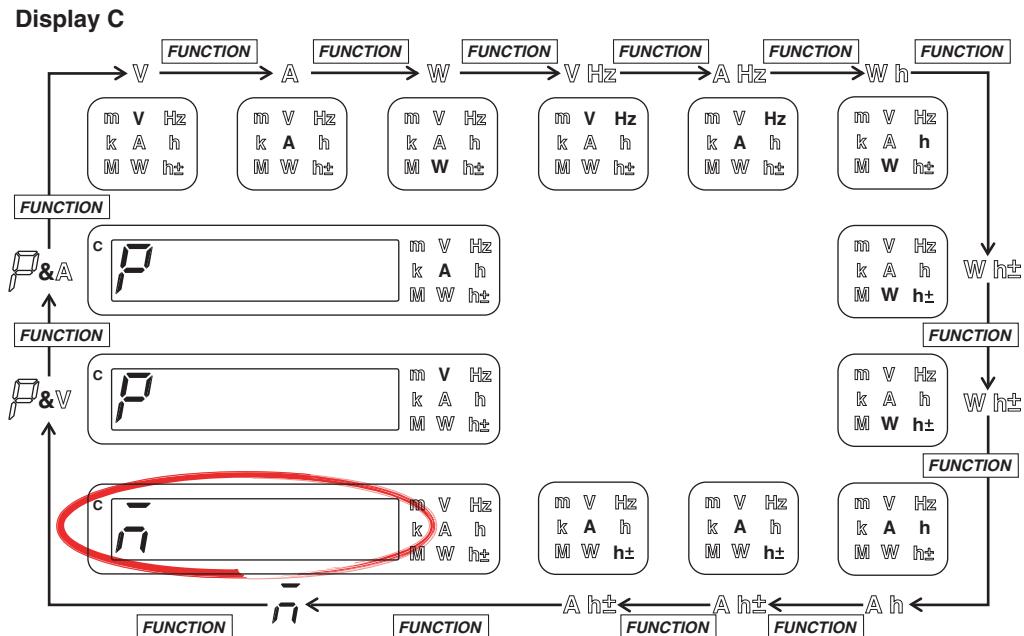


Displaying the Efficiency

<<For details, see section 5.5.>>

6. Displaying Efficiency on display C

Press **FUNCTION** on display C to show η (M) on display C. If *EFFI*, (EFFI) is selected in step 4 of page S-18, efficiency is displayed. The efficiency value is displayed as a percentage.



Display example of efficiency



This completes the setup procedures for wiring the circuit, selecting the wiring system, selecting the measurement range, and displaying the efficiency.

Confirming the Displayed Efficiency

To confirm the efficiency value that is shown, we will display the active power on the primary side of the inverter (power supplied by the source) on display A and the active power on the secondary side of the inverter (power consumed by the load) on display B.

- 1. Display the active power on the primary side of the inverter on display A.**
 - Press of display A to select function W.
 - Press of display A to select input element 2.
- 2. Display the active power on the secondary side of the inverter on display B.**
 - Press of display B to select function W.
 - Press of display B to select input element Σ .
- 3. Display efficiency on display C.**
Press on display C to show \bar{n} on display C. If *EFF*, is selected in step 4 of page S-18, efficiency is displayed.

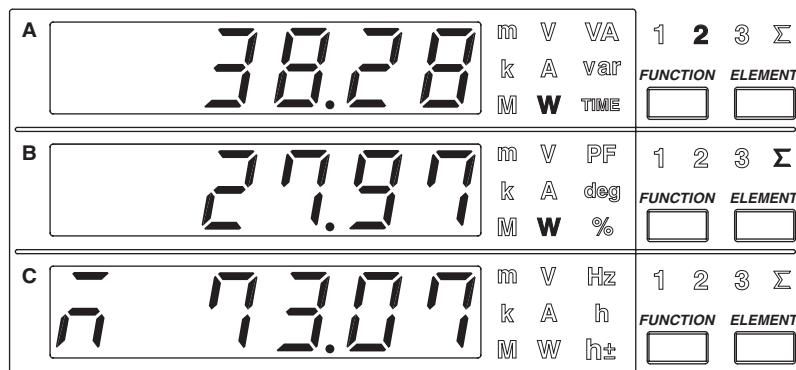
Confirmation Example of the Displayed Efficiency

The following figure shows the case in which displays A, B, and C are showing the active power on the primary side of the inverter (power supplied by the source), the active power on the secondary side of the inverter (power consumed by the load), and the efficiency, respectively.

If we divide the value shown on display B by the value shown on display A and convert the result to a percentage, we obtain the efficiency value shown on display C.

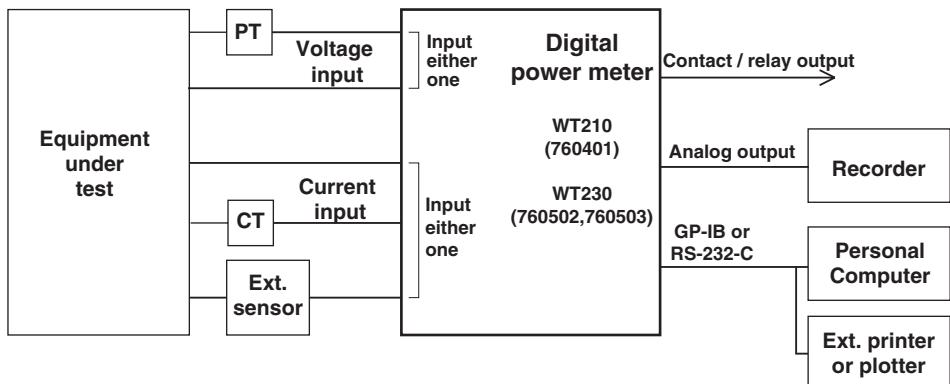
$$\frac{\text{Active power on the secondary side of the inverter (W)} \\ (\text{Power consumed by the load})}{\text{Active power on the primary side of the inverter (W)} \\ (\text{Power supplied by the source})} = \frac{\text{Value shown on display B}}{\text{Value shown on display A}} = \frac{27.97(\text{W})}{38.28(\text{W})} = 0.730668\cdots \cong 0.7307$$

73.07% when converted to a percentage



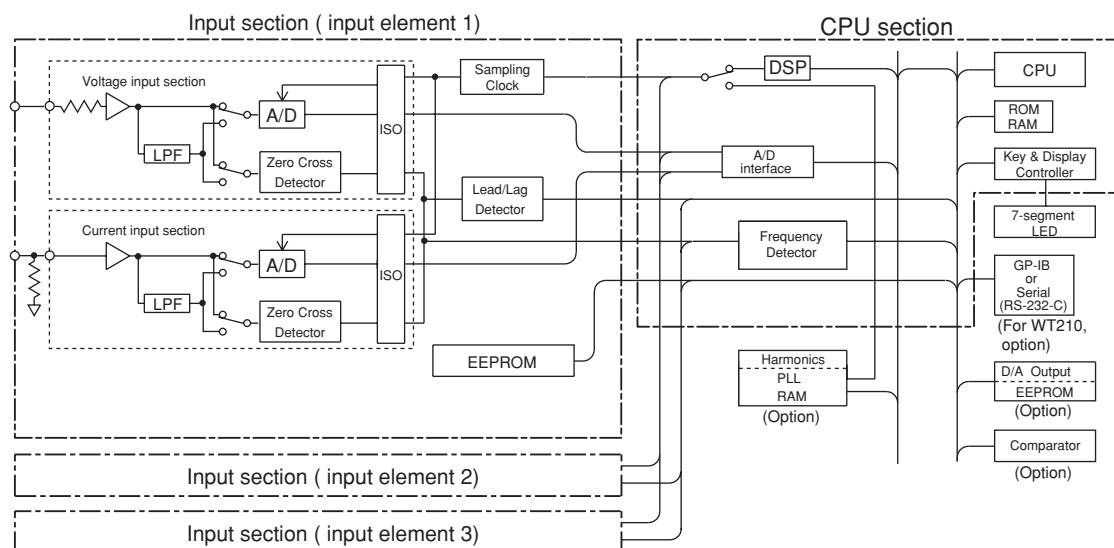
1.1 System Configuration and Block Diagram

System Configuration

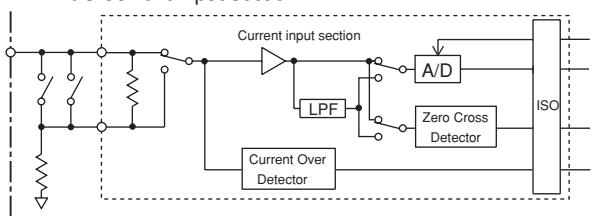


Block Diagram

Model	Input Section
760401	Built-in input element 1
760502	Built-in input element 1 and 3
760503	Built-in input element 1, 2, and 3



WT210's Current input section



1.1 System Configuration and Block Diagram

Signal Flow and Process

The sections that make up the WT210/WT230 are VOLTAGE INPUT, CURRENT INPUT, DSP, CPU, display, and interface.

In the voltage input circuit, the input voltage is normalized by a voltage divider and operational amplifier, then sent to the A/D converter. Shunt resistors form a close circuit at the current input circuit. The voltage across shunt resistor is amplified and normalized by the operational amplifier and then input to the A/D converter. This method enables switching of the current range without opening the current input circuit, so the current range can be switched while power is supplied to the circuit. This also enables remote control via communications outputs. The WT210 equipped with two shunt resistors, one for minute currents and another for large currents.,

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 (ISO), which is used to provide insulation between the current input circuit (or voltage circuit) and the DSP.

During normal measurement, the DSP converts digital values sampled at a period of approximately 20 μ S to voltage, current, and active power; sums the values over a predetermined period; and then divides the sum by the number of samples to derive the measured value of voltage, current, and active power. In addition, to achieve high accuracy, the start and end points of sampling are determined by synchronizing to the zero-crossing point of the voltage or current signal that you select to be measured. From the voltage, current, and active power, the DSP computes the apparent power, reactive power, power factor, and phase angle and performs processing such as scaling and averaging. During harmonic measurement, the DSP performs FFT based on the digital values sampled at an integer multiple of the period of the PLL source signal (period of the clock that the PLL circuit generates) and determines the measured values of various items of harmonic measurement.

The measured value is transmitted to the CPU section. Various computed values such as Σ and MATH are determined from the measured values. These measured values and computed values are displayed (on the 7-segment LED), output through a D/A converter, or output through communications.

During normal measurement, the processing on the DSP and CPU is pipelined, and the DSP processing is performed in real-time. Therefore, measurements with few data dropouts can be achieved against the input signal.

1.2 Functions

Input Functions

Voltage and Current Input Sections

The WT210/WT230 is a digital power meter that can measure the RMS value of voltage or current, or active power by applying voltage and current signals to the voltage and current input sections, respectively. From the measured values of voltage, current, and active power, power elements such as apparent power, reactive power, power factor, and phase angle can be determined.

Frequency Measuring Range

Measurement of DC voltage, current and power as well as AC voltage, current, and power in the frequency range of 0.5 Hz to 100 kHz.

Input Filter

The following two types of input filters are provided. The filters eliminates noise such as inverter waveforms and distorted waveforms and allow stable measured values to be obtained.

- **Line Filter**

This filter is inserted only into the measurement circuit. It eliminates noise components of the input signal. The cutoff frequency is 500 Hz.

- **Frequency Filter**

This filter is inserted only into the frequency measurement circuit. The cutoff frequency is 500 Hz. Since the WT210/230 is making measurements in sync with the input signal, the frequency of the input signal must be measured correctly.

Wiring System

The input units for voltage or current are located on the rear panel of this instrument. These units are called input elements. The number of input elements depends on the model, and the possible wiring systems are shown in the table below. The wiring system indicates the circuit configuration for measuring voltage, current, and power. The name of the system varies depending on the phase and number of electrical wires making up the circuit.

Model	Number of Elements	Wiring Systems Supported
760401	1	Single-phase, two-wire (1P2W)
760502	2	Single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); three-phase, three-wire (3P3W)
760503	3	Single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); three-phase, three-wire (3P3W); three-phase, four-wire (3P4W); three-voltage, three-current (3V3A)

Display Functions

Measured/computed values are displayed on three red high-intensity 7-segment LED displays. You can view three values simultaneously.

You can select the display update rate (0.1 s to 5 s) and the number of displayed digits (4 or 5) for voltage, current, and active power values.

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.

Computation Function

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 items such as external PT, CT, shunt, and external sensor (clamp), 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 when the measured values are not stable.

Efficiency (applicable only to the WT230)

Efficiency can be computed on models with multiple input elements.

Crest Factor

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

Four Arithmetic Operation

Displays six types of computed results. ($A+B$, $A-B$, $A\times B$, A/B , A^2/B , A/B^2)

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 Function

This function enables integration of active power and current. The integrated value (watt hour or current hour) and the elapsed time of integration as well as other measured (computed) values can be displayed even while the integration is in progress. Moreover, since 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 separately.

Frequency Measurement Function

This function measures the frequency of the voltage or current.

Measurable range: 0.5 Hz to 100 kHz (The measurement range varies depending on the display update rate.)

Harmonic Measurement Function (Option)

This function enables the 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 with respect to the fundamental (first order) on a single selected input element. Furthermore, the total rms value (fundamental + harmonic) of the voltage, current and active power, and the harmonic distortion factor (THD) can be calculated.

Store/Recall Function of Measured/Computed Data and Setup Parameters

This function enables the storage of measured/computed data and setup parameters in the internal memory. The stored measured/computed data and setup parameters can be recalled, and the data can be displayed or output via the communication interface.

D/A Output Function (Option)

This function converts the measured values of voltage, current, active power, apparent power, reactive power, power factor, phase angle, frequency, voltage peak, current peak, and integrated values to DC analog voltage with full scale of ± 5 V and outputs the voltage. Output items of up to 12 output channels (4 channels on WT210) can be selected.

1.2 Functions

Comparator Function (Option)

This function compares a preset limit and the measured, computed, or integrated value, and outputs the determination result using relay contacts.

Remote Control Function (Option)

On models with the /DA4, /DA12, or /CMP option, the TTL logic signal (negative pulse) can be used to control the WT210/WT230 or output externally.

External Input

The following five types of control signals are available.

EXT HOLD

Holds updating of the displayed values or releases the hold status.

EXT TRIG

Updates the displayed values in hold mode.

EXT START

Starts integration.

EXT STOP

Stops integration.

EXT RESET

Resets the integration result.

External Output

The following signal is output during integration.

INTEG BUSY

Outputs continuously from integration start through integration stop.

Communication Functions (Option on the WT210, Standard on the WT230)

You can select GP-IB interface or serial (RS-232-C) interface. Measured/computed data of up to 14 channels can be output to your PC via the communication interface. You can also set various functions of the WT210/WT230 from your PC.

Output Function to an External Plotter and Printer

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

Other Functions

Backup Function of Setup Parameters

This function backs up setup parameters (including computed values) if the power is cut off such as a result of a power failure.

Initialization of Setup Parameters

This function initializes the setup parameters to factory default.

Zero Level Compensation

Zero level compensation refers to creating a zero input condition inside the WT210/WT230 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.

Key Lock

Setup operations using front panel keys can be disabled except for the power switch and KEY LOCK switch.

1.3 Digital Numbers and Characters and Initial Menus

Digital Numbers and Characters

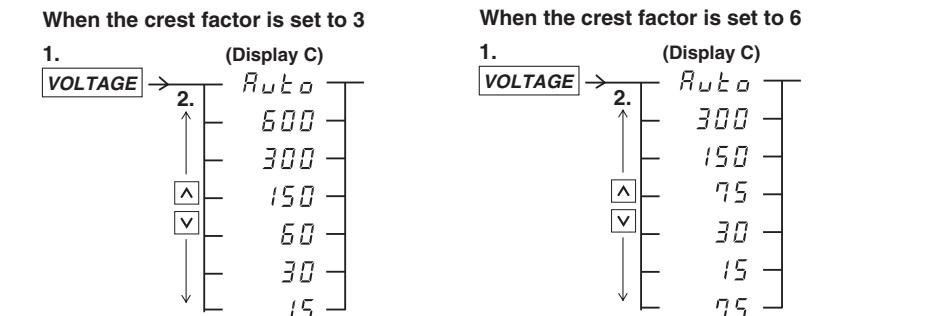
Because the WT210/WT230 uses a 7-segment LED display, numbers, alphabets, and operation symbols are represented using special characters as follows. Some of the characters are not used.

0 → 0	A → A	K → K	U → U	Λ (Exponent) → ^
1 → 1	B → b	L → L	V → V	
2 → 2	C → C Small c → c	M → n	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	÷ → ÷	

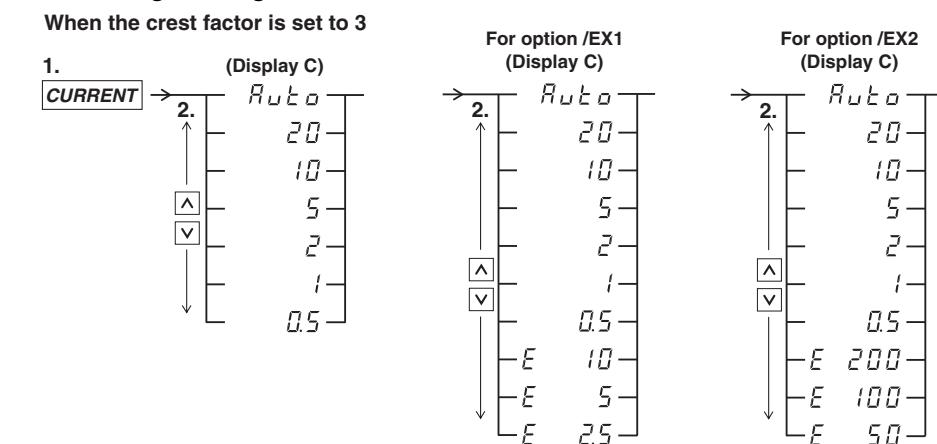
Initial Menus

Each function of the WT210/WT230 is set using a menu that appears on the display. The initial menu that appears when the operation keys are pressed are shown below.

Voltage Range Setting



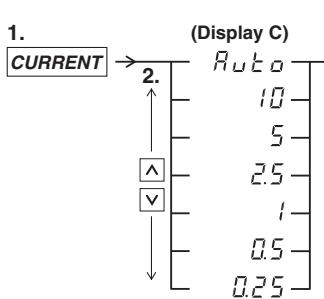
Current Range Setting



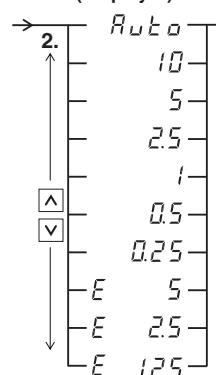
On the WT210, 5 to 200 mA range can also be specified.

1.3 Digital Numbers and Characters and Initial Menus

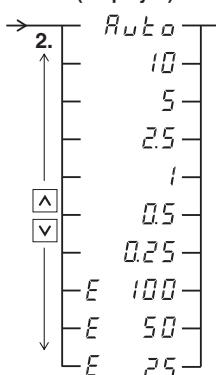
When the crest factor is set to 6



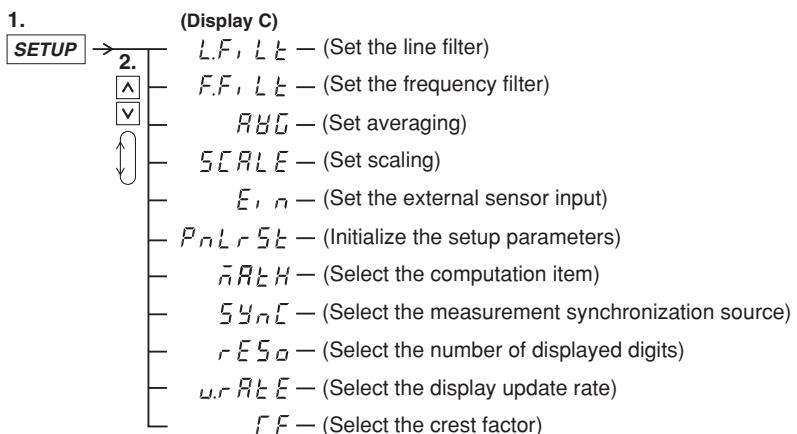
For option /EX1 (Display C)



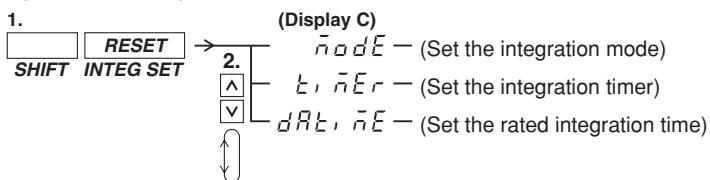
For option /EX2 (Display C)



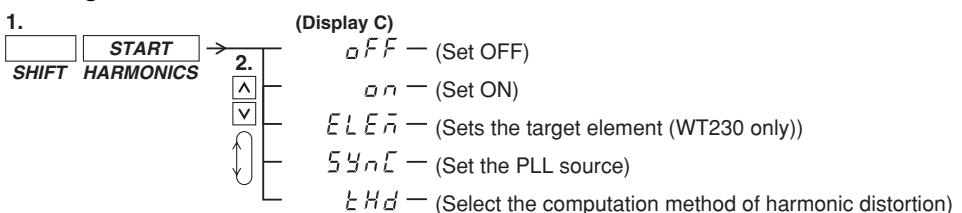
Filter/Scaling/Averaging/External Sensor Input/Initializing set-up parameters



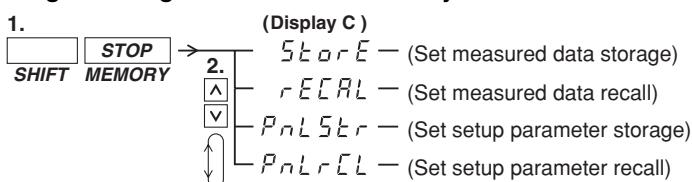
Integration Setting



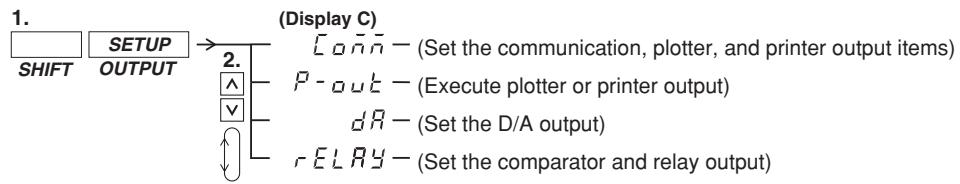
Turning the Harmonic Measurement Function ON/OFF



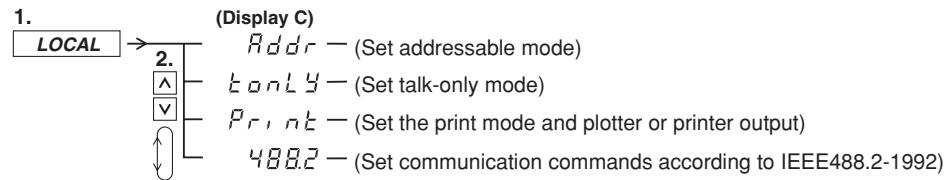
Storing/Recalling to/from Internal Memory



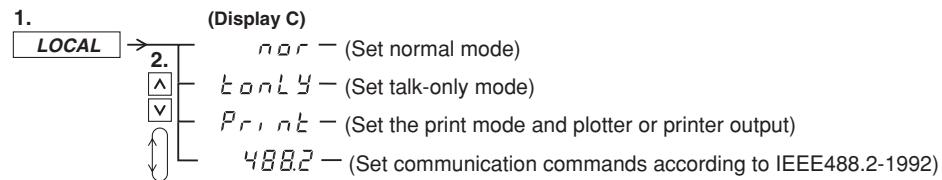
Setting Output



Setting Communication Interface (GP-IB)

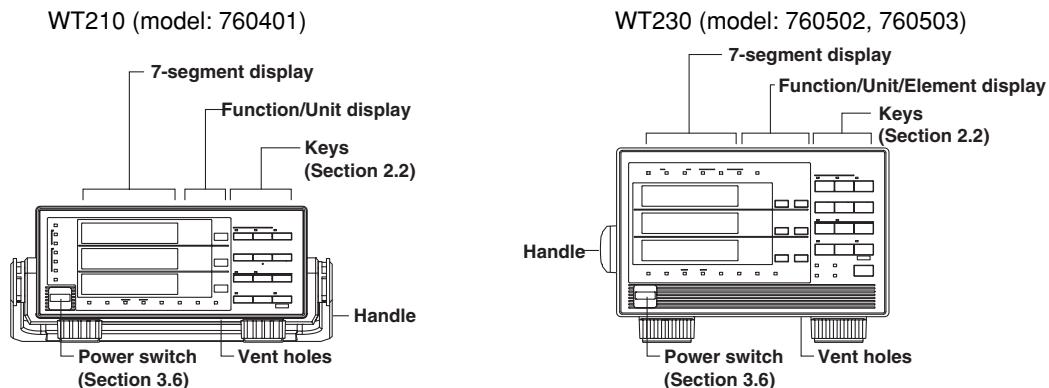


Setting Communication Interface (Serial)

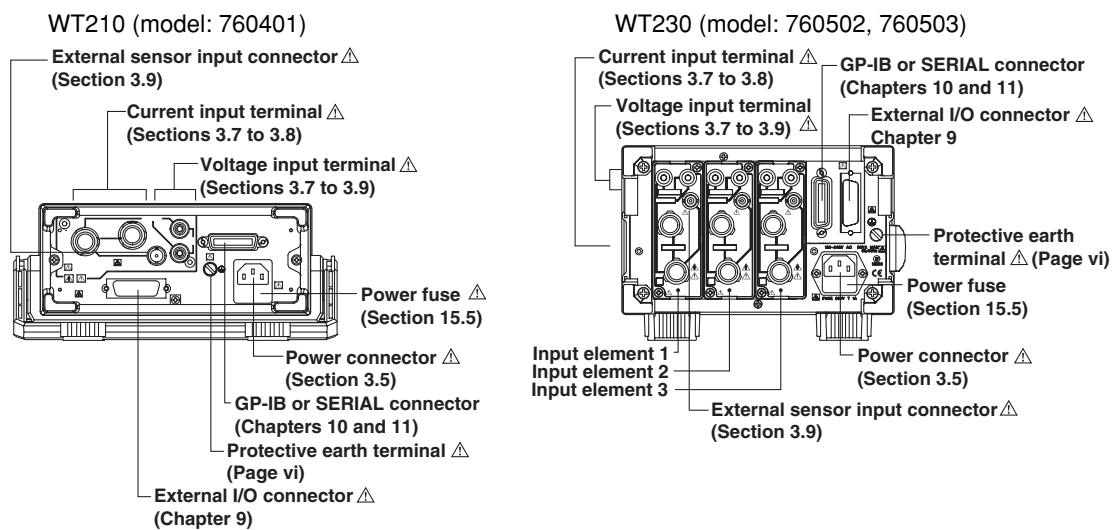


2.1 Front Panel, Rear Panel, and Top View

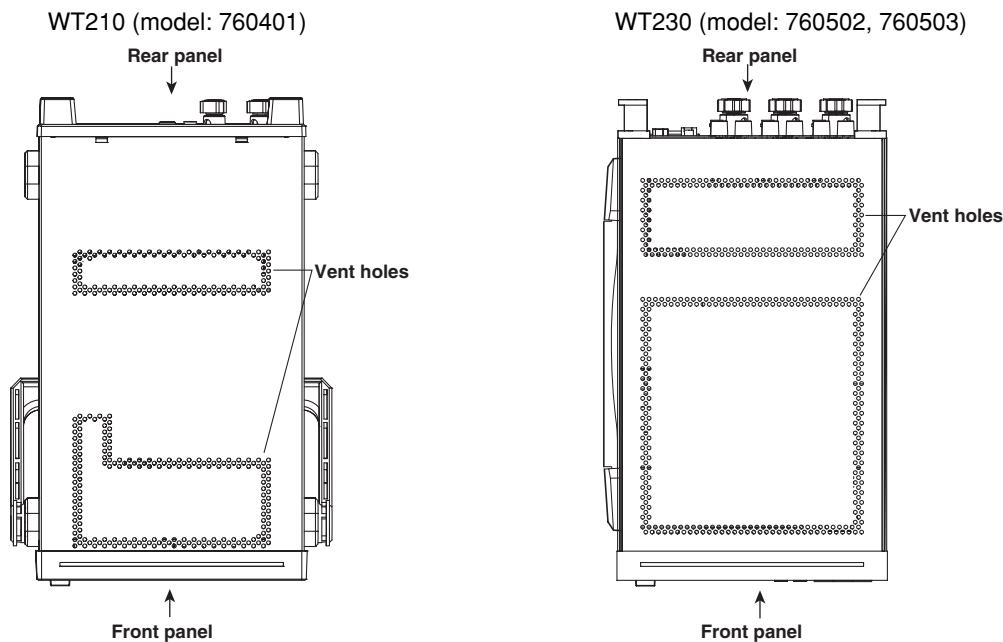
Front Panel



Rear Panel

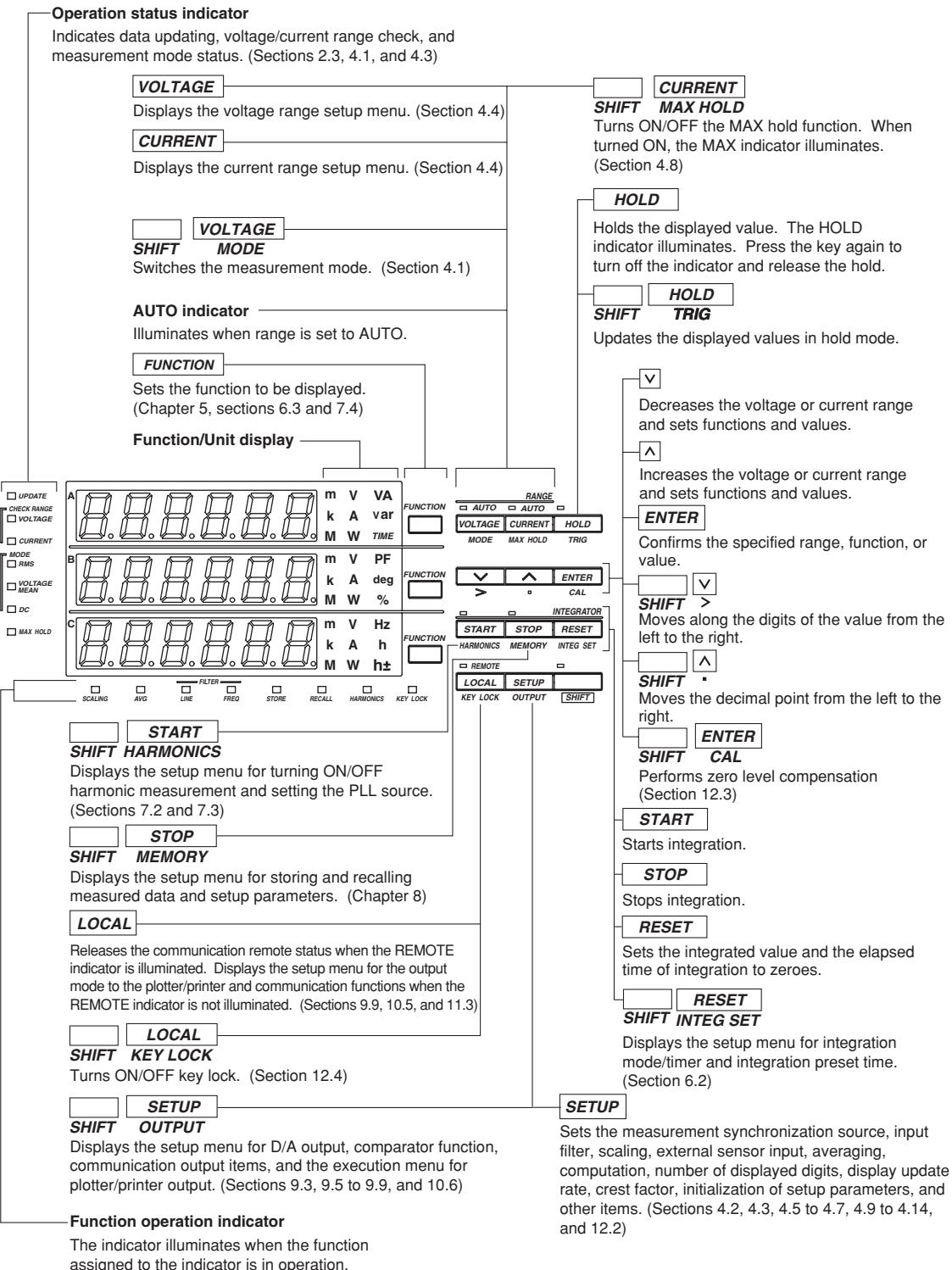


Top View



2.2 Operation Keys and Functions/Element Display

Operation Keys and Function Displays on the WT210 (model: 760401)

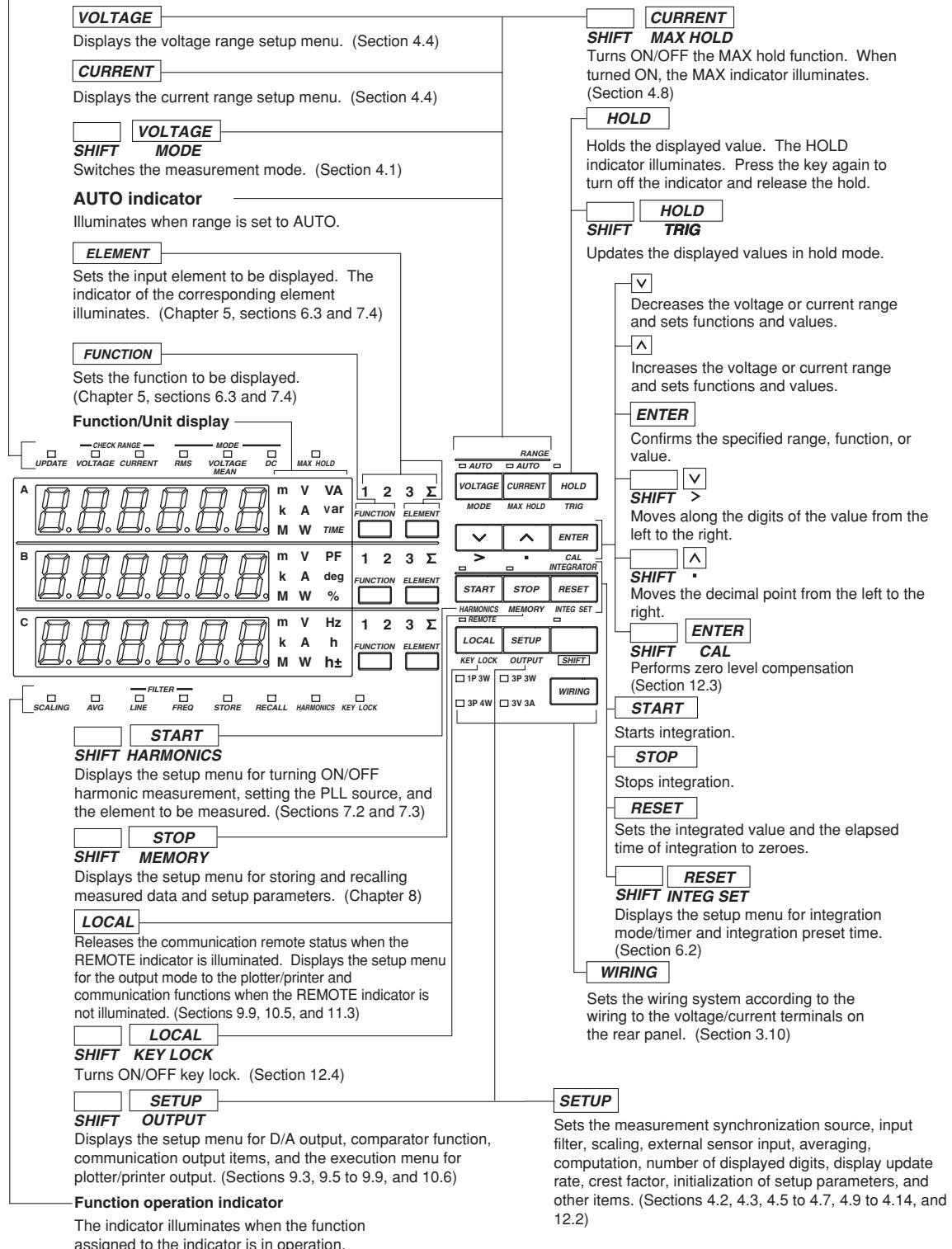


2.2 Operation Keys and Functions/Element Display

Operation Keys and Function Displays on the WT230 (model: 760502, 760503)

Operation status indicator

Indicates data updating, voltage/current range check, and measurement mode status. (Sections 2.1, 4.1, and 4.13)



2.3 Auto Range Monitor, OVERRANGE, and Error Displays during Measurement

OVERRANGE Display

During normal measurement, overrange occurs when the measured voltage V or measured current A exceeds 140% of the rated range. When using auto range, the range automatically steps up. OVERRANGE occurs when 140% of the maximum range is exceeded. OVERRANGE is indicated as follows: For the conditions in which overrange display occurs in harmonic measurement, see section 7.1.



Computation Over Display

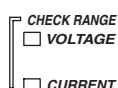
If the computed value overflows during the computation process, it is indicated as follows:



Auto Range Monitor

The indicator illuminates when the input signal meets the conditions for auto range switching. For details on the auto range function, see section 4.4.

WT210 indicator



WT230 indicator



Display When the Measured Value is too Small

If the measured voltage or current drops below 0.5% (less than or equal to 1% if the crest factor is set to 6) of the rated range, the condition is indicated as shown below. This applies only when the measurement mode (section 4.1, "Selecting the Measurement Mode") is set to RMS or VOLTAGE MEAN.

Function	Display
V (voltage)	
A (current)	Displays zero.
VA (apparent power)	
var (reactive power)	
PF (power factor)	PF Err
deg (phase angle)	DEErr

Measurement Abort/No Data Display (Bar Display)

If you change the displayed information by changing the measurement range or the function/element or there is no data to be displayed, the following bar display appears temporarily.



3.1 Handling Precautions

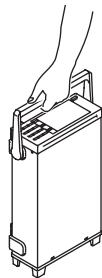
Safety Precautions

- If you are using this instrument for the first time, make sure to thoroughly read the "Safety Precautions" given on page vi and vii.
- Do not remove the case.
Some sections inside the instrument have high voltages that are extremely dangerous. For internal inspection or adjustment, contact your nearest YOKOGAWA dealer.
- Abnormal Behavior
Stop using the instrument if there are any symptoms of trouble such as strange odors or smoke coming from the instrument. If these symptoms occur, immediately turn OFF the power and unplug the power cord. In addition, turn OFF the power to the DUT that is connected to the input terminal. Then, contact your nearest YOKOGAWA dealer.
- Power Cord
Nothing should be placed on top of the power cord. The power cord should also be kept away from any heat sources. When unplugging the power cord from the outlet, never pull by the cord itself. Always hold and pull by the plug. If the cord is damaged, contact your dealer for replacement. Refer to page iii for the part number of the appropriate power cord when placing an order.

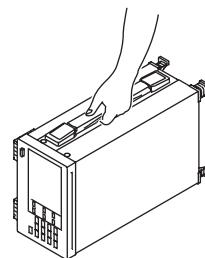
General Handling Precautions

- Do not place objects on top of the instrument.
Never place other instruments or any objects containing water on top of the instrument. Such act can lead to malfunction.
- When Carrying the Instrument
First, turn off the object to be measured and remove all cables including measurement cables and communication cables. Then, turn OFF the WT210/WT230 and remove the power cord from the outlet. To carry the instrument, use the handle or carry it using both hands.

WT210 (model: 760401)



WT230 (model: 760502, 760503)



- To prevent overheating, do not block the vent holes on top and bottom panels of the case.
- Keep electrically charged objects away from the input terminals. They may damage the internal circuitry.
- Do not pour volatile agents on the case or operation panel nor leave them in contact with rubber or PVC products for long periods of time. The operation panel is made of thermoplastic resin. Make sure heating elements such as soldering bits do not come in contact with the operation panel.
- When cleaning the case or the operation panel, first remove the power cord from the outlet. Then, wipe with a dry, soft cloth. Do not use volatile chemicals since this might cause discoloring and deformation.
- If you are not going to use the instrument for a long period of time, unplug the power cord from the outlet.

3.2 Installing the Instrument

Installation Condition

Install the instrument in a place that meets the following conditions.

Ambient Temperature and Humidity

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

Flat, Even Surface

Install the instrument in a stable horizontal place. Accurate measurements may be hindered when the instrument is used in an unstable place or tilted position.

Well-Ventilated Location

Vent holes are located on the top and bottom of the instrument. To prevent internal overheating, do not block the vent holes.

If you remove the legs from the bottom panel for rack mounting, allow an equivalent amount of space (20 mm or more) from the floor to prevent blocking the vent holes.

Do Not Install the Instrument in the Following Places:

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

Note

- For the most accurate measurements, use the instrument in the following environment.
Ambient temperature: 23±5°C Ambient humidity: 30 to 75%RH (no condensation)
When using the instrument in a place where the ambient temperature is 5 to 18°C or 28 to 40°C, add the temperature coefficient to the accuracy as specified in chapter 16.
- When installing the instrument in a place where the ambient humidity is 30% or below, take measures to prevent static electricity such as using an anti-static mat.
- Condensation may occur if the instrument is moved to another place where the ambient temperature is higher, or if the temperature changes rapidly. In this case, let the instrument adjust to the new environment for at least an hour before using the instrument.

Installation Position

Desktop

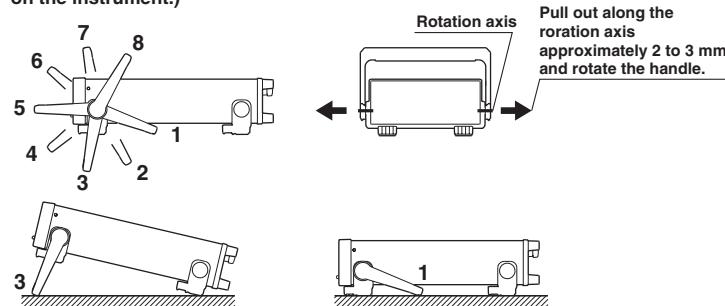
Place the instrument on a flat, even surface as shown in the figure below.

- **WT210 (model: 760401)**

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 outward along the rotational axis approximately 2 to 3 mm and slowly move the handle.

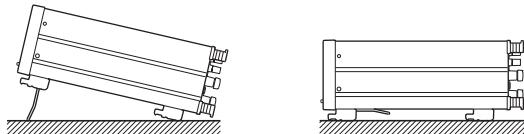
Fixed positions of the handle

(We recommend the positions 1, 3, 5, or 8. When using no 2 and 4, don't put any weight on the instrument.)



3.2 Installing the Instrument

- WT230 (model: 760502, 760503)



Rack Mount

To rack mount the instrument, use the rack mount kit that is sold separately.

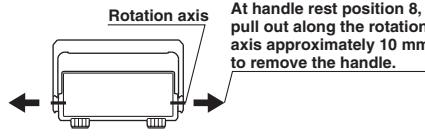
- Rack Mount Kit Model**

Specifications	Model	Specifications	Model
For WT210 EIA single mount	751533-E2	For WT230 EIA single mount	751533-E3
For WT210 JIS single mount	751533-J2	For WT230 JIS single mount	751533-J3
For WT210 EIA dual mount	751534-E2	For WT230 EIA dual mount	751534-E3
For WT210 JIS dual mount	751534-J2	For WT230 JIS dual mount	751534-J3

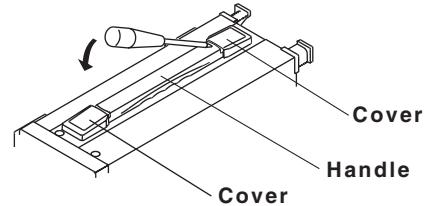
- Installation Procedure**

- Remove the handle. The handle on the WT210 is removed by rotating the handle to the handle rest position 8 (see the installation position figure on the previous page) and pulling out along the rotation axis approximately 10 mm. The handle on the WT230 is removed by removing the handle attachment cover and unfastening the handle attachment screws.

WT210 (model: 760401)



WT230 (model: 760502, 760503)



For details on the steps described below, see the instructions that are included with the rack mount kit.

- Remove the legs from the bottom panel of the instrument.
- Remove the seals from the side panels of the instrument.
- Attach the rack mount bracket.
- Attach the instrument to the rack.

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

To prevent the possibility of electric shock and damage to the instrument, follow the warnings below.



WARNING

- Employ protective earth ground before connecting measurement cables. The power cord that comes with the instrument is a three-pin type power cord. Connect the power cord to a properly grounded three-pin outlet.
- To ensure safety, if the current to be measured exceeds 7 A (RMS), use a cable or conductor that allows current greater than the current to be measured to flow through it, and always connect protective grounding prior to use of this instrument. For products shipped as of January 2004, the protective earth terminal is located* on the rear panel.
 - * If you need to confirm whether a protective earth terminal is installed, please contact the dealer from whom you purchased the instrument.
- Turn OFF the power to the object to be measured circuit (measurement circuit), when wiring the circuit. Connecting or removing measurement cables while the power is turned ON is dangerous.
- Take special caution not to wire a current measurement circuit to the voltage input terminal or a voltage measurement circuit to the current input terminal.
- Strip the insulation cover of the measurement cable so that when it is wired to the current input terminal, the conductive parts (bare wires) do not protrude from the terminal. Also, make sure to fasten the current input terminal screws securely so that the cable does not come loose.
- Use cables with safety terminals that cover the conductive parts for connecting to the voltage input terminals. Using a terminal with bare conductive parts (such as a banana plug) is dangerous when the terminal comes loose.
- Use cables with safety terminals that cover the conductive parts for connecting to the current sensor input connectors (external sensor input connectors). Using a terminal with bare conductive parts is dangerous when the connector comes loose.
- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the external sensor input connector. Since these terminals are electrically connected inside the instrument, this act is dangerous.
- When connecting measurement cables from an external current sensor to the external sensor input connector, remove the cables connected to the current input terminals. In addition, when the voltage of the circuit under measurement is being applied to the external sensor input connector, do not touch the current input terminals. Since these terminals are electrically connected inside the instrument, this act is dangerous.
- When using the external potential transformer (PT) or current transformer (CT), make sure it has enough withstand voltage with respect to the voltage (E) being measured (2E + 1000 V recommended). Also, make sure that the secondary side of the CT does not become an open circuit while the power is being applied. Otherwise, high voltage will appear at the secondary side of the CT, making it extremely dangerous.
- When using an external current sensor, make sure to use a sensor that comes in a case. The conductive parts and the case should be insulated, and the sensor should have enough withstand voltage with respect to the voltage being measured. Using a bare sensor is dangerous, because you might accidentally come in contact with it.

3.3 Wiring Precautions

- When using a shunt-type current sensor as an external current sensor, turn OFF the circuit under measurement. Connecting or removing a sensor while the power is ON is dangerous.
- When using a clamp-type current sensor as an external current sensor, have a good understanding of the voltage of the circuit under measurement and the specifications and handling of the clamp-type sensor. Then, confirm that there are no shock hazards.
- For safety reasons, when using the instrument on a rack mount, furnish a switch for turning OFF the circuit under measurement from the front side of the rack.
- After connecting the measurement cable, attach the current input protection cover for your safety. Make sure that the conductive parts are not exposed from the protection cover.
- To make the protective functions effective, check the following items before applying the voltage or current of the circuit under measurement.
 - The power cable provided with the instrument is used to connect to the power supply and the instrument is grounded.
 - The power switch of the instrument is turned ON.
 - The current input protective cover provided with the instrument is being used.
- When the power switch of the instrument is turned ON, do not apply a signal that exceeds the following values to the voltage or current input terminals.
When the instrument is turned OFF, turn OFF the circuit under measurement.
For other input terminals, see the specifications of each module in chapter 16.

Instantaneous Maximum Allowable Input (1 period, for 20 ms)

Voltage Input

Peak value of 2.8 kV or RMS value of 2.0 kV, whichever is less.

Current Input

5 mA to 200 mA range (2.5 mA to 100 mA range if the crest factor is set to 6) (WT210 only)

Peak value of 150 A or RMS value of 100 A, whichever is less.

0.5 A to 20 A range (0.25 A to 10 A range if the crest factor is set to 6) (common to WT210 and WT230)

Peak value of 450 A or RMS value of 300 A, whichever is less.

Continuous Maximum Allowable Input

Voltage Input

Peak value of 1.5 kV or RMS value of 1.0 kV, whichever is less.

Current Input

5 mA to 200 mA range (2.5 mA to 100 mA range if the crest factor is set to 6) (WT210 only)

Peak value of 30 A or RMS value of 20 A, whichever is less.

0.5 A to 20 A range (0.25 A to 10 A range if the crest factor is set to 6) (common to WT210 and WT230)

Peak value of 100 A or RMS value of 30 A, whichever is less.

- The voltage rating across the input (voltage and current) and ground on the WT230 varies depending on the operating conditions.
 - When protection cover is attached to the GP-IB or serial interface and external I/O connector
 - Voltage between input terminals and ground 600 Vrms max.
 - When protection cover is removed from the GP-IB or serial interface and external I/O connector or when the connector is used
 - Voltage between CURRENT, ± (VOLTAGE input and CURRENT) input terminals and ground
400 Vrms max.
 - Voltage between VOLTAGE input terminal and ground
600 Vrms max.



CAUTION

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

Example: When making measurements on a current of 20 A, use copper wires that have a conductive cross-sectional area of 4 mm².

Connecting to the Input Terminal

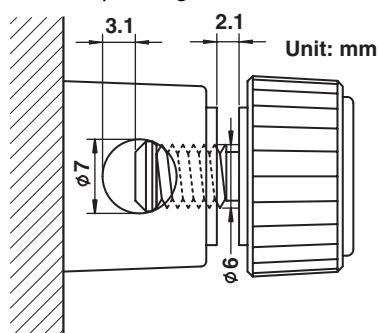
- **Voltage Input Terminal**

The terminal is a φ4-mm safety banana jack (female).

Insert the safety terminal (the conductive parts are not exposed) into the voltage input terminal.

- **Current Input Terminal**

- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the current sensor input terminals. Since these terminals are electrically connected inside the instrument, this act is dangerous.
- When connecting measurement cables from an external current sensor to the current sensor input connector, remove the cables connected to the current input terminals. In addition, when the voltage of the circuit under measurement is being applied to the current sensor input terminal, do not touch the current input terminals. Since these terminals are electrically connected inside the instrument, this act is dangerous.
- The terminal is a binding post. The screws used on the terminal (binding post) are M6 screws. Either wind the wire around the screw or pass the crimp-on lugs through the screw axis, then tighten firmly by holding the terminal knob. When doing so, make sure that no foreign objects are present in the contacts between the current input terminal and crimp-on lugs.
- Periodically check whether the current input terminal knob is loose, and whether any foreign objects are present in the contacts between the current input terminal and crimp-on lugs.



Note

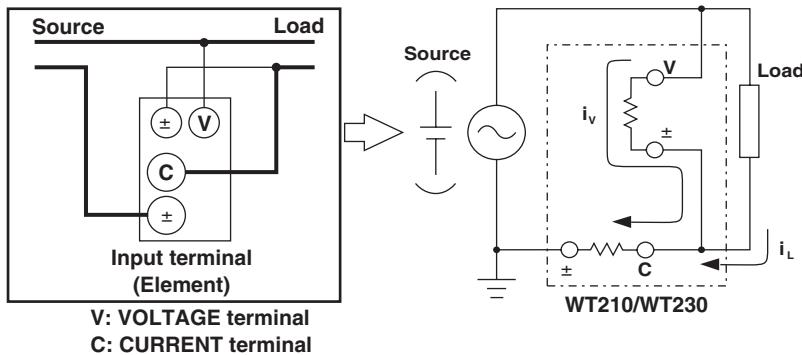
- On the WT230 (model: 760502, 760503), you must set the wiring system using the WIRING key after wiring the circuit. For the procedure, see section 3.10, "Selecting the Wiring System."
- When measuring large currents or voltages or currents that contain high frequency components, take special care in dealing with mutual interference and noise when wiring.
- Keep the measurement cables as short as possible to minimize the loss between the circuit under measurement and the instrument.
- The thick lines on the wiring diagrams shown in sections 3.7 and 3.9 are the sections where the current flows. Use appropriate wires that are suitable for the current.
- In order to make accurate measurements of the voltage of the circuit under measurement, connect the cable to the circuit as close as possible.
- In order to make correct measurements, separate the measurement cables as far away from the earth ground wires and the instrument's case as possible to minimize the static capacitance to earth ground.
- To more accurately measure apparent power and power factor in three-phase unbalanced circuits, we recommend the three-voltage three-current (3V3A) measurement method.

3.4 For Making Accurate Measurements

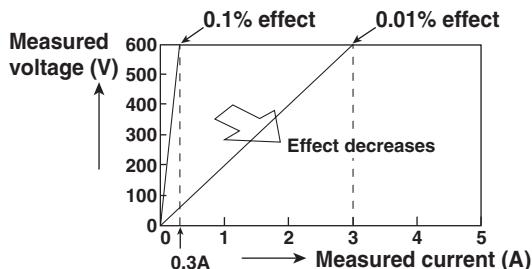
By wiring the circuit to match the load, you can minimize the effect of the power loss on the measurement accuracy. We will consider the current source (SOURCE) and load resistance (LOAD) below.

When the Measurement Current Is Relatively Large

Wire so that the voltage measurement circuit is connected to the load side. The current measurement circuit measures the sum of current i_L flowing through the load of the circuit under measurement and the current i_V flowing through the voltage measurement circuit. Because the current flowing through the circuit under measurement is i_L , i_V is the amount of error. For example, WT230's input resistance of the voltage measurement circuit of the instrument is approximately $2\text{ M}\Omega$. If the input is 600 V , i_V is approximately 0.3 mA ($600\text{ V}/2\text{ M}\Omega$). If the load current, i_L , is 300 mA or more (load resistance is $200\text{ }\Omega$ or less), then the effect of i_V on the measurement is 0.1% ($0.3\text{ mA}/300\text{ mA}$) or less. If the input is 600 V and 3 A , the effect on the measurement accuracy is 0.01% ($0.3\text{ mA}/3\text{ A}$).

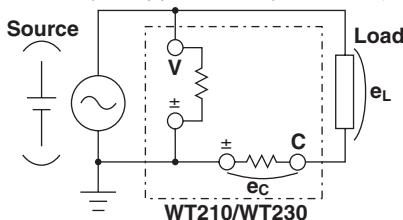


As a reference, the following figure shows the relationship between the voltage and current that cause 0.1% or 0.01% effect on the measurement accuracy.



When the Measurement Current Is Relatively Small

Wire so that the current measurement circuit is connected to the load side. In this case, the voltage measurement circuit measures the sum of the load voltage e_L and voltage drop e_C across the current measurement circuit. e_C is the amount of error in this case. For example, WT230's input resistance of the current measurement circuit is approximately $6\text{ m}\Omega$. If the load resistance is $600\text{ }\Omega$, the effect on the measurement accuracy is approximately 0.001% ($6\text{ m}\Omega/600\text{ }\Omega$).



3.5 Connecting the Power Supply

Before Connecting the Power

To prevent the possibility of electric shock and damage to the instrument, follow the warnings below.



WARNING

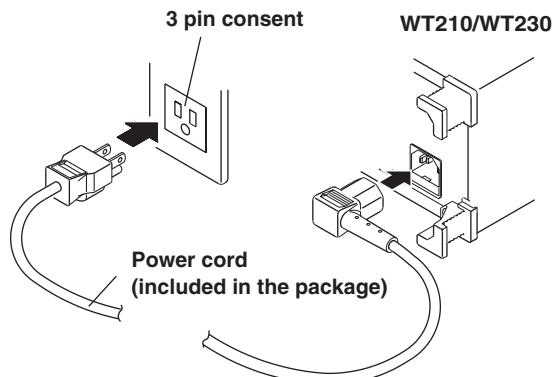
- Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the WT210/WT230 and that it is within the maximum rated voltage of the provided power cord.
- Connect the power cord after checking that the power switch of the instrument is turned OFF.
- To prevent the possibility of electric shock or fire, always use the power cord supplied by YOKOGAWA.
- Make sure to perform protective grounding to prevent the possibility of 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. Otherwise, the protection function will be compromised.

Connecting the Power Cord

1. Check that the power switch is OFF.
2. Connect the power cord plug to the power connector on the WT210/WT230. (Use the power cord that came with the package.)
3. Connect the plug on the other end of the power cord to the outlet that meets the conditions below. The AC outlet must be of a three-pin type with a protective earth ground terminal.

Item	Specifications
Rated supply voltage*	100 to 120 VAC/200 to 240 VAC
Permitted supply voltage range	90 to 132 VAC/180 to 264 VAC
Rated supply voltage frequency	50/60 Hz
Permitted supply voltage frequency range	48 to 63 Hz
Maximum power consumption	WT210: 35 VA, WT230: 55 VA

* The WT210/WT230 can use a 100-V or a 200-V system for the power supply. The maximum rated voltage of the power cord varies depending on its type. Check that the voltage supplied to the WT210/WT230 is less than or equal to the maximum rated voltage of the provided power cord (see page iii) before using it.



3.6 Turning ON/OFF the Power Switch and Opening Message

Points to Check before Turning ON the Power

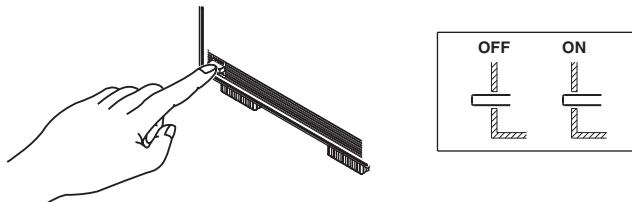
- Check that the instrument is installed properly (see section 3.2, "Installing the Instrument").
- Check that the power cord is connected properly (see section 3.5, "Connecting the Power Supply").
- Is the circuit under measurement wired properly (see sections 3.7, "Directly Wiring the Circuit under Measurement", 3.8, "Using an External PT or CT to Wire the Circuit under Measurement," and 3.9, "Using an External Sensor to Wire the Circuit under Measurement.")

Location of the Power Switch

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

Turning ON/OFF the Power Switch

The power switch is a push button. Press the button once to turn it "ON" and press it again to turn it "OFF."



Power Up Operation

A test program starts when the power switch is turned ON. The test programs checks various memories. If the test result is normal, an opening message as shown on the next page appears, and the WT210/WT230 is ready to make measurements.

If an error code remains on the display after the test program terminates, the WT210/WT230 will not operate properly. Turn OFF the power switch immediately and contact your nearest YOKOGAWA dealer. When contacting your dealer, please give them the model name, suffix code, and instrument No. written on the name plate on the side panel and the displayed error code.

Note

- If an error code appears, check the information in section 15.4, "Error Codes and Corrective Action" and perform the appropriate action.
- The warm-up time required to satisfy all specifications is approximately 30 minutes.

Shutdown Operation

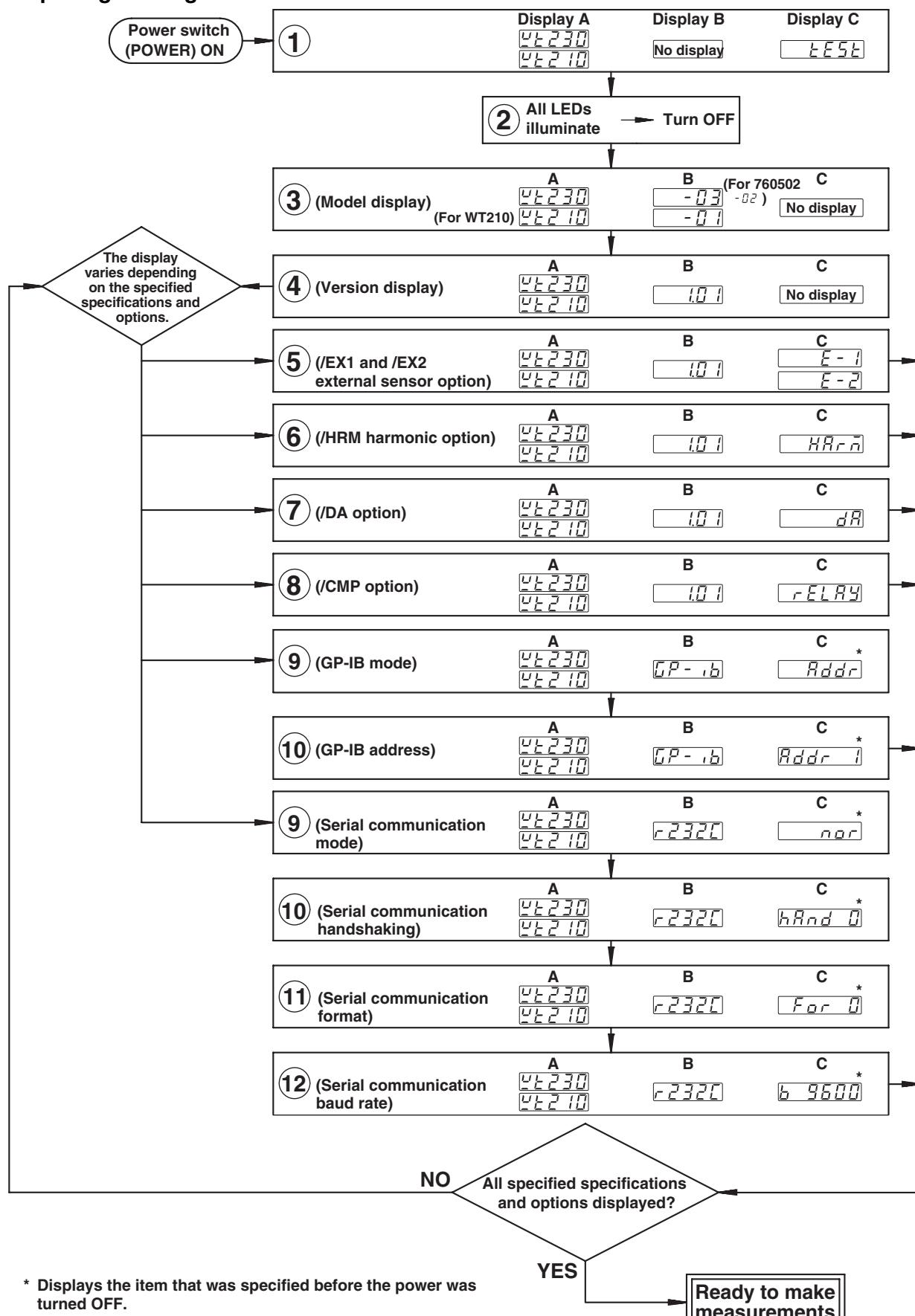
The setup parameters that exist immediately before the power switch is turned OFF are stored in memory. The same is true when the power cord gets disconnected from the outlet. The next time the power switch is turned ON, the instrument powers up using the stored setup parameters.

Note

A lithium battery is used to retain the setup parameters. If the lithium battery is low, error codes 60, 68, and 78 that indicate backup data failure (see section 15.4, "Error Codes and Corrective Actions") appear when the power switch is turned ON. If these error codes appear frequently, the lithium battery must be replaced quickly. The user cannot replace the battery. Contact your nearest YOKOGAWA dealer to have the battery replaced. For information regarding battery life, see section 15.6.

3.6 Turning ON/OFF the Power Switch and Opening Message

Opening Message



* Displays the item that was specified before the power was turned OFF.

3.7 Directly Wiring the Circuit under Measurement



WARNING

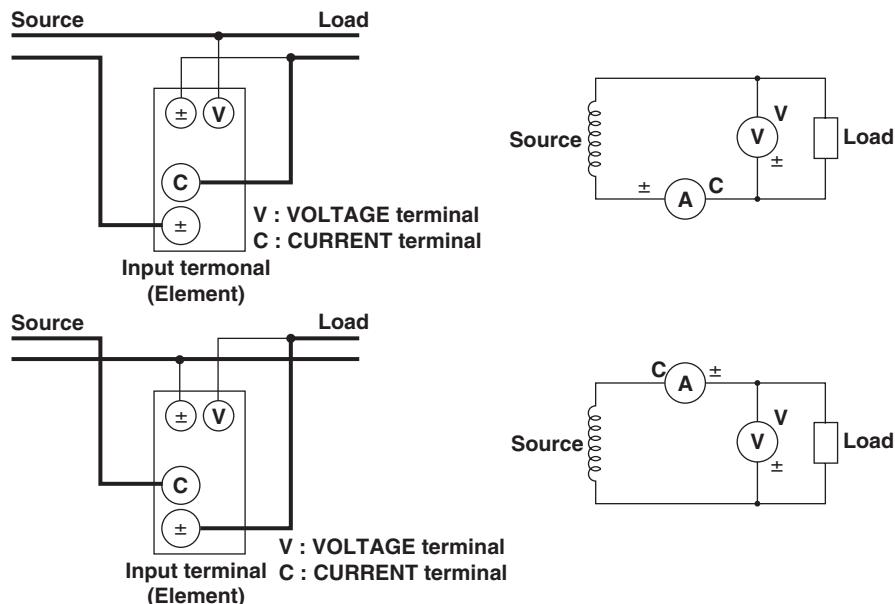
When measuring current by directly applying the current to flow through the current input terminals of the WT210/WT230, the voltage of the object to be measured appears at the external sensor input connector. To prevent the possibility of electric shock, remove the cable for measurements from the external sensor.



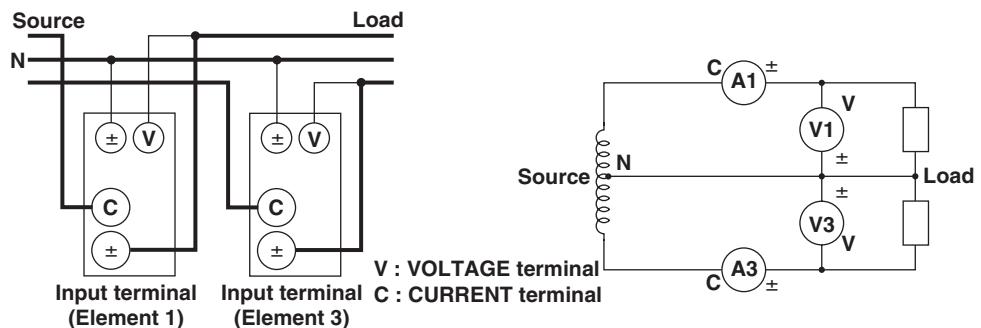
CAUTION

The measurement current flows through the thick lines in the figure below. Use wires with sufficient current capacity.

Wiring example of a single-phase, two-wire system (1P2W) ... Can be applied to models 760401, 760502, and 760503.



Wiring example of a single-phase, three-wire system (1P3W) ... Can be applied to models 760502, and 760503.

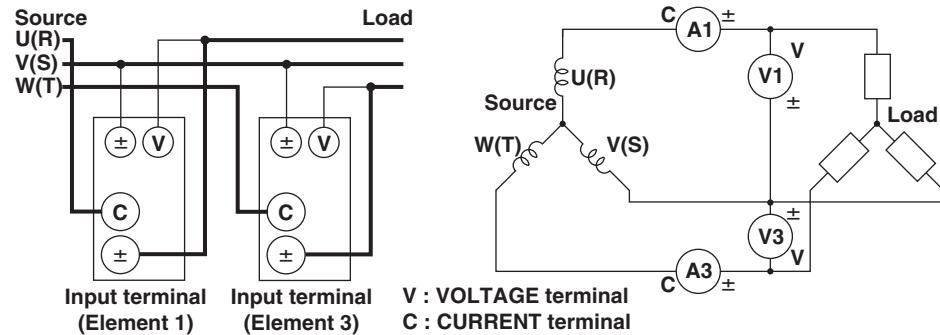


Note

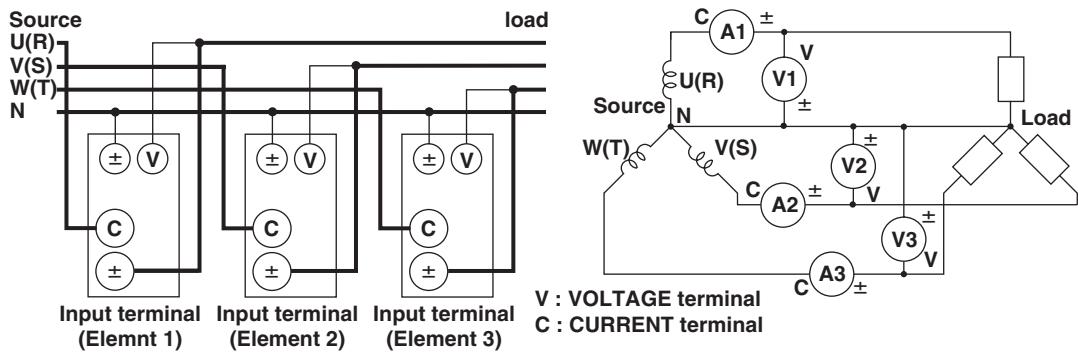
It is recommended that the wire connected from the source to the ± current terminal be routed as close as possible to the ground potential in order to minimize measurement error.

3.7 Directly Wiring the Circuit under Measurement

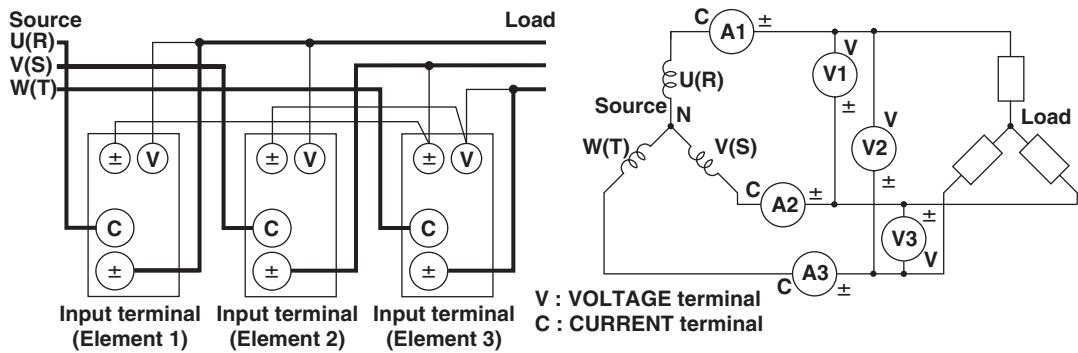
Wiring example of a three-phase, three-wire system (3P3W) ... Can be applied to models 760502, and 760503.



Wiring example of a three-phase, four-wire system (3P4W) ... Can be applied to model 760503.



Wiring example of a three-voltage, three-current system (3V3A) ... Can be applied to model 760503.



Note

- For the relationship between the wiring systems and the method of determining the measured values or computed values, see page 16-6.
- In 3P3W and 3V3A systems, the wiring system may be different between the WT210/230 and another product (another digital power meter) due to the differences in the input element that is wired. To achieve correct measurements, check the wiring system.

3.8 Using an External PT or CT to Wire the Circuit under Measurement



WARNING

When using an external CT, do not allow the secondary side of the CT to become an open circuit while current is flowing through the primary side. Otherwise, high voltage will appear at the secondary side of the CT, making it extremely dangerous.



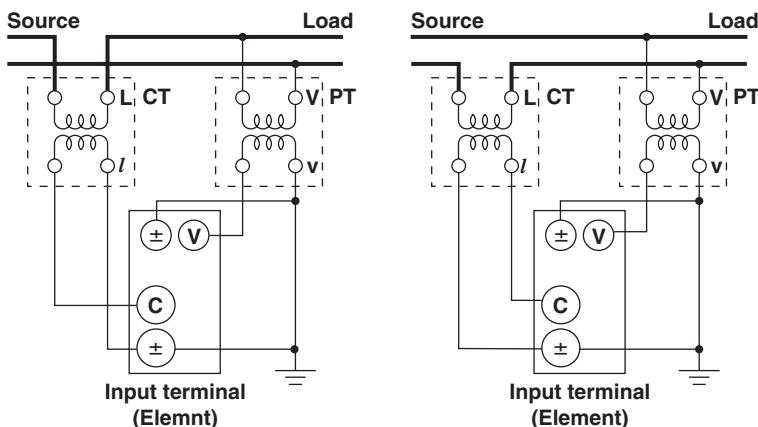
CAUTION

The measurement current flows through the thick lines in the figure below. Use wires with sufficient current capacity.

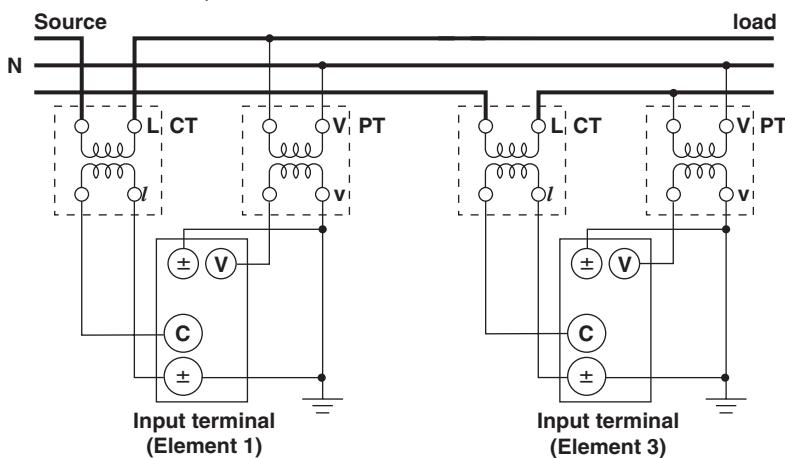
Use of a PT (or CT) enables measurement of voltage or current even if the maximum voltage or maximum current of the object to be measured exceeds the maximum measuring range.

- If the maximum voltage exceeds 600 V (300 V if the crest factor is set to 6), connect an external potential transformer (PT), and connect the secondary side of the PT to the voltage input terminals.
- If the maximum current exceeds 20 A (10 A if the crest factor is set to 6), connect an external current transformer (CT), and connect the secondary side of the CT to the current input terminals.

Wiring example of a single-phase, two-wire system (1P2W) when using a PT/CT... Can be applied to models 760401, 760502, and 760503.

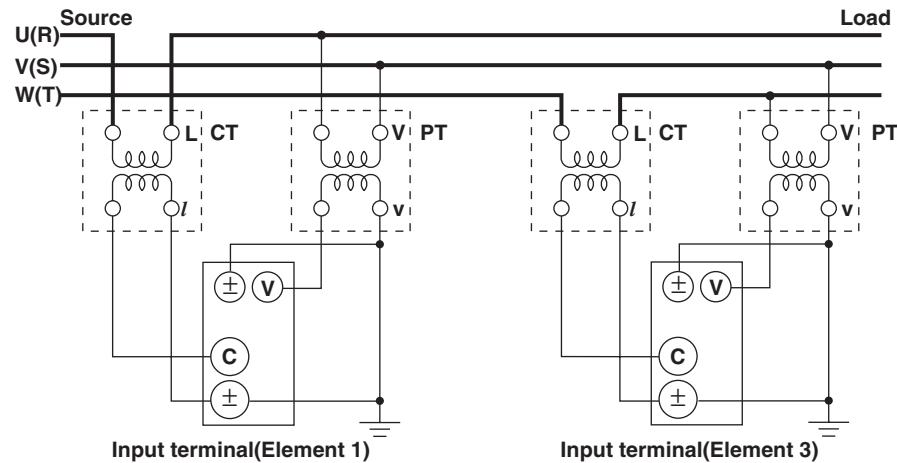


Wiring example of a single-phase, three-wire system (1P3W) when using a PT/CT... Can be applied to models 760502, and 760503.

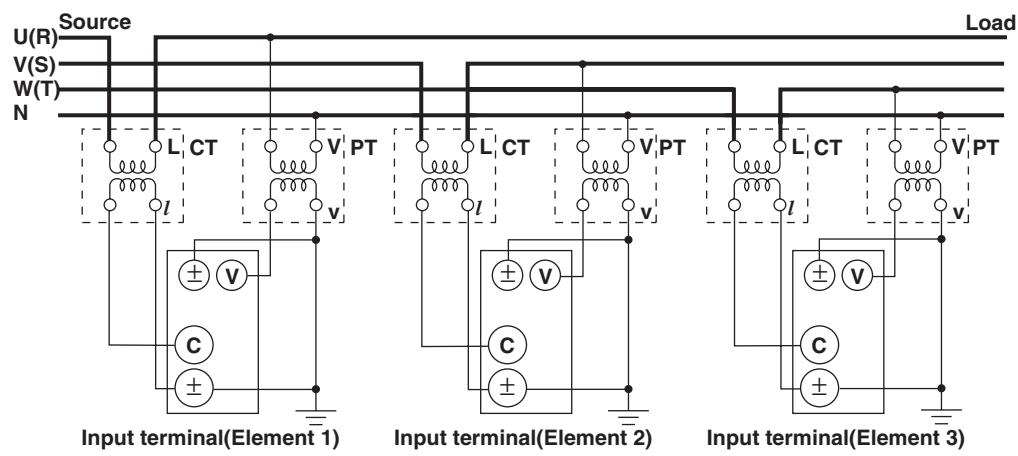


3.8 Using an External PT or CT to Wire the Circuit under Measurement

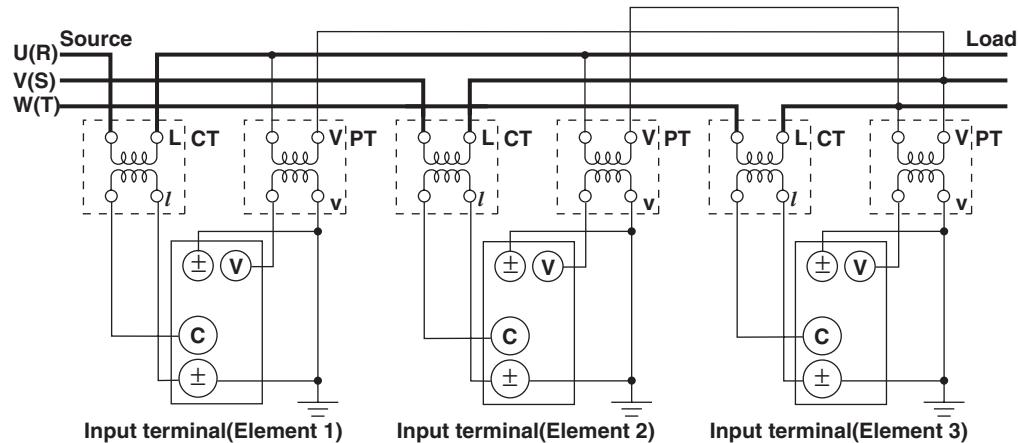
Wiring example of a three-phase, three-wire system (3P3W) when using a PT/CT... Can be applied to models 760502, and 760503.



Wiring example of a three-phase, four-wire system (3P4W) when using a PT/CT... Can be applied to model 760503.



Wiring example of a three-voltage, three-current system (3V3A) when using a PT/CT ... Can be applied to model 760503.



Note

- You can use the scaling function to directly read the measured values on the display. For the procedures, see section 4.5, "Setting the Scaling Constant when Using an External PT or CT."
- Note that the frequency and phase characteristics of the PT or CT affect the measured data.
- For safety reasons, this section indicates wiring diagrams in which the common terminals (+/- terminals) of the secondary side of the PT or CT are grounded.
- For the relationship between the wiring systems and the method of determining the measured values or computed values, see page 16-6.
- In 3P3W and 3V3A systems, the wiring system may be different between the WT210/230 and another product (another digital power meter) due to the differences in the input element that is wired. To achieve correct measurements, check the wiring system.

3.9 Using an External Sensor to Wire the Circuit under Measurement



WARNING

- When using an external sensor, make sure to use a sensor that comes in a case. The conductive parts and the case should be insulated, and the sensor should have enough withstand voltage with respect to the voltage being measured. Using a bare sensor is dangerous, because you might accidentally come in contact with it which results in electric shock.
- When using a shunt, do not wire while electricity is running. This act is extremely dangerous. Make sure to turn OFF the circuit under measurement. Voltage is applied to the shunt while electricity is running. Do not come in contact with it.
- 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 cables. 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.
- Use connectors with safety terminals that cover the conductive parts for connecting to the external sensor input terminals of the WT210/WT230. If the connector comes loose, voltage appears at the conductive parts making them extremely dangerous.

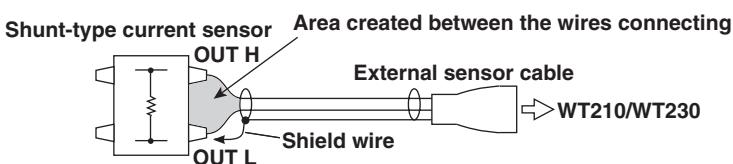


CAUTION

The measurement current flows through the thick lines in the wiring diagrams. Use wires with sufficient current capacity.

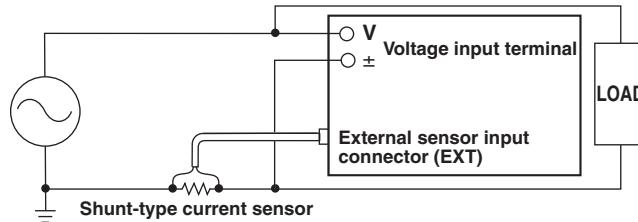
Note

- 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.
- To minimize error when using a shunt-type current sensor, note the following points when connecting the external sensor cable.
 - Connect the shielded wire of the external sensor cable to the L side of the shunt output terminal (OUT).
 - Minimize the area created between the wires connecting the current sensor to the external sensor cable. The effects due to the line of magnetic force (caused by the measurement current) and noise that enter this area of space can be reduced.

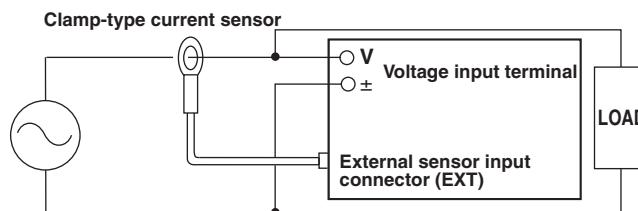


3.9 Using an External Sensor to Wire the Circuit under Measurement

- For a shunt-type current sensor, connect it to the power earth ground side as shown in the figure below. 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 mm²) 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).



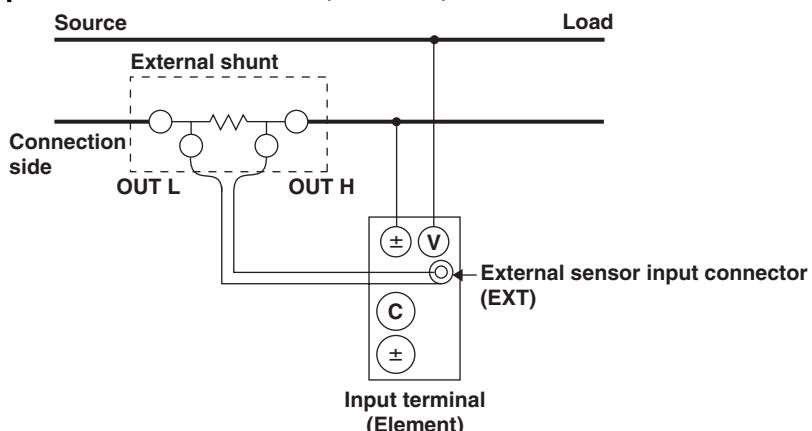
- Make sure you have the polarities correct when making the connections. Otherwise, the polarity of the measurement current will be reversed and correct measurements cannot be made. Be especially careful when connecting the clamp type current sensor, because it is easy to reverse the connection.
 - You 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 Value when External Sensor is Used (option)."
 - For the relationship between the wiring systems and the method of determining the measured values or computed values, see page 16-6.
-

3.9 Using an External Sensor to Wire the Circuit under Measurement

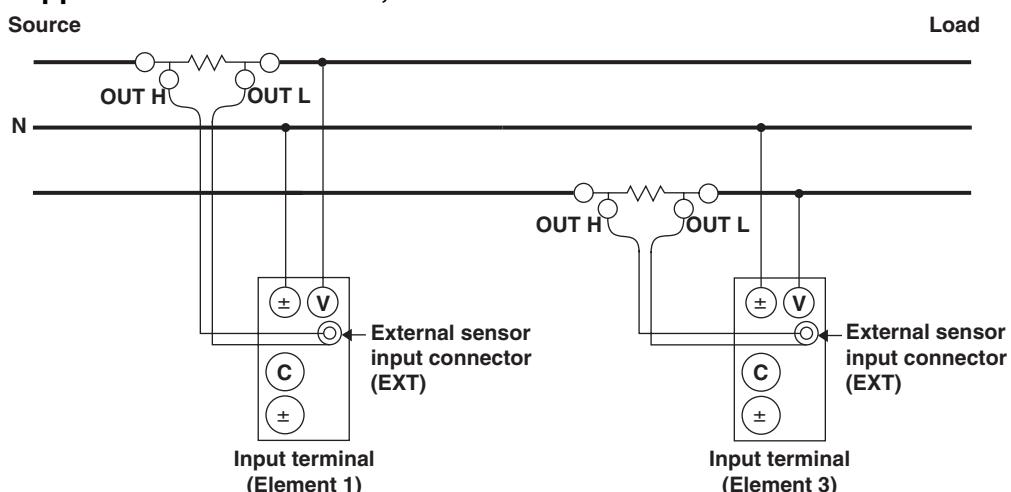
Connecting an external sensor enables measurements when the current of the object to be measured exceeds 20 A (10 A if the crest factor is set to 6). The range of the external sensor input of the WT210/WT230 comes in two types, one for 2.5, 5, and 10 V (1.25/2.5/5 V if the crest factor is set to 6) and another for 50, 100, and 200 mV (25/50/100 mV if the crest factor is set to 6). You can select either option.

The following wiring examples are for connecting external shunts. When connecting a clamp-type sensor, replace the shunt-type sensor with the clamp-type.

Wiring example of a single-phase, two-wire system (1P2W) when using an external shunt ... Can be applied to models 760401, 760502, and 760503.

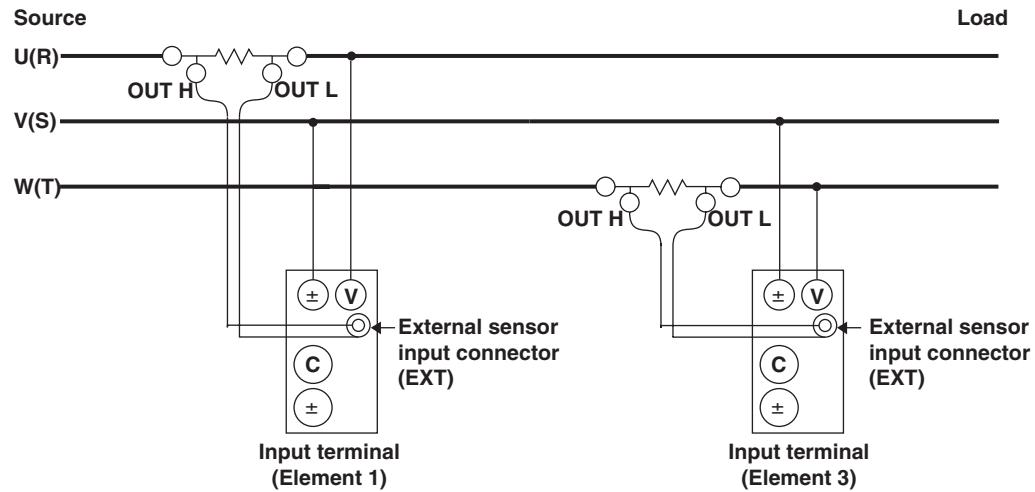


Wiring example of a single-phase, three-wire system (1P3W) when using an external shunt ... Can be applied to models 760502, and 760503.

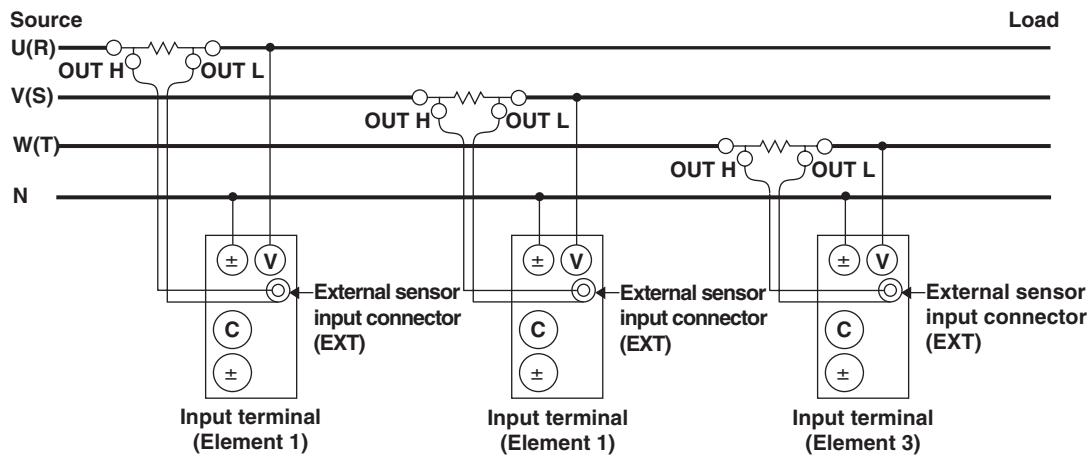


3.9 Using an External Sensor to Wire the Circuit under Measurement

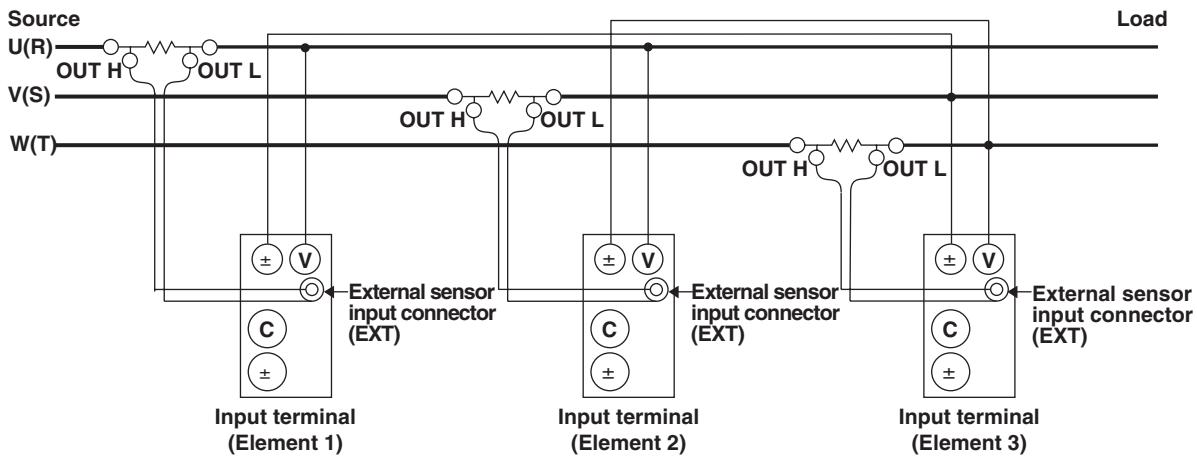
Wiring example of a three-phase, three-wire system (3P3W) when using an external shunt ... Can be applied to models 760502, and 760503.



Wiring example of a three-phase, four-wire system (3P4W) when using an external shunt ... Can be applied to model 760503.



Wiring example of a three-voltage, three-current system (3V3A) when using an external shunt ... Can be applied to model 760503.

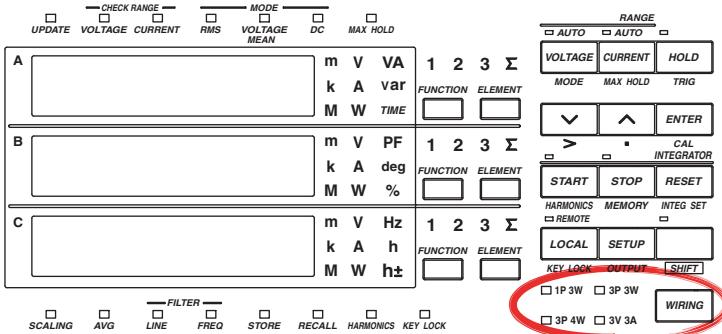


Note

In 3P3W and 3V3A systems, the wiring system may be different between the WT210/230 and another product (another digital power meter) due to the differences in the input element that is wired. To achieve correct measurements, check the wiring system.

3.10 Selecting the Wiring System (Applies Only to the WT230)

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Explanation

Wiring System

Press the WIRING key to select the wiring system. The selectable wiring systems vary depending on the model.

- **WT210 (model: 760401)**

There is no wiring system selection function. A single input element (Element 1) is installed. Measurement is possible only for the single-phase, two-wire system.

- **WT230 (model: 760502)**

The wiring system switches in the following order each time the WIRING key is pressed. Two input elements (Element 1 and Element 3) are installed.



1P3W : Single-phase, two-wire system

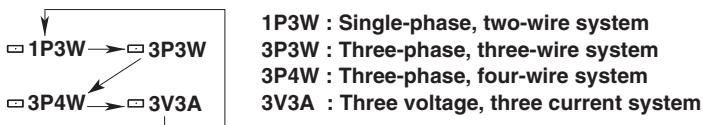
3P3W : Three-phase, three-wire system

3P4W 3V3A

*In case of a measurement circuit of single-phase, two-wire system, and having selected either element 1 or 3, selecting any of the above mentioned wiring methods will result in correct measurement/computation. However, the measurement/computation results in case element Σ has been selected lose the physical meaning.

- **WT230 (model: 760503)**

The wiring system switches in the following order each time the WIRING key is pressed. Three input elements (Element 1, Element 2, and Element 3) are installed.



1P3W : Single-phase, two-wire system

3P3W : Three-phase, three-wire system

3P4W : Three-phase, four-wire system

3V3A : Three voltage, three current system

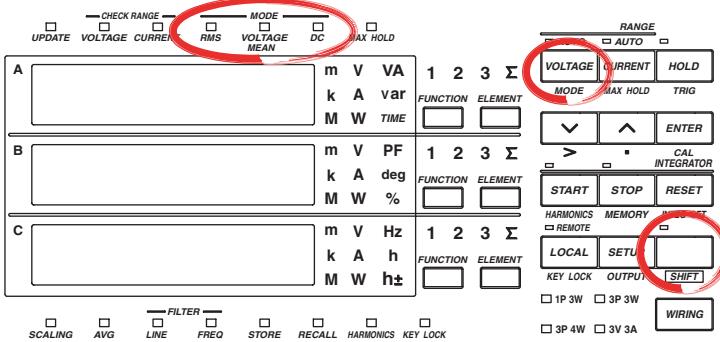
*In case of a measurement circuit of single-phase, two-wire system, and having selected either element 1 or 3, selecting any of the above mentioned wiring methods will result in correct measurement/computation. However, the measurement/computation results in case element Σ has been selected lose the physical meaning.

Note

Select the wiring system to match the circuit under measurement that is actually connected. The internal processing of the WT230 varies depending on the selected wiring system. If the selected wiring system does not match the actual circuit, measurements and computation will not be correct. For the relationship between the wiring systems and the method of determining the measured values or computed values, see page 16-6.

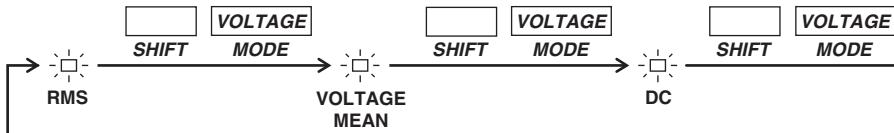
4.1 Selecting the Measurement Mode

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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
VOLTAGE 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

- **VOLTAGE 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.

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

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

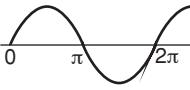
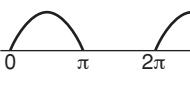
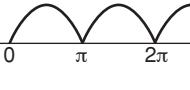
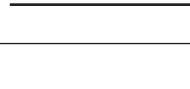
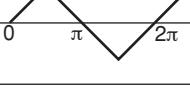
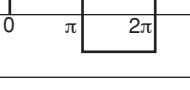
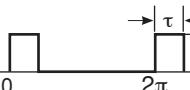
- **DC**

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

4.1 Selecting the Measurement Mode

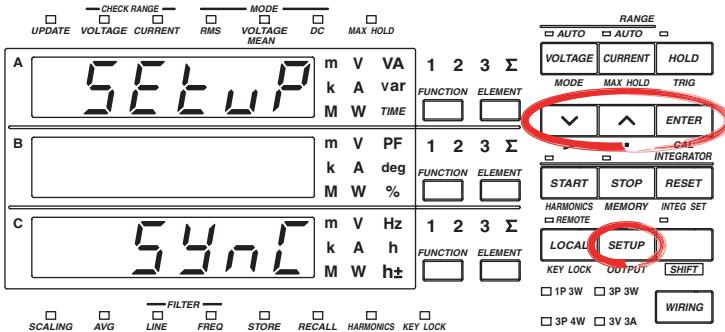
Typical Waveform Types and Differences in Measured Values between Measurement Modes

The WT210/WT230 does not support the mean value measurement mode shown in the table below.

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

4.2 Selecting the Measurement Synchronization Source

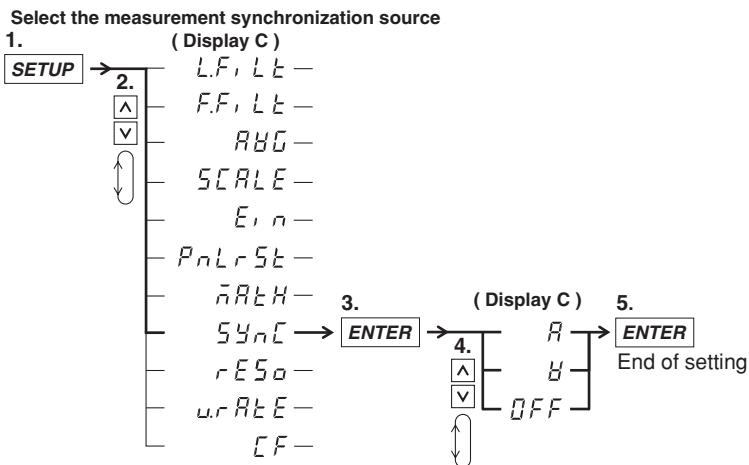
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.



4.2 Selecting 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 signal period to be used as the synchronization source. The current signal of each element is used as the synchronization source for the respective elements. If the period of the current signal cannot be detected, the voltage signal is made the synchronization source.

- V

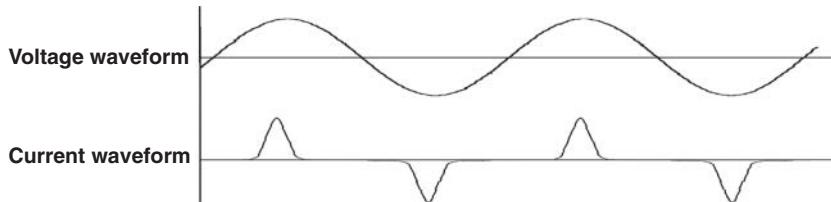
Priority is placed in detecting the voltage signal period to be used as the synchronization source. The voltage signal of each element is used as the synchronization source for the respective elements. If the period of the voltage signal cannot be detected, the current signal is made the synchronization source.

- oFF

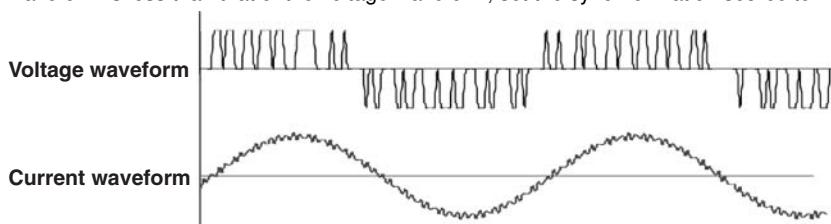
Measurement is not made by synchronizing to the voltage or current signal, but the sampled data over the entire period of the display update rate is averaged.

Note

- Select an input signal with stable input level and frequency (with little distortion) for the synchronization source. As a guideline, select a signal whose frequency can be stably measured.
For example if the object under test is a switching power supply and the distortion in the voltage waveform is less than that of the current waveform, set the synchronization source to V.



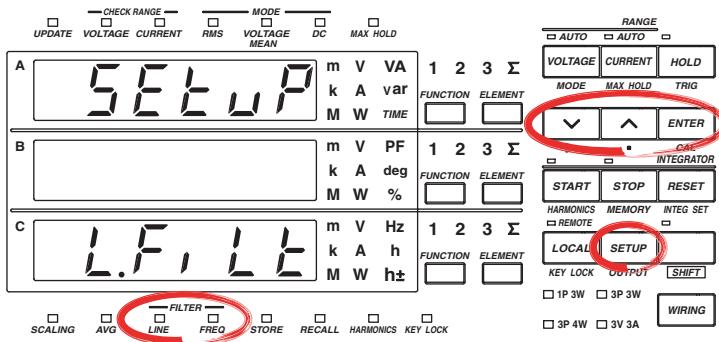
For example if the object under test is an inverter and the distortion in the current waveform is less than that of the voltage waveform, set the synchronization source to A.



- Zero cross is the timing at which the synchronization source crosses over (when rising or falling) the level zero (center value of the amplitude). Because it may be impossible to stabilize and calculate the zero cross if the synchronization source waveform is distorted and superimposed with harmonics and noise, the measured voltage and current values may be unstable. In this case, change the settings for the synchronization source, and turn ON the frequency filter. See section 4.3, for information on the frequency filter. As in the inverter example above, turn ON the frequency filter even if high frequency components were superimposed.
- When measuring DC signals, the measurement interval may be erroneous if noise crosses level zero and is recognized erroneously as a zero cross by the true signal. To avoid this, turn OFF the synchronization source. By turning the synchronization source OFF, sampling data from all intervals of the display update rate are used to calculate the measured values.
- If the period of the voltage or current signal cannot be detected even when "A" or "V" is selected, the sampled data over the entire period of the display update rate is averaged.

4.3 Turning ON/OFF the Input Filter

Keys

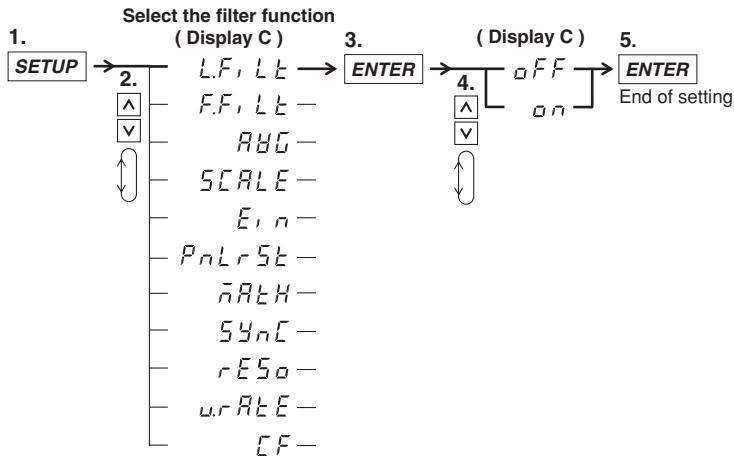


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

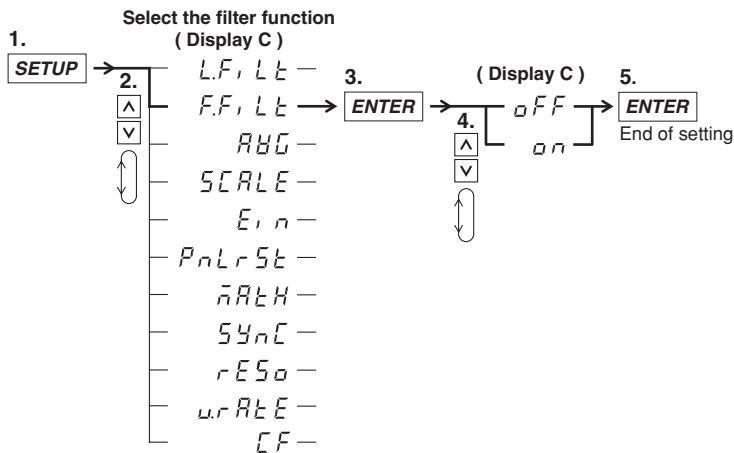
Procedure

- 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 ON/OFF the Line Filter



Turning ON/OFF the Frequency Filter



4.3 Turning ON/OFF the Input Filter

Explanation

The following two types of input filters are provided. The filters eliminates noise such as inverter waveforms and distorted waveforms and allow stable measured values to be obtained.

Line Filter

This filter is inserted only into the measurement circuit. It eliminates noise components of the input signal. The cutoff frequency is 500 Hz.

- on: Selecting on and pressing the ENTER key enables the line filter function and turns ON the LINE indicator.
- oFF: Selecting oFF and pressing the ENTER key disables the line filter function. The LINE indicator turns OFF.

Frequency Filter

This filter is inserted only into the frequency measurement circuit. The cutoff frequency is 500 Hz. Since the WT210/230 is making measurements in sync with the input signal, the frequency of the input signal must be measured correctly.

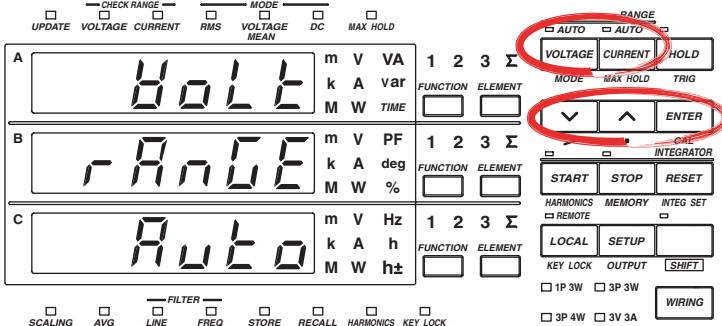
- on: Selecting on and pressing the ENTER key enables the frequency filter function and turns ON the FREQ indicator.
- oFF: Selecting oFF and pressing the ENTER key disables the frequency filter function. The FREQ indicator turns OFF.

Note

You cannot change the input filter ON/OFF setting when integration is started. You must stop and reset integration to do so.

4.4 Selecting the Measurement Range When Using Direct Input

Keys

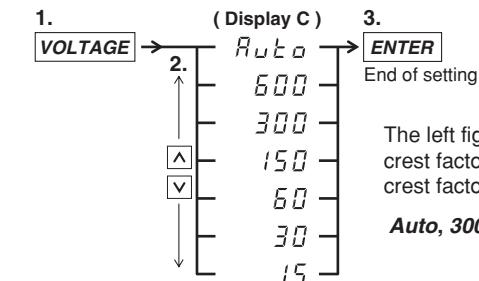


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 Voltage Range

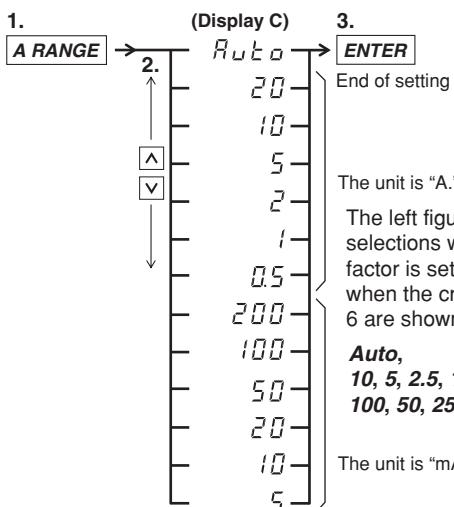


The left figure shows the selections when the crest factor is set 3. The selections when the crest factor is set to 6 are shown below.

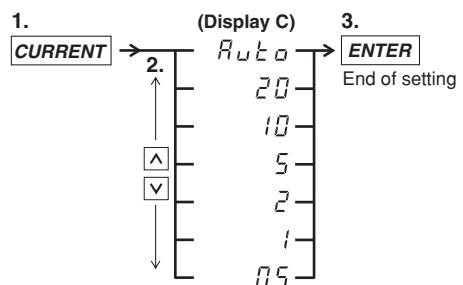
Auto, 300, 150, 75, 30, 15, 7.5

Setting the Current Range

On the WT210



On the WT230



Note

You cannot change to the minimum range by pressing the \wedge key from the auto range setting. Conversely, you cannot change to auto range by pressing the \vee key from the minimum range setting.

4.4 Selecting the Measurement Range When Using Direct Input

Explanation



WARNING

To ensure safe operation, if the current to be measured exceeds 7 A (rms value), use a cable or conductor that is capable of running a current higher than the current to be measured, and be sure to connect the protective earth before operating the instrument. The protective earth terminal is provided on the rear panel of products shipped in January 2004 and later.

Fixed Range (manual) versus Automatic Range (auto)

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

- **Fixed range**

Select the voltage range from the following:

- When the crest factor is set 3: 600, 300, 150, 60, 30, or 15 V
- When the crest factor is set 6: 300, 150, 75, 30, 15V, or 7.5 V

Select the current range from the following:

- When the crest factor is set to 3: 20, 10, 5, 2, 1, or 0.5 A (200 mA, 100 mA, 50 mA, 20 mA, 10 mA, and 5 mA are also selectable on the WT210)
- When the crest factor is set to 6: 10, 5, 2.5, 1, 0.5, or 0.25 A (100 mA, 50 mA, 25 mA, 10 mA, 5 mA, and 2.5 mA are also selectable on the WT210)

- **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:**

When the measured value of voltage or current (V or A) exceeds 130% of the rated range or when the peak value (instantaneous voltage or current value that is sampled) exceeds approximately 300% of the rated range, the range is increased the next time the measured value is updated. On the WT230, when any of the input elements meets the above condition, the range is increased the next time the measured value is updated.

- **Range down:**

When the measured value of the voltage or current is less than or equal to 30% of the rated range and the peak value is less than or equal to approximately 300% of the rated range of the next lower range, the range is decreased the next time the measured value is updated. On the WT230, when all of the input elements meet the above condition, the range is decreased the next time the measured value is updated.

Verifying the Range

To verify the current range setting press the VOLTAGE key or the CURRENT 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, 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 (1P2W)	voltage range × current range
single-phase, three-wire (1P3W)	
three-phase, three-wire (3P3W)	voltage range × current range × 2
three-voltage, three-current (3A3V)	
three-phase, four-wire (3P4W)	voltage range × current range × 3

4.4 Selecting the Measurement Range When Using Direct Input

- The maximum display is 99999 (when the number of displayed digits is set to 5).
- When the result of “voltage range × current range” exceeds 1000 W, the unit on the display will change to “kW”; When this result exceeds 1000 kW, the unit on the display will change to MW.

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 same ranges are set for apparent power (unit: VA) and reactive power (unit: var). Just replace the unit with VA or var when looking at the tables.
- The following table shows the case when the number of displayed digits is five. When the number of displayed digits is set to four, one digit is subtracted to the lowest digit of the values in the table. For selecting the number of displayed digits, see section 4.13.

On the WT230

- When the crest factor is set to 3

Wiring System	Voltage Range (V)	Current Range					
		500.00 mA	1.0000 A	2.0000 A	5.0000 A	10.000 A	20.000 A
Single-phase, two-wire (1P2W)	15.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
	30.000	15.000 W	30.000 W	60.000 W	150.00 W	300.00 W	600.00 W
	60.000	30.000 W	60.000 W	120.00 W	300.00 W	600.00 W	1.2000 kW
	150.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW
	300.00	150.00 W	300.00 W	600.00 W	1.5000 kW	3.0000 kW	6.0000 kW
	600.00	300.00 W	600.00 W	1.2000 kW	3.0000 kW	6.0000 kW	12.000 kW
Single-phase, three-wire (1P3W),	15.000	15.000 W	30.000 W	60.000 W	150.00 W	300.00 W	600.00 W
	30.000	30.000 W	60.000 W	120.00 W	300.00 W	600.00 W	1.2000 kW
Three-phase, three-wire (3P3W),	60.000	60.000 W	120.00 W	240.00 W	600.00 W	1.2000 kW	2.4000 kW
	150.00	150.00 W	300.00 W	600.00 W	1.5000 kW	3.0000 kW	6.0000 kW
Three voltage, three current (3V3A)	300.00	300.00 W	600.00 W	1.2000 kW	3.0000 kW	6.0000 kW	12.000 kW
	600.00	600.00 W	1.2000 kW	2.4000 kW	6.0000 kW	12.000 kW	24.000 kW
Three-phase, four-wire (3P4W)	15.000	22.500 W	45.000 W	90.000 W	225.00 W	450.00 W	900.00 W
	30.000	45.000 W	90.000 W	180.00 W	450.00 W	900.00 W	1.8000 kW
	60.000	90.000 W	180.00 W	360.00 W	900.00 W	1.8000 kW	3.6000 kW
	150.00	225.00 W	450.00 W	900.00 W	2.2500 kW	4.5000 kW	9.0000 kW
	300.00	450.00 W	900.00 W	1.8000 kW	4.5000 kW	9.0000 kW	18.000 kW
	600.00	900.00 W	1.8000 kW	3.6000 kW	9.0000 kW	18.000 kW	36.000 kW

- When the crest factor is set to 6

Wiring System	Voltage Range (V)	Current Range					
		250.00 mA	500 MA	1.0000 A	2.5000 A	5.0000 A	10.000 A
Single-phase, two-wire (1P2W)	7.5000	1.8750 W	3.7500 W	7.5000 W	18.750 W	37.500 W	75.000 W
	15.000	3.7500 W	7.5000 W	15.000 W	37.500 W	75.000 W	150.00 W
	30.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
	75.000	18.750 W	37.500 W	75.000 W	187.50 W	375.00 W	750.00 W
	150.00	37.500 W	75.000 W	150.00 W	375.00 W	750.00 W	1.5000 kW
	300.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW
Single-phase, three-wire (1P3W),	7.5000	3.7500 W	7.5000 W	15.000 W	37.500 W	75.000 W	150.00 W
	15.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
Three-phase, three-wire (3P3W),	30.000	15.000 W	30.000 W	60.000 W	150.00 W	300.00 W	600.00 W
	75.000	37.500 W	75.000 W	150.00 W	375.00 W	750.00 W	1.5000 kW
Three voltage, three current (3V3A)	150.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW
	75.000	150.00 W	300.00 W	600.00 W	1.5000 kW	3.0000 kW	6.0000 kW
Three-phase, four-wire (3P4W)	7.5000	5.6250 W	11.250 W	22.500 W	56.250 W	112.50 W	225.00 W
	15.000	11.250 W	22.500 W	45.000 W	112.50 W	225.00 W	450.00 W
	30.000	22.500 W	45.000 W	90.000 W	225.00 W	450.00 W	900.00 W
	75.000	56.250 W	112.50 W	225.00 W	562.50 W	1.1250 kW	2.2500 kW
	150.00	112.50 W	225.00 W	450.00 W	1.1250 kW	2.2500 kW	4.5000 kW
	300.00	225.00 W	450.00 W	900.00 W	2.2500 kW	4.5000 kW	9.0000 kW

4.4 Selecting the Measurement Range When Using Direct Input

On the WT210

- When the crest factor is set to 3

Voltage	Current Range					
Range (V)	500.00 mA	1.0000 A	2.0000 A	5.0000 A	10.000 A	20.000 A
15.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
30.000	15.000 W	30.000 W	60.000 W	150.00 W	300.00 W	600.00 W
60.000	30.000 W	60.000 W	120.00 W	300.00 W	600.00 W	1.2000 kW
150.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW
300.00	150.00 W	300.00 W	600.00 W	1.5000 kW	3.0000 kW	6.0000 kW
600.00	300.00 W	600.00 W	1.2000 kW	3.0000 kW	6.0000 kW	12.000 kW

Voltage	Current Range					
Range (V)	5.0000 mA	10.000 mA	20.000 mA	50.000 mA	100.00 mA	200.00 mA
15.000	75.000 mW	150.00 mW	300.00 mW	750.00 mW	1.5000 W	3.0000 W
30.000	150.00 mW	300.00 mW	600.00 mW	1.5000 W	3.0000 W	6.0000 W
60.000	300.00 mW	600.00 mW	1.2000 W	3.0000 W	6.0000 W	12.000 W
150.00	750.00 mW	1.5000 W	3.0000 W	7.5000 W	15.000 W	30.000 W
300.00	1.5000 W	3.0000 W	6.0000 W	15.000 W	30.000 W	60.000 W
600.00	3.0000 W	6.0000 W	12.000 W	30.000 W	60.000 W	120.00 W

- When the crest factor is set to 6

Voltage	Current Range					
Range (V)	250.00 mA	500.00 mA	1.0000 A	2.5000 A	5.0000 A	10.000 A
7.5000	1.8750 W	3.7500 W	7.5000 W	18.750 W	37.500 W	75.000 W
15.000	3.7500 W	7.5000 W	15.000 W	37.500 W	75.000 W	150.00 W
30.000	7.5000 W	15.000 W	30.000 W	75.000 W	150.00 W	300.00 W
75.000	18.750 W	37.500 W	75.000 W	187.50 W	375.00 W	750.00 W
150.00	37.500 W	75.000 W	150.00 W	375.00 W	750.00 W	1.5000 kW
300.00	75.000 W	150.00 W	300.00 W	750.00 W	1.5000 kW	3.0000 kW

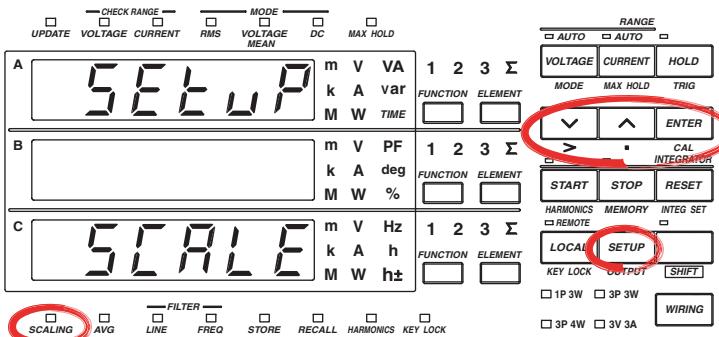
Voltage	Current Range					
Range (V)	2.5000 mA	5.0000 mA	10.000 mA	25.000 mA	50.000 mA	100.00 mA
7.5000	18.750 mW	37.500 mW	75.000 mW	187.50 mW	375.00 mW	750.00 mW
15.000	37.500 mW	75.000 mW	150.00 mW	375.00 mW	750.00 mW	1.5000 W
30.000	75.000 mW	150.00 mW	300.00 mW	750.00 mW	1.5000 W	3.0000 W
75.000	187.50 mW	375.00 mW	750.00 mW	1.8750 W	3.7500 W	7.5000 W
150.00	375.00 mW	750.00 mW	1.5000 W	3.7500 W	7.5000 W	15.000 W
300.00	750.00 mW	1.5000 W	3.0000 W	7.5000 W	15.000 W	30.000 W

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.
- If you open the voltage input terminal, a voltage value of up to 0.3 V may be displayed due to hum noise and other phenomena. This is because of the high input resistance of the voltage input terminal. Shorting the terminal will result in a value of 0 V.

4.5 Setting the Scaling Value When External PT/CT is Used

Keys

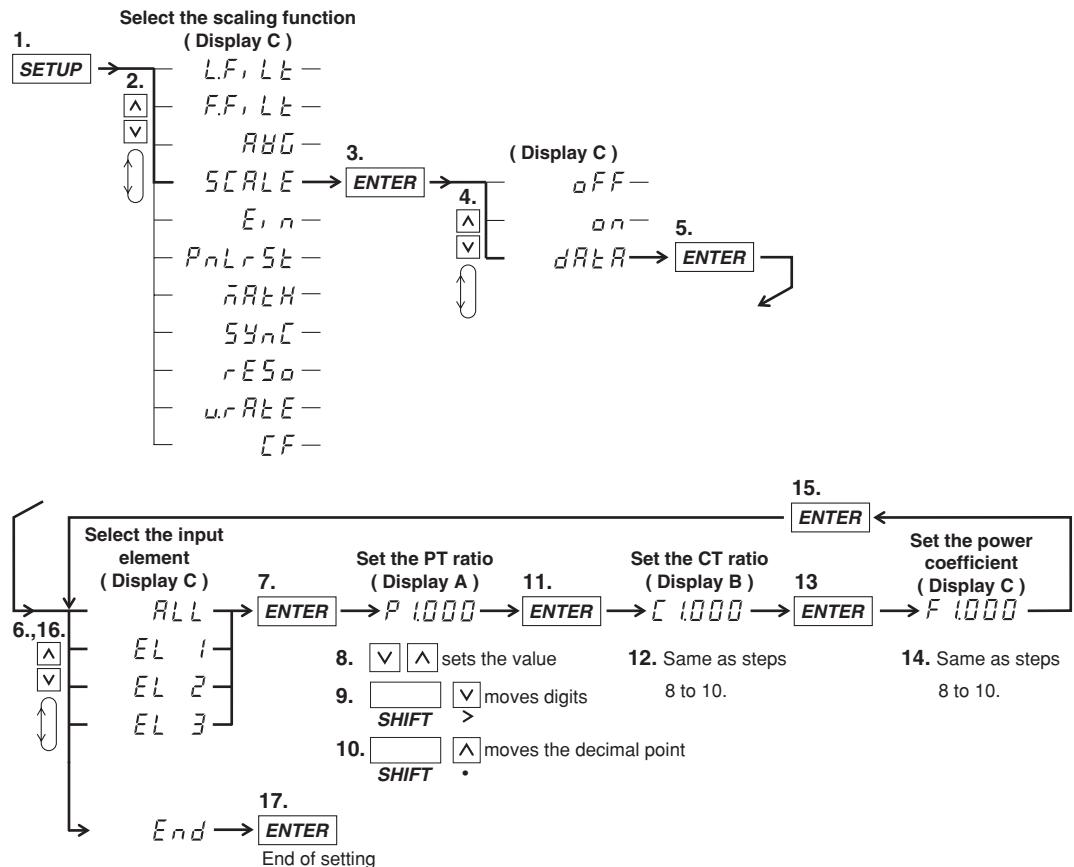


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

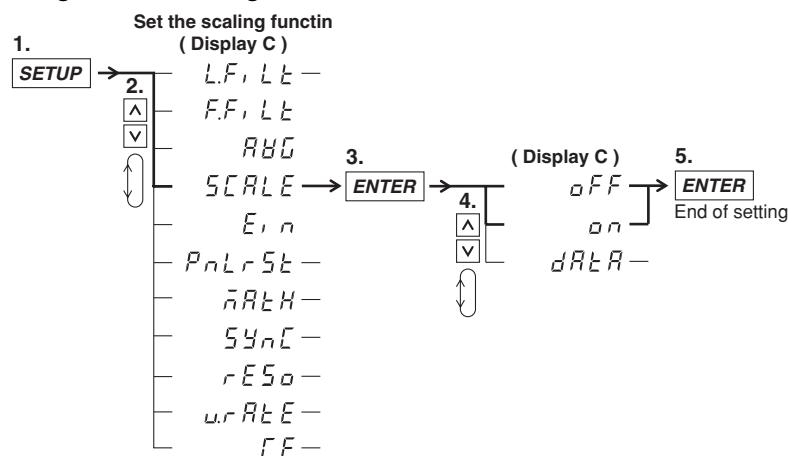
- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

Setting the Scaling Constant



4.5 Setting the Scaling Value When External PT/CT is Used

Turning ON/OFF Scaling



Explanation

Scaling Function

This function is useful for measuring voltage, current, power and such when you are using an external potential transformer (PT), current transformer (CT) or such, and have connected their secondary side outputs to the input elements. You set the scaling value to the PT ratio, CT ratio or power coefficient. When the scaling function is turned ON, measured values which have been converted to the corresponding values for the transformer primary sides, can be displayed or otherwise output.

Measured/computed value	Scaled result	
Voltage V	$P \times V$	P: Voltage scaling constant
Current A	$C \times A$	C: Current scaling constant
Active power W	$F \times P \times C \times W$	F: Power scaling constant
Reactive power var	$F \times P \times C \times \text{var}$	
Apparent power VA	$F \times P \times C \times VA$	

Selecting the Input Element

This setting is to select to which element scaling will be applied. The initial value is "ALL". At the WT210, this selection menu will not appear.

- ALL: Select this when the same scaling constant should be applied to all elements together.
- EL1: Select this when the scaling constant should only be applied to element 1.
- EL2: Select this when the scaling constant should only be applied to element 2. This selection will not appear on model 760502.
- EL3: Select this when the scaling constant should only be applied to element 3.
- End: Select this when you finished the setting, or when you want to abort the setting.

Setting the Scaling Constant

The scaling constant 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 value on display C

In case of the WT210, pressing the ENTER key after setting P, C and F respectively will end this scaling setting. In case of the WT230, selecting End at the input element menu will end this scaling setting.

Turning Scaling ON/OFF

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

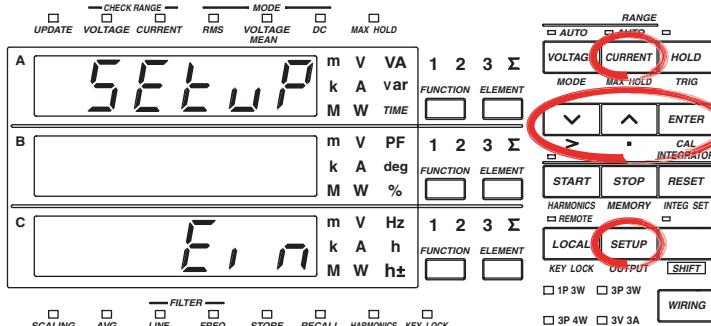
- on: Selecting on and pressing the ENTER key will start scaling and the SCALING indicator will light.
- oFF: Selecting oFF and pressing the ENTER key will stop scaling and SCALING indicator will extinguish.

Note

If scaling constant × measurement range exceeds 9999M(10^6), computation overflow (--OF-) is indicated.

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

Keys

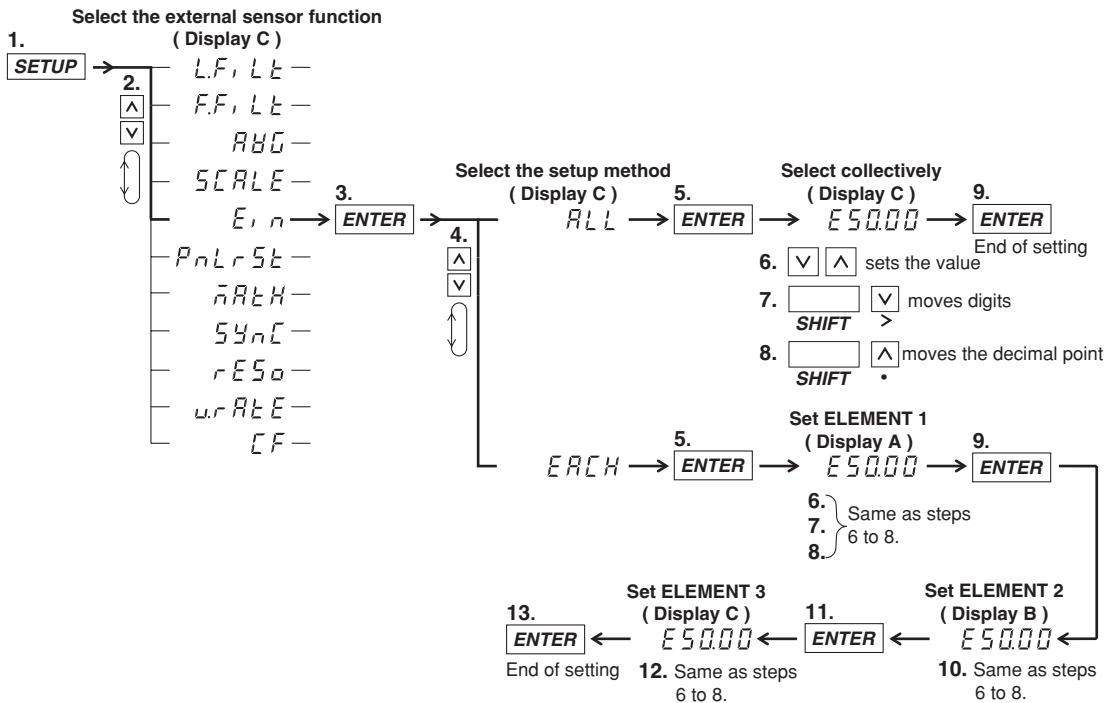


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 Constant of the External Sensor Input

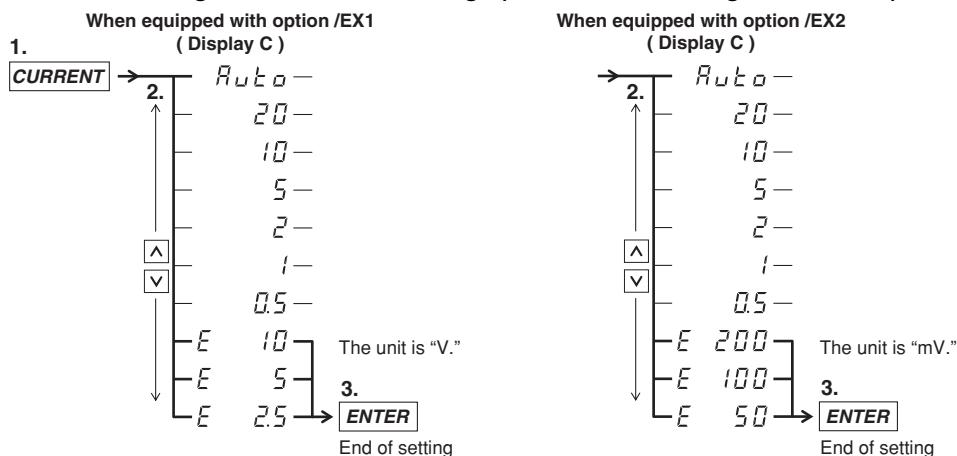


Note

The setup method menu (All/Each) does not appear on the WT210.

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

Selecting the Measurement Range (Current with Scaling Function ON)



The above figure shows the selections when the crest factor is set 3. The selections when the crest factor is set to 6 are shown below.

**Auto, 10, 5, 2.5, 1, 0.5, 0.25,
E 5, E 2.5, E 1.25**

The above figure shows the selections when the crest factor is set 3. The selections when the crest factor is set to 6 are shown below.

**Auto, 10, 5, 2.5, 1, 0.5, 0.25,
E 100, E 50, E 25**

The menu above is for the WT230. The WT210 displays mA range followed by the external sensor range (mV or V unit).

Explanation

Scaling Function in combination with External Sensor Input

This function is used when measuring the voltage or current by installing an external sensor and connecting its output to the input element of the WT210/WT230.

Setting Example of Scaling Constant for External Sensor Input

- In case the rated specs of the external sensor are 50 A/50 mV, measurement range is 50 mV, then
 $50 \text{ A}/50 \text{ mV} \times 50 \text{ mV} = 50 \text{ A}$: 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
 $100 \text{ A}/50 \text{ mV} \times 50 \text{ mV} = 100 \text{ A}$: 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
 $50 \text{ A}/80 \text{ mV} \times 50 \text{ mV} = 31.25 \text{ A}$: scaling constant is 31.25
However, since the setting range is 50 mV, use a setting within the 0 to 50 mV range.

This instrument uses this scaling coefficient in calculations like the ones below to obtain current values for display or output as data.

$$\text{Current value} = \frac{\text{Output voltage of the external sensor} \times \text{Scaling constant}}{\text{Measurement range value for the external sensor}}$$

The current value is used to determine the active power, reactive power, and apparent power to be displayed or output as data. The scaling function explained here is completely different from the PT/CT scaling function explained in the previous section.

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

Selecting the Setting Format of the Scaling Constant

You can select the setting format on the WT230. The following two setting formats are available. The initial value is “ALL”. A

- ALL: Select this when the same scaling constant should be applied to all elements together.
- EACH: Select this when the scaling constant should only be applied to each element separately.

Setting the Scaling Constant

The procedure to set the scaling constant depends on the setting format (previous setting). The setting ranges from 0.001 to 9999. The initial value is 50.00. In case of the WT210, the scaling constant is set at display C.

- When ALL is selected:

The scaling constant set at display C will be applied to all elements together.

- When EACH is selected:

- The scaling constant set at display A will be applied to element 1 only.
- The scaling constant set at display B will be applied to element 2 only. This selection will not appear on model 760502.
- The scaling constant set at display C will be applied to element 3 only.

After having selected ALL or EACH and entered the scaling constant, press the ENTER key to end this scaling setting.

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

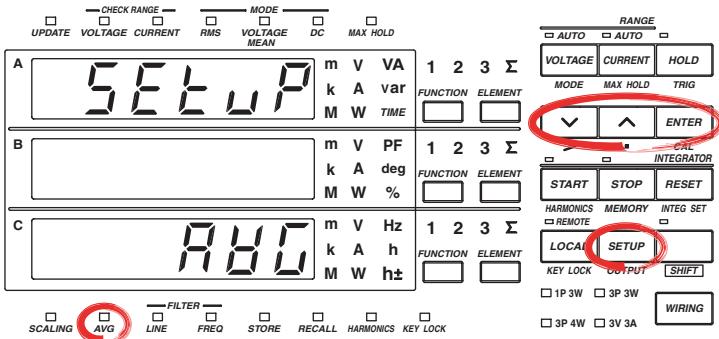
After having set the scaling constant, select the menu for the current measurement range. Select the rated output of the external sensor from this menu (refer to the Operating Procedure on the previous page). Scaling of the external sensor input will start as soon as you press the ENTER key after selecting.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

Note

- When performing measurements using the external sensor, and the scaling function for the external PT/CT turned ON, the PT/CT scaling constant will interfere.
- The input range for the external sensor can only be of the manual type. There is no auto range function.
- 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

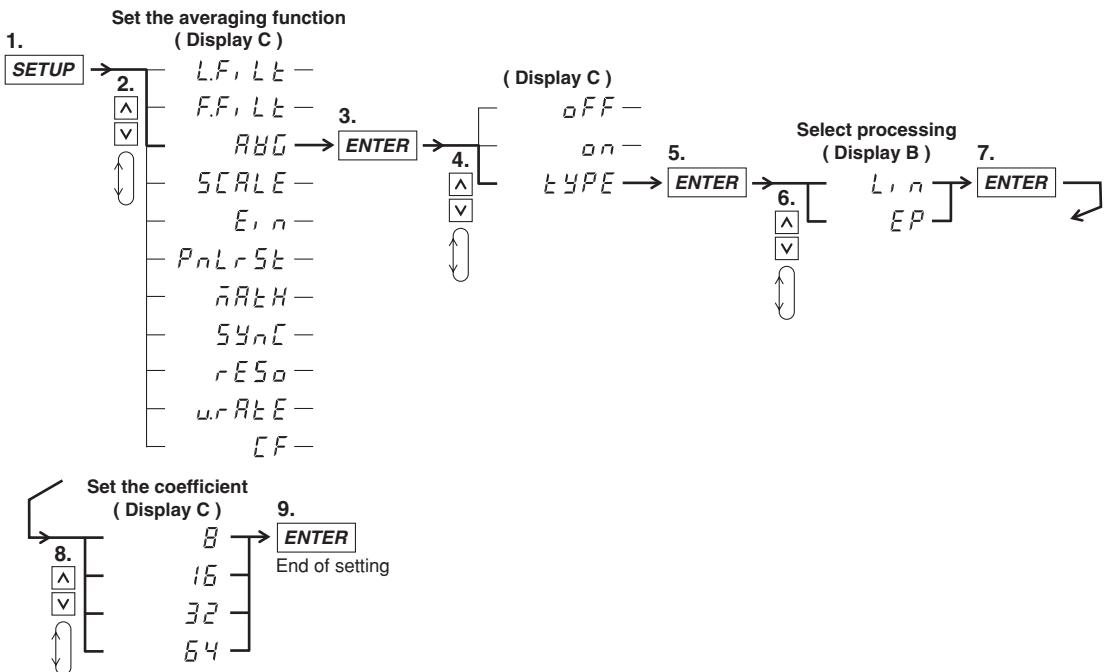


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

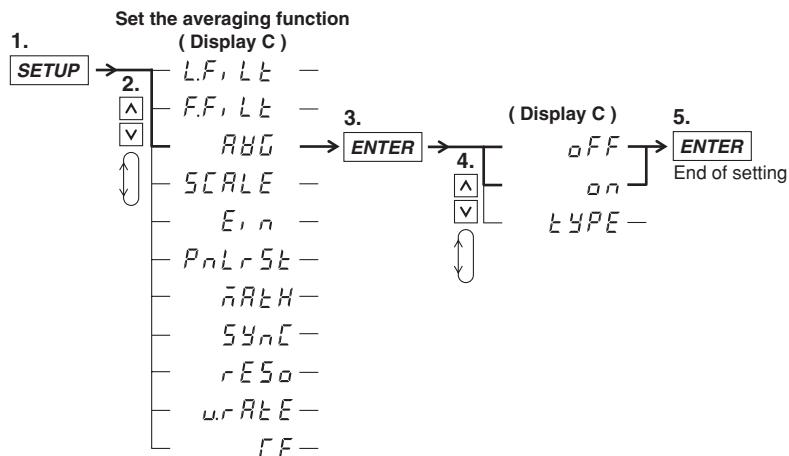
Procedure

- 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



Setting 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. The measurement items that are averaged directly are V (voltage), A (current), and W (active power). When using those measured V, A, and W values to calculate other measurement items, those items receive the effects of the averaging. Since certain values would lose their meaning if they were averaged (such as the peak (Vpk, Apk) values), averaging is not performed on them.

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.

$$D = D_{n-1} + (M_n - D_{n-1})/K$$

where

D_n : the value at the n^{th} display;

D_{n-1} : the exponentially averaged value at the $n-1^{\text{th}}$ 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.

$$D_n = (M_{n-(m-1)} + M_{n-(m-2)} + \dots + M_{n-2} + M_{n-1} + M_n)/m$$

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 initial value is "8".
8, 16, 32, or 64

Setting Averaging ON/OFF

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

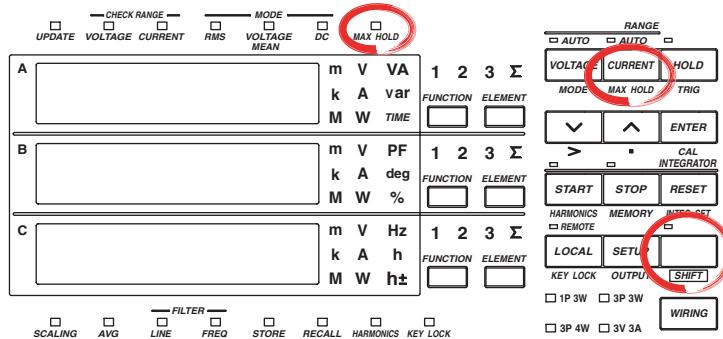
- on: Selecting on and pressing the ENTER key will start averaging and the AVG indicator will light.
- oFF: Selecting oFF and pressing the ENTER key will stop averaging and the AVG indicator will extinguish.

Note _____

- The average coefficient is common to exponential average and moving average. If you change the averaging process, change the averaging coefficient also.
 - The averaging function that can be used during harmonic measurement is exponential averaging. The attenuation constant is fixed to 8. Therefore, the setup procedure explained in this section is valid only during normal measurement.
 - The averaging function turns OFF when integration is started. It does not turn back ON even if integration is stopped and reset.
-

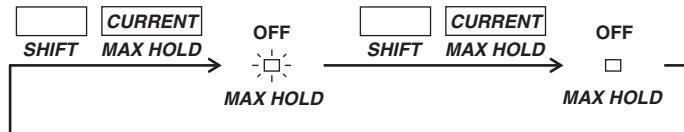
4.8 Using the MAX Hold Function

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure



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. When a value greater than the held value is measured, the larger value is held. The initial setting is OFF.

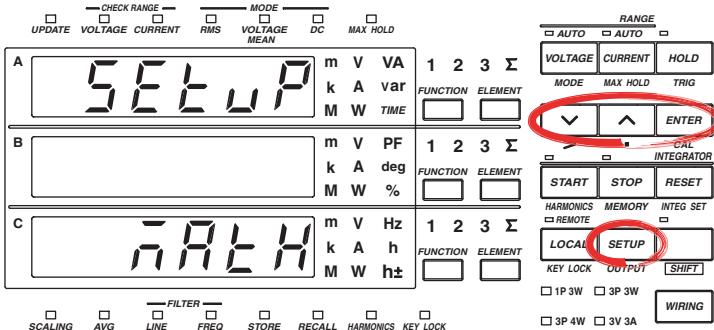
- on: The MAX HOLD indicator illuminates, and the MAX hold function is enabled.
- off: The MAX HOLD indicator turns OFF, and the MAX hold function is disabled.

Note

While the MAX hold function is active, the maximum values of V (voltage), A (current), W (active power), VA (apparent power), and var (reactive power) are displayed continuously. The displayed values for Vpk (voltage peak) and Apk (current peak) are the absolute values of the maximum value. For example, if the plus side peak is +100.1 Vpk and the minus side peak is -100.2 Vpk, then -100.2 Vpk is displayed for the voltage peak. 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 Computing the Efficiency (Applies to WT230 Only)

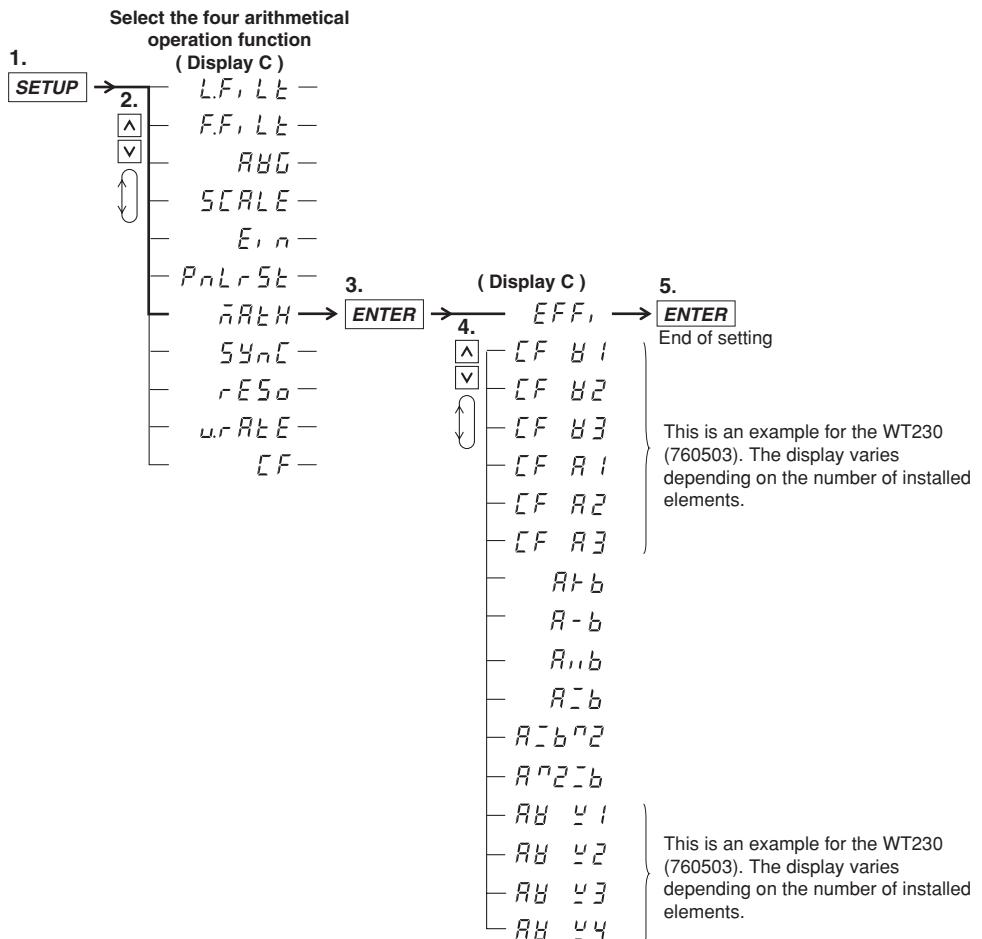
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.



4.9 Computing the Efficiency (Applies to WT230 Only)

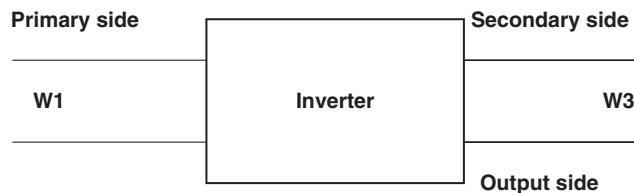
Explanation

The efficiency of the device can be computed and shown on display C. When displaying the efficiency, “-” is displayed at the front of the value.

Computing Equation of Efficiency

- **For the three-phase, three-wire model (760502)**

Computes the efficiency by taking the active power (W1) measured on element 1 as the active power applied to the primary side of the inverter and the active power (W3) measured on element 3 as the power consumed by the secondary side of the inverter.

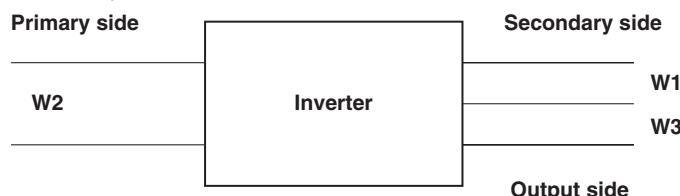


Equation

$$\text{Efficiency} = \frac{W3}{W1} \times 100(\%)$$

- **For the three-phase, four-wire model (760503)**

Computes the efficiency by taking the active power (W2) measured on element 2 as the active power applied to the primary side of the inverter and the active power (W1 and W3) measured on elements 1 and 3 as the power consumed by the secondary side of the inverter.



Equation

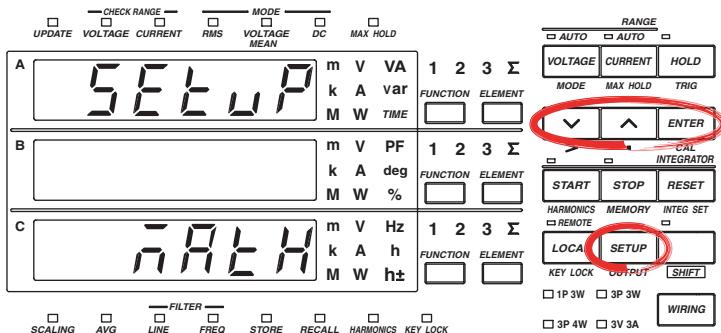
$$\text{Efficiency} = \frac{W1+W3}{W2} \times 100(\%)$$

Note

If the denominator of the above equation is less than or equal to 0.0001% of the rated range, computation overflow (-oF-) is indicated.

4.10 Computing the Crest Factor

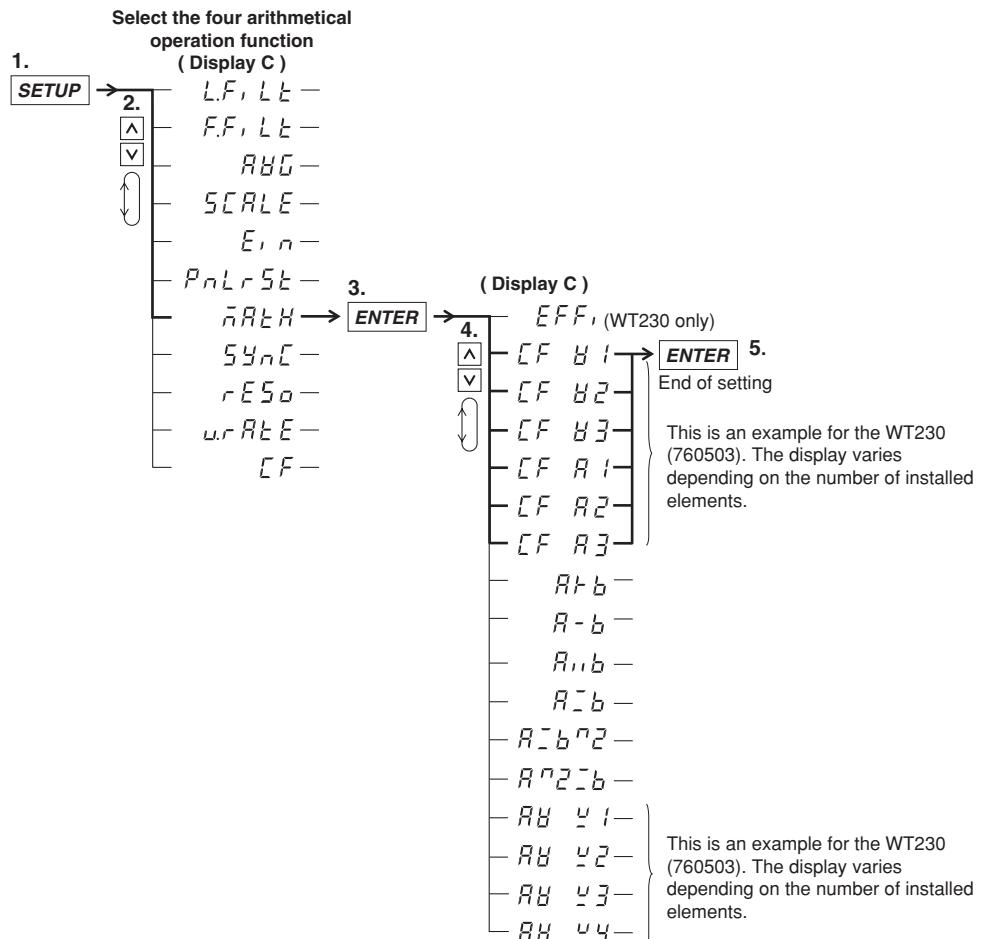
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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. The WT210/WT230 can compute the crest factors for voltage and current and show them on display C. “ $\tilde{\cdot}$ ” is displayed at the front of the value when the crest factor is being displayed.

Computing Equation for the Crest Factor and Display

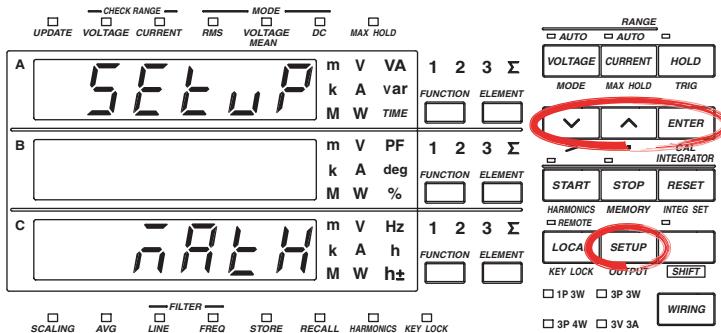
- $\text{CF } V1$: Displays the result of (Peak of V1)/(rms of V1)
- $\text{CF } V2$: Displays the result of (Peak of V2)/(rms of V2) (for 760503 only)
- $\text{CF } V3$: Displays the result of (Peak of V3)/(rms of V3) (for 760502 and 760503)
- $\text{CF } A1$: Displays the result of (Peak of A1)/(rms of A1)
- $\text{CF } A2$: Displays the result of (Peak of A2)/(rms of A2) (for 760503 only)
- $\text{CF } A3$: Displays the result of (Peak of A3)/(rms of A3) (for 760502 and 760503)

Note

- Definition of crest factor : $\frac{\text{PEAK value}}{\text{RMS value}}$
- If the RMS value is less than or equal to 0.5% (less than or equal to 1% if the crest factor is set to 6) of the rated range, computation overflow ($\tilde{\cdot}$ --oF-) is indicated.
- If the measurement mode is VOLTAGE MEAN or DC, no data ($\tilde{\cdot}$ -----) is indicated.

4.11 Performing Four Arithmetical Operation

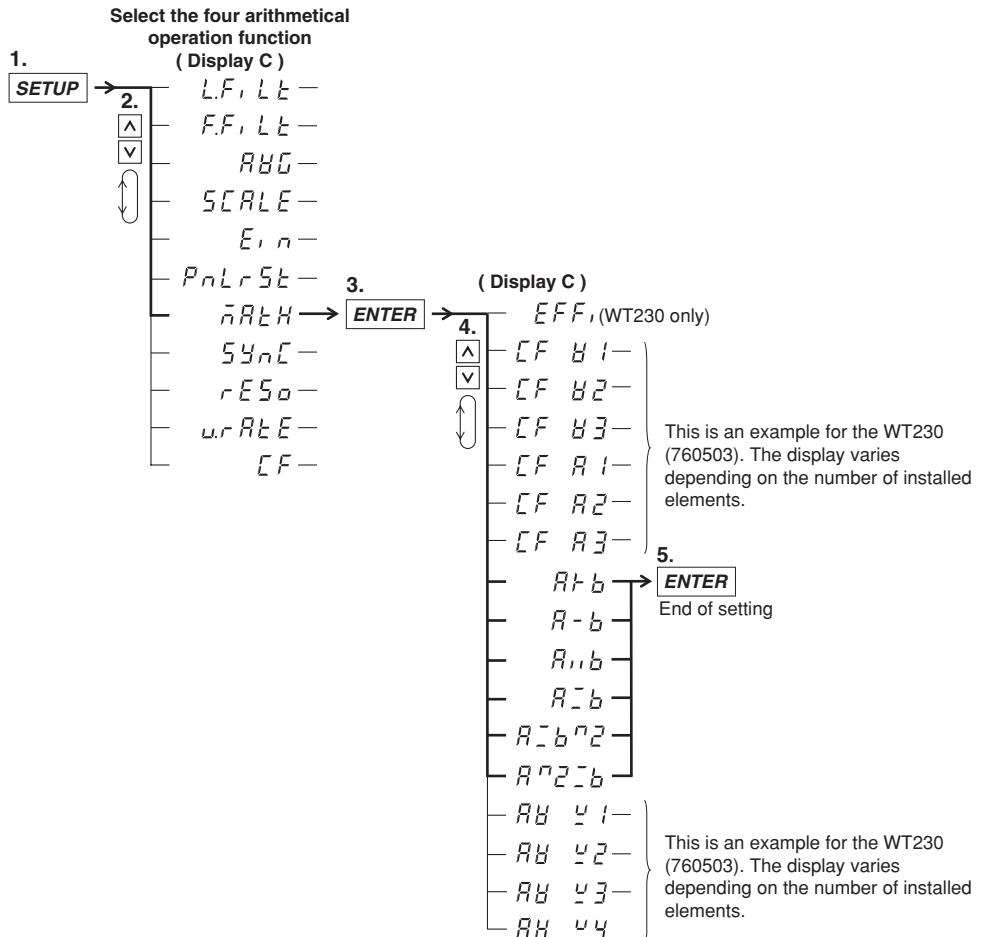
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.



4.11 Performing Four Arithmetical Operation

Explanation

Four Arithmetical Operations Function

The following computation results can be shown on display C. “ \bar{x} ” is displayed at the front of the value when the computation results are being displayed.

$$\begin{aligned}
 R\vdash b & : A + B \\
 R \dashv b & : A - B \\
 R, i, b & : A \times B \\
 R \sqsupseteq b & : A \div B \\
 R \sqsubseteq b^{\eta 2} & : A \div B^2 \\
 R^{\eta 2} \dashv b & : A^2 \div B
 \end{aligned}$$

R and *b* indicates the displayed value on display A and B. “*R+b*” adds the values shown on display A and B and shows the result on display C.

Note

- The meanings of the displayed symbols are as follows:
 - + : + (**Addition**)
 - - : - (**Subtraction**)
 - \times : \times (**Multiplication**)
 - \div : \div (**Division**)
 - \wedge : \wedge (**Exponent**)
 - When the display A function is indicating the elapsed integration time (TIME), the computed result indication is no data (---).
 - If the value of the display B function is less than or equal to 0.0001% of the rated range, computation overflow (--OF-) is indicated.

Application Example

R ⊢ *b*: Displays the result of display A + display B.

Computation example:

Display A	Display B	Display C	Wiring method
W1	W2 or W3	W1 + W2 or W1 + W3	Any
		W1 W2 or W3	

R - b: Displays the result of display A – display B.

Computation example 1:

Display A	Display B	Display C	Wiring method
W1	W3	W1 – W3	Any
W1	Inverter	W3	

4.11 Performing Four Arithmetical Operation

Computation example 2:

Display A	Display B	Display C	Wiring method
$\Sigma W (= W1 + W3)$	W2	$\Sigma W - W2$	3P3W

Computation example 3:

Display A	Display B	Display C	Wiring method
W2	$\Sigma W (= W1 + W3)$	$W2 - \Sigma W$	3P3W

R_{ab} : Displays the result of display A \times display B.

Useful when setting a function other than VA (apparent power) for display A and displaying VA on display C.

Computation example :

Display A	Display B	Display C	Wiring method
V1rms	A1rms	$A1rms \times A1rms$	Any

R_{ab} : Displays the result of display A \div display B.

When computing the absolute value of impedance

Computation example :

Display A	Display B	Display C	Wiring method
V1rms	A1rms	$ Z = \frac{V1rms}{A1rms}$	Any

R_{ab} : Displays the result of display A \div display B.

Line voltage ratio and line current ratio for a three-phase wiring can be determined.

Computation example :

Display A	Display B	Display C	Wiring method
V1rms	V3rms	$\frac{V1rms}{V3rms}$	3P3W
A1rms	A3rms	$\frac{A1rms}{A3rms}$	

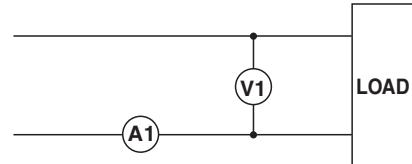
4.11 Performing Four Arithmetical Operation

$A \square b \square c$: Displays the result of display A ÷ (display B)²

When computing impedance (Z), resistance (R), and reactance (X)

Computation example :

Display A	Display B	Display C	Wiring method
VA1	A1rms	$ Z = \frac{VA1}{(A1rms)^2}$	Any
W1	A1rms	$R = \frac{W1}{(A1rms)^2}$	
Var1	A1rms	$ X = \frac{Var1}{(A1rms)^2}$	

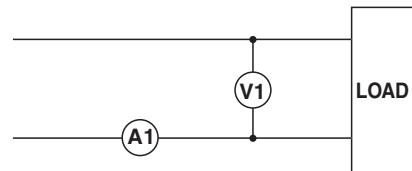


$A \square b \square c$: Displays the result of (display A)² ÷ display B

When computing resistance (R)

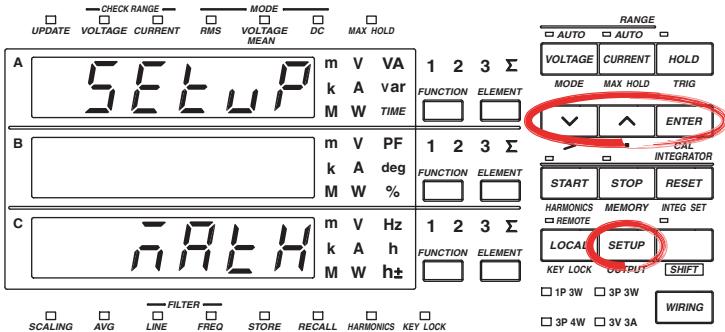
Computation example :

Display A	Display B	Display C	Wiring method
V1rms	W1	$R = \frac{(V1rms)^2}{W1}$	Any



4.12 Computing the Average Active Power during Integration

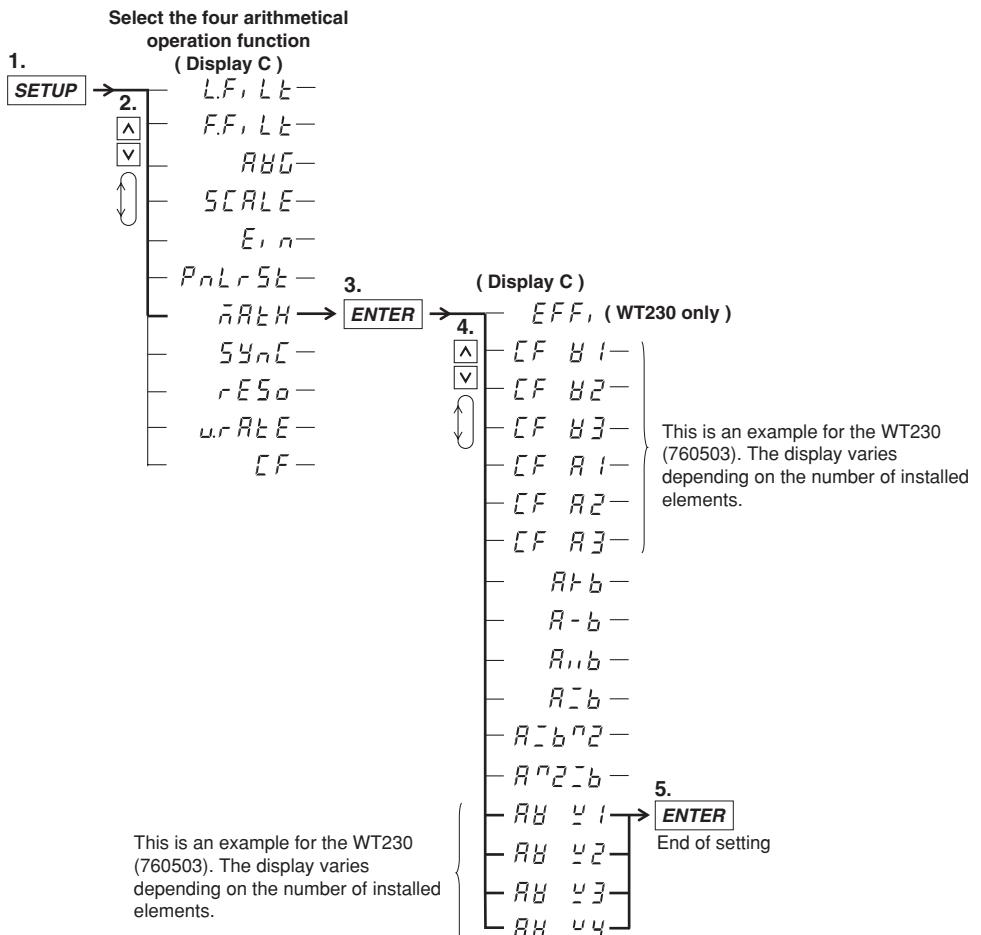
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.



4.12 Computing the Average Active Power during Integration

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. The result can be shown on display C. When displaying the average active power, “ \bar{n} ” is displayed at the front of the value.

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

Computing Method and Displayed Information of Average Active Power while Integration Is in Progress

RH $\Sigma 1$: Displays the computed result of (watt hour of element 1 Wh1)/the elapsed integration time

RH $\Sigma 2$: Displays the computed result of (watt hour of element 2 Wh2)/the elapsed integration time (760503 only)

RH $\Sigma 3$: Displays the computed result of (watt hour of element 3 Wh3)/the elapsed integration time (760502 and 760503)

RH $\Sigma 4$: Displays the computed result of (watt hour of element S SWh3)/the elapsed integration time (760502 and 760503)

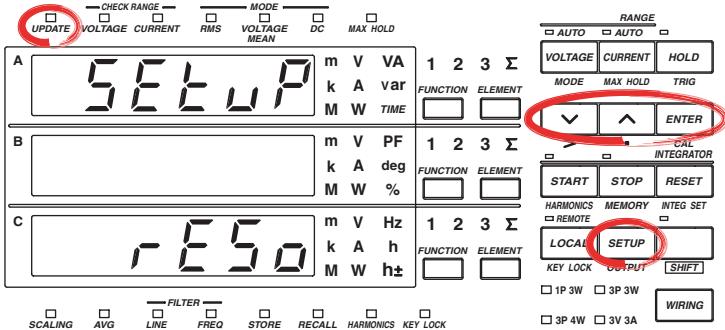
* The value of watt hour Σ Wh varies depending on the wiring system. The value that results is derived by replacing “W” in the table on page 5-2 with “Wh.”

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 “ $\bar{n}----$.” For details on integrator functions, see chapter 6.

4.13 Selecting the Number of Displayed Digits and the Display Update Rate

Keys

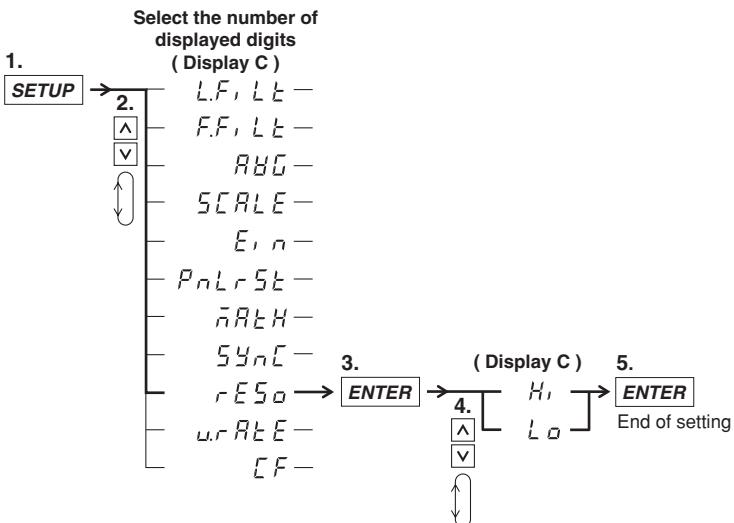


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

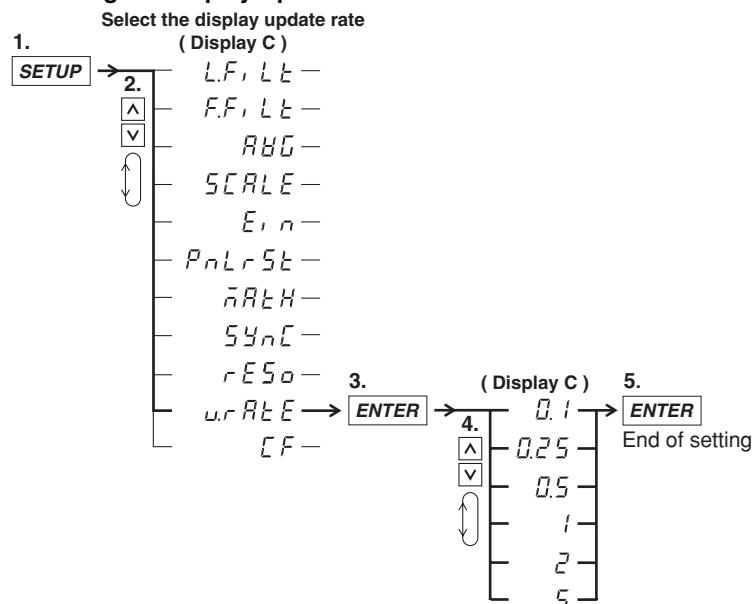
- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

Selecting the Number of Displayed Digits



4.13 Selecting the Number of Displayed Digits and the Display Update Rate

Selecting the Display Update Rate



Explanation

Selecting the Number of Displayed Digits

You can select the maximum number of displayed digits for V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), PF (power factor), VHz (voltage frequency), AHz (current frequency), and harmonic measurement values (voltage, current, active power, power factor, and relative harmonic content). The initial setting is Hi.

- 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.
- Values such as Vpk (voltage peak), Apk (current peak), phase angle, efficiency, crest factor, four arithmetic operations, average active power, integrated value, elapsed integration time, and harmonic measurement values (harmonic distortion and phase angle) are not affected by the number of displayed digits set in this section. For details, see the sections describing each item.

Selecting the Display Update Rate

You can select the display update rate of the measured or computed results shown on the display from the choices below. The UPDATE indicator blinks in sync with the selected display update rate. You can increase the display update rate to measure the load power that changes relatively fast or decrease the rate to measure the power of a signal with a relatively long period. The initial setting is 0.25 s.

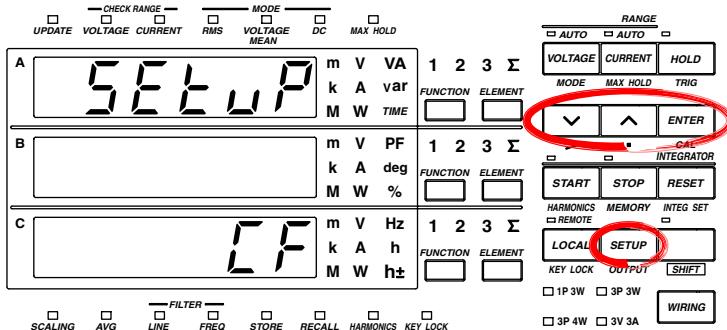
0.1 s, 0.25 s, 0.5 s, 1 s, 2 s, and 5 s

Note

The display update rate of 0.1 s appears as a possible selection when the harmonic measurement function is ON. However, it cannot be selected. If the display update rate had been set to 0.1 s when the harmonic measurement function was OFF, the rate is changed to 0.25 s when you turn on the harmonic measurement function. In this case, the display update rate remains at 0.25 s even if you turn the harmonic measurement function back OFF.

4.14 Selecting the Crest Factor

Keys

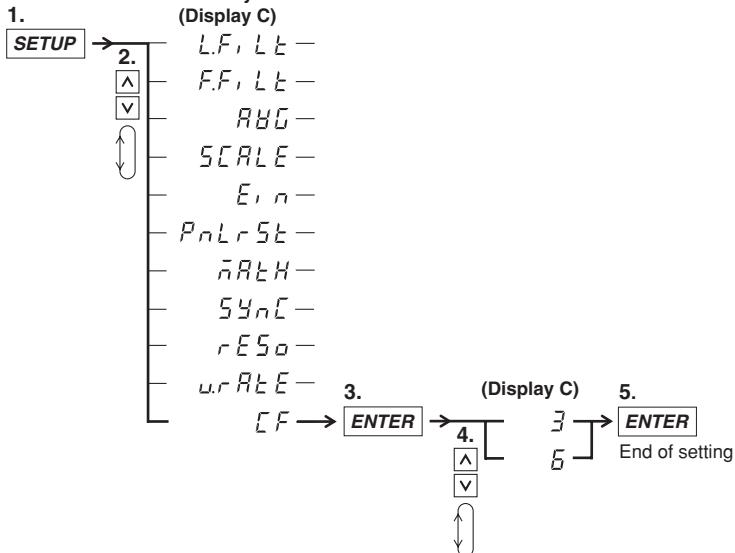


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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
(Display C)



Explanation

Selecting the Crest Factor

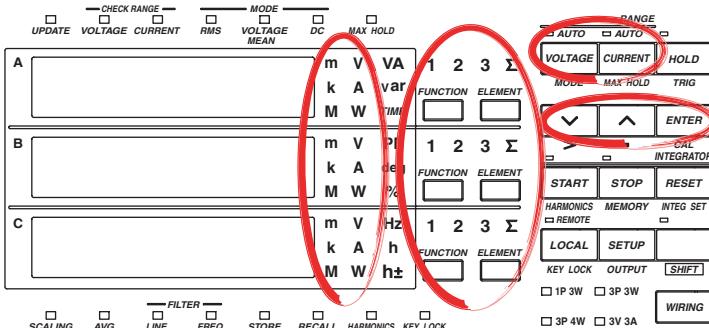
The crest factor is a ratio of the amplitude with respect to the rms value. You can select 3 or 6.

Note

- If the crest factor is entered using the ENTER key, the voltage range and current range are set to the maximum range.
The maximum current range is as follows:
 - Direct input range (5 mA to 20 A; 2.5 mA to 10 A if the crest factor is 6)
20 A (10 A if the crest factor is 6)
 - External sensor input range: Option /EX1 (2.5 V to 10 V; 1.25 V to 5 V if the crest factor is 6)
10 V (5 V if the crest factor is 6)
 - External sensor input range: Option /EX2 (50 mV to 200 mV; 25 mV to 100 mV if the crest factor is 6)
200 mV (100 mV if the crest factor is 6)
 - If you set the crest factor to 6, the measurement conditions of crest factor 5 and higher required by IEC 62018 are met.
-

5.1 Displaying Voltage, Current and Active Power

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1. Selecting the Display Function

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

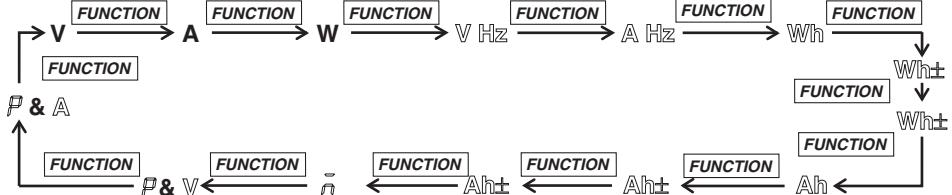
Display
A



B



C



$Wh\pm$ and $Ah\pm$ will light twice. \bar{P} and \bar{A} 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. Selecting the Input Element

Select the input element by pressing the ELEMENT key.

WT210
(760401)

No element selection function, because there is only a single input element.

WT230
(760502)



WT230
(760503)



3. Selecting the Measurement Range

You can select the voltage measurement range by pressing the VOLTAGE key, and the current measurement range by pressing the CURRENT key. For more details, refer to either of the following.

- 4.4 Selecting the Measurement Range in case of Direct Input;
- 4.5 Setting the Scaling Value when External PT/CT is Used;
- 4.6 Selecting the Measurement Range and Setting the Scaling Value when External Sensor is Used (option).

5.1 Displaying Voltage, Current and Active Power

4. Selecting the Measurement Mode

Select the measurement mode by pressing the VOLTAGE (MODE) key after having pressed the SHIFT key so that the SHIFT indicator is lit. For more details, refer to section 4.1, "Selecting the Measurement Mode."

Explanation

Continuous Maximum Allowable Input

- Voltage
Up to peak voltage of 1.5 kV or RMS value of 1.0 kV, whichever is less.
- Current
 - 5 mA to 200 mA range (2.5 mA to 100 mA range if the crest factor is set to 6) (WT210 only)
Up to peak current of 30 A or RMS value of 20 A, whichever is less.
 - 0.5 A to 20 A range (0.25 A to 10 A range if the crest factor is set to 6) (common to WT210 and WT230)
Up to peak current of 100 A or RMS value of 30 A, whichever is less.
 - External sensor input (common to WT210 and WT230)
Peak value of up to five times the measurement range.

Maximum Reading, Unit, and Unit Prefix

- Maximum reading: 99999 (when the number of displayed digits is 5) for voltage, current and power
- 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: active power will be displayed

Selecting the Input Element

The type of input element which can be selected depends on the model number.

Make your selection after having verified your model number.

- 1/2/3: Displays the measurement values of element 1/2/3
- Σ: Displays according to the wiring method, and is as follows.

Wiring method	ΣV	ΣA	ΣW	ΣVA	Σvar
1P3W	$\frac{V_1+V_3}{2}$	$\frac{A_1+A_3}{2}$	W_1+W_3	$V_1A_1+V_3A_3$	var_1+var_3
3P3W	$\frac{V_1+V_3}{2}$	$\frac{A_1+A_3}{2}$	W_1+W_3	$\frac{\sqrt{3}}{2} (V_1A_1+V_3A_3)$	var_1+var_3
3P4W	$\frac{V_1+V_2+V_3}{3}$	$\frac{A_1+A_2+A_3}{3}$	$W_1+W_2+W_3$	$V_1A_1+V_2A_2+V_3A_3$	$var_1+var_2+var_3$
3V3A	$\frac{V_1+V_2+V_3}{3}$	$\frac{A_1+A_2+A_3}{3}$	W_1+W_3	$\frac{\sqrt{3}}{3} (V_1A_1+V_2A_2+V_3A_3)$	var_1+var_3

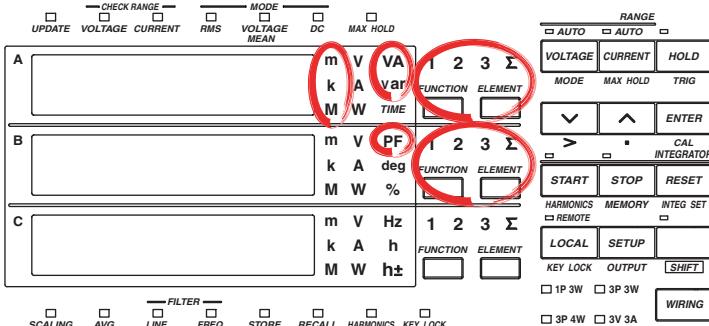
Wiring method	ΣPF	Σdeg
1P3W		
3P3W	$\frac{\Sigma W}{\Sigma VA}$	$\cos^{-1}\Sigma PF$
3P4W		
3V3A		

Note

For Σ var computation, when the current leads the voltage, each var value is computed as a negative value; when the current lags the voltage, the value is computed as a positive value.

5.2 Displaying Apparent Power, Reactive Power and Power Factor

Keys

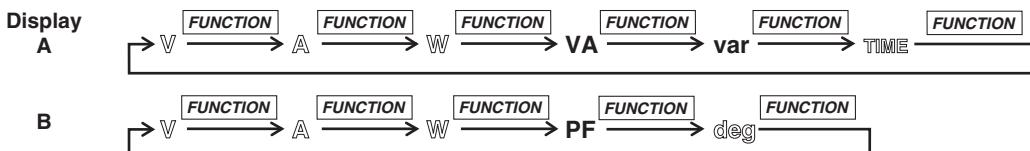


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1. Selecting the Display Function

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



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

2. Selecting the Input Element

Select the input element by pressing the ELEMENT key of display A or B. The operation is the same as the one described on page 5-1.

Explanation

Maximum Reading, Unit, and Unit Prefix

- 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 (when the num of displayed digits is 5)
(If the computed result lies between 1.0001 and 2.0000, 1.0000 is displayed. If it is 2.0001 or more, PFErr is displayed. If it is between -1.0001 and -2.0000, -1.0000 is displayed. If it is -2.0001 or below, PFErr is displayed.)
- Units: VA (apparent power), var (reactive power), power factor (no unit)
- Prefix: m, k, 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

Selecting the Input Element

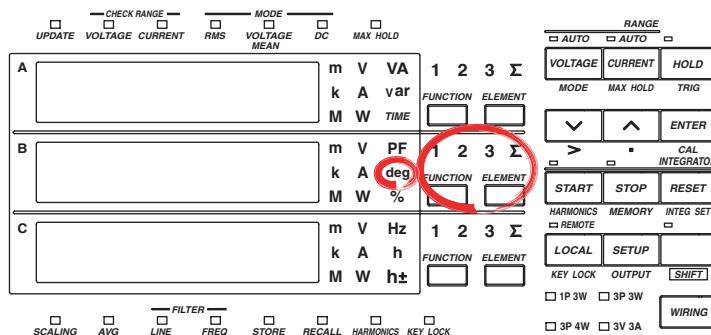
- 1/2/3: Displays the measurement values of element 1/2/3
- Σ: Refer to page 5-2.

Note

- Changing the measurement mode might result in different computed results, even when the input signal is the same. For more details on the measurement mode, refer to page 4-1.
- When either the voltage or current drops below 0.5% (less than or equal to 1% if the crest factor is set to 6) of the measurement range, PFErr will be displayed.

5.3 Displaying the Phase Angle

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1. Selecting the Display Function

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



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

2. Selecting the Input Element

Select the input element by pressing the ELEMENT key of display B. The operation is the same as the one described on page 5-1.

Explanation

Display Range and Unit

- 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.

Selecting the Input Element

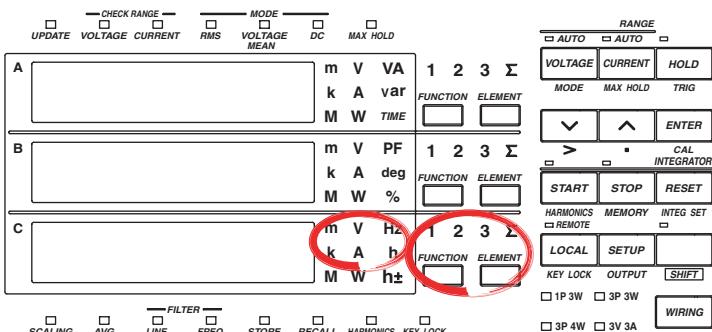
- 1/2/3: Displays the measurement values of element 1/2/3
- Σ : Refer to page 5-2.

Note

- Changing the measurement mode might result in different computed results, even when the input signal is the same. For more details on the measurement mode, refer to page 4-1.
- When either the voltage or current drops below 0.5% (less than or equal to 1% if the crest factor is set to 6) of the measurement range, dEGErr 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.
 - Between 1.0001 to 2.0000 or -1.0001 to -2.0000: the phase angle displays 0.0
 - 2.0001 or more or -2.0001 or less: the phase angle displays dEGErr.

5.4 Displaying the Frequency

Keys

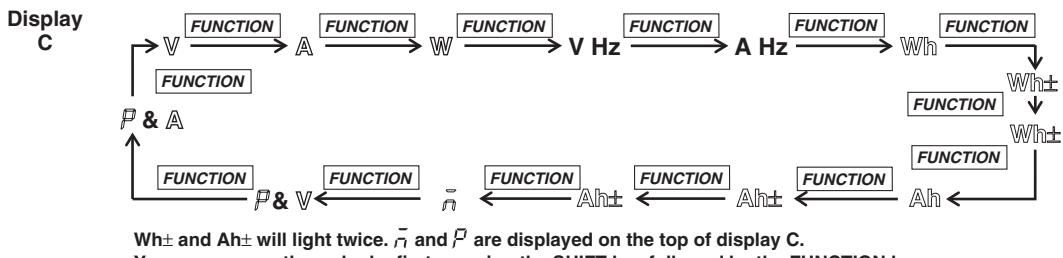


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1. Selecting the Display Function

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



2. Selecting the Input Element

Select the input element by pressing the ELEMENT key of display C. The operation is the same as the one described on page 5-1.

Explanation

Measurement Range

- The measurement range varies depending on the display update rate (see section 4.13) as follows:

Display Update Rate	Measurement Range
0.1 s	25 Hz to 100 kHz
0.25 s	10 Hz to 100 kHz
0.5 s	5 Hz to 100 kHz
1 s	2.5 Hz to 100 kHz
2 s	1.5 Hz to 50 kHz
5 s	0.5 Hz to 20 kHz

- There are six types of measurement ranges, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz. The measurement range switches automatically.

Maximum Reading, Unit, and Unit Prefix

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

5.4 Displaying the Frequency

Selecting the Display Function

The following selections are available.

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

Selecting the Input Element

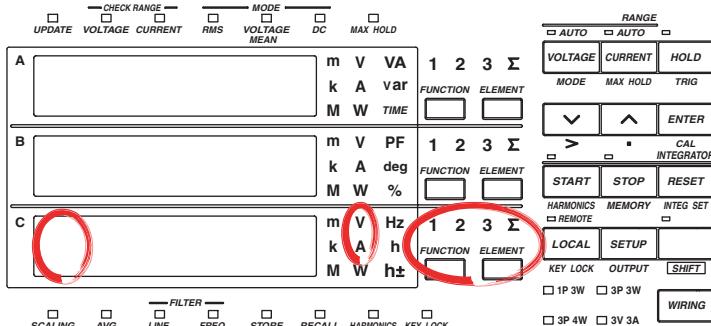
- 1/2/3: Displays the measurement values of element 1/2/3
- Σ: Displays no measurement values, only bar.

Note

- In case the level of the input signal is low (less than or equal to 7% if the crest factor is set to 3; less than or equal to 14% if the crest factor is set to 6), 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 frequency 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. This is because the filter with a cutoff frequency is 500 Hz attenuates the signal to a level that the instrument determines no signal is being input.
 - If the frequency exceeds the measurement range even when the frequency filter is set OFF, "ErrLo" might appear due to the internal circuit attenuating the signal to a level that the instrument determines no signal is being input.
-

5.5 Displaying Efficiency (WT230 Only), Crest Factor, Four Arithmetic Operation Value, Average Active Power, and Peak Value

Keys

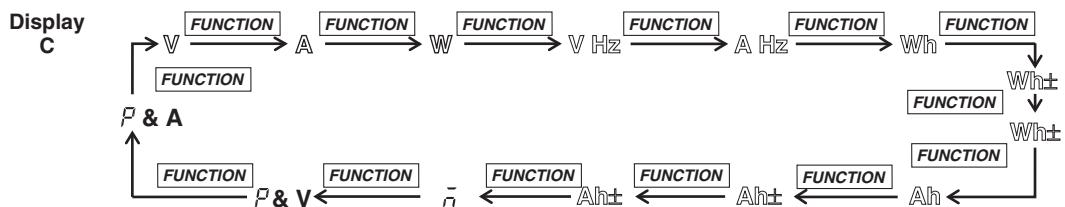


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1.1 Selecting the display Function

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



$Wh\pm$ and $Ah\pm$ 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.

2. Selecting the Input Element

To display the peak value, press the ELEMENT key of display C and select the input element of which the peak value is to be displayed.

The procedure is the same as shown on page 5-1.

Explanation

Displaying the Peak Value

P is displayed at the front of display C. The peak value of voltage is displayed when the unit display is V; the peak value of current is displayed when the unit display is A.

- Maximum display: 9999
- Unit: Voltage peak value V, current peak value A
- Prefixp: m, k, or M

The absolute values of the plus and minus sides of the displayed values for Vpk (voltage peak) and Apk (current peak) are compared, and the larger of the two is displayed. For example, if the plus side peak is +100.1 Vpk and the minus side peak is -100.2 Vpk, 100.2 Vpk is displayed for the peak value.

Efficiency (WT230 only), Crest Factor, Four Arithmetic Operation and Average Active Power Display

When \bar{n} is displayed at the front of display C, the efficiency, crest factor, four arithmetic operation value, or average active power specified in sections 4.9 to 4.12 is displayed.

- Maximum display (display range)
 - Efficiency: 0.00 to 999.99 (%)
 - Others (crest factor, four arithmetic operations, and average active power): 9999
- Unit
 - Average active power: W
 - Others (efficiency, crest factor, and four arithmetic operations): No unit
- Prefix
 - Four arithmetic operations and average active power: m, k, or M
 - Others (efficiency and crest factor): No prefix

Note

Depending on the computed item, computation overflow or no data may be indicated rather than a value.

Efficiency

If the denominator of the equation for deriving the efficiency is less than or equal to 0.0001% of the rated range, computation overflow ($\bar{n}--oF-$) is indicated.

Crest factor

- If the RMS value is less than or equal to 0.5% (less than or equal to 1% if the crest factor is set to 6) of the rated range, computation overflow ($\bar{n}--oF-$) is indicated.
- If the measurement mode is VOLTAGE MEAN or DC, no data ($\bar{n}----$) is indicated.

Four arithmetic operation

- If the display A function is indicating the elapsed integration time (TIME), the computed result indication is no data ($\bar{n}----$).
- If the value of the display B function is less than or equal to 0.0001% of the rated range, computation overflow ($\bar{n}--oF-$) is indicated.

6.1 Integrator Functions

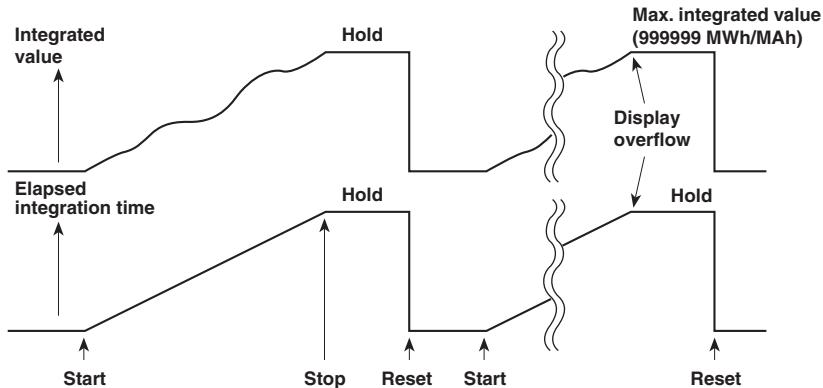
Active power integration and current integration can be carried out. All measurement values (and computed values) can be displayed, even when integration is in progress, except for the integrated values (watt hour or ampere hour) and elapsed integration time. Since integrated values of negative polarity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

Integration Modes

The following three modes are available as integration modes.

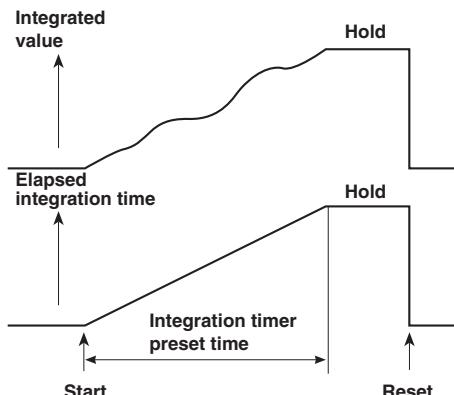
Manual Integration Mode

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



Standard Integration Mode

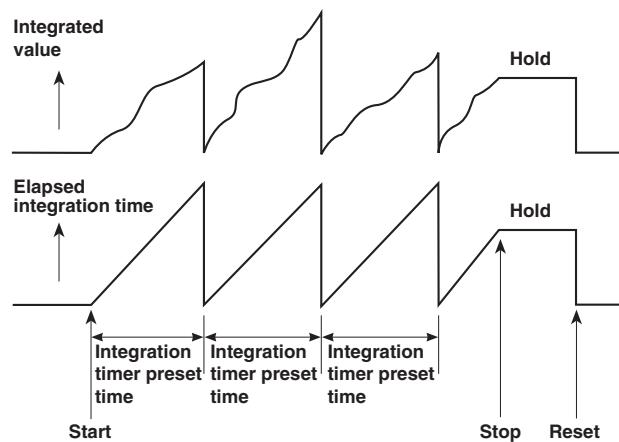
- Integration starts: after having pressed the START key
- Integration stops:
 - when the elapsed integration time is reached to preset time;
 - when the integrated value reaches the maximum value 999999 MWh/MAh, or when the integrated value drops to the minimum value -99999 MWh/MAh.
- Integration holds: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



6.1 Integrator Functions

Continuous Integration Mode (Repeat Integration)

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



Integration Methods

The computing equations are shown below. The result is displayed using time conversion.

Power integration		$\sum_{i=1}^n v_i \cdot i_i$
Current integration	RMS	$\sqrt{\sum_{i=1}^N A_i}$
	DC	$\sum_{i=1}^n i_i$

v_i and i_i are instantaneous values of voltage and current.

n is the number of samples.

A_i is the measured current for each display update rate.

N is the number of display updates

Power integration or current integration with the measurement mode set to DC are integration of instantaneous power or instantaneous current. If the measurement mode is set to RMS, integration is performed on the measured current on each display update rate (see section 4.13)

Note

If you stop integration, the integration process stops at the integrated value and elapsed integration time of the previous display update. The measured values between the previous display update and the execution of the integration stop are not integrated.

Display Resolution during Integration

The display resolution of integrated values is normally 99999 counts (counts up to 999999 only when the unit is MWh or MAh). When the integrated value reaches 100000 counts, the decimal point shifts automatically. For example, if 0.0001 mWh is added to 9.9999 mWh, the display shows “10.000 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, VOLTAGE MEAN, DC	both positive and negative watt hour values
Wh \pm ^{*1}	RMS, VOLTAGE MEAN, DC	positive watt hour value
Wh \pm ^{*1}	RMS, VOLTAGE MEAN, DC	negative watt hour value
Ah	RMS, VOLTAGE MEAN DC	total ampere hour values both positive and negative ampere hour values
Ah \pm ^{*2}	RMS, VOLTAGE MEAN DC	total ampere hour values (same as Ah) positive ampere hour value
Ah \pm ^{*2}	RMS, VOLTAGE MEAN DC	-0 negative ampere hour value

*1 When the Wh function is selected, pressing the FUNCTION key once or twice will result in Wh \pm . 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.

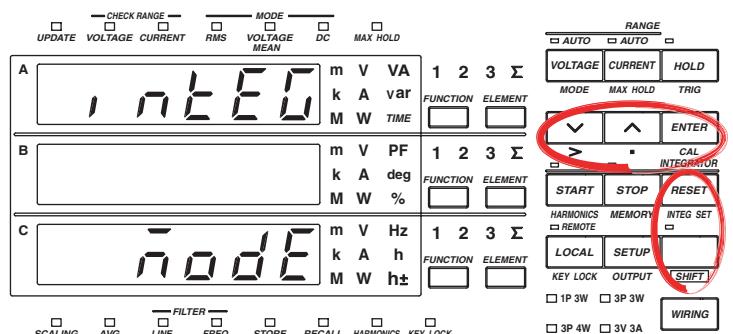
*2 When the Ah function is selected, pressing the FUNCTION key once or twice will result in Ah \pm . Pressing the FUNCTION key once will result in displaying the positive ampere hour value, whereas pressing the FUNCTION key twice will result in displaying the negative ampere hour value. In case of the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

Note

- When negative integrated values are displayed, the minimum display reading will become -99999 MWh/MAh because of the added minus character.
- During integration is in progress (until being reset), operation of other functions are restricted. Refer to page 6-10 for more details.

6.2 Setting Integration Mode and Integration Timer

Keys

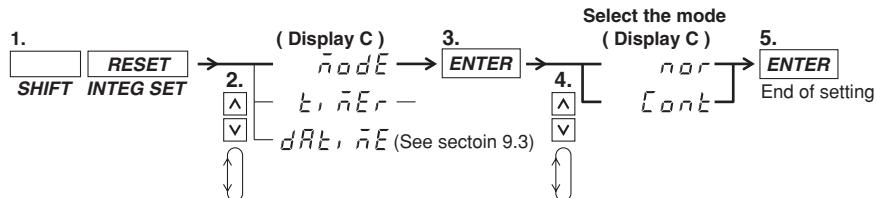


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

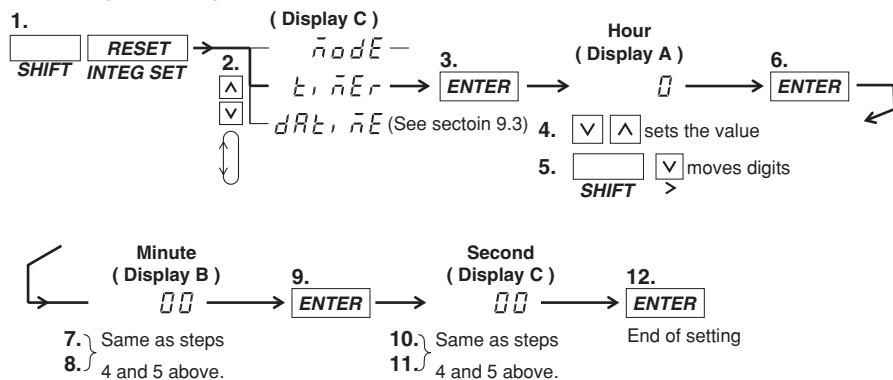
Procedure

- 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



Selecting 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.

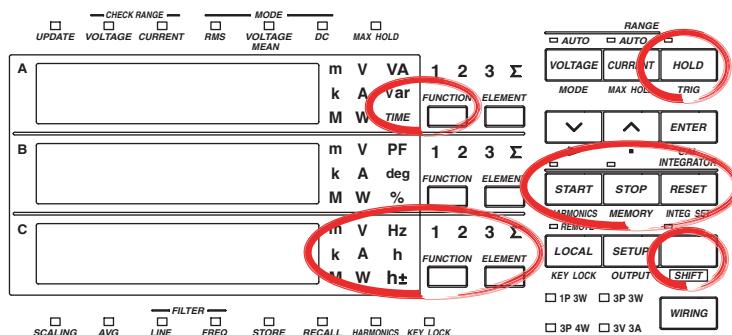
Setting the Integration Timer

Set the integration time. The setting ranges from 0.00.00 (0 hrs, 00 min, 00 s) to 10000.00.00 (10000 hrs, 00 min, 00 s). The initial value is 0.00.00.

- 0.00.00: When “nor” is selected on the integration menu, the manual integration mode will become valid. If Cont is selected, an error code is displayed when integration is started, and the integration is not performed.s
- 0.00.01 to 10000.00.00: The time during which integration will be performed when in the standard or continuous integration mode. The standard or continuous mode should be selected at the integration mode menu.

6.3 Displaying Integrated Values

Keys

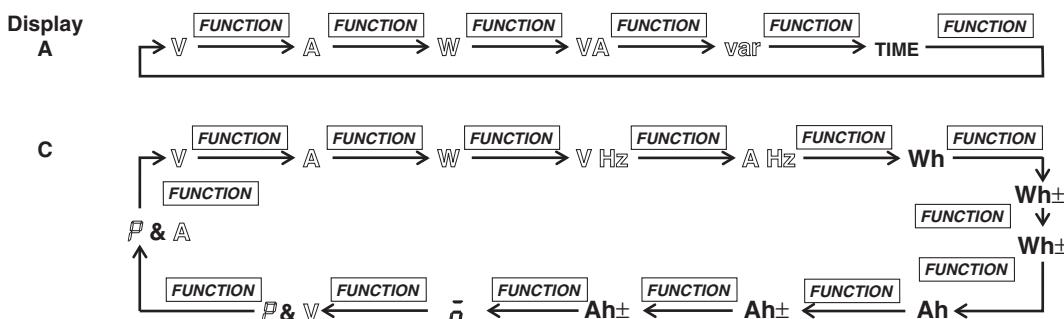


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

1. Selecting the Display Function

Pressing the FUNCTION key on display A will select TIME (elapsed integration time). Pressing the FUNCTION key on display C will select Wh/Wh \pm (power), Ah/Ah \pm (current), or \bar{n} (average active power during integration).



Wh \pm and Ah \pm 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. Selecting the Input Element

Select the input element by pressing the ELEMENT key on display C. The operation is the same as the one described on page 5-1.

3. Starting Integration

Press the START key. The START indicator will light, the integrated value will appear on display C and the elapsed integration time will appear 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 4.12).

START

4. Holding the displayed value

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

HOLD

5. Cancelling HOLD, and Updating the Integration

Continuing from step 4, press the HOLD key once more, or press the SHIFT key followed by the HOLD (TRIG) key. The HOLD indicator will extinguish and the displayed value will be updated.



6. Stopping Integration

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



7. Resetting Integration

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



Explanation

Maximum Reading of the Display and Units

Maximum reading

- Integrated value: 99999 (999999 only when the unit is MWh or MAh), -99999 when displaying negative polarity
- Elapsed integration time: 10000
- Units: Wh (power integration: watt hour value), Ah (current integration: ampere hour value)
- Prefix: m, k, M

Selecting the Display Function

The following selections are available.

- Wh: displays both the positive and negative watt hour values
- Wh \pm : displays the positive watt hour value
- Ah: displays the total ampere hour values
- Ah \pm : displays the total ampere hour values or the positive ampere hour value
- \bar{P} : the average active power during integration is displayed, if the function is specified in the computation settings (see section 4.12).

For more details, refer to page 6-3.

Selecting the Input Element

- 1/2/3: Displays the measurement values of element 1/2/3
- Σ : Displays the total integrated values of the elements installed. The method of computation depends on the wiring method. The computation method changes to Wh or Ah for the active power W (see page 5-2).

When the display function TIME is selected on display A, there is no element function available on display A. Pressing the ELEMENT key on display A will result in an error code.

Update Hold Function

- Although the held values will not be updated, the integration continues inside the instrument. Because the UPDATE LED blinks each time the internal data is updated, it will continue to blink. 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 page.

6.3 Displaying Integrated Values

Stopping Integration

If you stop integration, the integration process stops at the integrated value and elapsed integration time of the previous display update. The measured values between the previous display update and the execution of the integration stop are not integrated.

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 WT210/WT230 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 hr 59 min 59 s	0.00.00 to 9.59.59	1 s
10 hr to 99 hr 59 min 59 s	10.00.0 to 99.59.5	10 s
100 hr to 999 hr 59 min 59 s	100.00 to 999.59	1 min
1000 hr to 9999 hr 59 min 59 s	1000.0 to 9999.5	10 min
10000 hr	10000	1 hr

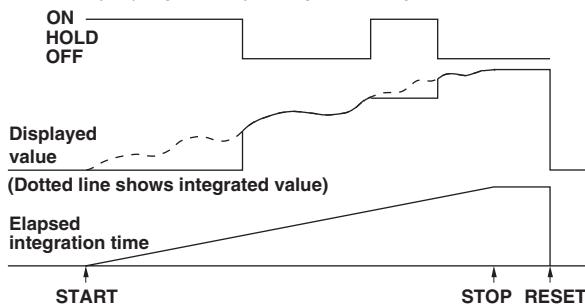
- For details on Wh, Wh±, Ah, Ah±, see page 6-3. For details related to the average active power during integration, see section 4.12.
 - The integrated value is determined and displayed by summing the value that is measured at every display update rate, irrespective of the MAX hold function.
-

6.4 Precautions Regarding Use of Integrator Function

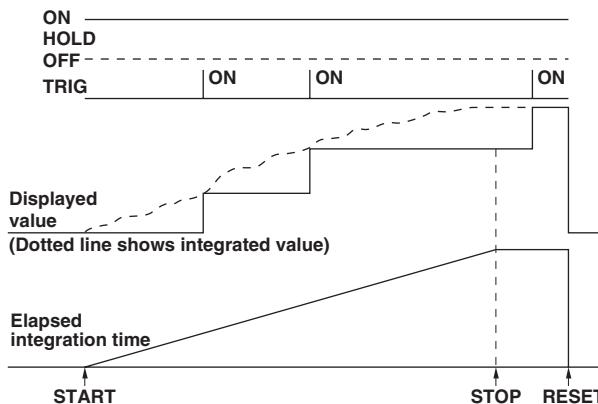
Relation between s and the START/STOP key

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.

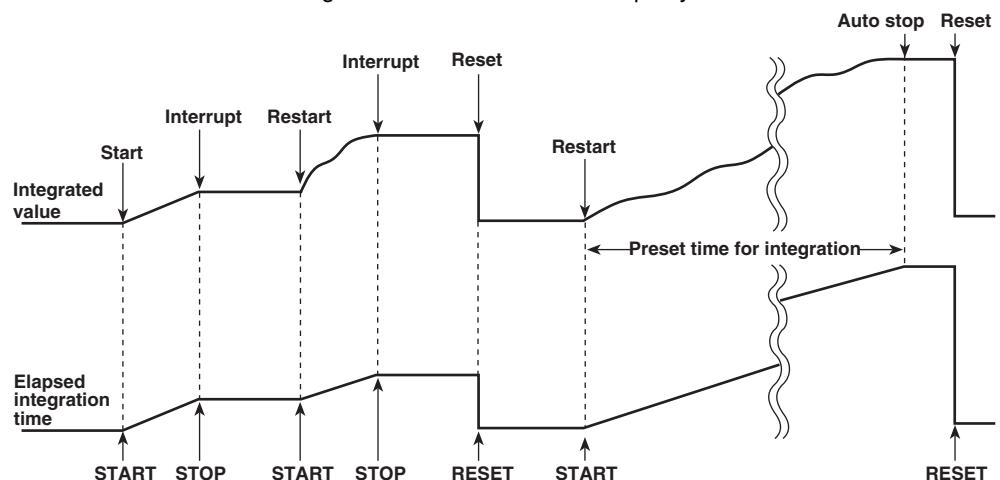


- Even when stopping integration while the hold function is on, the displayed integrated value will remain unchanged. However, as soon the hold function is turned off or a trigger is activated, the integrated results of the time when integration was stopped will be displayed or output.



Relation between Integration Reset and the START/STOP key

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



6.4 Precautions Regarding Use of Integrator Function

Backup During Power Failures

- If there is a power failure while integration is in progress, the integrated value and integration elapsed time 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) (STOP Indicator)	Not lit Not lit	Lit Not lit	Not lit Lit	
Function				
Wiring system (only WT230)	O	O	O	
Measurement synchronization source	O	X	X	
Measurement mode	O	X	X	
Filter	O	X	X	
Measurement range	O	X	X	
Crest factor	O	X	X	
Scaling	O	X	X	
Averaging	O	X	X	
MAX hold	O	O	O	
Display function	O	O	O	
Input element (only WT230)	O	O	O	
Number of displayed digits	O	O	O	
Display update rate	O	X	X	
Hold	O	O	O	
Trigger	O	O	O	
Integration mode	O	Settings cannot be changed, but can be displayed		
Integration timer	O	Settings cannot be changed, but can be displayed		
Integration start	O	X	O	
Integration stop	X	O	X	
Integration reset	O	X	O	
Harmonic measurement (option)	O	X	X	
Store/recall	O	XStore possible	XStore possible	
Comparator	O	O	O	
Plotter, printer	O	O	O	
Zero-level compensation	O	X	X	

- O: Settings can be changed
- X: Settings cannot be changed. Attempts will result in an error code.
- When integration is started during auto range, the measurement range will change to fixed range.
- If you start integration when averaging is ON, averaging is turned OFF. It does not turn back ON even if integration is stopped and reset.

Integration Computation when the Measured Value Exceeds Measurement Limits

Integration Computation When the Measured Value Exceeds the Measurement Limit
 When the instantaneous voltage or current of the sampled data exceeds approx. 333% (approximately 666% if the crest factor is set to 6) of the measurement range, the value is considered to be the value corresponding to approx. 333% (approximately 666% if the crest factor is set to 6) for the purpose of integration.

Integration When Current Input Is Small

When the measurement mode is RMS/VOLTAGE MEAN and the current input drops below 0.5% (less than or equal to 1% if the crest factor is set to 6) of the rated range, the ampere hour value is integrated as zero (0).

Valid Frequency Range for Integration

The sample rate is approximately 50 kHz. The voltage/current signal frequencies that are valid for the integration are as follows.

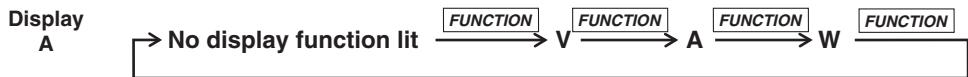
Integrated Item		Valid Frequency Range for Integration
Active power		DC to 25 kHz
Current	When the measurement mode is RMS	DC, lower limit frequency determined by the display update rate to 25 kHz
	When the measurement mode is VOLTAGE MEAN	DC, lower limit frequency determined by the display update rate to 25 kHz
	When the measurement mode is DC	DC to 25 kHz

7.1 Harmonic Measurement Function

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

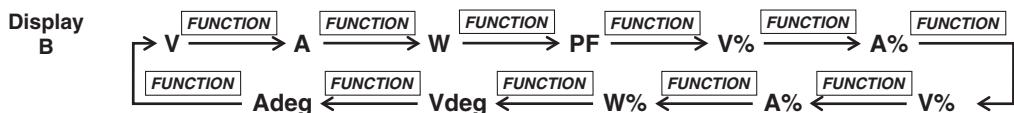
Measured/Displayed Items

After having set the harmonic measurement function to ON, the harmonic component of voltage, current, or active power, will be measured and displayed for one of the input elements (target element, not applicable for the WT210). Depending on the setting of the display function, the display changes as follows.



No display function lit : Displays the harmonic order (1 to 50)

Display function **V, A, W** : Displays all rms values (computed values) of 1 up to 50 components of voltage, current or active power



Display function **V** : Displays the measured voltage value of the order shown on display A

A : Displays the measured current value of the order shown on display A

W : Displays the active power measured 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 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)

7.1 Harmonic Measurement Function

Auto Range Operation

- **Range Up**

When the measured value of voltage or current (V or A) exceeds 200% of the rated range or when the peak value (instantaneous voltage or current value that is sampled) exceeds approximately 300% (approximately 600% if the crest factor is set to 6) of the rated range, the range is increased the next time the measured value is updated.

- **Range down**

When the measured value of the voltage or current is less than or equal to 30% of the rated range and the peak value is less than or equal to approximately 300% (less than or equal to approximately 600% if the crest factor is set to 6) of the rated range of the next lower range, the range is decreased the next time the measured value is updated.

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 Update Rate

In harmonic measurement, you can select the display update rate from 0.25 s, 0.5 s, 1 s, 2 s, and 5 s. For the setup procedure, see section 4.13.

Note

The display update rate of 0.1 s appears as a possible selection when the harmonic measurement function is ON. However, it cannot be selected. If the display update rate had been set to 0.1 s when the harmonic measurement function was OFF, the rate is changed to 0.25 s when you turn ON the harmonic measurement function. In this case, the display update rate remains at 0.25 s even if you turn the harmonic measurement function back OFF.

Holding the Display

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

Updating the Displayed Data

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

Overrange/Error Displays

When 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 measurement function is different from the frequency measurement range of normal measurement. Refer to Chapter 16 for more details.

Overrange Display

The overrange display (being the same as for normal measurement; see section 2.3) will appear when all rms values of the 1st to 50th order reach the following value:

- Greater than equal to 140% of the rated range for voltage measurement range 600 V or current measurement range 20 A
- Greater than equal to 140% of the rated range for voltage measurement range 300 V or current measurement range 10 A if the crest factor is set to 6
- Greater than 200% of the rated range for voltage measurement ranges other than 600 V or current measurement ranges other than 20 A
- Greater than equal to 200% of the rated range for voltage measurement ranges other than 300 V or current measurement ranges other than 10 A if the crest factor is set to 6

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.

Measurement Abort/No Data Display (Bar Display)

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

- When there are no more measured data to be displayed during harmonic measurement;
- Soon after the harmonic measurement function has been turned ON;
- When the PLL synchronization is being re-established;
- Until the initial measured 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);
- When an element which is not assigned to the measurement object, is selected. However, since the frequency is not related to the element setting, the fundamental frequency designated as the PLL source can be displayed.

Averaging Function

Exponential averaging is performed with an attenuation constant of 8.

Output to an External Plotter

Using the GP-IB or serial interface, harmonic measurement data can be printed as value or graph on an external plotter.

Effect of Aliasing

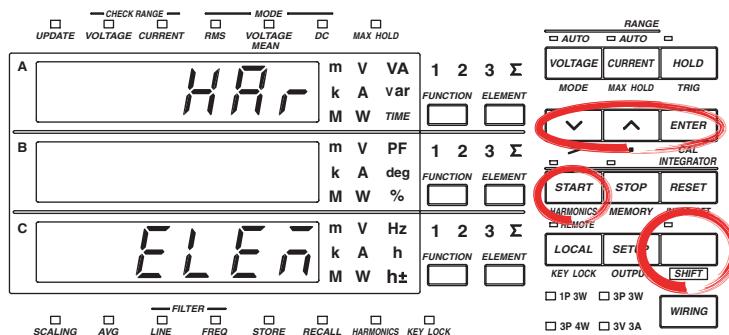
This instrument is not equipped with an internal aliasing filter. Due to aliasing accidental errors may occur under the following circumstances.

Fundamental frequency f in Hz

- | | |
|-----------------------|--|
| $40 \leq f < 70$ | When harmonic components of the 256th or higher exist; |
| $70 \leq f < 130$ | When harmonic components of the 128th or higher exist; |
| $130 \leq f < 250$ | When harmonic components of the 64th or higher exist; |
| $250 \leq f \leq 440$ | When harmonic components of the 32nd or higher exist. |

7.2 Setting the Target Element, PLL Source and Harmonic Distortion Method

Keys

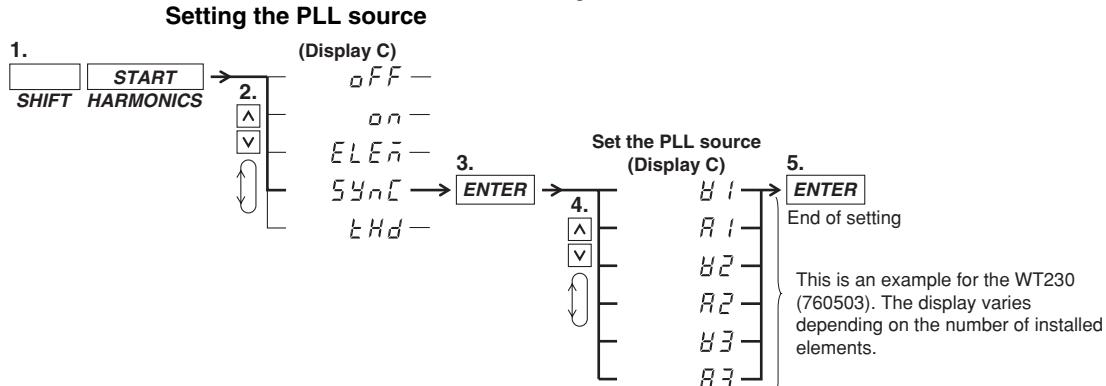
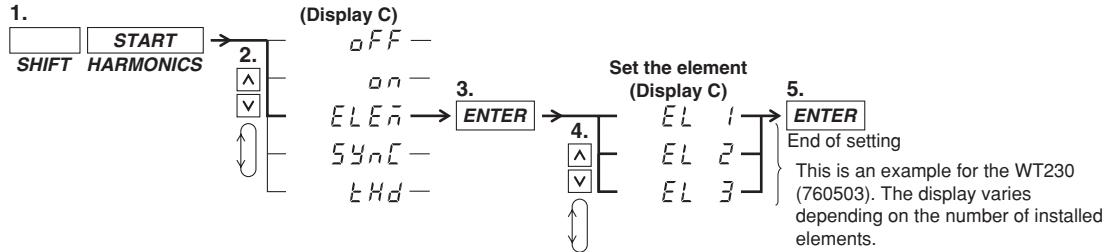


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

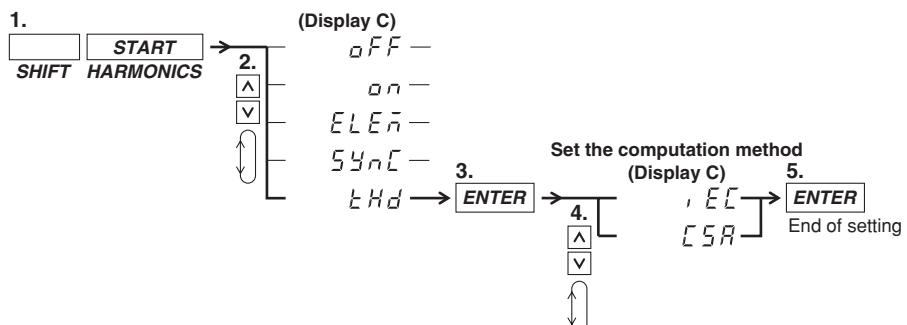
Procedure

- 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 Target Element (WT230 only)



Method of the Harmonic Distortion



7.2 Setting the Target Element, PLL Source and Harmonic Distortion Method

Explanation

Setting the Target Element

Only one input element should be set for harmonic measurement. The initial value is EL1. At the WT210 the element setting menu does not appear.

- EL1: Element 1 is used for measurement;
- EL2: Element 2 is used for measurement; For 760502, this menu is not shown;
- EL3: Element 3 is used for measurement.

Setting the PLL source

For harmonic measurement, 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 of element 1 as the PLL source;
- A1: Sets the current of element 1 as the PLL source;
- V2: Sets the voltage of element 2 as the PLL source;
- A2: Sets the current of element 2 as the PLL source;
- V3: Sets the voltage of element 3 as the PLL source;
- A3: Sets the current of element 3 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 frequency filter in cases where the fundamental frequency is 500 Hz or less and high frequency components are present. The cutoff frequency of this filter is 500 Hz. The filter is valid only for the PLL source.
- 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% (greater than or equal to 60% if the crest factor is set to 6) 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

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

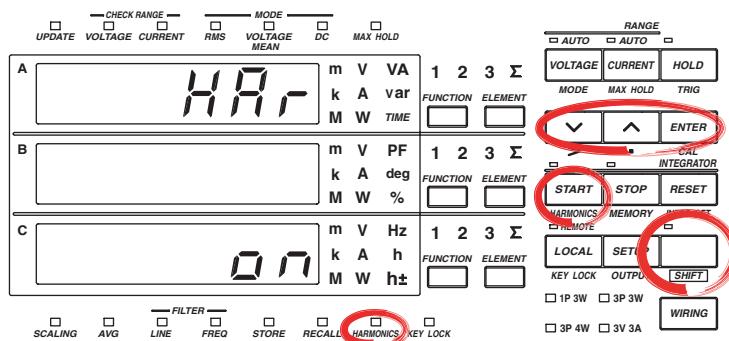
In case of CSA

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

- 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. Refer to Chapter 16 for more details.

7.3 Turning ON/OFF the Harmonic Measurement Function

Keys

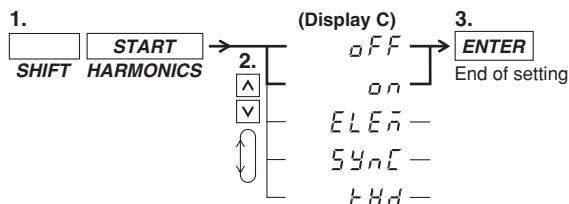


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 Measurement Function ON/OFF



Explanation

Turning the Harmonic Measurement Function ON/OFF

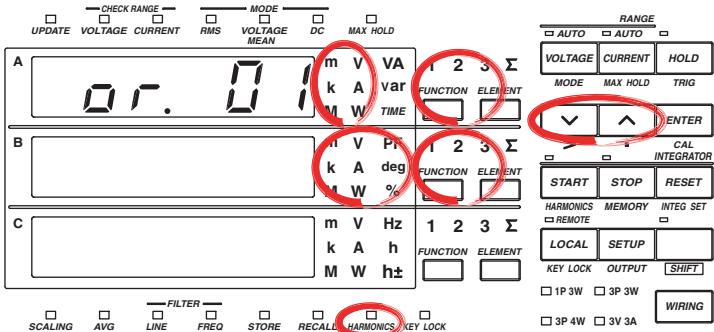
- on: Pressing the ENTER key after selecting on will result in starting of the harmonic measurement and the HARMONICS indicator will light up. The harmonic order will be displayed on display A.
- off: Pressing the ENTER key after selecting off will result in stopping of the harmonic measurement and the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

Note

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

7.4 Setting the Harmonic Order and Displaying the Measured Harmonic Value

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT20 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

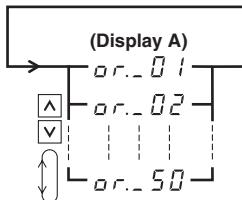
The following operations assume that the harmonic measurement function is turned ON.

Setting the Harmonics Order

- Light up the display function indicator of display A.

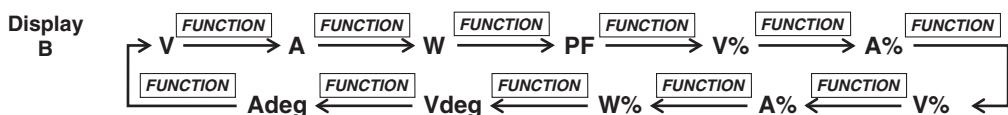


- Set the harmonics order.



Displaying the Measured Harmonic Values

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



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. Refer to Chapter 16 for more details on upper limits of analysis orders.

Displaying the Measured Harmonic Values

Depending on the setting of display function of display B and C, the measured data of 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 measured value of the voltage corresponding to the order shown on display A;
- A: Shows the measured value of the current corresponding to the order shown on display A;
- W: Shows the measured 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; Refer to page 7-5 for details. The display range is 0.00 to 99.99 to 100.0 to 999.9%.
- A%: Shows the harmonic distortion of the current followed by the character "t"; Two computation methods are available; Refer to page 7-5 for details. The display range is 0.00 to 99.99 to 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 when the number of displayed digits is 5 is 0.000 to 99.999 to 100.00 to 999.99%.
- A%: Shows the relative harmonic content of the current corresponding to the order shown on display A; The display range when the number of displayed digits is 5 is 0.000 to 99.999 to 100.00 to 999.99%.
- W%: Shows the relative harmonic content of the active power corresponding to the order shown on display A; The display range when the number of displayed digits is 5 is 0.000 to ±99.999 to ±100.00 to ±999.99%.
- V deg: In case 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.
In case 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: In case the fundamental (1st order) is shown on display A
Shows the same as in case of V deg.
In case 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.

7.4 Setting the Harmonic Order and Displaying the Measured Harmonic Value

• 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

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

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

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

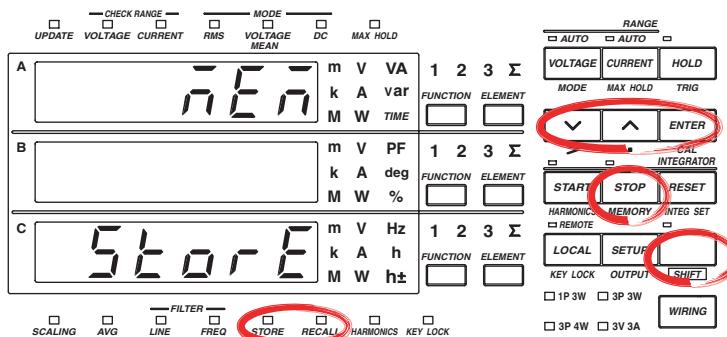
- V_k , A_k , W_k : Each component of 1st to 50th order of voltage, current and active power;
- k: Analysis order
- n: Maximum order. The maximum order depends on the fundamental frequency of the input set as the PLL source. Refer to Chapter 16 for more details.
- V Hz: Shows the fundamental frequency 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, refer to page 7-4. The measurement range is the same as in case of normal measurement.
The range of fundamental frequencies in case of harmonic measurement 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

- In case you select an input element using the ELEMENT key which is not the assigned element for the harmonic measurement or you selected a display function which is not being measured, then the bar display appears.
- When the harmonic measurement function is turned ON on the WT230, pressing the ELEMENT key will not result in moving to Σ .
- When pressing the FUNCTION key on display A, and the display function becomes V, A or W, then display A will show the same measured items as the V, A or W shown on display C.
- Characteristics such as maximum reading, display range, units, and prefix. which are not described on the previous page, are not different from the characteristics of normal measurement.

8.1 Storing/Recalling Measured/Computed Data

Keys

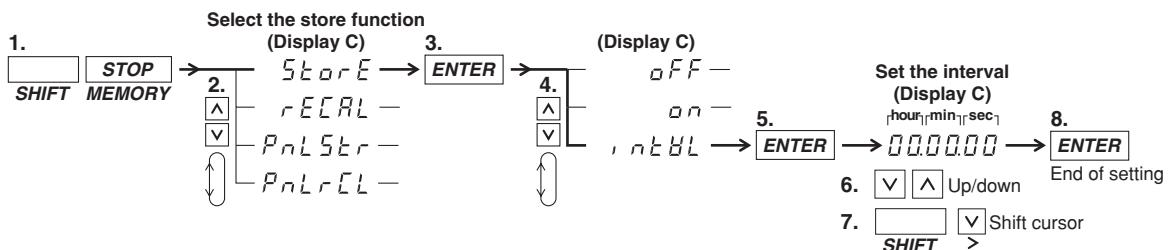


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

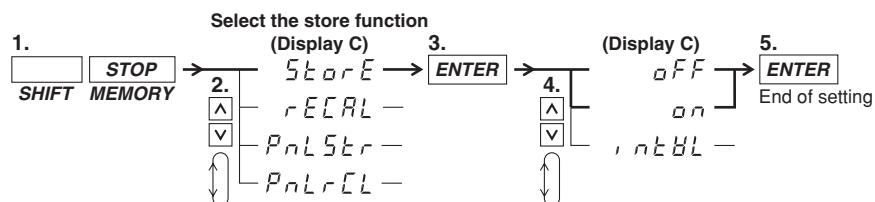
Procedure

- 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 Measured/Computed Data

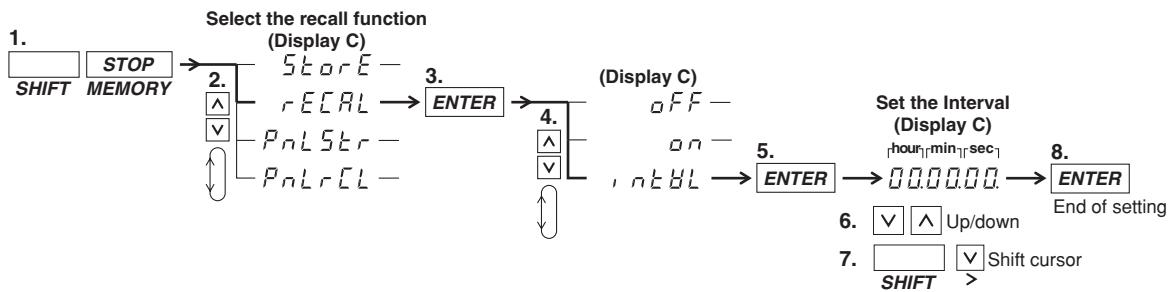


Turning Measured/Computed Data Storage ON/OFF

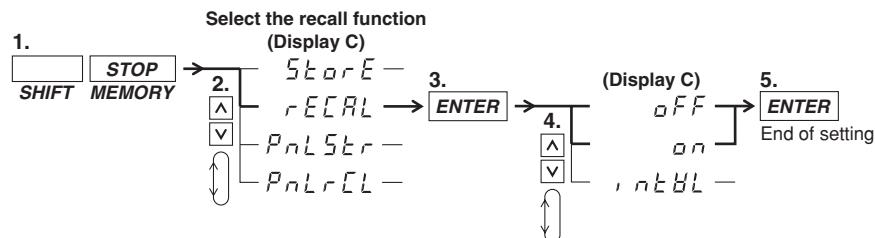


8.1 Storing/Recalling Measured/Computed Data

Setting the Recall Interval for Measured/Computed Data



Recalling Measured/Computed Data ON/OFF



Explanation

Storing Measured/Computed Data (Storing into Internal Memory)

One block consists of all data which are obtained when the display is updated once. 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. The number of blocks which can be stored into the internal memory is as follows.

Model	In case of normal measurement	In case of harmonic measurement
760401	600 Blocks	30 Blocks
760502	300 Blocks	30 Blocks
760503	200 Blocks	30 Blocks

• Items which can be stored

- When storing normal measured data (harmonic measurement function is turned OFF)

Each measured/computed/integrated data of normal measurement will be stored. However, only either the voltage frequency or current frequency will be stored.*

* If either one of the display function, V Hz or A Hz, is turned on, the frequency of the corresponding function is stored. If both display functions are OFF, the voltage frequency of the element assigned to display C is stored.
- When storing harmonic measurement data (harmonic measurement function is turned ON)

Normal measured data will not be stored. All measured data of the elements which are being used for the measurement, will be stored.

• Aborting Storage

The store operation stops in the following conditions.

- 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 starting storage, the recalling interval (see next page) is also set to the same value as the specified store interval.

- Setting range: 00.00.00 (0 hrs, 00 min, 00 sec) to 99.59.59 (99 hrs, 59 min, 59 sec)
- Initial value: 00.00.00

When set to 00.00.00, the store interval is set to the same value as the display update rate.

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. For a description of the lithium battery life, see section 15.6.
- When integrated values are not present, the bar 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 orders of harmonic measurement data are not present, the bar display will be stored as data.
- While storage is in progress, several settings cannot be changed, such as switching the harmonic measurement function ON/OFF, changing the target element, the PLL source, the harmonic distortion factor computation method, nor can display update rate, scaling, averaging, filter, measurement synchronization source, and crest factor 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.
- 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 also set to the maximum values (MAX) that are held.
- Settings for the the MAX hold function cannot be changed during storage.

8.1 Storing/Recalling Measured/Computed Data

Recalling Measured/Computed Data (Retrieving Data from the Internal Memory)

After displaying data stored in the internal memory, 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**

The recall operation stops in the following conditions.

- 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 interval for repeating the recall operation.

- Setting range: 00.00.00 (0 hrs, 00 min, 00 sec) to 99.59.59 (99 hrs, 59 min, 59 sec)
- Initial value: 00.00.00

When set to 00.00.00, the recalling interval is set to the display update rate as when the data was stored.

Recalling ON/OFF

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

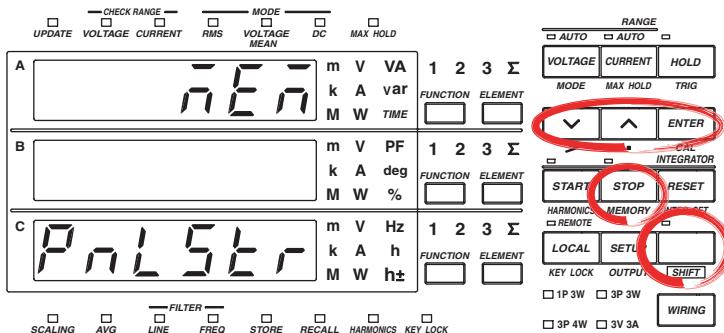
- on: Recalling will start by pressing the ENTER key after selecting “on”; the RECALL indicator will light while recalling is in progress.
- oFF: Recalling will stop by pressing the ENTER key after selecting “oFF”; the RECALL indicator will extinguish

Note

- During recalling, the measurement conditions/range* will become as those of the data being recalled. After recalling finishes, the original measurement conditions will return.
 - * Measurement range, measurement mode, measurement synchronization source, input filter ON/OFF, scaling ON/OFF, scaling constants, averaging ON/OFF, averaging mode, averaging coefficients, MAX hold ON/OFF, display update rate, crest factor, integration mode, integration time, harmonic measurement function ON/OFF, PLL source, target element, computation method of harmonic distortion factor
- 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 Setup Parameters

Keys

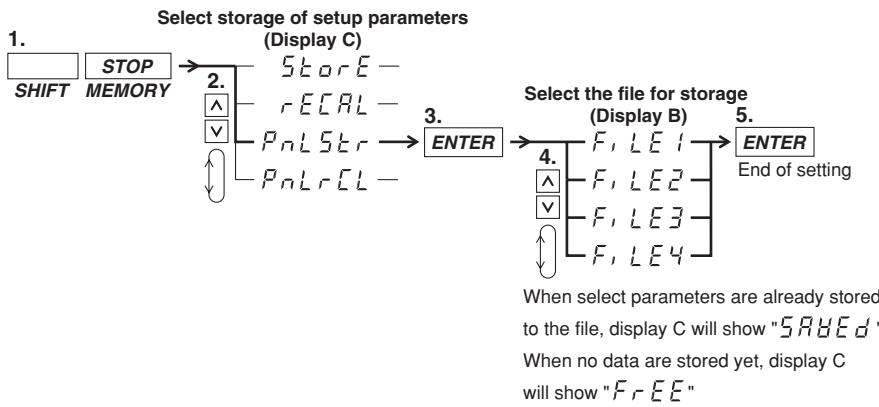


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

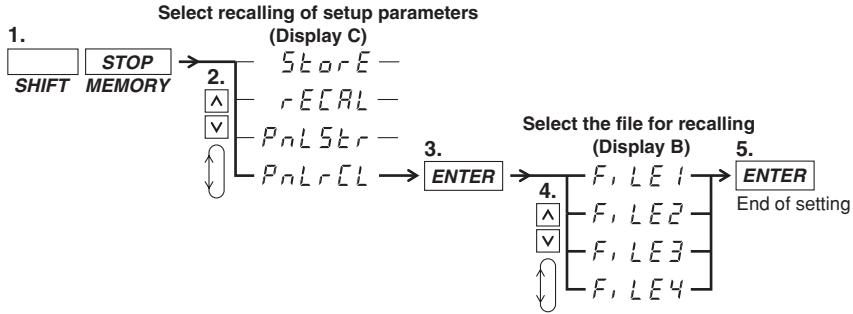
Procedure

- 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 Setup Parameters



Recalling Setup Parameters



8.2 Storing/Recalling Setup Parameters

Explanation

Storing Setup Parameters

- Stores the current setup parameters which consist of the following. Four destinations (FILE1/FILE2/FILE3/FILE4) are available.
Measurement range, measurement mode, measurement synchronization source, scaling settings, averaging settings, input filter settings, MAX hold ON/OFF setting, computation settings, number of displayed digits, display update rate setting, crest factor, 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.
- Setup parameters are saved in another internal memory than measured data.
- Saved setup parameters are backed up by the lithium battery in the same way as measured data. For a description of the lithium battery life, see section 15.6.

Recalling Setup Parameters

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

9.1 Pin Arrangement and Pin Assignments of the External I/O Connector (Option)



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 between CURRENT, \pm (VOLTAGE and CURRENT side) input terminals and ground
400 Vrms max.

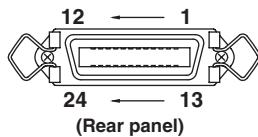
Voltage between VOLTAGE input terminal and ground
600 Vrms max.

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

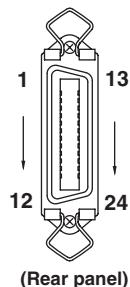
Using the external I/O connector, this instrument can be remotely controlled and D/A output can be done. The connector's pin sequence and signal assignment is as follows.

Connector's Pin Arrangement

WT210: 760401

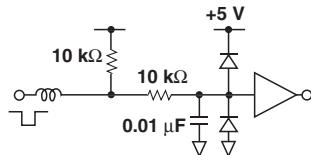


WT230: 760502, 760503



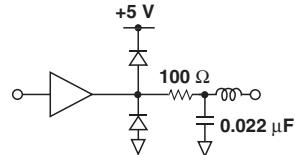
Pin Assignment

Remote control:input circuit



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

Remote control:output circuit



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

/DA4 specifications (for WT210: 760401 only)

remote control, 4 channel D/A output

Pin No.	Signal	Pin No.	Signal
1	DIGITAL COM	13	DIGITAL COM
2	EXT HOLD (Input)	14	EXT TRIG (Input)
3	EXT START (Input)	15	EXT STOP (Input)
4	EXT RESET (Input)	16	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

9.1 Pin Arrangement and Pin Assignments of the External I/O Connector (Option)

/DA12 specifications (for WT230: 760502, 760503)

remote control, 12 channel D/A output

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

/CMP specifications (for WT210/WT230: 760401, 760502, 760503)

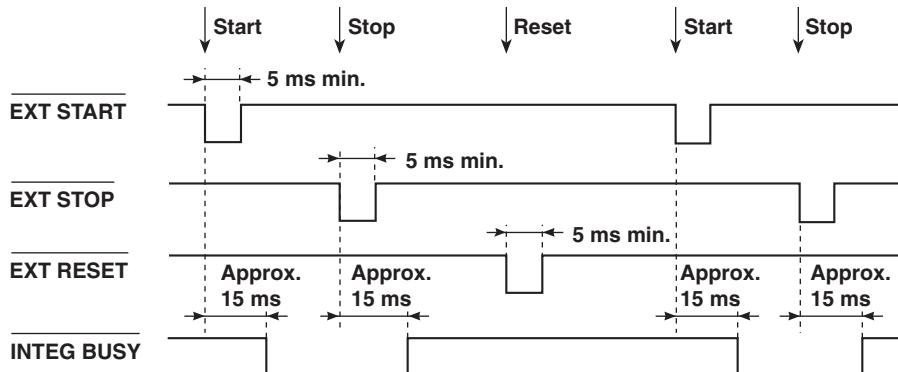
remote control, 4 channel D/A output, 4 channel comparator output

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

9.2 Remote Control (Option)

Controlling Integration

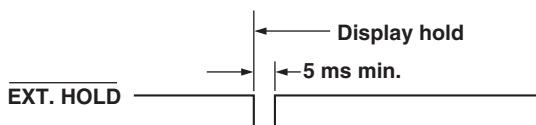
To control integration, apply timing signals according to the timing chart below.



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)

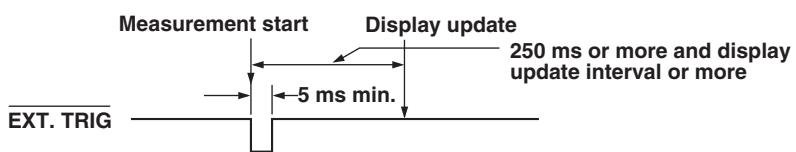
To hold the display update, apply the **EXT. HOLD** signal according to the timing chart below.



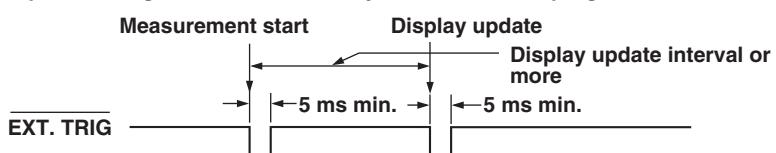
Updating Display Data which has been held (same function as TRIG key)

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



Note

If the period of the EXT. TRIG signal does not meet the conditions of the figure above, the signal may not be identified by the WT210/WT230.

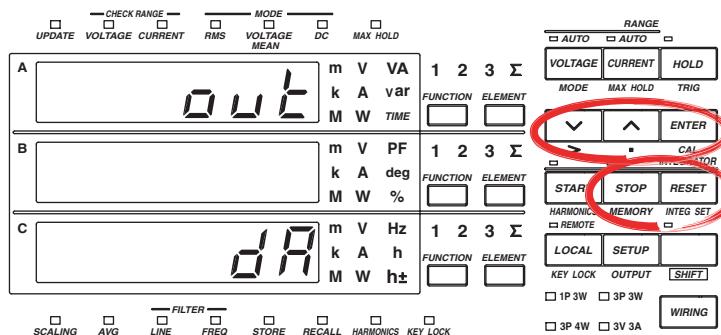


CAUTION

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 (Option)

Keys

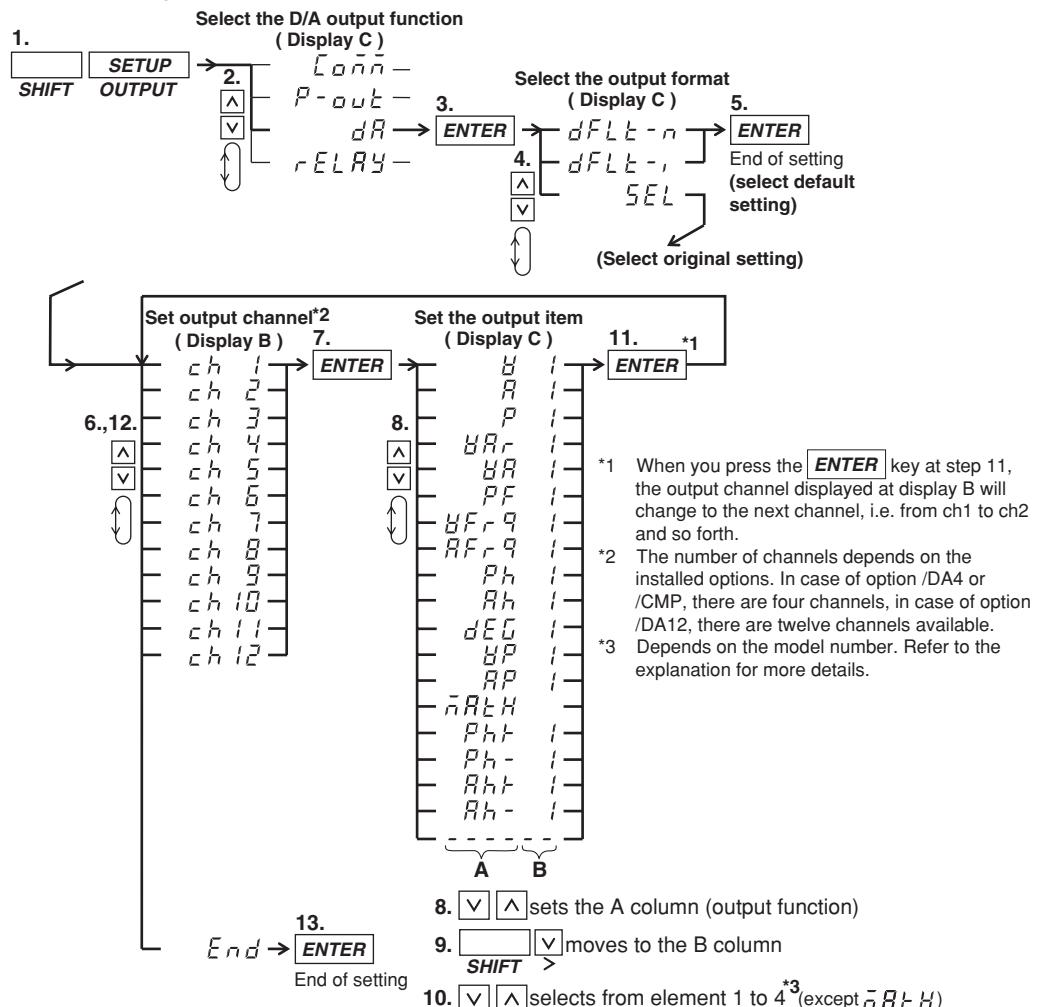


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, “Operation Keys and Functions/Element Display.”

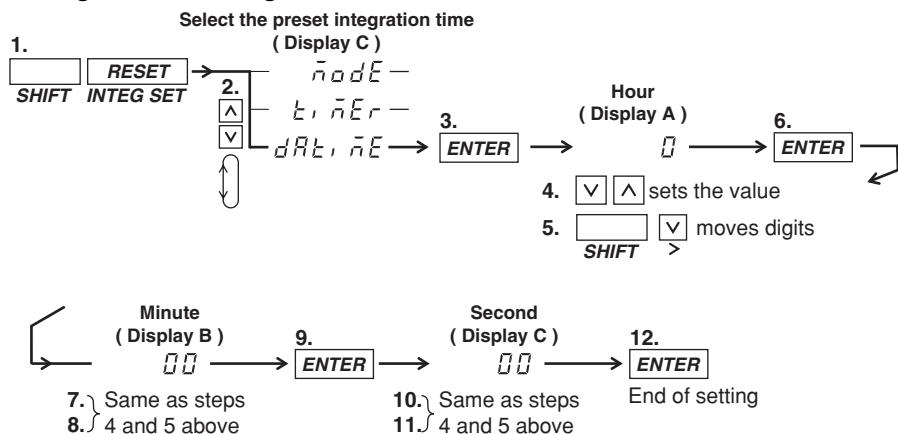
Procedure

- 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 D/A Output



Setting the Preset integration Time



Explanation

D/A Output

Voltage, current, active power, apparent power, reactive power, power factor, phase angle, harmonic measurement data and integrated data values will be output as a 5 V FS analog voltage. The number of items which can be output (number of output channels) depends on the installed options.

Default Setting of the Output Format (D/A)

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.

Option	/DA4			/DA12			/CMP		
	Model	760401	760502	760503	760401	760502	760503	760401	760502
Output channel	ch1	V	V1 *2	V1 *2	V	V1 *2	V1 *2		
	ch2	A	-	V2	A	A1	A1		
	ch3	W	V3	V3	W	W1	W1		
	ch4	Hz *1	ΣV	ΣV	Hz *1	Hz *1	Hz *1		
	ch5		A1	A1					
	ch6		-	A2					
	ch7			A3	A3				
	ch8		These channels cannot be set.	ΣA	ΣA				
	ch9			W1	W1				
	ch10			-	W2				
	ch11			W3	W3				
	ch12			ΣW	ΣW				

*1 If either one of the display function, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both display functions are OFF, the voltage frequency of the element assigned to display C is output.

*2 The number corresponds to input element 1, 2, or 3.

9.3 D/A Output (Option)

- **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.

Option	/DA4	/DA12		/CMP			
	Model	760401	760502	760503	760401	760502	760503
Output channel	ch1	W	W1 *2	W1 *2	W	W1 *2	W1 *2
	ch2	Wh	-	W2	Wh	Wh1	Wh1
	ch3	Ah	W3	W3	Ah	Ah1	Ah1
	ch4	Hz *1	ΣW	ΣW	Hz *1	Hz *1	Hz *1
	ch5		Wh1	Wh1			
	ch6		-	Wh2			
	ch7	These channels cannot be set.	Wh3	Wh3			
	ch8		ΣWh	ΣWh			
	ch9		Ah1	Ah1			
	ch10		-	Ah2			
	ch11		Ah3	Ah3			
	ch12		ΣAh	ΣAh			

*1 If either one of the display function, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both display functions are OFF, the voltage frequency of the element assigned to display C is output.

*2 The number corresponds to input element 1, 2, or 3.

Setting an Original Output Format

The items to be output (output function and element) are set per each output channel.

- **Setting the output channel**

The number of channels depends on the installed options and can be selected from the following.

- /DA4: 4 channels
- /DA12: 12 channels
- /CMP: 4 channels

- **Setting the output function (corresponds to column A in the procedure)**

The output function 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 function, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both display functions are OFF, the voltage frequency of the element assigned to display C that was illuminated last when display function V Hz or A Hz was illuminated is output.

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

- **Setting the element (corresponds to column B in the procedure)**

- WT210 (760401) no such element setting available;
- WT230 (760502) element can be selected from 1, 3, or 4
- WT230 (760503) element can be selected from 1, 2, 3, or 4

The element number 4 represents Σ.

Setting the rated integration time

The D/A output of integrated values is 5.0 VFS when rated value is input continuously for the specified time (integration preset time). This is also true when scaling or Σ is specified.

Selectable range: 0.00.00 (0 hours 00 minutes 00 seconds) to 10000.00.00 (10000 hours, 00 minutes, 00 seconds).

The initial value is 1.00.00. If the time is set to 0.00.00, the DA output value becomes 0 V.

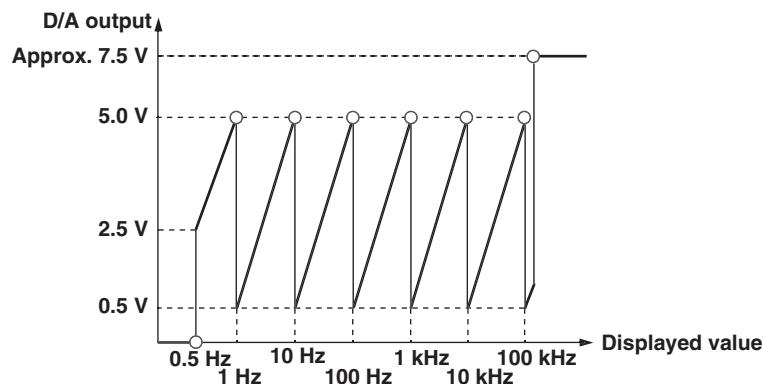
Note

- 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 configured so that 5.0 VFS 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 VFS is output when the value corresponding to the range rating is applied.
- Also when Σ is specified for the element with the scaling constant of each element is different, the D/A output is adjusted so that 5.0 VFS is output when the value corresponding to the range rating is applied to each element.
- If $\bar{R}E\bar{H}$ (computation) is specified, the D/A output is 0 V except for efficiency and average active power.

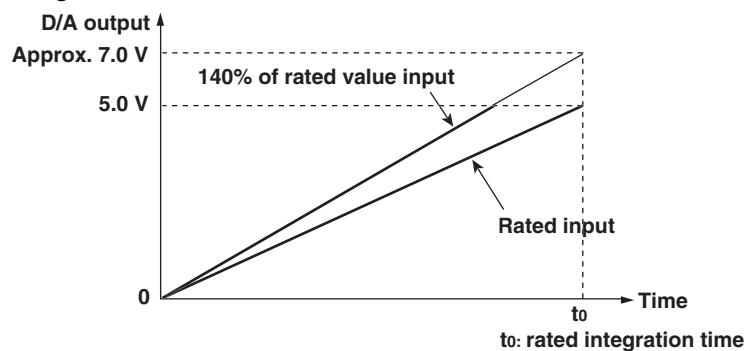
9.3 D/A Output (Option)

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

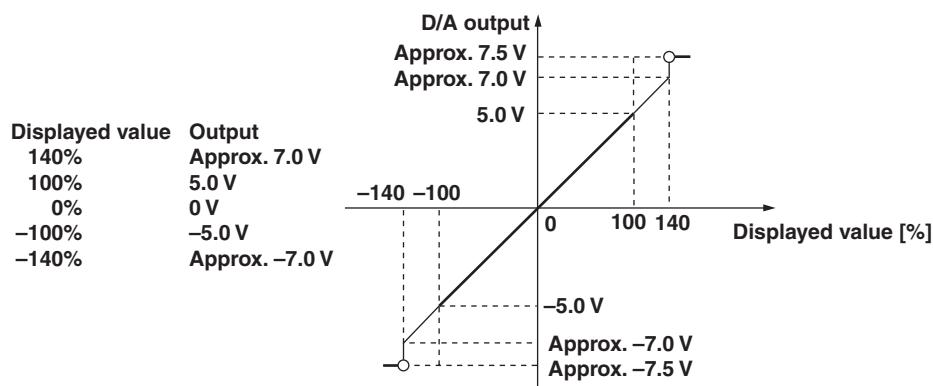
- Frequency



- Integrated value



- Other items



- 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.
- If the MATH setting is set to efficiency, the output will be +5 V for 100%
- For Vp and Ap, the output will be ± 5 V when the value is three times (six times if the crest factor is set to 6) the range.

9.4 Comparator Function (Option)

When the instrument is equipped with option /CMP you can compare the measured, computed, and integrated 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 (4 ch) 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 rating: rated 24 V/0.5 A (max. 30 V/0.5 A)
- Minimum load: 10 mV/10 μ A
- Operating life with load: approx. 500000 times (at contact rating)
- Operating life without load: approx. one hundred million times
- Contact Response time: 2 times the display update rate or less

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

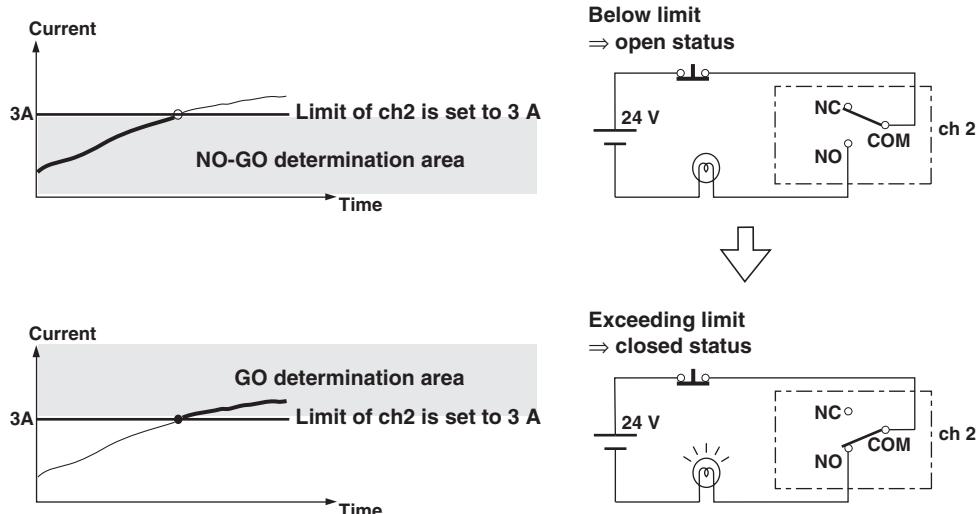
The following two comparator modes are available.

Single Mode

If the measured, computed, and integrated 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. Refer to 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.



9.4 Comparator Function (Option)

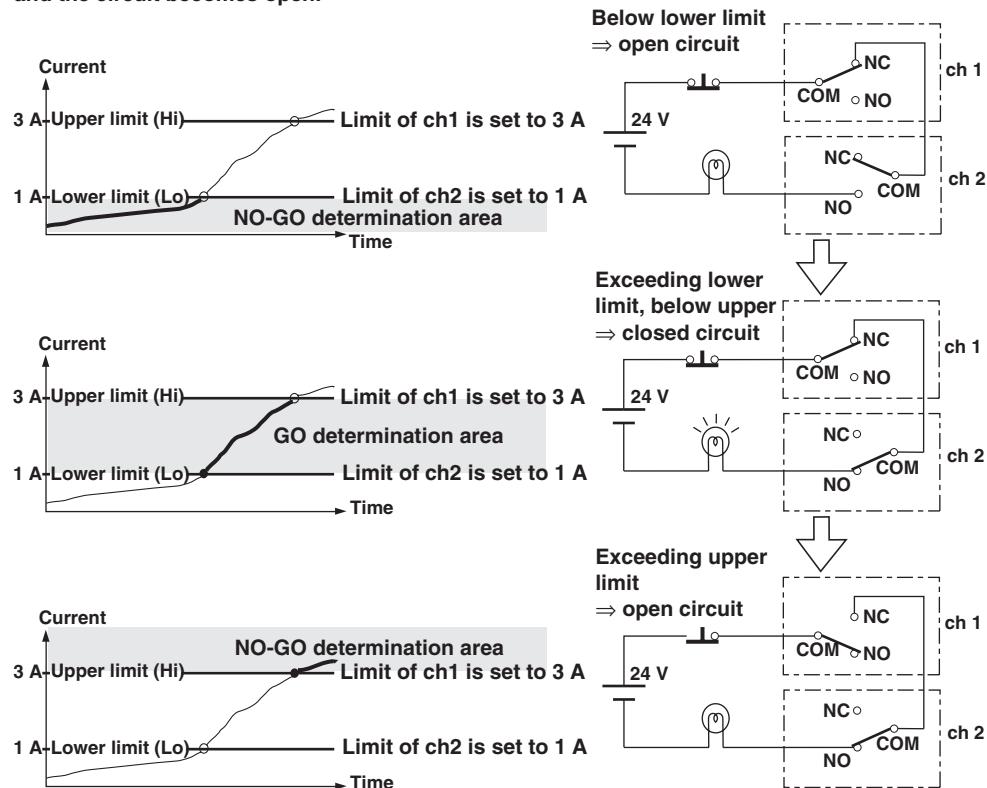
Dual Mode

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, and integrated 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 than 3 A: GO will be determined and the circuit becomes closed.

When the current value lies below 1 A, or exceeds 3 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 following combinations 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.



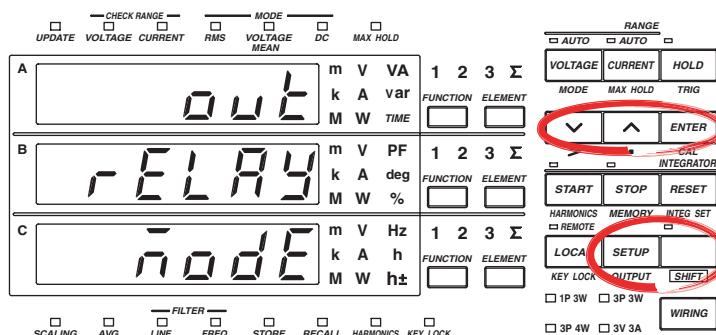
CAUTION

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 erroneous 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.
FrqErr (frequency error in case of harmonic measurement)	The NC contact is closed.
— (error when no data are present)	The NC contact is closed.

9.5 Setting the Comparator Mode (Option)

Keys

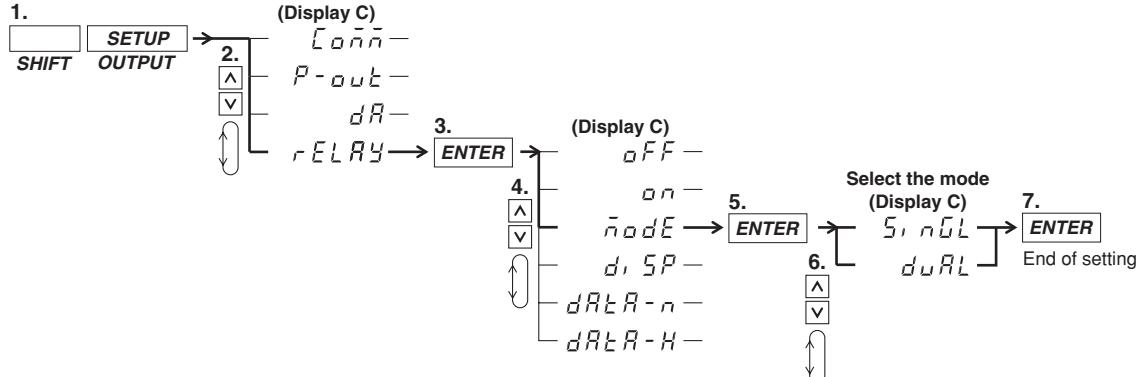


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 comparator function



Explanation

Setting the Comparator Mode

The following two settings are available. For details, see pages 9-9 and 9-10. 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 page 9-13 and succeeding pages), the situation will change as follows. Also verify the comparator limits again.

When you change the mode to the dual mode after having set limits in the single mode, the limit of ch2 (see page 9-15) will take the value of the limit of ch1, and the limit of ch4 will take the value of the limit of ch3. When you return again to the single mode, the previous values of each channel will be restored.

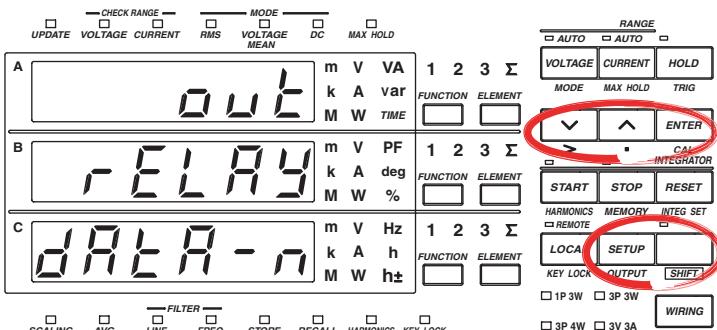


CAUTION

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

9.6 Setting the Comparator Limit Values (Option)

Keys



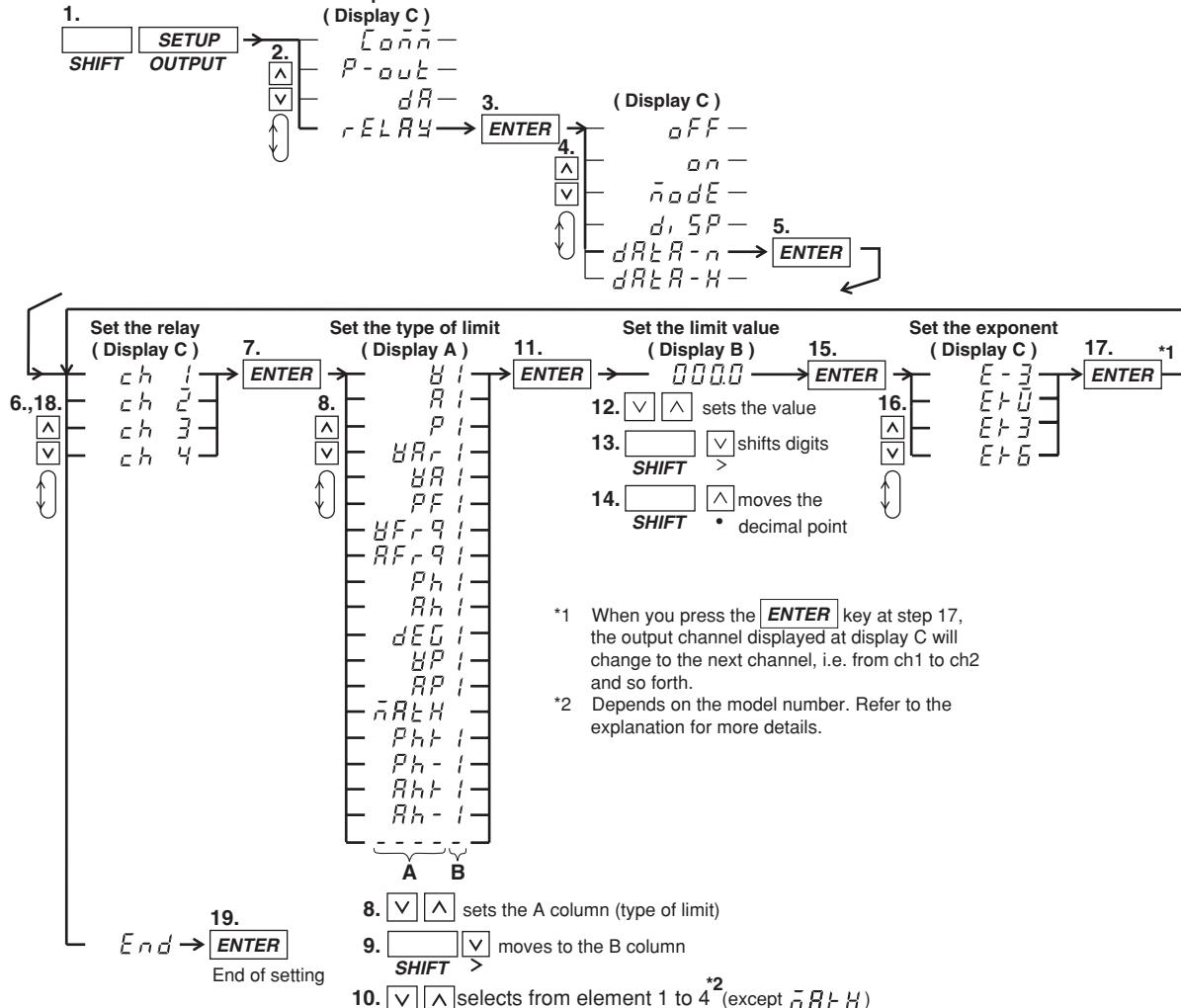
The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, “Operation Keys and Functions/Element Display.”

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

Select the comparator function

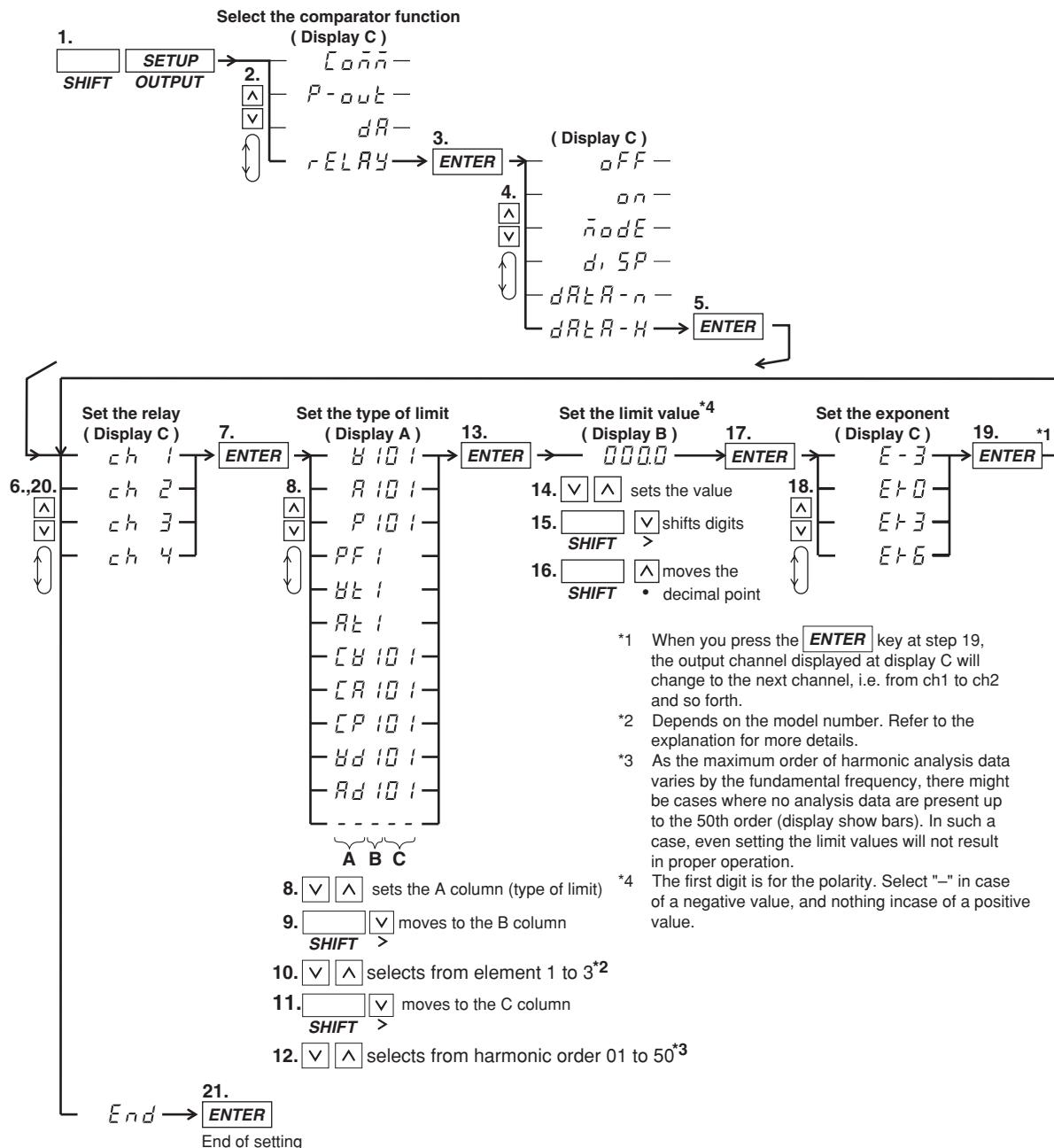


*1 When you press the **ENTER** key at step 17, the output channel displayed at display C will change to the next channel, i.e. from ch1 to ch2 and so forth.

*2 Depends on the model number. Refer to the explanation for more details.

9.6 Setting the Comparator Limit Values (Option)

Setting the Comparator Limit Values in case of Harmonic Measurement



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 separately.

- **Selecting the relay**

Selects the relay for assigning the type of limit from Ch1 to ch4.

- **Selecting the type of limit (corresponds 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 only the same type of limit can be selected 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), AFrq (current frequency), 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^{*}), Ah- (negative ampere hour value^{*}), ----- (no data)

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

- **Selecting the element (corresponds to column B in the procedure)**

- WT210 (760401) no such element setting available;
- WT230 (760502) element can be selected from 1, 3, or 4
- WT230 (760503) element can be selected from 1, 2, 3, or 4

The element number 4 represents Σ .

- **Setting the limit value**

No element setting is available on the WT210.

Setting range: 0.000 to ± 9999

Initial setting:

ch1 : V (type) : 1 (element) : 600.0 (value) : E+0 (exponent) [600 V voltage limit of element 1 for channel 1]

ch2 : A (type) : 1 (element) : 20.00 (value) : E+0 (exponent) [20.00 A current limit of element 1 for channel 2]

ch3 : P (type) : 1 (element) : 1.200 (value) : E+3 (exponent) [1.2 kW active power limit of element 1 for channel 3]

ch4 : PF (type) : 1 (element) : 1.000 (value) : E+0 (exponent) [Power factor 1 limit of element 1 for channel 4]

- **Selecting 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 Measurement

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

- **Selecting the relay**

Selects the relay (ch1 to ch4) for which the type of limit and its value will be set.

- **Selecting the type of limit (corresponds 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 only the same type of limit can be selected 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 details on the meaning of harmonic measurement values, see chapter 7.

9.6 Setting the Comparator Limit Values (Option)

- **Selecting the element (corresponds to column B in the procedure)**
 - WT210 (760401) no such element setting available;
 - WT230 (760502) element can be selected from 1 or 3
 - WT230 (760503) element can be selected from 1, 2, or 3

- **Selecting the harmonic order (corresponds to column C in the procedure)**

Setting range: 01 to 50

Initial value: refer to the following.

The maximum order of harmonic measurement data varies by the fundamental frequency. Therefore, there might be cases where no measure data is present up to the 50th order (and the display will show bars). In such a case, even if you select an harmonic order, determination will not be carried out. Therefore, before setting, verify the maximum order (chapter 16) and the fundamental frequency of the object of measurement.

- **Setting the limit value**

No element setting is available on the WT210.

Setting range: 0.000 to ±9999

Initial setting:

```
ch1 : V (type) : 1 (element) : 600.0 (value) : E+0 (exponent) [ 600 V voltage  
limit of element 1 for channel 1]  
ch2 : A (type) : 1 (element) : 20.00 (value) : E+0 (exponent) [ 20.00 A current  
limit of element 1 for channel 2]  
ch3 : P (type) : 1 (element) : 1.200 (value) : E+3 (exponent) [ 1.2 kW active  
power limit of element 1 for  
channel 3]  
ch4 : PF (type) : 1 (element) : 1.000 (value) : E+0 (exponent) [ Power factor 1  
limit of element 1 for channel 4]
```

- **Selecting the exponent**

The following selections are available. The initial value is as described above.

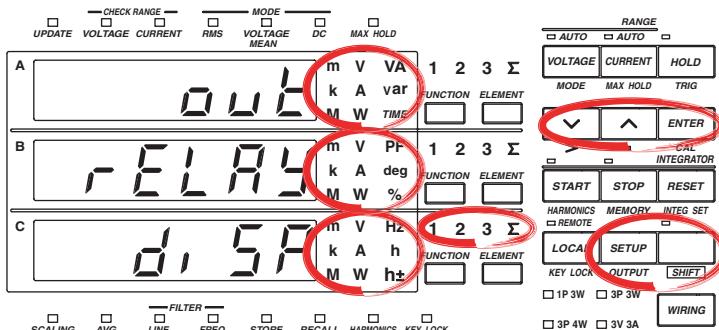
E−3 (10^{−3}), E+0 (10⁰), E+3 (10³), E+6 (10⁶)

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 measurement data, make sure to set the harmonic measurement function to ON before you set the comparator function ON (see section 9.8).
- Although the four relays used in case of normal measurement and in case of harmonic measurement are the same, the contents of the settings will be kept for both separately. For example, even after setting a limit for ch1 in case of harmonic measurement 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 (Option)

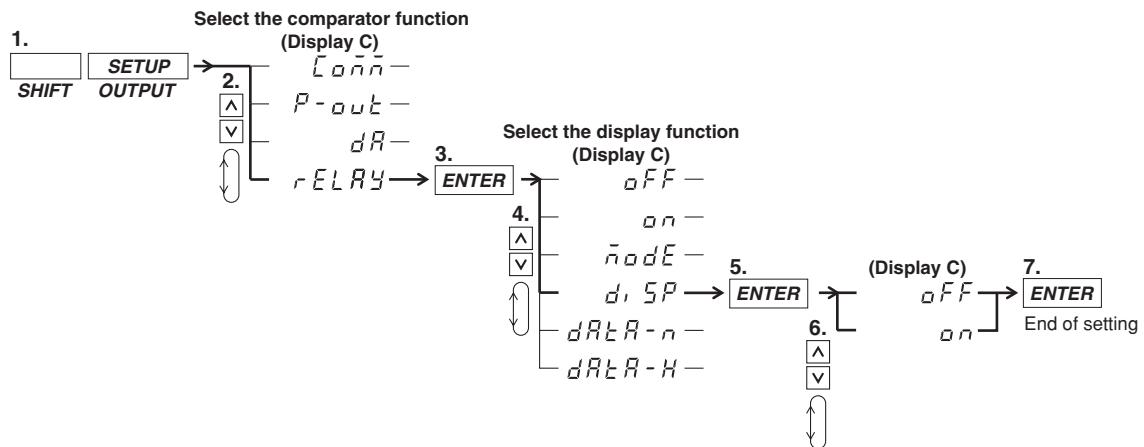
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.



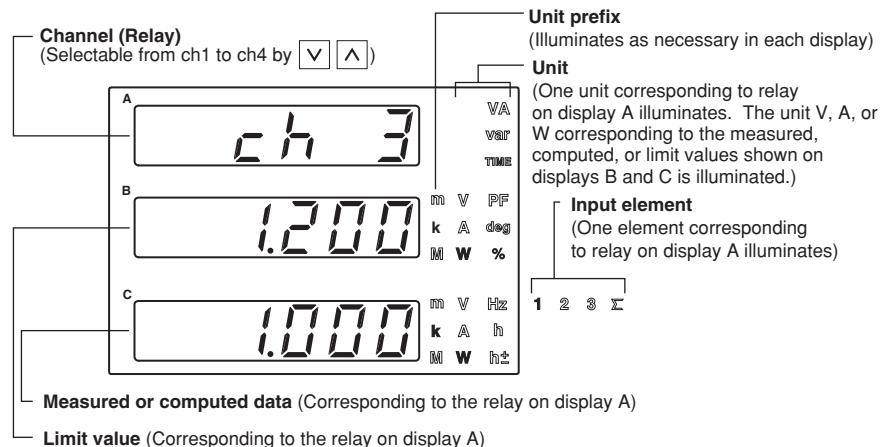
9.7 Comparator Display (Option)

Explanation

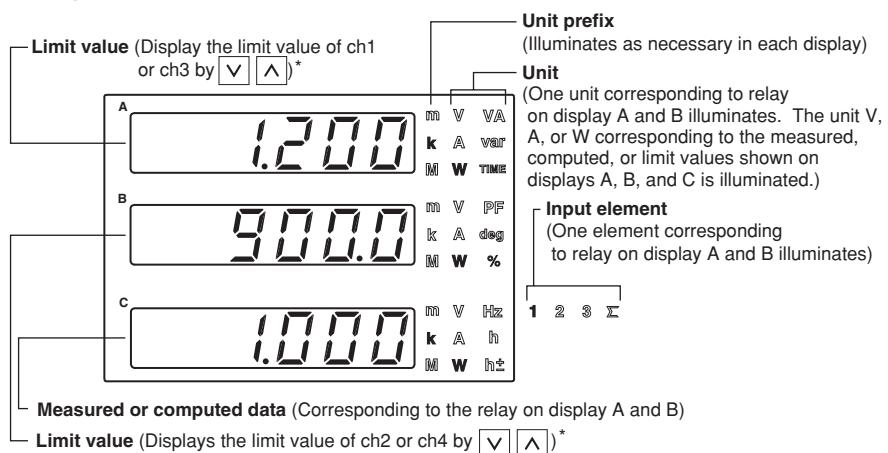
Comparator Display Function

This function allows you to verify the set limits together with measurement/computation 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 $\boxed{\vee}$ $\boxed{\wedge}$ keys. Check the displayed limit value, unit, or the limit value setting menu to see which pair is being displayed,

Comparator Display Function ON/OFF

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

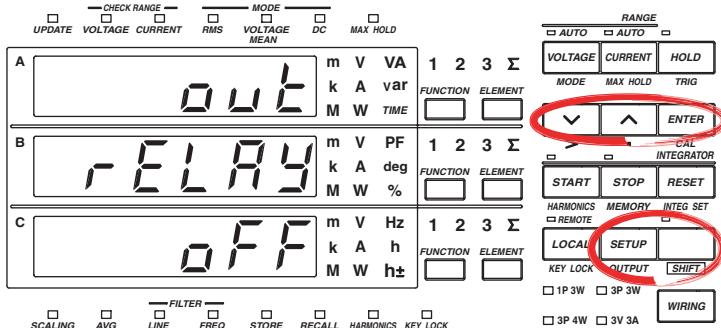
- **oN:** The comparator display will appear by pressing the ENTER key after selecting "on";
- **oFF:** The normal measurement or harmonic measurement display will appear by pressing the ENTER key after selecting "oFF."

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 (Option)

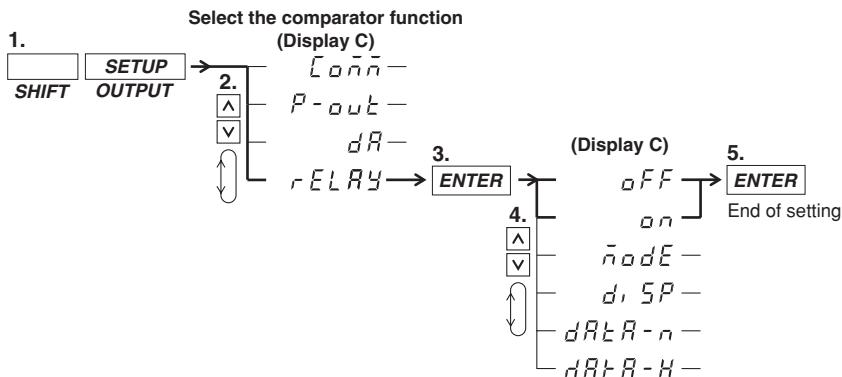
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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".

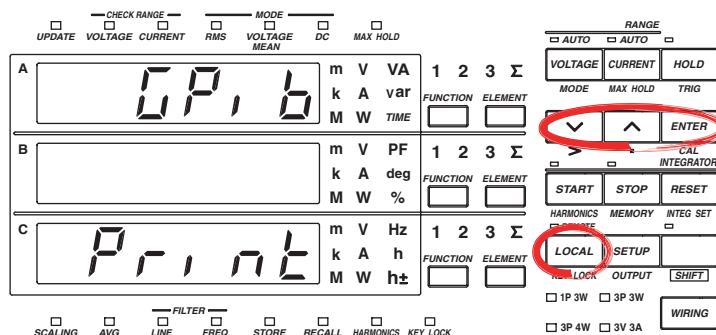


CAUTION

- After having turned ON the comparator function, do not change the comparator mode. Changing the type of limit 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 on page 9-11. When using the output relay as a control signal, make sure to match these control signals with other equipments to eliminate erroneous control.

9.9 Outputting to an External Plotter or External Printer

Keys

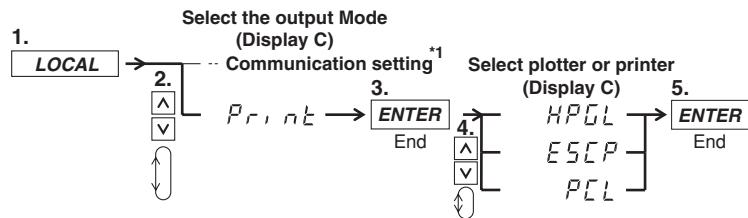


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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.

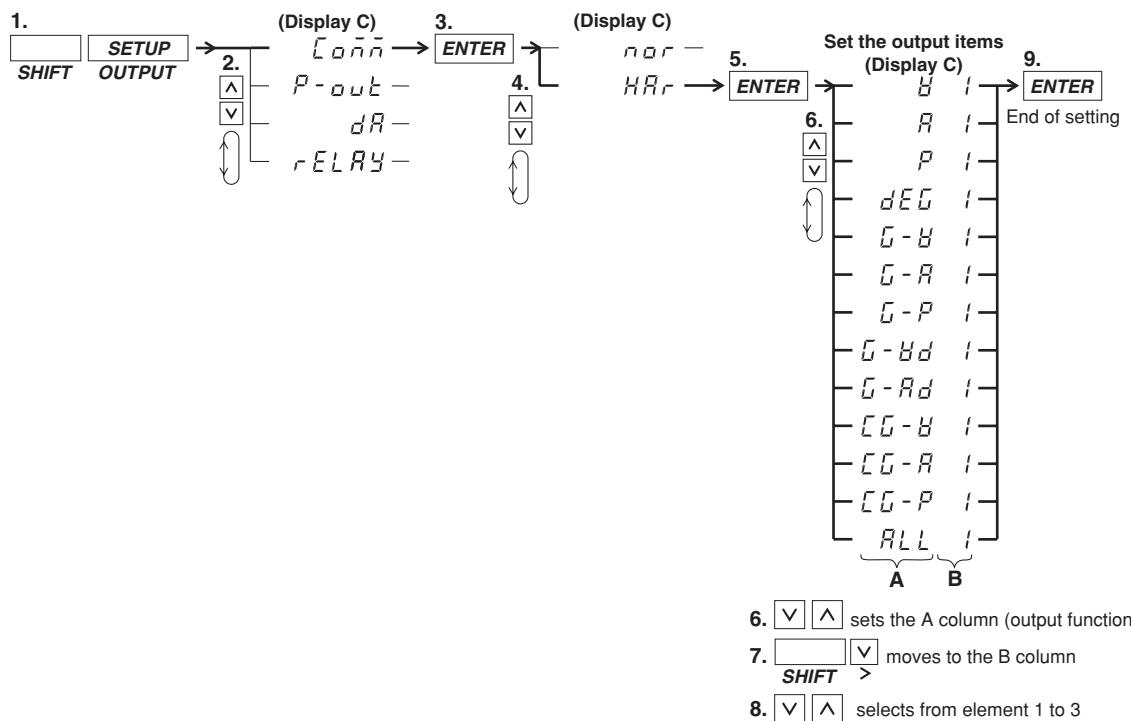
Selecting the Output Mode



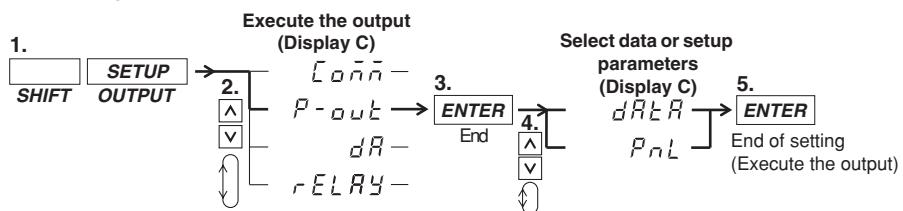
*1 Communication settings depend on your communication interface.
Refer to chapter 10 or 11 for the menu.

If the communication interface that you purchased is a serial interface, the menu proceeds to the "Handshaking method" menu of section 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.

Select the Output Items



Activating the Output



Explanation

Selecting the Output (Printing) Mode

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 and computed data is output. However, for frequency, if either one of the display function, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both display functions are OFF, the voltage frequency of the element assigned to display C is output.

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

- **Selecting the Output function (corresponds to column A in the procedure)**

One of the following items should be selected, which will then be printed out on an external plotter/printer. The initial value is V.

- V: Prints the numerical values of the measured values and relative harmonic content of the voltage;
 - A: Prints the numerical values of the measured values and relative harmonic content of the current;
 - P: Prints the numerical values of the measured values 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 measured voltage values;
 - G-A: Prints the numerical values^{*} and the graph of the measured current values;
 - G-P: Prints the numerical values^{*} and the graph of the measured 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 measured 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.

- **Setting the Element (corresponds to column B in the procedure)**

One of the following should be selected. The output items corresponding to the set element will then be printed out on an external plotter. The initial value is 1. On the WT210, this setting is always 1.

- 1: Select this when the output items of element 1 should be printed out;
- 2: Select this when the output items of element 2 should be printed out; This setting is not available on model 760502.
- 3: Select this when the output items of element 3 should be printed out.

Executing Output

After connecting the external plotter/printer to the WT210/WT230, execute the output.

dATA: All data selected as output items will be output.

PnL: All set-up parameters will be output.

Note

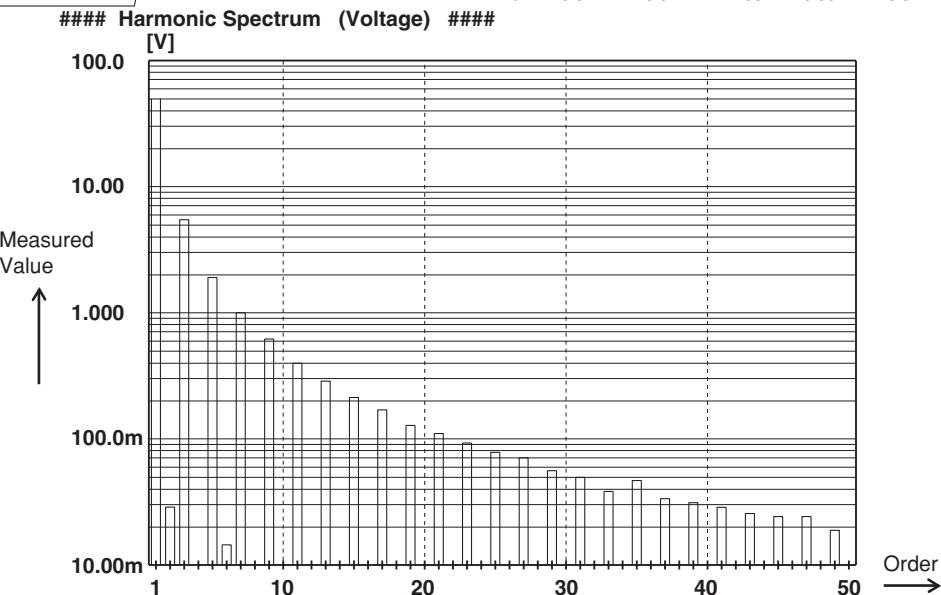
- The harmonic measurement items that are output via the communication interface (GP-IB or serial) vary depending on the output items of harmonic measurement selected here.
 - When V, A, P, or dEG is selected, the item is output via communication interface as-is.
 - When ALL is selected, V, A, P, and dEG become items output via the communication interface.
 - When graph printing G-V to CG-P is selected, only the numerical data of the item is output via the communication interface.
- The orders are printed up to the maximum analysis order.
- When the fundamental frequency lies outside the measurement range of the harmonic measurement (display B will show FrqEr), an attempt to output will result in an error code.
- When you set an element which is not the element of measurement (column B), an attempt to output will result in an error code.
- When no measured data is 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 (approx. 60 s) will result in an error code.
- If the LOCAL key is pressed during printing, printing stops.

Example of Output to an External Plotter

(Some sections in the following figure such as fonts and graph lines differ in appearance from the actual output.)

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

	Model	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	Crest Factor	Measured Value			Relative Harmonic Content		
														Order	Or	Volt [V]	Cont [%]	Or	Volt [V]
Voltage range	M/760503/HRM													1	49.62	11.09	2	0.03	0.06
Current range														3	5.50	4.01	4	0.01	0.02
Function and element														5	1.99	2.03	6	0.02	0.03
PLL source														7	1.01	2.03	8	0.01	0.01
Model	M/760503/HRM													9	0.62	1.24	10	0.00	0.01
V Range	60V													11	0.41	0.82	12	0.00	0.01
A Range	1A													13	0.30	0.60	14	0.00	0.00
Function	V 1													15	0.22	0.45	16	0.00	0.01
Sync	PLL V1													17	0.17	0.35	18	0.00	0.01
Freq V1	60.00 Hz													19	0.14	0.28	20	0.00	0.00
V1 rms	49.98 V													21	0.12	0.23	22	0.00	0.01
A1 rms	0.002 A													23	0.09	0.19	24	0.00	0.01
W1	0.02 W													25	0.08	0.16	26	0.00	0.01
DEG1 = LEAD	50.1 deg													27	0.07	0.14	28	0.01	0.01
PF1	0.641													29	0.06	0.11	30	0.00	0.01
V1 THD(IEC)	12.01 %													31	0.05	0.10	32	0.00	0.01
A1 THD(IEC)	95.58 %													33	0.04	0.08	34	0.00	0.01
AVG(EXP 8)	OFF													35	0.05	0.09	36	0.00	0.01
Scaling	OFF													37	0.03	0.07	38	0.00	0.00
Crest Factor	3													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



9.9 Outputting to an External Plotter / Printer

Example of Output to an External Printer

(Some sections in the following figure such as fonts and graph lines differ in appearance from the actual output.)

Output example of setup parameters

```
WT210/230 Setup Lists
Rev. : 2.01
Model : 760503-C2/EX2/HRM/CMP

Voltage range
Current range
External sensor scaling values
Items shown
Update Rate
Wiring method
Frequency filter
Line filter
Hold ON/OFF
Scaling ON/OFF
Voltage(PT)ratio
Current(CT)ratio
Power value
Averaging ON/OFF
Type
Coefficient
Crest factor
Integration mode
Integration timer
Rated integration time
Storage ON/OFF
Recall ON/OFF
Sync source
MAX Hold
Display digits
PLL source
Harmonics measurement function ON/OFF
Order
Element
Distortion formula
Comparator function ON/OFF
Mode
Display ON/OFF
Channel
Comm. command
Element
Voltage
Current
Active power
Apparent power
Reactive power
Power factor
Phase angle
Voltage peak
Current peak
Efficiency
Frequency
Integration status
Elapsed integration time
Watt-hour
Ampere-hour

V Range : 15 Vrms Auto
A Range : 0.5 Arms Auto
Ext. Sensor (Elem 1) = 50.00A
Ext. Sensor (Elem 2) = 50.00A
Ext. Sensor (Elem 3) = 50.00A

Display A : V Element 1
Display B : A Element 1
Display C : W Element 1
Mathematics : Efficiency
Update Rate : 250ms
Wiring : 1 Phase 3 Wire
Freq.Filter : Off
Line.Filter : Off
Hold : Off
Scaling : Off

PT Ratio (Elem 1) = 1.000
CT Ratio (Elem 1) = 1.000
Scaling Factor (Elem 1) = 1.000
PT Ratio (Elem 2) = 1.000
CT Ratio (Elem 2) = 1.000
Scaling Factor (Elem 2) = 1.000
PT Ratio (Elem 3) = 1.000
CT Ratio (Elem 3) = 1.000
Scaling Factor (Elem 3) = 1.000

Scaling Factor : Off
Averaging Type : Linear
Averaging Coefficient : 8
Reset Factor : 3

Integrate Mode : Manual
Integrate Timer : 00000:00:00
Rated Time (DA) : 00001:00:00

Store : Off
Store Interval : 00:00:00
Recall : Off
Recall Interval : 00:00:00
Sync. Source : A
Max Hold : Off
Resolution : High

Sync. Source : PLL V1
Harmonics : Off
Display A Order : 01
Harmonics Element : Element 1
Distortion Formula : IEC

Comparator : Off
Comparator Mode : Single
Comparator Display : Off
Comparator Channel : 1

Communication Command : 0

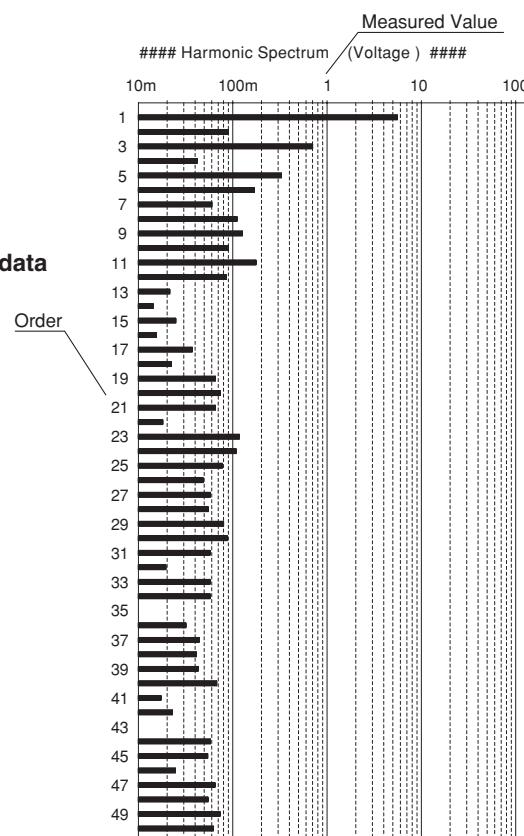
Element 1, Element 2, Element 3, Sigma
V 2.998, 2.993, 2.999, 2.997
A 49.910, 49.924, 49.937, 49.924
W 0.00, -0.00, 0.00, 0.0000k
VA 149.63, 149.42, 149.77, 0.4488k
Var 149.63, 149.42, 149.77, -0.1496k
PF 0.0000, -0.0000, 0.0000, 0.0000
DEG 90.0, 90.0, 90.0, 90.0
Vpk 5.28, 5.23, 5.25
Apk -86.51, -86.53, -86.50
EFF 644.7
HzV 59.999, ----, ----
Integrator : Start
Integrator Time : 00000:01:30

Element 1, Element 2, Element 3, Sigma
Wh+ 1.3051, 1.3031, 1.3058, 3.9140
Wh- -1.3050, -1.3031, -1.3058, -3.9138
Wh 0.0306m, 0.0663m, 0.0718m, 0.1687m
Ah+ 1.2512, 1.2516, 1.2519, 3.7546
Ah- 0.0000m, 0.0000m, 0.0000m, 0.0000m
Ah 1.2512, 1.2516, 1.2519, 3.7546
```

Output example of harmonic measured data

```
Model : M/760503/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
Crest Factor = 3

##### 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
```



Output example of normal measured data

```
Element 1, Element 2, Element 3, Sigma
V 2.998, 2.993, 2.999, 2.997
A 49.910, 49.924, 49.937, 49.924
W 0.00, -0.00, 0.00, 0.0000k
VA 149.63, 149.42, 149.77, 0.4488k
Var 149.63, 149.42, 149.77, -0.1496k
PF 0.0000, -0.0000, 0.0000, 0.0000
DEG 90.0, 90.0, 90.0, 90.0
Vpk 5.28, 5.23, 5.25
Apk -86.51, -86.53, -86.50
EFF 644.7
HzV 59.999, ----, ----
Integrator : Start
Integrator Time : 00000:01:30

Element 1, Element 2, Element 3, Sigma
Wh+ 1.3051, 1.3031, 1.3058, 3.9140
Wh- -1.3050, -1.3031, -1.3058, -3.9138
Wh 0.0306m, 0.0663m, 0.0718m, 0.1687m
Ah+ 1.2512, 1.2516, 1.2519, 3.7546
Ah- 0.0000m, 0.0000m, 0.0000m, 0.0000m
Ah 1.2512, 1.2516, 1.2519, 3.7546
```

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.

Overview of the GP-IB Interface

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

Mode	Function
Addressable mode	Listener
	measured and computed data output request setting parameters output request error code output request
Talker	measured and computed data output setting parameters output, error code output, status byte output
Talk-only mode	measured and computed data output

Addressable Mode

This mode allows the WT210/WT230 to be controlled using commands from the controller. The command system before the IEEE St'd 488.2 standard can be used. The WT210/WT230 outputs data when a data output request command "OD" is received. This mode allows data to be read at an arbitrary time.

488.2 Mode

Like the addressable mode, this mode allows the WT210/WT230 to be controlled using commands from the controller. This mode allows commands conforming to the IEEE St'd 488.2-1992 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 measurement data are output to the external plotter or external printer. For details, refer to section 9.9.

Note

Conventional power meters WT110, WT110E, WT130, WT200, WT1010, WT1030, WT1030M, WT2010, and WT2030 supported addressable mode A and addressable mode B. The WT210/WT230 supports addressable mode A.

GP-IB Interface Specifications

- Electrical & mechanical specifications: conforms to IEEE std 488-1978
- Functional specifications: refer to the table below
- Protocol: Varies depending on the mode used. See the previous page.
- Code: ISO (ASCII) code
- Address setting: 0 to 30 listener and talker addresses, or talk-only can be selected 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	PR0	no parallel polling capability
device clear	DC1	full device clear capability
device trigger	DT1	full device trigger capability
controller	C0	no controller function

**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 between CURRENT, \pm (VOLTAGE and CURRENT side) input terminals and ground

400 Vrms max.

Voltage between VOLTAGE input 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, and Remote/Local Modes

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)

Clears GP-IB input/output buffer, and resets an error. The setup information 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)

Updates the measured/computed data when in hold mode.

Same function as the SHIFT + HOLD (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. Setup 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. Setup 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 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 be 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 by 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 for Measured/Computed Data, Setup Parameters, and Error Codes

This section describes ASCII data output format in addressable mode or talk-only mode. For the data output format in 488.2 mode, see section 14.3.9, "MEASure Group" and pages 14-32 to 14-34.

Output Format of Normal Measured/Computed Data

Data Format

Normal measurement data consists of a 6-byte header and 11-byte data (total of 17 bytes).

Header (6 bytes)	Data (11 bytes)
------------------	-----------------

Header Section

h1	h2	h3	h4	h5	h6
----	----	----	----	----	----

h1 to h3: data type (Types of data that can be classified using h1 to h3)

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	EFF : Efficiency (WT230 only)	
CV1 : V1 crest factor	CV2 : V2 crest factor*	CV3 : V3 crest factor*
CA1 : A1 crest factor	CA2 : A2 crest factor*	CA3 : A3 crest factor*
A+B : (display A)+(display B)	A-B : (display A)-(display B)	
AxB : (display A)×(display B)	A/B : (display A)/(display B)	
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	
(Items that can be output for efficiency and crest factor vary depending on the model.)		

h4: Element

1: Element 1 2: Element 2 3: Element 3 4: Σ

h1-h4: data type (Types of data that is classified using h1 to h4)

A/B2: (display A)/(display B)2

A2/B: (display A)2/(display B)

AVGW: Average active power of element 1 while integration is in progress

AVW2: Average active power of element 2 while integration is in progress

AVW3: Average active power of element 3 while integration is in progress

AVW4: Average active power of element Σ while integration is in progress

(The average active power of element Σ varies depending on the wiring system.)

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

10.4 Output Measured/Computed Data, Setup Parameters, and Error Codes

Data Section

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	.	E	+	3
----	----	----	----	---	---	---	---	---	---	---	---	---	---	---	---

- **Data state in case of a computation overflow**

(“oF”, “PFErr”, “dEGER”, “ErrLo”, “ErrHi” 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 - - - -)**

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

- **Elapsed time of integration**

H	M	S	_	_	_	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11
---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	-----	-----

d1 to d5: Hour d6: “,”

d7 to d8: Minute d9: “:”

d10 to d11: Second

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 : by the FUNCTION key and ELEMENT key of display C (except WT210)
 - 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” (no data) 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 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	

10.4 Output Measured/Computed Data, Setup Parameters, and Error Codes

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 ch12 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

- WT210 (760401)

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	

- WT230 (760502)

Line 1	Data number	Terminator	(The data number will only be output in case of recall)
Line 2	V1 data	,	V3 data , SV data Terminator
Line 3	A1 data	,	A3 data , SA data Terminator
Line 4	W1 data	,	W3 data , SW data Terminator
Line 5	Frequency	,	Display C Terminator
Line 6	END	Terminator	

- WT230 (760503)

Line 1	Data number	Terminator	(The data number will only be output in case of recall)
Line 2	V1 data	,	V2 data , V3data , SV data Terminator
Line 3	A1 data	,	A2 data , A3 data , SA data Terminator
Line 4	W1 data	,	W2 data , W3 data , SW data Terminator
Line 5	Frequency	,	Display C Terminator
Line 6	END	Terminator	

Default Output Format in case Integration Measurement

- **WT210 (760401)**

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	

- **WT230 (760502)**

Line 1	Data number	Terminator	(The data number will only be output in case of recall)
Line 2	W1 data	,	W3 data , SW data Terminator
Line 3	Wh1data	,	Wh3data , SWhdata Terminator
Line 4	Ah1data	,	Ah3data , SAhdata Terminator
Line 5	Frequency	, Elapsed integration time	Terminator
Line 6	END	Terminator	

- **WT230 (760503)**

Line 1	Data number	Terminator	(The data number will only be output in case of recall)
Line 2	W1 data	,	W2 data , W3 data , SW data Terminator
Line 3	Wh1data	,	Wh2data , Wh3data , SWhdata Terminator
Line 4	Ah1data	,	Ah2data , Ah3data , SAhdata Terminator
Line 5	Frequency	, Elapsed integration time	Terminator
Line 6	END	Terminator	

Output Format of Harmonic Measurement Data

Data Format

Harmonic measurement data consists of an 8-byte header and 11-byte data (total of 19 bytes).

Header (8 bytes)	Data (11 bytes)
------------------	-----------------

Header Section

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 2: Element 2 3: Element 3

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

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	Measured value for fundamental (1st order)	,	Frequency	Terminator
Line 3	Measured value for 2nd harmonic	,	Relative harmonic content for 2nd harmonic	Terminator
		⋮		⋮
Line 51	Measured 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	Measured value for fundamental (1st order)	,	Frequency	Terminator
Line 3	Measured value for 2nd harmonic	,	Relative harmonic content for 2nd harmonic	Terminator
		⋮		⋮
Line 51	Measured 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		⋮		⋮
Line 51	Phase angle between fundamental and 50th harmonic of voltage	,	Phase angle between fundamental and 50th harmonic of current	Terminator
	END	Terminator		

- **In case of ALL setting**

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

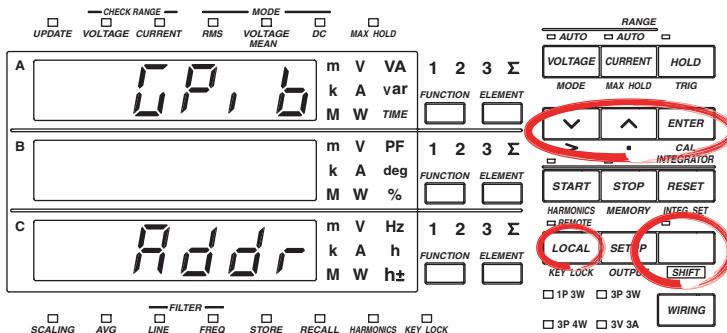
- The output format of each item is as described for each item above;
- The END line is not output for each item, but after finishing the entire output operation.

Output Format of Setup Parameters and Error Codes

See the response examples of “OS” and “OE” commands in section 13.1. For a description of the displayed information of the response examples, see the explanation of the respective command in section 13.1.

10.5 Setting the Address and Mode

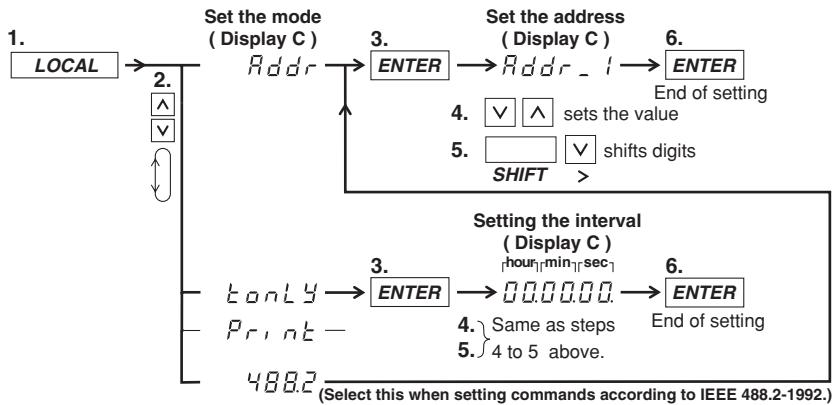
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 Mode

Refer to page 10-1 for details.

Setting the Address

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." The address is retained even if the instrument is initialized.

Talk-only Function

This function only allows the instrument to send data to other devices. Data can be sent even when talk-only is OFF. In talk-only mode, the instrument cannot be controlled by a controller.

Interval

In case of the talk-only mode, this setting specifies the interval to output data.

Setting range: 00.00.00 (0 hr 00 min 00 sec) to 99.59.59 (99 hrs 59 min 59 sec)

Initial value: 00.00.00

When set to 00.00.00, the interval is equal to the display update rate. In addition, when the specified interval is shorter than the display update rate, the data is output using the display update rate.

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

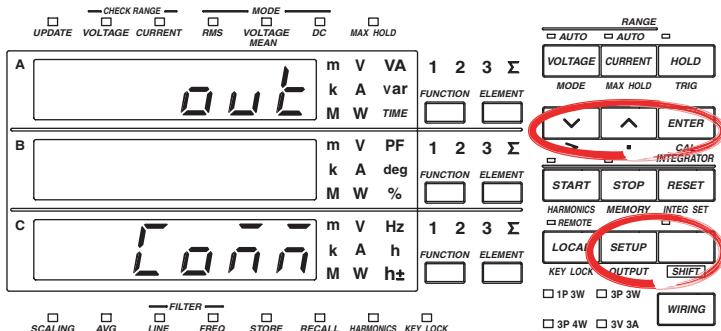
The sending terminator is set using the DL command. The initial setting is "CR+LF+EOI."

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

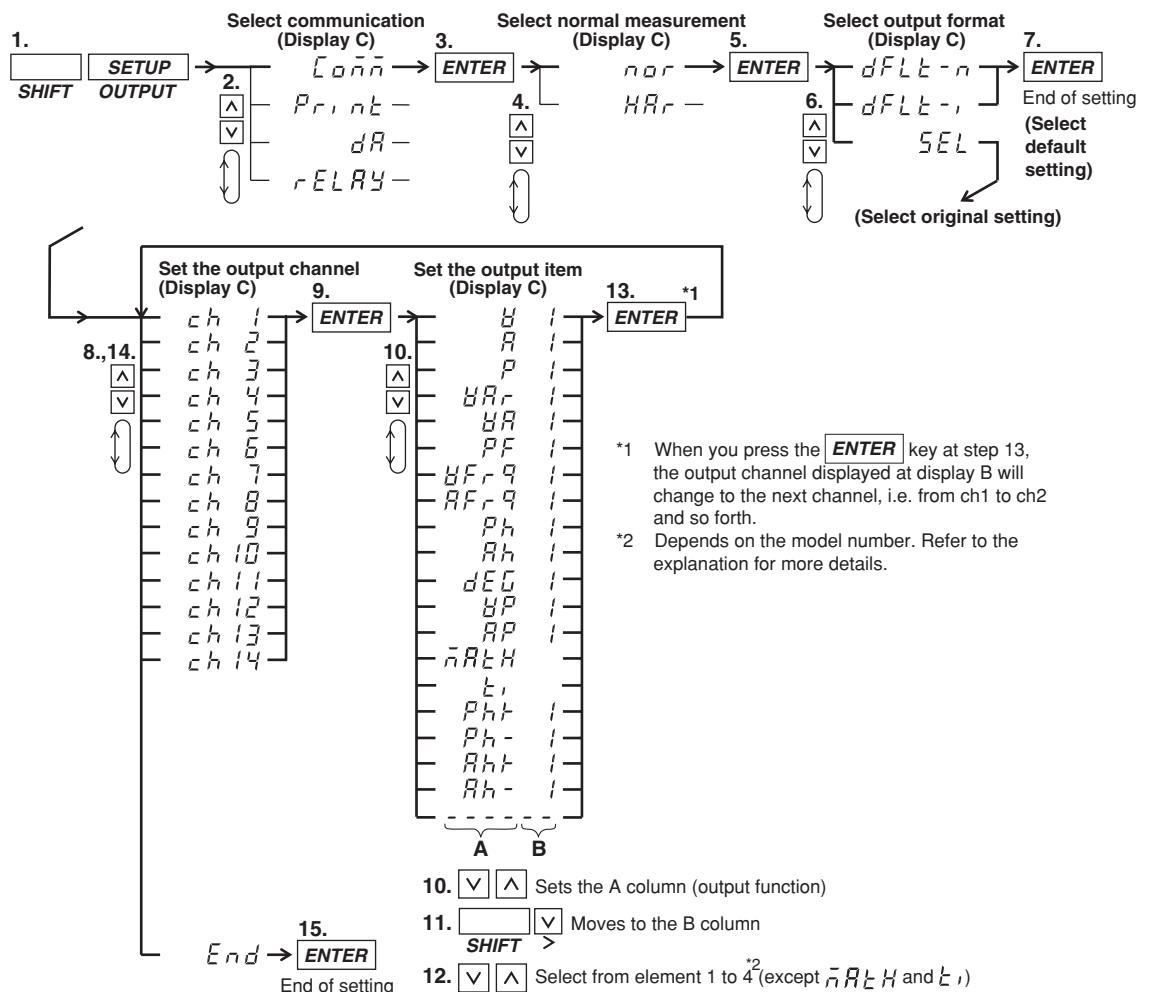


The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

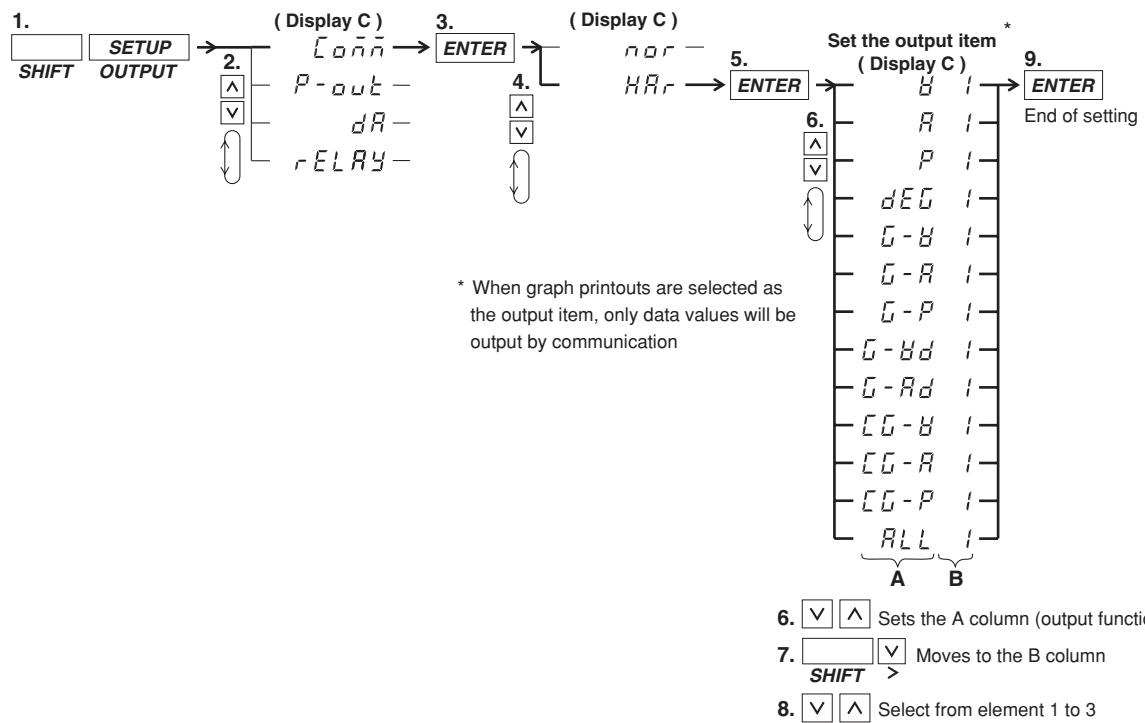
- Operate the instrument by following the thick lines in the menu below.
- Press the ENTER key to confirm a selection or setting.
- To leave the current menu in the middle of the operation, press the key indicated in step 1. The confirmed settings up to that point are kept.

Setting the Output Item in case of Normal Measurement



10.6 Setting the Output Items

Setting the Output Item in case of Harmonic Measurement



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 a description of the output format in addressable mode or talk-only mode, see 10-5 to 10-8. For a description of the output pattern in 488.2 mode, see the description for the MEASure[:NORMAl]:ITEM:PRESet command (page 14-31).

• 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 Original Settings

You can set original output items (output function and element) to each output channel from ch1 to ch14.

• Setting the channel

Select the output channel for assigning the output item from ch1 to ch14.

• Setting the output function (corresponds to column A in the procedure)

Any of the following function 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 function, V Hz or A Hz, is turned on, the frequency of the corresponding function is output. If both display functions are OFF, the voltage frequency of the element assigned to display C is output.

^{*2} For details concerning the positive value of the ampere hour, refer to page 6-3.

• Setting the element (corresponds to column B in the procedure)

The element setting depends on the model and is as follows. The initial value is "1."

- WT210 (760401) no such element setting available;
- WT230 (760502) element can be selected from 1, 3, or 4
- WT230 (760503) element can be selected from 1, 2, 3, or 4

The element number 4 represents Σ .

Setting the Output Item in case of Harmonic Measurement

The setting is carried out in the same way as described in section 9.9, "Outputting to an External Plotter or External Printer." However, graph printing is not possible for communication output. Only numerical data is output. For details, refer to page 9-23, 9-24.

For a description of the output format in addressable mode or talk-only mode, see 10-9 and 10-10. For a description of the output pattern in 488.2 mode, see the description for the MEASure:HARMonics:ITEM:PRESet command (page 14-29).

10.7 Commands (before the IEEE 488.2 Standard)

For a detailed description of each command, refer to section 13.1.

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

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

Note

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

11.1 Serial Interface Functions and Specifications

This instrument is equipped with a serial (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 Serial 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 and computed data output request setting parameters output request error code output request
	Transmission	measured and computed data output setting parameters output error code output status byte output
Talk-only mode	Transmission	measured and computed data output

Normal Mode

This mode is equivalent to the addressable mode 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 488.2-1992 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.

Print Mode

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

11.1 Serial Interface Functions and Specifications

Serial Interface Specifications

Electrical characteristics:	conforms to EIA-232 (RS-232)
Connection:	point-to-point
Communications:	full-duplex
Synchronization:	start-stop system
Baud rate:	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:	256 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 between CURRENT, \pm (VOLTAGE and CURRENT side) input terminals and ground

400 Vrms max.

Voltage between VOLTAGE input terminal and ground

600 Vrms max.

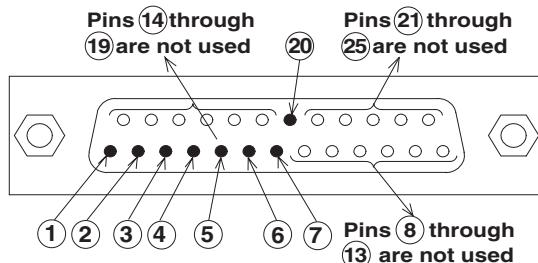
Put the protective cover on the connector when this function is not used.

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 from the computer. For details, refer to 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.



SERIAL Connector: DBSP-JB25S or equivalent

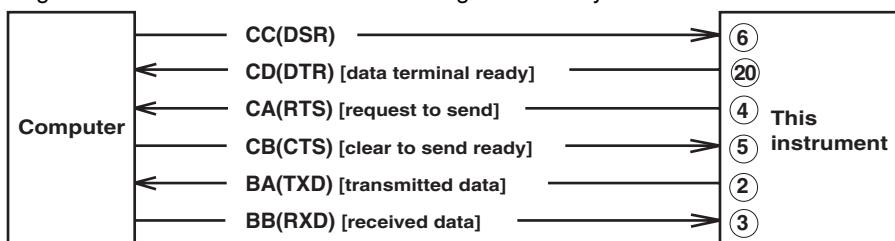
1 AA(GND: Protective Ground)	Grounded to the case of this instrument
2 BA(TXD: Transmitted Data)	Data transmitted to personal computer Signal direction: output
3 BB(RXD: Received Data)	Data received from personal computer Signal direction: input
4 CA(RTS: Request to Send)	Signal used to handshake when 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 serial interface.



11.2 Connecting the Interface Cable

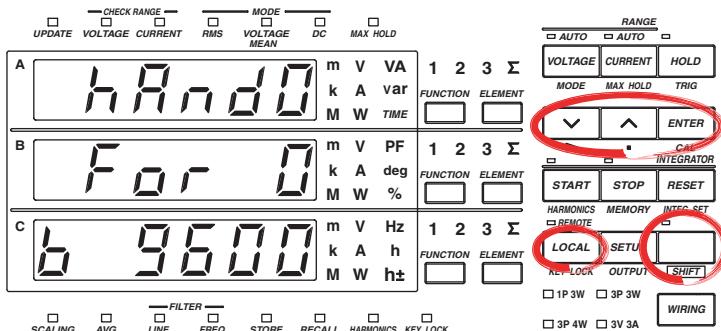
Table of RS-232 Standard Signals and their JIS and CCITT Abbreviations

Pin No. (25-pin connector)	Abbreviations			Name
	RS-232	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	ST1/ST2	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 serial interface of this instrument

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

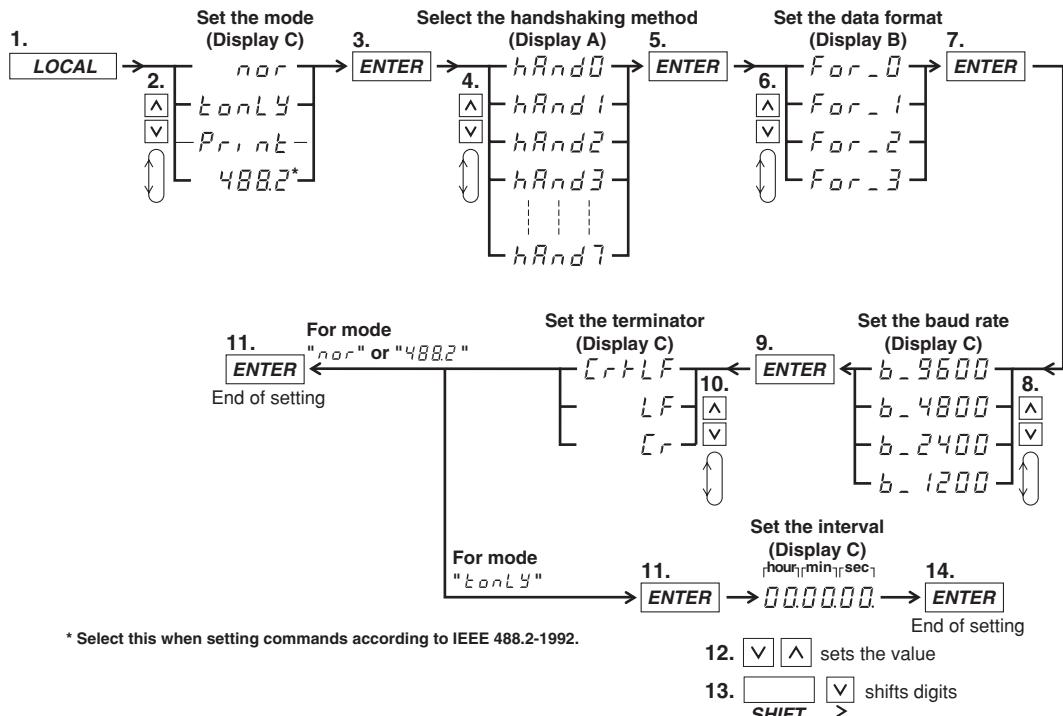
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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

Refer to page 11-1 for more details.

Handshaking

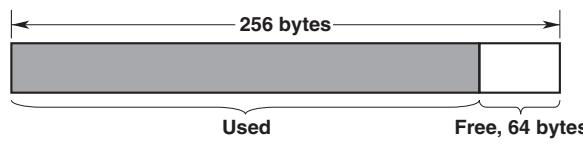
To use an RS-232-C interface to transfer data between this instrument and a computer, it is necessary to use certain procedures by mutual agreement to ensure the proper transfer of data. These procedures are called "handshaking". Various handshaking systems are available depending on the computer to 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)

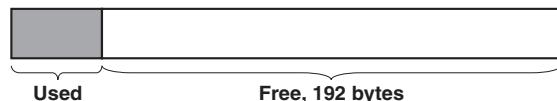
Mode selection no.	Data sending control (Control method when sending data to computer)			Data receiving control (Control method when receiving data from computer)		
	Software handshake	Hardware handshake	No handshake	Software handshake	Hardware handshake	No handshake
Sending stops when X-off is received, 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.	
0			O			O
1	O			O		
2	O				O	
3	O					O
4		O			O	
5		O				O
6			O		O	
7			O			O

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 64 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 64 bytes since data cannot be passed to the main program fast enough to keep up with the transmission.



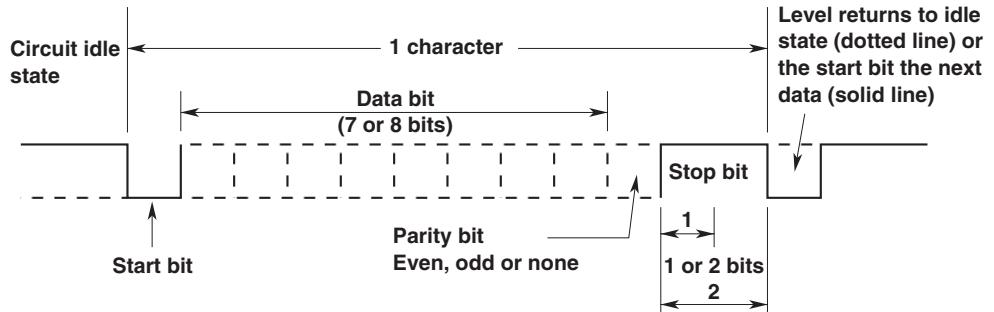
After reception of data stops, data continues to be passed to the internal program. Reception of data starts again when the free space in the buffer increases to 192 bytes.



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 serial 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. Refer to 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 1200, 2400, 4800, and 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 output data.

Setting range: 00.00.00 (0 hr 00 min 00 sec) to 99.59.59 (99 hrs 59 min 59 sec)

Initial value: 00.00.00

When set to 00.00.00, the interval is equal to the display update rate. In addition, when the specified interval is shorter than the display update rate, the data is output using the display update rate.

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 IEEE488.2 Standard)

Output Format

The format of output data is the same as the GP-IB interface. Refer to section 10.4 for more details.

Commands

The commands used in serial communications on the WT210/WT230 are common with GP-IB commands. However, the following commands are different.

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

In the serial communications on the WT210/WT230, the GP-IB interface message functions are assigned to the following commands.

<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).

For a description of the status byte format, see section 10.3. However, in the serial communications of the WT210/WT230, SRQ (DI07) is always 1.

<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).

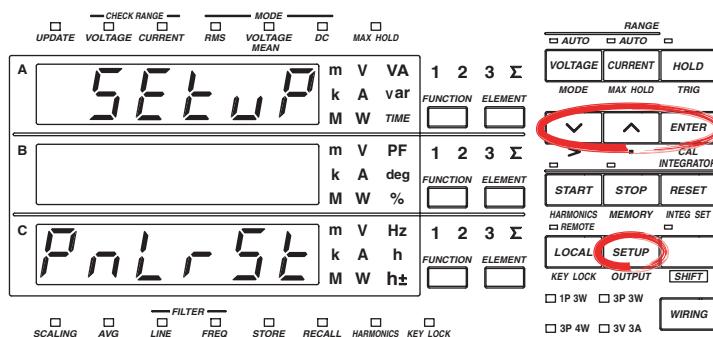
12.1 Back-up of Setup Parameters

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

- Wiring method**
- Voltage range**
- Current range**
- Measurement mode of voltage and current**
- Data hold**
- Line filter ON/OFF**
- Frequency 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**
- Crest factor**
- Computing Equation of MATH function**
- Display function/element for each display**
- Number of displayed digits**
- Display update rate**
- Integration mode**
- Integration timer preset time**
- Integration value**
- Integration elapsed time**
- Data stored in internal memory**
- Storage interval**
- Recalling interval**
- Output items for plotter/communication**
- Harmonic measurement ON/OFF (only when equipped with the harmonic measurement option)**
- PLL source (only when equipped with the harmonic measurement 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 is installed)**
- Handshaking method (when serial interface is installed)**
- Data format (when serial interface is installed)**
- Baud rate (when serial interface is installed)**

12.2 Initializing Setup Parameters

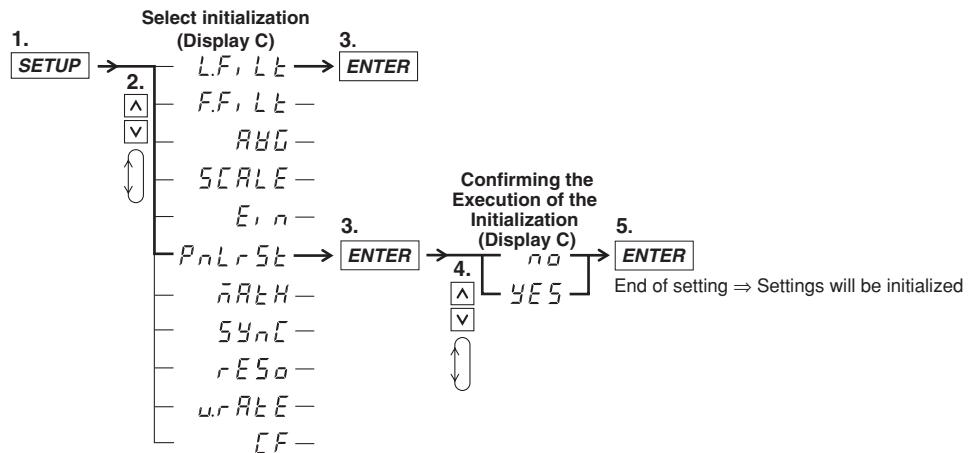
Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

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 Setup Parameters**

Select “YES” in the confirmation menu of the setup procedure and press the ENTER key to execute the initialization. The initial settings are as follows.

Item	Initial setting
Display A	Display function: V, element: 1
Display B	Display function: A, element: 1
Display C	Display function: W, element: 1
Number of displayed digits	Hi (5 digits)
Display update rate	0.25 s
Line filter	OFF
Frequency filter	OFF
Measurement synchronization source	A
Measurement range	Auto range
Measurement mode	RMS
Wiring method (only WT230)	1P3W
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	50.00 A
Averaging	Averaging type: exponential, attenuation constant: 8 Averaging ON/OFF: OFF
Crest factor	3
MATH computing equation	WT210: Voltage crest factor WT230: Efficiency
Frequency	VHz
Integration	Reset condition, integration mode: manual Integration preset time: 0 hr, 00 min, 00 s
Harmonic measurement (option)	PLL source: V1, harmonic distortion factor computation format: IEC, element: 1 Harmonic measurement function ON/OFF: OFF
Storage/recalling	Interval: 0hr 00min 00sec, storage/recalling ON/OFF: OFF
D/A output (option)	Output items: normal measurement items, rated integration time: 1 hr, 00 min, 00 s
Comparator (option)	Mode: single, determination function: (V1, A1, P1, PF1) Limit value: refer to section 9.6, display function ON/OFF: OFF
Data output	Communication, item: normal measurement setting
GP-IB	Mode: addressable mode, address: 1, status byte: 15, delimiter: 0
Serial	Mode: normal mode, handshaking mode: 0, format: 0, Baud rate: 9600, delimiter: 0, status byte: 15

Note

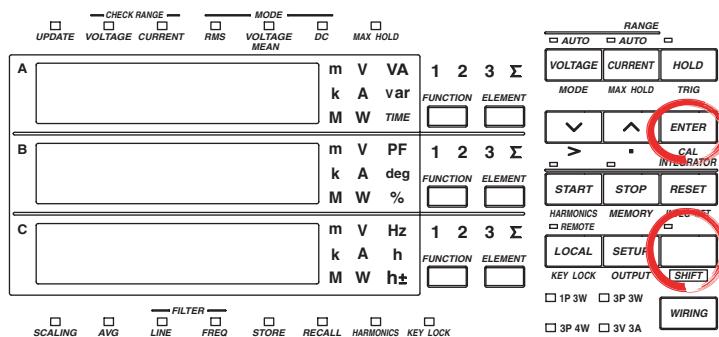
- Be careful since measurement data will be lost when initializing. However, measurement data or setup parameters stored in the internal memory will be kept.
- If the setup parameters are initialized by a communication command (RC command or *RST command), parameters related to GPIB and serial communication will not be initialized.

When Initializing Setup Parameters at Power-On

If the power switch is turned ON while holding down the ENTER key, the WT210/WT230 powers up using initial settings. Keep holding down the ENTER key until the illumination of all LEDs turn off (step ② of the “Opening Message” on page 3-10). All setup parameters including communication parameters will be initialized as indicated above. When the setup parameters are initialized, error codes “Err. 60” and “Err. 78” are shown as messages to indicate the initialization; they do not indicate a malfunction.

12.3 Performing Zero-Level Compensation

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

SHIFT **ENTER** (Execute zero-level compensation)
CAL

Explanation

Zero-Level Compensation

This function is used to create a zero input condition using the internal circuit of the WT210/WT230 and setting the level at that point to zero level. Zero-level compensation must be performed to meet the specifications of the WT210/WT230 (see chapter 16).

Zero-level compensation is executed when you carry out the following operations.

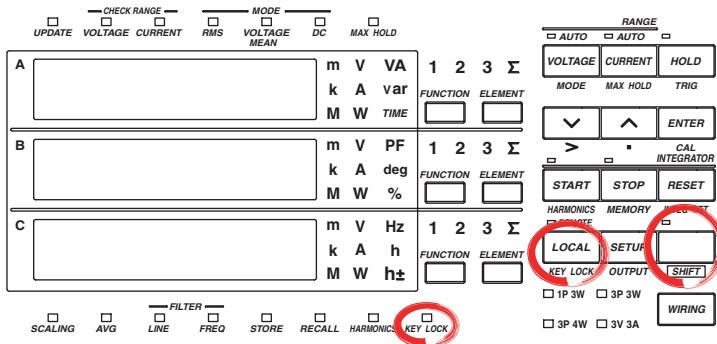
- When you press the SHIFT key to illuminate the indicator above and to the left of the SHIFT key followed by the ENTER key.
- When you change the measurement range.

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 needs 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. It is recommended that zero level compensation be performed in this case.

12.4 Key Lock

Keys



The explanation given in this section uses WT230 as an example. For the differences between the WT210 and the WT230, see section 2.2, "Operation Keys and Functions/Element Display."

Procedure

- **Turning ON the key lock**

LOCAL (Key lock ON)
SHIFT KEY LOCK

The KEY LOCK indicator on the front panel illuminates. From this point, you can only operate the power switch or carry out the operation to turn OFF the key lock.

- **Turning OFF the key lock**

Carry out the following procedure while the KEY LOCK indicator is lit.

LOCAL (Key lock OFF)
SHIFT KEY LOCK

The KEY LOCK indicator on the front panel turns OFF. All key operations are enabled.

Explanation

Key Lock

You can disable (key lock) the front panel key operation. However, the following switch and key operations are enabled even during key lock.

- ON/OFF of the power switch
- Operation to turn OFF key lock

Chapter 13 Communication Commands 1 (System of Commands before the IEEE 488.2 Standard)

13.1 Commands

AA/AA? Sets the current auto range ON or OFF/inquires about 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/inquires about 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/inquires about 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)/inquires about 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/inquires about 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.

CF/CF? Sets the crest factor and queries the current setting.

Syntax CF m <terminator>
 m is the crest factor value
 m = 0: Crest factor 3
 1: Crest factor 6

Query CF? <terminator>

Example CFO

Description

- Parameter error 12 will occur if "m" is set to an illegal value.
- You cannot change the setting while integration is in progress. Error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

13.1 Commands

CM/CM? Selects scaling constants simultaneous setting command group or individual setting command group for command data which come after this command/inquires about the current setting.

Syntax CM m <terminator>
"m" indicates command group used.
m= 0: WT210/230 command/output format group (scaling constant simultaneous setting command group)
1: command/output format group by element (scaling constant individual setting command 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 WT210 is the same for m=0 or 1.

DA/DA? Sets the function for display A/inquires about the current setting.

Syntax DA m <terminator>
"m" indicates one of the following functions.
• in case of normal measurement
m= 1: voltage (V)
2: current (A)
3: power (W)
4: reactive power (var)
5: apparent power (VA)
15: Elapsed integration time (TIME)
• in case of harmonic measurement
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 measurement 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/inquires about the current setting.

Syntax DB m <terminator>
"m" indicates one of the following functions.
• in case of normal measurement
m= 1: voltage (V)
2: current (A)
3: power (W)
6: power factor (PF)
11: phase angle (deg)
• in case of harmonic measurement
m= 1: Measured value of each component of voltage (V)
2: Measured value of each component of current (A)
3: Measured 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.
• in case of normal measurement
m= 1: voltage (V)
2: current (A)
3: power (W)

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	<pre> 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-) · in case of harmonic measurement 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) </pre>	Description Parameter error 12 will occur if "m" is set to an illegal value.
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)/inquires about the current setting.	
Syntax	<pre>DF m <terminator> "m" indicates the computation method for harmonic distortion (refer to section 7.2) m= 0: IEC 1: CSA</pre>	
Query	DF? <terminator>	
Example	DF0	
Description	<ul style="list-style-type: none"> 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/inquires about the current setting.	
Syntax	<pre>DL <terminator> "m" indicates terminator GP-IB Serial m= 0: CR+LF+EOI CR+LF 1: IF LF 2: EOI CR</pre>	
Query	DL? <terminator>	
Example	DL0	
		<p>DR/DR? Displays the current range.</p> <p>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. 2: displays the shunt value of element 1, 2 and 3 on display A, B and C respectively (WT230 only).</p>
Query	DR? <terminator>	
Example	DRO	
Description	Parameter error 12 will occur if "m" is set to an illegal value.	
DS/DS?	Sets the number of displayed digits/inquires about the current setting.	
Syntax	<pre>DS m <terminator> "m" indicates the number of digits. m= 0: 4 digits 1: 5 digits</pre>	
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	<pre>DY m <terminator> "m" indicates display for comparator ON/OFF m= 0: cancels the display for comparator 1: sets the display for comparator ON</pre>	
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/inquires about the current setting.	
Syntax	<pre>EA m <terminator> "m" indicates element. m= 1: Element 1 2: Element 2 (for WT230 model 760503 only) 3: Element 3 (for WT230 only) 4: Σ (for WT230 only)</pre>	
Query	EA? <terminator>	
Example	EA1	
Description	Parameter error 12 will occur if "m" is set to an illegal value.	

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EB/EB? Sets the element for display B/inquires about the current setting.

Syntax EB m <terminator>
 “m” indicates element.
 m= 1: Element 1
 2: Element 2 (for WT230 model
 760503 only)
 3: Element 3 (for WT230 only)
 4: Σ (for WT230 only)

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/inquires about the current setting.

Syntax EC m <terminator>
 “m” indicates element.
 m= 1: Element 1
 2: Element 2 (for WT230 model
 760503 only)
 3: Element 3 (for WT230 only)
 4: Σ (for WT230 only)

Query EC? <terminator>

Example EC1

Description Σ 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 hold mode.

FL/FL? Determines whether or not frequency filter is used/inquires about the current setting.

Syntax FL m <terminator>
 “m” indicates whether frequency 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.

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

Syntax HA m <terminator>
 “m” indicates whether the harmonic measurement function or normal measurement function is set.

 m= 0: Normal measurement
 1: Harmonic measurement

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 measurement cannot be performed; error 13 will occur.
 • Integration cannot be started when the harmonic measurement function is in progress; error 16 will occur.
 • While recalling or storing is in progress, execution error 19 will occur.

• If you switch the harmonic measurement mode ON/OFF using this command and query the measurement mode using the “OD” command immediately afterwards, the measured data of the previous measurement mode may be output. To retrieve the measured data in the new measurement mode, a wait of approximately 2 seconds is required after issuing this command.

HD/HD? Determines whether or not output data (display, communications, etc.) should be updated/inquires about 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.

HE/HE? Determines the element of the harmonic measurement function/inquires about the current setting.

Syntax HE m <terminator>
 “m” indicates the element of the harmonic measurement function.
 m= 1: Element 1
 2: Element 2 (for WT230 model
 760503 only)

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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/inquires about 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.

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

Syntax IM m <terminator>
 "m" is assigned as follows ($0 \leq m \leq 15$).
 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 45 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/inquires about the current setting.

Syntax KH m <terminator>
 "m" indicates MAX hold ON/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 or storing is in progress, execution error 19 will occur.
 • Cannot be changed in harmonic measurement mode. Execution error 19 will occur.

KL/KL? Turns ON/OFF key lock/inquires about the current setting.

Syntax KL m <terminator>
 "m" indicates whether key lock is ON or OFF.
 m= 0: OFF
 1: ON

Query KL? <terminator>

Example KL0

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

Sets the scaling constant/inquires about the current setting.
KV is used for voltage measurement, **KA** for current measurement, and **KW** for power measurement.

Syntax When CM0 is set:

KV n <terminator>
 KA n <terminator>
 KW n <terminator>

When CM1 is set:

KV m,n <terminator>
 KA m,n <terminator>
 KW m,n <terminator>

"m" indicates element.

m= 0: All elements (Setting not allowed during inquiry)

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<p>1: Element 1 2: Element 2 (for WT230 model 760503 only) 3: Element 3 (for WT230 only) "n" indicates scaling value. $0.001 \leq n \leq 9999$</p> <p>Query When CM0 is set: KV? <terminator> KA? <terminator> KW? <terminator></p> <p>When CM1 is set: KV1? <terminator> KA2? <terminator> KW3? <terminator></p>	<p>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.</p> <p>MT/MT? Sets the computing equation of MATH function/inquires about the current setting.</p> <p>Syntax MT m<terminator> m indicates the computing equation. m= 0: Efficiency (for WT230 only) 1: Crest factor of the voltage input waveform of element 1 2: Crest factor of the voltage input waveform of element 2 (for WT230 model 760503 only) 3: Crest factor of the voltage input waveform of element 3 (for WT230 only) 4: Crest factor of the current input waveform of element 1 5: Crest factor of the current input waveform of element 2 (for WT230 model 760503 only) 6: Crest factor of the current input waveform of element 3 (available only on 7: display A + display B 8: display A - display B 9: display A × display B 10: display A / display B 11: display A / (display B)² 12: (display A)² / display B 13: Average active power of element 1 while integration is in progress 14: Average active power of element 2 while integration is in progress (for WT230 model 760503 only) 15: Average active power of element 3 while integration is in progress (for WT230 only) 16: Average active power of element S while integration is in progress (for WT230 only)</p>
<p>Example When CM0 is set: KV1.000 KA1.000 KW1.000</p> <p>When CM1 is set: KV1,1.000 KA2,1.000 KW3,1.000</p> <p>Description • Parameter error 12 will occur if "m" is set to an illegal value. • "n" must be floating-point or integer. • Error 12 will occur when an inquiry is made if the scaling values set for each element by CM0 differ from each other. • While recalling or storing is in progress, execution error 19 will occur.</p>	
<p>LF/LF? Turns ON/OFF the line filter/inquires about the current setting.</p> <p>Syntax LF m <terminator> "m" indicates whether the line filter is ON or OFF. m= 0: OFF 1: ON</p> <p>Query LF? <terminator></p> <p>Example LF0</p> <p>Description • Parameter error 12 will occur if "m" is set to an illegal value. • You cannot change the setting while integration is in progress. Execution error 13 will occur. • While recalling or storing is in progress, execution error 19 will occur.</p>	
<p>MN/MN? Sets the measurement mode for voltage and current/inquires about the current setting.</p> <p>Syntax MN m <terminator> "m" indicates the measurement mode. m= 0: RMS 1: VOLTAGE MEAN (MEAN in case of voltage, RMS in case of current) 2 :DC</p> <p>Query MN? <terminator></p>	

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Query	MT?<terminator>
Example	MT0
Description	Average active power (MT13, 14, 15, 16) is displayed only during integration.
OA/OA?	Sets D/A output items/inquires about the current settings. Up to 4 or 12 measured data can be selected and output as analog signal from the D/A converter.
Syntax	<pre>OA m1,m2,m3 <terminator> "m1" indicates D/A output channel, and must be set within the following range. 1 ≤ m1 ≤ 12 or 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 2: Element 2 (for WT230 model 760503 only) 3: Element 3 (for WT230 only) 4: Σ (for WT230 only)</pre>
Query	OA1? <terminator>
Example	OA1,3,2
Description	<ul style="list-style-type: none"> 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) or the average active power (MT13 to 16) when integration is in progress, the D/A output is fixed to 0 (V). "No output" and "computation result" have no relation to the element, but when using them with the "OA" command, set m3=1.
OAD/OAD?	Initializes D/A output items/inquires about 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	<pre>OAD m <terminator> "m" indicates default no. m= 2: Select mode 0: Default for normal measurement 1: Default for integration</pre>
Query	OAD? <terminator>
Example	OAD1
Description	<ul style="list-style-type: none"> 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>
OE	Requests output of error codes via communications.
Syntax	OE <terminator>
Example	<pre>ERR11 <terminator> Error code Description 11 Command error 12 Parameter error 13 Attempted to change settings which cannot be changed while integration was in progress. 14 Attempted to set auto range mode while external sensor range was selected. 15 Attempted to execute a command that was protected. 16 Attempted to execute a command that was protected while harmonic measurement was being performed. 17 Time-out in print output. 18 Not in printing mode, or no data available. 19 Attempted to execute commands while recalling/ storing is in progress. 30 File data failure 31 File is damaged. 32 Not stored in internal memory. 33 No data to be stored in internal memory. 41 Attempted to start integration when integration had been stopped due to an irregularity. 42 Attempt made to start integration during integration.</pre>

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43 Measurement stopped due to overflow during integration or due to a power failure.
 44 Attempt made to stop integration while integration was interrupted.
 45 Attempt made to reset integration while integration was in progress.
 46 Attempt made to start integration when peak overflow was detected.
 47 The integration timer is set to zero when integration is started in continuous integration mode.
 51 Measurement data overflow occurred. “-oL” is displayed.
 52 Voltage peak overflow occurred
 53 Current peak overflow occurred
 54 Power factor exceeded “2”. “PFErr” is displayed.
 55 “degErr” was displayed.
 56 Frequency input level was too low or below measurement range. “ErrLo” is displayed.
 57 Frequency was above the measurement range. “ErrHi,” is displayed.
 58 Computation overflow occurred. “-oF-” is displayed.
 59 When harmonic measurement is carried out, “FrqEr” is displayed

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: Integration time
 24: Positive watt-hour (Wh+)
 25: Negative watt-hour (Wh-)
 26: Positive ampere-hour (Ah+)
 27: Negative ampere-hour (Ah-)
 “m3” indicates element, and must be set within the following range.
 $1 \leq m3 \leq 4$

Query OF1? <terminator>

Example OF1,3,2

- Description**
- Parameter error 12 will occur if “m1”, “m2” or “m3” is set to an illegal value.
 - “No output,” “computation range,” and “elapsed integration time” have no relation to the element, but when using them with the “OF” command, set m3=1.

OFD/OFD? **Initializes communication output information type/inquires about the current settings. Two sets of default setting are available: one is for normal measurement and the other is for integration.**

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.

OF/OF? **Sets communication output information types/inquires about 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.

$1 \leq m1 \leq 14$

“m2” indicates output type no.

m2= 0: No output

1: Voltage (V)

2: Current (A)

3: Power (W)

4: Reactive power (var)

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OH/OH? Sets communication output information types in case of harmonic measurement/ inquires about the current settings.

Syntax OH m1,m2 <terminator>
 "m1" indicates output type no.
 • in case of print mode
 m1= 1: (V) outputs measured voltage value and relative harmonic content as a numerical value
 2: (A) outputs measured current value and relative harmonic content as a numerical value
 3: (W) outputs measured active power value and relative harmonic content as a numerical value
 4: (deg) outputs the phase angle as a numerical value
 5: (GV) outputs measured voltage value as numerical value and graph
 6: (GA) outputs measured current value as numerical value and graph
 7: (GW) outputs measured active power 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 measured value of both voltage and current

- in case of any other mode
- m1= 1: (V) outputs measured voltage value and relative harmonic content as a numerical value
- 2: (A) outputs measured current value and relative harmonic content as a numerical value
- 3: (W) outputs measured active power 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 measured voltage value and relative harmonic content as numerical value
- 6: (GA) outputs measured current value and relative harmonic content as numerical value
- 7: (GW) outputs measured active power 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 measured value of voltage and relative harmonic content as numerical value
- 11: (CGA) outputs the measured value of current and relative harmonic content as numerical value
- 12: (CGW) outputs the measured value of active power and relative harmonic content as numerical value

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	<pre>13: (ALL) outputs the relative harmonic content and measured value of both voltage and current "m2" indicates element m2=1: Element 1 2: Element 2 (for WT230 model 760503 only) 3: Element 3 (for WT230 only)</pre>	
Query	OH? <terminator>	Line 8: Scaling (for CM0) KV1.000;KA1.000; KW1.000 <terminator>
Example	OH13,1	(for CM1, WT210) KV1,1.000;KA1,1.000; KW1,1.000 <terminator>
Description	Parameter error 12 will occur if "m1" or "m2" is set to an illegal value.	(for CM1, WT230) KV1,1.000;KV2,1.000; KV3,1.000; KA1,1.000;KA2,1.000; KA3,1.000; KW1,1.000;KW2,1.000; KW3,1.000 <terminator>
OR/OR?	Designates the harmonic order of the harmonic component shown on display B (V,A,W,V %, A%, W%, V deg, A deg)/ inquires about the current settings.	Line 9: Averaging setting AT1;AC1 <terminator>
Syntax	OR m <terminator> "m" indicates the harmonic order m= Integer between 1 to 50 (or 30)	Line 10: Integration setting IC0; TM0,0,0 <terminator>
Query	OR? <terminator>	Line 11: Store and recall settings SO0;SR0,0,0:R00; RR0,0,0 <terminator>
Example	OR50	Line 12: Harmonic measurement (for models with /HRM option) PS1;HA0;OR1;HE1; DF0 <terminator>
Description	<ul style="list-style-type: none">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 [—].	Line 13: D/A output setting (for models with /DA4, /DA12, or /CMP option) RT1,0,0 <terminator>
OS	Requests output of setting parameters via communications.	Line 14: Comparator output setting (for models with /CMP option) Y00;YM1;DY0; YC1 <terminator>
Syntax	OS <terminator>	Line 15: Command system used CM0 <terminator>
Example	Line 1: Model MODEL760503 <terminator> Line 2: Voltage range RV9;AV1 <terminator> Line 3: Current range (for CM0) RA9;AA1;SA50.00 <terminator> (for CM1) RA9;AA1;SA1,50.00; SA2,50.00; SA3,50.00 <terminator> Line 4: Display function DA1;DB2;DC3 <terminator> Line 5: Display element EA1;EB1;EC1 <terminator> Line 6: Measurement condition WR2;FL0;SC0;AG0;HD0; MT0 <terminator> Line 7: Measurement mode MN0 <terminator>	Line 16: Measurement synchronization source, integration type, MAX hold, and number of displayed digits SN1;IG0;KH0; DS1 <terminator>
		Line 17: Display update rate and line filter SI1;LF0;FL0 <terminator>
		Line 18: Output end END <terminator>
Description		<ul style="list-style-type: none">The number of lines varies depending on the options used.When a CM0 is issued, if the shunt current values or scaling values set for each element differ from each other, the value set for element 1 will be output.

13.1 Commands

OY/OY? Sets the relay output items in case of normal measurement/inquires about the current setting. Up to four items can be set.

Syntax OY m1,m2,m3,m4,m5 <terminator>
 "m1" indicates the output relay channel
 $1 \leq m1 \leq 4$
 "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
 2: Element 2 (for WT230 model 760503 only)
 3: Element 3 (for WT230 only)
 4: Σ (for WT230 only)
 "m4" indicates setting value.
 $0.000 \leq m4 \leq \pm 9999$
 "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.
 • "No output" and "computation result" have no relation to the element, but when using them with the "OY" command, set m3=1.

OYH/OYH? Sets the relay output items in case of harmonic measurement/inquires about 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

$1 \leq m1 \leq 4$
 "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
 2: Element 2 (for WT230 model 760503 only)
 3: Element 3 (for WT230 only)
 "m4" indicates order of the harmonic.
 m4= Integer between 1 and 50 (or 30)
 "m5" indicates setting value.
 $0.000 \leq m5 \leq \pm 9999$
 "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.

13.1 Commands

PS/PS? Sets the input as the PLL source/inquires about the current setting.

Syntax PS m <terminator>
"m" indicates the input as the PLL source
m= 1: V1
2: A1
3: V2 (for WT230 model 760503 only)
4: A2 (for WT230 model 760503 only)
5: V3 (for WT230 only)
6: A3 (for WT230 only)

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/inquires about the current setting.

Syntax RA m <terminator>
"m" indicates current range.
• When the crest factor is set to 3
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 mA range (WT210 only)
22: 10 mA range (WT210 only)
23: 20 mA range (WT210 only)
24: 50 mA range (WT210 only)
25: 100 mA range (WT210 only)
26: 200 mA range (WT210 only)
• When the crest factor is set to 6
m = 4: 0.25 A range
5: 0.5 A range
6: 1 A range
7: 2.5 A range
8: 5 A range
9: 10 A range
15: 25 mV range (only when equipped with option /EX2)

16: 50 mV range (only when equipped with option /EX2)
17: 100 mV range (only when equipped with option /EX2)
18: 1.25 V range (only when equipped with option /EX2)
19: 2.5 V range (only when equipped with option /EX2)
20: 5 V range (only when equipped with option /EX2)
21: 2.5 mA range (only when equipped with option /EX2)
22: 5 mA range (WT210 only)
23: 10 mA range (WT210 only)
24: 25 mA range (WT210 only)
25: 50 mA range (WT210 only)
26: 100 mA range (WT210 only)

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 2.5V, 5V and 10V 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>
Description For details on initialization, see section 12.2, "Initializing Setup Parameters." Setup parameters excluding those related to communication are initialized.

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 recalling interval/inquires about the current setting.

Syntax RR m1,m2,m3 <terminator>
"m1" indicates the hours
0 ≤ m1 ≤ 99
"m2" indicates the minutes
0 ≤ m2 ≤ 59
"m3" indicates the seconds
0 ≤ m3 ≤ 59

13.1 Commands

Query RR? <terminator>

Example RR0,0,0

- Description**
- Parameter error 12 will occur if an illegal value is set.
 - If the recalling interval is set to 0 h 0 min 0 s, the recalling interval is set to the display update rate as when the data was stored.
 - 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/inquires about the current setting.**

Syntax RT m1,m2, m3 <terminator>

“m1” indicates the hours
 $0 \leq m1 \leq 1000$
 “m2” indicates the minutes
 $0 \leq m2 \leq 59$
 “m3” indicates the seconds
 $0 \leq m3 \leq 59$

Query RT? <terminator>

Example RT1,0

- Description**
- Parameter error 12 will occur if an illegal value is set.
 - The maximum time that can be specified is 10000 (hours).

RV/RV? **Sets voltage range/inquires about the current setting.**

Syntax RV m <terminator>

“m” indicates voltage range.
 • When the crest factor is set to 3
 $m= 3: 15V$ range
 $4: 30 V$ range
 $5: 60 V$ range
 $6: 100 V$ range
 $7: 150 V$ range
 $8: 300 V$ range
 $9: 600 V$ range
 • When the crest factor is set to 6
 $m= 3: 7.5 V$ range
 $4: 15 V$ range
 $5: 30 V$ range
 $7: 75 V$ range
 $8: 150 V$ range
 $9: 300 V$ 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 value/inquires about the current setting.**

Syntax When CM0 is set:

Query SA n <terminator>

When CM1 is set:

SA m,n <terminator>
 “m” indicates element.
 $m= 0: All$ elements (Setting not allowed during inquiry)
 $1: Element 1$
 $2: Element 2$ (for WT230 model 760503 only)
 $3: Element 3$ (for WT230 only)

“n” indicates external sensor scaling value.
 $0.001 \leq n \leq 9999$

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.
 - Error 12 will occur when an inquiry is made if the shunt current values set for each element by CM0 differ from each other.
 - While recalling or storing is in progress, execution error 19 will occur.

SC/SC? **Determines whether or not to use the scaling function/inquires about 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.

SI/SI? **Sets the display update rate/inquires about the current setting.**

Syntax SI m <terminator>

“m” indicates the display update rate.
 $m= 0: 0.1 s$
 $1: 0.25 s$
 $2: 0.5 s$
 $3: 1 s$
 $4: 2 s$
 $5: 5 s$

Query SI? <terminator>

Example SI1

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

13.1 Commands

- You cannot change the setting while integration is in progress. Execution error 13 will occur.
- While recalling or storing is in progress, execution error 19 will occur.

SL Recalls setup parameters from a selected file.

Syntax SL m <terminator>
 "m" indicates file no., and must be set within the following range.
 $1 \leq m \leq 4$

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/inquires about the current setting.

Syntax SN m <terminator>
 "m" indicates the type of measurement synchronization source.
 m= 0: V (voltage)
 1: A (current)
 2: OFF

Query SN? <terminator>

Example SNO

Description • Parameter error 12 will occur if "m" is set to an illegal value.
 • You cannot change the setting while integration is in progress. Execution error 13 will occur.
 • While recalling or storing is in progress, execution error 19 will occur.

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/inquires about the current setting.

Syntax SR m1,m2,m3 <terminator>
 "m1" indicates the hours
 $0 \leq m1 \leq 99$
 "m2" indicates the minutes
 $0 \leq m2 \leq 59$

"m3" indicates the seconds
 $0 \leq m3 \leq 59$

Query SR? <terminator>

Example SR0,0,0

Description • Parameter error 12 will occur if an illegal value is set.
 • If the store interval is set to 0 h 0 min 0 s, the store interval is set to the same interval as the display update rate.
 • While recalling or storing is in progress, execution error 19 will occur.

SS Stores setup parameters into a selected file.

Syntax SS m <terminator>
 "m" indicates file no., and must be set within the following range.
 $1 \leq m \leq 4$

Description • Parameter error 12 will occur if "m" is set to an illegal value.
 • The following setup parameters can be stored:
 All setup parameters which can be output by the OS command
 Information related to communications (GP-IB, serial, etc.)

TM/TM? Sets integration preset time/inquires about the current setting.

Syntax TM m1,m2, m3 <terminator>
 "m1" indicates the hours
 $0 \leq m1 \leq 1000$
 "m2" indicates the minutes
 $0 \leq m2 \leq 59$
 "m3" indicates the seconds
 $0 \leq m3 \leq 59$

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 time that can be specified is 10000 (hours).

WR/WR? Sets the wiring system/inquires about the current setting.

Syntax WR m <terminator>
 m= 2: 1P3W (for WT230 only)
 3: 3P3W (for WT230 only)
 4: 3P4W (for WT230 model 760503 only)
 5: 3V3A (for WT230 model 760503 only)

Query WR? <terminator>

Example WR2

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

13.1 Commands

YC/YC? Sets the display channel while the comparator function is ON/inquires about the current setting.

Syntax YC m <terminator>
 "m" indicates the channel number for display
 • in case of 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
 • in case of 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/inquires about 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 Executes zero-level compensation.

Syntax ZC <terminator>

Description

- Zero-level compensation is not allowed while integration is in progress; execution error 13 will occur.
- While recalling is in progress, execution error 19 will occur.

13.2 Before Programming

Environment

- Model: IBM-compatible PC
- Language: Visual Basic Ver5.0 Professional Edition or later.
- GP-IB board: AT-GPIB/TNT IEEE-488.2 by National Instruments.

Settings on Visual Basic

Standard modules used: Niglobal.bas
Vbib-32.bas

WT210/WT230 Settings

GP-IB address

- The sample programs given in this chapter use a GP-IB address of 1 for the WT210/WT230.
- Set the GP-IB address to 1 according to the procedures described in section 10.5.

Setting the GP-IB Board

The sample programs in this chapter use the GP-IB serial polling function (ilrsp function). Turn OFF automatic serial polling (clear the Automatic Serial Polling check box) to make the sample programs work properly.

Basic Form of Programming

The program data structure of the WT210/WT230 is as follows:

Command + Parameter + Terminator

ASCII codes are used.

Example	DA	2	CR LF
	Command	Parameter	Terminator

Command

Defined by one to three uppercase alphabet characters.

Parameter

Value or character string in ASCII code.

Terminator

- **For GP-IB communication**

When the WT210/WT230 is a listener, "CR+LF," "LF," or "EOI" can be received as a terminator.

When the WT210/WT230 is a listener, the terminator specified by the DL command (see page 13-3) is sent.

- **For Serial communication**

See pages 11-8 and 13-3.

Multiple Command Statements

Multiple commands can be written on a single line. In this case, delimit each command statement (command + parameter) using a semicolon.

Note

A space or a tab can either exist or not exist between a command and a parameter.

Query Commands

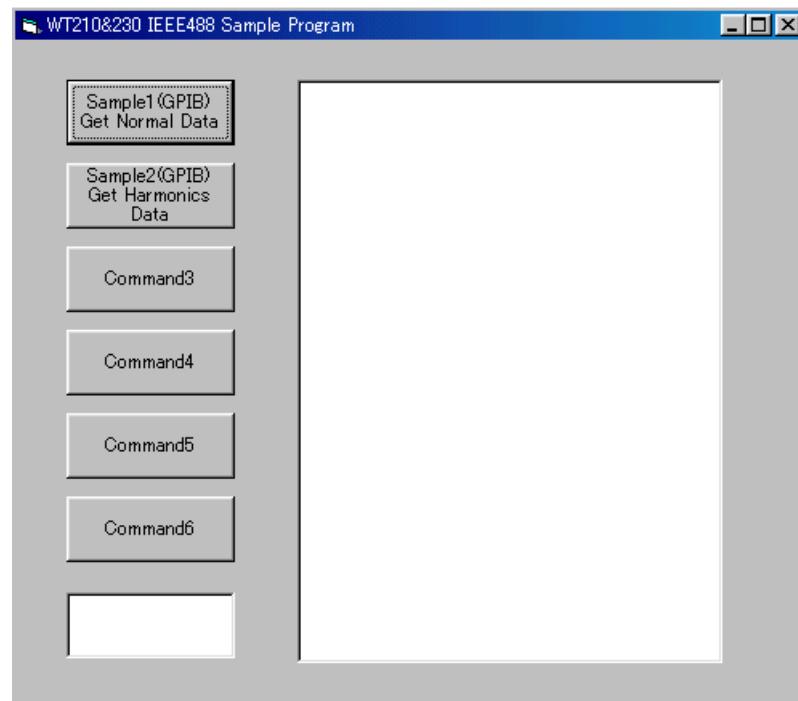
A query command has a question mark attached to the end of the command. The returned data in response to a query command is as follows:

Query	Returned data
DA? ===>	DA1

Numeric Parameters

Digits that exceed 5 digits in floating-point parameters are truncated.

13.3 Sample Program Image



13.4 Sample Program (Initialization, Error, and Execution Functions)

```

Option Explicit
Dim StartFlag As Integer
Dim addr As Integer
Dim Timeout As Integer
Dim Dev As Integer
Dim term As String
Dim Query(1100) As String
Dim Dummy As Integer
' Start Flag
' GPIB Address
' Timeout
' Device ID(GPIB)
' Terminator
' Query String

Private Function InitGpib() As Integer
    Dim eos As Integer
    Dim eot As Integer
    Dim brd As Integer
    Dim sts As Integer
    ' EOS
    ' EOI
    ' GPIB Board ID
    eos = &HCOA
    eot = 1
    term = Chr(10)
    Timeout = T10s
    ' Terminator = LF
    ' EOI = Enable
    ' Timeout = 10s

    brd = ilfind("GPIB0")
    If (brd < 0) Then
        GoTo GPIBError
    End If
    Dev = ildev(0, addr, 0, Timeout, eot, eos)
    If (Dev < 0) Then
        GoTo GPIBError
    End If
    sts = ilsic(brd)
    If (sts < 0) Then
        GoTo GPIBError
    End If
    InitGpib = 0
    Exit Function

GPIBError:
    Call DisplayGPIBError(sts, "ilsic")
    InitGpib = 1
End Function

Private Sub DisplayGPIBError(ByVal sts As Integer, ByVal msg As String)
    Dim wrn As String
    Dim ers As String
    Dim ern As Integer
    If (sts And TIMO) Then
        wrn = "Time out" + Chr(13)
    Else
        wrn = ""
    End If
    If (sts And EERR) Then
        ern = iberr
        If (ern = EDVR) Then
            ers = "EDVR:System error"
        ElseIf (ern = ECIC) Then
            ers = "ECIC:Function requires GPIB board to be CIC"
        ElseIf (ern = ENOL) Then
            ers = "ENOL:No Listeners on the GPIB"
        ElseIf (ern = EADR) Then
            ers = "EADR:GPIB board not addressed correctly"
        ElseIf (ern = EARG) Then
            ers = "EARG:Invalid argument to function call"
        ElseIf (ern = ESAC) Then
            ers = "ESAC:GPIB board not System Controller as required"
        ElseIf (ern = EABO) Then
            ers = "EABO:I/O operation aborted(timeout)"
        ElseIf (ern = ENEB) Then
            ers = "ENEB:Nonexistent GPIB board"
        ElseIf (ern = EDMA) Then
            ers = "EDMA:DMA error"
        ElseIf (ern = EOIP) Then
            ers = "EOIP:I/O operation started before previous operation completed"
        ElseIf (ern = ECAP) Then
            ers = "ECAP:No capability for intended operation"
        ElseIf (ern = EFSO) Then
            ers = "EFSO:File system operation error"
        ElseIf (ern = EBUS) Then
            ers = "EBUS:GPIB bus error"
        ElseIf (ern = ESTB) Then
            ers = "ESTB:Serial poll status byte queue overflow"
        ElseIf (ern = ESRQ) Then
            ers = "ESRQ:SRQ remains asserted"
    End If
End Sub

```

13.4 Sample Program (Initialization, Error, and Execution Functions)

```
        ElseIf (ern = ETAB) Then
            ers = "ETAB:The return buffer is full"
        ElseIf (ern = ELCK) Then
            ers = "ELCK:Address or board is locked"
        Else
            ers = ""
        End If
    Else
        ers = ""
    End If
    MsgBox ("Status No. " + Str(sts) + Chr(13) + wrn + "Error No. " + Str(ern) + Chr(13) + ers +
Chr(13) + msg), vbExclamation, "Error!"
    Call ibonl(Dev, 0)
    Dev = -1
End Sub
-----
Private Sub Command1_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = GpibNormal
    'Run Sample1(GPIB) Get Normal Data
    If (sts = 0) Then
        Text1.Text = "END"
    Else
        Text1.Text = "ERROR"
    End If
    StartFlag = 0
End Sub
-----
Private Sub Command2_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = GpibHarmonics
    'Run Sample2(GPIB) Get Harmonics Data
    If (sts = 0) Then
        Text1.Text = "END"
    Else
        Text1.Text = "ERROR"
    End If
    StartFlag = 0
End Sub
-----
Private Sub Command3_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Command4_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
```

13.4 Sample Program (Initialization, Error, and Execution Functions)

```
Private Sub Command5_Click()
    Dim sts As Integer
    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Command6_Click()
    Dim sts As Integer
    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Form_Load()
    StartFlag = 0                      'Clear Start Flag
    Dev = -1                            'Clear device id
    addr = 1                            'GPIB Address = 1
    Command1.Caption = "Sample1(GPIB)" + Chr(13) + "Get Normal Data"
    Command2.Caption = "Sample2(GPIB)" + Chr(13) + "Get Harmonics Data"
    Text1.Text = ""
End Sub
```

13.5 Sample Program (Output of Normal Measurement Data)

```
Sample1(GPIB) Get Normal Data
-----
Private Function GpibNormal() As Integer
    Dim msg As String
    Dim qry As String
    Dim qrytemp As String
    Dim sts As Integer
    Dim item As Integer
    Dim comma As Integer
    Dim cnt As Integer
    Dim spr As Integer

    term = Chr$(10)                                'terminator
    msg = Space$(100)
    qry = Space$(500)
    qrytemp = Space$(200)

    List1.AddItem "Now Initializing. Wait a moment."
    Dummyy = DoEvents()

    sts = InitGpib                               'Initialize GPIB
    If (sts <> 0) Then
        GpibNormal = 1
        Exit Function
    End If

    'Initialize the settings
    msg = "RC" + term                           'Initialize the settings
    sts = ilwrt(Dev, msg, Len(msg))             'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement condition
    'Hold off, Frequency Filter off, Line Filter off,
    'Scaling off, Averaging off
    msg = "HD0;FL0;SC0;AG0" + term
    sts = ilwrt(Dev, msg, Len(msg))             'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set function and element of display
    'DisplayA : V,Element1, DisplayB : A,Element1, DisplayC : W,Element1
    msg = "DA1;EA1;DB2;EB1;DC3;EC1" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement range
    msg = "RV7" + term                          'Voltage range = 150V
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "RA7" + term                          'Current range = 5A
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement mode
    msg = "MNO" + term                         'Measurement mode = RMS
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the communication output items (Default for normal measurement)
    'Set the communication output delimiter (CR+LF+EOI)
    msg = "OFD0;DL0" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
```

13.5 Sample Program (Output of Normal Measurement Data)

```

'Clear the RQS of status byte (Read and trash the response)
Sleep 1000
sts = ilrsp(Dev, spr)                                'Serial Poll

List1.Clear
'Read and display the numerical data (It is repeated 10 times in this program)
For cnt = 1 To 10
    GoSub Readdata
Next cnt

List1.AddItem " All end"
List1.ListIndex = List1.ListIndex + 1
Call ibonl(Dev, 0)
GpibNormal = 0
Exit Function

GPIBError:
Call DisplayGPIBError(sts, msg)

GpibNormal = 1
Exit Function

Readdata:
sts = ilrsp(Dev, spr)                                'Serial Poll
If (sts < 0) Then
    GoTo GPIBError
End If

If ((spr And &H41) <> &H41) Then
    cnt = cnt - 1
    Return
End If

'Read out the measurement data till END
qry = ""
msg = "OD" + term
sts = ilwrt(Dev, msg, Len(msg))
If (sts < 0) Then
    GoTo GPIBError
End If

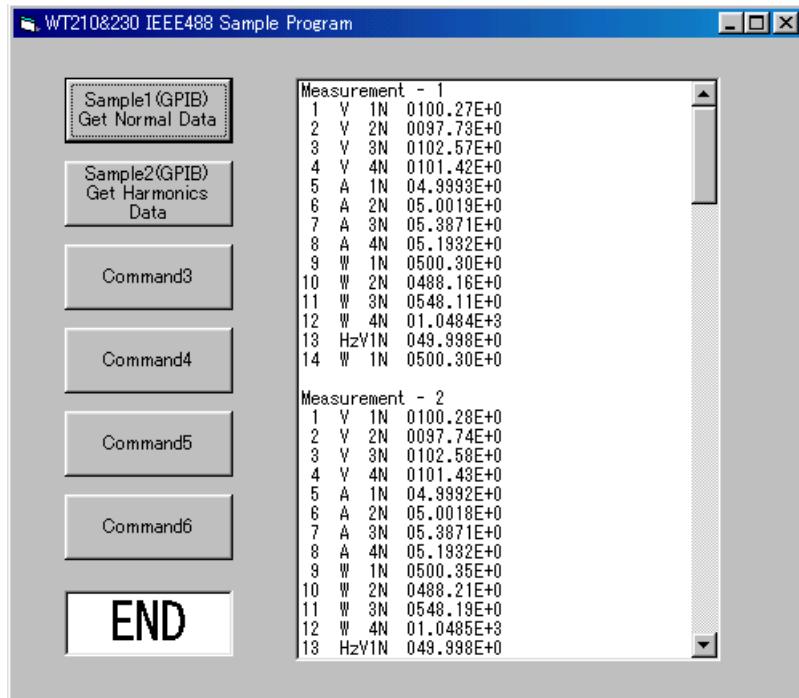
Do While qrytemp <> "END"
    qrytemp = Space$(200)
    sts = ilrd(Dev, qrytemp, Len(qrytemp))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    qrytemp = Left(qrytemp, InStr(qrytemp, term) - 2)
    qry = qry + qrytemp
    If (qrytemp <> "END") Then
        qry = qry + ","
    End If
Loop

'Extract items that are separated by commas(,) from the received data
List1.AddItem "Measurement - " + CStr(cnt)
List1.ListIndex = List1.ListIndex + 1
item = 1
Do While qry <> "END"
    comma = InStr(qry, ",")
    If (comma = 0) Then Exit Do
    Query(item) = Left(qry, comma - 1)
    If item < 10 Then
        List1.AddItem " " + CStr(item) + " " + Query(item)
    Else
        List1.AddItem CStr(item) + " " + Query(item)
    End If
    qry = Mid(qry, comma + 1)
    List1.ListIndex = List1.ListIndex + 1
    item = item + 1
Loop
List1.AddItem ""
List1.ListIndex = List1.ListIndex + 1
qrytemp = Space$(200)
qry = Space$(500)
Dummy = DoEvents()

Return

End Function
-----
```

13.5 Sample Program (Output of Normal Measurement Data)



13.6 Sample Program (Output of Harmonic Measurement Data)

```

Sample2(GPIB) Get Harmonics Data
-----
Private Function GpibHarmonics() As Integer
    Dim msg As String
    Dim qrytemp As String
    Dim sts As Integer
    Dim cnt As Integer
    Dim spr As Integer

    term = Chr$(10)                                'terminator
    msg = Space$(100)

    List1.AddItem "Now Initializing. Wait a moment."
    Dummy = DoEvents()

    sts = InitGpib                               'Initialize GPIB
    If (sts <> 0) Then
        GpibHarmonics = 1
        Exit Function
    End If

    'Initialize the settings
    msg = "RC" + term                            'Initialize the settings
    sts = ilwrt(Dev, msg, Len(msg))              'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement condition
    msg = "SI2" + term                           'Update rate = 500ms
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement range
    msg = "RV7" + term                           'Voltage range = 150V
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    msg = "RA7" + term                           'Current range = 5A
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Setting related to harmonic measurement
    'Object element = 1, PLL source = V1, Computation method of THD = IEC
    msg = "HE1;PS1;DF0;HA1" + term
    sts = ilwrt(Dev, msg, Len(msg))              'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the communication output items (A,Element1)
    msg = "OH2,1" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Clear the RQS of status byte (Read and trash the response)
    Sleep 1000                                    'Serial Poll
    sts = ilrsp(Dev, spr)

    List1.Clear
    'Read and display the harmonics data (It is repeated 10 times in this program)
    For cnt = 1 To 10
        GoSub Readdata
    Next cnt

    List1.AddItem " All end"
    List1.ListIndex = List1.ListIndex + 1
    Call ibonl(Dev, 0)
    GpibHarmonics = 0
    Exit Function

```

13.6 Sample Program (Output of Harmonic Measurement Data)

```

GPIBError:
    Call DisplayGPIBError(sts, msg)
    GpibHarmonics = 1
    Exit Function

Readdata:
    sts = ilrsp(Dev, spr)                      'Serial Poll
    If (sts < 0) Then
        GoTo GPIBError
    End If

    If ((spr And &H41) <> &H41) Then
        cnt = cnt - 1
        Return
    End If

    'Read out numerical data till END
    msg = "OD" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

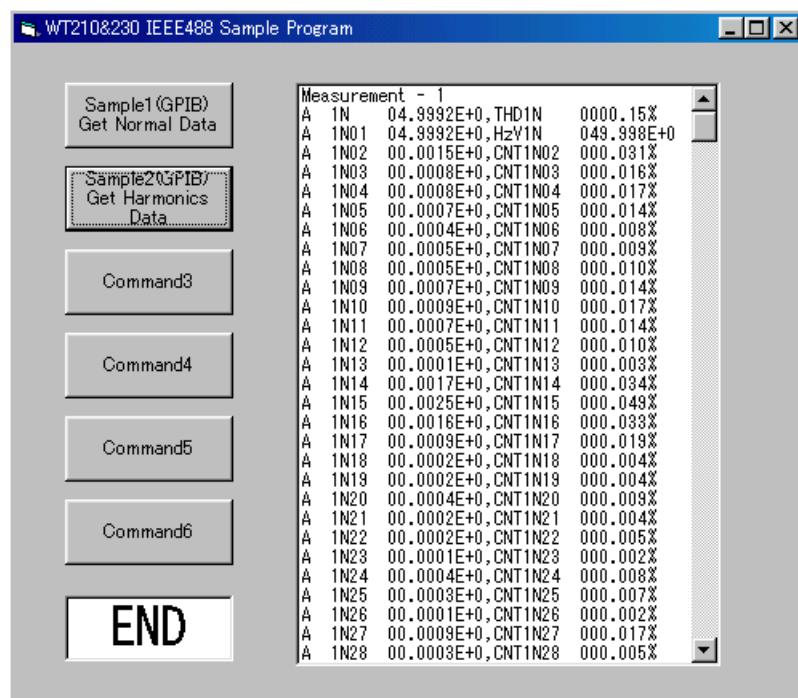
    List1.AddItem "Measurement - " + CStr(cnt)
    List1.ListIndex = List1.ListIndex + 1

    Do While qrytemp <> "END"
        qrytemp = Space$(200)
        sts = ilrd(Dev, qrytemp, Len(qrytemp))
        If (sts < 0) Then
            GoTo GPIBError
        End If
        qrytemp = Left(qrytemp, InStr(qrytemp, term) - 2)
        If (qrytemp = "END") Then
            Exit Do
        End If

        List1.AddItem qrytemp
        List1.ListIndex = List1.ListIndex + 1

    Loop
    Dummy = DoEvents()
    qrytemp = Space$(200)
    List1.AddItem ""
    List1.ListIndex = List1.ListIndex + 1

    Return
End Function
-----
```



14.1 Overview of IEEE 488.2-1992

The GP-IB interface provided with this instrument conforms to IEEE 488.2-1992. This standard requires the following 23 points be stated in this document. This appendix describes these points.

- 1 Subsets supported by IEEE 488.1 interface functions
Refer to 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 LOCAL key menu (see page 10-11). The newly set address is valid until another new address is set.
- 4 Device setup 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
Refer to 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
Refer to section 14.2 or 14.3.
- 7 Buffer size which affects transmission of block data
During block data transmission, the output queue is expanded according to the size.
- 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
Refer to 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 488.2-1992 are supported.
- 11 Size of data block of response data
Up to 24576 bytes
- 12 List of supported common 5commands
Refer to section 14.3.15 Common Command Group.
- 13 Condition of device when calibration is successfully completed
*CAL? is not supported.
- 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?
Refer to section 14.3.15 Common Command Group.

14.1 Overview of IEEE 488.2-1992

- 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
Refer to section 14.3.15 Common Command Group.
*LRN?, *RCL, *SAV
These commands are not supported.
- 20 Execution range of self-test using *TST?
Refer to section 14.3.15 Common Command Group.
- 21 Structure of extended return status
Refer to section 14.4.
- 22 To find out whether each command is performed in parallel or sequentially
Refer to section 14.2.6, "Synchronization with the Controller," or Section 14.3.
- 23 Functions performed until a message indicating completion of the command is displayed
Refer to the function description of each command in Section 14.3, and to 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, refer to pages 14-7 to 14-8.

Symbol	Description	Example	Example
<>	Defined value	ELEMENT<x>	<x>=1 to 3 ELEMENT3
{}	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		

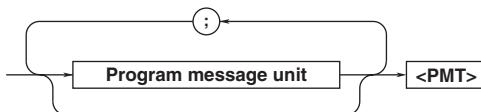
14.2.2 Messages

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 commands 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, refer to the explanation given further below.

Example :CONFIGURE:MODE RMS;FILTER ON<PMT>

 |_____|_____
 Unit Unit

<PMT>

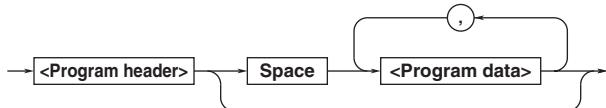
PMT is a terminator used to terminate each program message. The following three types of terminator are available.

- 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.)

14.2 Program Format

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, refer to page 14-5.

<Program data>

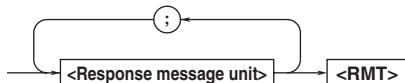
If certain conditions are required for the execution of a command, program data must be added. Program data must be separated from the header by a space (ASCII code "20H"). If multiple items of program data are included, they must be separated by a "," (comma).

Example

:CONFIGURE:AVERAGING:TYPE LINEAR, 8<PMT>
 Header Data

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, refer to the next item.

Example

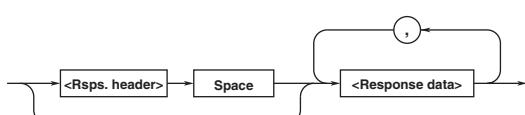
:CONFIGURE:VOLTAGE:RANGE 15.0E+00;AUTO 0<RMT>
 Unit Unit

<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, refer to 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

:500.0E-03<RMT> :CONFIGURE:MODE RMS<RMT>
 Data Header Data

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 is 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

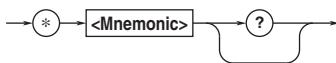
There are two types of command (program header) which can be sent from the controller to this instrument. They differ in the format of their program headers.

They are

- Common command header
- Compound header

Common Command Header

Commands defined in IEEE 488.2-1992 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.

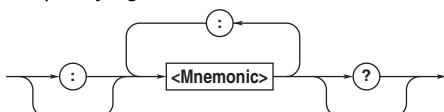


An example of a common command

*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:START
INTEGRATE:STOP
INTEGRATE:RESET
```

14.2 Program Format

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 488.2-1992 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<RMT>`

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 #HPE)
<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 "1:00:00")
<Block data>	Data containing 8-bit arbitrary values (Example: Response of measured/computed data (binary format) -> #500012ABCDEF GHijkl)

<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.

Data	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 <NR1> to <NR3>. This is represented by <NRf>.

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.

14.2 Program Format

<Voltage>, <Current>, <Time>

<Voltage>, <Current>, and <Time> 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
S	Second	Time

<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>	#q77
#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, refer to "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' "IEEE488.2-1992"

If the character string enclosed in single quotation marks contains a double quotation mark ("), it is represented as (""). This rule also applies to double quotation marks ("").

The character string data of a response message is always enclosed in double quotation marks ("").

Because <Character string data> is an arbitrary character string, if the last single quotation mark ('') or double quotation mark ("") is missing, the instrument may assume that the remaining program message units are part of the <Character string data> and may not detect the error.

<Block data>

<Block data> is arbitra 8-bit data. <Block data> is only used for response messages. Response messages are expressed in the following form.

Form	Example
#N<N-digit decimal value><Data byte string>	#500012ABCDEFGHIJKL

#N

Indiates that the data is <Block data>. “N” is an ASCII character string number (digits) which indicates the number of data bytes that follow.

<N-digits decimal value>

Indicates that number of bytes of data. (Example: 00012 = 12bytes)

<Data byte string>

The actual data. (Example: ABCDEFGHIJKL)

Data is comprised of 8-bit values (0 to 255). This means that the ASCII code “0AH”, which stands for “NL”, can also be a code used for data. Hence, care must be taken when programming the controller.

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).

```
STATus:FILTter1 FALL;:STATus:EESE 1;  
EESR?;*SRE 8;[:CONFIGURE]:VOLTage:  
RANGE 60V<PMT>  
(Service request is awaited.)  
MEASure[:NORMal]:VALue?<PMT>
```

“STATus:FILTter1 FALL” indicates that the transit filter is set so that bit 0 is set to “1” when bit 0 (FILTter1) 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 8” 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.

14.2 Program Format

Using the COMMUicate:WAIT command

The “COMMUicate:WAIT” command halts communications until a specific event is generated.

Example

```
STATus:FILTter1 FALL;:STATus:EESR?;  
[:CONFigure]:VOLTage:  
RANGE 60V<PMT>  
(Response to STATus:EESR? is decoded.)  
COMMUicate:WAIT 1;:  
MEASure[:NORMal]:VALue?<PMT>
```

For a description of “STATus:FILTter1 FALL” and “STATus:EESR?”, refer to “Using the extended event register” on this page.

“COMMUicate: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.	14-15
:AOUTput:CHANnel<x>	Sets/queries the D/A output item.	14-15
:AOUTput:IRTime	Sets/queries the preset integration time for D/A output of integrated values.	14-15
:AOUTput:PRESet	Sets the default value as D/A output items.	14-15
COMMUnicatE Group		
:COMMUnicatE?	Queries all settings related to communication.	14-16
:COMMUnicatE:HEADER	Sets/queries whether a header is to be added.	14-16
:COMMUnicatE:LOCKout	Sets/cancels local lockout.	14-16
:COMMUnicatE:REMote	Sets remote/local condition.	14-16
:COMMUnicatE:STATus?	Queries the status of a specified circuit.	14-16
:COMMUnicatE:VERBose	Sets/queries the response to be in full or abbreviated form.	14-17
:COMMUnicatE:WAIT	Waits until one of the specified extended event occurs.	14-17
:COMMUnicatE:WAIT?	Generates a response when on of the specified extended events occurs.	14-17
CONFigure Group		
:CONFigure?	Queries all settings related to the measurement conditions.	14-19
[:CONFigure]:AVERaging?	Queries all settings related to the averaging function.	14-19
[:CONFigure]:AVERaging[:STATE]	Sets/queries averaging ON/OFF.	14-19
[:CONFigure]:AVERaging:TYPE	Sets/queries averaging type and coefficient.	14-19
[:CONFigure]:CFACtor	Sets the crest factor or queries the current setting.	14-19
[:CONFigure]:CURRent?	Queries all settings related to the current range.	14-19
[:CONFigure]:CURRent:AUTO	Sets/queries the current auto range ON/OFF.	14-19
[:CONFigure]:CURRent:ESCaling?	Queries all settings related to the external sensor.	14-20
[:CONFigure]:CURRent:ESCaling[:ALL]	Sets the scaling constants for the external sensor for all elements at once.	14-20
[:CONFigure]:CURRent:ESCaling:ELEMent<x>	Sets/queries the scaling constants for the external sensor for each element.	14-20
[:CONFigure]:CURRent:RANGE	Sets/queries the current range.	14-20
[:CONFigure]:FILTer	Sets/queries the frequency filter ON/OFF.	14-20
[:CONFigure]:LFILTER	Sets/queries the line filter ON/OFF.	14-20
[:CONFigure]:MHold[:STATE]	Sets/queries the MAX hold ON/OFF.	14-20
[:CONFigure]:MODE	Sets/queries the measurement mode.	14-21
[:CONFigure]:SCALing?	Queries all settings related to the scaling function.	14-21
[:CONFigure]:SCALing:{PT CT SFACtor}?	Queries all settings related to scaling constants for {voltage current power}.	14-21
[:CONFigure]:SCALing:{PT CT SFACtor}[:ALL]	Sets the scaling constants for all elements of {voltage current power}.	14-21
[:CONFigure]:SCALing:{PT CT SFACtor}:ELEMENT<x>	Sets the scaling values for each element of {voltage current power}.	14-21
[:CONFigure]:SCALing[:STATE]	Sets/queries the scaling function ON/OFF.	14-21
[:CONFigure]:SYNChronize	Sets/queries the measurement synchronization source.	14-21
[:CONFigure]:VOLTage?	Queries all settings related to the voltage range.	14-21
[:CONFigure]:VOLTage:AUTO	Sets/queries the voltage auto range ON/OFF.	14-21
[:CONFigure]:VOLTage:RANGE	Sets/queries the voltage range.	14-21
[:CONFigure]:WIRing	Sets/queries the wiring method.	14-22

14.3 Commands

Command	Description	Page
DISPlay Group		
:DISPLAY<x>?	Queries all the display settings.	14-22
:DISPLAY<x>:ELEMENT	Sets/queries the element to be displayed.	14-22
:DISPLAY<x>:FUNCTION	Sets/queries the function to be displayed.	14-23
:DISPLAY<x>:MODE	Sets/queries the contents of the display.	14-23
:DISPLAY<x>:RESolution	Sets/queries the number of display digits.	14-23
HARMonics Group		
:HARMonics?	Queries all settings related to harmonic measurement.	14-24
:HARMonics:DISPLAY?	Queries all settings related to the display in case of harmonic measurement.	14-24
:HARMonics:DISPLAY:ORDer	Sets/queries the order of the harmonic component to be shown on display B.	14-24
:HARMonics:ELEMENT	Sets/queries the element for harmonic measurement.	14-24
:HARMonics[:STATE]	Sets/queries the harmonic measurement mode ON/OFF.	14-24
:HARMonics:SYNChronize	Sets/queries the input to be used as PLL source.	14-25
:HARMonics:THD	Sets/queries the computation method for harmonic distortion.	14-25
INTEGrate Group		
:INTEGrate?	Queries all settings related to integration.	14-25
:INTEGrate:MODE	Sets/queries the integration mode.	14-25
:INTEGrate:RESet	Resets the integration values.	14-25
:INTEGrate:START	Starts integration.	14-25
:INTEGrate:STOP	Stops integration.	14-25
:INTEGrate:TImer	Sets/queries the integration timer.	14-25
MATH Group		
:MATH?	Queries all settings related to the computing function.	14-26
:MATH:ARITHmetic	Sets/queries the computing equation of the four arithmetic operations.	14-26
:MATH:AVERage	Sets/queries the average active power computation during integration.	14-26
:MATH:CFACtor	Sets/queries the computing equation of the crest factor.	14-26
:MATH:TYPE	Sets/queries the computing equation.	14-27
MEASure Group		
:MEASure?	Queries all settings related to measurement/computation data.	14-29
:MEASure:HARMonics?	Queries all settings related to harmonic measurement data.	14-29
:MEASure:HARMonics:ITEM?	Queries all settings related to the output items of harmonic measurement data.	14-29
:MEASure:HARMonics:BINary?	Queries harmonic measurement data set by commands other than "MEASure:HARMonics:ITEM" (binary format).	14-29
:MEASure:HARMonics:ITEM:PRESet	Sets the ON/OFF pattern for all communication outputs of the harmonic measurement function.	14-29
:MEASure:HARMonics:ITEM:{SYNChronize <harmonic measurement function>}	Sets/queries the communication output item of harmonic measurement ON/OFF.	14-30
:MEASure:HARMonics:VALue?	Queries harmonic measurement data set by commands other than "MEASure:HARMonics:ITEM" (ASCII format).	14-30
:MEASure:HEADer	Turns ON/OFF the additional information output when outputting measured/computed data in binary format.	14-30
:MEASure:NORMal?	Queries all settings related to normal measured/computed data.	14-30
:MEASure[:NORMal]:BINary?	Queries normal measurement data set by commands other than "MEASure[:NORMal]:ITEM" (binary format).	14-30
:MEASure[:NORMal]:ITEM?	Queries all settings related to the output items of normal measured/computed data.	14-30
:MEASure[:NORMal]:ITEM:PRESet	Sets the ON/OFF pattern for all communication outputs of the normal measurement function.	14-31

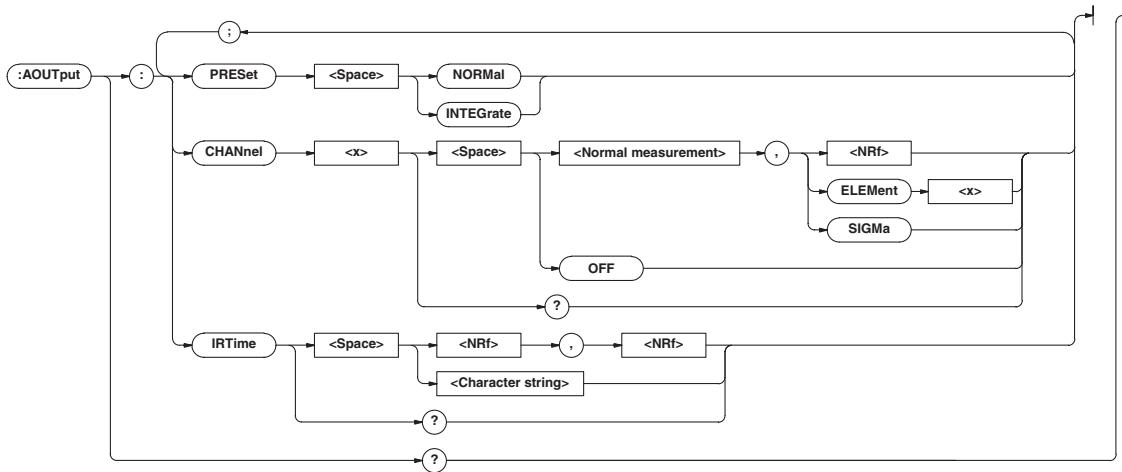
Command	Description	Page
:MEASure[:NORMal]:ITEM:{TIME MATH}	Sets/queries the ON/OFF state of the communication output of {integration time MATH}.	14-31
:MEASure[:NORMal]:ITEM:<normal measurement function>?	Queries communication output settings of the normal measurement function.	14-31
:MEASure[:NORMal]:ITEM:<normal measurement function>[:ALL]	Sets the communication output items concerning all elements or S ON/OFF at once.	14-31
:MEASure[:NORMal]:ITEM:<normal measurement function>:ELEMENT<x>	Sets/queries the communication output items concerning each element ON/OFF.	14-31
:MEASure[:NORMal]:ITEM:<normal measurement function>:SIGMa	Sets/queries the communication output items concerning S ON/OFF.	14-31
:MEASure[:NORMal]:VALUE?	Queries normal measured/computed data set by commands other than "MEASure[:NORMal]:ITEM" (ASCII format).	14-31
RECall Group		
:RECall?	Queries all settings related to recalling data.	14-36
:RECall:INTerval	Sets/queries the recalling interval.	14-36
:RECall:PANEL	Retrieves the setup parameters file.	14-36
:RECall[:STATE]	Sets/queries recalling ON/OFF.	14-36
RELay Group		
:RELay?	Queries all settings related to the comparator function.	14-37
:RELay:DISPLAY	Sets/queries the comparator display OFF, or in case of ON, the channel to be displayed.	14-37
:RELay:HChannel<x>?	Queries all settings related to relay output items in case of harmonic measurement.	14-37
:RELay:HChannel<x>:FUNCTION	Sets/queries function of the relay output item in case of harmonic measurement.	14-38
:RELay:HChannel<x>:THreshold	Sets/queries the threshold level for the relay output item.	14-38
:RELay:MODE	Sets/queries the mode of the comparator function.	14-38
:RELay:NChannel<x>?	Queries all settings related to the relay output items in case of normal measurement.	14-38
:RELay:NChannel<x>:FUNCTION	Sets/queries the function of the relay output in case of normal measurement.	14-38
:RELay:NChannel<x>:THreshold	Sets/queries the threshold level for the relay output item.	14-38
:RELay[:STATE]	Sets/queries the comparator function ON/OFF.	14-38
SAMPle Group		
:SAMPLE?	Queries all settings related to sampling.	14-39
:SAMPLE:HOLD	Sets/queries to hold the output of data (display, communication).	14-39
:SAMPLE:RATE	Sets the display update rate or queries the current setting.	14-39
STATus Group		
:STATus?	Queries all settings related to the status of communication.	14-40
:STATus:CONDition?	Queries the contents of the condition filter.	14-40
:STATus:EESE	Sets/queries the extended event register.	14-40
:STATus:EESR?	Queries the contents of the extended event register and clears it.	14-40
:STATus:ERRor?	Queries the occurred error code and message.	14-40
:STATus:FILTer<x>	Sets/queries the transit filter.	14-40
:STATus:QMESSage	Sets/queries whether or not to apply the corresponding message to the query "STATus:ERRor?".	14-41
:STATus:SPOlL?(Serial Poll)	Executes serial polling.	14-41

14.3 Commands

Command	Description	Page
STORe Group		
:STORe?	Queries all settings related to storing data.	14-41
:STORe:INTerval	Sets/queries the interval for storing data.	14-41
:STORe:PANel	Saves the setup parameters to a file.	14-41
:STORe[:STATE]	Sets/queries the store function ON/OFF.	14-41
Common Command Group		
*CAL?	Executes zero-level compensation and queries the results.	14-42
*CLS	Clears the standard event register, extended event register and error queue.	14-42
*ESE	Sets/queries the value of the standard event enable register.	14-42
*ESR?	Sets/queries the value of the standard event register and clears it.	14-42
*IDN?	Queries the instrument model.	14-43
*OPC	This command is not supported by this instrument.	14-43
*OPC?	This command is not supported by this instrument, and is always “1”.	14-43
*OPT?	Queries installed options.	14-43
*PSC	Sets/queries whether or not to clear some registers at power ON.	14-43
*RST	Initializes the setup parameters.	14-43
*SRE	Sets/queries the value of the service request enable register.	14-43
*STB?	Queries the value of the status byte register.	14-43
*TRG	Executes the same operation as the TRIG(SHIFT+HOLD) key.	14-43
*TST?	Executes a self-test and queries the results.	14-43
*WAI	This command is not supported by this instrument.	14-43

14.3.2 AOUTput Group

The commands in the AOUTput group are used to make settings relating to, and inquires about D/A output (option). 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".



AOUTput?

Function Queries all the settings relating to D/A output.
Syntax AOUTput?
Example AOUTPUT? -> :AOUTPUT:CHANNEL1 V,1;
 CHANNEL2 V,2;CHANNEL3 V,3;CHANNEL4 V,
 SIGMA;CHANNEL5 A,1;CHANNEL6 A,2;
 CHANNEL7 A,3;CHANNEL8 A,SIGMA;
 CHANNEL9 W,1;CHANNEL10 W,2;
 CHANNEL11 W,3;CHANNEL12 W,SIGMA;:
 AOUTPUT:IRTIME 1,0

AOUTput:CHANnel<x>

Function Sets the D/A output item, or queries the current setting.
Syntax AOUTput:CHANnel<x> {<normal measurement function>,(<NRF>|
 ELEMENT<1-3>|SIGMa)|OFF}
 <x>= 1 to 12(in case of /DA12)
 1 to 4 (in case of /DA4 or /CMP)
 <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:
 CHANNEL1 V,1
 AOUTPUT:CHANNEL2? -> :AOUTPUT:
 CHANNEL2 OFF

Note

In the following pages, the alphanumeric character strings used in the descriptions of the <normal measurement function> or the <harmonic measurement function> indicates the following data.

- <Normal measurement function>
 V: voltage, A: current, W: effective 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: current hour, AHP: positive current hour, AHM: negative current hour, MATH: MATH computation result, VPK: peak voltage, APK: peak current
- <Harmonic measurement function>
 See page 14-33.
- Other
 TIME: elapsed integration time, ORDer: harmonic order

Description If <normal measurement function> is set to MATH, the element setting is void. You can omit it.

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

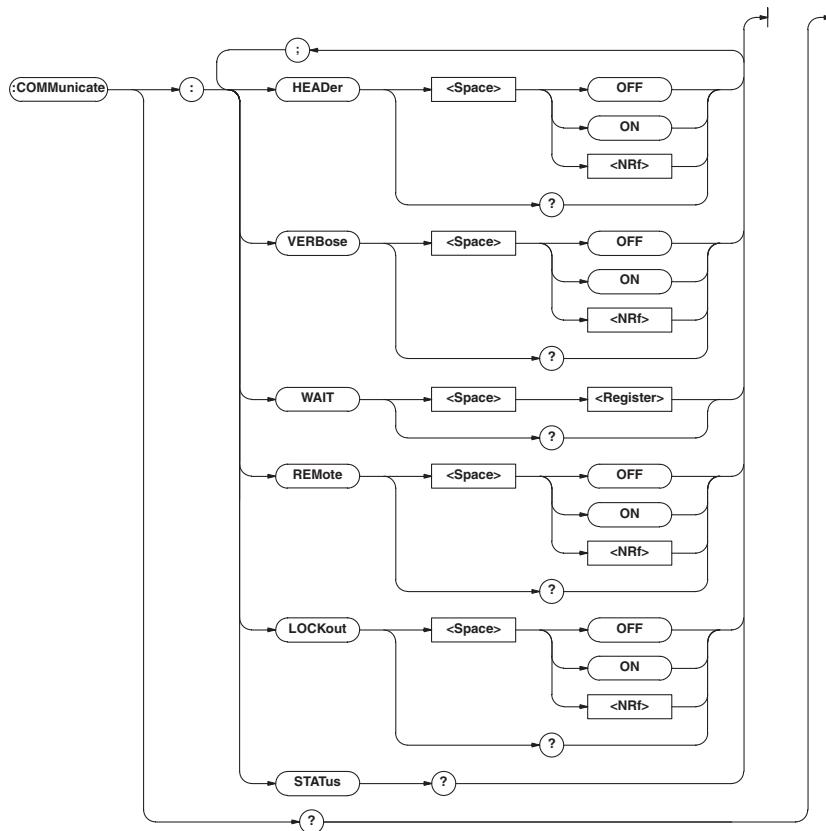
AOUTput:PRESet

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 Refer to section 9.3 for a description of default D/A output items for normal measurement and integration.

14.3 Commands

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 used for the serial 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 used for the serial 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	Serial
0	permanent	Parity error comm. 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

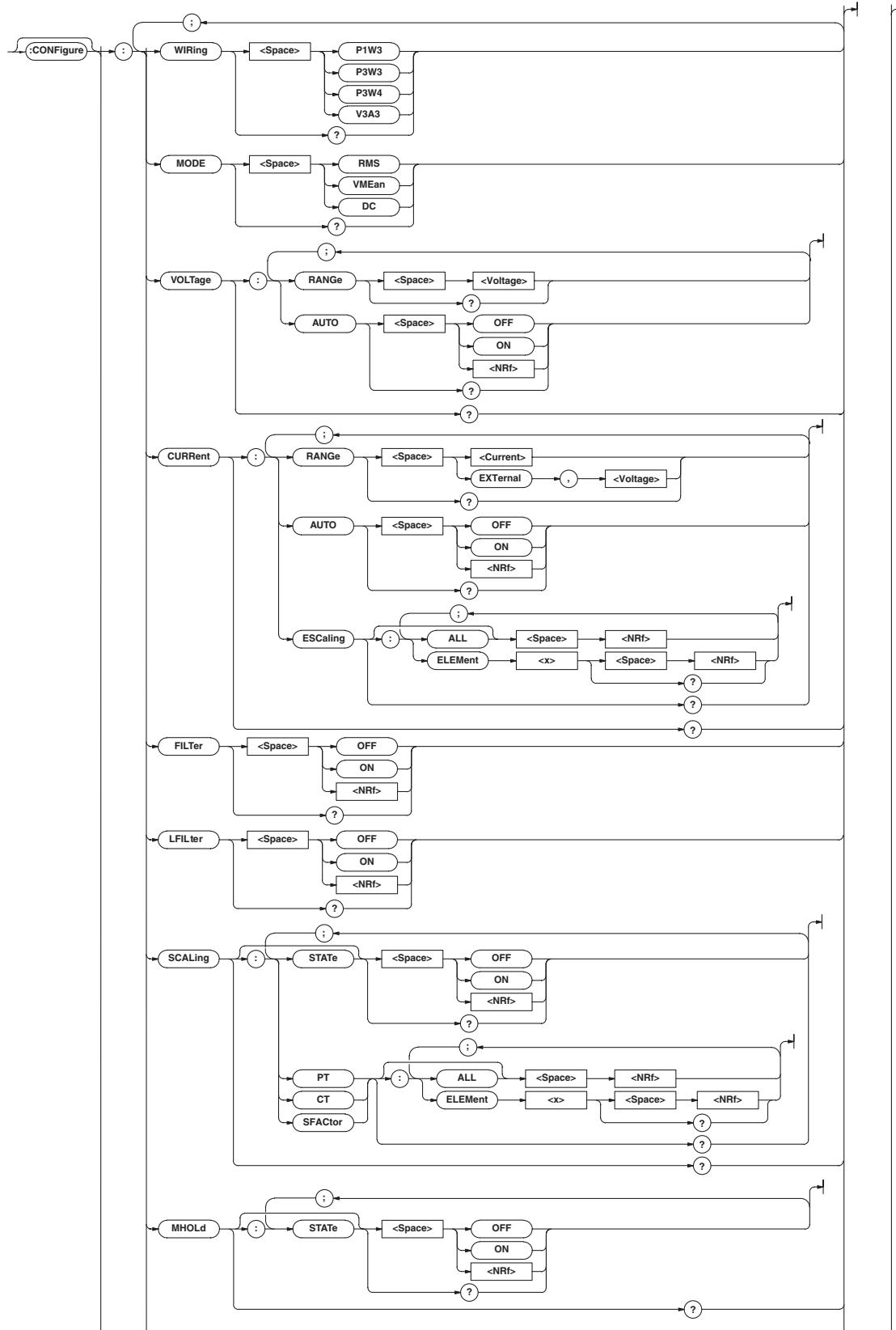
- Function** Waits until one of the specified extended event occurs.
- Syntax** COMMUnicatE:WAIT <Register>
<Register>= 0 to 65535 (For a description of the extended event register, refer to page 14-47.)
- Example** COMMUNICATE:WAIT 65535
- Description** For a description of synchronization using "COMMUnicatE:WAIT", refer to page 14-9.

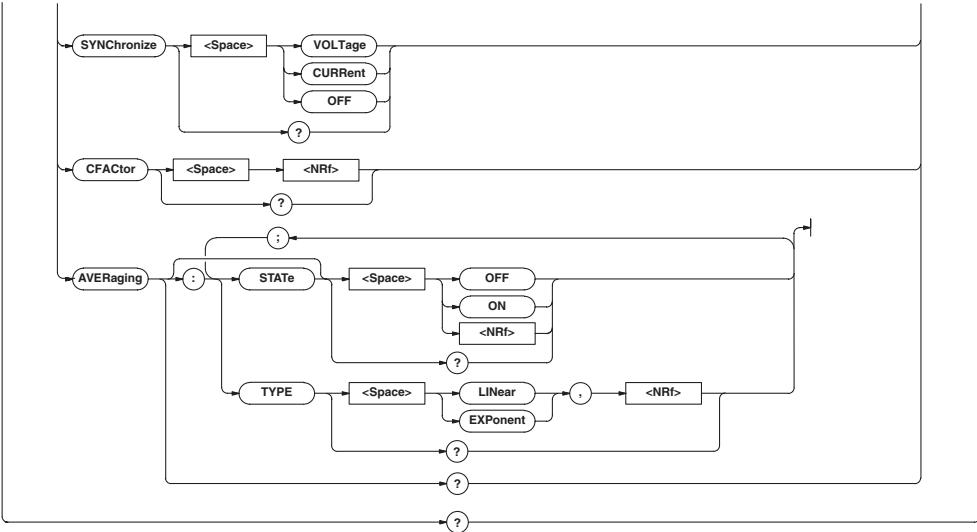
COMMUnicatE:WAIT?

- 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, refer to page 14-47.)
- 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, VOLTAGE key, CURRENT key, MODE (SHIFT + VOLTAGE) key and SETUP key (except for “PnLrSt”, “u.rAtE”) on the front panel. The external sensor input range and external sensor scaling values are only valid 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? -> :CONFIGURE:WIRING P1W3;
MODE RMS;VOLTAGE:RANGE 600.0E+00;
AUTO 1;:CONFIGURE:CURRENT:
RANGE 20.0E+00;AUTO 1;ESCALING:
ELEMENT1 50.00E+00;
ELEMENT2 50.00E+00;
ELEMENT3 50.00E+00;:CONFIGURE:
FILTER 0;LFILTER 0;SCALING:
STATE 0;PT:
ELEMENT1 1.000E+00;
ELEMENT2 1.000E+00;
ELEMENT3 1.000E+00;
:CONFIGURE:SCALING:
CT:ELEMENT1 1.000E+00;
ELEMENT2 1.000E+00;
ELEMENT3 1.000E+00;
:CONFIGURE:SCALING:
SFACTOR:ELEMENT1 1.000E+00;
ELEMENT2 1.000E+00;
ELEMENT3 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 coefficient, queries the current setting.

Syntax [CONFIGure]:AVERaging:TYPE { (LINEar |
EXPonent),<NRF> }
[CONFIGure]:AVERaging:TYPE?
{<NRF>}=8, 16, 32, 64 (averaging coefficient)

Example [CONFIGURE]:AVERAGING:TYPE LINEAR,8
[CONFIGURE]:AVERAGING:TYPE?
-> :CONFIGURE:AVERAGING:TYPE LINEAR,8

[CONFIGure]:CFACTOR?

Function Sets the crest factor or queries the current setting.

Syntax [CONFIGure]:CFACTOR {<NRF> }
[CONFIGure]:CFACTOR?
{<NRF>} = 3, 6

Example [CONFIGURE]:CFACTOR 3
[CONFIGURE]:CFACTOR? ->
:CONFIGURE:CFACTOR 3

[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;
ELEMENT2 50.00E+00;ELEMENT3 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

14.3 Commands

[CONFIGURE]:CURREnt:ESCALing?

Function Queries all scaling constants for the external sensor.

Syntax [CONFIGURE]:CURREnt:ESCALing?

Example [CONFIGURE]:CURRENT:ESCALING?
-> :CONFIGURE:CURRENT:ESCALING:
ELEMENT1 50.00E+00;
ELEMENT2 50.00E+00;
ELEMENT3 50.00E+00

[CONFIGURE]:CURREnt:ESCALing[:ALL]

Function Sets the scaling constants for the external sensor for all elements at once.

Syntax [CONFIGURE]:CURREnt:ESCALing[:
ALL] {<NRF>}
<NRF>= 0.001 to 9999

Example [CONFIGURE]:CURRENT:ESCALING:
ALL 50.00

Description The setting values differ as follows.

Less than 1.000 : Three digits after the floating-point are valid.

1.000 to 9999 : The first five digits are valid.

[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 (WT210 single-phase
model)
1, 3 (WT230 three-phase,
three-wire model)
1 to 3 (WT230 three-phase,
four-wire model)

{<NRF>}=0.001 to 1000

Example [CONFIGURE]:CURRENT:ESCALING:
ELEMENT1 50.00[CONFIGURE]:CURRENT:
ESCALING:ELEMENT1? -> :CONFIGURE:
CURRENT:ESCALING:ELEMENT1 50.00E+00

Description Setting values differ as described at

[CONFIGURE]: CURREnt:ESCALing[:ALL].

[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?

- When the crest factor is set to 3

<current> =500mA to 20A (0.5, 1,
2, 5, 10, 20A)
The following settings
available only on WT210.
5mA to 200mA (5m, 10m,
20m, 50m, 100m, 200mA)

<voltage> =50mV to 200mV (50, 100,
200mV, for /EX2 option)
=2.5V to 10V (2.5, 5,
10V, for /EX1 option)

- When the crest factor is set to 6

<Current> =250 mA to 10 A (0.25,
0.5, 1, 2.5, 5, or 10 A)
The following settings
available only on
WT210.2.5 mA to 100 mA
(2.5 m, 5 m, 10 m, 25 m,
50 m, or 100 mA)

<Voltage> =25 mV to 100 mV (25,
50, 100 mV, for /EX2
option)
=1.25 V to 5 V (1.25,
2.5, 5 V, 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 (in case of /EX2 option)
[CONFIGURE]:CURRENT:RANGE EXTERNAL,
50MV
[CONFIGURE]:CURRENT:RANGE?
-> :CONFIGURE:CURRENT:RANGE EXTERNAL,
50.0E-03

[CONFIGURE]:FILTer

Function Sets the frequency filter ON/OFF, queries the current setting.

Syntax [CONFIGURE]:FILTer {<Boolean>}
[CONFIGURE]:FILTter?

Example [CONFIGURE]:FILTER OFF[CONFIGURE]:
FILTER? -> :CONFIGURE:FILTER 0

[CONFIGURE]:LFILTter

Function Sets the line filter ON/OFF queries the current setting.

Syntax [CONFIGURE]:LFILTter {<Boolean>}
[CONFIGURE]:LFILTter?

Example [CONFIGURE]:LFILTER OFF
[CONFIGURE]:LFILTER?
-> :CONFIGURE:LFILTER 0

[CONFIGURE]:MHOLD[:STATE]

Function Sets the MAX hold ON/OFF, queries the current setting.

Syntax [CONFIGURE]:MHold[:
STATE] {<Boolean>}

[CONFIGURE]:MHOLD[:STATE]?

Example [CONFIGURE]:MHOLD:STATE OFF
[CONFIGURE]:MHOLD:STATE? ->
:CONFIGURE:MHOLD:STATE 0

[CONFIGURE]:MODE		1, 3 (WT230 three-phase, three-wire model) 1 to 3 (WT230 three-phase, four-wire model) $\{<\text{NRF}>\}=0.001 \text{ to } 9999$
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; ELEMENT2 1.000E+00; ELEMENT3 1.000E+00; :CONFIGURE:SCALING:CT: ELEMENT1 1.000E+00; ELEMENT2 1.000E+00; ELEMENT3 1.000E+00;:CONFIGURE: SCALING:SFACTOR:ELEMENT1 1.000E+00; ELEMENT2 1.000E+00; ELEMENT3 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; ELEMENT2 1.000E+00; ELEMENT3 1.000E+00	
[CONFIGURE]:SCALing:{PT CT SFACTOR}[:ALL]		
Function	Sets the scaling constants for all elements of {voltage current power} at once.	
Syntax	[CONFIGURE]:SCALing:{PT CT SFACTOR}[:ALL] {<NRF>} $\{<\text{NRF}>\}=0.001 \text{ to } 9999$	
Example	[CONFIGURE]:SCALING:PT:ALL 1.000	
Description	The setting values are rounded as follows. Less than 1.000 : Three digits after the decimal point are valid. 1.000 to 9999 : The first five digits are valid.	
[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>? $<\text{x}>=1$ (WT210 single-phase model)	
[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 the measurement synchronization source/queries the current setting.	
Syntax	[CONFIGURE]:SYNChronize {VOLTage CURREnt OFF} [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? -> :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? -> :CONFIGURE:VOLTAGE:AUTO 1	
[CONFIGURE]:VOLTage:RANGE		
Function	Sets the voltage range/queries the current setting.	
Syntax	[CONFIGURE]:VOLTage:RANGE {<voltage>} [CONFIGURE]:VOLTage:RANGE? <ul style="list-style-type: none">• When the crest factor is set to 3 $<\text{voltage}>=15\text{V}$ to 600V (15, 30, 60, 150, 300, 600V)• When the crest factor is set to 6 $<\text{Voltage}> = 7.5 \text{ V}$ to 300 V (7.5, 15, 30, 75, 150, or 300)	

14.3 Commands

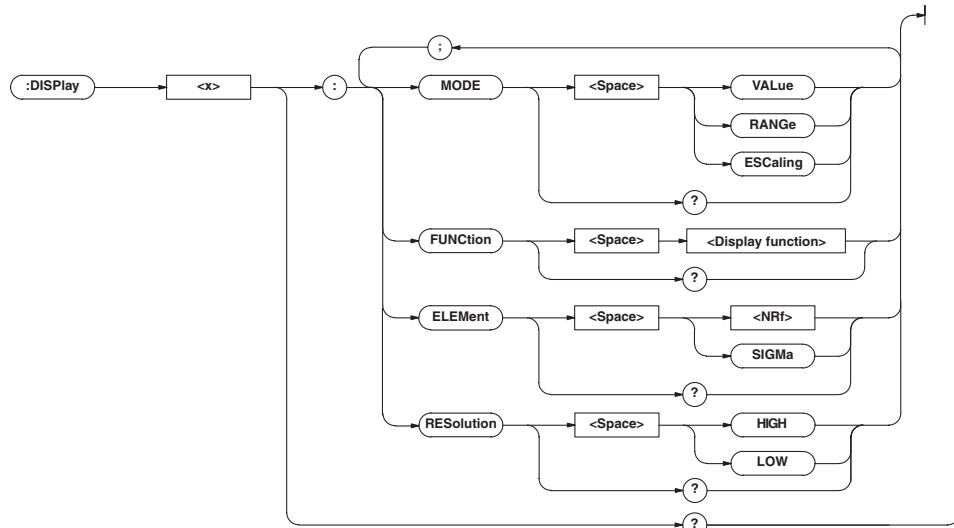
Example [CONFIGURE]:VOLTAGE:RANGE 600V
 [CONFIGURE]:VOLTAGE:RANGE?
 -> :CONFIGURE:VOLTAGE:RANGE 600.0E+00

[CONFIGURE]:WIRing

Function Sets the wiring method/queries the current setting.
 Syntax [CONFIGURE]:WIRing {P1W2|P1W3|P3W3|P3W4|V3A3}
 [CONFIGURE]:WIRing?
 Example [CONFIGURE]:WIRING P1W3
 [CONFIGURE]:WIRING?
 -> :CONFIGURE:WIRING P1W3
 Description The selections stand for the following.
 P1W3: Single-phase, three-wires (only for WT230)
 P3W3: Three-phase, three-wires (only for WT230)
 P3W4: Three-phase, four-wires (only for WT230 3-phase, 4-wire model)
 V3A3: Three-voltage, three-current (only for WT230 3-phase, 4-wire model)

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;RESOLUTION HIGH

DISPLAY<x>:ELEMENT

Function Sets the element to be displayed/queries the current setting.
 Syntax DISPLAY<x>:ELEMENT {<NRf>|SIGMA}
 DISPLAY<x>:ELEMENT?
 <x>= 1 to 3
 1:Display A
 2:Display B
 3:Display C
 {<NRf>}=1 (WT210 single-phase model)
 1, 3 (WT230 three-phase, three-wire model)
 1 to 3 (WT230 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 In case of normal measurement: <display function>={V A W VA VAR PF DEGRee VHZ AHZ WH WHP WHM AH AHP AHM MATH VPK APK TIME} In case of harmonic measurement: <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
Description	For the meanings of the symbols of functions, see Note on page 14-14.

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 values of the external sensor of element 1. ESCaling: displays the scaling values 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.

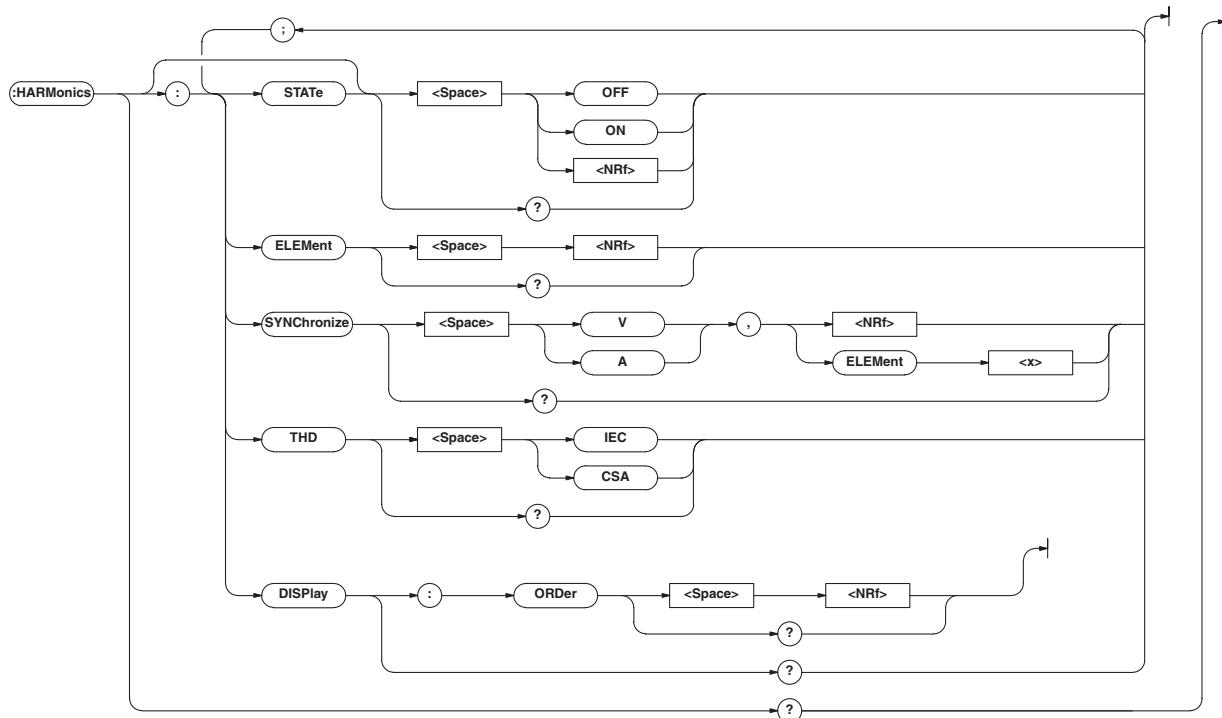
DISPlay<x>:RESolution

Function	Sets the number of displayed digits/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 Commands

14.3.6 HARMonics Group

The commands in the HARMonics group relate to the harmonic measurement 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 measurement.
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 measurement.
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 measurement/ queries the current setting.
Syntax HARMonics:ELEMENT {<NRf>}

HARMonics:ELEMENT?

{<NRf>}=1 (WT210 single-phase model)
1, 3 (WT230 three-phase, three-wire model)
1 to 3 (WT230 three-phase, four-wire model)

Example HARMONICS:ELEMENT 1
HARMONICS:ELEMENT?
-> :HARMONICS:ELEMENT 1

HARMonics[:STATe]

Function Sets the harmonic measurement mode ON/OFF, queries the current setting.
Syntax HARMonics[:STATe] {<Boolean>}
HARMonics[:STATe]?
Example HARMONICS:STATE ON
HARMONICS:STATE? -> :HARMONICS:
STATE 1
Description If you switch the harmonic measurement mode ON/OFF using this command and query the measurement mode using the “:MEASure:HARMonics:VALue?” or “:MEASure[:NORMal]:Value?” command immediately afterwards, the measured data of the previous measurement mode may be output. To retrieve the measured data in the new measurement mode, a wait of approximately 2 seconds is required after issuing this command.

HARMonics:SYNChronize

Function Sets the fundamental frequency for PLL synchronization (PLL source)/queries the current setting.

Syntax HARMonics:SYNChronize
{ (V|A), (<NRF> | ELEMent<1-3>) }
HARMonics:SYNChronize?

Example HARMONICS:SYNCHRONIZE V,1
HARMONICS:SYNCHRONIZE?
-> :HARMONICS:SYNCHRONIZE V,1

HARMonics:THD

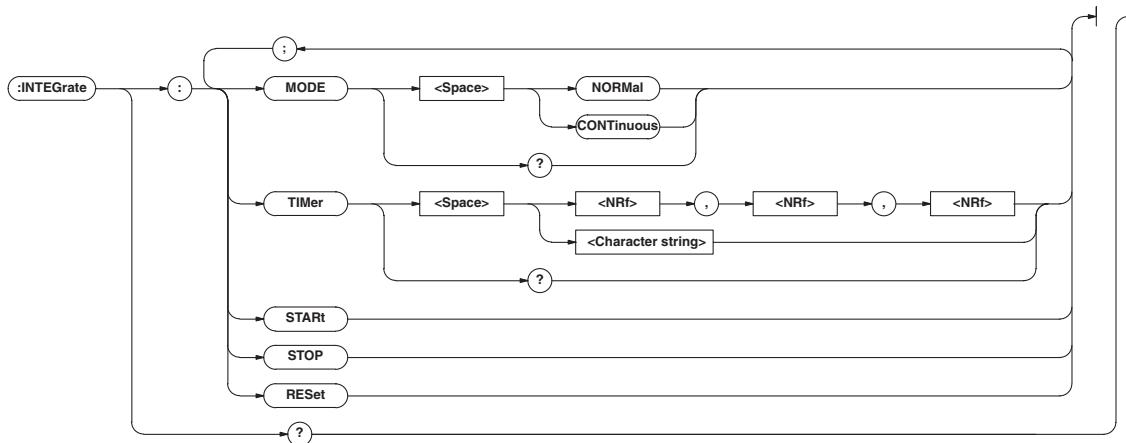
Function Sets the computation method for harmonic distortion (THD) for harmonic measurement/queries the current setting.

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

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

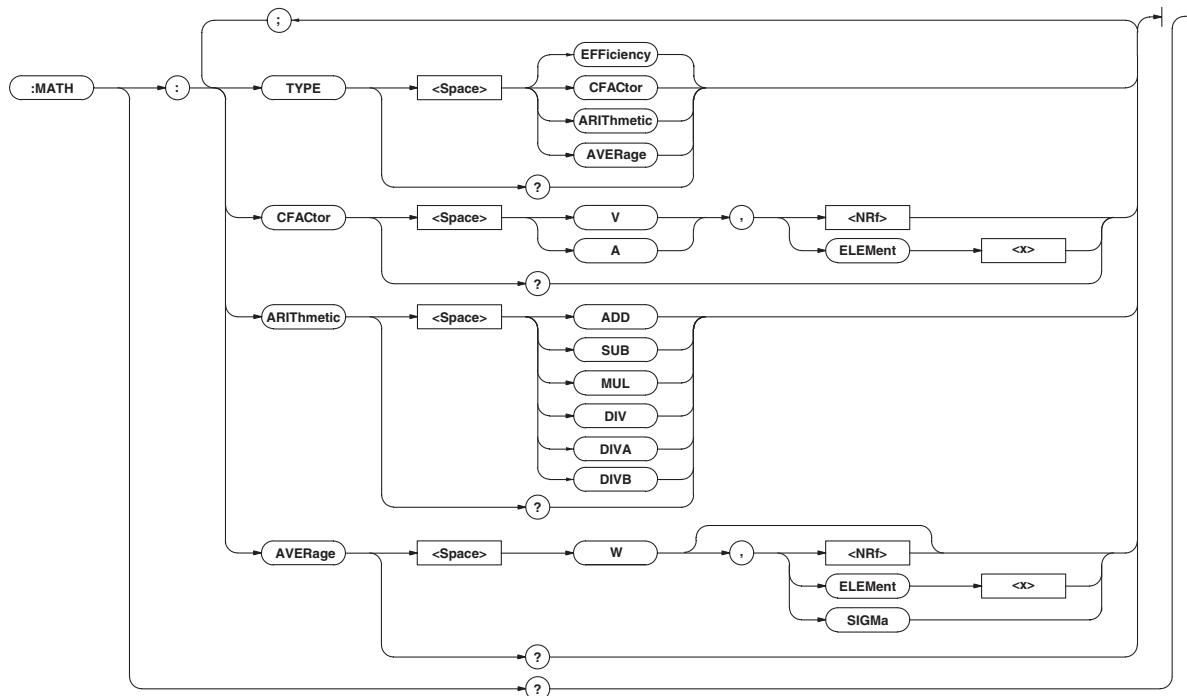
Function Sets the integration timer/queries the current setting.

Syntax INTEGrate:TIMER {<NRF>, <NRF>, <NRF> |
<String>}
{<NRF>, <NRF>, <NRF>}=0,0,0 to
10000,0,0
{<String>}=HHHH:MM:SS HHHHH hour MM
minute SS second

Example INTEGRATE:TIMER 10,0,0
INTEGRATE:TIMER "10:00:00"
INTEGRATE:TIMER? -> :INTEGRATE:
:TIMER 10,0,0

14.3.8 MATH Group

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 active power computation.

Syntax MATH:AVERage {W[,(<NRf>|

ELEMent<1-3>|SIGMa)]}

MATH:AVERage?

Example MATH:AVERAGE W,1

MATH:AVERAGE? -> :MATH:AVERAGE W,1

Description If [MATH:TYPE] is not set to [AVERage], this command will be meaningless.

MATH:CFActor

Function Sets/queries the computing equation of the crest factor

Syntax MATH:CFACTOR {((V|A),(<NRf>|

ELEMent<x>)}

<x>= 1 (WT210 single-phase
model)

1, 3 (WT230 three-phase
three-wire model)

1 to 3 (WT230 three phase four-
wire model)

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

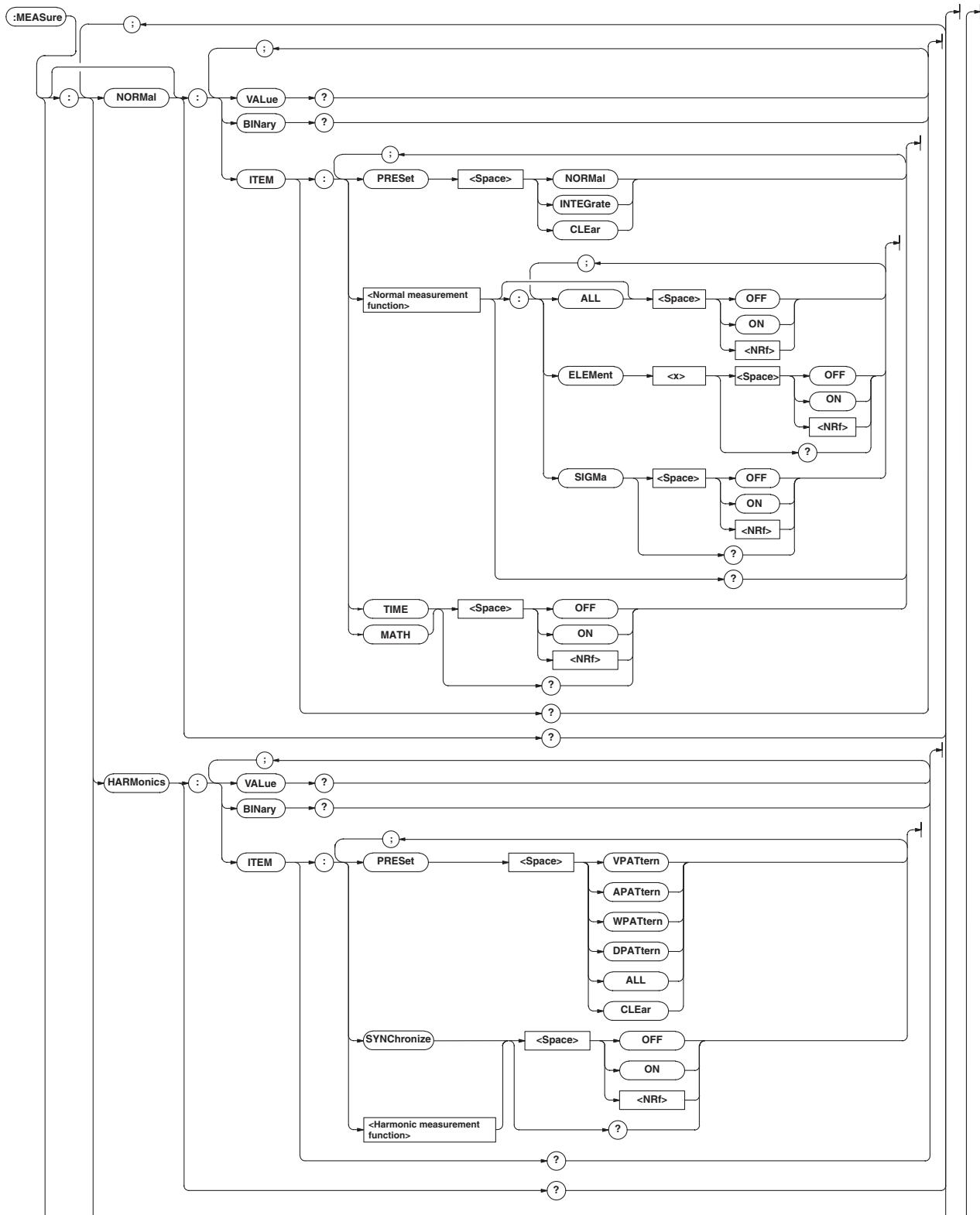
Syntax MATH:TYPE {EFFiciency |
CFACTOR|ARITHmetic|AVERage}
MATH:TYPE?

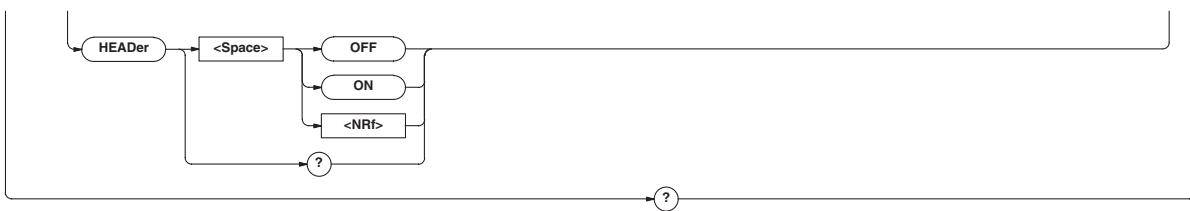
Example MATH:TYPE CFACTOR
MATH:TYPE? -> :MATH:TYPE CFACTOR

Description The equation method selections are as follows:
EFFiciency : Efficiency (valid only for WT230)
CFACTOR : Crest factor
ARITHmetic : Four arithmetic operations
AVERage : Average active power 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 /HARM (harmonic measurement function) to be able to use the related commands. Setting the output items for measurement/computation data is only valid in the communication mode.



**MEASure?**

Function Queries all the settings related to measurement/computation data.

Syntax MEASure?

Example Example of WT230 three-phase four-wire model
`MEASURE? -> :MEASURE:NORMAL:ITEM:V: ELEMENT1 1;ELEMENT2 1;ELEMENT3 1; SIGMA 1;:MEASURE:NORMAL:ITEM:A: ELEMENT1 1;ELEMENT2 1;ELEMENT3 1; SIGMA 1;:MEASURE:NORMAL:ITEM:W: ELEMENT1 1;ELEMENT2 1;ELEMENT3 1; SIGMA 1;:MEASURE:NORMAL:ITEM:VA: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:VAR: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:PF: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:DEGREE: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:VHZ: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:AHZ: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:WH: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:WHP: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:WHM: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:AH: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:AHP: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:AHM: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:VPK: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 0;:MEASURE:NORMAL:ITEM:APK: ELEMENT1 0;ELEMENT2 0;ELEMENT3 0; SIGMA 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:HEADER 0`

MEASure:HARMonics?

Function Queries all settings related to harmonic measurement 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:BINary?

Function Queries harmonic measurement data set by commands other than “MEASure:HARMonics:ITEM” (binary format).

Syntax MEASure:HARMonics:BINary?

Example MEASURE:HARMONICS:BINARY?
`-> #5(number of bytes, 5 digits)(series of data bytes)`

Description For a description of the output format of harmonic measurement data, see page 14-35.

MEASure:HARMonics:ITEM?

Function Queries all settings related to the communication output items of harmonic measurement 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 measurement 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

14.3 Commands

MEASure:HARMonics:ITEM:{SYNChronize|<harmonic measurement function>}

Function Sets the communication output item of harmonic measurement ON/OFF, queries the current setting.

Syntax MEASure:HARMonics:ITEM:{SYNChronize|<harmonic measurement function>} {<Boolean>}
MEASure:HARMonics:ITEM:{SYNChronize|<harmonic measurement function>}?
SYNChronize=PLL source
<harmonic measurement 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 measurement data set by commands other than "MEASure:HARMonics:ITEM" (ASCII format).

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 measurement data output here occurs when bit0 (UPD) of the condition register (refer to page 14-47) changes from high to low. For more details, refer to 14.2.6.
• For the output format of harmonic measurement data, refer to page 14-33.

MEASure:HEAder

Function Turns ON/OFF the additional information output when outputting measured/computed data in binary format.

Syntax MEASure:HEAder {<Boolean>}

Example MEASURE:HEADER OFF
MEASURE:HEADER?
-> :MEASURE:HEADER 0

Description For a description of the additional information, see page 14-35.

MEASure:NORMAl?

Function Queries all settings related to normal measured/computed data.

Syntax MEASure:NORMAl?

Example Example of WT230 three-phase four-wire model

```
MEASURE:NORMAL? -> :MEASURE:NORMAL:  
ITEM:V:ELEMENT1 1;ELEMENT2 1;  
ELEMENT3 1;SIGMA 1;:MEASURE:NORMAL:  
ITEM:A:ELEMENT1 1;ELEMENT2 1;  
ELEMENT3 1;SIGMA 1;:MEASURE:NORMAL:  
ITEM:W:ELEMENT1 1;ELEMENT2 1;  
ELEMENT3 1;SIGMA 1;:MEASURE:NORMAL:  
ITEM:VA:ELEMENT1 0;ELEMENT2 0;  
ELEMENT3 0;SIGMA 0;:MEASURE:NORMAL:  
ITEM:VAR:ELEMENT1 0;ELEMENT2 0;  
ELEMENT3 0;SIGMA 0;:MEASURE:NORMAL:  
ITEM:PF:ELEMENT1 0;ELEMENT2 0;  
ELEMENT3 0;SIGMA 0;:MEASURE:NORMAL:  
ITEM:DEGREE:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:VHZ:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:AHZ:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:WH:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:WHP:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:WHM:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:AH:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:AHP:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:AHM:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:VPK:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:APK:ELEMENT1 0;  
ELEMENT2 0;ELEMENT3 0;SIGMA 0;:  
MEASURE:NORMAL:ITEM:TIME 0;MATH 0
```

MEASure[:NORMAl]:BINary?

Function Queries normal measurement data set by commands other than "MEASure[:NORMAl]:ITEM" (binary format).

Syntax MEASure[:NORMAl]:BINary?

Example MEASURE:NORMAL:BINARY?
-> #5(number of bytes, 5
digits)(series of data bytes)

Description For a description of the output format of normal measurement data, see page 14-35.

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. The same setting applies to the current all elements or Σ .

- 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 integration time|MATH} ON/OFF, queries about the current setting.

Syntax MEASure[:NORMal]:ITEM:{TIME|MATH} {<Boolean>}

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>?

Example MEASURE:NORMAL:ITEM:V?
-> :MEASURE:NORMAL:ITEM:V:ELEMENT1 1;
ELEMENT2 1;ELEMENT3 1;SIGMA 1

Description For the meanings of the symbols of functions, see Note on page 14-14.

MEASure[:NORMal] :ITEM:**<normal measurement function>[:ALL]**

Function Sets the communication output concerning all elements or Σ ON/OFF at once.

Syntax MEASure[:NORMal]:ITEM:<normal measurement function>[:ALL] {<Boolean>}

Example MEASURE:NORMAL:ITEM:V:ALL ON

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>}

Example MEASURE[:NORMal]:ITEM:<normal measurement function>:
ELEMENT<x>?

<x>= 1 (WT210 single-phase model)

1, 3 (WT230 three-phase three-wire model)
1 to 3 (WT230 three phase four-wire model)

Example MEASURE:NORMAL:ITEM:V:ELEMENT1 ON
MEASURE:NORMAL:ITEM:V:ELEMENT?
-> :MEASURE:NORMAL:ITEM:V:
ELEMENT1 1

MEASure[:NORMal] :ITEM:**<normal measurement function>:SIGMa**

Function Sets the communication output concerning Σ ON/OFF, queries the current setting.

Syntax MEASure[:NORMal]:ITEM:<normal measurement function>:SIGMa {<Boolean>}

Example MEASURE:NORMAL:ITEM:V:SIGMA ON
MEASURE:NORMAL:ITEM:V:SIGMA?
-> :MEASURE:NORMAL:ITEM:V:SIGMA 1

MEASure[:NORMal] :VALUE?

Function Queries normal measured/computed data set by commands other than "MEASure[:NORMal]:ITEM" (ASCII format).

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 occurs when bit0 (UPD) of the condition register (refer to page 14-47) changes from high to low. For more details, refer to 14.2.6.
- For the output format of normal measured/computed data, refer to page 14-32.
- When the harmonic measurement function is ON, harmonic measurement data will be returned (same as the response to MEASure:HARMonics:VALue?).

Data Format/Output Format of Normal and Harmonic Measurement Data <ASCII>

The data format/output format of normal and harmonic measurement data which is requested by MEASure[:NORMal]:VALue? or MEASure:HARMonics:VALue?, is as follows.

Data Format of Normal Measurement Data

- All data of the <harmonic measurement function> are output in the <NR3> format.

(Example) 123.45E+00

V,A,W,VA,VAR,PF,DEGR,VHZ,AHZ,VPK,APK,MATH → mantissa: max. 5 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 integration time is output as hours, minutes, seconds in the <NR1> format.

(Example) 999,59,59

- Only one of the six parameters, VHZ1, VHZ2, VHZ3, AHZ1, AHZ2, or AHZ3, can be measured for frequency. Data that is not measured is set to no data (9.91E+37).
- VHZΣ, AHZΣ, VPKΣ, and APKΣ always output no data (9.91E+37).

Output Format of Normal Measurement 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 integration time 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, note that for model 760401 only element 1 is valid, and for model 760502 only element 1, 3 and S are valid.

(o. Data number in case of recalling)

1. V1	→V2	'	→V3	→VΣ
2. A1	→A2		→A3	→AΣ
3. W1	→W2		→W3	→WΣ
4. VA1	→VA2		→VA3	→VAΣ
5. VAR1	→VAR2		→VAR3	→VARΣ
6. PF1	→PF2		→PF3	→PFΣ
7. DEGR1	→DEGR2		→DEGR3	→DEGRΣ
8. VHZ1	→VHZ2		→VHZ3	→VHZΣ
9. AHZ1	→AHZ2		→AHZ3	→AHZΣ
10. WH1	→WH2		→WH3	→WHΣ
11. WHP1	→WHP2		→WHP3	→WHPΣ
12. WHM1	→WHM2		→WHM3	→WHMΣ
13. AH1	→AH2		→AH3	→AHΣ
14. AHP1	vAHP2		→AHP3	→AHPΣ
14. AHM1	→AHM2		→AHM3	→AHMΣ

16. TIME (elapsed integration time)

Each data is divided by a comma "," and is ended by the terminator <RMT>.

Output Example of Normal Measurement Data

- Output example for model 760502 after having sent the following commands.

```
(Sent)          MEASURE:NORMAL:ITEM:PRESET NORMAL
                MEASURE:NORMAL:VALUE?

(Received data) 10.004E+00,10.002E+00,10.003E+00,49.041E+00,49.052E+00,
                49.047E+00,429.000E+00,429.02E+00,0.8580E+03

(Data contents) V1:10.004E+00    V3:10.002E+00    VΣ:10.003E+00
                  A1:49.041E+00    A3:49.052E+00    AΣ:49.047E+00
                  W1:429.000E+00   W3:429.02E+00    WΣ:0.8580E+03
```

- Output example for model 760503 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) 10,428.60E+00,428.10E+00,428.80E+00,
                1.2855E+03,71.450E+00,71.370E+00,71.490E+00,214.31E+00,
                8.2342E+00,8.2354E+00,8.2519E+00,24.721E+00,0,10,0

(Data contents)
    Recalled data number: 10
    W1:428.60E+00    W2:428.10E+00    W3:428.80E+00    WΣ:1.2855E+03
    WH1:71.450E+00    WH2:71.370E+00    WH3:71.490E+00    WHΣ:214.31E+00
    AH1:8.2342E+00    AH2:8.2354E+00    AH3:8.2519E+00    AHΣ:24.721E+00
    Elapsed integration time: 0 (hours), 10 (minutes), 0 (seconds)
```

Data Format of Harmonic Measurement

All data will be output in the <NR3> format. (mantissa: max. 5 digits + exponent: 2 digits)

Output Format of Harmonic Measurement

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.AC0N
8.PF	9.W	10.WCON	11.VDEG	12.ADEG	

Harmonic measurement 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 measured value (1st order)→harmonic measurement value (2nd order)→· · · →harmonic measurement 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 the 1st 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 the 1st 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 Measurement Data

- Output example for model 760503, after having sent the following commands. (Refer also to page 9-23 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 measured value (1st order):	49.62E+00 (V)
Harmonic measurement value (2nd order):	0.03E+00 (V)
:	:
Harmonic measurement 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.

Data Format/Output Format of Normal Measurement and Harmonic Measurement Data <BINARY>

The data format and output format of normal measurement and harmonic measurement data in binary format that are output by the MEASure[:NORMAl]:BINary? or MEASure:HARMonics:BINary? command are as follows:

Data Format

Measured data consists of a 2-byte header and 4-byte data (total of 6 bytes).

Header (2 bytes)	Data (4 bytes)
------------------	----------------

Header structure

The header consists of a 1-byte status and 1-byte ASCII conversion information.

Status (1 byte)	ASCII conversion information (1 byte)
-----------------	---------------------------------------

- **Status byte**

b7	b6	b5	b4	b3	b2	b1	b0
----	----	----	----	----	----	----	----

- b7 to b4: Lead/Lag phase information
(This information is meaningful only when the data is a phase angle (DEGR).
For all other cases, the value is always 0000.)

0000: Lag	0001: Lead	0010: Cannot be detected
-----------	------------	--------------------------

- b3 to b0: Data status

0000: Normal	0001: Overrange (-oL-)	0010: Voltage peak over
0011: Current peak over	0100: Power factor error (PFEr)	0101: Phase angle error (dEGEr)
0110: Frequency error (ErrLo)	0111: Frequency error (ErrHi)	1000: Computation overflow (-oF-)
1001: PLL error (FreqEr)	1010: No data (----)	

- **ASCII conversion information**

b7	b6	b5	b4	b3	b2	b1	b0
----	----	----	----	----	----	----	----

- b7 to b4: Prefix unit

0000: None (E+0)	0001: m (E-3)	0010: k (E+3)
0011: M (E+6)		
- b3 to b0: Decimal point position

0000: _____ .	0001: _____. -	0010: _____. --
0011: ___._____	0100: . _____. --	0101: . _____. --

Data structure

Data is in 4-byte IEEE single-precision floating point format.

S	E	E	E	E	M	M	M	M	M	M	M	M	M	M	M	M	M	M
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

The byte order is MSB first.

$$\text{Physical value} = (-1)^S \times (2^{E-127}) \times (1+M/(2^{23}))$$

S: Sign bit, 0 or 1

E: Exponent in the range of 0 to 254

M: Mantissa as a 23-bit binary value

- For elapsed integration time

Outputs the time in units of seconds. For example, 0x45610000 (=3600) if the time is 1 hour (1:00:00).

- For overrange and computation overflow

0x7E94F56A (=9.9E+37)

- For no data

0x7E951BEE (=9.91E+37)

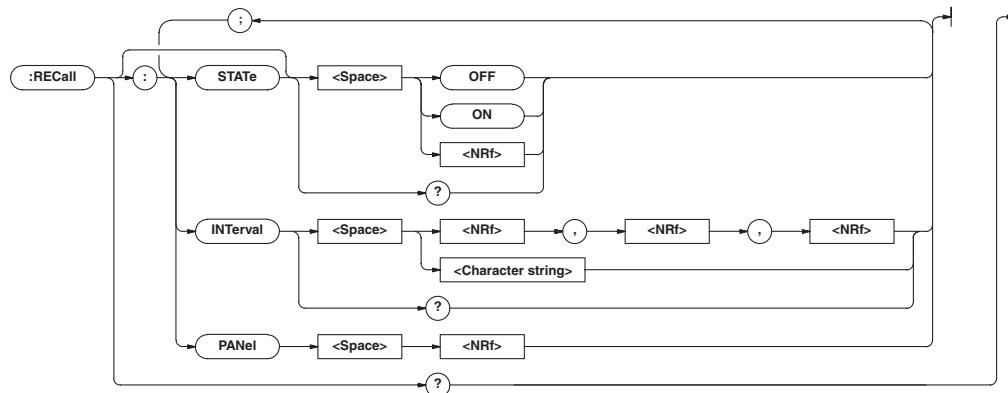
Output format

The output format (output order of measured data) is the same as the ASCII format.

14.3 Commands

14.3.10 RECall Group

The commands in the RECall group are used to make settings relating to, and inquiries 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 If the recalling interval is set to 0 h 0 min 0 s, the recalling interval is set to the display update rate as when the data was stored.

RECall:PANel

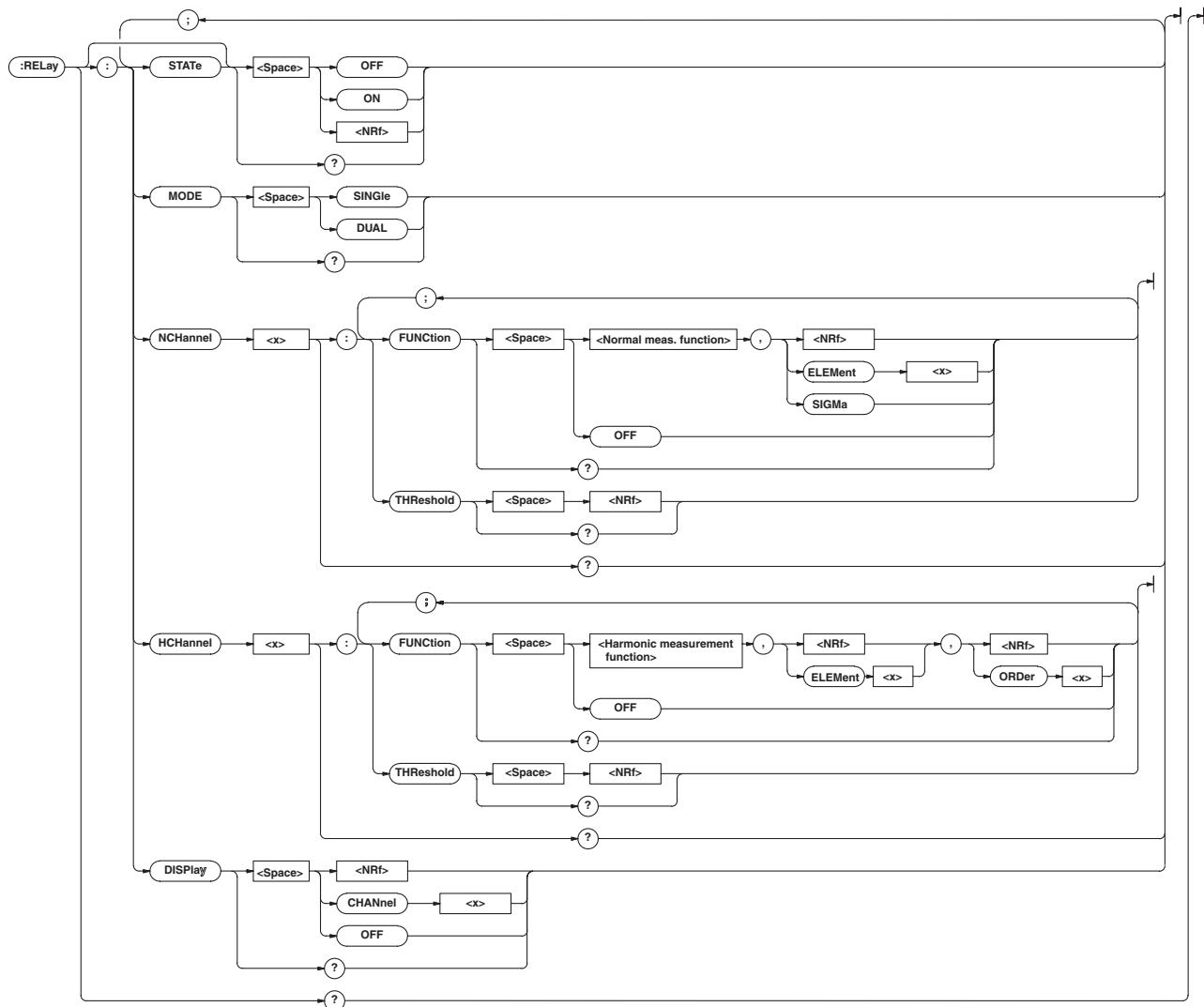
Function Retrieves the setup parameters file.
Syntax RECall:PANel {<NRf>}
 {<NRf>}=1 to 4 : file number
Example RECALL:PANEL 1

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;THRESHOLD 1.000E+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 when ON, the channel to be displayed/queries the current setting.
Syntax	RELay:DISPLAY {<NRf>} CHANnel<1-4> OFF
Example	RELAY:DISPLAY? {<NRf>}=1 to 4:channel RELAY:DISPLAY 1 RELAY:DISPLAY? -> :RELAY:DISPLAY 1

RELay:HCHANNEL<x>?

Function	Queries all settings related to relay output items in case of harmonic measurement.
Syntax	RELay:HCHANNEL<x>?
Example	RELAY:HCHANNEL1? -> :RELAY:HCHANNEL1: FUNCTION V,1,1; THRESHOLD 600.0E+00

14.3 Commands

RELay:HChannel<x>:FUNCTION

Function	Sets the function of the relay output item in case of harmonic measurement/queries the current setting.
Syntax	RELay:HChannel<x>:FUNCTION {<harmonic measurement function>,(<NRf> ELEMENT<1-3>),(<NRf> ORDer<1-50>) OFF}<harmonic measurement function>={VIHD 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	<ul style="list-style-type: none"> The order setting will be ignored in case the harmonic measurement function is set to VTHD, ATHD or PF and might therefore be 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 measurement/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:THRESHOLD? -> :RELAY:HCHANNEL1:THRESHOLD 600.0E+00
Description	<p>The mantissa of the setting value is rounded as follows.</p> <p>Less than 1.000: Rounded to the third digit left of the decimal.</p> <p>1.000 to 9999: Rounded to the fourth significant digit.</p>

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<1-3> SIGMa) 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 function. 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

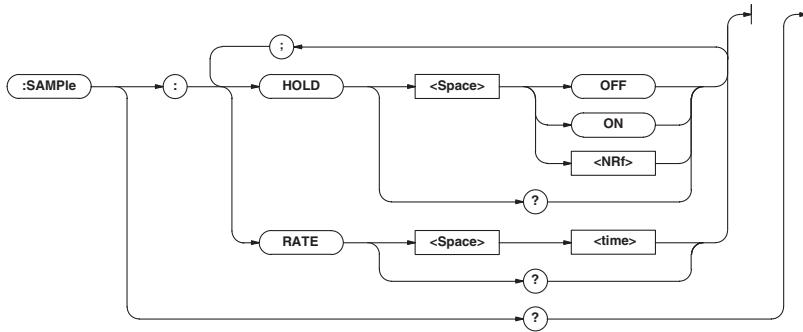
Function	Sets the threshold level for the relay output item in case of normal measurement/queries the current setting.
Syntax	RELay:NChannel<x>:THRESHOLD {<NRf>}<x>=1 to 4<NRf>=0.000E+00 to ±9.999E+09
Example	RELAY:NCHANNEL3:THRESHOLD 1.200E+03 RELAY:NCHANNEL3:THRESHOLD? -> :RELAY:NCHANNEL3:THRESHOLD 1.200E+03
Description	<p>The mantissa of the setting value is rounded as follows.</p> <p>Less than 1.000: Rounded to the third digit left of the decimal.</p> <p>1.000 to 9999: Rounded to the fourth significant digit.</p>

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 sampling. The commands allow you to make the same settings and inquiries as when the [HOLD] key on the front panel or the “u.rAtE” menu of the [SETUP] key is used.



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

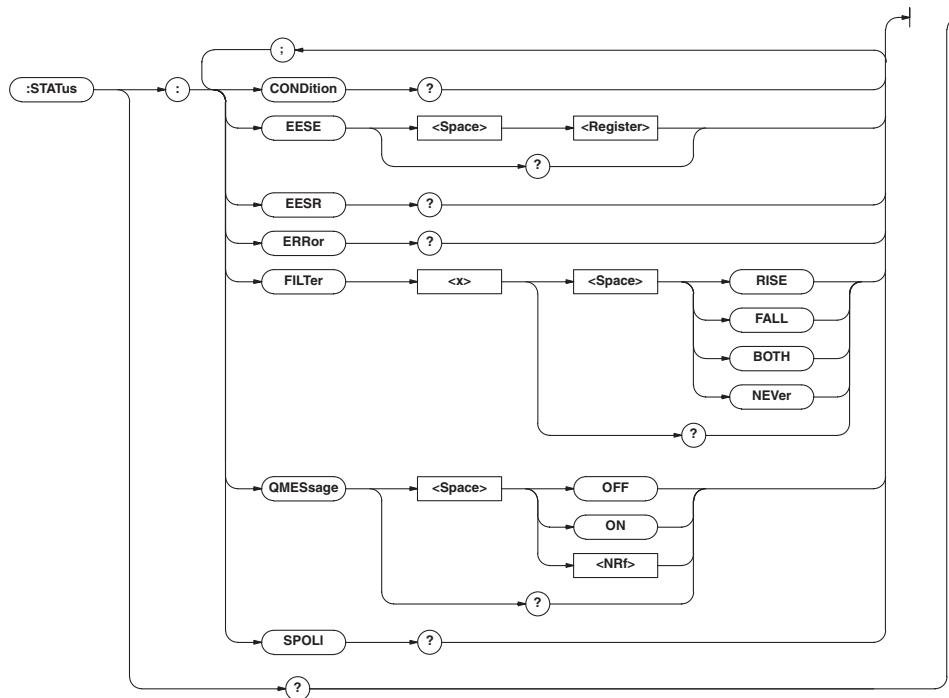
SAMPLE:RATE

Function Sets the display update rate or queries the current setting.
Syntax SAMPLE:RATE {<time>}
 <time> = 0.1 to 5 s (0.1, 0.25, 0.5, 1, 2, 5)
Example SAMPLE:RATE 0.25S
 SAMPLE:RATE?
 -> :SAMPLE:RATE 0.25E+00

14.3 Commands

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. Refer to section 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;
QMMESSAGE 1

STATus:CONDition?

Function Queries the contents of the condition filter.

Syntax STATus:CONDition?

Example STATus:CONDition -> 16

Description Refer to 14.4 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 Refer to Section 14.4 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 Refer to Section 14.4 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:FILTter<x> {RISE|FALL|BOTH|

NEVer}

STATus:FILTter<x>?

<x>=1 to 16

Example STATus:FILTER2 RISE

STATus:FILTER2?

-> :STATus:FILTER2 RISE

Description Refer to 14.4 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:QMMESSAGE OFF
STATUS:QMMESSAGE? -> :STATUS:
QMMESSAGE 0

STATUs:SPOLL?(Serial Poll)

Function Executes serial polling.

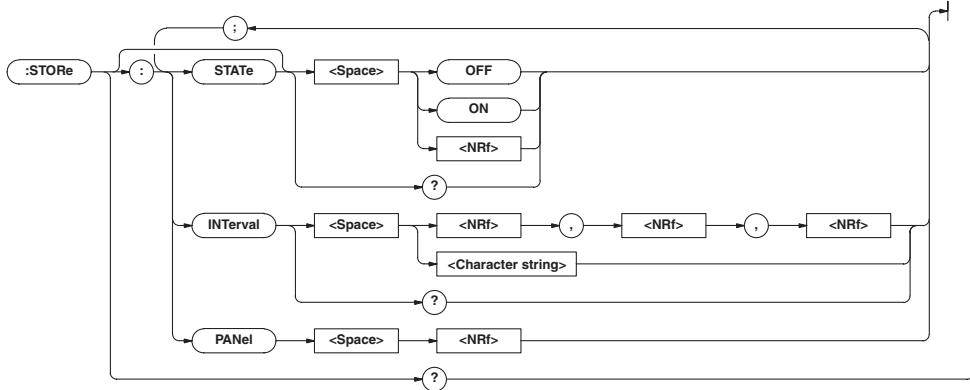
Syntax STATUs:SPOLL?

Example STATUS:SPOLL? -> STATUS:SPOLL 0

Description This command is used for the serial 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 hours MM minutes SS seconds

Example STORE:INTERVAL 0,0,0
STORE:INTERVAL “00:00:00”
STORE:INTERVAL?
-> :STORE:INTERVAL 0,0,0

Description If the store interval is set to 0 h 0 min 0 s, the store interval is set to the same interval as the display update rate.

STORe:PANel

Function Saves the setup 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.

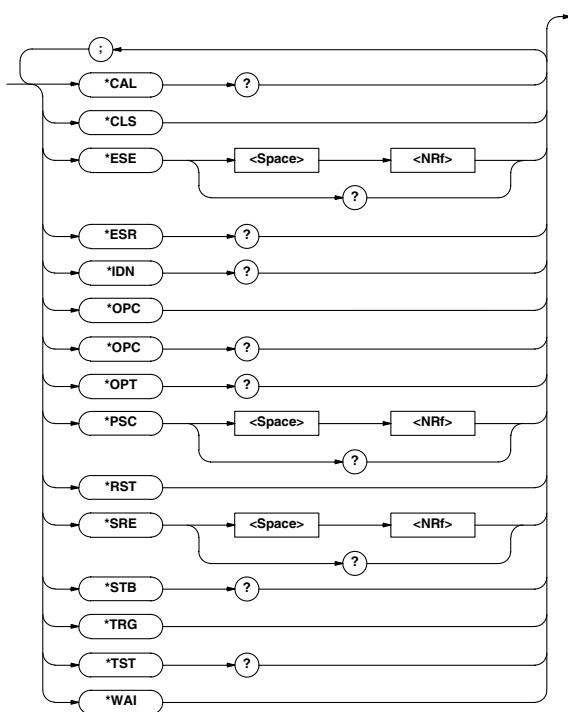
Syntax STORe[:STATE] {<Boolean>}
STORe:STATE?

Example STORE:STATE ON
STORE:STATE? -> :STORE:STATE 1

14.3 Commands

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 Execute 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, refer to 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 251

Example *ESE 253

*ESE? -> 251

Description

- Each bit is expressed as a decimal number.

- For example, if "*ESE 251" is set, the standard enable register will be set to "11111011". 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 0", i.e. all bits are disabled.
- The standard event enable register will be cleared when an inquiry is made using *ESE?.
- For details referring the standard event enable register, refer to page 14-45.

*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.

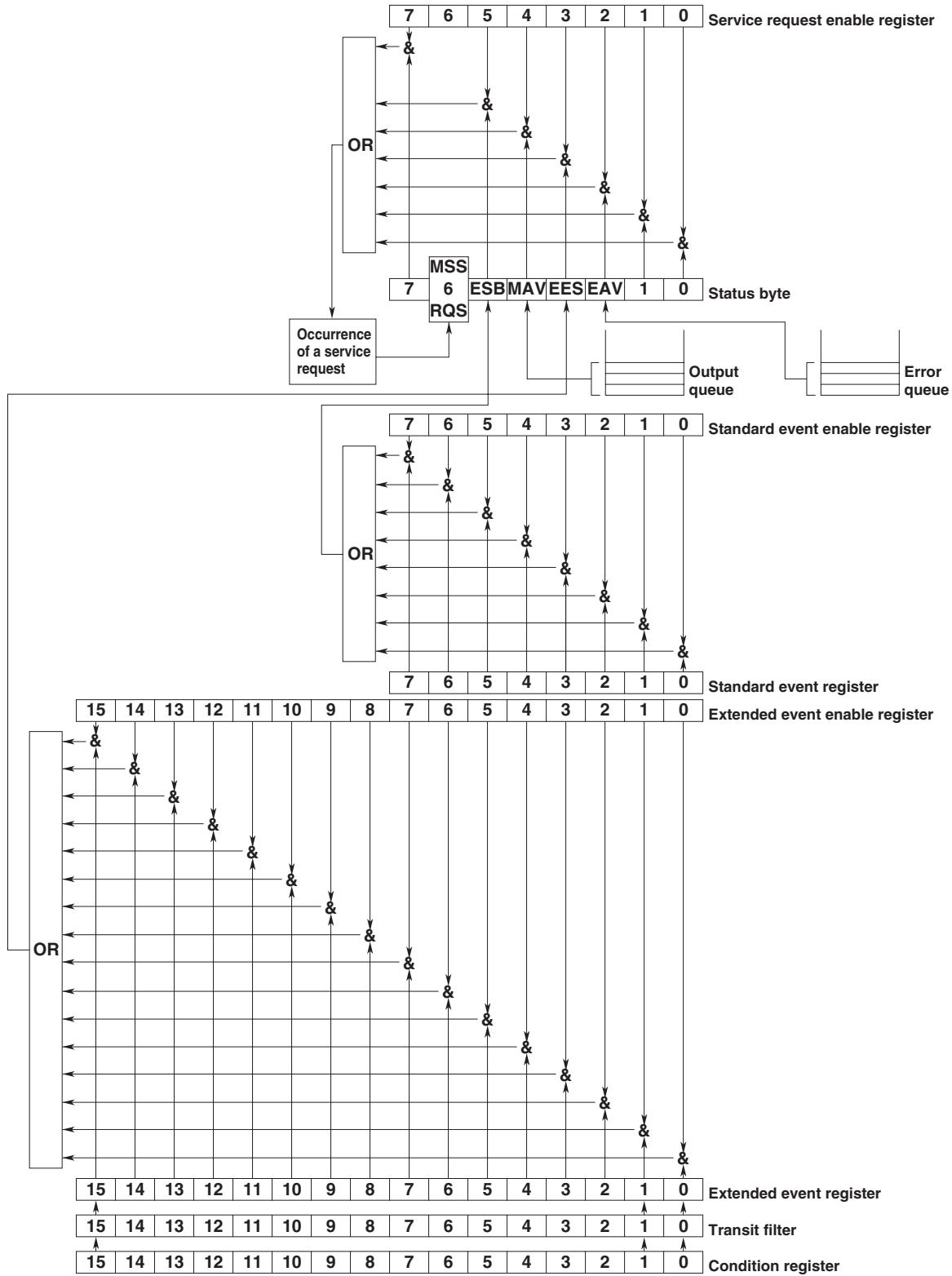
- It is possible to ascertain the type of event which has occurred, while SRQ is occurring.
- For example, if "*ESR 32" is returned, this means that the standard event register is "00100000", i.e. the SRQ has occurred due to a command syntax error.
- If a query is made using *ESR?, the standard event register will be cleared.
- For details referring the standard event enable register, refer to page 14-46.

*IDN?		
Function	Queries the instrument model.	
Syntax	*IDN?	
Example	*IDN? -> YOKOGAWA, 760503, 0, F1.01	
Description	A reply consists of the following information: <Model>,<Type>,<Serial No.> and <Firmware version>. In actuality, <Serial No.> is not returned.	
*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	<ul style="list-style-type: none"> "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	Refer to Section 14.4 for more details on the registers.	
*RST		
Function	Resets (initializes) the present settings.	
Syntax	*RST	
Example	*RST	
Description	Refer to 12.2 for initial settings. All settings except communication settings are reset to factory default values.	
*SRE		
Function	Sets the value of the service request enable register, or queries the current setting.	
Syntax	*SRE {<NRf>} *SRE?	
Example		<p>{<NRf>}=0 to 255</p> <p>*SRE 239 *SRE? -> 175 (since the bit 6 (MSS) setting is ignored)</p>
Description	<ul style="list-style-type: none"> 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 4 (MAV) of the status byte register will not be set to "1," even if the output queue is not empty. Bit 6 (MSS) of the status byte register is the MSS bit itself, and therefore, is 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, refer to page 14-45. 	
*STB?		
Function	Queries the value of the status byte register.	
Syntax	*STB?	
Example	*STB? -> 4	
Description	<ul style="list-style-type: none"> 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, refer to page 14-45. 	
*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

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 488.2-1992.



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 <x>	STATUs:FILTTer	STATUs:FILTTer<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, refer to 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, refer to page 14-44.

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. Refer to page 14-47.

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. Refer to page 14-44.

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. Refer to page 14-46.

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, refer to 14.3.

14.4 Status Report

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, refer to 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.

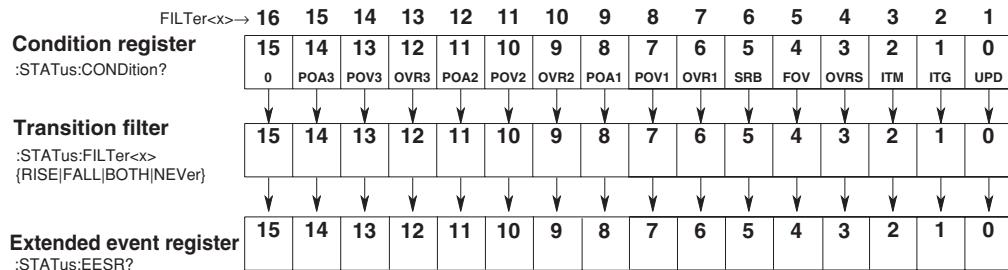
Clearing the Standard Event Register

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.

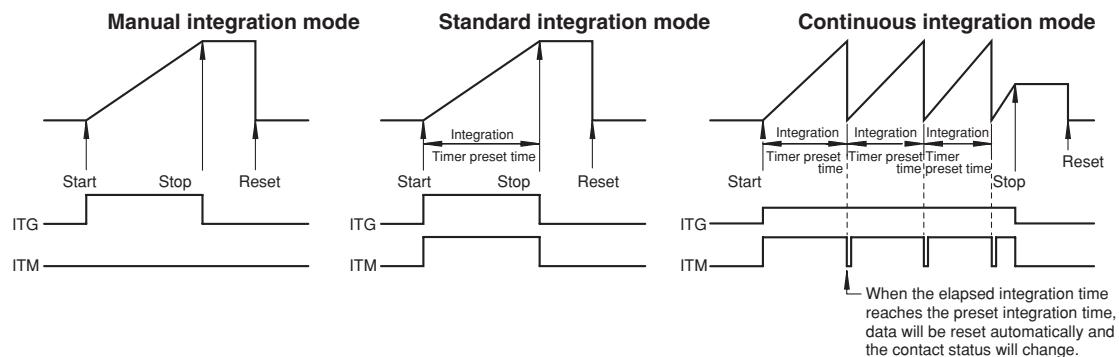


The meaning of each bit of the condition register is as follows.

Bit 0 UPD (Updating)	Set to "1" during updating of measurement data.
Bit 1 ITG (Integrate busy)	Set to "1" during integration. (See figure below)
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 separately, 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).

14.4 Status Report



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

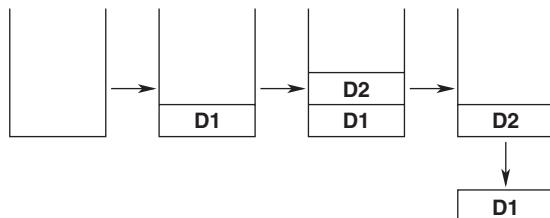
Overview of the Output Queue

The output queue is provided to store response messages to queries. For example, when the MEASure[:NORMAL]:VALue? 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 (refer to 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 Before Programming

Environment

- Model: IBM-compatible PC
- Language: Visual Basic Ver5.0 Professional Edition or later.
- GP-IB board: AT-GPIB/TNT IEEE-488.2 by National Instruments.

Settings on Visual Basic

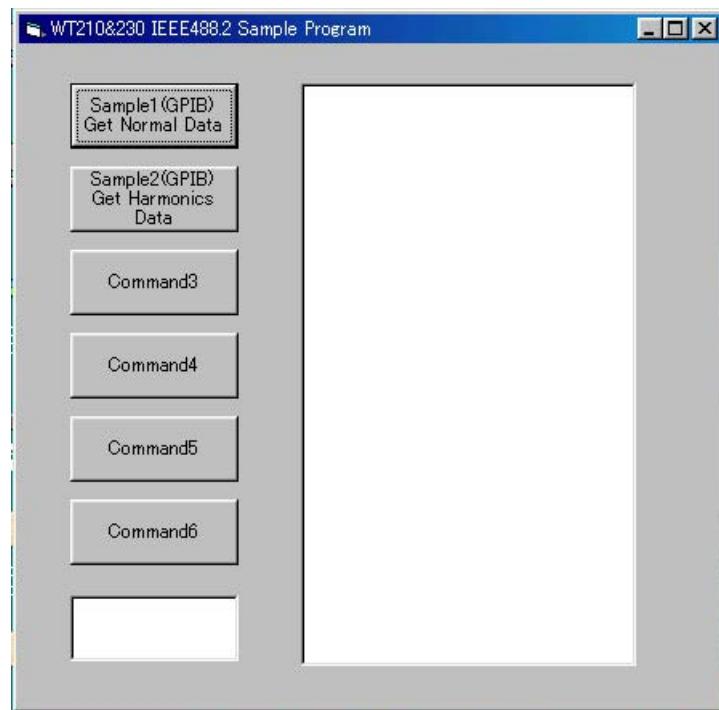
Standard modules used: Niglobal.bas
Vbib-32.bas

WT210/WT230 Settings

GP-IB address

- The sample programs given in this chapter use a GP-IB address of 1 for the WT210/WT230.
- Set the GP-IB address to 1 according to the procedures described in section 10.5.

14.6 Sample Program Image



14.7 Sample Program (Initialization, Error, and Execution Functions)

```

Option Explicit
Dim StartFlag As Integer
Dim addr As Integer
Dim Timeout As Integer
Dim Dev As Integer
Dim term As String
Dim Query(1100) As String
Dim Dummy As Integer
-----
```

```

Private Function InitGpib() As Integer
    Dim eos As Integer
    Dim eot As Integer
    Dim brd As Integer
    Dim sts As Integer
    eos = &HC0A
    eot = 1
    term = Chr(10)
    Timeout = T10s
    brd = ilfind("GPIB0")
    If (brd < 0) Then
        GoTo GPIBError
    End If
    Dev = ildev(0, addr, 0, Timeout, eot, eos)
    If (Dev < 0) Then
        GoTo GPIBError
    End If
    sts = ilsic(brd)
    If (sts < 0) Then
        Call DisplayGPIBError(sts, "ilsic")
        InitGpib = 1
        Exit Function
    End If
    InitGpib = 0
    Exit Function
GPIBError:
    Call DisplayGPIBError(sts, "ilsic")
    InitGpib = 1
End Function
-----
```

```

Private Sub DisplayGPIBError(ByVal sts As Integer, ByVal msg As String)
    Dim wrn As String
    Dim ers As String
    Dim ern As Integer
    If (sts And TIMO) Then
        wrn = "Time out" + Chr(13)
    Else
        wrn = ""
    End If
    If (sts And EERR) Then
        ern = iberr
        If (ern = EDVR) Then
            ers = "EDVR:System error"
        ElseIf (ern = ECIC) Then
            ers = "ECIC:Function requires GPIB board to be CIC"
        ElseIf (ern = ENOL) Then
            ers = "ENOL:No Listeners on the GPIB"
        ElseIf (ern = EADR) Then
            ers = "EADR:GPIB board not addressed correctly"
        ElseIf (ern = EARG) Then
            ers = "EARG:Invalid argument to function call"
        ElseIf (ern = ESAC) Then
            ers = "ESAC:GPIB board not System Controller as required"
        ElseIf (ern = EAEO) Then
            ers = "EAEO:I/O operation aborted(timeout)"
        ElseIf (ern = ENEB) Then
            ers = "ENEB:Nonexistent GPIB board"
        ElseIf (ern = EDMA) Then
            ers = "EDMA:DMA error"
        ElseIf (ern = EOIP) Then
            ers = "EOIP:I/O operation started before previous operation completed"
        ElseIf (ern = ECAP) Then
            ers = "ECAP:No capability for intended operation"
        ElseIf (ern = EFSD) Then
            ers = "EFSD:File system operation error"
        ElseIf (ern = EBUS) Then
            ers = "EBUS:GPIB bus error"
        ElseIf (ern = ESTB) Then
            ers = "ESTB:Serial poll status byte queue overflow"
    End If
End Sub

```

14.7 Sample Program (Initialization, Error, and Execution Functions)

```
        ElseIf (ern = ESRQ) Then
            ers = "ESRQ:SRQ remains asserted"
        ElseIf (ern = ETAB) Then
            ers = "ETAB:The return buffer is full"
        ElseIf (ern = ELCK) Then
            ers = "ELCK:Address or board is locked"
        Else
            ers = ""
        End If
    Else
        ers = ""
    End If

    MsgBox ("Status No. " + Str(sts) + Chr(13) + wrn + "Error No. " + Str(ern) + Chr(13) + ers +
Chr(13) + msg), vbExclamation, "Error!"
    Call ibonl(Dev, 0)
    Dev = -1
End Sub
-----
Private Sub Command1_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = GpibNormal
    'Run Sample1(GPIB) Get Normal Data
    If (sts = 0) Then
        Text1.Text = "END"
    Else
        Text1.Text = "ERROR"
    End If
    StartFlag = 0
End Sub
-----
Private Sub Command2_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    Dummy = DoEvents()
    sts = GpibHarmonics
    'Run Sample2(GPIB) Get Harmonics Data
    If (sts = 0) Then
        Text1.Text = "END"
    Else
        Text1.Text = "ERROR"
    End If
    StartFlag = 0
End Sub
-----
Private Sub Command3_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Command4_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
```

14.7 Sample Program (Initialization, Error, and Execution Functions)

```
Private Sub Command5_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Command6_Click()
    Dim sts As Integer

    If (StartFlag = 1) Then
        Exit Sub
    End If
    StartFlag = 1
    Text1.Text = "START"
    List1.Clear
    List1.AddItem "NOT MAKE"
    Text1.Text = "END"
    StartFlag = 0
End Sub
-----
Private Sub Form_Load()
    StartFlag = 0
    Dev = -1
    addr = 1
    Command1.Caption = "Sample1(GPIB)" + Chr(13) + "Get Normal Data"
    Command2.Caption = "Sample2(GPIB)" + Chr(13) + "Get Harmonics Data"
    Text1.Text = ""
End Sub
```

14.8 Sample Program (Output of Normal Measurement Data)

```
Sample1(GPIB) Get Normal Data
-----
Private Function GpibNormal() As Integer
    Dim msg As String
    Dim qry As String
    Dim sts As Integer
    Dim item As Integer
    Dim comma As Integer
    Dim length As Integer
    Dim cnt As Integer

    term = Chr$(10)                                'terminator
    msg = Space$(100)
    qry = Space$(200)

    List1.AddItem "Now Initializing. Wait a moment."
    Dummy = DoEvents()

    sts = InitGpib                               'Initialize GPIB
    If (sts <> 0) Then
        GpibNormal = 1
        Exit Function
    End If

    'Initialize the settings
    msg = "*RST" + term                         'Initialize the settings
    sts = ilwrt(Dev, msg, Len(msg))              'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement condition
    msg = "SAMPLE:HOLD OFF" + term                'Hold off
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "MODE RMS" + term                      'Measurment Mode = RMS
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "FILTER OFF" + term                    'Frequency Filter off
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "LFILTER OFF" + term                  'Line Filter off
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "SCALING OFF;AVERAGING OFF" + term   'Scaling & Averaging off
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement range
    msg = "VOLTAGE:RANGE 150V" + term           'Voltage range = 150V
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    msg = "CURRENT:RANGE 5A" + term             'Current range = 5A
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'For measure the voltage frequency of element1, set function and element of displayC.
    msg = "DISPLAY3:FUNCTION VHZ;ELEMENT 1" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
```

14.8 Sample Program (Output of Normal Measurement Data)

```

' Set the communication output items
'1. V/A/W -> on, others -> off
msg = "MEASURE:ITEM:PRESET NORMAL" + term
sts = ilwrt(Dev, msg, Len(msg))
If (sts < 0) Then
    GoTo GPIBError
End If
'2. Element1 VHz -> on
msg = "MEASURE:ITEM:VHZ:ELEMENT1 ON" + term
sts = ilwrt(Dev, msg, Len(msg))
If (sts < 0) Then
    GoTo GPIBError
End If

' Set the transition filter used to detect the completion of the data updating
msg = "STATUS:FILTER1 FALL" + term           'Falling edge of bit0(UPD)
sts = ilwrt(Dev, msg, Len(msg))
If (sts < 0) Then
    GoTo GPIBError
End If

Sleep 1000
List1.Clear

'Read and display the measurement data (It is repeated 10 times in this program)
For cnt = 1 To 10
    'Clear the extended event register (Read and trash the response)
    msg = "STATUS:EESR?" + term
    sts = ilwrt(Dev, msg, Len(msg))
    sts = ilrd(Dev, qry, Len(qry))

    'Wait for the completion of the data updating
    msg = "COMMUNICATE:WAIT 1" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

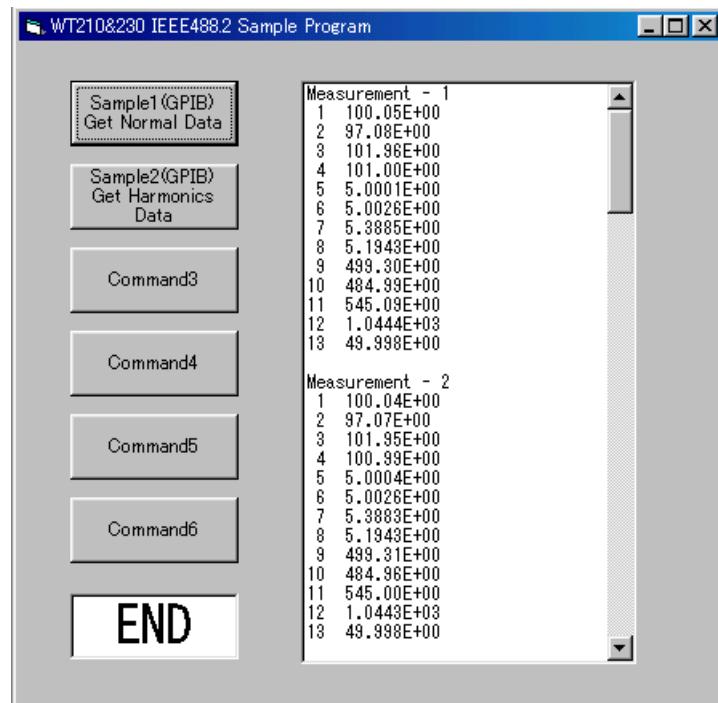
    'Read out the measurement data
    msg = "MEASURE:NORMAL:VALUE?" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    sts = ilrd(Dev, qry, Len(qry))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Extract items that are separated by commas(,) from the received data
    List1.AddItem "Measurement - " + CStr(cnt)
    List1.ListIndex = List1.ListIndex + 1
    For item = 1 To 13
        length = Len(qry)
        comma = InStr(qry, ",")
        If (comma = 0) Then comma = InStr(qry, term)
        If (comma = 0) Then Exit For
        Query(item) = Left(qry, comma - 1)
        If item < 10 Then
            List1.AddItem " " + CStr(item) + " " + Query(item)
        Else
            List1.AddItem CStr(item) + " " + Query(item)
        End If
        qry = Mid(qry, comma + 1)
        List1.ListIndex = List1.ListIndex + 1
    Next item
    List1.AddItem ""
    List1.ListIndex = List1.ListIndex + 1
    qry = Space$(200)
    Dummy = DoEvents()
Next cnt

List1.AddItem " All end"
List1.ListIndex = List1.ListIndex + 1
Call ibonl(Dev, 0)
GpibNormal = 0
Exit Function

GPIBError:
    Call DisplayGPIBError(sts, msg)
    GpibNormal = 1
End Function
-----
```

14.8 Sample Program (Output of Normal Measurement Data)



14.9 Sample Program (Output of Harmonic Measurement Data)

```

Sample2(GPIB) Get Harmonics Data
-----
Private Function GpibHarmonics() As Integer
    Dim msg As String
    Dim qry As String
    Dim sts As Integer
    Dim cnt As Integer
    Dim item As Integer
    Dim comma As Integer
    Dim length As Integer

    term = Chr$(10)                                'terminator
    msg = Space$(100)
    qry = Space$(1000)

    List1.AddItem "Now Initializing. Wait a moment."
    Dummy = DoEvents()

    sts = InitGpib                               'Initialize GPIB
    If (sts <> 0) Then
        GpibHarmonics = 1
        Exit Function
    End If

    'Initialize the settings
    msg = "*RST" + term                         'Initialize the settings
    sts = ilwrt(Dev, msg, Len(msg))              'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement condition
    msg = "SAMPLE:RATE 500MS" + term            'Update rate = 500ms
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the measurement range
    msg = "VOLTAGE:RANGE 150V" + term           'Voltage range = 150V
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    msg = "CURRENT:RANGE 5A" + term             'Current range = 5A
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Setting related to harmonics analize
    'Object element = 1, PLL source = V1, Computation method of THD = IEC
    msg = "HARMONICS:ELEMENT 1;SYNCHRONIZE V,1;THD IEC;STATE ON" + term
    sts = ilwrt(Dev, msg, Len(msg))              'Send Command
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the communication output items
    '1. All function -> off
    msg = "MEASURE:HARMONICS:ITEM:PRESET CLEAR" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    '2. Necessary function -> on
    msg = "MEASURE:HARMONICS:ITEM:SYNCHRONIZE ON;ATHD ON;A ON" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Set the transition filter used to detect the completion of the data updating
    msg = "STATUS:FILTER1 FALL" + term           'Falling edge of bit0(UPD)
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

```

14.9 Sample Program (Output of Harmonic Measurement Data)

```
Sleep 1000
List1.Clear

'Read and display the harmonics data (It is repeated 10 times in this program)
For cnt = 1 To 10
    'Clear the extended event register (Read and trash the response)
    msg = "STATUS:EESR?" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    sts = ilrd(Dev, qry, Len(qry))           'Receive Query
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Wait for the completion of the data updating
    msg = "COMMUNICATE:WAIT 1" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If

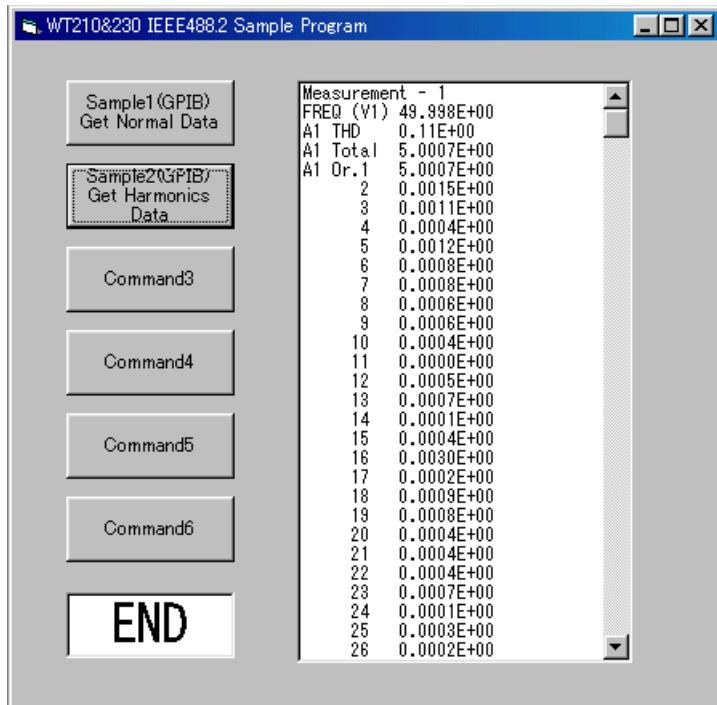
    'Read out the harmonics data
    msg = "MEASURE:HARMONICS:VALUE?" + term
    sts = ilwrt(Dev, msg, Len(msg))
    If (sts < 0) Then
        GoTo GPIBError
    End If
    sts = ilrd(Dev, qry, Len(qry))
    If (sts < 0) Then
        GoTo GPIBError
    End If

    'Extract items that are separated by commas(,) from the received data
    List1.AddItem "Measurement - " + CStr(cnt)
    List1.ListIndex = List1.ListIndex + 1
    For item = 1 To 53
        length = Len(qry)
        comma = InStr(qry, ",")
        If (comma = 0) Then comma = InStr(qry, term)
        Query(item) = Left(qry, comma - 1)
        If (item = 1) Then
            List1.AddItem "FREQ (V1)" + " " + Query(item)
        ElseIf (item = 2) Then
            List1.AddItem "A1 THD" + " " + Query(item)
        ElseIf (item = 3) Then
            List1.AddItem "A1 Total" + " " + Query(item)
        ElseIf (item = 4) Then
            List1.AddItem "A1 Or.1" + " " + Query(item)
        ElseIf (item < 13) Then
            List1.AddItem " " + CStr(item - 3) + " " + Query(item)
        Else
            List1.AddItem " " + CStr(item - 3) + " " + Query(item)
        End If
        qry = Mid(qry, comma + 1)
        List1.ListIndex = List1.ListIndex + 1
    Next item
    List1.AddItem ""
    List1.ListIndex = List1.ListIndex + 1
    qry = Space$(1000)
    Dummy = DoEvents()
Next cnt

List1.AddItem " All end"
List1.ListIndex = List1.ListIndex + 1
Call ibonl(Dev, 0)
GpibHarmonics = 0
Exit Function

GPIBError:
    Call DisplayGPIBError(sts, msg)
    GpibHarmonics = 1
End Function
```

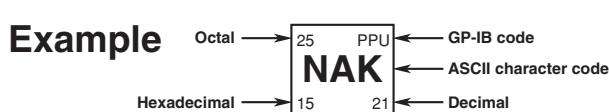
14.9 Sample Program (Output of Harmonic Measurement Data)



14.10 ASCII Character Codes

ASCII character codes are given below.

	0	1	2	3	4	5	6	7
0	0 NUL 0 0 10 16 20 40 60 16 100 0 120 16 140 0 160 16	20 DEL 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	40 SP 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	60 0 @ 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	160 P 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	160 ‘ 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	160 p 0 0 10 16 20 32 30 48 40 64 50 80 60 96 70 112	
1	1 GTL 1 1 11 17 21 LLO 41 ! 1 61 17 101 1 121 17 141 1 161 17	21 DC1 1 1 11 17 21 33 31 49 41 65 51 81 61 97 71 113	41 ! 1 1 11 17 21 33 31 49 41 65 51 81 61 97 71 113	61 1 A 1 1 11 17 21 33 31 49 41 65 51 81 61 97 71 113	121 Q 1 1 11 17 21 33 31 49 41 65 51 81 61 97 71 113	17 141 1 161 17	141 a 1 1 11 17 21 33 31 49 41 65 51 81 61 97 71 113	1 161 17
2	2 STX 2 2 12 18 22 42 ” 2 62 18 102 2 122 18 142 2 162 18	22 DC2 2 2 12 18 22 34 32 50 42 66 52 82 62 98 72 114	” 2 2 12 18 22 34 32 50 42 66 52 82 62 98 72 114	62 2 B 2 2 12 18 22 34 32 50 42 66 52 82 62 98 72 114	122 R 2 2 12 18 22 34 32 50 42 66 52 82 62 98 72 114	18 142 2 162 18	142 b 2 2 12 18 22 34 32 50 42 66 52 82 62 98 72 114	2 162 18
3	3 ETX 3 3 13 19 23 43 # 3 63 19 103 3 123 19 143 3 163 19	23 DC3 3 3 13 19 23 35 33 51 43 67 53 83 63 99 73 115	# 3 3 13 19 23 35 33 51 43 67 53 83 63 99 73 115	63 3 C 3 3 13 19 23 35 33 51 43 67 53 83 63 99 73 115	123 S 3 3 13 19 23 35 33 51 43 67 53 83 63 99 73 115	19 143 3 163 19	143 c 3 3 13 19 23 35 33 51 43 67 53 83 63 99 73 115	3 163 19
4	4 SDC 4 4 14 20 24 44 \$ 4 64 20 104 4 124 20 144 4 164 20	24 DCL 4 4 14 20 24 36 34 52 44 68 54 84 64 100 74 116	\$ 4 4 14 20 24 36 34 52 44 68 54 84 64 100 74 116	64 4 D 4 4 14 20 24 36 34 52 44 68 54 84 64 100 74 116	124 T 4 4 14 20 24 36 34 52 44 68 54 84 64 100 74 116	20 144 4 164 20	144 d 4 4 14 20 24 36 34 52 44 68 54 84 64 100 74 116	4 164 20
5	5 PPC 5 5 15 21 25 45 % 5 65 21 105 5 125 21 145 5 165 21	25 PPU 5 5 15 21 25 37 35 53 45 69 55 85 65 101 75 117	% 5 5 15 21 25 37 35 53 45 69 55 85 65 101 75 117	65 5 E 5 5 15 21 25 37 35 53 45 69 55 85 65 101 75 117	125 U 5 5 15 21 25 37 35 53 45 69 55 85 65 101 75 117	21 145 5 165 21	145 e 5 5 15 21 25 37 35 53 45 69 55 85 65 101 75 117	5 165 21
6	6 ACK 6 6 16 22 26 46 & 6 66 22 106 6 126 22 146 6 166 22	26 SYN 6 6 16 22 26 38 36 54 46 70 56 86 66 102 76 118	& 6 6 16 22 26 38 36 54 46 70 56 86 66 102 76 118	66 6 F 6 6 16 22 26 38 36 54 46 70 56 86 66 102 76 118	126 V 6 6 16 22 26 38 36 54 46 70 56 86 66 102 76 118	22 146 6 166 22	146 f 6 6 16 22 26 38 36 54 46 70 56 86 66 102 76 118	6 166 22
7	7 BEL 7 7 17 23 27 47 , 7 67 23 107 7 127 23 147 7 167 23	27 ETB 7 7 17 23 27 39 37 55 47 71 57 87 67 103 77 119	, 7 7 17 23 27 39 37 55 47 71 57 87 67 103 77 119	67 7 G 7 7 17 23 27 39 37 55 47 71 57 87 67 103 77 119	127 W 7 7 17 23 27 39 37 55 47 71 57 87 67 103 77 119	23 147 7 167 23	147 g 7 7 17 23 27 39 37 55 47 71 57 87 67 103 77 119	7 167 23
8	8 BS 8 8 18 24 28 50 (8 70 24 110 8 130 24 150 8 170 24	30 CAN 8 8 18 24 28 40 38 56 48 72 58 88 68 104 78 120	(8 8 18 24 28 40 38 56 48 72 58 88 68 104 78 120	70 8 H 8 8 18 24 28 40 38 56 48 72 58 88 68 104 78 120	130 X 8 8 18 24 28 40 38 56 48 72 58 88 68 104 78 120	24 150 8 170 24	150 h 8 8 18 24 28 40 38 56 48 72 58 88 68 104 78 120	8 170 24
9	9 HT 9 9 19 25 29 51) 9 71 25 111 9 131 25 151 9 171 25	31 EM 9 9 19 25 29 41 39 57 49 73 59 89 69 105 79 121) 9 9 19 25 29 41 39 57 49 73 59 89 69 105 79 121	71 9 I 9 9 19 25 29 41 39 57 49 73 59 89 69 105 79 121	131 Y 9 9 19 25 29 41 39 57 49 73 59 89 69 105 79 121	25 151 9 171 25	151 i 9 9 19 25 29 41 39 57 49 73 59 89 69 105 79 121	9 171 25
A	A LF A 10 1A 26 2A 52 * 10 72 26 112 10 132 26 152 10 172 26	32 SUB A 10 1A 26 2A 42 3A 52 40 74 5A 90 6A 106 7A 122	* A 10 1A 26 2A 42 3A 52 40 74 5A 90 6A 106 7A 122	72 10 J A 10 1A 26 2A 42 3A 52 40 74 5A 90 6A 106 7A 122	132 Z A 10 1A 26 2A 42 3A 52 40 74 5A 90 6A 106 7A 122	26 152 10 172 26	152 j A 10 1A 26 2A 42 3A 52 40 74 5A 90 6A 106 7A 122	10 172 26
B	B VT B 11 1B 27 2B 53 + ; 11 73 27 113 11 133 27 153 11 173 27	33 ESC B 11 1B 27 2B 43 3B 53 4B 75 5B 91 6B 107 7B 123	; B 11 1B 27 2B 43 3B 53 4B 75 5B 91 6B 107 7B 123	73 11 K B 11 1B 27 2B 43 3B 53 4B 75 5B 91 6B 107 7B 123	133 [B 11 1B 27 2B 43 3B 53 4B 75 5B 91 6B 107 7B 123	27 153 11 173 27	153 k B 11 1B 27 2B 43 3B 53 4B 75 5B 91 6B 107 7B 123	11 173 27
C	C FF C 12 1C 28 2C 54 , 12 74 28 114 12 134 28 154 12 174 28	34 FS C 12 1C 28 2C 44 3C 54 , 12 74 28 114 12 134 28 154 12 174 28	, C 12 1C 28 2C 44 3C 54 , 12 74 28 114 12 134 28 154 12 174 28	74 12 L C 12 1C 28 2C 44 3C 54 , 12 74 28 114 12 134 28 154 12 174 28	114 \ C 12 1C 28 2C 44 3C 54 , 12 74 28 114 12 134 28 154 12 174 28	28 154 12 174 28	154 l C 12 1C 28 2C 44 3C 54 , 12 74 28 114 12 134 28 154 12 174 28	12 174 28
D	D CR D 13 1D 29 2D 55 - = 13 75 29 115 13 135 29 155 13 175 29	35 GS D 13 1D 29 2D 45 3D 55 - = 13 75 29 115 13 135 29 155 13 175 29	= D 13 1D 29 2D 45 3D 55 - = 13 75 29 115 13 135 29 155 13 175 29	75 13 M D 13 1D 29 2D 45 3D 55 - = 13 75 29 115 13 135 29 155 13 175 29	115] D 13 1D 29 2D 45 3D 55 - = 13 75 29 115 13 135 29 155 13 175 29	29 155 13 175 29	155 m D 13 1D 29 2D 45 3D 55 - = 13 75 29 115 13 135 29 155 13 175 29	13 175 29
E	E SO E 14 1E 30 2E 56 . > 14 76 30 116 14 136 30 156 14 176 30	36 RS E 14 1E 30 2E 46 3E 56 . > 14 76 30 116 14 136 30 156 14 176 30	.> E 14 1E 30 2E 46 3E 56 . > 14 76 30 116 14 136 30 156 14 176 30	76 14 N E 14 1E 30 2E 46 3E 56 . > 14 76 30 116 14 136 30 156 14 176 30	116 ^ E 14 1E 30 2E 46 3E 56 . > 14 76 30 116 14 136 30 156 14 176 30	30 156 14 176 30	156 n E 14 1E 30 2E 46 3E 56 . > 14 76 30 116 14 136 30 156 14 176 30	14 176 30
F	F SI F 15 1F 31 2F 57 / ? 15 77 UNL 117 O 15 137 UNT 157 O 15 177 DEL F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	37 US F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	/? F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	77 UNL 117 O F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	117 UNT 157 O F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	15 137 157 O F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	15 177 DEL F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)	177 (RUBOUT) F 15 1F 31 2F 47 3F 63 4F 79 5F 95 6F 111 7F 127 (RUBOUT)
	Address Command	Universal Command	Listener Address	Talker Address	Secondary Command			



14.11 Communication-related Error Messages

Error messages related to communications are given below.

When servicing is required, contact your nearest YOKOGAWA representative.

Only error messages relating to the communication mode 488.2 are given here. For other error messages, refer to appendix 1 and section 15.4.

Errors in communications commands (100 to 199)

Code	Message	Action	Reference
102	Syntax error	Incorrect syntax	Section 14.2, 14.3
103	Invalid separator	Insert a comma between data items to separate them.	14-3
104	Data type error	Refer to pages 14-7, 14-8 and enter data using the correct data format.	14-7, 14-8
108	Parameter not allowed	Check the number of parameters.	14-7, 14.3
109	Missing parameter	Enter the required number of parameters.	14-7, 14.3
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).	14.3
113	Undefined header	Check the header.	14.3
114	Header suffix out of range	Check the header.	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.	14-7, 14.3
124	Too many digits	Limit the number of digits to 255 or less.	14-7, 14.3
128	Numeric data not allowed	Enter in a format other than <NRf> format.	14-7, 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 { }.	14.3
144	Character data too long	Check the character strings in { }.	14.3
148	Character data not allowed	Enter in a format other than one of those in { }.	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.	14.3
158	String data not allowed	Enter in a data format other than <Character string>.	14.3
161	Invalid block data	<Block data> is not allowed.	14-9, 14.3
168	Block data not allowed	<Block data> is not allowed.	14-9, 14.3
171	Invalid expression	Equation is not allowed.	14.3
178	Expression data not allowed	Equation is not allowed.	14.3
181	Invalid outside macro definition	Does not conform to the macro definition specified in IEEE488.2.	—

14.11 Communication-related Error Messages

Errors in communications execution (200 to 299)

Code	Message	Action	Reference
221	Setting conflict	Check the relevant setting.	14.3
222	Data out of range	Check the setting range.	14.3
223	Too much data	Check the data byte length.	14.3
224	Illegal parameter value	Check the setting range.	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
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)

Code	Message	Action	Reference
813 to 819	Invalid operation	Refer to 15.4	15-14
830 to 833	Internal memory access error	Refer to 15.4	15-14
841 to 847	Integrator execute error	Refer to 15.4	15-14

Error in System Operation (912)

Code	Message	Action	Reference
912	Fatal error in Communication driver	Service is required.	—

Warnings (350, 390)

Code	Message	Action	Reference
350	Queue overflow	Read out the queue.	14-48
390	Overrun error (only for RS-232-C)	Adjust the baud rate.	11-5

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 (15 to 150 V, 0.1 to 5A/60 Hz)

recommended: FLUKE 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 (0.5%)

Recommended: Yokogawa 7555

Standard power meter

Recommended instrument: Yokogawa WT2000

Adjusting

Preparations

- **Preparing this instrument**

1. While pressing the SHIFT key, turn ON the power switch (adjustment mode). Release the SHIFT key after the following sequence of events: illumination of all LEDs, turning OFF of all LEDs, error 60 indication, error 78 indication, and then indication of the model. "rAnGE" appears on display C.

Note

Error codes 60 and 78 appear, because all setup parameters are initialized when the instrument enters adjustment mode. If you terminate adjustment mode (turn OFF the power switch) and turn the power back ON, the WT210/230 starts with the setup parameters initialized.

2. Select "rAnGE" and press the ENTER key. Then let the instrument warm up for at least 30 minutes. Press the \wedge or \vee 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.

- **Preparing the AC voltage/current standard and DMM**

3. Warm up the AC voltage/current standard for at least an hour. Warm up the DMM for at least an hour as necessary.

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: Aborts the adjustment and returns to the screen on which "rAnGE" is shown on display C. The adjustment results are applied when the WT210/WT230 is power-cycled to the normal measurement condition (turning ON the power switch without pressing the SHIFT key).

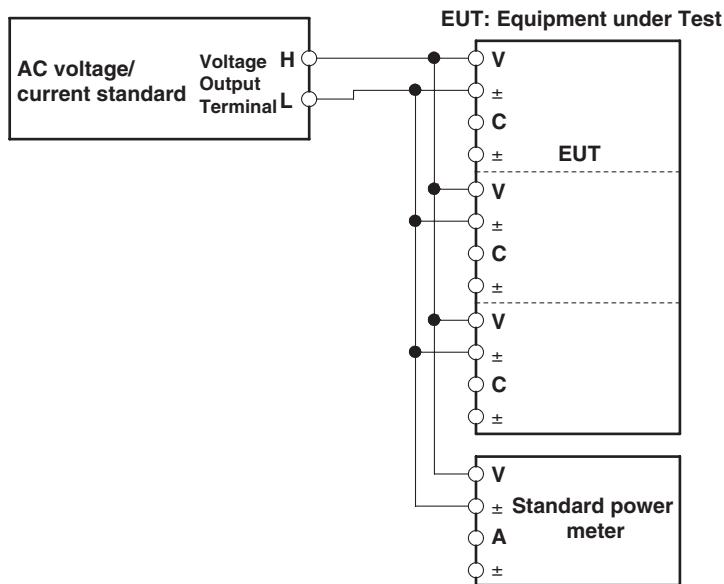
RESET: Returns to normal measurement. However, all adjusted data will become invalid.

CURRENT: 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.

VOLTAGE: 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

- As shown in the figure below, connect the voltage output terminal of the AC voltage/current standard to the voltage input terminal of the WT210/WT230 and the voltage terminal of the standard power meter.



- In step 2 of "Preparations" described earlier, select "rAnGE2" and press the ENTER key. Display B changes to the voltage range of "15.00" V.
Display A CAL
Display B 15.00V
Display C Measured value (The measured value is displayed using 5 digits.)
- Set the output voltage of the generator so that the standard power meter reads 15.000 V.
- Wait for the measured value on display C to stabilize. Even in stable condition, the value fluctuates up to approximately ± 2 digits.
- Press the ENTER key. The adjustment value is confirmed. Display B shows the next voltage range.
Display A CAL
Display B **.**V
Display C Measured value (The measured value is displayed using 5 digits.)
- Set the output voltage of the standard according to the voltage range shown on display B and output the signal.
- Repeat steps 4 to 6 to adjust the voltage range shown in the table below. The type and the order of the voltage ranges that are displayed are fixed.

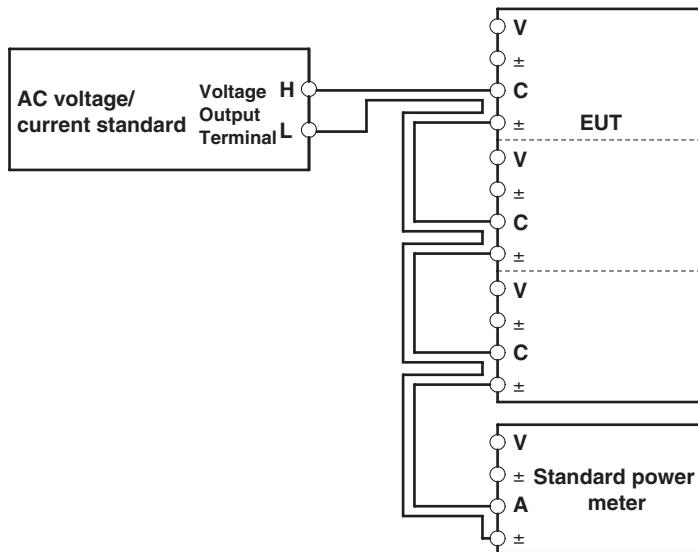
Voltage Range (Shown on display B)	Output Voltage of the Standard
15.00 V	15.000 V
30.00 V	30.000 V
60.00 V	60.000 V
150.0 V	150.00 V
F 150.0 V	150.00 V (F indicates that the line filter is ON)

- Turn OFF the output of the standard.
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. Connect the current output terminal of the AC voltage/current standard to the current input terminal of the WT210/WT230 and the current terminal of the standard power meter.

EUT: Equipment under Test



2. In step 8 of "Adjusting the Voltage Range" described earlier, the current range on display B is set to "500.0" mA. On the WT210, the current range is set to "100.0" mA. The following procedure primarily describes the steps for the WT230.
 Display A CAL
 Display B 500.0 mA (100.0 mA on the WT210)
 Display C Measured value (The measured value is displayed using 5 digits.)
3. Set the output current of the generator so that the standard power meter reads 0.5000 A.
4. Wait for the measured value on display C to stabilize. Even in stable condition, the value fluctuates up to approximately ± 1 digit.
5. Press the ENTER key. The adjustment value is confirmed. Display B shows the next current range.
 Display A CAL
 Display B **.*A
 Display C Measured value (The measured value is displayed using 5 digits.)
6. Set the output current of the standard according to the current range shown on display B and output the signal.
7. Repeat steps 4 to 6 to adjust the current range shown in the table below. The type and the order of the current ranges that are displayed are fixed.

Current Range (Shown on display B)	Output Current of the Standard
100.0 mA (Applies only to the WT210)	100.00 mA
500.0 mA	500.00 mA
1.000 A	1.0000 A
2.000 A	2.0000 A
5.000 A	5.0000 A
F 1.000 A	1.0000 A (F indicates that the line filter is ON)

8. Turn OFF the output of the standard.

9. 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 Sensor Input Option is installed (/EX1 or /EX2)**

1. Connect the voltage output terminal of the AC voltage/current standard to the voltage input terminal of the WT210/WT230. Connect the H terminal of the standard to the core of the EXT terminal of the WT210/WT230 and the L terminal to the shield of the EXT terminal of the WT210/WT230. On the WT230, the core of the EXT terminals and the shield of the EXT terminals of all input elements are connected collectively.
2. In step 2 of "Preparations" described earlier, select "Ein" and press the ENTER key. Display B shows the external sensor range "E 10.00" V (or "E200.0" mV).
3. Set the output voltage of the standard to 10.000 V (or 200.00 mV) and output the signal.
4. Wait for the measured value on display C to stabilize. Even in stable condition, the value fluctuates up to approximately ± 2 digits.
The displayed value when using external sensor input is a value converted to current. If a voltage value that is equal to the specified external sensor range is input, display C shows the rated range of 50.000 A (assuming that there is no error in the WT210/WT230 or the standard).
5. Press the ENTER key. The adjustment value is confirmed.
6. Press The SHIFT key and display C will change to "Ein". This completes the external sensor input adjustments. When you press the RESET key instead of the SHIFT key, the carried out adjustments will become invalid.

Adjusting the D/A Output

- **Preparations**

1. Connect the D/A output terminal (pin) corresponding to channel 1 of the external I/O connector to the H terminal of the DMM and the COM terminal (pin No. 24) to the L terminal. For the relationship between the D/A output terminals and the D/A output channels, see "Pin Assignments" in section 9.1.
2. Set the DMM range to 20 V.
3. In step 2 of "Preparations" on page 15-1, select "dA" and 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. Press the \wedge or \vee key to select the channel to be adjusted shown on display A.
2. Press the ENTER key. The first digit on display C starts blinking. A voltage of approximately +5 V is output from the external I/O connector.
3. Press the VOLTAGE or CURRENT key to move the blinking digit on display C and press \wedge or \vee key to set the value of the blinking digit the same as the value displayed on the DMM.
4. After setting all the digits on display C, press the ENTER key. Display C shows "-5.0000" V and a voltage of approximately -5 V is output from the external I/O connector.
5. Repeat step 3.
6. After setting all the digits on display C, press the ENTER key.
7. The channel shown on display A changes from "ch1" to "ch2."
8. Reconnect the D/A output terminal that is connected to the DMM to the terminal (pin) corresponding to channel 2. Make sure the output terminals do not come in contact with each other or the conductive parts of the terminal to come in contact with other objects.

9. Repeat steps 2 to 6 to adjust channel 2.
10. Repeat steps 2 to 6 for all channels to be adjusted.
11. 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 for Adjustment

Command	Description
CAL1	Enters range adjustment mode.
CR0	Switches to 15 V range in range adjustment mode.
CR1	Switches to 30 V range in range adjustment mode.
CR2	Switches to 60 V range in range adjustment mode.
CR3	Switches to 150 V range in range adjustment mode.
CR4	Switches to 100 mA range in range adjustment mode (WT210only).
CR5	Switches to 500 mA range in range adjustment mode.
CR6	Switches to 1 A range in range adjustment mode.
CR7	Switches to 2 A range in range adjustment mode.
CR8	Switches to 5 A range in range adjustment mode.
CR11	Switches to 150 V range in range adjustment mode with the line filter turned ON.
CR12	Switches to 1 A range in range adjustment mode with the line filter turned ON.
CAN	Exits range adjustment mode discarding the adjustments. Corresponds to the RESET key.
END	Exits range adjustment mode keeping the adjustments. Corresponds to the SHIFT key.
ENT	Confirms the adjustment value. Corresponds to the ENTER key.
CAL2	Enters external sensor input range adjustment mode.
EX0	No external sensor input option.
EX1	Option /EX1 (2.5 V, 5 V, and 10 V ranges)
EX2	Option /EX2 (50 mV, 100 mV, and 200 mV ranges)
CR9	/EX2 Switch to 200 mV range.
CR10	/EX1 Switch to 10 V range.
CAN	Exits range adjustment mode discarding the adjustments. Corresponds to the RESET key.
END	Exits range adjustment mode keeping the adjustments. Corresponds to the SHIFT key.
ENT	Confirms the adjustment value. Corresponds to the ENTER key.
CAL3	Enter D/A output adjustment mode.
CHm	Switches channels in D/A output adjustment mode. m = 1 to 12
CDm,n	Enter the actual output value in D/A output adjustment mode. m = 1 to 12, n = actual output value.
DO0	Execute +5 V output in D/A output adjustment mode.
DO1	Execute -5 V output in D/A output adjustment mode.
CAN	Exits range adjustment mode discarding the adjustments. Corresponds to the RESET key.
END	Exits range adjustment mode keeping the adjustments. Corresponds to the SHIFT key.
ENT	Confirms the adjustment value. Corresponds to the ENTER key.
CAL0	Exits adjustment (returns to normal measurement mode).
OD	Communication output request for measured/computed data. The output format is normally default.

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 sensor input range adjustment mode, execute the ENT command.

15.2 Calibration

Required Equipment

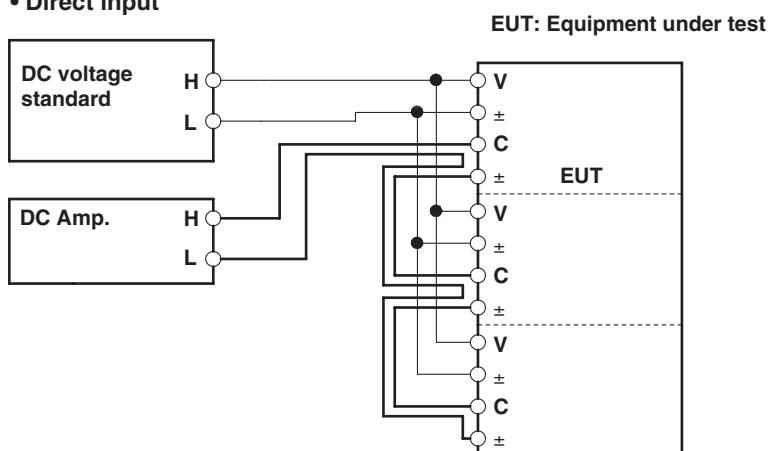
DC Voltage/Current Standard
recommended: FLUKE 9100
AC Voltage/Current Standard
recommended: FLUKE 9100
or FLUKE 5700A and FLUKE 5700A + GUILDLINE 7620
Digital Power Meter
recommended: Yokogawa WT2000
2ch Synchronizer
recommended: Yokogawa FG120

Calibration of DC Voltage, Current and Power

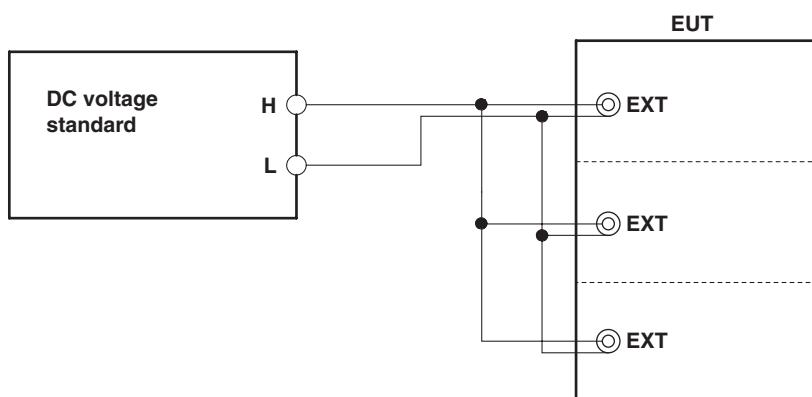
Wiring

Connect the DC voltage and DC current standard as follows. In case of the WT230, voltages are connected parallel, and currents in series.

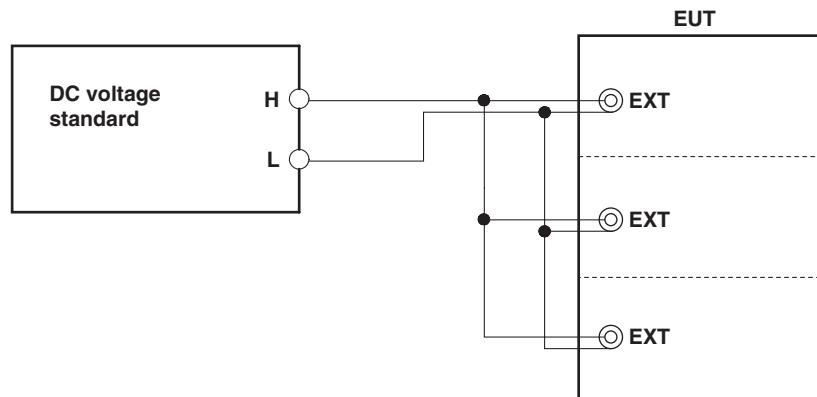
- Direct input



- External sensor input (equipped with option /EX1)



- External sensor input (equipped with option /EX2)



Calibration

1. Set the voltage range and current range of the WT210/WT230 to the range to be calibrated.
2. Set the output voltage of the DC voltage standard to the rated range of the WT210/WT230.
3. Set the output current of the DC current standard to the rated range of the WT210/WT230.

The voltage, current, and power values displayed on the WT210/WT230 at this point are the calibration values.

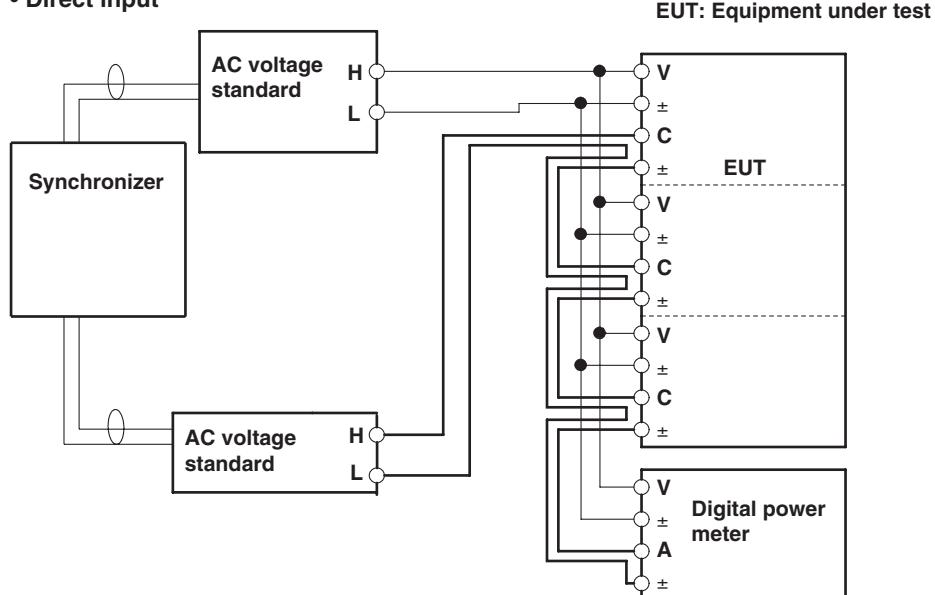
Set the crest factor to 3.

Calibration of AC Voltage, Current and Power

Wiring

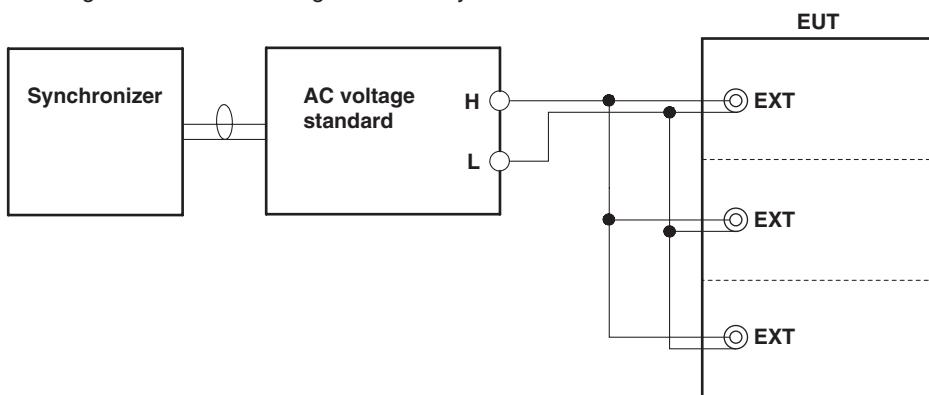
Connect the Digital Power meter, Synchronizer and the AC voltage and AC current standard as follows.

- Direct input



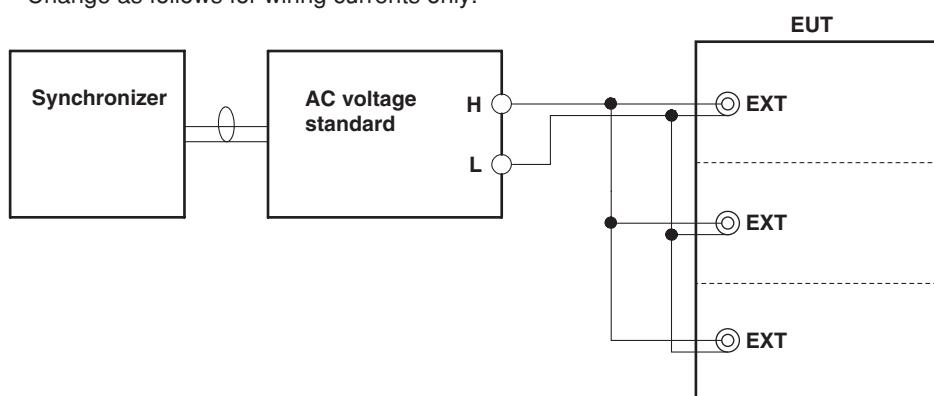
- External sensor input (equipped with option /EX1)

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.

Set the crest factor to 3.

Calibrating

- **Calibration of voltage and current**

1. Set the voltage range and current range of the WT210/WT230 to the range to be calibrated.
2. Set the output voltage of the AC voltage standard so that the voltage reading on the standard power meter matches the rated voltage range of the WT210/WT230.
3. Set the output current of the AC current standard so that the current reading on the standard power meter matches the rated current range of the WT210/WT230.

The voltage and current values displayed on the WT210/WT230 at this point are the calibration values.

- **Calibration of power when the power factor = 1**

4. Shift the phase of the current signal channel of the phase shifter so that the power indicated on the standard power meter shows the rated value.

The power value displayed on the WT210/WT230 at this point is the calibration value when power factor = 1.

- **Calibration of power when the power factor = 0**

5. Shift the phase of the current signal channel of the phase shifter so that the power indicated on the standard power meter shows zero.

The power value displayed on the WT210/WT230 at this point is the calibration value when power factor = 0.

- **Calibration of power with high accuracy**

6. To calibrate the WT210/WT230 with even higher accuracy, adjust the AC voltage/current standard and phase shifter so that the display on the standard power meter matches the calibration value of the standard power meter.

The displayed value on the WT210/WT230 at this point is the calibration value with higher accuracy.

- **Calibration at a frequency other than 60 Hz**

7. To perform calibration at a frequency other than 60 Hz, set the frequencies of the phase shifter and the standard and carry out the procedure above in a similar fashion. Make sure to use a standard that can guarantee adequate accuracy against the output frequency. As a guideline, use a measuring instrument that has three to four times the accuracy of the specifications of the WT210/WT230.

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 15-4). However, calibration of the WT230 can also be carried out when only element 1 is connected.
2. Set the D/A output of this instrument to V1 for each channel.
Set the crest factor to 3.

Calibrating

1. Connect the D/A output terminal corresponding to channel 1 of the external I/O connector in the same fashion as when making adjustments.
2. Set the voltage range of the WT210/WT230 to an appropriate range.
3. Set the output voltage of the voltage standard to match the positive rated value of the rated range of the WT210/WT230.
4. Read the value displayed on the DMM. This readout is the calibration value for the positive D/A output.
5. Set the output voltage of the voltage standard to match the negative rated value of the rated range of the WT210/WT230.
6. Read the value displayed on the DMM. This readout is the calibration value for the negative D/A output.
7. Connect the D/A output terminal corresponding to each channel to the DMM one by one and repeat steps 2 to 6. Check the calibration value for all channels.
8. Turn OFF the output of the voltage standard.

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 10 V for each channel.
Set the crest factor to 3.

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 50MΩ.
5. Turn the output of the voltage standard OFF.

Verifying of the Harmonic Measurement Function

Connection

Use the same instruments as in case of AC power measurement and connect them in the same way (refer to page 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 measurement function ON.
Set the crest factor to 3.

Calibrating Currents

1. Set the voltage signal channel of the synchronizer to 60 Hz, current signal channel 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. On the WT230, change the settings of the element on which harmonic measurement is to be performed (see section 7.2) and confirm elements 1, 2, and 3 on display B.
6. If required, change the current signal channel's 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 voltage signal channel of the synchronizer to 900 Hz (15 times), current signal channel 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. On the WT230, change the settings of the element on which harmonic measurement is to be performed (see section 7.2) and confirm elements 1, 2, and 3 on display B.
6. If required, change the voltage signal channel's 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.

Verifying of Functions**Auto Range Operation**

1. Set the voltage or current range of this instrument to Auto range. When the voltage or current input is zero, the voltage and current ranges are automatically set to 15 V range and 0.5 A range (5 mA range on the WT210), respectively. Set the crest factor to 3.
2. Press the VOLTAGE key to verify the 15 V range and then press this key once more.
3. Press the CURRENT key and check that that the range is set to 0.5 A (5 mA on the WT210). Then, press the CURRENT key again.
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 measured voltage on the WT210/WT230 shows bars (---) and changes to 600 V few seconds later.
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 measured current on the WT210/WT230 shows bars (---) and changes to 20 A few seconds later.
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. When contacting your representative, inform the ROM version No. which is displayed on display B on power-up.

Symptom	Items to check	Section
Nothing is displayed when the power is turned ON.	<ul style="list-style-type: none">• 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?• Has the fuse blown?	3.5 3.5 15.5
Displayed data is odd.	<ul style="list-style-type: none">• Is there a possibility of noise?• Are measurement leads connected correctly?• Is the setting for the measured sync source suitable in this case?• Is the input filter ON or OFF?• Are the ambient temperature and humidity within the allowed range?	3.2 3.3 to 3.9 4.2 4.3 16.10
Keys do not function properly.	<ul style="list-style-type: none">• Is the "REMOTE" indicator ON?• Is the "KEY LOCK" indicator ON?	10.2 12.4
Instrument cannot be controlled via GP-IB interface.	<ul style="list-style-type: none">• 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 serial 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	Section
11	Received a command not used by this instrument.	Check for error in the command sent.	13.1, 14.3
12	Parameter value specified is outside the allowed range.	Correct the value.	13.1, 14.3
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, 13.1, 14.3
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 measurement was being performed or was interrupted, that cannot be executed or received in such a state.	Check whether harmonic measurement 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.	Chapter 8
33	No space to store data in the internal memory.		8.1
41	<ul style="list-style-type: none"> • Attempted to start integration while there is an overflow condition. • Attempted to start integration after elapsed 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 inprogress 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. "Err-Lo" is displayed.		5.4
57	Measured frequency exceeded the measurement range. "Err-Hi" is displayed.		5.4
58	Computation overflow occurred. "oF" is displayed.		2.3
59	Harmonic measurement 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 setup parameters backup. (setup parameters other than communication 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.
68	Data file failure (measurement data, setup parameter file failure)	File will be initialized automatically.
71, 72, 73	DSP communications failure.	Service is required.
74	RAM failure on the harmonics measure board (for models with the /HRM option).	Service is required.
75	Internal DSP error.	Service is required.
78	Backup data failure in setup parameters.	–
79	ROM checksum error.	Service is required.
84	DSP 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



WARNING

- The fuse used must be of the specified rating (current, voltage, type) in order to prevent a fire hazard.
- Make sure to turn OFF the power switch and to unplug the power cord from its source before replacing the fuse.
- Never short-circuit the fuse holder.

Fuse Ratings

The fuse used in the WT230 has the following specifications.

100V/200V Common

Maximum rated voltage: 250 V

Maximum rate current: 1 A

Type: Time-lag

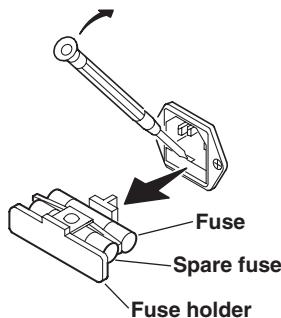
Approved standard: UL/VDE

Parts number: A1347EF

Replacing Procedure

Replace the fuse as follows.

- 1 Turn the power switch OFF.
- 2 Unplug the power cord from the power connector.
- 3 Place the tip of a flat-blade screwdriver in to the slot of the fuse holder, and move the screwdriver in the direction of the arrow to remove the fuse holder.
- 4 Remove the blown fuse.
- 5 Insert a new fuse into the holder, then install the holder in place.



15.6 Recommended Replacement Parts

The one-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 (WT210 only)	<p>This is the relay used to switch the current input circuit. The specifications of the relay are as follows:</p> <ul style="list-style-type: none">• Electric switching life: Approx. 50,000 times (at rated capacity).• Mechanical life: Approx. 1,000,000 times.
Comparator function relay	<p>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:</p> <ul style="list-style-type: none">• Rated contact capacity: 24 V/0.5 A.• Electric switching life: Approx. 500,000 times (at rated capacity).• Mechanical life: Approx. 100,000,000 times.
Backup battery (Lithium battery)	3 years

16.1 Input

Item	Specifications
Input terminal type	<p>Voltage Plug-in terminal (safety terminal structure)</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input: Large binding post • Current sensor input (option): BNC connector (insulation type)
Input format	<p>Voltage Floating input, resistive voltage divider</p> <p>Current Floating input, shunt input</p>
Measurement range (Rated value)	<p>Voltage 15 V, 30 V, 60 V, 150 V, 300 V, 600 V</p> <p>Current</p> <ul style="list-style-type: none"> • DC input • When the crest factor is set to 3 <ul style="list-style-type: none"> • Common to WT210 and WT230: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A • WT210 only: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200mA • When the crest factor is set to 6 <ul style="list-style-type: none"> • Common to WT210 and WT230: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A • WT210 only: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA • External sensor input (option) <ul style="list-style-type: none"> • When the crest factor is set to 3 <ul style="list-style-type: none"> • Either "2.5 V, 5 V, and 10 V" or "50 mV, 100 mV, 200 mV" • When the crest factor is set to 6 <ul style="list-style-type: none"> • Either "1.25 V, 2.5 V, and 5 V" or "25 mV, 50 mV, 100 mV"
Input impedance	<p>Voltage Input resistance: Approx. 2 MΩ, input capacitance: Approx. 13 pF</p> <p>Current</p> <ul style="list-style-type: none"> • DC input <ul style="list-style-type: none"> • WT230 Input resistance: Approx. 6 mΩ, input inductance: Approx. 0.1 μH • WT210 (when the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges) Input resistance: Approx. 6 mΩ + 10 mΩ (max)*, input inductance: Approx. 0.1 μH • WT210 (when the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges) Input resistance: Approx. 500 mΩ, input inductance: Approx. 0.1 μH • External sensor input <ul style="list-style-type: none"> • When the crest factor is set to 3: 2.5 V, 5 V, and 10 V ranges; when the crest factor is set to 6: 1.25 V, 2.5 V, and 5 V ranges Input resistance: Approx. 100 kΩ • When the crest factor is set to 3: 50 mV, 100 mV, and 200 mV ranges; when the crest factor is set to 6: 25 mV, 50 mV, and 100 mV ranges Input resistance: Approx. 20 kΩ
Instantaneous maximum allowable input (1 period, for 20 ms)	<p>Voltage Peak value of 2.8 kV or RMS value of 2.0 kV, whichever is less.</p> <p>Current</p> <ul style="list-style-type: none"> • DC input <ul style="list-style-type: none"> • When the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges Peak value of 450 A or RMS value of 300 A, whichever is less. • When the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges Peak value of 150 A or RMS value of 100 A, whichever is less. • External sensor input Peak value less than or equal to 10 times the rated range.

* Factory default

16.1 Input

Item	Specifications
Instantaneous maximum allowable input (for 1 s)	<p>Voltage Peak value of 2.0 kV or RMS value of 1.5 kV, whichever is less.</p> <p>Current</p> <ul style="list-style-type: none"> • DC input • When the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges Peak value of 150 A or RMS value of 40 A, whichever is less. • When the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges Peak value of 30 A or RMS value of 20 A, whichever is less. • External sensor input Peak value less than or equal to 10 times the rated range.
Continuous maximum allowable input	<p>Voltage Peak value of 1.5 kV or RMS value of 1.0 kV, whichever is less.</p> <p>Current</p> <ul style="list-style-type: none"> • DC input • When the crest factor is set to 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges; when the crest factor is set to 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, and 10 A ranges Peak value of 100 A or RMS value of 30 A, whichever is less. • When the crest factor is set to 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges; when the crest factor is set to 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, and 100 mA ranges Peak value of 30 A or RMS value of 20 A, whichever is less. • External sensor input Peak value less than or equal to 5 times the rated range.
Continuous maximum common mode voltage (during 50/60 Hz input)	600 Vrms (when using the output connector protection cover) CAT II 400 Vrms (when the output connector protection cover is removed) CAT II
Influence from common mode voltage	<p>When 600 Vrms is applied between the input terminal and case with the voltage input terminals shorted, current input terminals open and external sensor input terminals shorted.</p> <ul style="list-style-type: none"> • At 50/60 Hz –80 dB or more ($\pm 0.01\%$ of range or less) • Up to 100 kHz (reference value) <ul style="list-style-type: none"> • 15 V, 30 V, 60 V, 150 V, 300 V, 600 V ranges and 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A ranges Within $\pm \left[\frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.001 \times f\% \text{ of range} \right]$ <p>The maximum rated range is 600 V for the voltage input terminal and 20 A for the current input terminal.</p> <ul style="list-style-type: none"> • 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges Within $\pm \left[\frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.0002 \times f\% \text{ of range} \right]$ <p>The maximum rated range is 200 mA.</p> <ul style="list-style-type: none"> • External sensor input ranges Within $\pm \left[\frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.01 \times f\% \text{ of range} \right]$ <p>The “maximum rated range” is 10 V for option /EX1 and 200 mV for option /EX2 (twice these values when the crest factor is set to 6).</p> <p>Except, at least 0.01%. The unit of frequency f is kHz.</p>
Line filter	See “Voltage, Current, and Active Power Measurement” in section 16.3, “Functions.”
Frequency filter	See “Frequency Measurement” in section 16.3, “Functions.”
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 16 bits. Maximum conversion rate: Approx. 20 μ s (approx. 51 kHz).

16.2 Accuracy

Voltage and Current Accuracy

Item	Specifications
Accuracy	<p>Requirements</p> <ul style="list-style-type: none">• Temperature: 23±5°C.• Humidity: 30 to 75%RH.• Power factor: 1• Crest factor: 3• Input waveform: Sine wave• Common-mode voltage: 0 V• Scaling function: OFF• Number of displayed digits: 5 digits• Frequency filter: Turn ON to measure voltage or current of 200 Hz or less• After warm-up time has passed• After wiring is complete and zero-level compensation or measurement range is changed.
Accuracy (3 months after calibration)	
Frequency	Accuracy (The accuracy shown below is the sum of reading and range errors.)
DC	±(0.2% of reading + 0.2% of range)
0.5 Hz ≤ f < 45 Hz	±(0.1% of reading + 0.2% of range)
45 Hz ≤ f ≤ 66 Hz	±(0.1% of reading + 0.1 % of range)
66 Hz < f ≤ 1 kHz	±(0.1% of reading + 0.2 % of range)
1 kHz < f ≤ 10 kHz	±((0.07 × f)% of reading + 0.3 % of range)
10 kHz < f ≤ 100 kHz	±(0.5 % of reading + 0.5 % of range) ± [(0.04 × (f - 10))% of reading]
* The unit of f in the read error equation is kHz.	
Add ±10 µA to the DC accuracy of current.	
Effective input range	1 to 130% with respect to the rated range of voltage or current. (Except, add the reading error × 0.5 for the range of 110% to 130% of the rated range.)
Lower limit of measurement frequency	
Display update rate	0.1 s 0.25 s 0.5 s 1 s 2 s 5 s
Lower limit of measurement frequency	25 Hz 10 Hz 5 Hz 2.5 Hz 1.5 Hz 0.5 Hz
Effect when the line filter is turned ON	45 to 66 Hz: Add 0.2% of reading. Less than 45 Hz: Add 0.5% of reading.
Temperature coefficient	Add ±0.03% of reading/°C in the range 5 to 18°C or 28 to 40°C.
One year accuracy (Accuracy 12 months after calibration)	Add (reading error of the accuracy at 3 months after calibration) × 0.5 to the accuracy at 3 months after calibration.
Accuracy when the crest factor is set to 6	Accuracy obtained by doubling the measurement range error for the accuracy when the crest factor is set to 3.

16.2 Accuracy

Active Power Accuracy

Item	Specifications	
Accuracy	Requirements Same as the conditions for voltage and current. Accuracy (3 months after calibration)	
	Frequency	Accuracy (The accuracy shown below is the sum of reading and range errors.)
	DC	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$
	$0.5 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$
	$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$
	$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$
	$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm(0.1\% \text{ of reading} + 0.3\% \text{ of range}) \pm [(0.067 \times (f - 1))\% \text{ of reading}]$
	$10 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range}) \pm [(0.09 \times (f - 10))\% \text{ of reading}]$
	* The unit of f in the read error equation is kHz.	
	Add $\pm 10 \mu\text{A} \times$ voltage reading to the DC accuracy of power.	
Influence of power factor	When power factor (PF) = 0(VA: apparent power) <ul style="list-style-type: none"> • $\pm 0.2\%$ of VA for $45 \text{ Hz} \leq f \leq 66 \text{ Hz}$. • $\pm[(0.2 + 0.2 \times f)\% \text{ of VA}]$ for up to 100 kHz as reference data. The unit for frequency f is kHz. When $0 < \text{PF} < 1$ (ϕ : phase angle of the voltage and current) Add the power reading $\times \{\tan\phi \times (\text{influence when PF} = 0)\}\%$.	
Effect when the line filter is turned ON	45 to 66 Hz: Add 0.3% of reading. Less than 45 Hz: Add 1% of reading.	
Temperature coefficient	Same as the temperature coefficient for voltage and current.	
One year accuracy (Accuracy 12 months after calibration)	Add (reading error of the accuracy at 3 months after calibration) $\times 0.5$ to the accuracy at 3 months after calibration.	
Accuracy when the crest factor is set to 6	Accuracy obtained by doubling the measurement range error for the accuracy when the crest factor is set to 3.	

Accuracy of Other Parameters and Computation Accuracy

- For the accuracy of frequency voltage and current, see "Frequency Measurement" in section 16.3, "Functions."
- For the accuracy of integrated values Wh, Wh+, Wh-, Ah, Ah+, and Ah- and the integration timer, see "Integration" in section 16.3, "Functions."
- For the accuracy of voltage, current and power during harmonic measurement, see "Harmonic Measurement" in section 16.3, "Functions."
- For the D/A output accuracy, see section 16.5, "D/A Output."

16.3 Functions

Voltage, Current, and Active Power Measurements

Item	Specifications
Measurement method	Digital sampling method, summation averaging method
Crest factor	3 or 6
Wiring system	WT210 (single-phase model, 760401) Single-phase, two-wire (1P2W) WT230 (three-phase, three-wire model, 760502) Select from single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); and three-phase, three-wire (3P3W) WT230 (three-phase, four-wire model, 760503) Select from single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); three-phase, three-wire (3P3W); three-phase, four-wire (3P4W); and three-voltage, three-current (3V3A).
Range switching	Select fixed range or auto range.
Auto range	Step up When the measured value exceeds 130% of the rated range or the peak value exceeds approximately 300% (Approx. 600% if the crest factor is set to 6) of the rated range. For the WT230, when the condition is met on any of the input elements. Step down Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than 300% (Less than or equal to 600% if the crest factor is set to 6) of the subordinate range. For the WT230, when the condition is met on all input elements.
Measurement mode switching	Select from RMS (the true RMS value of voltage and current), VOLTAGE MEAN (the rectified mean value calibrated to the RMS value of the voltage and the true RMS value of the current), DC (simple average of voltage and current).
Measurement synchronization source	Select voltage, current, or the entire period of the display update rate for the signal used to achieve synchronization during measurement.
Line filter	Select OFF or ON (cutoff frequency of 500 Hz).
Peak measurement	Measures the peak value of voltage or current from the instantaneous voltage or instantaneous current that is sampled.
Zero-level compensation	Creates a zero input condition inside the WT210/WT230 and sets the level at that point as the zero level.

Frequency Measurement

Item	Specifications														
Measured item	WT210 (single-phase model, 760401) Select voltage (V) or current (A). WT230 (three-phase, three-wire model, 760502) Select voltage of input element 1 (V1), voltage of input element 3 (V3), current of input element 1 (A1), or current of input element 3 (A3). WT230 (three-phase, four-wire model, 760503) Select voltage of input element 1 (V1), voltage of input element 2 (V2), voltage of input element 3 (V3), current of input element 1 (A1), current of input element 2 (A2), or current of input element 3 (A3).														
Method	Reciprocal method														
Frequency measuring range	Varies depending on the display update period (see description given later) as follows.														
	<table border="1"> <thead> <tr> <th>Display Update Rate</th> <th>Measurement Range</th> </tr> </thead> <tbody> <tr> <td>0.1 s</td> <td>25 Hz to 100 kHz</td> </tr> <tr> <td>0.25 s</td> <td>10 Hz to 100 kHz</td> </tr> <tr> <td>0.5 s</td> <td>5 Hz to 100 kHz</td> </tr> <tr> <td>1 s</td> <td>2.5 Hz to 100 kHz</td> </tr> <tr> <td>2 s</td> <td>1.5 Hz to 50 kHz</td> </tr> <tr> <td>5 s</td> <td>0.5 Hz to 20 kHz</td> </tr> </tbody> </table>	Display Update Rate	Measurement Range	0.1 s	25 Hz to 100 kHz	0.25 s	10 Hz to 100 kHz	0.5 s	5 Hz to 100 kHz	1 s	2.5 Hz to 100 kHz	2 s	1.5 Hz to 50 kHz	5 s	0.5 Hz to 20 kHz
Display Update Rate	Measurement Range														
0.1 s	25 Hz to 100 kHz														
0.25 s	10 Hz to 100 kHz														
0.5 s	5 Hz to 100 kHz														
1 s	2.5 Hz to 100 kHz														
2 s	1.5 Hz to 50 kHz														
5 s	0.5 Hz to 20 kHz														

16.3 Functions

Item	Specifications
Measurement range	Auto switching among six types: 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 100 kHz.
Frequency filter	Select OFF or ON (cutoff frequency of 500 Hz).
Accuracy	Requirements <ul style="list-style-type: none"> The amplitude of the measure signal is at least 30% (greater than or equal to 60% if the crest factor is set to 6) of the rated value of the voltage or current range. Frequency filter is ON when measuring voltage or current of 200 Hz or less. Accuracy $\pm(0.06\% \text{ of reading})$

Computation

Item	Specifications				
Computing equation of apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg)					
					i: Input element number
Wiring System	Active Power (W)	Apparent Power (VA)	Reactive Power (var)	Power Factor (PF)	Phase Angle (deg)
Single-phase, two-wire	W	VA = V _i •A _i	var = $\sqrt{(VA)^2 - W^2}$	PF = $\frac{W}{VA}$	$\text{deg} = \cos^{-1}\left(\frac{W}{VA}\right)$
Single-phase, three-wire (i=1, 3)	W _i $\Sigma W = W_1 + W_3$	V _{Ai} = V _i •A _i $\Sigma VA = VA_1 + VA_3$	var _i = $\sqrt{(VA_i)^2 - W_i^2}$	$PF_i = \frac{W_i}{VA_i}$ $\Sigma PF = \frac{\Sigma W}{\Sigma VA}$	$\text{deg}_i = \cos^{-1}\left(\frac{W_i}{VA_i}\right)$ $\Sigma \text{deg} = \cos^{-1}\left(\frac{\Sigma W}{\Sigma VA}\right)$
Three-phase, three-wire (i=1, 3)	W _i $\Sigma W = W_1 + W_3$	V _{Ai} = V _i •A _i $\Sigma VA = \frac{\sqrt{3}}{2} (VA_1 + VA_3)$	$\Sigma var = var_1 + var_3$		
Three-phase, four-wire (i=1, 2, 3)	W _i $\Sigma W = W_1 + W_2 + W_3$	V _{Ai} = V _i •A _i $\Sigma VA = VA_1 + VA_2 + VA_3$	var _i = $\sqrt{(VA_i)^2 - W_i^2}$ $\Sigma var = var_1 + var_2 + var_3$		
Three-voltage, three-current (i=1, 2, 3)	W _i (W ₂ has no physical meaning) $\Sigma W = W_1 + W_3$	V _{Ai} = V _i •A _i $\Sigma VA = \frac{\sqrt{3}}{3} (VA_1 + VA_2 + VA_3)$	var _i = $\sqrt{(VA_i)^2 - W_i^2}$ $\Sigma var = var_1 + var_3$		

Note

- The WT210/WT230 computes apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) from voltage, current, and active power through digital computation. If distorted signal is input, the value obtained on this instrument may differ from that obtained on other instruments using a different measurement principle.
- If the voltage or current is less than 0.5% (less than or equal to 1% if the crest factor is set to 6) of the rated range, zero is displayed for VA or var, and error is displayed for PF and deg.
- The accuracy of detecting lead or lag is defined for a voltage and current input that is at least 50% (range rating if the crest factor is set to 6) of the rated range.
Detection accuracy: ± 5 deg (20 Hz to 2 kHz)
- For $\pm \Sigma var$ computation, when the current leads the voltage, each var value is computed as a negative value; when the current lags the voltage, the value is computed as a positive value.

Item	Specifications
Scaling	When performing voltage or current measurements with items such as external PT, CT, shunt, and external sensor (clamp), set a scaling factor to the primary/secondary ratio. <ul style="list-style-type: none"> • Significant digits: Selected automatically according to significant digits in the voltage and current ranges. • Selectable range: 0.001 to 9999
Averaging	Select the method from the following two types. <ul style="list-style-type: none"> • Exponential averaging method • Moving average method Select the attenuation constant for exponential averaging; select the sample number from 8, 16, 32, and 64 for moving average.
Efficiency	Computation of efficiency is possible on the WT230.
Crest factor	Computes the crest factor (peak value/RMS value) of voltage and current.
Four arithmetic operation	Six types of four arithmetic operations possible (A+B, A-B, A*B, A/B, A ² /B, and A/B ²)
Average active power during integration	Computes the average active power within the integrated period.

Integration

Item	Specifications
Mode	Select manual integration mode, standard integration mode, or repetitive integration mode.
Timer	Automatically stop integration by setting a timer. Selectable range: 0 hours 00 minutes 00 seconds to 10000 hours 00 minutes 00 seconds (Set automatically to manual integration mode for 0 hours 00 minutes 00 seconds)
Count overflow	Holds the elapsed integration time and integration value and stops integration when the elapsed time of integration reaches the maximum integration time of 10000 hours or when the integrated value reaches the maximum displayable integration value (999999M or -99999M).
Accuracy	\pm (Power accuracy (or current accuracy) + 0.1% of reading)
Timer accuracy	\pm 0.02%
Remote control	Start, stop, reset possible using an external remote signal. (applies to products with the /DA4, /DA12, or /CMP option)

16.3 Functions

Harmonic Measurement (/HRM Option)

Item	Specifications																				
Measured item	Select only a single wiring unit.																				
Method	PLL synchronization method																				
Frequency range	Fundamental frequency of the PLL source is in the range of 40 Hz to 440 Hz.																				
PLL source	Select voltage or current of each input element.																				
Measured items	See "Displayed Items" on page 7-1.																				
FFT data length	1024																				
FFT processing word length	32 bits																				
Window function	Rectangular																				
Sample rate, window width, and upper limit of analysis	<table border="1"> <thead> <tr> <th>Fundamental Frequency PLL Source f (Hz)</th> <th>Sample rate (S/s)</th> <th>Window Width against of the FFT Data Length (Frequency of the Fundamental Wave)</th> <th>Upper Limit of Harmonic Analysis</th> </tr> </thead> <tbody> <tr> <td>40≤f<70</td><td>f×512</td><td>2</td><td>50</td></tr> <tr> <td>70≤f<130</td><td>f×256</td><td>4</td><td>50</td></tr> <tr> <td>130≤f<250</td><td>f×128</td><td>8</td><td>50</td></tr> <tr> <td>250≤f≤440</td><td>f×64</td><td>16</td><td>30</td></tr> </tbody> </table>	Fundamental Frequency PLL Source f (Hz)	Sample rate (S/s)	Window Width against of the FFT Data Length (Frequency of the Fundamental Wave)	Upper Limit of Harmonic Analysis	40≤f<70	f×512	2	50	70≤f<130	f×256	4	50	130≤f<250	f×128	8	50	250≤f≤440	f×64	16	30
Fundamental Frequency PLL Source f (Hz)	Sample rate (S/s)	Window Width against of the FFT Data Length (Frequency of the Fundamental Wave)	Upper Limit of Harmonic Analysis																		
40≤f<70	f×512	2	50																		
70≤f<130	f×256	4	50																		
130≤f<250	f×128	8	50																		
250≤f≤440	f×64	16	30																		
Accuracy	Add ±0.2% of range to the accuracy of normal measurement. However, for n^{th} order component input, add $\{10/(m+1)\}\%$ of the n^{th} order reading to $n+m^{\text{th}}$ order and $n-m^{\text{th}}$ order.																				
Auto range	<p>Step up When the measured value exceeds 200% of the rated range or the peak value exceeds approximately 300% (Approx. 600% if the crest factor is set to 6) of the rated range.</p> <p>Step down Range down: When the measured value becomes less than 30% of the rated range and the peak value is less than 300% (Less than or equal to 600% if the crest factor is set to 6) of the subordinate range</p>																				

Display

Item	Specifications
Display type	7-segment LED
Simultaneous display	3 items
Display items	<p>During normal measurement</p> <ul style="list-style-type: none"> • Display function V (voltage) A (current) W (active power) VA (apparent power) var (reactive power) TIME (elapsed integration time) PF (power factor) deg (phase angle) VHz (voltage frequency) AHz (current frequency) Wh (sum of watt hours) Ah (sum of ampere hours) Wh± (positive or negative watt hour) Ah± (positive or negative ampere hour) <p>Result of efficiency computation, crest factor computation, four arithmetic operations, and average active power during integration.</p> <p>Voltage peak Current peak</p> <ul style="list-style-type: none"> • Display area • Display A V, A, W, VA, var, and TIME • Display B V, A, W, PF, and deg • Display C V, A, W, VHz, AHZ, Wh, Wh±, Ah, Ah±, result of efficiency computation, crest factor computation, four arithmetic operations, and average active power during integration, voltage peak, and current peak

Item	Specifications																																																								
Display items	During Harmonic Measurement <ul style="list-style-type: none"> • Display function <table> <tr> <td>V (voltage of harmonic signal)</td> <td>A (current of harmonic signal)</td> </tr> <tr> <td>W (active power of harmonic signal)</td> <td>PF (power factor of fundamental signal)</td> </tr> <tr> <td>V% (total harmonic distortion of voltage THD/relative harmonic content of each harmonic order)</td> <td></td> </tr> <tr> <td>A% (total harmonic distortion of current THD/relative harmonic content of each harmonic order)</td> <td></td> </tr> <tr> <td>W% (relative harmonic content of each harmonic order of active power)</td> <td></td> </tr> <tr> <td>Vdeg (phase angle of each harmonic component of voltage)</td> <td></td> </tr> <tr> <td>Vdeg (phase angle of each harmonic component of current)</td> <td></td> </tr> <tr> <td>VHz (frequency of the voltage set to be the PLL synchronization source)</td> <td></td> </tr> <tr> <td>AHz (frequency of the current set to be the PLL synchronization source)</td> <td></td> </tr> </table> For details, see "Displayed Items" on page 7-1. <ul style="list-style-type: none"> • Display area <ul style="list-style-type: none"> • Display A V, A, W, harmonic order • Display B V, A, W, PF, V%, A%, W%, Vdeg, Adeg • Display C V, A, W, VHHz, AHZ 			V (voltage of harmonic signal)	A (current of harmonic signal)	W (active power of harmonic signal)	PF (power factor of fundamental signal)	V% (total harmonic distortion of voltage THD/relative harmonic content of each harmonic order)		A% (total harmonic distortion of current THD/relative harmonic content of each harmonic order)		W% (relative harmonic content of each harmonic order of active power)		Vdeg (phase angle of each harmonic component of voltage)		Vdeg (phase angle of each harmonic component of current)		VHz (frequency of the voltage set to be the PLL synchronization source)		AHz (frequency of the current set to be the PLL synchronization source)																																					
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AHz (frequency of the current set to be the PLL synchronization source)																																																									
Element	Select the input element or Σ on the WT230 Displays the display item of the selected element.																																																								
Maximum display (display range)	During normal measurement <table border="1"> <tr> <td>Displayed item</td> <td>When the number of displayed digits is 5</td> <td>When the number of displayed digits is 4</td> </tr> <tr> <td>V, A, W, VA*, var*</td> <td>99999</td> <td>9999</td> </tr> <tr> <td>PF*</td> <td>1.0000 to -1.0000</td> <td>1.000 to -1.000</td> </tr> <tr> <td>deg*</td> <td>G180.0 to d180.0</td> <td>G180.0 to d180.0</td> </tr> <tr> <td>VHz*, AHZ*</td> <td>99999</td> <td>9999</td> </tr> <tr> <td>Wh, Wh\pm, Ah, Ah\pm</td> <td colspan="2"> <ul style="list-style-type: none"> • When the unit is MWh or MAh 999999 (-99999 for negative watt hour and ampere hour.) • When the unit is other than MWh or MAh 99999 </td></tr> <tr> <td>TIME</td> <td colspan="2">See "Note" on page 6-8.</td></tr> <tr> <td>Efficiency (WT230 only)</td> <td>0.00 to 999.99</td> <td>0.00 to 999.99</td> </tr> <tr> <td>Crest factor</td> <td>9999</td> <td>9999</td> </tr> <tr> <td>Four arithmetic operation</td> <td>9999</td> <td>9999</td> </tr> <tr> <td>Average active power</td> <td>9999</td> <td>9999</td> </tr> <tr> <td>Voltage peak, current peak</td> <td>9999</td> <td>9999</td> </tr> </table> During harmonic measurement <table border="1"> <tr> <td>Displayed item</td> <td>When the number of displayed digits is 5</td> <td>When the number of displayed digits is 4</td> </tr> <tr> <td>V, A, W</td> <td>99999</td> <td>9999</td> </tr> <tr> <td>PF</td> <td>1.0000 to -1.0000</td> <td>1.000 to -1.000</td> </tr> <tr> <td>V%, A%, W% (relative harmonic content)</td> <td>0.000 to 99.999 to 100.00 to 999.99%</td> <td>0.00 to 99.99 to 100.0 to 999.9%</td> </tr> <tr> <td>V%, A%(THD)</td> <td>0.00 to 99.99 to 100.0 to 999.9%</td> <td>0.00 to 99.99 to 100.0 to 999.9%</td> </tr> <tr> <td>Vdeg, Adeg</td> <td colspan="2"> <ul style="list-style-type: none"> • Phase angle of the 1st order current with respect to the 1st order voltage G180.0 to d180.0 G180.0 to d180.0 • Phase angle of the 2nd order and higher orders of voltage with respect to the 1st order voltage -180.0 to 180.0 -180.0 to 180.0 • Phase angle of the 2nd order and higher orders of current with respect to the 1st order current -180.0 to 180.0 -180.0 to 180.0 </td></tr> </table>			Displayed item	When the number of displayed digits is 5	When the number of displayed digits is 4	V, A, W, VA*, var*	99999	9999	PF*	1.0000 to -1.0000	1.000 to -1.000	deg*	G180.0 to d180.0	G180.0 to d180.0	VHz*, AHZ*	99999	9999	Wh, Wh \pm , Ah, Ah \pm	<ul style="list-style-type: none"> • When the unit is MWh or MAh 999999 (-99999 for negative watt hour and ampere hour.) • When the unit is other than MWh or MAh 99999 		TIME	See "Note" on page 6-8.		Efficiency (WT230 only)	0.00 to 999.99	0.00 to 999.99	Crest factor	9999	9999	Four arithmetic operation	9999	9999	Average active power	9999	9999	Voltage peak, current peak	9999	9999	Displayed item	When the number of displayed digits is 5	When the number of displayed digits is 4	V, A, W	99999	9999	PF	1.0000 to -1.0000	1.000 to -1.000	V%, A%, W% (relative harmonic content)	0.000 to 99.999 to 100.00 to 999.99%	0.00 to 99.99 to 100.0 to 999.9%	V%, A%(THD)	0.00 to 99.99 to 100.0 to 999.9%	0.00 to 99.99 to 100.0 to 999.9%	Vdeg, Adeg	<ul style="list-style-type: none"> • Phase angle of the 1st order current with respect to the 1st order voltage G180.0 to d180.0 G180.0 to d180.0 • Phase angle of the 2nd order and higher orders of voltage with respect to the 1st order voltage -180.0 to 180.0 -180.0 to 180.0 • Phase angle of the 2nd order and higher orders of current with respect to the 1st order current -180.0 to 180.0 -180.0 to 180.0 	
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* The computation accuracy (the value calculated from the measured value) is one-half the display resolution.

16.3 Functions

Item	Specifications
Unit symbols	m, k, M, V, A, W, VA, var, deg, Hz, h \pm , TIME, %
Number of displayed digits	Select 5 or 4 digits
Display update rate	<p>During normal measurement Select 0.1 s, 0.25 s, 0.5 s, 1 s, 2 s, or 5 s.</p> <p>During harmonic measurement Select 0.25 s, 0.5 s, 1 s, 2 s, or 5 s.</p>
Response time	Approx. (display update rate + 100 ms) (The time it takes to reach the accuracy of the final value when the displayed value changed from 0 to 100% or 100 to 0% of the rated range)
Auto range monitor	The indicator illuminates when the input signal meets the conditions for auto range switching.
Overrange display	<p>Overrange “- - oL-” is displayed for the following conditions.</p> <p>During normal measurement When the measured value exceeds 140% of the rated range</p> <p>During harmonic measurement</p> <ul style="list-style-type: none"> • For 600-V range or 20-A range (300 V range or 10 A range if the crest factor is set to 6) When the measured value exceeds 140% of the rated range • For other ranges When the measured value exceeds 200% of the rated range
Hold	Holds the displayed value.
Single update	Updates the displayed value once each time the TRIG key is pressed during Hold.
MAX hold	Holds the maximum displayed value of V, A, W, VA, var, voltage peak, and current peak.

Internal memory

Item	Specifications												
Measured data	<p>Number of stored data points</p> <table border="1" style="margin-left: 20px; margin-top: 10px;"> <thead> <tr> <th>Product</th> <th>Normal measurement</th> <th>Harmonic measurement</th> </tr> </thead> <tbody> <tr> <td>WT210 (single-phase model, 760401)</td> <td>600 blocks</td> <td>30 blocks</td> </tr> <tr> <td>WT230 (three-phase, three-wire model, 760502)</td> <td>300 blocks</td> <td>30 blocks</td> </tr> <tr> <td>WT230 (three-phase, four-wire model, 760503)</td> <td>200 blocks</td> <td>30 blocks</td> </tr> </tbody> </table>	Product	Normal measurement	Harmonic measurement	WT210 (single-phase model, 760401)	600 blocks	30 blocks	WT230 (three-phase, three-wire model, 760502)	300 blocks	30 blocks	WT230 (three-phase, four-wire model, 760503)	200 blocks	30 blocks
Product	Normal measurement	Harmonic measurement											
WT210 (single-phase model, 760401)	600 blocks	30 blocks											
WT230 (three-phase, three-wire model, 760502)	300 blocks	30 blocks											
WT230 (three-phase, four-wire model, 760503)	200 blocks	30 blocks											
	<p>Store interval Display update rate or in the range of 1 s to 99 hrs 59 min 59 s.</p>												
	<p>Recall interval Display update rate or in the range of 1 s to 99 hr 59 min 59 s.</p>												
Setup information	Stores/Recalls four patterns of setup information.												

16.4 External Sensor Input (/EX1 and /EX2 options)

Item	Specifications
Allows input of voltage output type current sensor signal. For detailed input specifications, see section 16.1, "Input."	
Measurement range of the /EX1 option:	
When the crest factor is set to 3: 2.5 V, 5 V, and 10 V	
When the crest factor is set to 6: 1.25 V, 2.5 V, and 5 V	
Measurement range of the /EX2 option:	
When the crest factor is set to 3: 50 mV, 100 mV, and 200 mV	
When the crest factor is set to 6: 25 mV, 50 mV, and 100 mV	

16.5 D/A Output (/DA4, /DA12, and /CMP Options)

Item	Specifications
Output voltage	±5 V FS (approx. ±7.5 V maximum) against each rated value. For the relationship between the output items and output voltage (D/A output voltage), see page 9-8.
Output current	±1 mA
Number of output channels	4 outputs for products with the /DA4 or /CMP option; 12 outputs for products with the /DA12 option.
Output items	Set for each channel.
Accuracy	±(accuracy of each measurement item + 0.2% of FS)
Update rate	Same as the display update rate.
Temperature coefficient	±0.05%/°C of FS

16.6 Comparator Output (/CMP Option)

Item	Specifications
Comparator mode	Select single mode or dual mode.
Output type	Relay contact output (contact structure: 1C contact)
Number of output relays	4 outputs
Type of limit	Set for each relay.
Contact capacity	24 V/0.5 A (rating)

16.7 Remote Control Input/Output Signal (/DA4, /DA12, and /CMP Options)

Item	Specifications
Remote control input signal	EXT HOLD, EXT TRIG, EXT START, EXT STOP, EXT RESET
Remote control output signal	INTEG BUSY
I/O level	TTL
I/O logic format	Negative logic, falling edge

16.8 GP-IB Interface (Standard on -C1, /C1 Option)

Item	Specifications
Electrical and mechanical specifications	Conforms to IEEE Std 488-1978 (JIS C 1901-1987).
Functional specifications	SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0
Protocol	Conforms to IEEE Std 488.2-1992 (Provides communication commands other than those of the IEEE Std 488.2 protocol.)
Code	ISO (ASCII) code
Address	0 to 30
Clear remote mode	Remote mode can be cleared by pressing LOCAL (except during Local Lockout).

16.9 Serial (RS-232-C) Interface (Standard on -C2, /C2 Option)

Item	Specifications
Connector type	D-Sub 25-pin (plug)
Electrical specifications	Conforms to EIA-232 (RS-232)
Connection	Point-to-point
Transmission mode	Full-duplex
Synchronization	Start-stop synchronization
Baud rate	Select from 1200, 2400, 4800, and 9600 bps.

16.10 General Specifications

Item	Specifications
Warm-up time	Approx. 30 minutes
Operating conditions	Temperature: 5 to 40°C Humidity: 20 to 80% RH (no condensation)
Operating altitude	2000 m or less
Storage conditions	Temperature: 25 to 60°C Humidity: 20 to 80% RH (no condensation)
Rated supply voltage	100 to 120 VAC, 200 to 240 VAC
Permitted supply voltage range	90 to 132 VAC, 180 to 264 VAC
Rated supply voltage frequency	50/60 Hz
Permitted supply voltage frequency range	48 to 63 Hz
Maximum power consumption	WT210: 35 VA, WT230: 55 VA
Insulation resistance	50 MΩ or more at 500 VDC Between all voltage input terminals and case Between all current input terminals and output terminals collectively, Between all voltage input terminals and all current input terminals, Between all voltage input terminals of input elements, Between all current input terminals of input elements, Between all voltage input terminals and power supply plug, Between all current input terminals and power supply plug, Between case and power supply plug
Withstand voltage	3700 VAC at 50/60 Hz for one minute Between all voltage input terminals and case Between current input terminals collectively and output terminals collectively, Between all voltage input terminals and all current input terminals, Between all voltage input terminals of input elements, Between all current input terminals of input elements, Between all voltage input terminals and power supply plug, Between all current input terminals and power supply plug 1500 VAC at 50/60 Hz for one minute Between case and power supply plug
Oscillation condition	Sweep test: Sweeps a frequency range of 8 to 150 Hz, 3 directions each, 1 minute reciprocation Endurance test: frequency 16.7 Hz, peak-to-peak amplitude 4 mm, 3 directions each, 2 hours.
Shock condition	Shock test: Acceleration 490 m/s ² , 3 directions each Endurance test: Free fall test Height 100 mm, once on four sides
External dimensions (excluding projections.)	WT210: Approx. 213 (W) × 88 (H) × 379 (D) mm WT230: Approx. 213 (W) × 132 (H) × 379 (D) mm
Weight	WT210: Approx. 3 kg WT230: Approx. 5 kg
Battery backup	Backs up the setup parameters and stored data with the lithium battery.
Standard accessories	<ul style="list-style-type: none"> • Power cord: 1 piece • Spare power fuse : 1 piece (Attached to the fuse holder) • 24-pin connector: 1 piece (included in products with the /DA4, /DA12, and /CMP options) • Current input protection cover: 1 piece (included with the WT210/WT230) • Hind feet rubber: 1 set • User's manual : 1 piece (this manual)

16.10 General Specifications

Item	Specifications
Safety standard ^{*1}	Complying standard EN61010-1 Installation category (overvoltage category) CAT II ^{*2} Measurement Category CAT II ^{*5} Pollution degree 2 ^{*3}
Emission ^{*1}	Complying standard EN61326-1 Class A EN55011 Class A, Group 1 EN61000-3-2 EN61000-3-3 C-tick EN55011 Class A, Group 1 This product is a Class A (for industrial environment) product. Operation of this product in a residential area may cause radio interference in which case the user is required to correct the interference. Cable condition <ul style="list-style-type: none">• Serial (RS-232-C) interface connector Use shielded serial cables^{*4}.• GP-IB interface connector Use shielded GP-IB cables^{*4}.• D/A output terminal Use shielded cables^{*4}.• Connecting cables may cause radio interference in which case the user is required to correct the interference.
Immunity ^{*1}	Complying standard EN61326-1 Table 2 (for use in industrial locations) However, the measured values may receive noise effects. Cable condition Same as the cable condition for emission above.

*1 Applies to products with CE marks. For all other products, contact your nearest YOKOGAWA dealer.

*2 The Overvoltage Category is a value used to define the transient overvoltage condition and includes the impulse withstand voltage regulation. Overvoltage Category II: Applies to equipment supplied with electricity from fixed installations like a distribution board.

*3 Pollution Degree: Applies to the degree of adhesion of a solid, liquid, or gas which deteriorates withstand voltage or surface resistivity. Pollution Degree 1: Applies to closed atmospheres (with no, or only dry, non-conductive pollution). Pollution Degree 2: Applies to normal indoor atmospheres (with only non-conductive pollution).

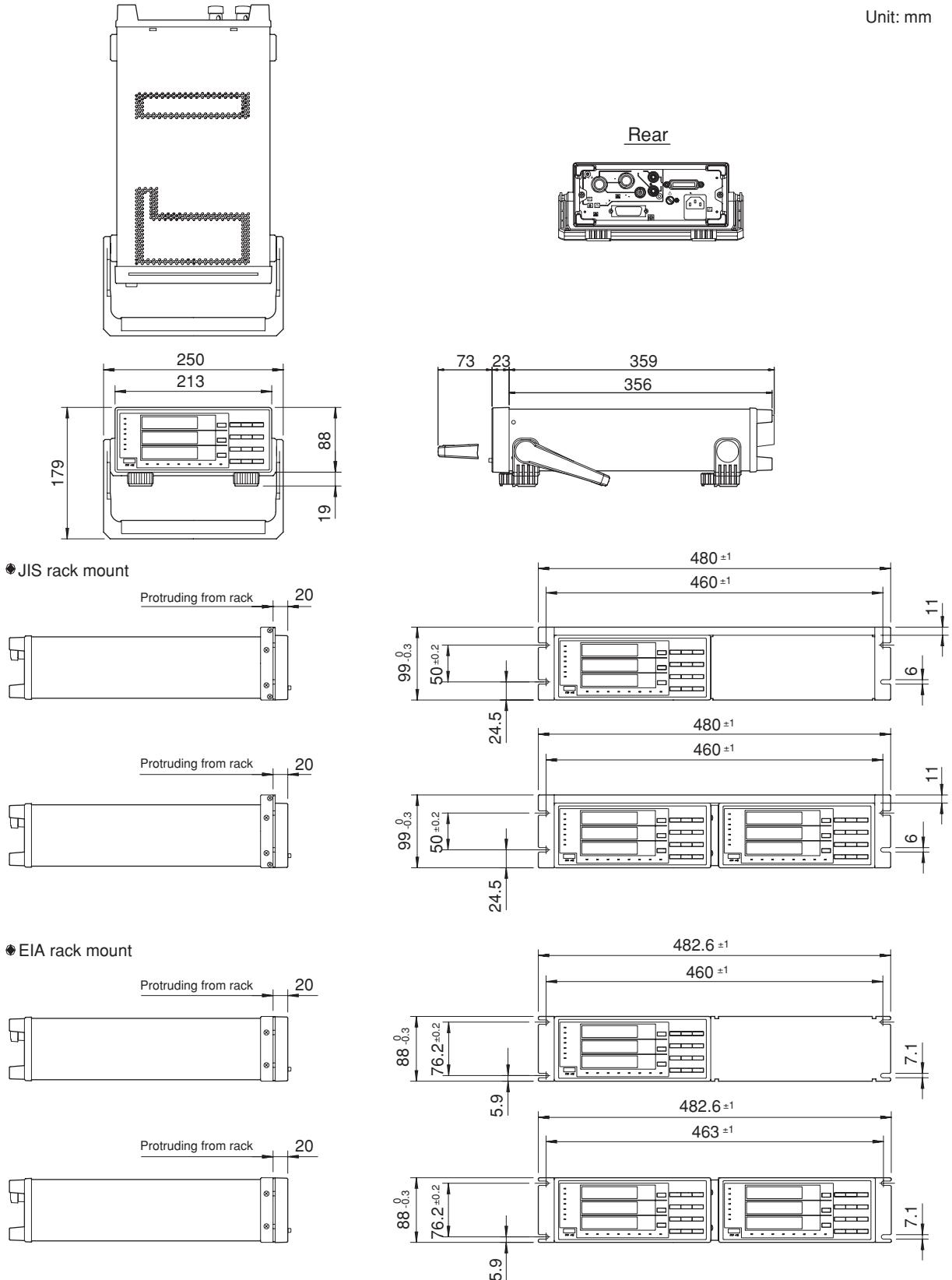
*4 Use cables of length 3 m or less.

*5 Measurement Category II (CAT II) applies to electrical equipment that is powered through a fixed installation such as a wall outlet wired to a distribution board and measurement performed on such wiring.

16.11 Dimensional Drawings

WT210 (Model: 760401)

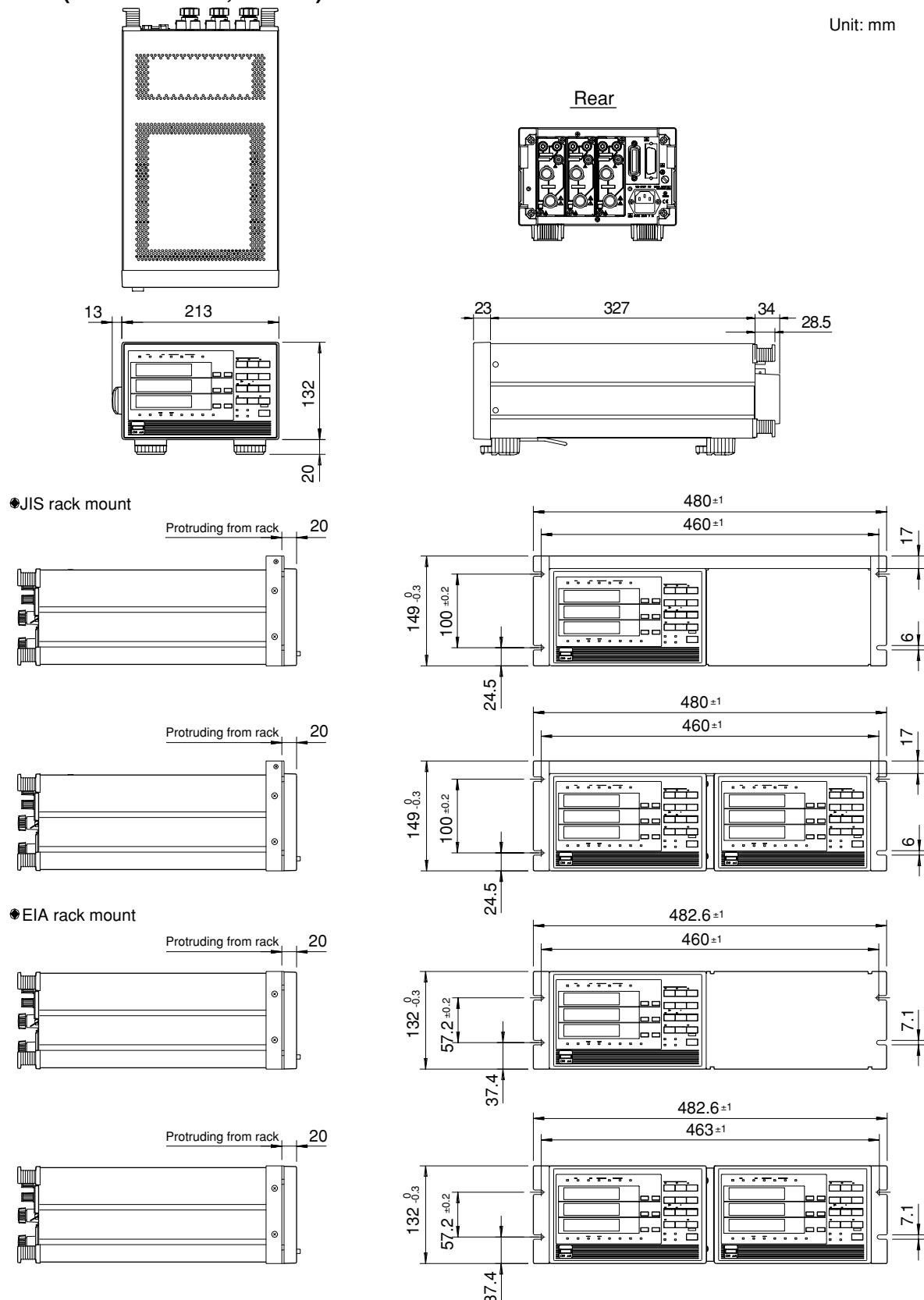
Unit: mm



Unless otherwise specified, tolerance is $\pm 3\%$ (However, tolerance is $\pm 0.3\text{mm}$ when below 10mm)

16.11 Dimensional Drawings

WT230 (Model: 760502, 760503)



Unless otherwise specified, tolerance is $\pm 3\%$ (However, tolerance is $\pm 0.3\text{mm}$ when below 10mm)

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