

**User's
Manual**

**WT310/WT310HC/WT332/WT333
Digital Power Meter
Getting Started Guide**

Product Registration

Thank you for purchasing YOKOGAWA products.

YOKOGAWA provides registered users with a variety of information and services.

Please allow us to serve you best by completing the product registration form accessible from our website.

<http://tmi.yokogawa.com/>

Thank you for purchasing the WT310, WT310HC, WT332, or WT333 Digital Power Meter (hereinafter, "WT300 series" will refer to all of these products). The WT300 series is a power measurement instrument that can measure parameters such as voltage, current, and power.

This getting started guide primarily explains the handling precautions and basic operations of the WT300 series. To ensure correct use, please read this manual thoroughly before beginning operation. Keep this manual in a safe place for quick reference in the event that a question arises.

List of Manuals

The following manuals, including this one, are provided as manuals for the WT300 series. Please read all manuals.

Manual Title	Manual No.	Description
WT310/WT310HC/WT332/WT333 Digital Power Meter User's Manual	IM WT310-01EN	The manual explains all features of this instrument, except for the communication interface features, and how to use them.
WT310/WT310HC/WT332/WT333 Digital Power Meter Getting Started Guide	IM WT310-02EN	This guide. Provided as a printed manual. The manual explains the handling precautions and basic operations of this instrument and provides an overview of its features.
WT310/WT310HC/WT332/WT333 Digital Power Meter Communication Interface User's Manual	IM WT310-17EN	This manual explains the communication interface features of this instrument and how to use them.
WT310/WT310HC/WT332/WT333 Digital Power Meter	IM WT310-92Z1	Document for China

PDF files of all the manuals above are included in the accompanying CD.

The "EN" and "Z1" in the manual numbers are the language codes.

Contact information of Yokogawa offices worldwide is provided on the following sheet.

Document No.	Description
PIM 113-01Z2	List of worldwide contacts

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 functionality. The figures given in this manual may differ from those that actually appear on your 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.
- Copying or reproducing all or any part of the contents of this manual without the permission of YOKOGAWA is strictly prohibited.
- The TCP/IP software of this product and the documents concerning it have been developed/created by YOKOGAWA based on the BSD Networking Software, Release 1 that has been licensed from the Regents of the University of California.

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Revisions

- January 2013 1st Edition
- June 2013 2nd Edition
- January 2016 3rd Edition

Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If the wrong items have been delivered, if items are missing, or if there is a problem with the appearance of the items, contact your nearest YOKOGAWA dealer.

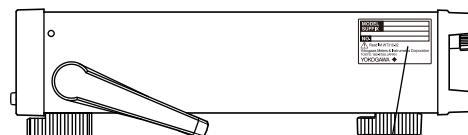
WT310/WT310HC/WT332/WT333 (WT300 series)

Check that the product that you received is what you ordered by referring to the model name and suffix code given on the name plate on the left side panel.

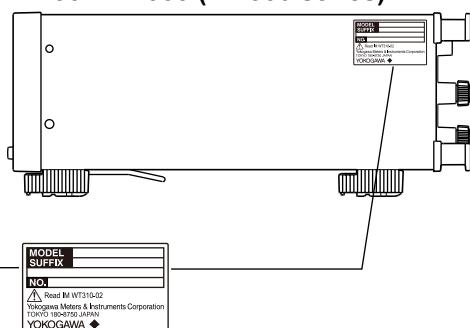
The WT300 series includes the WT310, WT310HC, WT332 and WT333.

The WT330 series includes the WT332 and WT333.

WT310/WT310HC



WT332/WT333 (WT330 series)



Model	Suffix Code	Description
WT310		WT310 Digital Power Meter One input element model
WT310HC		WT310 Digital Power Meter One input element/large current model
WT332		WT330 Digital Power Meter Two input element model
WT333		WT330 Digital Power Meter Three input element model
Power cord ¹	-D -F -Q -R -H -N	UL/CSA Standard power cord (Part No.: A1006WD) Maximum rated voltage: 125 V VDE Standard power cord (Part No.: A1009WD) Maximum rated voltage: 250 V BS Standard power cord (Part No.: A1054WD) Maximum rated voltage: 250 V AS Standard power cord (Part No.: A1024WD) Maximum rated voltage: 250 V GB Standard power cord (Part No.: A1064WD) Maximum rated voltage: 250 V NBR Standard power cord (Part No.: A1088WD) Maximum rated voltage: 250 V
Communication interface (The instrument is equipped with one of these.)	-C1 -C2	GP-IB interface RS-232 interface
Options	/C7 /EX1 ² /EX2 ² /G5 /DA4 /DA12 /US	Ethernet Communication 2.5 V/5 V/10 V external input 50 mV/100 mV/200 mV/500 mV/1 V/2 V external input Harmonic measurement DA output (4CH); for the WT310 or WT310HC DA output (12CH); for the WT332 or WT333 US Package

1 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in.

2 A single instrument cannot have both the /EX1 and /EX2 options.

For products whose suffix code contains "Z," an exclusive manual may be included.

Please read it along with the standard manual.

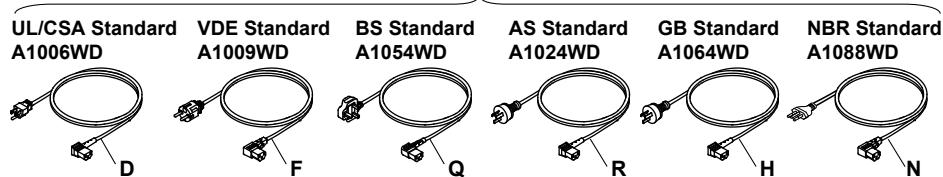
No. (Instrument number)

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

Standard Accessories

The instrument is shipped with the following accessories. Make sure that all accessories are present and undamaged.

Power cord (one cord that matches the suffix code is included)¹



Safety terminal adapter set²
758931



D/A cable³
705926



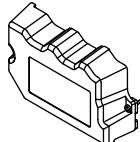
Rubber feet
A9088ZM



Current input protection
cover⁴
B8212BX



Current input protection
cover⁵
B8212FX



Manuals⁶

- Printed manuals
- Manual CD

- 1 Make sure that the attached power cord meets the designated standards of the country and area that you are using it in.
- 2 Same number of sets as the number of installed input elements
WT310: One set with one hexagonal socket wrench
WT310HC: One set with one hexagonal socket wrench
WT332: Two sets with one hexagonal socket wrench
WT333: Three sets with one hexagonal socket wrench
For instructions on how to assemble the 758931, see section 2.6.
- 3 Included with models that have D/A output and remote control (/DA4 or /DA12)
- 4 For the WT310/WT310HC
- 5 For the WT332/WT333
- 6 For information on the types of printed manuals and manuals on the CD that are provided, see page i.

Checking the Contents of the Package

CD

The CD contains the data listed below. To view the PDF user's manuals, you need Adobe Reader.

PDFs of the WT300 Series User's Manuals

These manuals are in the Manuals folder.

English

File Name	Manual Title	Manual No.
User's Manual.pdf	WT310/WT310HC/WT332/WT333 Digital Power Meter IM WT310-01EN User's Manual	
Getting Started Guide.pdf	WT310/WT310HC/WT332/WT333 Digital Power Meter IM WT310-02EN Getting Started Guide	
Communication Interface.pdf	WT310/WT310HC/WT332/WT333 Digital Power Meter IM WT310-17EN Communication Interface User's Manual	

Japanese

The PDFs of the Japanese user's manuals are also included on the CD.

Installer for the WTViewerFreePlus Application Software (For the WT300 Series)

- WTViewerFreePlus_Installer.exe
- WTViewerFreePlus (folder)
- YKMUSB (folder)

PDF of the Manual for the WTViewerFreePlus Application Software

These manuals are in the Manuals folder.

English

File Name	Manual Title	Manual No.
WTViewerFreePlus User's Manual.pdf	Application Software WTViewerFreePlus for WT310/ WT310HC/WT332/WT333 User's Manual	IM 760121-02E

Japanese

The PDFs of the Japanese user's manuals are also included on the CD.

WARNING

Never play this CD on an audio CD player. Doing so may cause loss of hearing or speaker damage due to the large sounds that may be produced.

Optional Accessories (Sold separately)

The following optional accessories are available for purchase separately. Use the accessories specified in this manual. Moreover, use the accessories of this product only with Yokogawa products that specify them as accessories.

For information about ordering accessories, contact your nearest YOKOGAWA dealer.

Item	Model/ Part No.	Min. Q'ty	Note
External sensor cable	B9284LK	1	For connecting to the external current sensor input terminal of this instrument. Length: 0.5 m.
Measurement lead	758917	1	Two leads in one set. Used with the 758922 or 758929 adapter (sold separately). Length: 0.75 m. Rated voltage: 1000 V. ¹
Safety terminal adapter set	758923	1	Two pieces in one set. Rated voltage 600 V. ¹
	758931	1	Two pieces in one set. Rated voltage 1000 V. ¹²
Alligator clip adapter set	758922	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage 300 V. ¹
	758929	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage 1000 V. ¹
Fork terminal adapter set	758921	1	Two pieces in one set. For use with measurement lead 758917. Rated voltage 1000 V. ¹ Rated current: 25 A.
Conversion adapter	758924	1	BNC-4 mm socket adapter. Rated voltage: 500 V. ¹

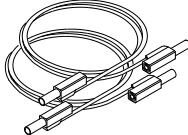
1 The actual voltage that can be used is the lowest voltage of this instrument and cable specifications.

2 For instructions on how to assemble the 758931, see section 2.6.

**External sensor
cable
B9284LK**



**Measurement
lead
758917**



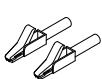
**Safety terminal
adapter set
758923**



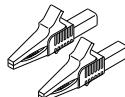
**Safety terminal
adapter set
758931**



**Alligator clip
adapter set
758922**



**Alligator clip
adapter set
758929**



**Fork terminal
adapter set
758921**



**Conversion adapter
758924**



Safety Precautions

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

The general safety precautions described herein 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 assumes no liability for the customer's failure to comply with these requirements.

The WT300 series is a power measurement instrument that can measure parameters such as voltage, current, and power. Do not use this instrument for anything other than its intended purpose.

The following symbols are used on this instrument.

 Warning: handle with care. Refer to the user's manual or service manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions.

 Risk of electric shock

 Ground (earth) or functional ground terminal (do not use this terminal as a protective ground terminal.)

 Alternating current

 Both direct and alternating current

 On (power)

 Off (power)

 On (power) state

 Off (power) state

Failure to comply with the precautions below could lead to injury or death or damage to the instrument.

WARNING

Use the Instrument Only for Its Intended Purpose

The WT300 series is a power measurement instrument that can measure parameters such as voltage, current, and power. Do not use this instrument for anything other than as a power measurement instrument.

Check the Physical Appearance

Do not use the instrument if there is a problem with its physical appearance.

Use the Correct Power Supply

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

Use the Correct 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. Additionally, do not use the power cord supplied with this instrument with another instrument.

Connect the Protective Grounding Terminal

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-prong type power cord. Connect the power cord to a properly grounded three-prong outlet.

Do Not Impair the Protective Grounding

Never cut off the internal or external protective earth wire or disconnect the wiring of the protective earth terminal. Doing so may result in electric shock or damage to the instrument.

Do Not Use When the Protection Functions Are Defective

Before using this instrument, check that the protection functions, such as the protective grounding and fuse, are working properly. If you suspect a defect, do not use the instrument.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or vapors. Doing so is extremely dangerous.

Do Not Remove the Covers or Disassemble or Alter the Instrument

Only qualified YOKOGAWA personnel may remove the covers and disassemble or alter the instrument. The inside of the instrument is dangerous because parts of it have high voltages.

Ground the Instrument before Making External Connections

Securely connect the protective grounding before connecting to the item under measurement or to an external control unit. Before touching a circuit, turn off its power and check that it has no voltage.

Measurement Category

This instrument is a measurement category II product. Do not use it for measurement category III or IV measurements.

Install or Use the Instrument in Appropriate Locations

- Do not install or use the instrument outdoors or in locations subject to rain or water.
- Install the instrument so that you can immediately remove the power cord if an abnormal or dangerous condition occurs.

When Carrying the Instrument

First, turn off the circuit under measurement and remove the measurement cables. Then, turn off the instrument and remove the power cord and any attached cables. When carrying the instrument, use the handle, or use both hands to hold the instrument firmly.

Connect Cables Correctly

Power meters can measure large voltages and currents directly. If you use a voltage transformer or a current transformer together with this power meter, you can measure even larger voltages or currents. When you are measuring a large voltage or current, the power capacity of the item under measurement becomes large. If you do not connect the cables correctly, an overvoltage or overcurrent may be generated in the circuit under measurement. This may lead to not only damage to the power meter and the item under measurement, but electric shock and fire as well. Be careful when you connect the cables, and be sure to check the following points.

Before you begin measuring (before you turn the item under measurement on), check that:

- Cables have been connected to the power meter's input terminals correctly.
Check that there are no voltage measurement cables that have been connected to the current input terminals.
Check that there are no current measurement cables that have been connected to the voltage input terminals.
If you are measuring multiphase power, check that there are no mistakes in the phase wiring.
- Cables have been connected to the power supply and the item under measurement correctly.
Check that there are no short circuits between terminals or between connected cables.
- The cables are connected firmly to the current input terminals.
- There are no problems with the current input terminals and the crimping terminals, such as the presence of foreign substances.

During measurement (never touch the terminals and the connected cables when the item under measurement is on), check that:

- There are no problems with the input terminals and the crimping terminals, such as the presence of foreign substances.
- The input terminals are not abnormally hot.
- The cables are connected firmly to the input terminals.
The terminal connections may become loose over time. If this happens, heat may be generated due to changes in contact resistance. If you are going to take measurements using the same setup for a long time, periodically check that the cables are firmly connected to the terminals. (Be sure to turn both the power meter and the item under measurement off before you check the connections.)

After measuring (immediately after you turn the item under measurement off):

After you measure a large voltage or current, power may remain for some time in the item under measurement even after you turn it off. This remaining power may lead to electric shock, so do not touch the input terminals immediately after you turn the item under measurement off. The amount of time that power remains in the item under measurement varies depending on the item.

Accessories

Use the accessories specified in this manual. Moreover, use the accessories of this product only with Yokogawa products that specify them as accessories.

Do not use faulty accessories.

CAUTION**Operating Environment Limitations**

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.

Sales in Each Country or Region

Waste Electrical and Electronic Equipment

Waste Electrical and Electronic Equipment (WEEE), Directive

(This directive is valid only in the EU.)

This product complies with the WEEE directive marking requirement. This marking indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category

With reference to the equipment types in the WEEE directive, this product is classified as a "Monitoring and control instruments" product.

When disposing products in the EU, contact your local Yokogawa Europe B.V. office.
Do not dispose in domestic household waste.



EU Battery Directive

EU Battery Directive

(This directive is valid only in the EU.)

Batteries are included in this product. This marking indicates they shall be sorted out and collected as ordained in the EU battery directive.

Battery type: Lithium battery

You cannot replace batteries by yourself. When you need to replace batteries, contact your local Yokogawa Europe B.V. office.



Authorized Representative in the EEA

Yokogawa Europe B.V. is the authorized representative of Yokogawa Meters & Instruments Corporation for this product in the EEA. To contact Yokogawa Europe B.V., see the separate list of worldwide contacts, PIM 113-01Z2.

Symbols and Notation Used in This Manual

Units

k: Denotes 1000.

Example: 100 kHz (frequency)

K: Denotes 1024.

Example: 720 KB (file size)

Notes

The notes and cautions in this manual are categorized using the following symbols.



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 user's manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING

Calls attention to actions or conditions that could cause serious or fatal injury 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.

Note

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

Characters That Appear on the 7-Segment LED

Because this instrument uses a 7-segment LED display, numbers, letters, and mathematical symbols are displayed using special characters. For details, see section 1.3, "Digital Numbers and Characters."

Symbols and Conventions Used in Procedural Explanations

The contents of the procedural explanations are indicated using the following symbols.

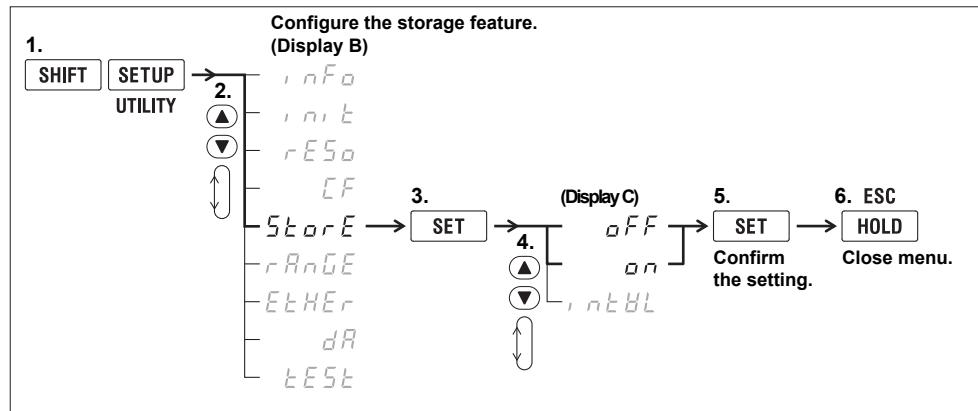
WTViewerFreePlus

This mark appears on the right side of the page to indicate features and settings that can be operated and configured using the WTViewerFreePlus application software, which comes with the instrument.

Procedure

Operations are explained using flowcharts. See the example below for an explanation of how various operations are indicated. All procedures are written under the assumption that you are starting operation at the beginning of the procedure, so you may not need to carry out all the steps in a procedure when you are changing the settings.

Example: Operations for turning the storage feature on and off



The above flow chart indicates the following operations.

You can configure items that are blinking.

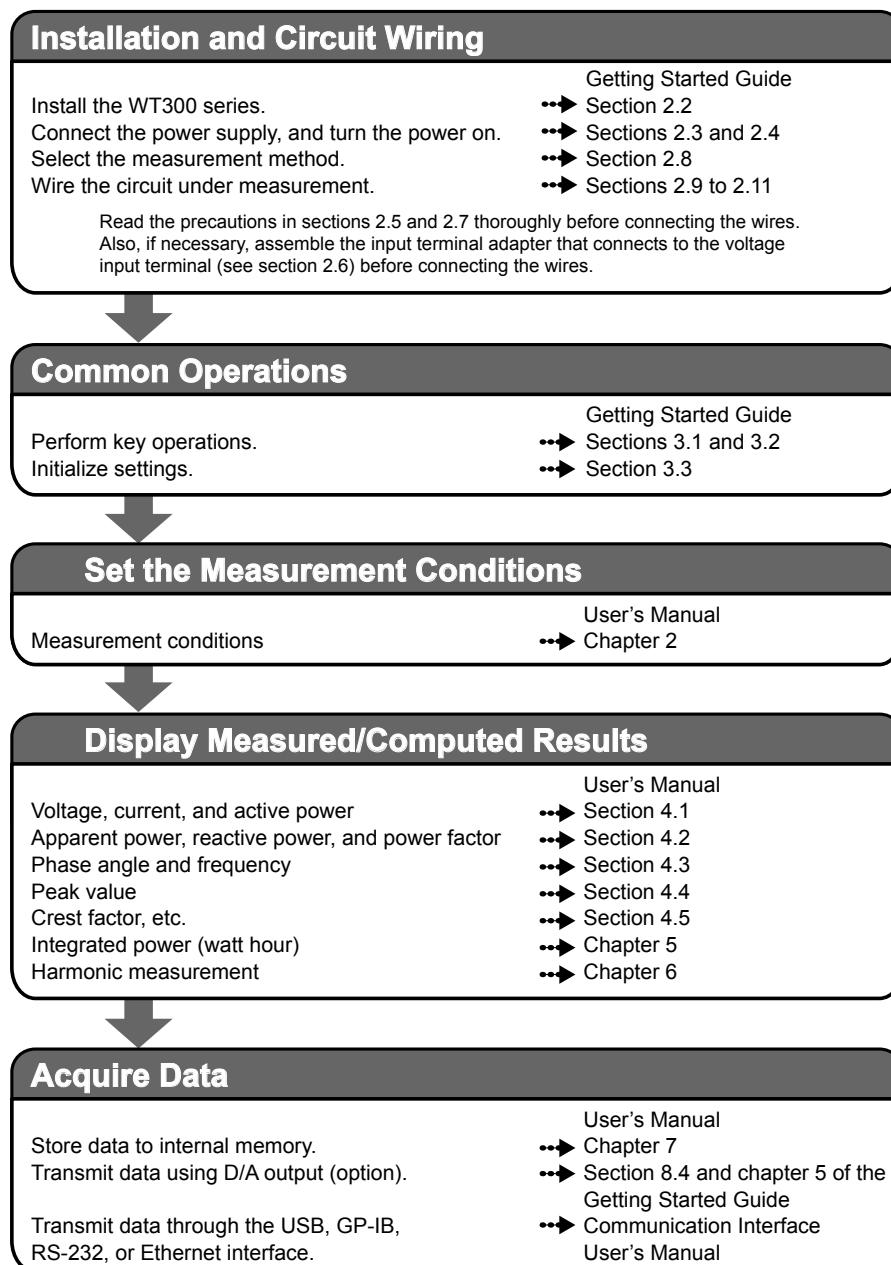
1. Press the **SHIFT** key so that it illuminates, and then press **SETUP (UTILITY)**.
A menu appears in display B.
 2. Use **▲** or **▼** to select **StorE**.
Pressing either key cycles through 9 menu items.
 3. Press **SET** to confirm the selection of **StorE**.
The **StorE** function menu that you selected in step 2 appears in display C.
 4. Use **▲** or **▼** to select **oFF** or **on**.
Pressing either key cycles through 3 menu items.
 5. Press **SET** to confirm the selection of **oFF**.
The selected or set item is confirmed when you press **SET**.
A menu appears in display B.
 6. Press **HOLD (ESC)** to return the menu display to the measurement data display.
- When you are making a number positive (no sign) or negative (–) or setting a number, when the digit in the display that the input will be added to is blank, an underscore flashes at the position of the digit.
 - While you are performing menu operations, to leave the menu display, press **HOLD (ESC)**. All setting changes that you have confirmed by pressing the **SET** key will be reflected in the settings.

Explanation

This section describes the setup items and the limitations regarding the procedures. It may not give a detailed explanation of the feature. For a detailed explanation of the feature, see chapter 1 in the User's Manual, IM WT310-01EN.

Workflow

The figure below is provided to familiarize the first-time user with the workflow of WT300 series operation. For a description of an item, see the relevant section or chapter. In addition to the sections and chapters that are referenced in the figure below, this manual also contains safety precautions for handling and wiring the instrument. Be sure to observe the precautions.



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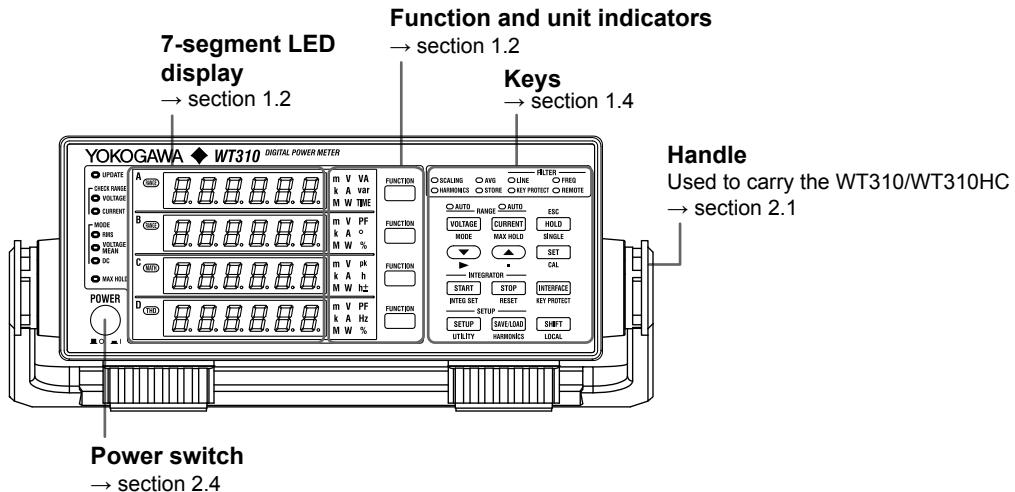
Appendix

Appendix 1	How to Make Accurate Measurements	App-1
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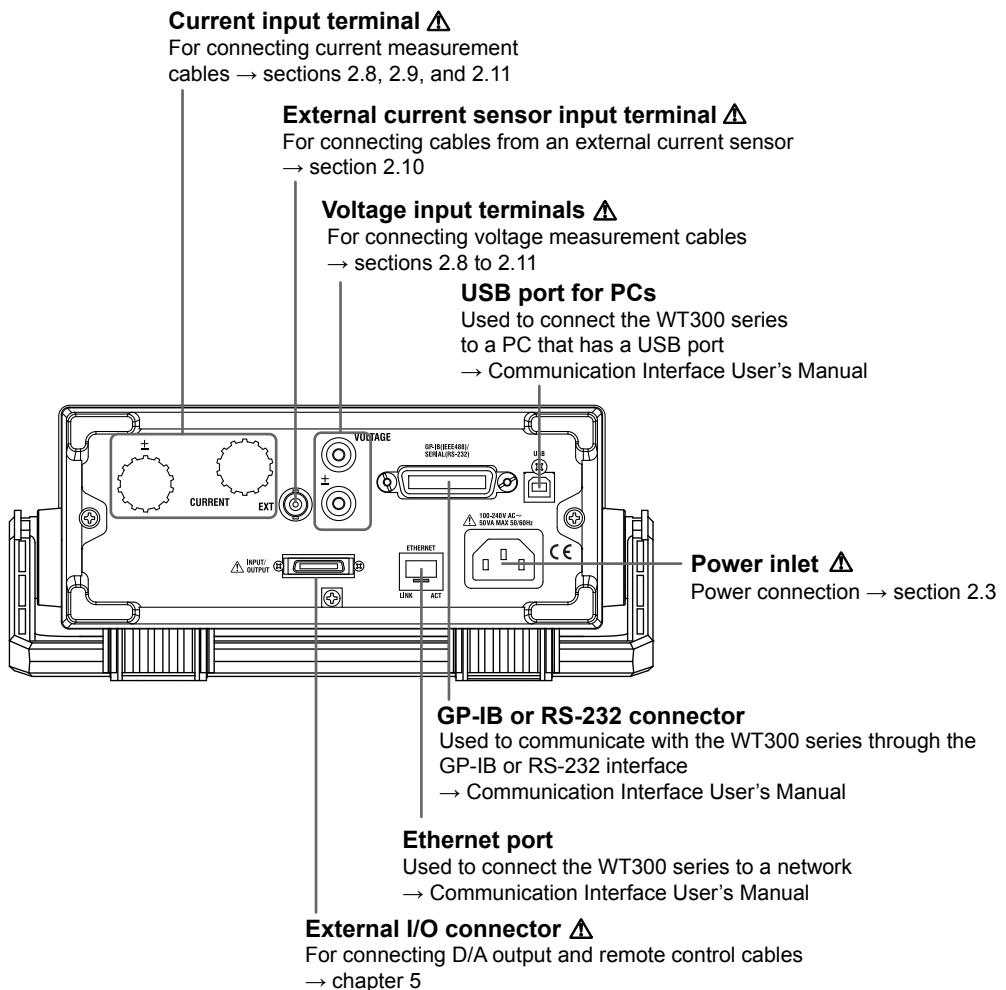
1.1 Front Panel, Rear Panel, and Top Panel

WT310/WT310HC

Front Panel



Rear Panel

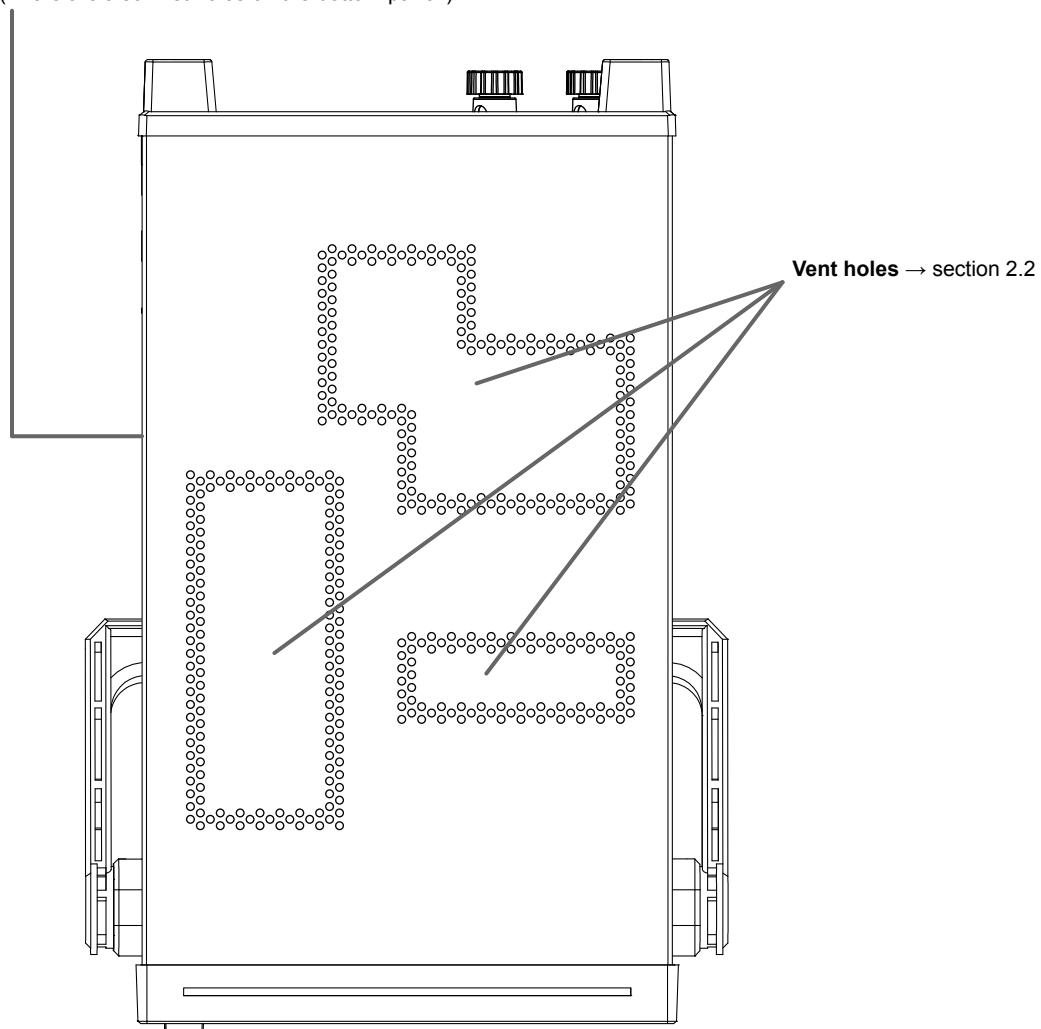


1.1 Front Panel, Rear Panel, and Top Panel

Top Panel

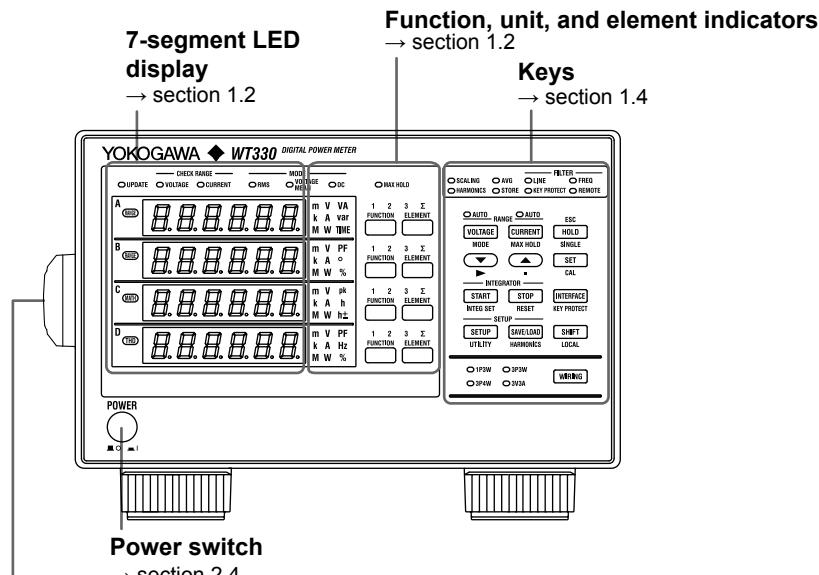
Inlet holes → section 2.2

(There are also inlet holes on the bottom panel.)



1.1 Front Panel, Rear Panel, and Top Panel

WT332/WT333 (WT330 series) Front Panel

**Handle**

Used to carry the WT332/WT333
→ section 2.1

Rear Panel

Current input terminal △

For connecting current measurement cables
→ sections 2.8, 2.9, and 2.11

External current sensor input terminal △

For connecting cables from an external current sensor
→ section 2.10

Voltage input terminals △

For connecting voltage measurement cables
→ sections 2.8 to 2.11

GP-IB or RS-232 connector

Used to communicate with the WT300 series through the GP-IB or RS-232 interface
→ Communication Interface User's Manual

Ethernet port

Used to connect the WT300 series to a network
→ Communication Interface User's Manual

External I/O connector △

For connecting D/A output and remote control cables
→ chapter 5

Power inlet △

Power connection → section 2.3

USB port for PCs

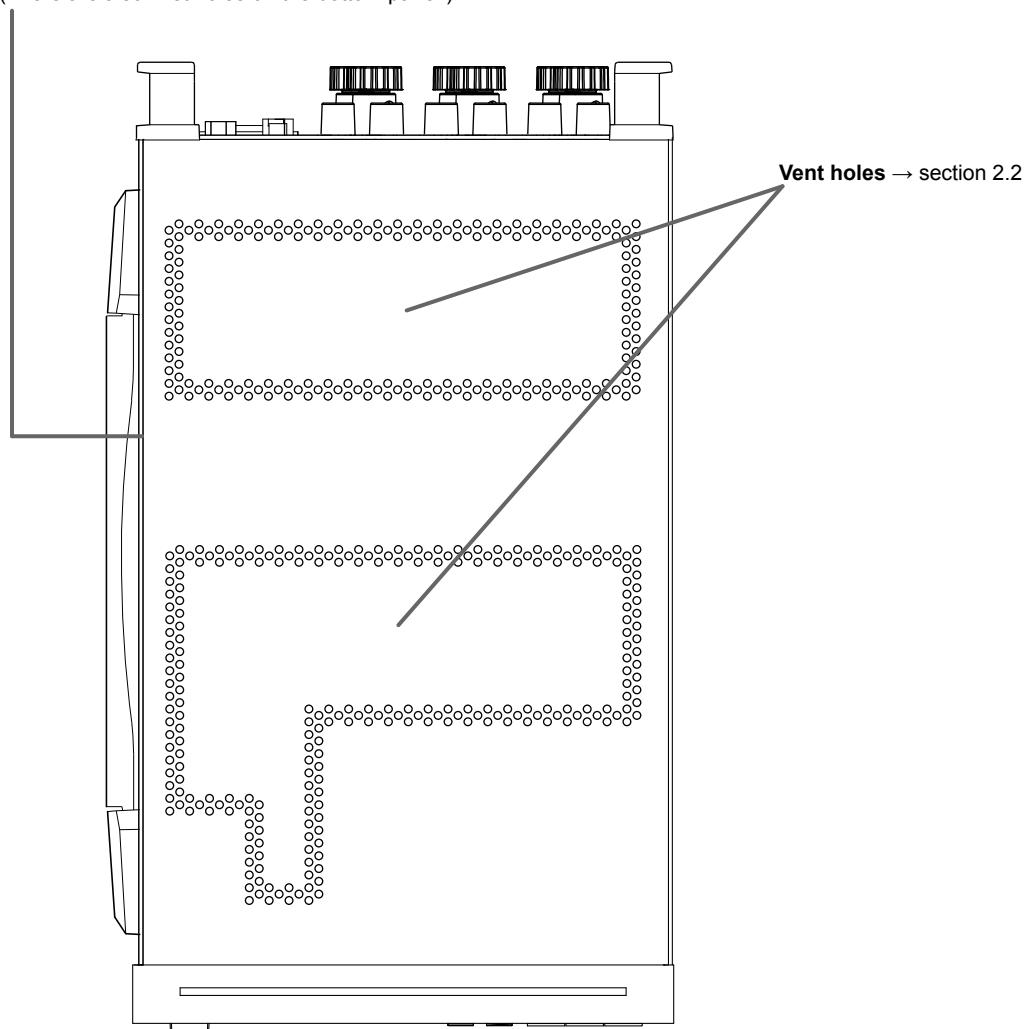
Used to connect the WT300 series to a PC that has a USB port
→ Communication Interface User's Manual

1.1 Front Panel, Rear Panel, and Top Panel

Top Panel

Inlet holes → section 2.2

(There are also inlet holes on the bottom panel.)



1.2 Displayed Items

WT310/WT310HC

Data update indicator (UPDATE)

Blinks when measurement data is being updated.

Auto range monitor (CHECK RANGE)

Lights when an input signal meets the conditions for auto range switching

Measurement mode indicator (MODE)

Indicates the voltage and current measurement modes

MAX HOLD indicator (MAX HOLD)

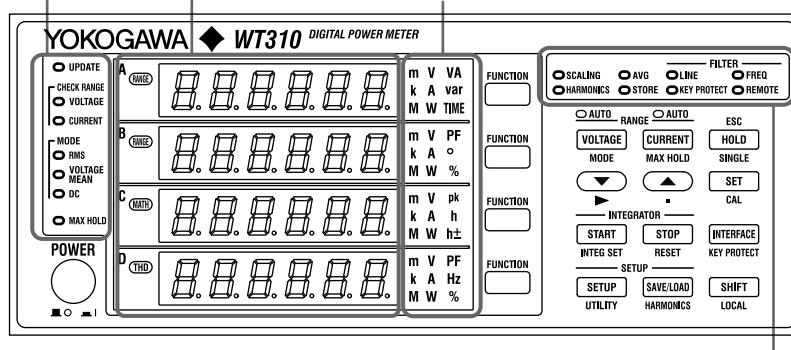
Lights when MAX HOLD is enabled

7-segment LED display

Displays the measured data for the function that you select using the function key and displays menus when you are using menus to configure the settings

Function and unit indicators

Indicates the type of function and unit that are being shown on the 7-segment LED display



Scaling indicator (SCALING)

Lights when scaling is enabled

Averaging indicator (AVG)

Lights when averaging is enabled

Line filter indicator (FILTER-LINE)

Lights when the line filter is enabled

Frequency filter indicator (FILTER-FREQ)

Lights when the frequency filter is enabled

Harmonic measurement display indicator (HARMONICS)

Lights when the harmonic measurement display is on

Storage indicator (STORE)

When you start storage, this indicator blinks at the pace at which storage is taking place.

Key protection indicator (KEY PROTECT)

Lights when the keys are locked

Remote indicator (REMOTE)

Lights when the WT310/WT310HC is in remote mode

1.2 Displayed Items

WT332/WT333 (WT330 series)

Data update indicator (UPDATE)

Blinks when measurement data is being updated.

Auto range monitor (CHECK RANGE)

Lights when an input signal meets the conditions for auto range switching

Measurement mode indicator (MODE)

Indicates the voltage and current measurement modes

MAX HOLD indicator (MAX HOLD)

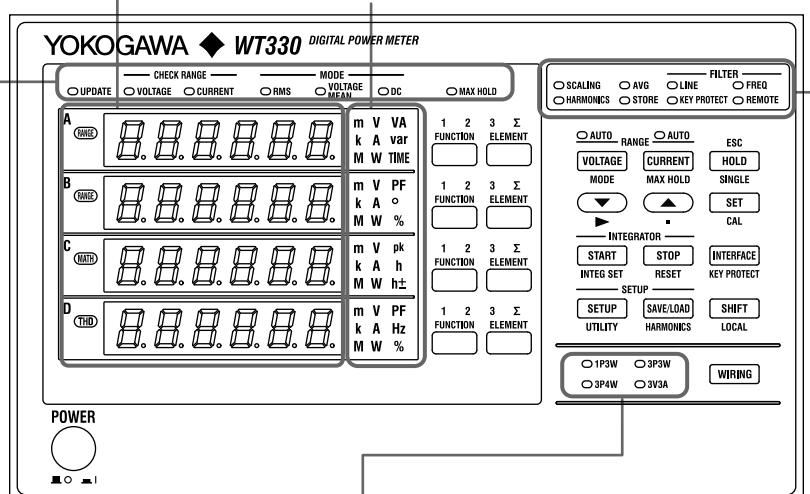
Lights when MAX HOLD is enabled

7-segment LED display

Displays the measured data for the function that you select using the function key and displays menus when you are using menus to configure the settings

Function and unit indicators

Indicates the type of function and unit that are being shown on the 7-segment LED display



Wiring method indicator

Indicates the wiring method

Scaling indicator (SCALING)

Lights when scaling is enabled

Averaging indicator (AVG)

Lights when averaging is enabled

Line filter indicator (FILTER-LINE)

Lights when the line filter is enabled

Frequency filter indicator (FILTER-FREQ)

Lights when the frequency filter is enabled

Harmonic measurement display indicator (HARMONICS)

Lights when the harmonic measurement display is on

Storage indicator (STORE)

When you start storage, this indicator blinks at the pace at which storage is taking place.

Key protection indicator (KEY PROTECT)

Lights when the keys are locked

Remote indicator (REMOTE)

Lights when the WT332/WT333 is in remote mode

1.3 Digital Numbers and Characters

Because this instrument uses a 7-segment LED display, numbers, letters, and mathematical symbols are displayed using special characters in the manner shown below. Some of the characters shown below are not used by this instrument.

$0 \rightarrow \text{O}$	$A \rightarrow R$	$K \rightarrow U$	$U \rightarrow u$	\wedge (exponentiation) $\rightarrow ^n$
$1 \rightarrow \text{l}$	$B \rightarrow b$	$L \rightarrow L$	$V \rightarrow V$	
$2 \rightarrow \text{Z}$	$C \rightarrow L$ Lowercase c $\rightarrow L$	$M \rightarrow n$	$W \rightarrow w$	
$3 \rightarrow \text{J}$	$D \rightarrow d$	$N \rightarrow n$	$X \rightarrow x$	
$4 \rightarrow \text{Y}$	$E \rightarrow E$	$O \rightarrow o$	$Y \rightarrow y$	
$5 \rightarrow \text{S}$	$F \rightarrow F$	$P \rightarrow P$	$Z \rightarrow z$	
$6 \rightarrow \text{G}$	$G \rightarrow G$	$Q \rightarrow Q$	$+ \rightarrow +$	
$7 \rightarrow \text{H}$	$H \rightarrow H$ Lowercase h $\rightarrow h$	$R \rightarrow r$	$- \rightarrow -$	
$8 \rightarrow \text{B}$	$I \rightarrow i$	$S \rightarrow S$	$\times \rightarrow \times$	
$9 \rightarrow \text{G}$	$J \rightarrow J$	$T \rightarrow T$	$\div \rightarrow \div$	

1.4 Keys

Switching the Display

FUNCTION Key

Choose which function to display.

ELEMENT Key (Only on the WT332/WT333)

Choose which input element to display. The indicator of the selected element lights.

WT310/WT310HC



WT332/WT333



Measurement Range and Mode

VOLTAGE Key

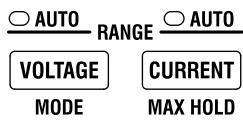
Displays the voltage range setting menu. The AUTO indicator lights when the range is set to AUTO.

CURRENT Key

Displays the current range setting menu. The AUTO indicator lights when the range is set to AUTO.

SHIFT+VOLTAGE (MODE) Key

Switches the measurement mode.



Wiring System

WIRING Key (Only on the WT332/WT333)

Select the wiring system that corresponds to the wiring system you are using to connect to the voltage and current terminals on the rear panel.

1P3W 3P3W

3P4W 3V3A

WIRING

Display Hold/MAX Hold

SHIFT+CURRENT (MAX HOLD) Key

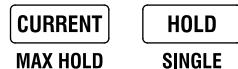
Turns the MAX hold feature on and off. When the MAX hold feature is on, the MAX HOLD indicator lights.

HOLD Key

Switches from updating the display after each data update interval to stopping the series of display operations and holding the display of the numeric data. The HOLD key lights. If you press HOLD again, the data starts getting updated again, and the HOLD key light turns off.

SHIFT + HOLD Key

While the numeric data is held, press SINGLE to measure data only once at the set data update interval and then update and hold the displayed values.



General-Purpose Keys

▲ and ▼ Keys

Select features and set values.

SHIFT+▼ (►) Key

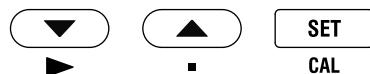
Moves the digit that is being set in a value to the right (or from the farthest right position back to the farthest left position)

SHIFT+▲ (.) Key

Moves the decimal point to the right (or from the farthest right position back to the farthest left position)

SET Key

Confirms the specified range, feature, or value



Zero-Level Compensation

SHIFT+SET Key (CAL)

Executes zero-level compensation. When zero-level compensation is executed, the WT300 series creates a zero input condition in its internal circuitry and sets the zero level to the level at that point.



Integrated Power (Watt hour)

START Key

Starts integration

STOP Key

Stops integration

SHIFT+START (INTEG SET) Key

Displays a menu for setting the integration mode, timer, and rated integration time

SHIFT+STOP Key (RESET)

Resets the integrated value and the elapsed integration time.



Communication Interface

INTERFACE Key

Displays the communication interface setting menu and connection information



Key Lock

SHIFT+INTERFACE (KEY PROTECT) Key

Turns key protection on and off.

The key protection indicator lights, and the front panel keys are locked. Press this key combination again to unlock the keys.



Other Features

SETUP Key

Set the measurement synchronization source, input filter, scaling, external current sensor input, averaging, computation, data update interval, etc.

SAVE/LOAD Key

Save or load setup data.

SHIFT+SETUP (UTILITY) Key

Displays a menu for displaying system information (model information, suffix code, instrument number, and firmware version), initializing settings, setting the number of displayed digits, performing self-tests, and configuring crest factor, storage, network, and D/A output settings.

SHIFT+SAVE/LOAD (HARMONICS) Key

Displays a setting menu for turning the harmonic measurement display on and off, setting the PLL source, etc.

SHIFT Key

When you press the SHIFT key once, an indicator illuminates, and you can access the features that are written in purple below each key. Pressing the key again disables the shifted state. Holding the key for at least two seconds enables SHIFT lock.

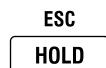
SHIFT (LOCAL) Key

Press this key to switch from remote mode (in which the REMOTE indicator is illuminated) to local mode (in which front panel key operations are valid). This key is disabled when the WT300 series is in local lockout mode.



ESC Key

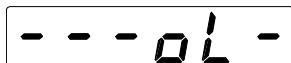
Pressing this key when a setup menu is showing returns the screen to the waveform data display.



1.5 Auto Range, OVERRANGE, and Error Indications During Measurement

OVERRANGE INDICATION

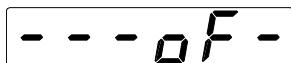
The measured voltage and rated current values are determined to be overrange when they exceed 140% of their rated range.* When auto range is enabled, the range is automatically increased, but if a value exceeds 140% of its maximum range, it is determined to be overrange, and the following indication appears.



- * On the WT310HC, the current is determined to be overrange when it exceeds 110% of the maximum current range (40 A range).

COMPUTATION OVERFLOW INDICATION

If a computed value cannot be displayed using the specified decimal place or unit, the following indication appears.



Auto Range Monitor Indications

When an input signal meets the conditions for auto range switching, an indicator lights.

WT310/WT310HC



WT332/WT333



Colors and Meanings of Auto Range Monitor Indicators

Color	Description
Red	Peak overrange
Magenta	Greater than 140% of the rated range (overrange) ¹
Yellow	Greater than 130% of the rated range and not more than 140% (condition for raising the auto range) ²
Cyan	30% or less of the rated range (condition for reducing the auto range) If the range is already at the minimum measurement range, this indicator will not light even when values are 30% or less of the rated range.

- 1 On the WT310HC, the current is determined to be overrange when it exceeds 110% of the maximum current range (40 A range).
- 2 On the WT310HC, the current is determined to be overrange when it exceeds 100% of the maximum current range (40 A range).

Indications When the Measured Value Is Too Small

When the measured voltage or current is 0.5% or less of the rated range (1% or less when the crest factor is set to 6), the following indications appear. These indications only appear when the measurement mode is RMS or VOTLAGE MEAN.

Function	Indication
Voltage, current, apparent power, or reactive power	A zero appears.
Power factor or phase angle	Error

Measurement Suspension/No Data Indication (Dashes)

When the measurement range, function, or element is switched and the displayed contents change or when there is no data to display, the following dashes are displayed temporarily.



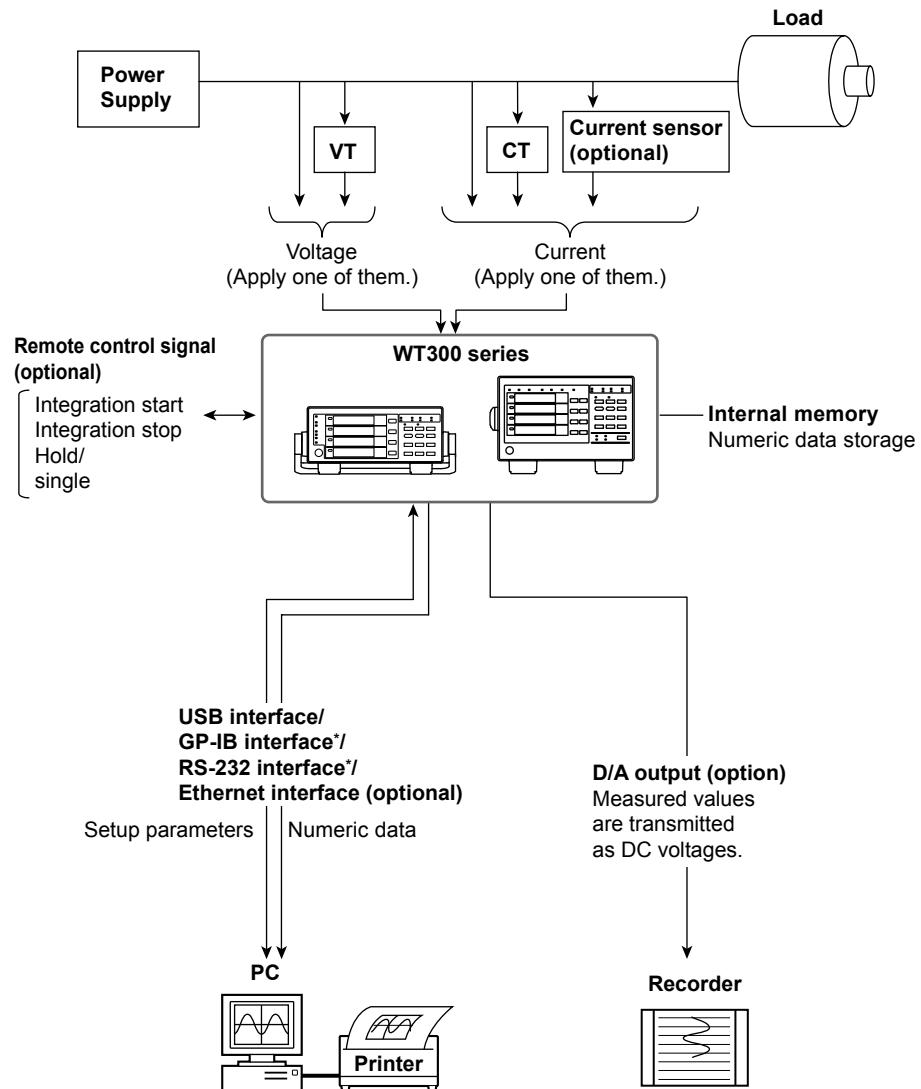
1.5 Auto Range, OVERRANGE, and Error Indications During Measurement

Error

Displayed in cases such as when a measured value is outside of its determined range.



1.6 System Configuration



* The WT300 series is standard-equipped with a GP-IB or RS-232 interface (whichever you choose).

2.1 Handling Precautions

Safety Precautions

If you are using this instrument for the first time, make sure to read "Safety Precautions" on pages vi to viii.

Do Not Remove the Case

Do not remove the case from the instrument. Some parts of the instrument use high voltages and are extremely dangerous. For internal inspection and adjustment, contact your nearest YOKOGAWA dealer.

Unplug If Abnormal Behavior Occurs

If you notice smoke or unusual odors coming from the instrument, immediately turn off the power and unplug the power cord. Also, turn off the power to any circuits under measurement that are connected to the input terminals. Then, contact your nearest YOKOGAWA dealer.

Do Not Damage the 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 removing the plug from the power outlet, do not pull on the cord. Pull from the plug. If the power cord is damaged, purchase a replacement with the same part number as the one indicated on page iii.

General Handling Precautions

Do Not Place Objects on Top of the Instrument

Never stack the instrument or place other instruments or any objects containing water on top of it. Doing so may damage the instrument.

Keep Electrically Charged Objects Away from the Instrument

Keep electrically charged objects away from the input terminals. They may damage the internal circuitry.

Unplug during Extended Non-Use

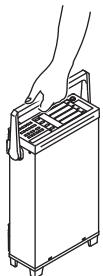
Turn off the power to the circuit under measurement and the instrument and remove the power cord from the outlet.

2.1 Handling Precautions

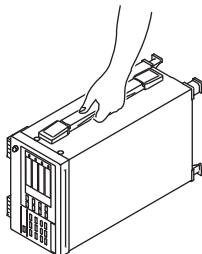
When Carrying the Instrument

First, turn off the circuit under measurement and remove the measurement cables. Then, turn off the instrument and remove the power cord and any attached cables. When carrying the instrument, use the handle as shown in the following figure, or use both hands to hold the instrument firmly.

WT310/WT310HC



WT332/WT333



When Cleaning the Instrument

When cleaning the case or the operation panel, turn off the circuit under measurement and the instrument and remove the instrument's power cord from the outlet. Then, wipe the instrument lightly with a clean dry cloth. Do not use chemicals such as benzene or thinner. Doing so may cause discoloring and deformation.

2.2 Installing the Instrument

Installation Conditions

WARNING

- Do not install the instrument outdoors or in locations subject to rain or water.
- Install the instrument so that you can immediately remove the power cord if an abnormal or dangerous condition occurs.

Install the instrument in an indoors environment that meets the following conditions.

Flat, Even Surface

Use the instrument on a stable surface that is level in all directions. If you use the instrument on an unstable or tilted surface, the accuracy of its measurements may be impeded.

Well-Ventilated Location

Inlet and vent holes are located on the top and bottom of the instrument. To prevent internal overheating, allow at least 20 mm of space around the inlet and vent holes.

When connecting measurement wires and other various cables, allow extra space for operation.



CAUTION

If you block the inlet or outlet holes on the instrument, it will become hot and may break down.

Ambient Temperature and Humidity

Ambient temperature: 5 to 40°C

Ambient humidity: 20 to 80% RH
(No condensation)

Do Not Install the Instrument in the Following Places

- Outdoors.
- In direct sunlight or near heat sources.
- Where the instrument is exposed to water or other liquids.
- Where an excessive amount of soot, steam, dust, or corrosive gas is present.
- Near strong magnetic field sources.
- Near high voltage equipment or power lines.
- Where the level of mechanical vibration is high.
- On an unstable surface.

Note

- For the most accurate measurements, use the instrument in the following kind of environment.

Ambient temperature: 23°C ± 5°C Ambient humidity: 30% RH to 75% RH (no condensation)

When using the instrument in a place where the ambient temperature is 5°C to 18°C or 28°C to 40°C, add the temperature coefficient to the accuracy as specified in chapter 7.

- When installing the instrument in a place where the ambient humidity is 30% or less, 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 or humidity is higher, or if the temperature changes rapidly. In these kinds of circumstances, wait for at least an hour before using the instrument, to acclimate it to the surrounding temperature.

2.2 Installing the Instrument

Storage Location

- Ambient temperature: -25 to 60°C (no condensation)
- Ambient humidity: 20 to 80% RH (no condensation)

Do not store the instrument:

- Where the level of mechanical vibration is high
- In direct sunlight
- Where there are corrosive or explosive gasses
- Where an excessive amount of soot, dust, salt, or iron is present
- Near a strong source of heat or moisture
- Where water, oil, or chemicals may splash onto the instrument

We recommend that the instrument be stored in an environment where the temperature is between 5°C and 40°C and the relative humidity is between 20% RH and 80% RH.

Installation Position

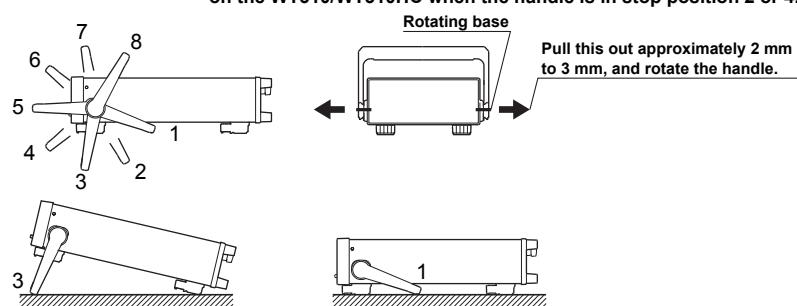
Desktop

Place the instrument in a horizontal position or tilt it on its handle or movable legs. Place the instrument on a flat, level surface as shown in the figure below.

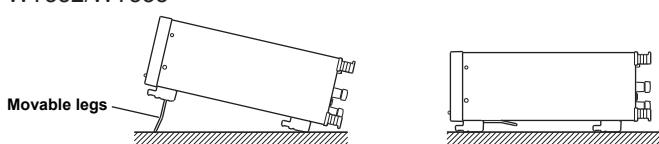
- WT310/WT310HC

To use the handle as a stand to tilt the instrument, first check that the handle is fixed in place, and then position the instrument. To rotate the handle, first pull the handle's rotary axis out approximately 2 mm to 3 mm on both the left and right sides of the instrument, and then rotate it slowly to one of its stop positions.

Handle stop positions (We recommend that you use positions 1, 3, 5, and 8. Do not place a heavy load on the WT310/WT310HC when the handle is in stop position 2 or 4.)



- WT332/WT333



WARNING

- When adjusting the WT310/WT310HC handle, be careful not to injure your hand with the edges of the handle.
- When you put away the handle or movable legs, be careful not to get your hand caught between the handle or movable legs and the instrument.
- Handling the movable legs or handle without firmly supporting the instrument can be dangerous. Please take the following precautions.
 - Only handle the movable legs or handle when the instrument is on a stable surface.
 - Do not handle the movable legs or handle when the instrument is tilted.
 - Do not place the instrument in any position other than those shown in the above figures.

2.2 Installing the Instrument

Rubber Feet

If the instrument is installed so that it is flat as shown in the above figure, rubber stoppers can be attached to the feet to prevent the instrument from sliding. One set of rubber stoppers (two stoppers) are included in the package.

Rack Mounting

To mount the instrument on a rack, use a rack mount kit (sold separately).

- For the WT310/WT310HC

Item	Model	Note
Rack mount kit	751533-E2	For EIA single mount
Rack mount kit	751533-J2	For JIS single mount
Rack mount kit	751534-E2	For EIA dual mount
Rack mount kit	751534-J2	For JIS dual mount

- For the WT332/WT333

Item	Model	Note
Rack mount kit	751533-E3	For EIA single mount
Rack mount kit	751533-J3	For JIS single mount
Rack mount kit	751534-E3	For EIA dual mount
Rack mount kit	751534-J3	For JIS dual mount

A summary of the procedure for mounting the instrument on a rack is given below. For detailed instructions, see the manual that is included with the rack mount kit.

- Remove the handle from the instrument.

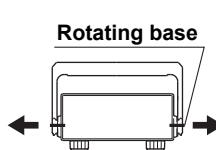
- WT310/WT310HC

Rotate the handle to position 8 (see the figure on the previous page), and then pull out the rotating base of the handle by approximately 10 mm on both sides.

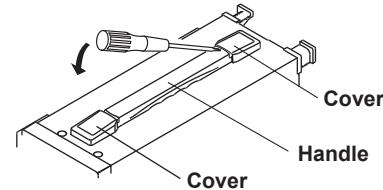
- WT332/WT333

Remove the handle attachment section cover, and remove the handle attachment screws.

WT310/WT310HC



WT332/WT333



For detailed instructions for the procedures below, see the manual that is included with the rack mount kit.

- Remove the feet from the bottom of the instrument.
- Peel off the seals over the rack mount attachment holes on both side panels of the instrument, and pull out the rubber rivets.
- Place seals over the feet and handle attachment holes.
- Attach the rack mount kit to the instrument.
- Mount the instrument on a rack.

Note

- When rack-mounting the instrument, allow at least 20 mm of space around the inlet and exhaust holes to prevent internal heating.
- Make sure to provide adequate support from the bottom of the instrument. The support should not block the inlet and vent holes.

2.3 Connecting the Power Supply

Before Connecting the Power Supply

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



WARNING

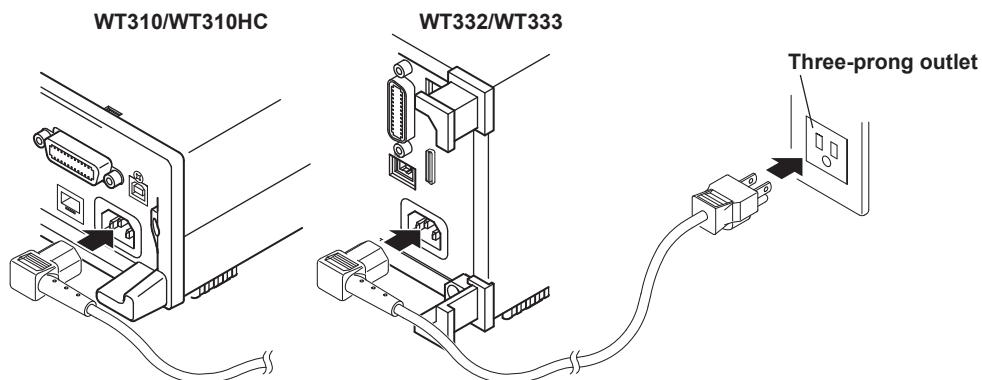
- Make sure that the power supply voltage matches the instrument's rated supply voltage and that it does not exceed the maximum voltage range specified for the power cord.
- Connect the power cord after checking that the power switch of the instrument is turned OFF.
- To prevent fire and electric shock, only use a power cord supplied by YOKOGAWA.
- To avoid electric shock, be sure to ground the instrument. Connect the power cord to a three-prong power outlet with a protective earth terminal.
- Do not use an ungrounded extension cord. If you do, the instrument will not be grounded.
- If an AC outlet that conforms to the supplied power cord is unavailable and you cannot ground the instrument, do not use the instrument.

Connecting the Power Cord

1. Check that the instrument's power switch is off.
2. Connect the power cord plug to the power inlet on the rear panel of the instrument.
3. Connect the other end of the cord to an outlet that meets the following conditions. Use a grounded three-prong outlet.

Item	Specification
Rated supply voltage	100 VAC to 120 VAC, 200 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 132 VAC, 180 VAC to 264 VAC
Rated power supply frequency	50/60 Hz
Permitted supply frequency range	48 Hz to 63 Hz
Maximum power consumption	WT310/WT310HC: 50 VA, WT332/WT333: 70 VA

* This instrument can use a 100 V or a 200 V power supply. The maximum rated voltage differs according to the type of power cord. Before you use the instrument, check that the voltage supplied to it is less than or equal to the maximum rated voltage of the power cord provided with it (see page v for the maximum voltage rating).



2.4 Turning the Power Switch On and Off

Before Turning On the Power, Check That:

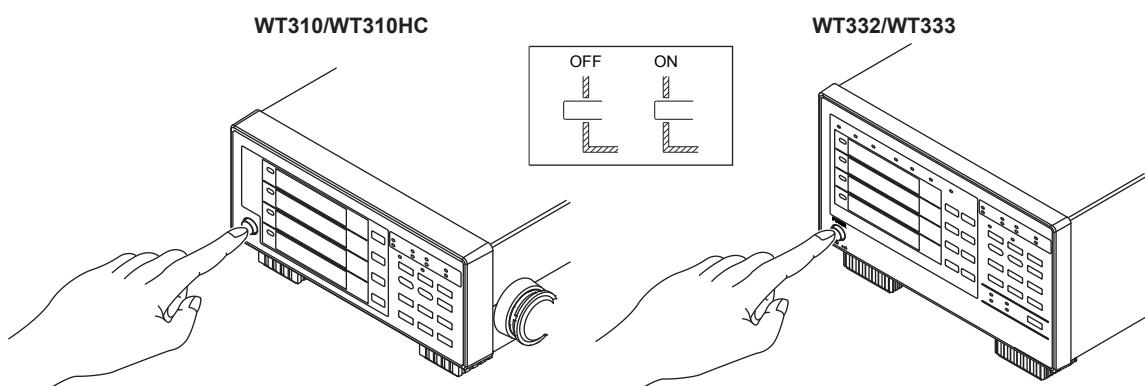
- The instrument is installed properly. → section 2.2, “Installing the Instrument”
- The power cord is connected properly. → section 2.3, “Connecting the Power Supply”

Power Switch Location

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

Turning the Power Switch On and Off

The power switch is a push button. Press the button once to turn the instrument on and press it again to turn the instrument off.



Operations Performed When the Power Is Turned On

When the power switch is turned on, a self-test starts automatically. When the self-test completes successfully, the screen that was displayed immediately before the power was turned off appears.

Note

- After turning the power off, wait at least 10 seconds before you turn it on again.

When the Power-on Operation Does Not Finish Normally

- If the instrument does not operate as described above when the power switch is turned on, turn the power switch off, and then:
 - Check that the power cord is securely connected.
 - Check that the correct voltage is coming to the power outlet. → section 2.3, “Connecting the Power Supply”
 - After checking the above, try turning on the power while holding down SET to initialize the settings (reset them to their factory defaults). For details about initializing the settings, see section 3.3, “Initializing Settings.”
- If the instrument still does not work properly, contact your nearest YOKOGAWA dealer for repairs.
- If an error code is displayed, see section 6.2, “Error Code Descriptions and Corrective Actions,” and take the appropriate actions.
- It may take a few seconds for the startup message to appear.

To Make Accurate Measurements

- Allow the instrument to warm up for at least 30 minutes after turning on the power switch.
- After the instrument warms up, execute zero-level compensation. → section 8.3 of the User’s Manual, IM WT310-01EN

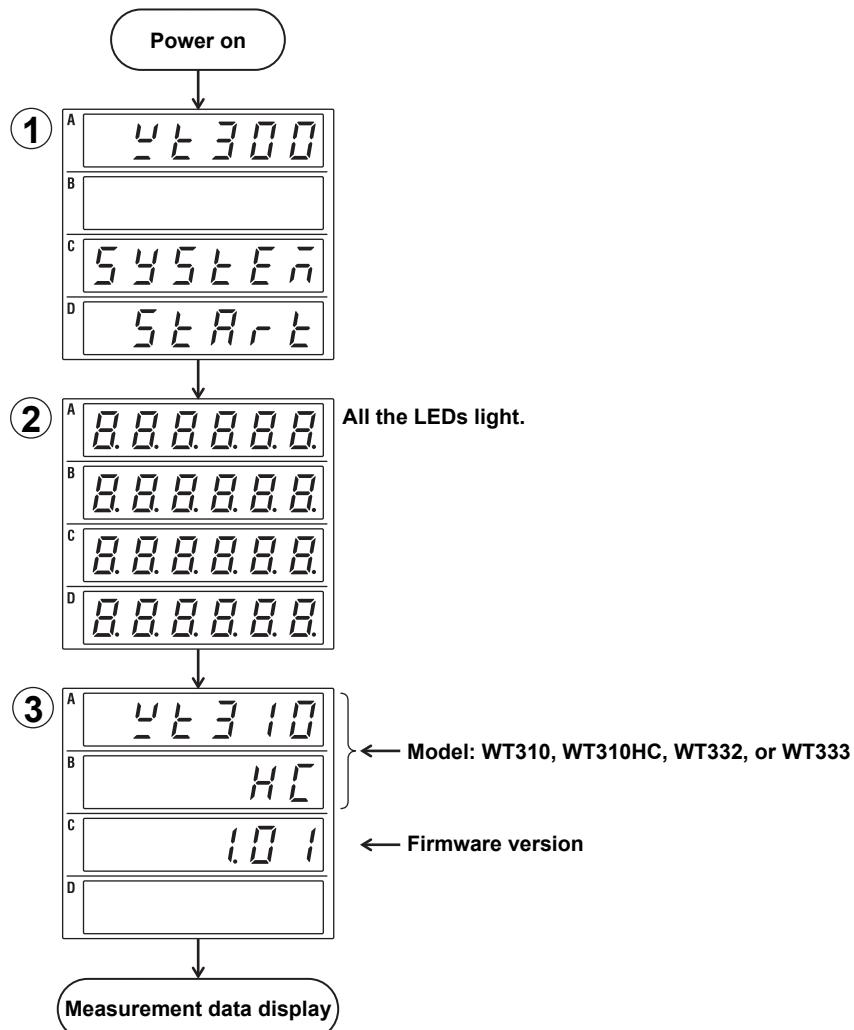
Operations Performed When the Power Is Turned Off

After the power is turned off, the instrument stores the setup parameters in its memory before shutting down. The same is true when the power cord is disconnected from the outlet. The next time the power is turned on, the instrument powers up using the stored setup parameters.

Note

The instrument stores the settings using an internal lithium battery. When the lithium battery voltage falls below a specified value, you will no longer be able to store setup parameters, and error code 901 will appear on the screen when you turn on the power (see section 6.2, "Error Code Descriptions and Corrective Actions"). If this message appears frequently, you need to replace the battery soon. Do not try to replace the battery yourself. Contact your nearest YOKOGAWA dealer to have the battery replaced.

Power-on Messages



2.5

Precautions When Wiring the Circuit under Measurement

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



WARNING

- Ground the instrument before connecting measurement cables. The power cord that comes with the instrument is a three-prong cord. Insert the power cord into a grounded three-prong outlet.
- Turn the circuit under measurement off before connecting and disconnecting cables to it. Connecting or removing measurement cables while the power is on is dangerous.
- Do not wire a current circuit to the voltage input terminal or a voltage circuit to the current input terminal.
- Strip the insulation covers of measurement cables so that when they are wired to the input terminals, the conductive parts (bare wires) do not protrude from the terminals. Also, make sure to fasten the input terminal screws securely so that cables do not come loose.
- When connecting measurement cables to the voltage input terminals, only connect measurement cables that have safety terminals that cover their conductive parts. Using a terminal with bare conductive parts (such as a banana plug) can be dangerous if the terminal comes loose.
- When connecting cables to the external current sensor input terminals, only connect cables that have safety terminals that cover their conductive parts. Using a connector with bare conductive parts can be dangerous if the terminal comes loose.
- When you apply current directly to the current input terminals to measure it, the voltage of the item under measurement appears at the external current sensor input terminal. To prevent electric shock, remove the cable connected to the external current sensor.
- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the external current sensor input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.
- When connecting a measurement cable from an external current sensor to an external current sensor input terminal, remove the cables connected to the current input terminals. Also, when the voltage of the circuit under measurement is being applied to the external current sensor input terminals, do not touch the current input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.
- When using an external voltage transformer (VT) or current transformer (CT), make sure that it has enough dielectric strength for the voltage (U) being measured ($2U + 1000\text{ V}$ recommended). Also, make sure that the secondary side of the CT does not become an open circuit while the power is being applied. If this happens, 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 case should be insulated, and the sensor should have enough dielectric strength for the voltage of the circuit under measurement. Using a bare sensor is dangerous, because there is a high probability that you might accidentally touch it.
- When using a shunt-type current sensor as an external current sensor, turn off the circuit under measurement before you connect the sensor. Connecting or removing the sensor while the power is on is dangerous.
- When using a clamp-type current sensor as an external current sensor, make sure that you understand the voltage of the circuit under measurement and the specifications and handling of the clamp-type sensor, and then confirm that there are no dangers, such as shock hazards.
- For safety reasons, when using the instrument after mounting it on a rack, furnish a switch for turning off the circuit under measurement from the front side of the rack.
- For safety reasons, after you connect the measurement cables, use the included screws to attach the current input protection cover (screw tightening torque: $0.6\text{ N}\cdot\text{m}$). Make sure that the conductive parts do not protrude from the protection cover.

2.5 Precautions When Wiring the Circuit under Measurement

- To make the protective features effective, before applying the voltage or current from the circuit under measurement, check that:
 - The power cord provided with the instrument is being used to connect to the power supply and that the instrument is grounded.
 - The instrument is turned on.
 - The current input protection cover provided with the instrument is attached.
- When 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 the circuit under measurement off. For information about other input terminals, see the specifications in chapter 6.

Instantaneous maximum allowable input (within 20 ms)

Voltage input

Peak value of 2.8 kV or rms value of 2 kV, whichever is less.

Current input

Direct input

- WT310 and WT332/WT333
 - When the crest factor is 3: 0.5 A to 20 A
 - When the crest factor is 6: 0.25 A to 10 A
 - Peak value of 450 A or rms value of 300 A, whichever is less.
- WT310
 - When the crest factor is 3: 5 mA to 200 mA
 - When the crest factor is 6: 2.5 mA to 100 mA
 - Peak value of 150 A or rms value of 100 A, whichever is less.
- WT310HC
 - When the crest factor is 3: 1 A to 40 A
 - When the crest factor is 6: 0.5 A to 20 A
 - Peak value of 450 A or rms value of 300 A, whichever is less.

External current sensor input

Peak value less than or equal to 10 times the range.

Instantaneous maximum allowable input (1 s or less)

Voltage input

Peak value of 2 kV or rms value of 1.5 kV, whichever is less.

Current input

Direct input

- WT310 and WT332/WT333
 - When the crest factor is 3: 0.5 A to 20 A
 - When the crest factor is 6: 0.25 A to 10 A
 - Peak value of 150 A or rms value of 40 A, whichever is less.
- WT310
 - When the crest factor is 3: 5 mA to 200 mA
 - When the crest factor is 6: 2.5 mA to 100 mA
 - Peak value of 30 A or rms value of 20 A, whichever is less.
- WT310HC
 - When the crest factor is 3: 1 A to 40 A
 - When the crest factor is 6: 0.5 A to 20 A
 - Peak value of 150 A or rms value of 44 A, whichever is less.

External current sensor input

Peak value less than or equal to 10 times the range.

2.5 Precautions When Wiring the Circuit under Measurement

Continuous maximum allowable input

Voltage input

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

Current input

Direct input

- WT310 and WT332/WT333

When the crest factor is 3: 0.5 A to 20 A

When the crest factor is 6: 0.25 A to 10 A

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

- WT310

When the crest factor is 3: 5 mA to 200 mA

When the crest factor is 6: 2.5 mA to 100 mA

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

- WT310HC

When the crest factor is 3: 1 A to 40 A

When the crest factor is 6: 0.5 A to 20 A

Peak value of 100 A or rms value of 44 A, whichever is less.

External current sensor input

Peak value less than or equal to 5 times the range.



CAUTION

Use measurement cables with dielectric strengths and current capacities that are appropriate for the voltage or current being measured.

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

Attaching a measurement cable to this product may cause radio interference in which case the user will be required to correct the interference.

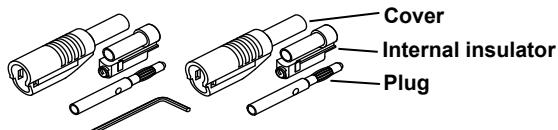
Note

- If you are measuring large currents or voltages or currents that contain high frequency components, take special care in dealing with mutual interference and noise when you wire the cables.
- Keep 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 2.9 to 2.11 are the parts where the current flows. Use wires that are suitable for the current levels.
- To make accurate measurements of the voltage of the circuit under measurement, connect the measurement cable that is connected to the voltage input terminal to the circuit as closely as possible.
- To make accurate measurements, separate the measurement cables as far away from the ground wires and the instrument's case as possible to minimize static capacitance to the ground.
- To measure the apparent power and power factor more accurately on an unbalanced three-phase circuit, we recommend that you use the three-voltage, three-current method (3V3A).

2.6 Assembling the Adapters for the Voltage Input Terminals

When connecting a measurement cable to a WT300 series voltage input terminal, use the included 758931 Safety Terminal Adapter or the 758923 Safety Terminal Adapter (sold separately).

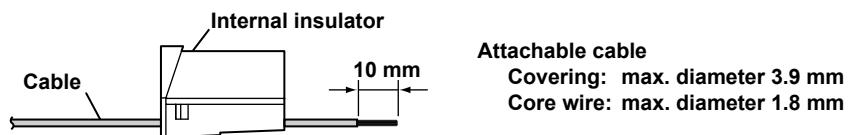
758931 Safety Terminal Adapter



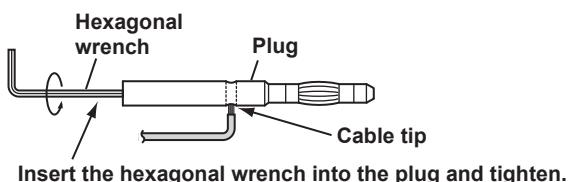
When using the 758931 Safety Terminal Adapter, assemble it according to the following procedure.

Assembling the Safety Terminal Adapter

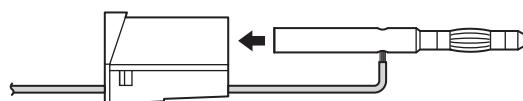
1. Remove approximately 10 mm of the covering from the end of the cable and pass the cable through the internal insulator.



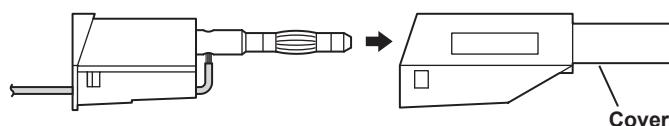
2. Insert the tip of the cable into the plug. Fasten the cable in place using the hexagonal wrench.



3. Insert the plug into the internal insulator.



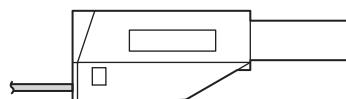
4. Attach the external cover. Make sure that the cover does not come off.



Note

Once you attach the cover, it is difficult to disassemble the safety terminal adapter. Use care when attaching the cover.

Below is an illustration of the adapter after it has been assembled.

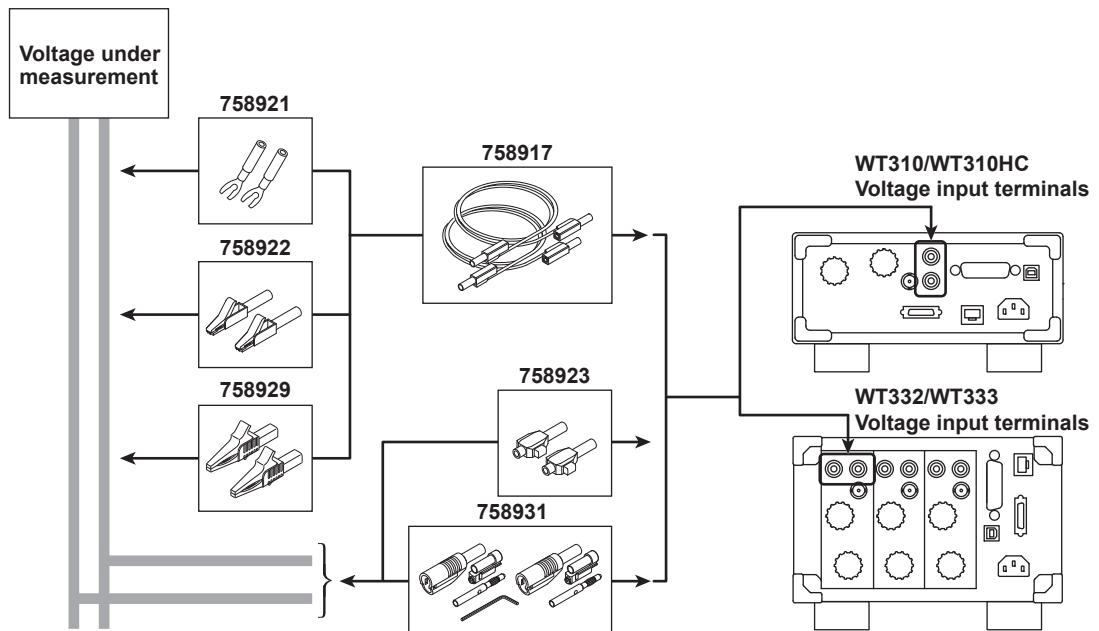


2.6 Assembling the Adapters for the Voltage Input Terminals

Explanation

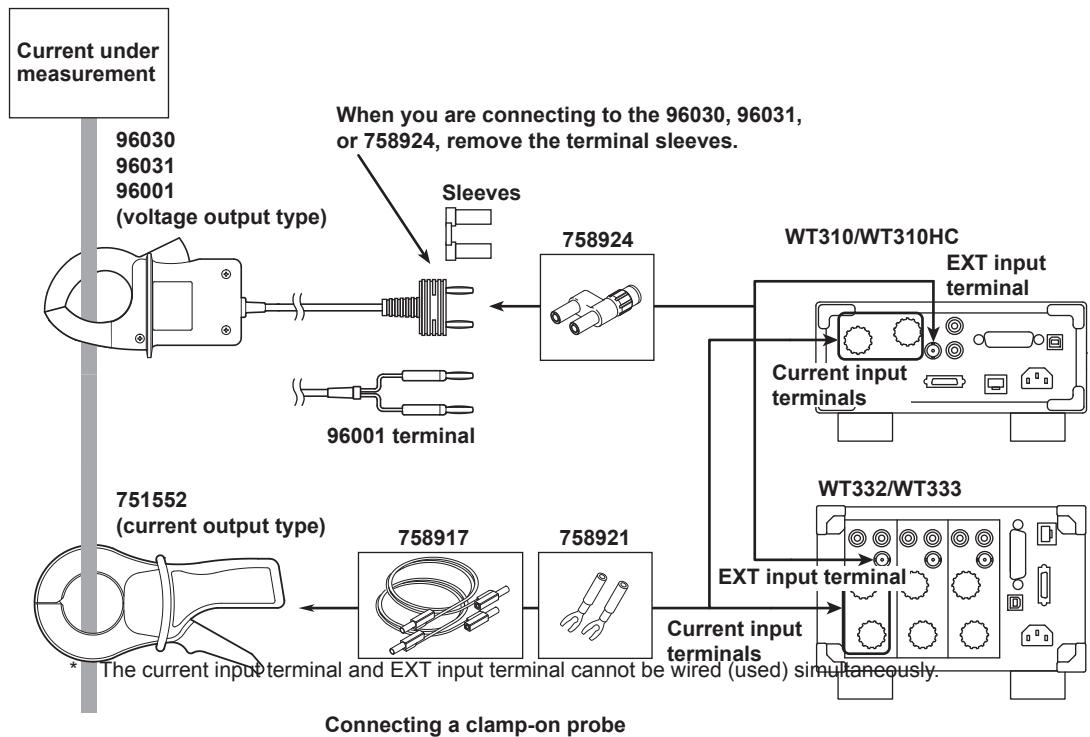
Wire the adapters that come with the WT300 series or the adapters and various sensors that are sold separately as shown below:

Wiring to a Voltage Input Terminal



Wiring to a Current Input Terminal

Use the clamp-on probes (sold separately) as shown below.



2.7

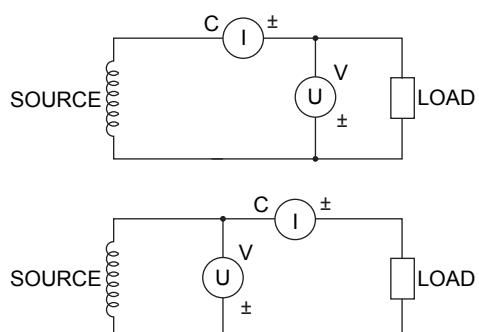
Wiring for Accurately Measuring a Single-phase Device

When you are wiring a single-phase device, there are the four patterns of terminal wiring positions shown in the following figures for wiring the voltage input and current input terminals. Depending on the terminal wiring positions, the effects of stray capacitance and the effects of the measured voltage and current amplitudes may become large. To make accurate measurements, refer to the items below when wiring the voltage input and current input terminals.

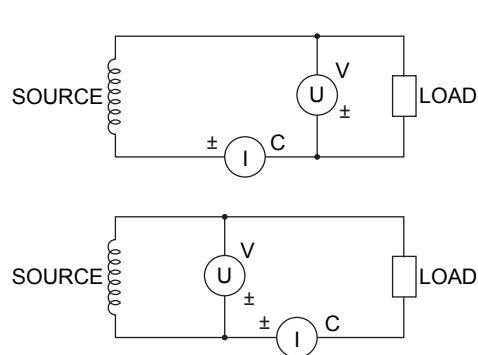
Effects of Stray Capacitance

When you are measuring the power of a single-phase device, you can minimize the effects of stray capacitance on measurement accuracy by connecting the instrument's current input terminal to the side that is closest to the earth potential of the power supply (SOURCE).

- Easily affected



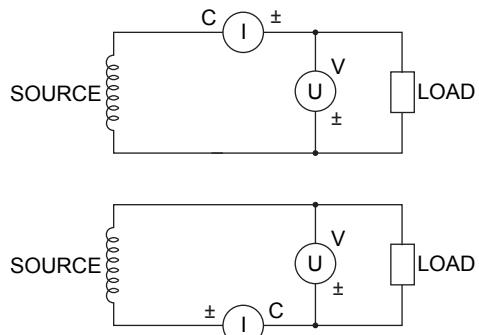
- Not easily affected



Effects of the Measured Voltage and Current Amplitudes

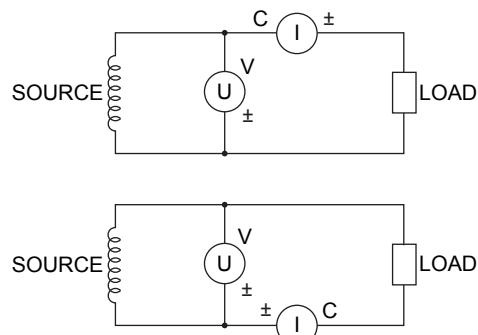
- When the measured current is relatively large

Connect the voltage input terminal between the current input terminal and the load.



- When the measured current is relatively small

Connect the current input terminal between the voltage input terminal and the load.



Explanation

For details on the effects of stray capacitance and the effects of the measured voltage and current amplitudes, see appendix 1, "How to Make Accurate Measurements."

2.8 Guide for Selecting the Method Used to Measure the Power

Select the measurement method from the table below according to the amplitude of the measured voltage or current. For details about a wiring method, see the section indicated in the table.

Voltage Measurement Methods

		When the Voltage Is 600 V or Less	When the Voltage Exceeds 600 V
Voltage wiring	Direct input	→ section 2.9	Direct input is not possible.
	Voltage transformer (VT)	→ section 2.11	

Current Measurement Methods

		When the Voltage Is 600 V or Less		When the Voltage Exceeds 600 V
Product name	WT310/WT332/WT333	When the Current Is 20 A or Less	When the Current Exceeds 20 A	
	WT310HC	When the Current Is 40 A or Less	When the Current Exceeds 40 A	
Current wiring	Direct input	→ section 2.9	Direct input is not possible.	
	Shunt-type current sensor	→ section 2.10		Shunt-type current sensors cannot be used.
	Clamp-type current sensor (voltage output type)	→ section 2.10		
	Clamp-type current sensor (current output type)	→ section 2.11		
	Current transformer (CT)	→ section 2.11		

2.9 Wiring the Circuit under Measurement for Direct Input

This section explains how to wire the measurement cable directly from the circuit under measurement to the voltage or current input terminal. To prevent electric shock and damage to the instrument, follow the warnings given in section 2.5, "Precautions When Wiring the Circuit under Measurement."

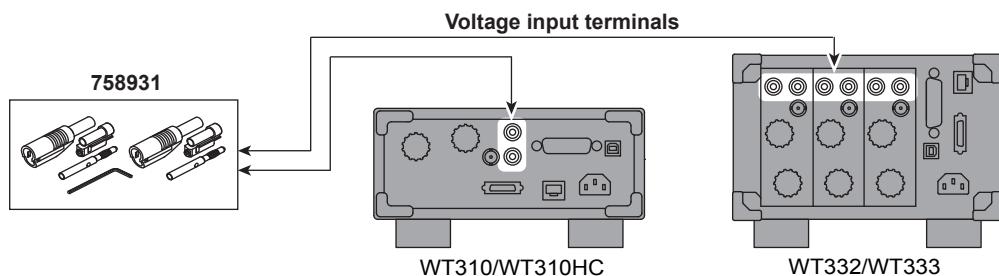
Connecting to the Input Terminals

Voltage Input Terminals

The terminals are safety banana jacks (female) that are 4 mm in diameter.

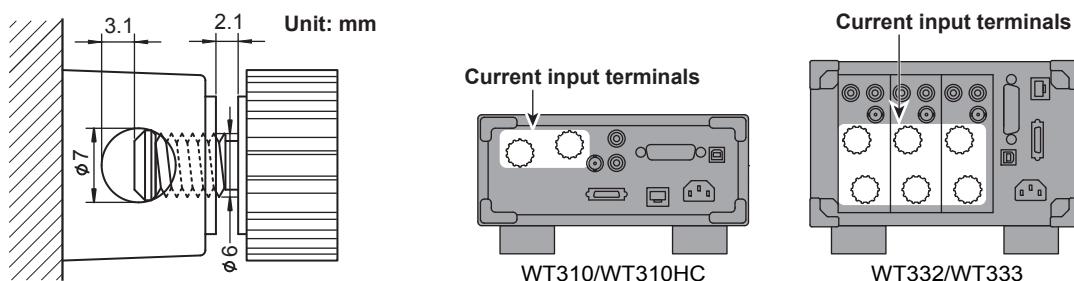
Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.

If you are using the included 758931 Safety Terminal Adapter, see section 2.6.



Current Input Terminals

The terminals are binding posts, and the screws are M6. Either wind a wire around a screw or pass a crimped terminal through the screw axis, and then tighten firmly with the terminal knob.



WARNING

- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the external current sensor input terminal. Doing so is dangerous because the terminals are electrically connected inside the instrument.
- When connecting a measurement cable from an external current sensor to an external current sensor input terminal, remove the cables connected to the current input terminals. Also, when the voltage of the circuit under measurement is being applied to the external current sensor input terminals, do not touch the current input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.



CAUTION

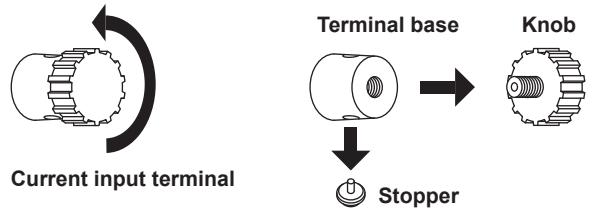
Confirm that no foreign materials are caught between the current input terminal and the crimped terminal. Periodically confirm that the current input terminal is not loose and that there are no foreign materials caught between the current input terminal and the crimped terminal.

2.9 Wiring the Circuit under Measurement for Direct Input

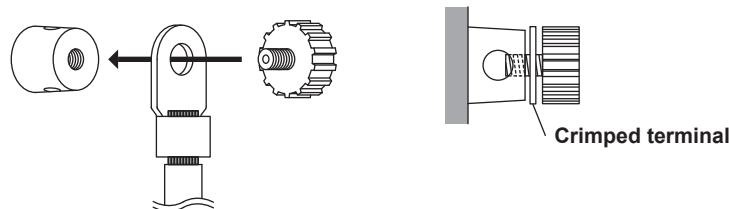
Connecting to a Round Crimped Terminal

To connect a cable with a round crimped terminal to a current input terminal, follow the procedure below. Note that once the stopper pressed into the knob is removed, it will easily come off if it is used again. Have a new knob and stopper ready before you remove the stopper.

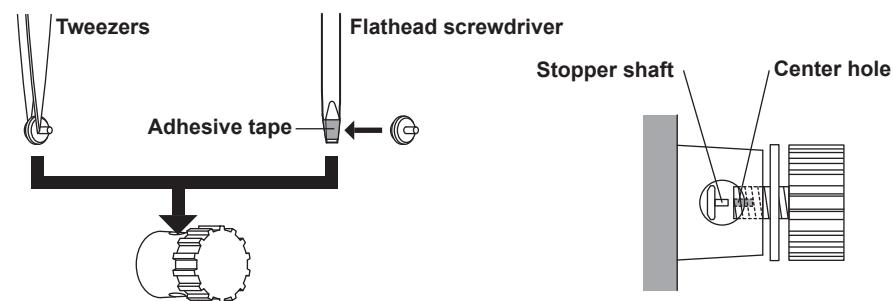
- Turn the current input terminal knob to loosen it. If the knob becomes difficult to turn, apply more force to turn it further. Inside the terminal base, the stopper for the knob will disconnect from the screw portion of the knob, and the knob will become easier to turn.



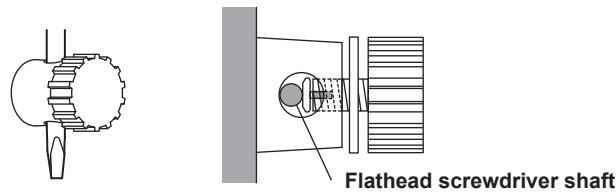
- Insert the screw of the new knob into the crimped terminal, and attach the knob to the terminal base. Tighten the knob until the tip of the knob screw is slightly visible from the hole in the terminal base.



- Use one of the following methods to insert the new stopper into the terminal base and hold it in place.
 - Hold the stopper with tweezers and insert it into the terminal base.
 - Wrap adhesive tape around a flathead screwdriver so that the adhesive side of the tape faces outward, then attach the stopper to the adhesive tape.



- Align the shaft of the stopper with the hole in the center of the knob screw. Twist the knob until the shaft of the stopper enters all the way into the center of the screw.
If the shaft of the stopper doesn't enter all the way into the screw even after you tighten the knob, insert the shaft of a screwdriver into the hole in the terminal base, and twist the knob.

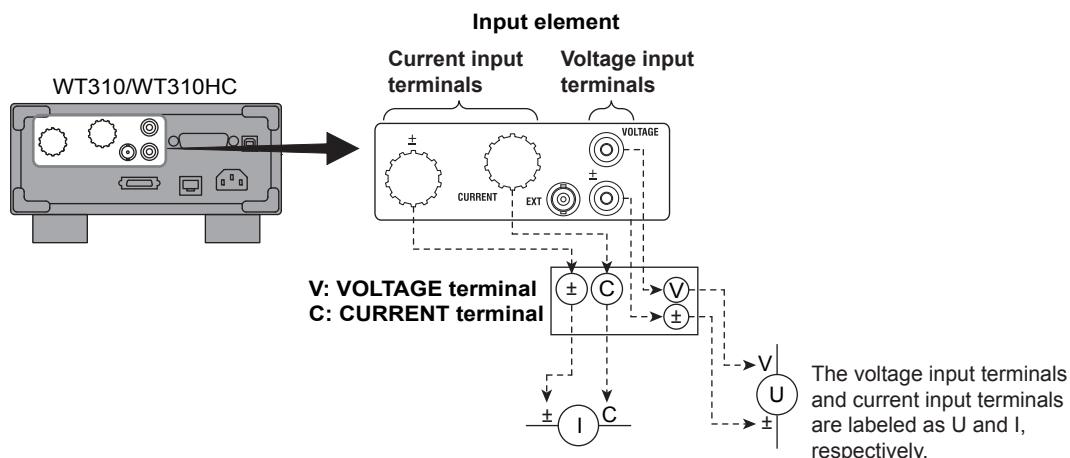


Note

When using a crimped terminal with a measurement cable, be sure to use a crimped terminal that matches the size of the cable and to crimp the terminal to the cable using the appropriate crimping tool for the terminal. For precautions about using crimped terminals and crimping tools, see the manuals for the crimped terminal and the crimping tool that you are using.

Connecting to the WT310/WT310HC

In the wiring examples that follow, the WT310/WT310HC input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.

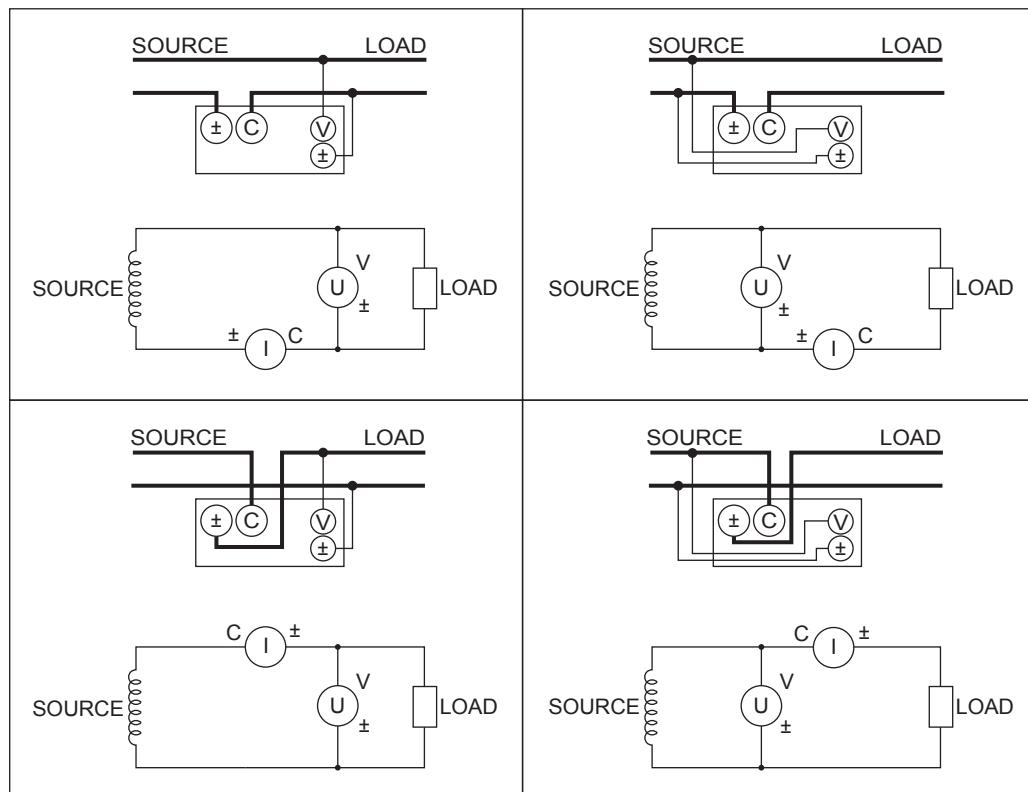


CAUTION

The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

Wiring Patterns

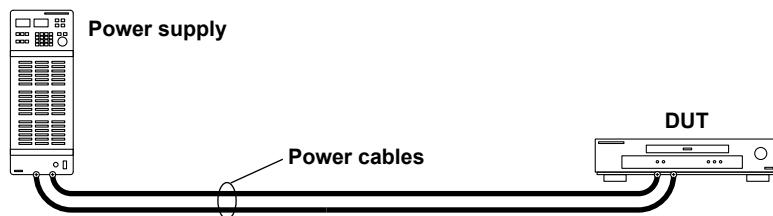
When you are wiring a single-phase device, there are the four patterns of terminal wiring positions shown in the following figures for wiring the voltage input and current input terminals. To select which pattern to use, see section 2.7.



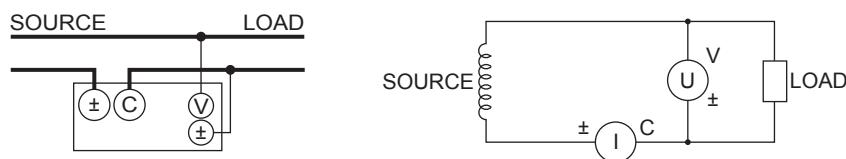
2.9 Wiring the Circuit under Measurement for Direct Input

Example Wiring Procedure

This example will explain the procedure that you should use to configure the wiring when using the WT310 to measure the power of a single-phase, two-wire DUT. The procedure is the same when measuring using the WT310HC.



This example shows how to configure the wiring pattern shown in the upper left of the figure on the previous page.



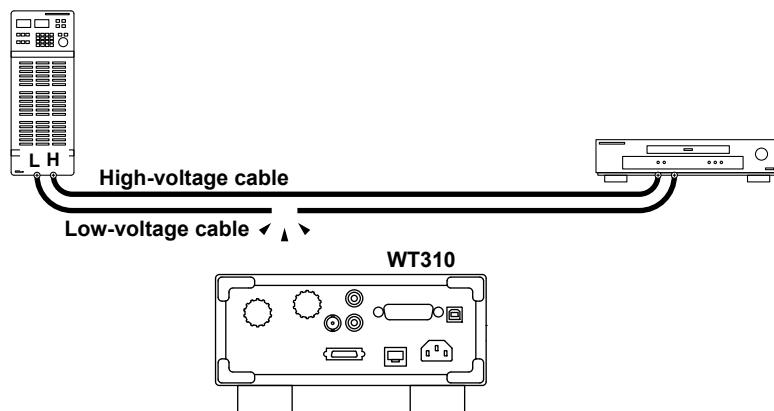
Order of Connection

Generally, it is easier to follow the wiring diagram if you wire to the current input terminals first and then to the voltage input terminals. In this example as well, we will wire to the WT310 current input terminals first and then to the voltage input terminals.

Wiring to the Current Input Terminals

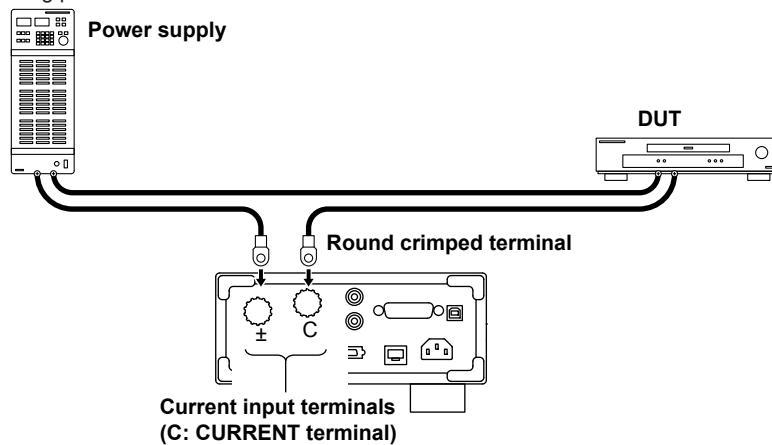
Connect the current input terminals in series with the DUT along one of the power cables between the DUT and the power source.

- Cut one power cable at the position that you want to insert the power meter into.
Cutting the low-voltage cable and inserting the power meter reduces the effects of noise during power measurement.

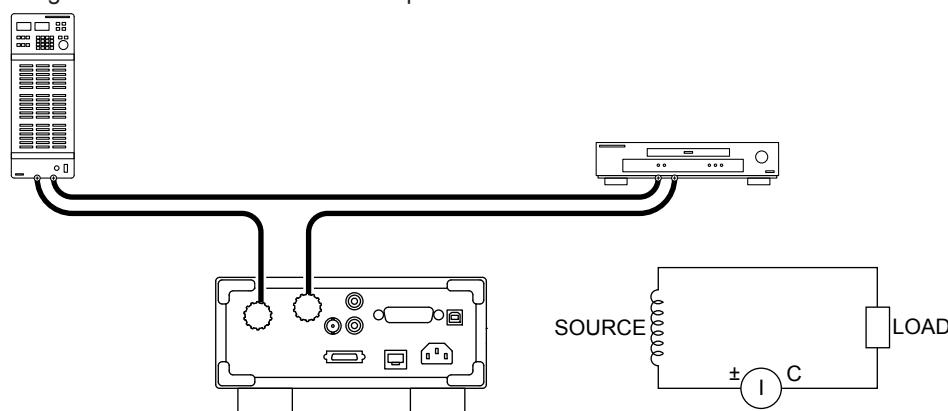


2.9 Wiring the Circuit under Measurement for Direct Input

- 2 Strip the insulation of the power cable that you cut, and attach round crimped terminals if necessary. Connect the power cable to the WT310 in the following ways.
- Power-source-side cable: Connect to the \pm current input terminal.
 - DUT side cable: Connect to the CURRENT current input terminal.
- Pay attention to the terminal polarities so that you don't attach the cables to terminals (C and \pm) with the wrong polarities.



The wiring for current measurement is complete.



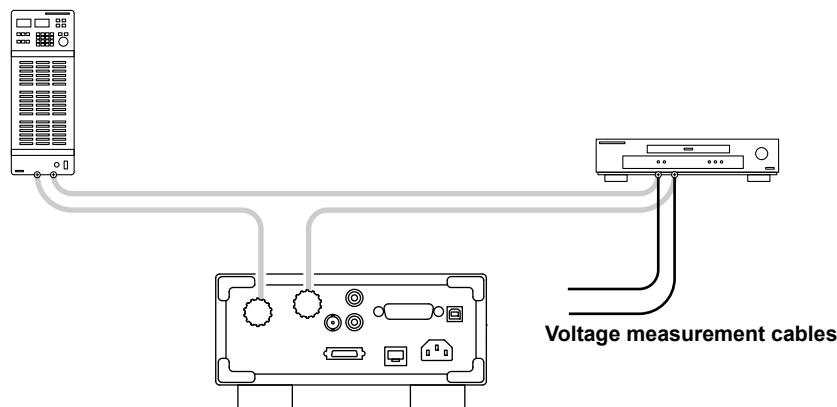
Wiring to the Voltage Input Terminals

Connect the voltage input terminals in parallel with the DUT.

- 3 Connect the voltage measurement cables to the power supply terminals of the DUT.

Use cables that meet the following conditions.

- Sufficient dielectric strength for the voltage of the circuit under measurement
- Of a size to which the 758931 Safety Terminal Adapter can be attached
 - Covering: max. diameter 3.9 mm
 - Core wire: max. diameter 1.8 mm

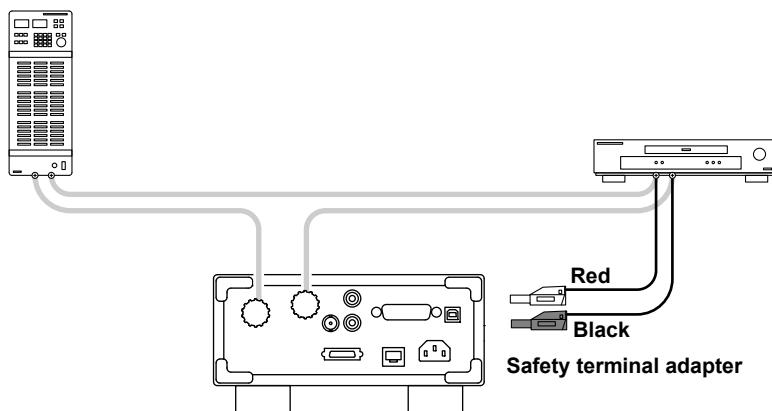


2.9 Wiring the Circuit under Measurement for Direct Input

- 4** Attach 758931 Safety Terminal Adapters to the voltage measurement cables.

For details on how to assemble and attach the safety terminal adapters, see section 2.5.

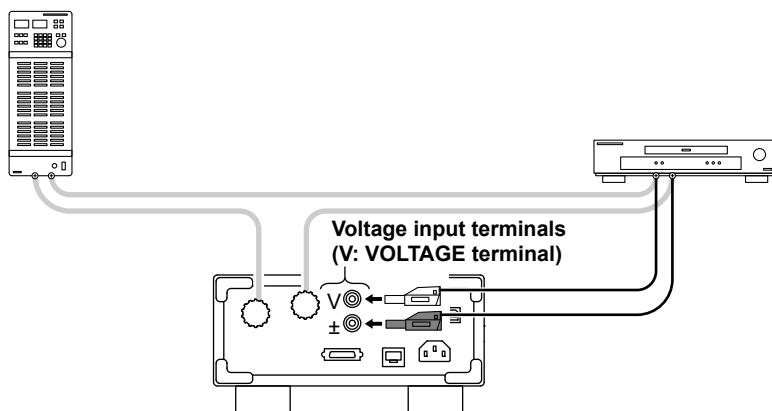
You can avoid wiring mistakes by connecting a red adapter to the high-voltage cable and a black adapter to the low-voltage cable.



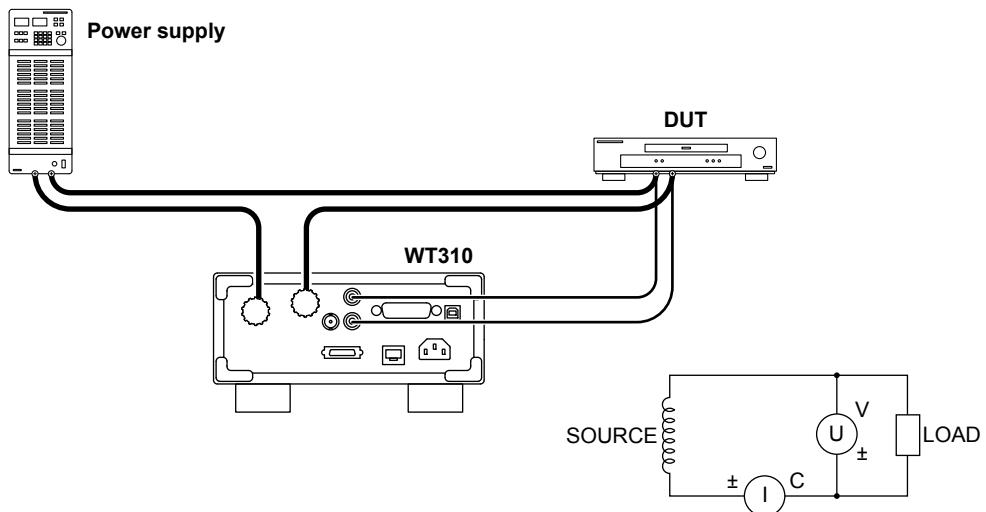
- 5** Connect the safety terminal adapters to the WT310 voltage input terminals.

- Red adapter: Connect to the VOLTAGE voltage input terminal.
- Black adapter: Connect to the \pm voltage input terminal.

Pay attention to the terminal polarities so that you don't attach the cables to terminals (V and \pm) with the wrong polarities.

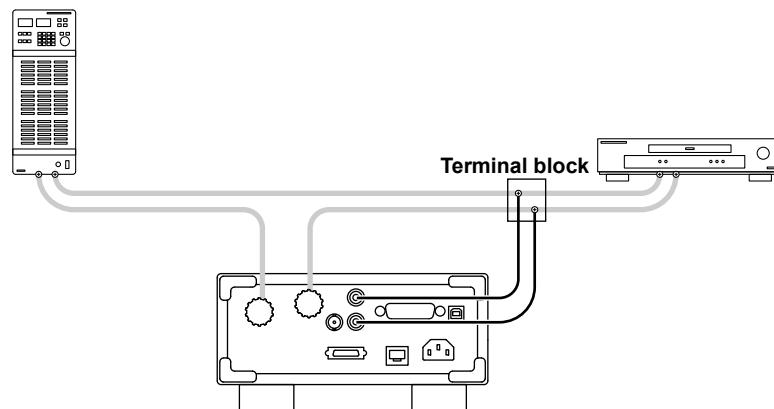


The wiring for voltage measurement is complete. The wiring for measuring the power of a single-phase, two-wire DUT is complete.



2.9 Wiring the Circuit under Measurement for Direct Input

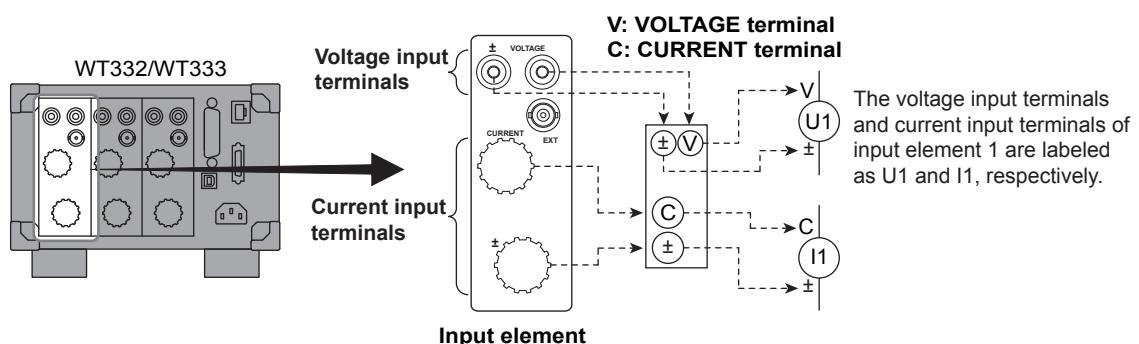
You can also connect to the circuit under measurement by placing a terminal block near the WT310 and connecting the power cables and voltage measurement cables to the terminal block.



2.9 Wiring the Circuit under Measurement for Direct Input

Connecting to the WT332/WT333

In the wiring examples that follow, the WT332/WT333 input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.

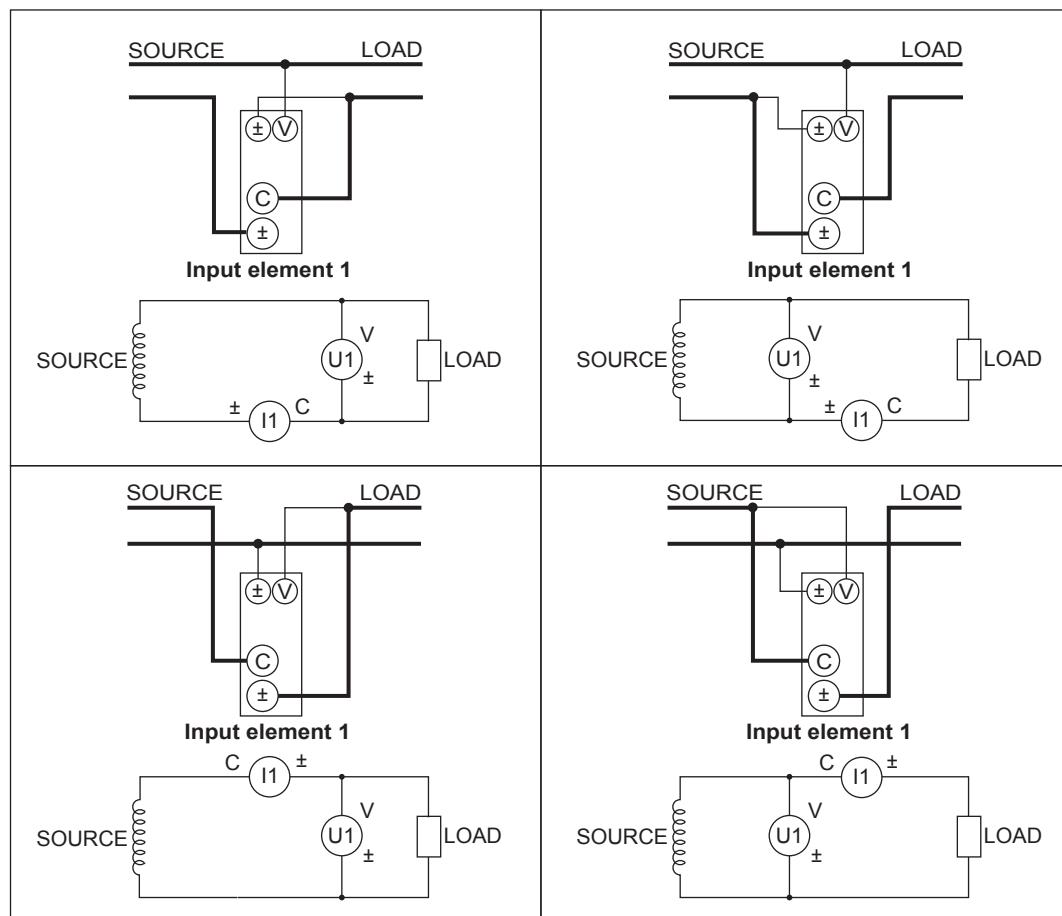


Note

The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

Wiring Examples of Single-Phase, Two-Wire Systems (1P2W)

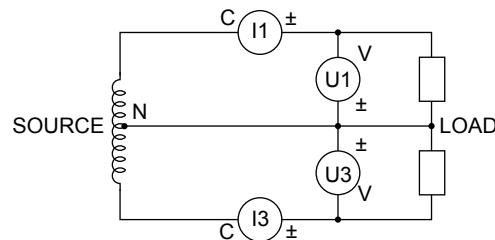
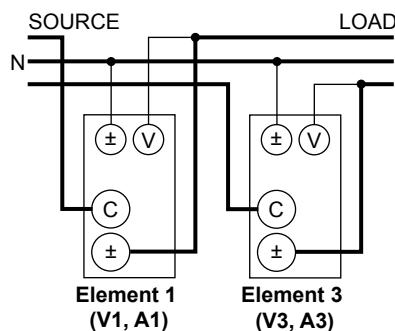
The following wiring example shows how to configure the wiring to connect to input element 1. To configure the wiring for other input elements, substitute the numbers in the figures with the appropriate element numbers.



2.9 Wiring the Circuit under Measurement for Direct Input

Wiring Example of a Single-Phase, Three-Wire System (1P3W)

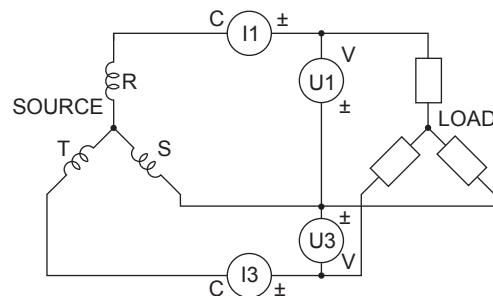
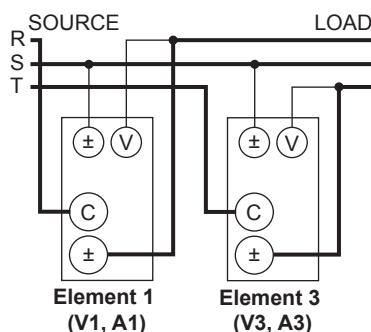
The wiring is connected to input elements 1 and 3.



Wiring Example of a Three-Phase, Three-Wire System (3P3W)

The wiring is connected to input elements 1 and 3.

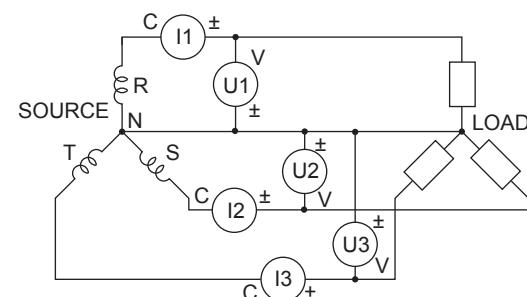
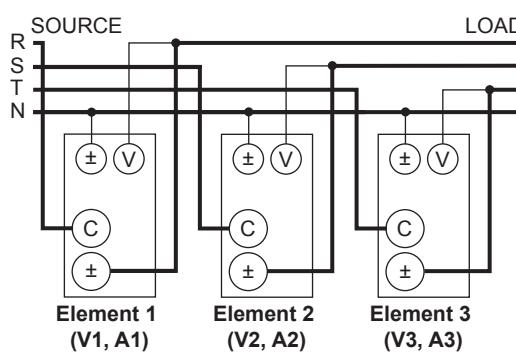
Measure the line voltage using S-phase power as the reference.



Wiring Example of a Three-Phase, Four-Wire System (3P4W)

Applies to the WT333.

The wiring is connected to input elements 1, 2, and 3.

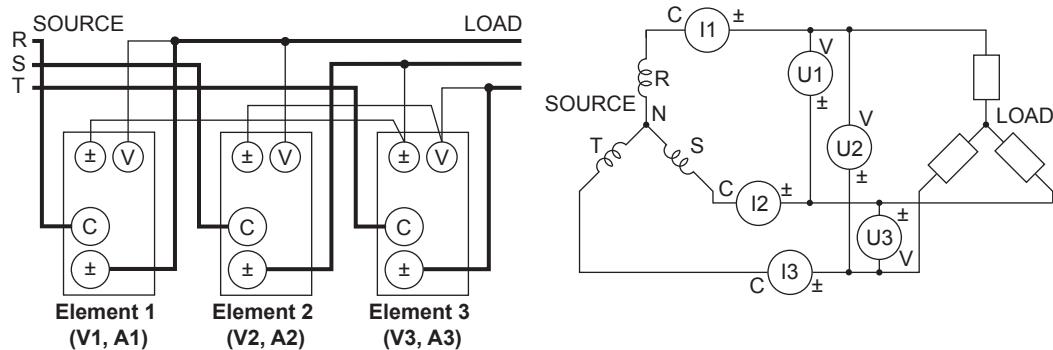


2.9 Wiring the Circuit under Measurement for Direct Input

Wiring Example with the Three-Voltage, Three-Current Method (3V3A)

Applies to the WT333.

The wiring is connected to input elements 1, 2, and 3.



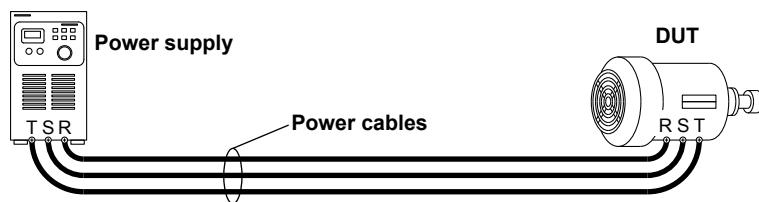
Note

For details about the relationship between the wiring system and how measured and computed values are determined, see appendix 1, "Symbols and Determination of Measurement Functions."

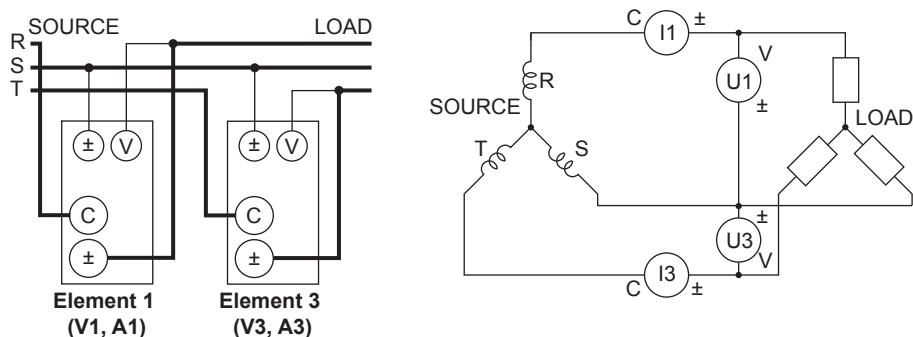
2.9 Wiring the Circuit under Measurement for Direct Input

Wiring Procedure Example for a Three-Phase, Three-Wire System (3P3W)

This example will explain the procedure that you should use to configure the wiring when using the WT332/WT333 to measure the power of a three-phase, three-wire DUT.



This section will explain how to configure the wiring as shown below.



Note

The wiring procedure for a single-phase, two-wire DUT on page 2-19 is a useful reference for thinking about the voltage of each phase and the current wiring.

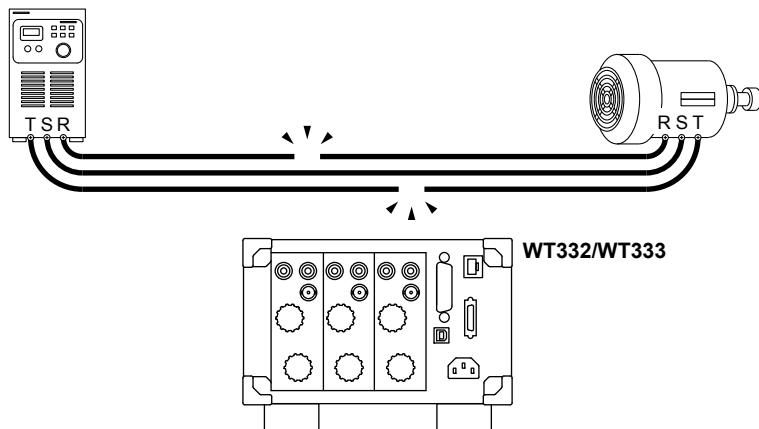
Order of Connection

Generally, it is easier to follow the wiring diagram if you wire to the current input terminals first and then to the voltage input terminals. In this example as well, we will wire to the WT332/WT333 current input terminals first and then to the voltage input terminals.

Wiring to the Current Input Terminals

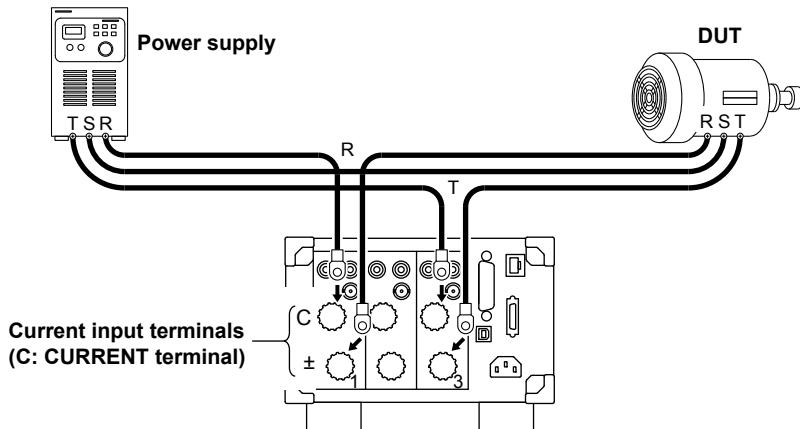
Connect the current input terminals between the R phase and T phase of the power cable.

- 1 Cut the power cables at the positions where you want to insert the power meter.

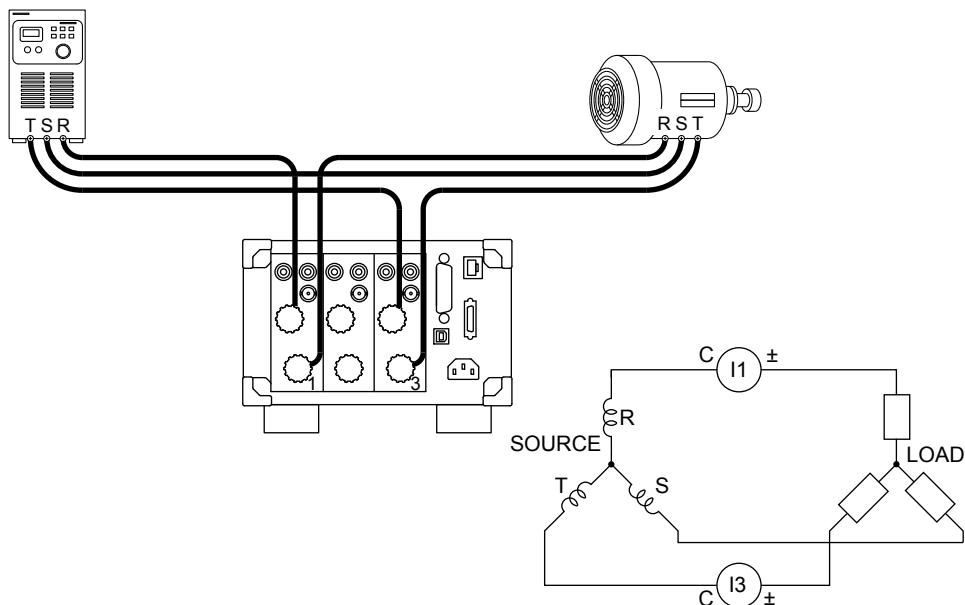


2.9 Wiring the Circuit under Measurement for Direct Input

- 2 Strip the insulation of the power cables that you cut, and attach round crimped terminals if necessary. Connect the power cables to the WT332/WT333 in the following ways.
- R-phase cable: Connect to element 1.
 - Power-source-side cable: Connect to the \pm current input terminal of element 1.
 - DUT side cable: Connect to the CURRENT current input terminal of element 1.
 - T-phase cable: Connect to element 3.
 - Power-source-side cable: Connect to the \pm current input terminal of element 3.
 - DUT side cable: Connect to the CURRENT current input terminal of element 3.
- Pay attention to the terminal polarities so that you don't attach the cables to terminals (C and \pm) with the wrong polarities.



The wiring for current measurement is complete.



Note

Why You Do Not Have to Connect the WT332/WT333 Current Input Terminals to the S-Phase Cable

In a three-phase, three-wire wiring system, there is no neutral line. This means that either the R, S, or T phase is treated as a virtual neutral line when power is measured. In this example, the S-phase cable is treated as the virtual neutral line. Therefore, in the voltage terminal connection described later, phase S is used as the reference to measure the line voltage between phase R and phase S and between phase T and phase S. This type of power measurement method is referred to as the two-wattmeter method.

2.9 Wiring the Circuit under Measurement for Direct Input

Wiring to the Voltage Input Terminals

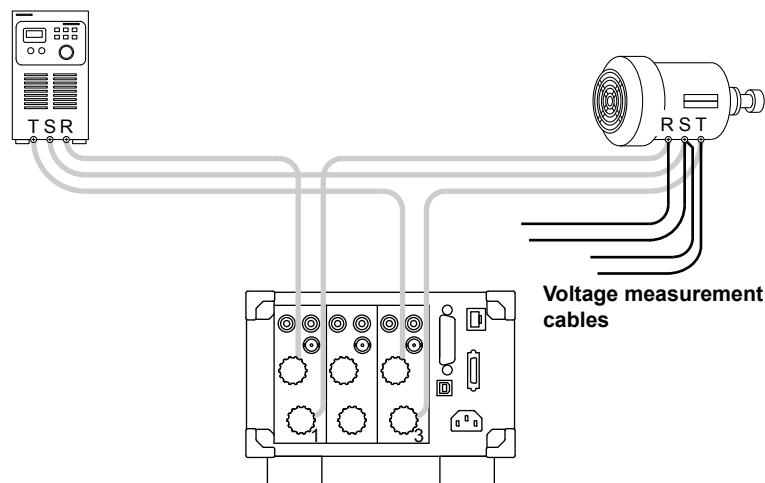
Connect the voltage input terminals in parallel with the DUT.

Using phase S as the reference, measure the line voltage between phase R and phase S and between phase T and phase S.

- 3 Connect the voltage measurement cables to the power supply terminals of the DUT. Connect two cables to the S-phase terminal.

Use cables that meet the following conditions.

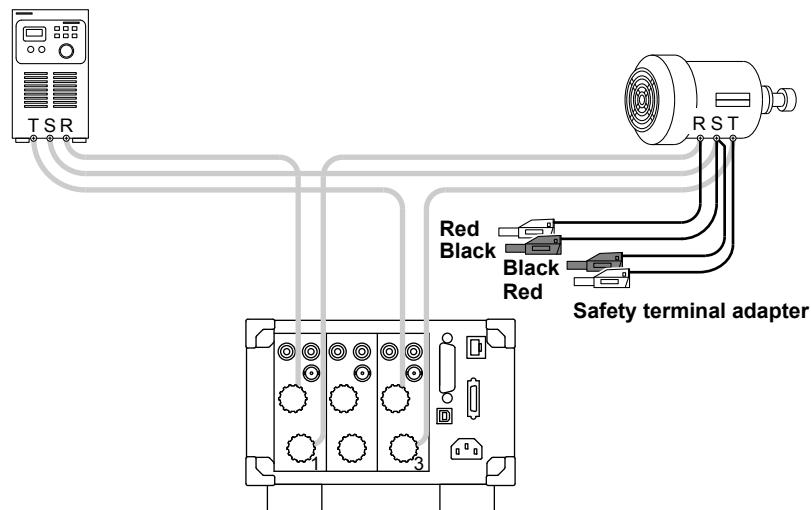
- Sufficient dielectric strength for the voltage of the circuit under measurement
- Of a size to which the 758931 Safety Terminal Adapter can be attached
 - Covering: max. diameter 3.9 mm
 - Core wire: max. diameter 1.8 mm



- 4 Attach 758931 Safety Terminal Adapters to the voltage measurement cables.

For details on how to assemble and attach the safety terminal adapters, see section 2.5.

You can avoid wiring mistakes by connecting red adapters to the R- and T-phase cables and black adapters to the S-phase cables.

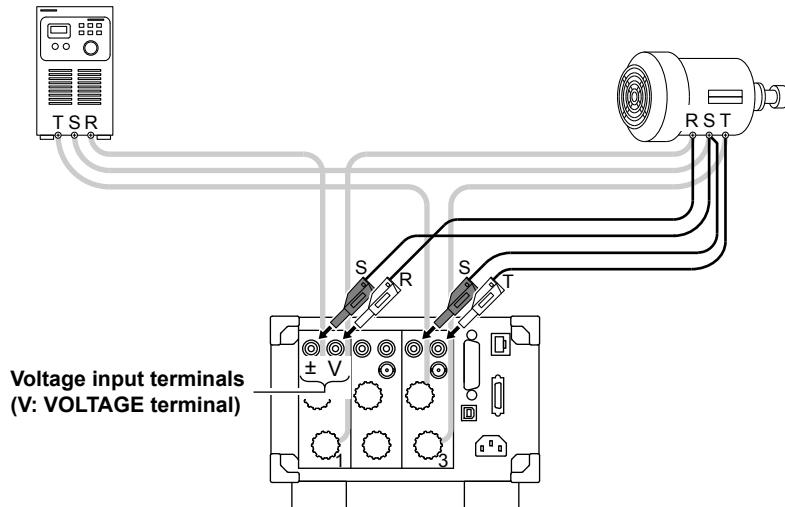


2.9 Wiring the Circuit under Measurement for Direct Input

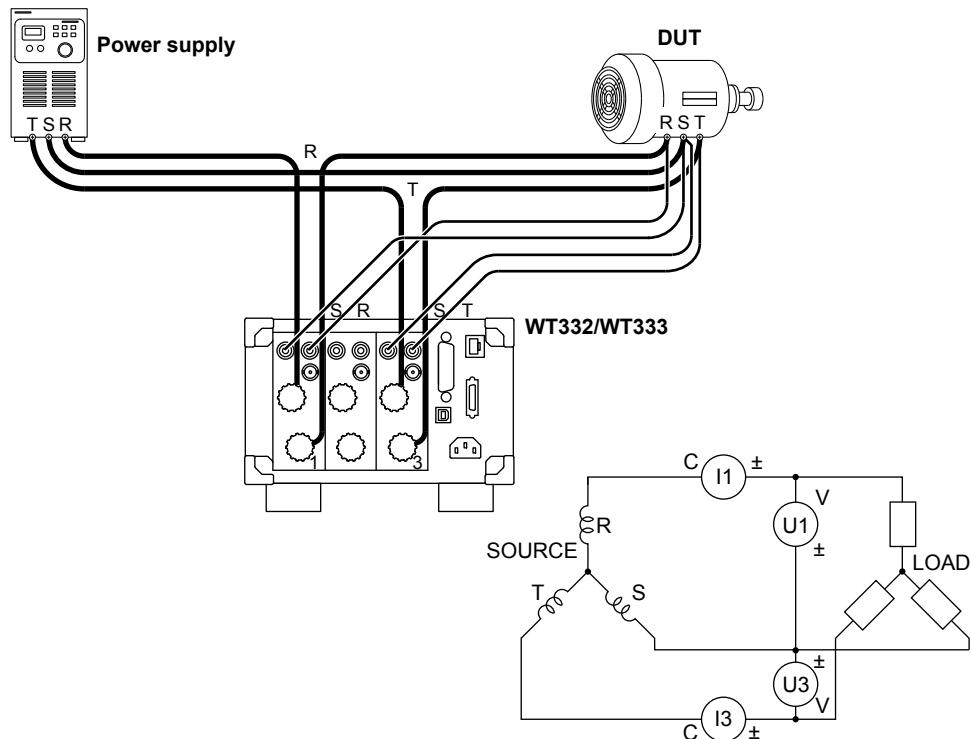
- 5 Connect the safety terminal adapters to the WT332/WT333 voltage input terminals.

- Red R-phase adapter: Connect to the VOLTAGE voltage input terminal of element 1.
- Red T-phase adapter: Connect to the VOLTAGE voltage input terminal of element 3.
- Black S-phase adapters: Connect to the \pm voltage input terminals of elements 1 and 3.

Pay attention to the terminal polarities so that you don't attach the cables to terminals (VOLTAGE and \pm) with the wrong polarities.

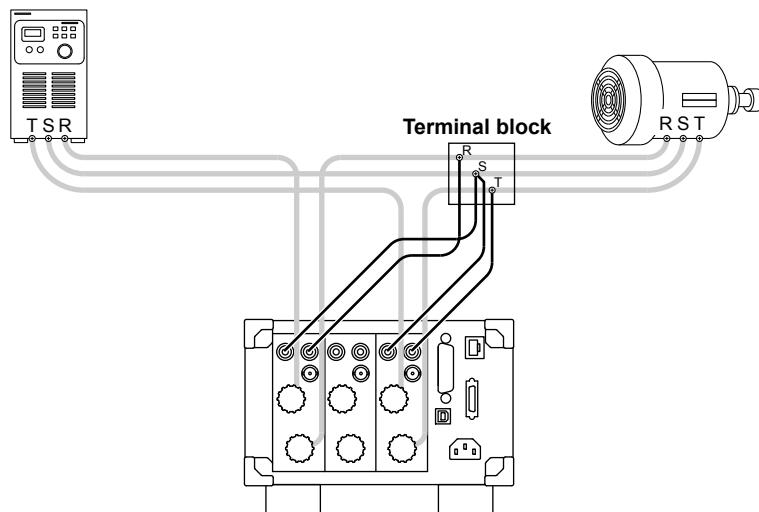


The wiring for voltage measurement is complete. The wiring for measuring the power of a three-phase, three-wire DUT is complete.



2.9 Wiring the Circuit under Measurement for Direct Input

You can also connect to the circuit under measurement by placing a terminal block near the WT332/WT333 and connecting the power cables and voltage measurement cables to the terminal block.



Wiring Procedure with the Three-Voltage, Three-Current Method (3V3A)

You can configure the wiring for the three-voltage, three-current method (3V3A) by adding the following wiring to the wiring for a three-phase, three-wire system.

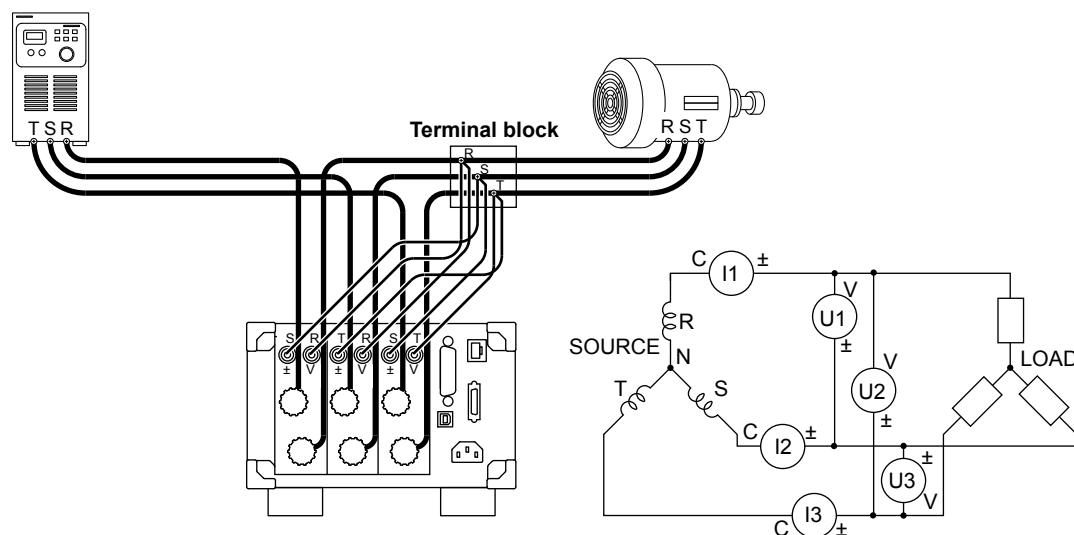
Wiring to the Current Input Terminals

In the aforementioned steps 1 and 2, connect the current input terminals of element 2 to the S-phase power cable.

Wiring to the Voltage Input Terminals

In the aforementioned steps 3 to 5, connect the voltage input terminals of element 2 so as to measure the line voltage between phase R and phase T.

The result of wiring the three-phase, three-wire system shown in the figure above is for the three-voltage, three-current method (3V3A) is shown below.



2.10 Wiring the Circuit under Measurement When Using Current Sensors

To prevent electric shock and damage to the instrument, follow the warnings given in section 2.5, "Precautions When Wiring the Circuit under Measurement."

If the maximum current of the circuit under measurement exceeds the maximum range of the input elements, you can measure the current of the circuit under measurement by connecting an external current sensor to the external current sensor input terminal.

- WT310 and WT332/WT333
When the maximum current exceeds 20 Arms
- WT310HC
When the maximum current exceeds 40 Arms

Current Sensor Output Type

Voltage Output

Refer to the wiring examples in this section when using a shunt-type current sensor or a clamp-type current sensor that outputs voltage.

Current Output

If you are using a clamp-type current sensor that outputs current, see section 2.11.

Connecting to the Input Terminals

Voltage Input Terminals

The terminals are safety banana jacks (female) that are 4 mm in diameter.

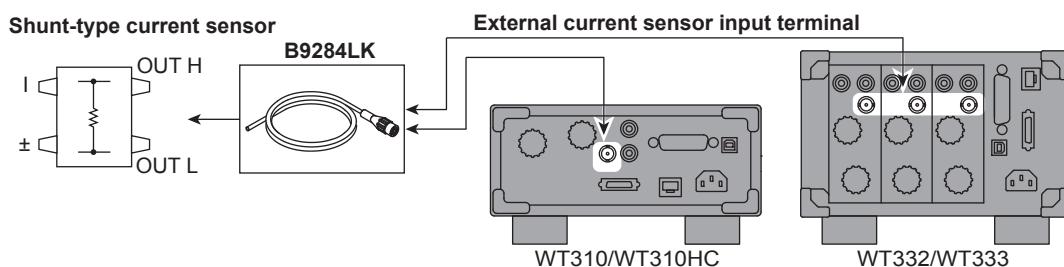
Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.

If you are using the included 758931 Safety Terminal Adapter, see section 2.6.

External Current Sensor Input Terminal

The terminal is an isolated BNC connector.

Connect an external current sensor cable with an isolated BNC connector (B9284LK, sold separately) to an external current sensor input terminal.



Remove the measurement cable connected to the current input terminal. Because the external current sensor input terminal and the current input terminal are connected internally, connecting both terminals simultaneously not only results in measurement errors but may also cause damage to the instrument. Also, when the voltage of the circuit under measurement is being applied to the external current sensor input terminals, do not touch the current input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.

2.10 Wiring the Circuit under Measurement When Using Current Sensors



CAUTION

The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

Note

- Make sure that you have the polarities correct when you make connections. If the polarity is reversed, the polarity of the measurement current will be reversed, and you will not be able to make correct measurements. Be especially careful when connecting clamp-type current sensors to the circuit under measurement, because it is easy to reverse the connection.
- Note that the frequency and phase characteristics of the current sensor affect the measured data.
- To measure the apparent power and power factor more accurately on an unbalanced three-phase circuit, we recommend that you use the three-voltage, three-current method (3V3A).

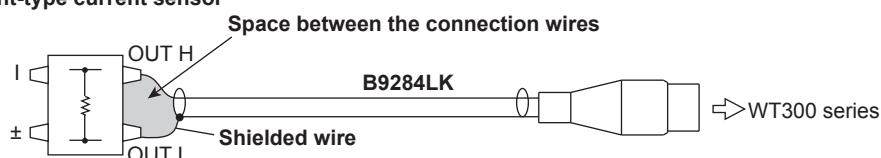
Notes about Using Shunt-type Current Sensors and Clamp-on Probes

Connecting an External Current Sensor Cable

To minimize error when using shunt-type current sensors, follow the guidelines below when connecting the external current sensor cable.

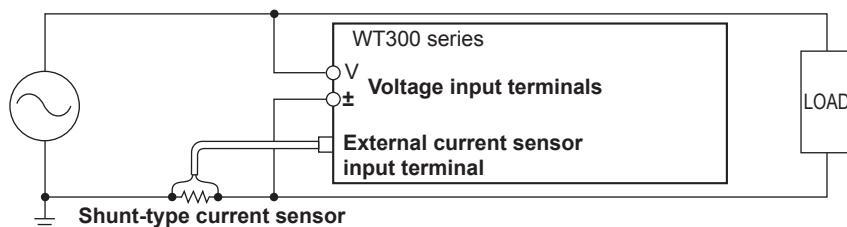
- Connect the shielded wire of the external current sensor cable to the L side of the shunt output terminal (OUT).
- Minimize the area of the space between the wires connecting the current sensor to the external current sensor cable. This reduces the effects of the lines of magnetic force (which are caused by the measurement current) and the external noise that enter the space.

Shunt-type current sensor



Position on the (Grounded) Circuit under Measurement That You Should Connect the Shunt-type Current Sensor To

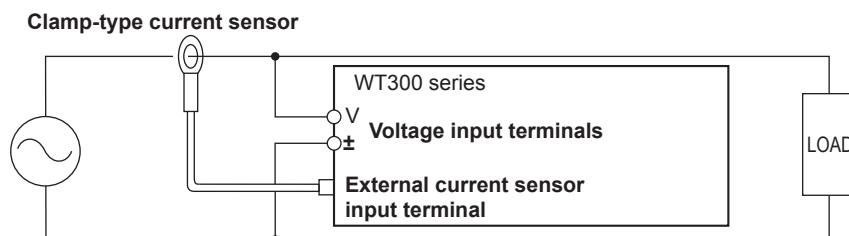
Connect the shunt-type current sensor to the power earth ground as shown in the figure below. If you have to connect the sensor to the non-earth side, use a wire that is thicker than AWG18 (with a conductive cross-sectional area of approximately 1 mm²) between the sensor and the instrument to reduce the effects of common mode voltage. Take safety and error reduction into consideration when constructing external current sensor cables.



2.10 Wiring the Circuit under Measurement When Using Current Sensors

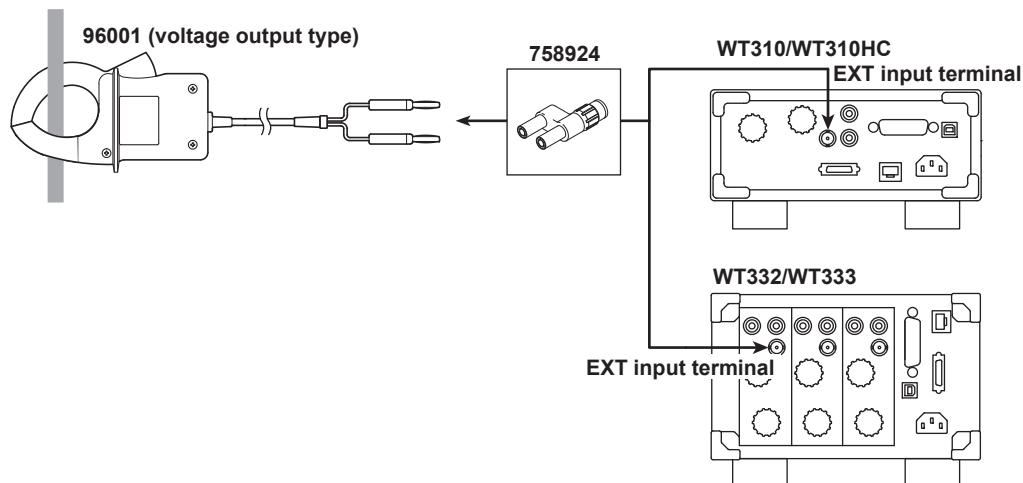
Ungrounded Measurement Circuits

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



Connecting the 96001 Clamp-on Probe

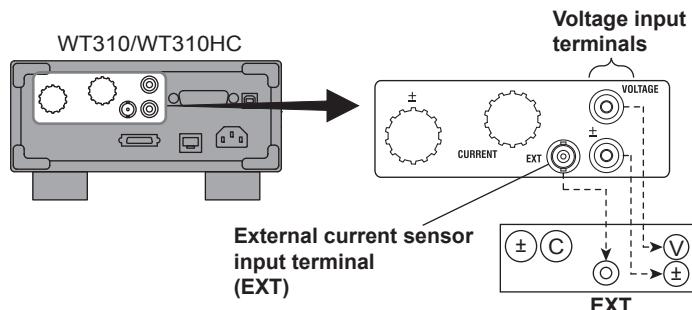
When using the Yokogawa 96001 Clamp-on Probe, use the 758924 Conversion Adapter (optional accessory).



2.10 Wiring the Circuit under Measurement When Using Current Sensors

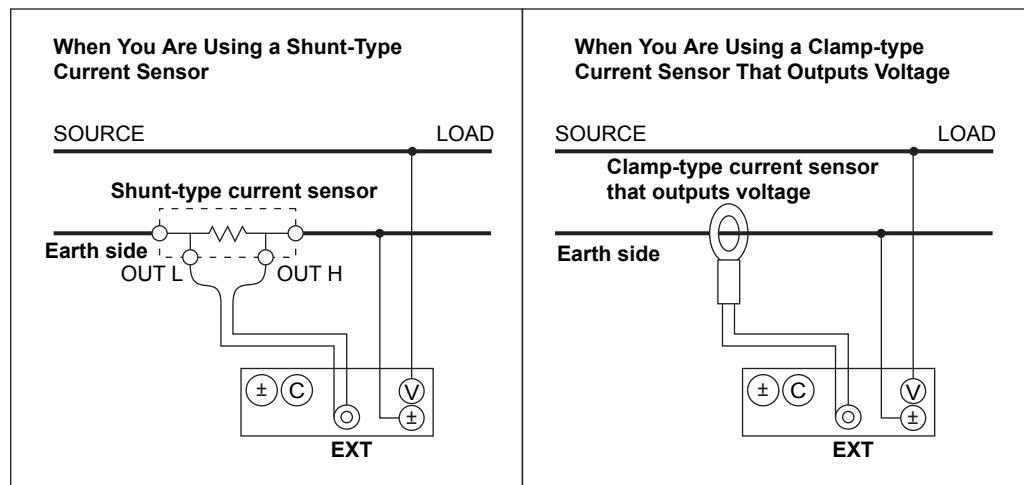
Connecting to the WT310/WT310HC

In the wiring examples that follow, the WT310/WT310HC input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.

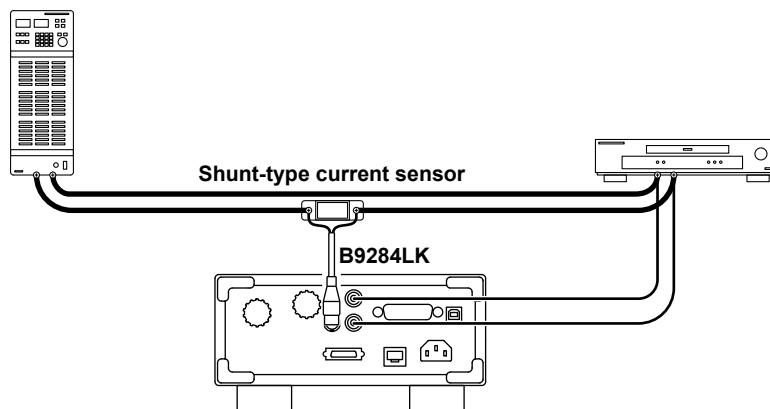


Wiring Example

The following figures show how to connect to the WT310/WT310HC.



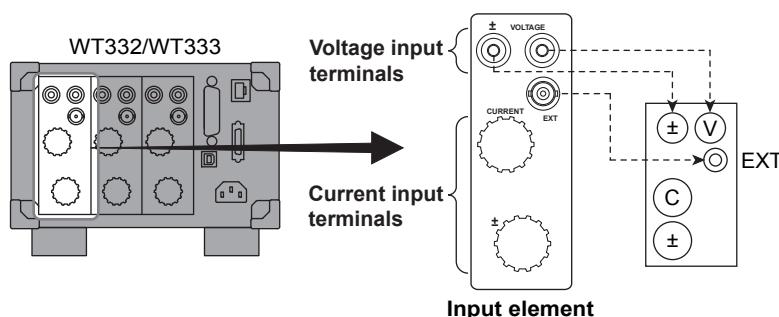
When you use a shunt-type current sensor in the wiring configuration shown at the bottom of page 2-21, the configuration changes as shown in the figure below.



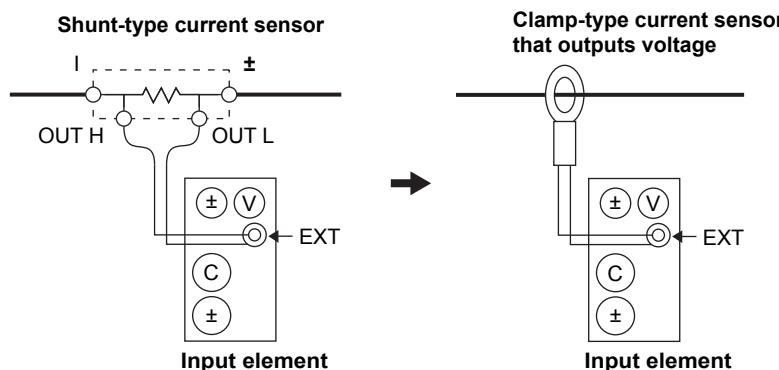
2.10 Wiring the Circuit under Measurement When Using Current Sensors

Connecting to the WT332/WT333

In the wiring examples that follow, the WT332/WT333 input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.

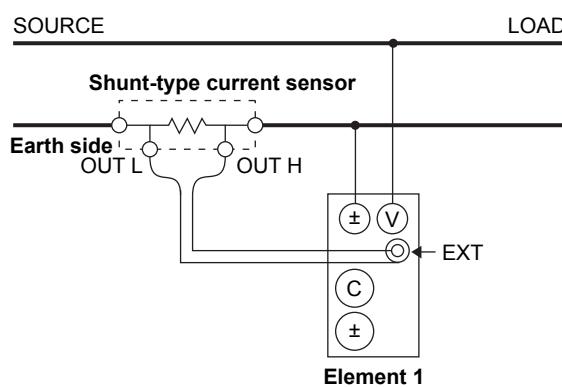


Also, the wiring example is for when a shunt-type current sensor is connected. When connecting a clamp-type current sensor that outputs voltage, substitute the shunt-type current sensor with the clamp-type current sensor.



Wiring Example of a Single-Phase, Two-Wire System (1P2W) with a Shunt-Type Current Sensor

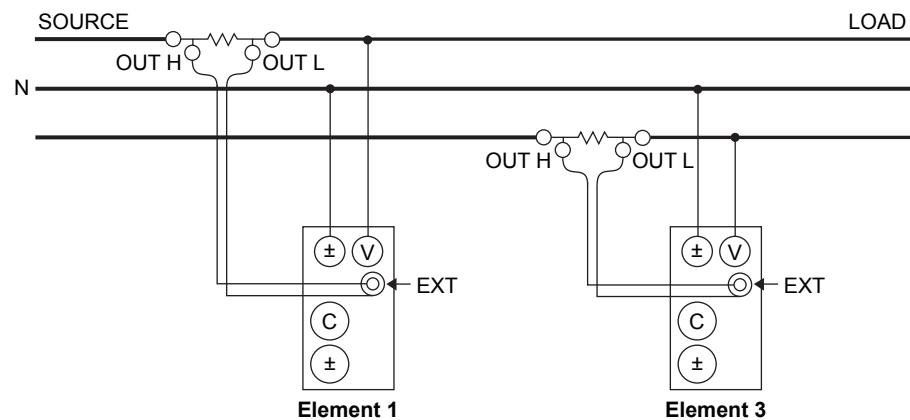
The following wiring example shows how to configure the wiring to connect to input element 1. To configure the wiring for other input elements, substitute the numbers in the figures with the appropriate element numbers.



2.10 Wiring the Circuit under Measurement When Using Current Sensors

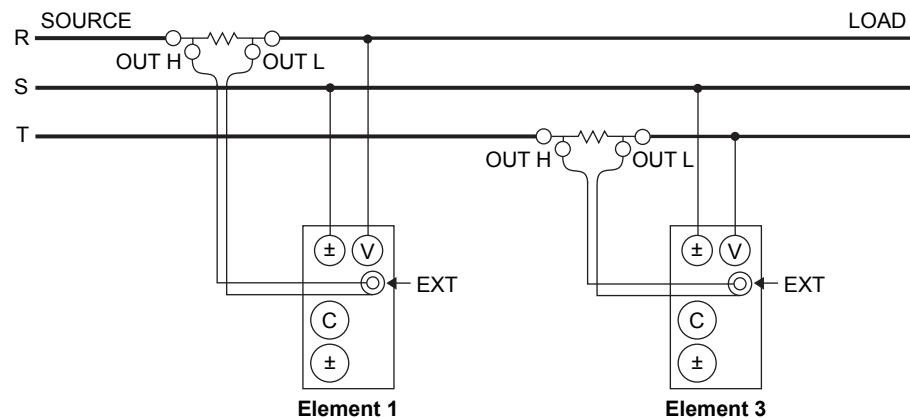
Wiring Example of a Single-Phase, Three-Wire System (1P3W) with Shunt-Type Current Sensors

The wiring is connected to input elements 1 and 3.



Wiring Example of a Three-Phase, Three-Wire System (3P3W) with Shunt-Type Current Sensors

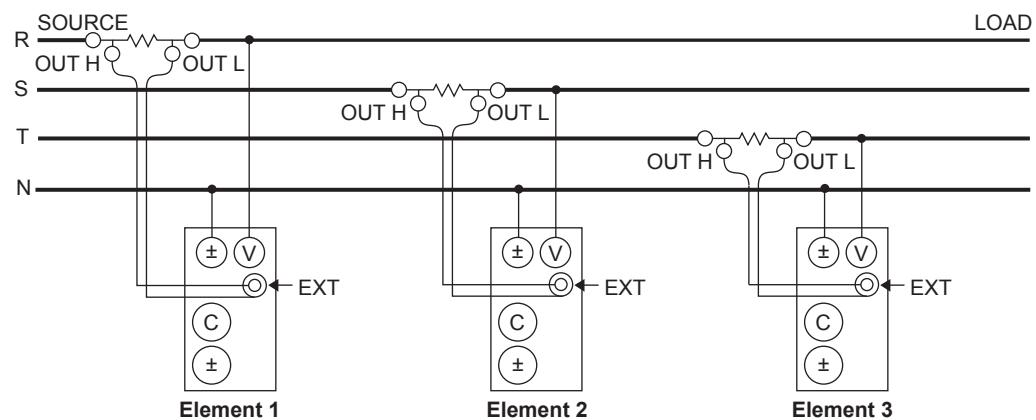
The wiring is connected to input elements 1 and 3. Measure the line voltage using S-phase power as the reference.



Wiring Example of a Three-Phase, Four-Wire System (3P4W) with Shunt-Type Current Sensors

Model: Applies to the WT333.

The wiring is connected to input elements 1, 2, and 3.

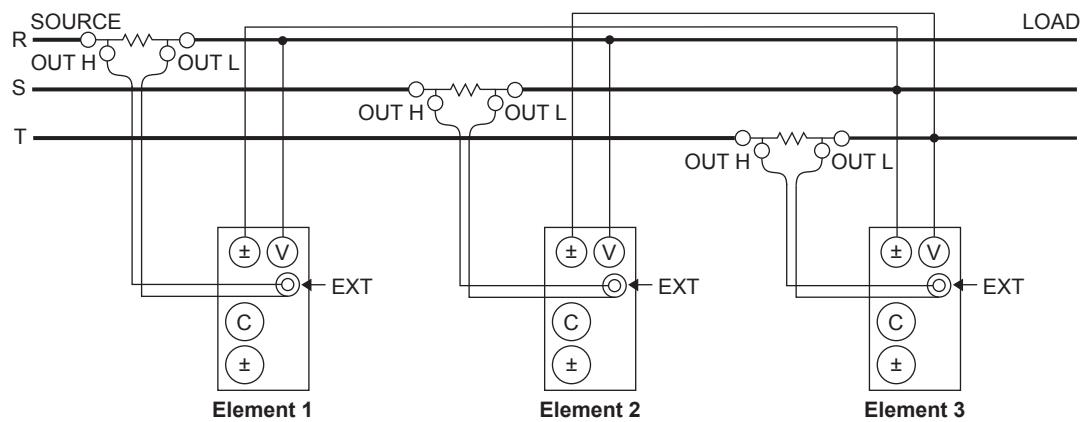


2.10 Wiring the Circuit under Measurement When Using Current Sensors

Wiring Example with the Three-Voltage, Three-Current Method (3V3A) and Shunt-Type Current Sensors

Model: Applies to the WT333.

The wiring is connected to input elements 1, 2, and 3.



Note

For details about the relationship between the wiring system and how measured and computed values are determined, see appendix 1, "Symbols and Determination of Measurement Functions."

2.11 Wiring the Circuit under Measurement When Using a Voltage or Current Transformer

This section explains how to wire measurement cables from external voltage transformers¹ or current transformers² to the voltage or current input terminals of input elements. Also refer to this section when wiring clamp-type current sensors that output current.

*1 VT (voltage transformer)

*2 CT (current transformer)

To prevent electric shock and damage to the instrument, follow the warnings given in section 2.5, "Precautions When Wiring the Circuit under Measurement."

Voltage Measurement

When the maximum voltage of the circuit under measurement exceeds 600 Vrms, you can perform measurements by connecting an external VT to the voltage input terminal.

Current Measurement

If the maximum current of the circuit under measurement exceeds the maximum measurement range, you can measure the current of the circuit under measurement by connecting an external CT or a clamp-type sensor that outputs current to the current input terminal.

- WT310 and WT332/WT333
 - When the maximum current exceeds 20 Arms
- WT310HC
 - When the maximum current exceeds 40 Arms

Connecting to the Input Terminals

Voltage Input Terminals

The terminals are safety banana jacks (female) that are 4 mm in diameter.

Only insert a safety terminal whose conductive parts are not exposed into a voltage input terminal.

If you are using the included 758931 Safety Terminal Adapter, see section 2.6.

Current Input Terminals

- The terminals are binding posts, and the screws are M6. Either wind a wire around a screw or pass a crimped terminal through the screw axis, and then tighten firmly with the terminal knob.
- For the dimensions of the terminal parts, see section 2.9.
- When the voltage of the circuit under measurement is being applied to the current input terminals, do not touch the external current sensor input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.
- When connecting a measurement cable from an external current sensor to an external current sensor input terminal, remove the cables connected to the current input terminals. Also, when the voltage of the circuit under measurement is being applied to the external current sensor input terminals, do not touch the current input terminals. Doing so is dangerous because the terminals are electrically connected inside the instrument.
- For the precautions to follow when you connect the current input terminal and the crimping terminal and after you connect these terminals, see section 2.9.

General VT and CT Handling Precautions

- Do not short the secondary side of a VT. Doing so may damage it.
- Do not short the secondary side of a CT. Doing so may damage it.

Also, follow the VT or CT handling precautions in the manual for the VT or CT that you are using.

2.11 Wiring the Circuit under Measurement When Using a Voltage or Current Transformer



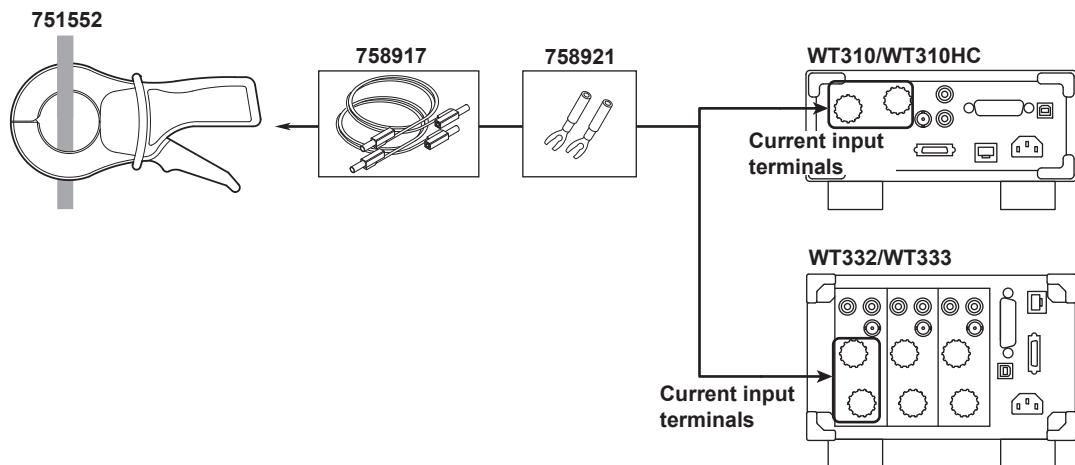
CAUTION

The thick lines on the wiring diagrams are the parts where the current flows. Use wires that are suitable for the current levels.

Note

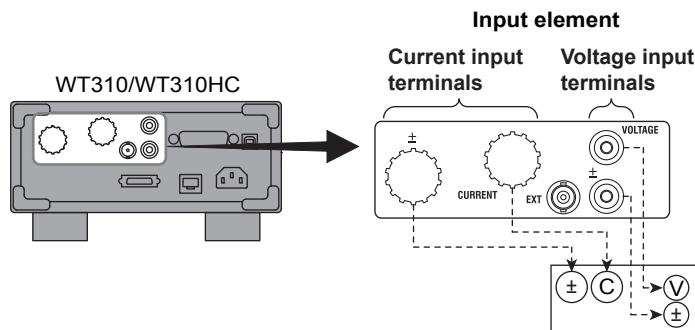
- Make sure that you have the polarities correct when you make connections. If the polarity is reversed, the polarity of the measurement current will be reversed, and you will not be able to make correct measurements. Be especially careful when connecting clamp-type current sensors to the circuit under measurement, because it is easy to reverse the connection.
- Note that the frequency and phase characteristics of the VT or CT affect the measured data.
- For safety reasons, the common terminals (+/-) of the secondary side of the VT and CT are grounded in the wiring diagrams in this section. However, the necessity of grounding and the grounding location (ground near the VT or CT or ground near the power meter) vary depending on the item under measurement.
- To measure the apparent power and power factor more accurately on an unbalanced three-phase circuit, we recommend that you use the three-voltage, three-current method (3V3A).

When using the Yokogawa 751552 Clamp-on Probe, use the 758917 Measurement Lead and the 758921 Fork Terminal Adapter Set (optional accessory).



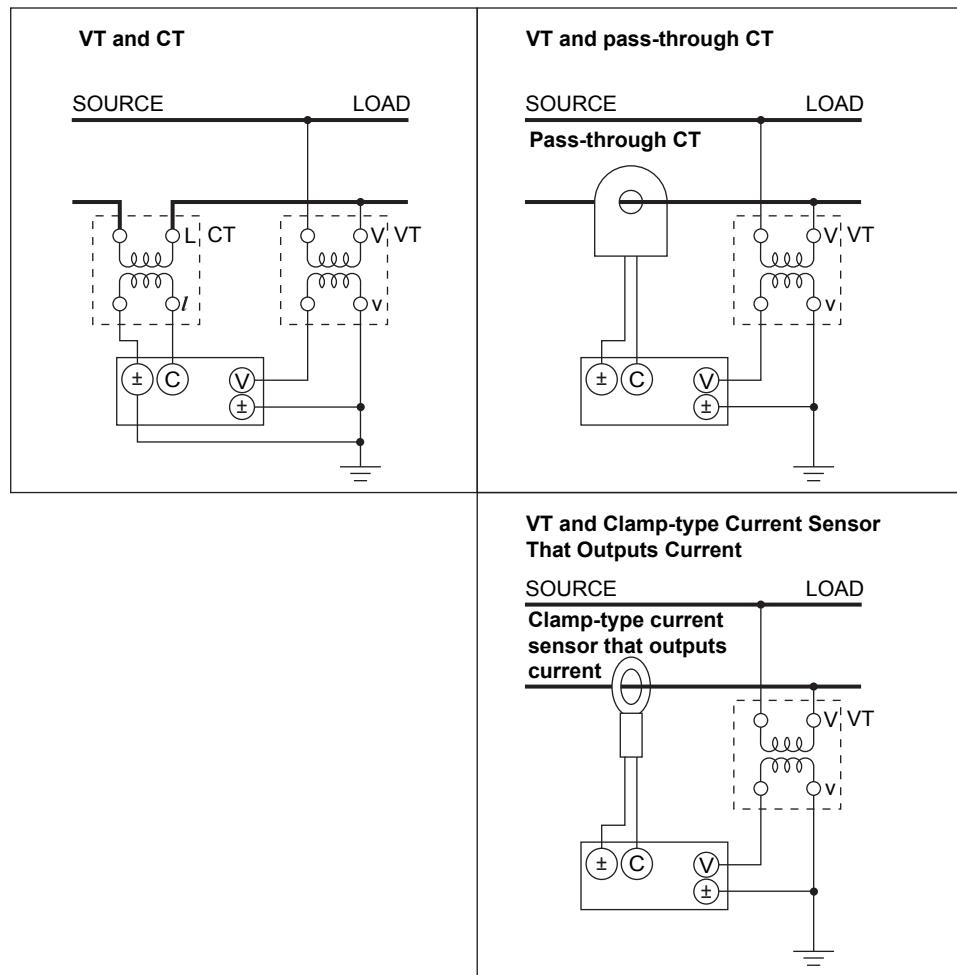
Connecting to the WT310/WT310HC

In the wiring examples that follow, the WT310/WT310HC input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.



Wiring Example

The following figures show how to connect to the WT310/WT310HC.



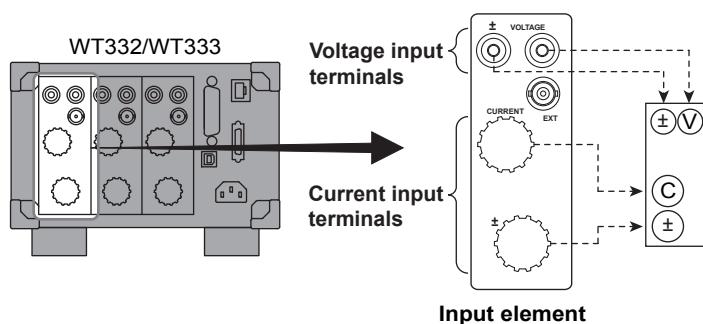
Note

Some CTs (including through types) require load resistance and power supplies. Check your CT's manual.

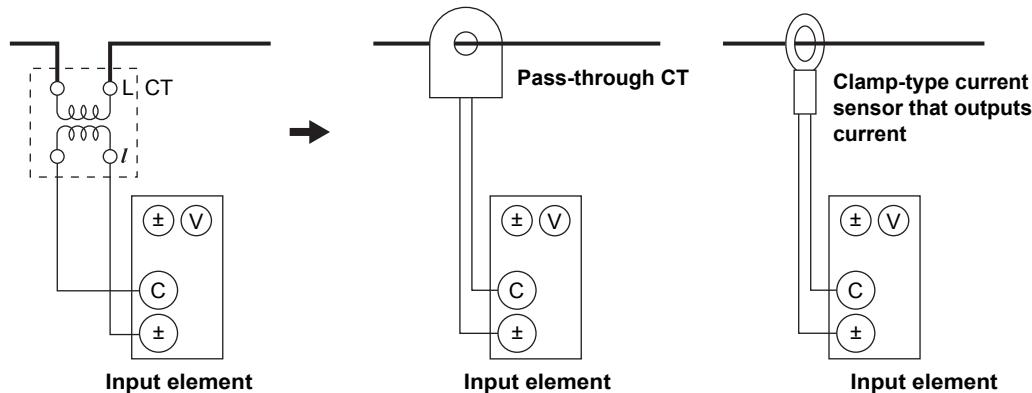
2.11 Wiring the Circuit under Measurement When Using a Voltage or Current Transformer

Connecting to the WT332/WT333

In the wiring examples that follow, the WT332/WT333 input elements, voltage input terminals, and current input terminals are simplified as shown in the following figure.

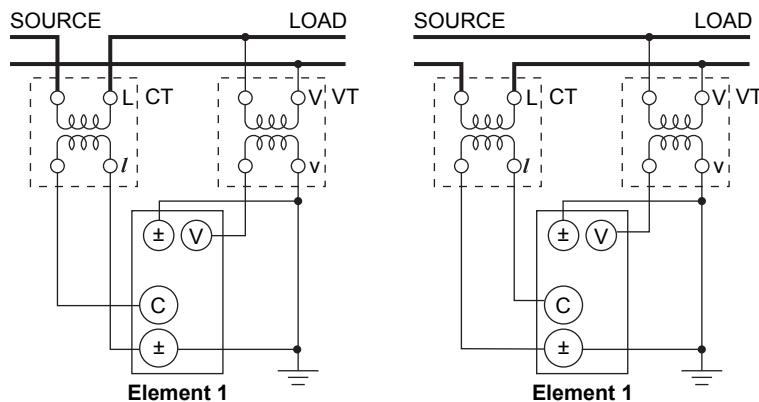


Also, the wiring examples are for when a CT is connected. When connecting a pass-through CT or a clamp-type current sensor that outputs current, substitute the CT with the pass-through CT or clamp-type current sensor.



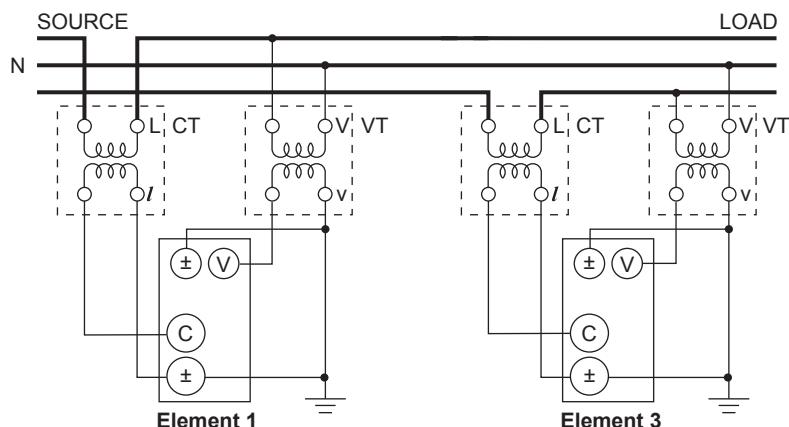
Wiring Example of Single-Phase, Two-Wire Systems (1P2W) with a VT and CT

The following wiring example shows how to configure the wiring to connect to input element 1. To configure the wiring for other input elements, substitute the numbers in the figures with the appropriate element numbers.



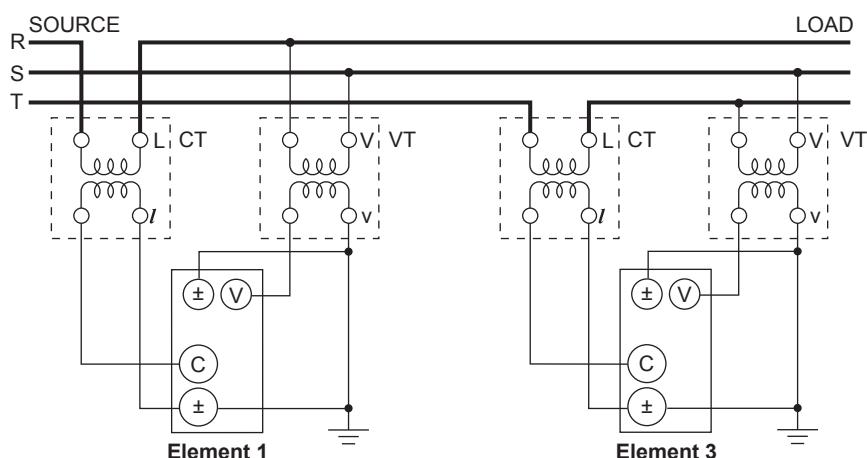
Wiring Example of a Single-Phase, Three-Wire System (1P3W) with VTs and CTs

The wiring is connected to input elements 1 and 3.



Wiring Example of a Three-Phase, Three-Wire System (3P3W) with VTs and CTs

The wiring is connected to input elements 1 and 3. Measure the line voltage using S-phase power as the reference.

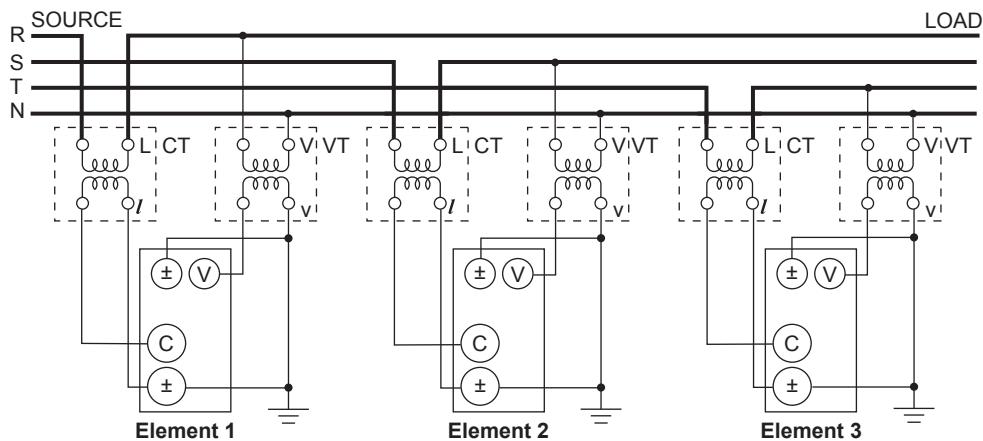


2.11 Wiring the Circuit under Measurement When Using a Voltage or Current Transformer

Wiring Example of a Three-Phase, Four-Wire System (3P4W) with VTs and CTs

Model: Applies to the WT333.

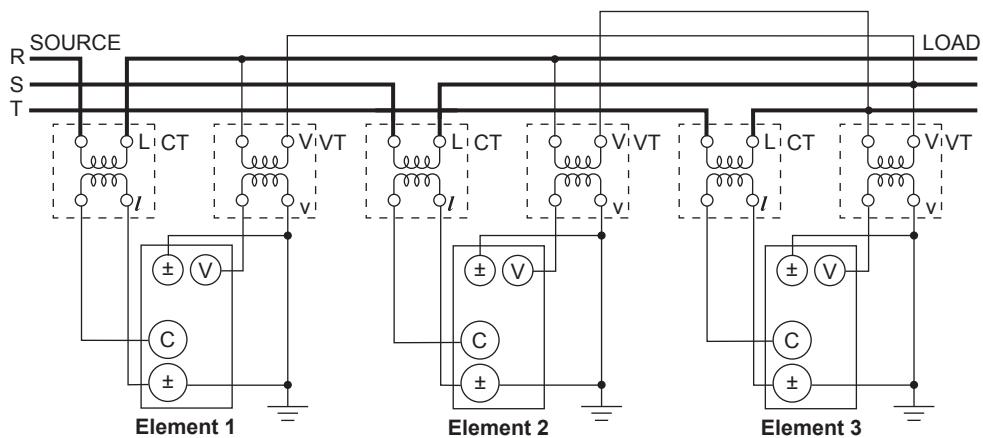
The wiring is connected to input elements 1, 2, and 3.



Wiring Example With the Three-Voltage, Three-Current Method (3V3A) and VTs and CTs

Model: Applies to the WT333.

The wiring is connected to input elements 1, 2, and 3.

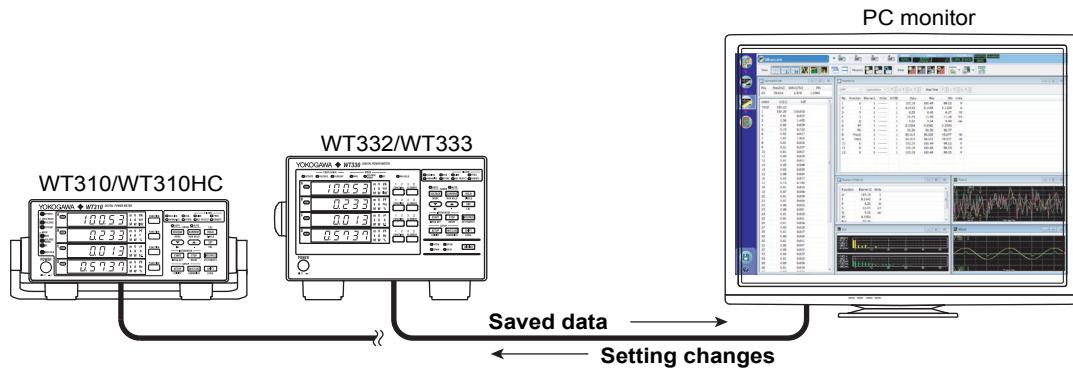


Note

For details about the relationship between the wiring system and how measured and computed values are determined, see appendix 1, "Symbols and Determination of Measurement Functions."

2.12 Connecting to a PC via USB (Installing WTVIEWERFREEPLUS)

When you connect the WT300 series to a PC, you can save measured data to the PC and change the WT300 series settings from the PC. In addition, you can use WTVIEWERFREEPLUS, which is a software application supplied with the WT300 series, to save measured data to the PC and change the WT300 series settings, without having to create original communication control programs.



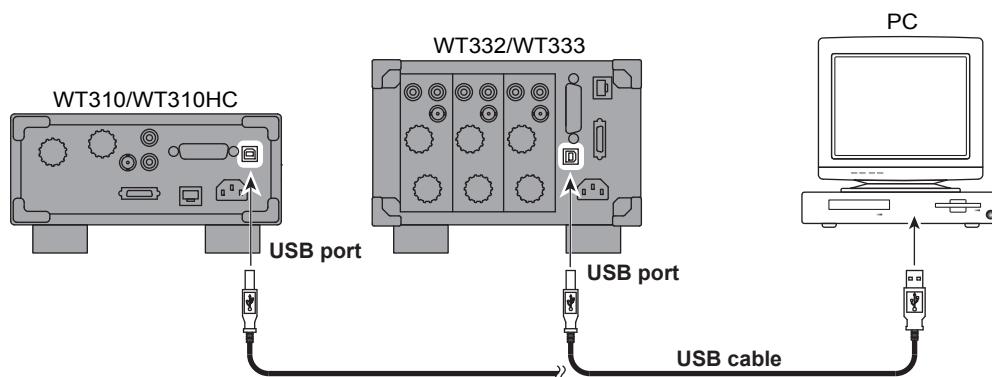
The WT300 series can be connected to a PC using the following communication interfaces.

- USB
- GP-IB
- RS-232
- Ethernet

This section explains how to connect the WT300 series to a PC via USB. To connect to a PC via a different communication interface, see chapter 4 in the WTVIEWERFREEPLUS User's Manual, IM 760121-02E.

Connecting the WT300 series to a PC via USB

Use a USB cable to connect the USB port for PCs (type B connector) on the rear panel of the WT300 series to the PC.



2.12 Connecting to a PC via USB (Installing WTViewerFreePlus)

Installing WTViewerFreePlus

Supported operating systems: English version of Windows Vista, Windows 7, Windows 8, or Windows 8.1

Have the CD that contains the software ready.

If an older version of WTViewerFreePlus has already been installed, uninstall it.

There is a PDF of the manual for the software on the CD in the Manuals folder. To view the manual, you need to have Adobe Reader installed.

Before you install the software, make sure that your PC meets the system requirements.

The following procedure explains how to install the software on Windows 7.

1. Turn on the PC and start Windows. Log on as an administrator.
2. Insert the installation disk that contains this software into the CD drive.
3. On the PC, select the CD drive.
4. Double-click WTViewerFreePlus_Installer.exe. The InstallShield wizard will start.



5. Follow the instructions on the screen to install the software.
The following two items will be installed, one after the other.
 - WTViewerFreePlus
 - YKMUSB (USB driver)
6. On Windows Vista or Windows 7, the “User Account Control” window will appear during the installation. Click Allow or Yes to continue the installation.
7. After the installation finishes, a new WTViewerFreePlus folder is added to the Start menu in Windows. You can open the folder by clicking the Start button, All Programs, YOKOGAWA, and then WTViewerFreePlus.

Starting WTViewerFreePlus

1. Before you start WTViewerFreePlus, turn on the WT300 series.
2. To start WTViewerFreePlus, click the **Start** button, **All Programs**, **YOKOGAWA**, **WTViewerFreePlus**, and then **WTViewerFreePlus**. After you start WTViewerFreePlus, it will automatically identify the WT300 series devices that you can connect to and will display them in the upper left of the screen.

Note

The WT300 series will not be automatically detected if you turn it on after starting WTViewerFreePlus.

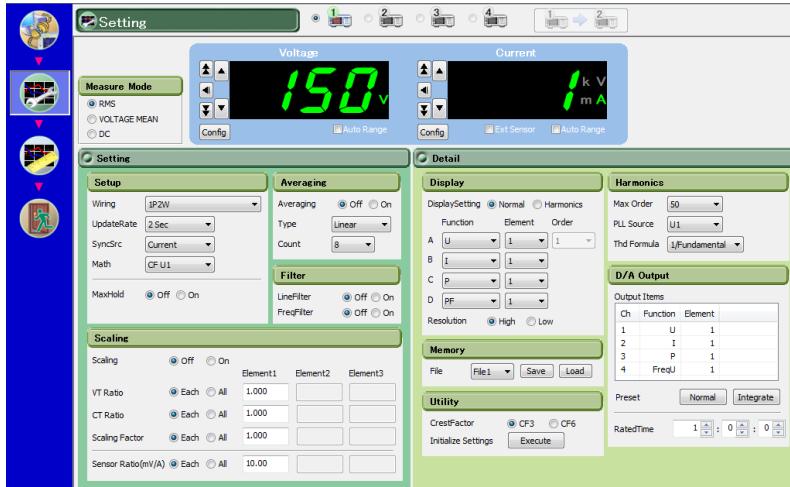
3. Select the WT300 series that you want to connect to.

2.12 Connecting to a PC via USB (Installing WTVIEWERFREEPLUS)

For information on how to display measured data and change the WT300 series settings from WTVIEWERFREEPLUS, see chapters 5 and 6 in the WTVIEWERFREEPLUS User's Manual, IM 760121-02E.

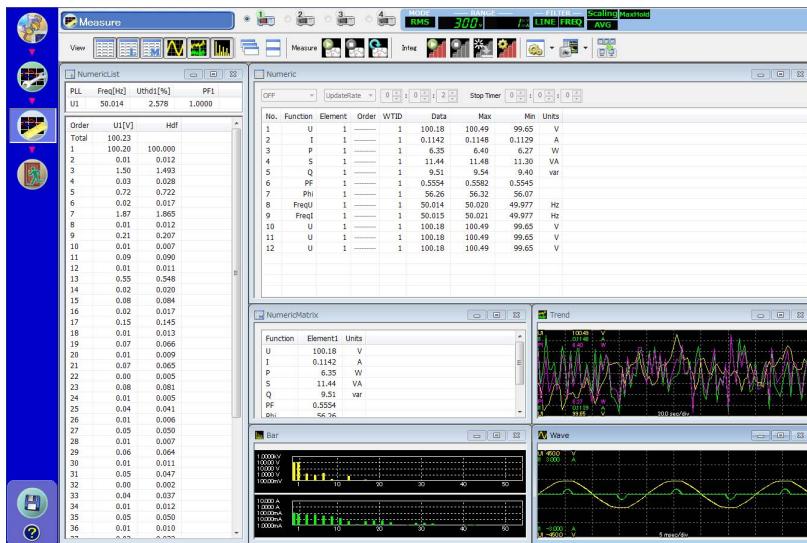
Example of a Window for Configuring the WT300 series

You can change the WT300 series settings from a PC.



Example of a Window Showing the Measured Data of the WT300 series

You can display multiple measured data items at the same time and save measured data to files.



3.1 Key Operation and Functions

Key Operations

Selecting Which Function to Display

Press **FUNCTION** to select which function to display.

Each time you press FUNCTION, the displayed function changes in the order shown below.

Display

A → V → A → W → VA → var → TIME

B → V → A → W → PF → °

C → V → A → W → Vpk(+) → Vpk(-) → Apk(+) → Apk(-) → Wpk(+) →
Wpk(-)
MATH ← Ah±(-) ← Ah±(+) ← Ah ← Wh±(-) ← Wh±(+) ← Wh ←

D → V → A → W → PF → VHz → AHZ → THD V% → THD A%

- Vpk, Apk, Wpk, Wh±, and Ah± are all displayed twice. The first time is for the positive measurements and the second time is for the negative measurements.
- MATH and THD are displayed on the left side of the 7-segment LED display.
- Press SHIFT before pressing FUNCTION to change the displayed function in reverse order.

Selecting Which Element to Display (Only on the WT332/WT333)

Press **ELEMENT** to select which element to display.

Each time you press ELEMENT, the input element changes in the order shown below.

The WT310 and WT310HC only have one input element, so there is no input element selection.

WT332

(two input element model)

→ 1 → 3 → Σ

WT333

(three input element model)

→ 1 → 2 → 3 → Σ

Setup and Execution Keys

How to Use the Setup Menus That Appear When Setup Keys Are Pressed

1. Press a setup key to display the setup menu that corresponds to that key.
2. Use ▲ or ▼ to select an item.
3. Press **SET** to confirm the item that you selected or set. If there are more items to set, those items will appear. If you have finished configuring the settings and there are no more items to set, you will return to the previous menu level or to the measurement data display.

How to Display the Setup Menus That Are Written in Purple below the Keys

In the explanations in this manual, “SHIFT+key name (written in purple)” is used to indicate the following operation.

1. Press **SHIFT**. The SHIFT key illuminates to indicate that the keys are shifted.
Now you can select the setup menus and functions written in purple below the keys.
2. Press the desired setup or execution key.

Using the ▲ and ▼ Keys

The operation varies as indicated below depending on what you are setting.

- When you are setting a value, you can use the keys to increase and decrease the value.
- When you are selecting a setting to configure, you can use the keys to change the selected setting.

SET Key Operation

Press **SET** to confirm the selected item.

ESC Key Operation

Press **HOLD (ESC)** while a setup menu is displayed to close the setup menu and return to the measurement data display. All setting changes that you have confirmed by pressing the SET key will be reflected in the settings.

Execution Key Operations

Press the **HOLD**, **START**, or **STOP** key to execute the specified feature.

3.2 Entering Values

Selecting a Value

The digit that is blinking is the one that is currently being set.

Use ▲ or ▼ to select a number.

Moving the Digit That Is Being Set

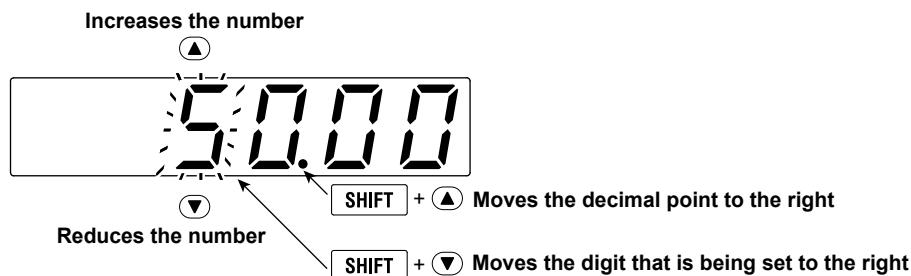
Press SHIFT+▼ (►) to move the digit that is being set to the right.

If you press SHIFT+▼ (►) when the digit that is being set is the digit that is furthest to the right, the digit that is being set will switch to the leftmost digit that can be set.

Moving the Decimal Point

Press SHIFT+▲ (.) to move the decimal point to the right.

If you press SHIFT+▲ (.) when the decimal point is as far to the right as it can be, the decimal point will move to the leftmost possible position.



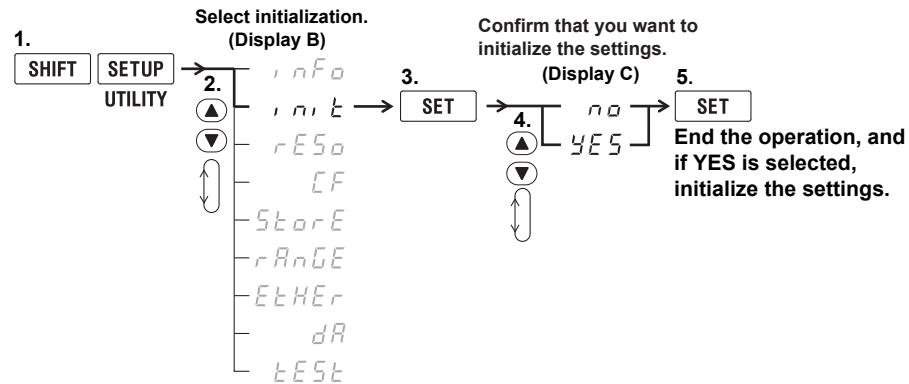
3.3 Initializing the Settings

WTViewerFreePlus 

This section explains how to reset the WT300 series settings to their factory default values. This feature is useful when you want to cancel all of the settings that you have entered or when you want to redo measurement from scratch.

Procedure

Follow the procedure indicated by the thick lines in the following menu.



Explanation

For details on initialization, see section 8.2 in the User's Manual, IM WT310-01E.

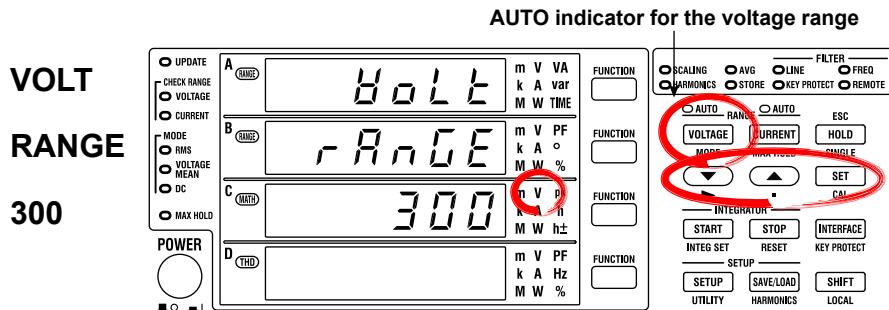
4.1 Setting the Measurement Ranges

For details, see section 2.3 in the User's Manual, IMWT310-01EN.

WTViewerFreePlus

To make accurate measurements, you need to set the measurement ranges (the voltage and current ranges) appropriately.

Setting the Voltage Range



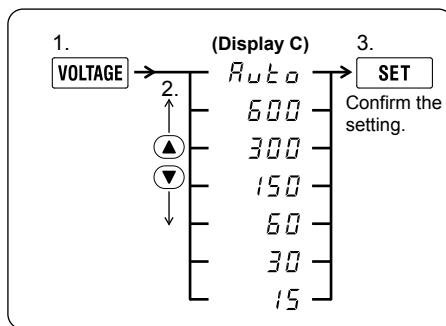
For information about the other digital numbers and characters that are displayed in the 7-segment LED displays, see section 1.3.

An illustration of the WT310/WT310HC is used in this explanation, but this operation can be performed using the same keys on the WT332/WT333.

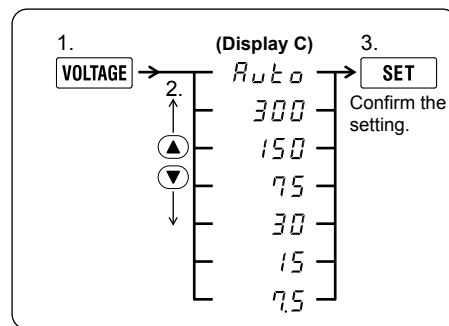
1. Press **VOLTAGE**.
The voltage range setup menu appears.
The selected voltage range blinks in display C.
If you previously set the voltage range to *RuLo* (the AUTO indicator for the voltage range is lit), the voltage range that has been automatically selected on the basis of the measured voltage blinks.
2. Press **▼** or **▲** to display the voltage range that you want to select in display C.
3. Press **SET**.
The voltage range is confirmed, and each of the displays returns to showing measured values.

The figures below show steps 1 to 3 in flowcharts. The User's Manual, IM WT310-01EN, uses these types of flowcharts to explain procedures.

When the Crest Factor Is Set to 3



When the Crest Factor Is Set to 6

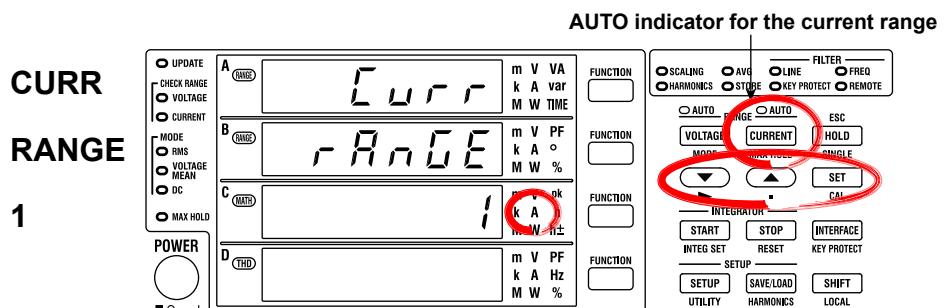


Note

In addition to the above operation, you can also change the voltage range without displaying the voltage range setup menu. For details, see section 2.3 in the User's Manual, IM WT310-01EN.

4.1 Setting the Measurement Ranges

Setting the Current Range



For information about the other digital numbers and characters that are displayed in the 7-segment LED displays, see section 1.3.

An illustration of the WT310/WT310HC is used in this explanation, but this operation can be performed using the same keys on the WT332/WT333.

1. Press **CURRENT**.

The current range setup menu appears.

The selected current range blinks in display C.

If you previously set the current range to **RuEto** (the AUTO indicator for the current range is lit), the current range that has been automatically selected on the basis of the measured current blinks.

2. Press **▼** or **▲** to display the current range that you want to select in display C.

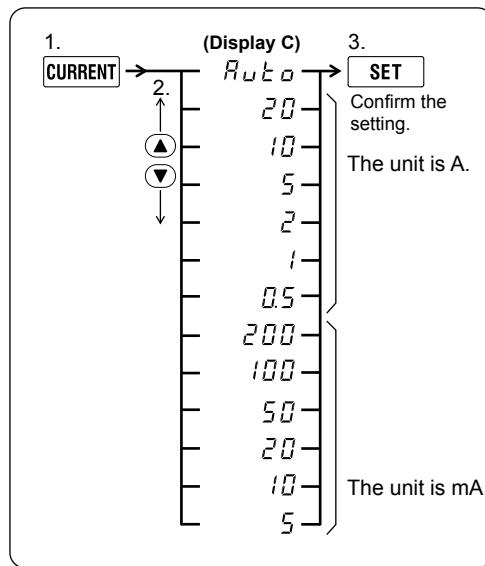
3. Press **SET**.

The current range is confirmed, and each of the displays returns to showing measured values.

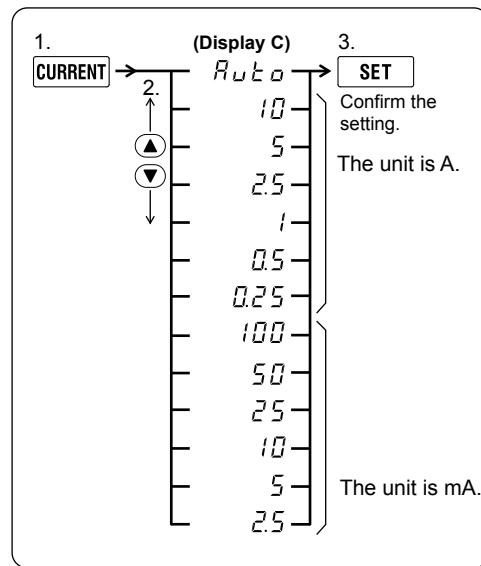
The figures below show steps 1 to 3 in flowcharts. The User's Manual, IM WT310-01EN, uses these types of flowcharts to explain procedures.

WT310 Current Ranges

When the Crest Factor Is Set to 3



When the Crest Factor Is Set to 6

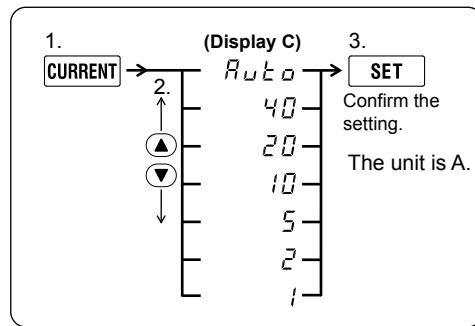


There are more ranges to choose from on models with the /EX1 or /EX2 option. For details, see section 2.4 in the User's Manual, IM WT310-01EN.

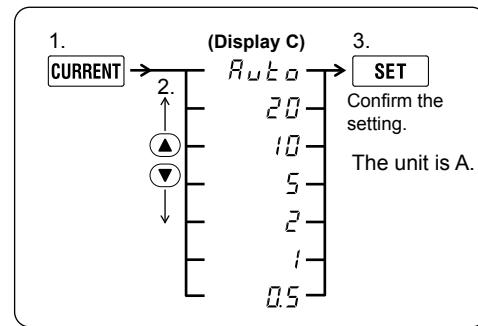
4.1 Setting the Measurement Ranges

WT310HC Current Ranges

When the Crest Factor Is Set to 3



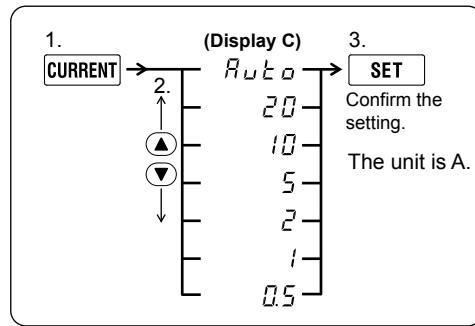
When the Crest Factor Is Set to 6



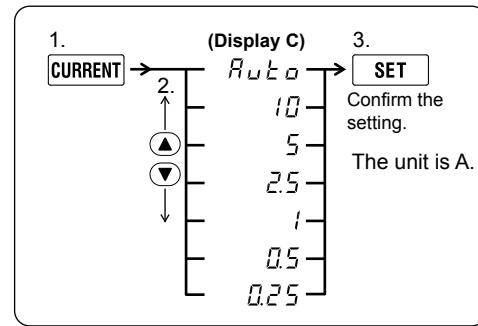
There are more ranges to choose from on models with the /EX1 or /EX2 option. For details, see section 2.4 in the User's Manual, IM WT310-01EN.

WT332/WT333 Current Ranges

When the Crest Factor Is Set to 3



When the Crest Factor Is Set to 6



There are more ranges to choose from on models with the /EX1 or /EX2 option. For details, see section 2.4 in the User's Manual, IM WT310-01EN.

Note

In addition to the above operation, you can also change the current range without displaying the current range setup menu. For details, see section 2.3 in the User's Manual, IM WT310-01EN.

4.2 Configuring the Wiring System Settings (Only on the WT332/WT333)

For details, see section 2.2 in the User's Manual, IMWT310-01EN.

WTViewerFreePlus 

On the WT332/WT333, you can set a wiring system that matches the connected circuit under measurement.

The wiring system on the WT310/WT310HC is a single-phase, two-wire system.

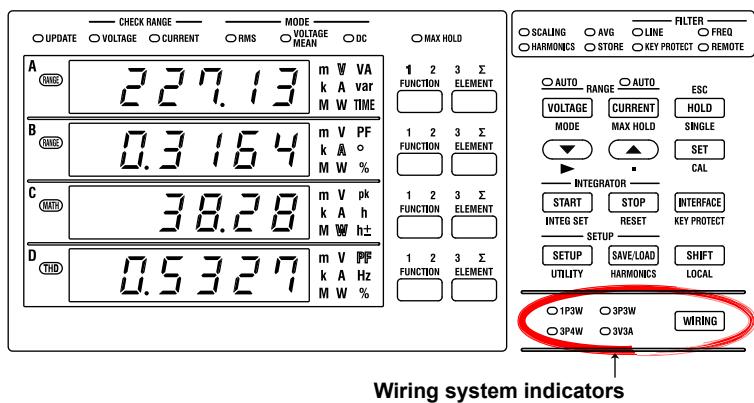
If you set the displayed function to input element Σ , the average current and voltage of each of the wired input elements and the total power of each of the input elements are displayed in accordance with the selected wiring system.*

* The current and voltage values do not have any physical meaning.

See appendix 1 for the formula that is used to determine the total power.

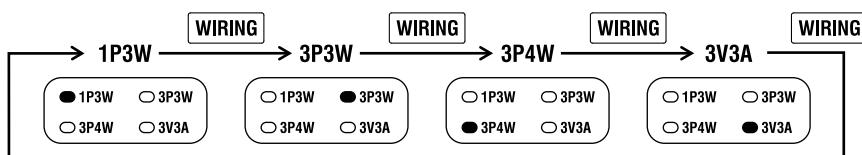
For the procedure for selecting input element Σ , see section 4.4.

Configuring the Wiring System Settings



Press **WIRING** to select "3P3W" as the wiring system.

When you press **WIRING**, the wiring system indicators light in the following order.



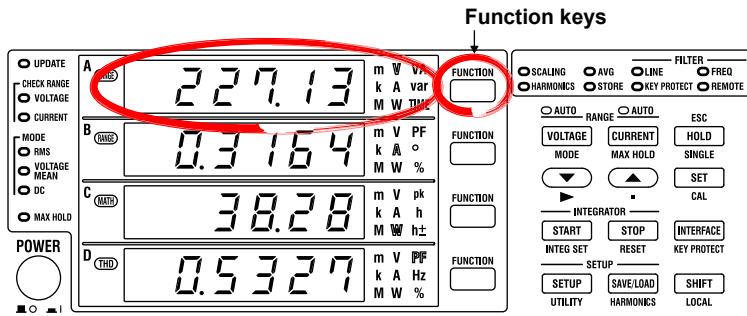
4.3 Displaying the Voltage, Current, and Active Power on the WT310/WT310HC

For details, see section 4.1 in the User's Manual, IMWT310-01EN.



After you select the measurement ranges (the voltage and current ranges), select the measurement items that you want to show in each display.

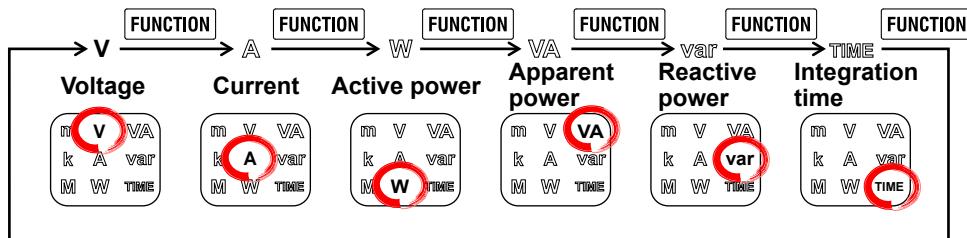
Displaying the Voltage in Display A on the WT310/WT310HC



Press the **FUNCTION** key for display A, and select V.

When you press **FUNCTION**, the function and unit indicators for display A light in the following order. To display the voltage on display A, press the key until V lights.

Display A



The WT310/WT310HC moves the decimal point so that the measured value can be displayed using the number of digits available in display A. The unit prefix changes in accordance with the position of the decimal point.

- m: 10^{-3}
- k: 10^3
- M: 10^6

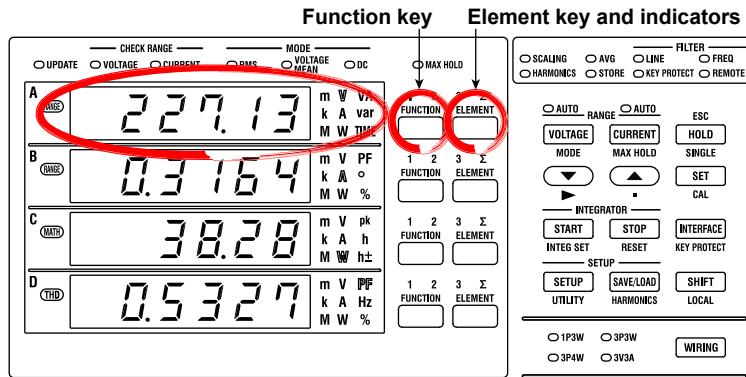
4.4 Displaying Voltages, Currents, and Active Powers on the WT332/WT333

For details, see section 4.1 in the User's Manual, IMWT310-01EN.

WTViewerFreePlus 

After you select the measurement ranges (the voltage and current ranges), select the measurement items that you want to show in each display.

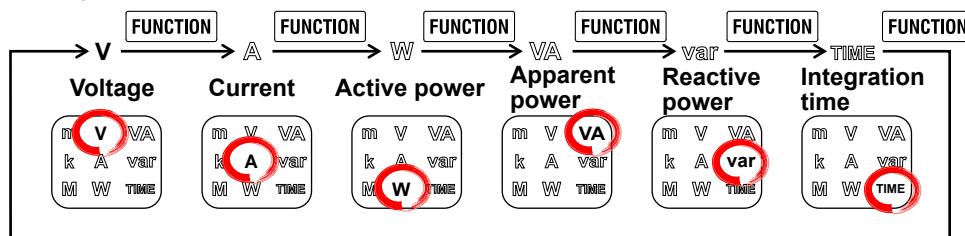
Displaying a Voltage in Display A on the WT332/WT333



- Press the **FUNCTION** key for display A, and select V.

When you press **FUNCTION**, the function and unit indicators for display A light in the following order. To display a voltage on display A, press the key until V lights.

Display A

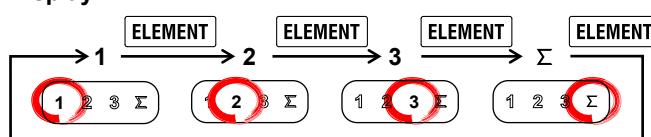


The WT3330 moves the decimal point so that the measured value can be displayed using the number of digits available in display A. The unit prefix changes in accordance with the position of the decimal point (m: 10^{-3}), k: 10^3 , M: 10^6).

- Press the **ELEMENT** key for display A to select input element 1, 2, 3, or Σ .

When you press **ELEMENT**, the element indicators for display A light in the following order.

Display A



* On the WT332 (the two input element model) element indicator 2 is skipped.

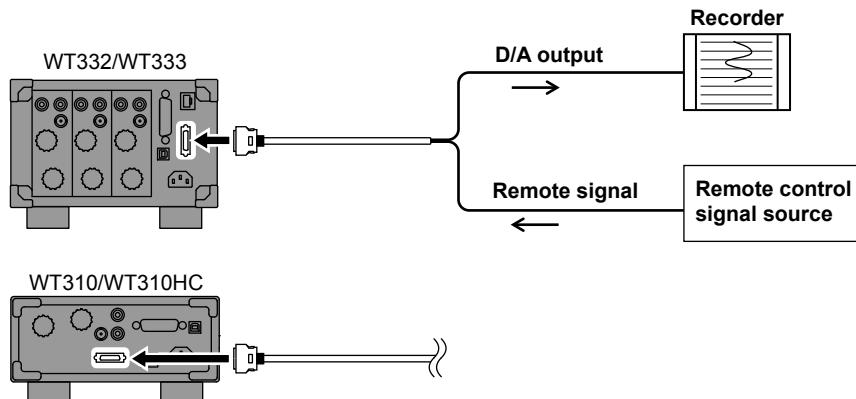
For example, in a three-phase, three-wire system, the circuit under measurement will be connected to input elements 1 and 3 on the WT332/WT333.

- The display for input element 1 shows the line voltage between phases R-S (see page 2-27).
- The display for input element 3 shows the line voltage between phases T-S (see page 2-27).
- The display for input element Σ shows the average of the line voltage between phases R-S and T-S. This value does not have any physical meaning.

5.1 External I/O Connector Pin Arrangement and Pinout

If you select the /DA4 or /DA12 option, D/A output and remote control features are installed in the WT300 series.

You can use the external I/O connector on the rear panel to control the WT300 series remotely and produce D/A output.



Remote Control



CAUTION

Only apply voltages that are within the range of 0 V to 5 V to the remote control input pins. Do not short or apply external voltages to the output pins. Doing so may damage the WT300 series.

D/A Output

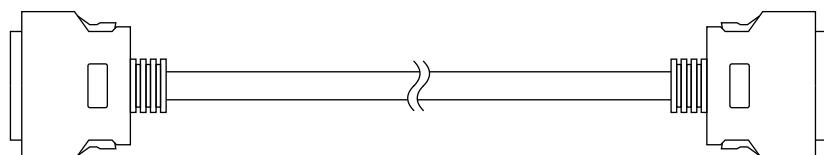


CAUTION

- Do not short or apply an external voltage to the D/A output terminal. Doing so may damage the WT300 series.
- When connecting the D/A output to another device, do not connect the wrong signal pin. Doing so may damage the WT300 series or the connected instrument.

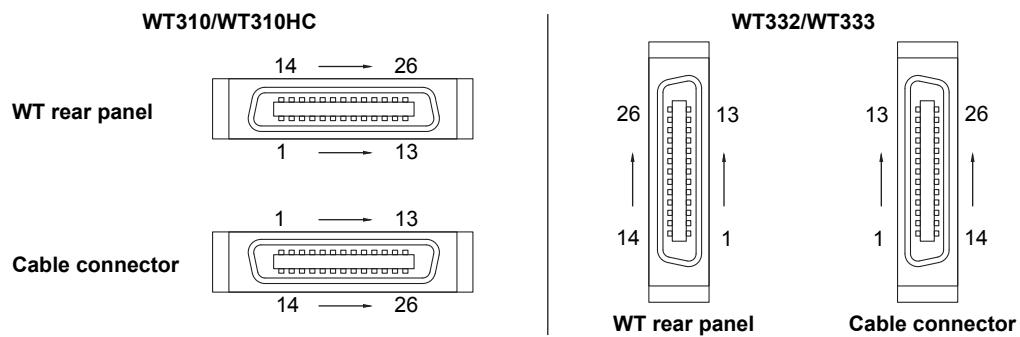
D/A Cable (705926)

Cut the D/A cable to the necessary length, strip the insulation around the internal core wires, and connect the cable to another device.



5.1 External I/O Connector Pin Arrangement and Pinout

Connector Pin Arrangement



Pinout

/DA4 (WT310/WT310HC)

Pin No.	Core Wire Color	Signal Name	Pin No.	Core Wire Color	Signal Name
1	Orange (Red 1)	EXT COM	14	Gray (Black 2)	EXT SINGLE (input)
2	Orange (Black 1)	EXT HOLD (input)	15	White (Red 2)	EXT STOP (input)
3	Gray (Red 1)	EXT START (input)	16	White (Black 2)	INTEG BUSY (output)
4	Gray (Black 1)	EXT RESET (input)	17	Yellow (Red 2)	No Connection
5	White (Red 1)	No Connection	18	Yellow (Black 2)	No Connection
6	White (Black 1)	No Connection	19	Pink (Red 2)	No Connection
7	Yellow (Red 1)	No Connection	20	Pink (Black 2)	No Connection
8	Yellow (Black 1)	No Connection	21	Orange (Red 3)	No Connection
9	Pink (Red 1)	No Connection	22	Orange (Black 3)	DA 4ch (output)
10	Pink (Black 1)	DA 3ch (output)	23	Gray (Red 3)	DA 2ch (output)
11	Orange (Red 2)	DA 1ch (output)	24	Gray (Black 3)	DA COM
12	Orange (Black 2)	DA COM	25	White (Red 3)	No Connection
13	Gray (Red 2)	DA COM	26	White (Black 3)	No Connection

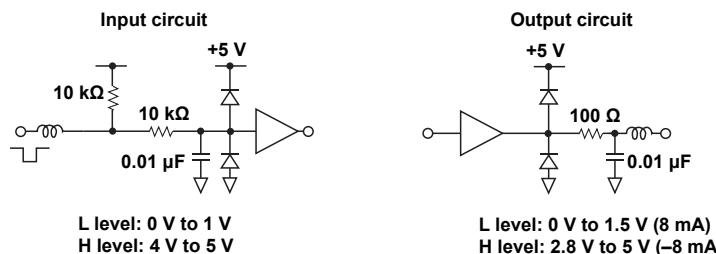
/DA12 (WT332/WT333)

Pin No.	Core Wire Color	Signal Name	Pin No.	Core Wire Color	Signal Name
1	Orange (Red 1)	EXT COM	14	Gray (Black 2)	EXT SINGLE (input)
2	Orange (Black 1)	EXT HOLD (input)	15	White (Red 2)	EXT STOP (input)
3	Gray (Red 1)	EXT START (input)	16	White (Black 2)	INTEG BUSY (output)
4	Gray (Black 1)	EXT RESET (input)	17	Yellow (Red 2)	No Connection
5	White (Red 1)	No Connection	18	Yellow (Black 2)	DA 12ch (output)
6	White (Black 1)	DA 11ch (output)	19	Pink (Red 2)	DA 10ch (output)
7	Yellow (Red 1)	DA 9ch (output)	20	Pink (Black 2)	DA 8ch (output)
8	Yellow (Black 1)	DA 7ch (output)	21	Orange (Red 3)	DA 6ch (output)
9	Pink (Red 1)	DA 5ch (output)	22	Orange (Black 3)	DA 4ch (output)
10	Pink (Black 1)	DA 3ch (output)	23	Gray (Red 3)	DA 2ch (output)
11	Orange (Red 2)	DA 1ch (output)	24	Gray (Black 3)	DA COM
12	Orange (Black 2)	DA COM	25	White (Red 3)	No Connection
13	Gray (Red 2)	DA COM	26	White (Black 3)	No Connection

Note

The EXT COM and DA COM signals are connected internally.

Remote Control I/O Circuit

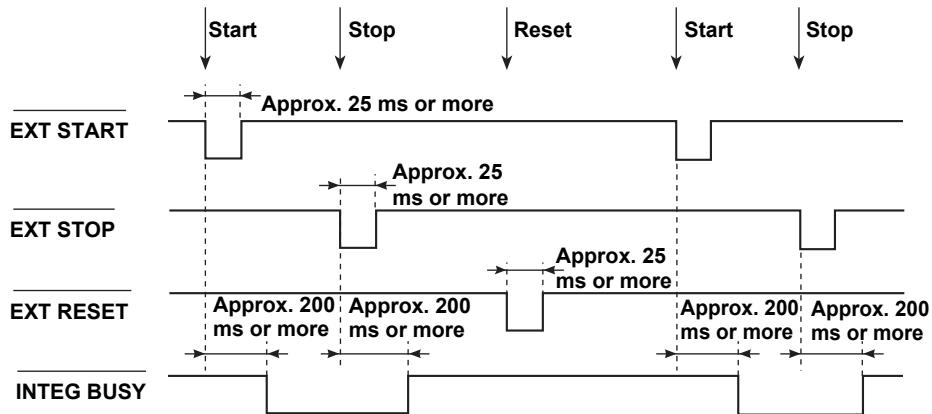


5.2 Controlling the WT300 series Remotely

Through external control, you can hold values, perform single measurements, and start, stop, and reset integration.

Controlling Integration Remotely

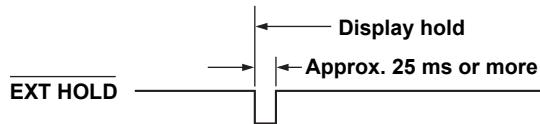
Apply signals according to the following timing chart.



The **INTEG BUSY** output signal is set to low level during integration.
Use this signal when you are observing integration.

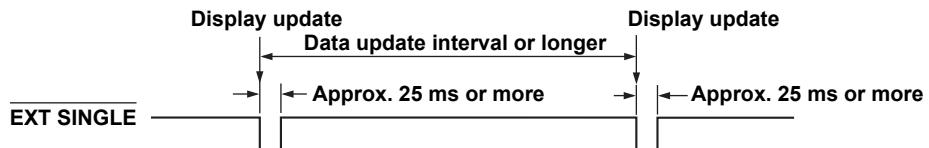
Holding the Updating of Displayed Data

This produces the same effect as pressing HOLD. Apply an EXT HOLD signal as shown in the following figure.



Updating Held Display Data

This produces the same effect as pressing SINGLE. While the display is being held, you can update it by applying an EXT SINGLE signal.



Note

If the period of the EXT SINGLE signal does not meet the conditions shown in the above figure, the signal may not be detected by the WT300 series.

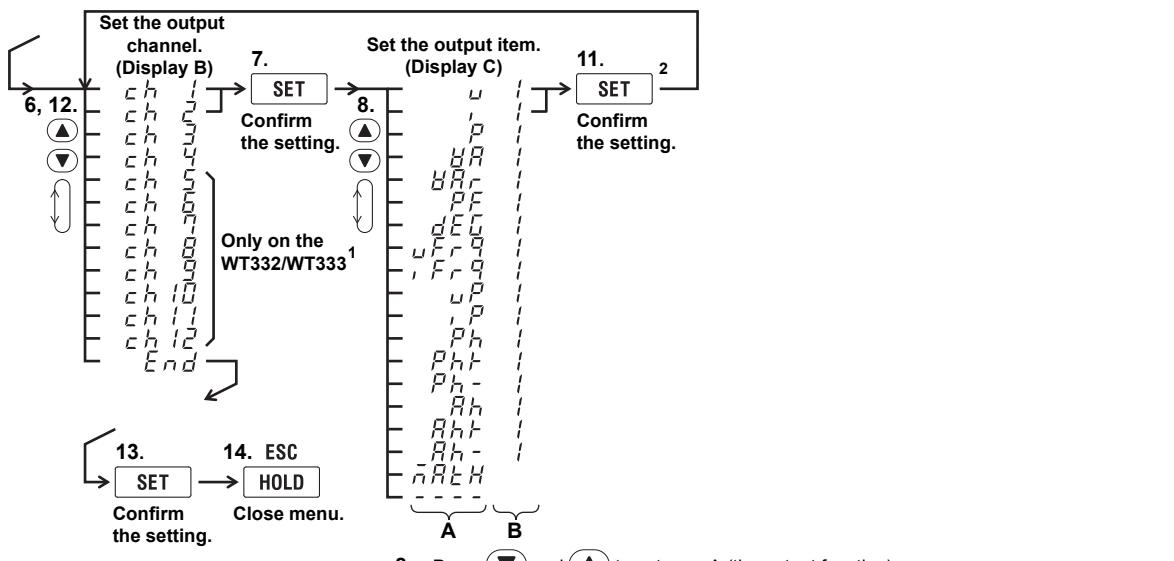
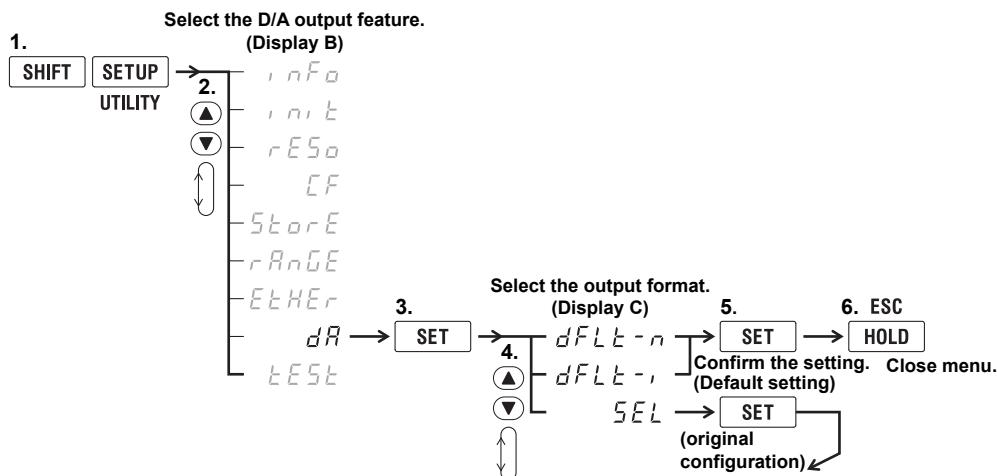
5.3 Producing D/A Output

WTViewerFreePlus

Procedure

Follow the procedure indicated by the thick lines in the following menu.

Setting the D/A Output Format



8. Press **▼** and **▲** to set area A (the output function).

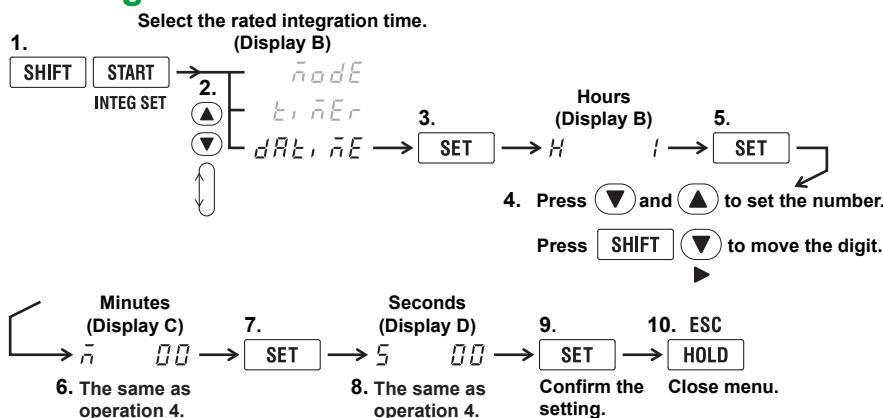
On the WT332/WT333, select the element in the following steps 9 and 10.

9. Press **SHIFT** **▼** to move to area B.

10. Press **▼** and **▲** to select an element (you cannot select an element for **RAH**).³

- 1 The number of channels varies depending on the specific option that is installed.
 - /DA4 option on the WT310/WT310HC: 4 channels
 - /DA12 option on the WT332/WT333: 12 channels
- 2 When you press SET in step 11, the output channel shown in display B changes to the next channel. For example, ch1 changes to ch2.
- 3 The numbers (element numbers) that you can select vary depending on the model. For details, see "Explanation" in this section.

Rated Integration Time



Note

If you operate the WT300 series frequently to configure settings such as the D/A output items and rated integration time, you can connect the WT300 series to a PC and use WTVIEWERFREEPLUS to easily configure settings from the PC.

Explanation

D/A Output

You can output voltage, current, active power, apparent power, reactive power, power factor, phase angle, frequency, voltage peak, current peak, and integrated values using a ±5 V FS DC voltage.

Number of Channels

The number of channels varies depending on the specific option that is installed.

- /DA4 option on the WT310/WT310HC: 4 channels
- /DA12 option on the WT332/WT333: 12 channels

Output Format

You can select a preconfigured output format or configure your own original format.

Using the Default Settings

Select one of the default settings to output preconfigured (default) items.

Default Values for Normal Measurement: dFLt-n

Select this setting to output normal measured values. The output settings are as follows:

	Suffix Code	/DA4	/DA12	
Product Name	WT310 WT310HC	WT332	WT333	
Output Channel	ch1	U1	U1	U1
	ch2	I1	-	U2
	ch3	P1	U3	U3
	ch4	fU	UΣ	UΣ
	ch5	1	I1	I1
	ch6		-	I2
	ch7		I3	I3
	ch8		IΣ	IΣ
	ch9		P1	P1
	ch10		-	P2
	ch11		P3	P3
	ch12		PΣ	PΣ

1 These channels cannot be set.

2 The numbers are used to indicate input elements 1, 2, and 3.

5.3 Producing D/A Output

Default Values for Integration: dFLt-i

Select this setting to output integrated values. The output settings are as follows:

	Suffix Code	/DA4	/DA12	
	Product Name	WT310 WT310HC	WT332	WT333
Output Channel	ch1	P1	P1	P1
	ch2	WP1	-	P2
	ch3	q1	P3	P3
	ch4	fU	PΣ	PΣ
	ch5	1	WP1	WP1
	ch6		-	WP2
	ch7		WP3	WP3
	ch8		WPΣ	WPΣ
	ch9		q1	q1
	ch10		-	q2
	ch11		q3	q3
	ch12		qΣ	qΣ

1 These channels cannot be set.

2 The numbers are used to indicate input elements 1, 2, and 3.

Configuring an Original Output Format

You can specify output items (output functions and elements) for each output channel.

Output Functions (Area A in step 8 in the procedural explanation for setting the D/A output format)

You can select from the following options.

u (voltage U), i (current I), P (active power P), VA (apparent power S),
VAr (reactive power Q), PF (power factor λ), dEG (phase angle Φ),
uFrq (voltage frequency fU), iFrq (current frequency fI),
uP (peak voltage value Upk), iP (peak current value Ipk),
Ph (sum of watt hours Wp), Ph+ (positive watt hour Wp+), Ph- (negative watt hour Wp-),
Ah (sum of ampere hours q), Ah+ (positive ampere hour* q+), Ah- (negative ampere hour* q-),
MATH (integration), ---- (0 V D/A output; no element is specified)

* For more information about positive and negative ampere hours, see page 5-4 of the User's Manual, IM WT310-01EN.

Elements (Area B in step 10 in the procedural explanation for setting the D/A output format)

Product Name	Element
WT310 or WT310HC	1
WT332	1, 3, or 4
WT333	1, 2, 3, or 4

Element number 4 represents Σ.

Rated Integration Time

In the D/A output of integrated values, 5.0 V FS represents the integrated value when the rated range value is applied for the rated integration time. The same is true if scaling is enabled or the value for Σ is being measured. The default setting is 1.00.00 (1 h, 0 min, 0 s).

- Range: 0.00.00 (00 h, 00 min, 00 s) to 10000.00.00 (10000 h, 00 min, 00 s)

If you set the rated integration time to 0.00.00, the D/A output value will be 0 V.

Note

- When the MAX hold feature (see section 4.6 in the User's Manual, IM WT310-01EN) is enabled, the maximum held values (MAX values) for the following items are displayed. The maximum held values (MAX values) are also output in D/A output.
 - Voltage, current, active power, apparent power, peak voltage, peak current
- D/A output is performed for each output item with 5.0 V FS representing the application of the rated range value for voltage, current, and power.
- Even when scaling constants are set for voltage, current, and power, the D/A output of 5.0 V FS represents the application of the rated range value.
- Even if the elements have different scaling constants, when you set the element to Σ , 5.0 V FS of D/A output represents the application of the rated range value to each element.
- The D/A output for all math functions except for those indicated below is 0 V.

Efficiency, average active power during integration

D/A Output Range Mode (Range Mode)

(For products with firmware version 1.04 and later)

You can select the D/A output range mode from the following options. The default setting is Fixed.

You can set this feature by sending communication commands through the communication interface.

You cannot set this feature from the WT300 series display menu. For details, see the Communication Interface User's Manual, IM WT310-17EN.

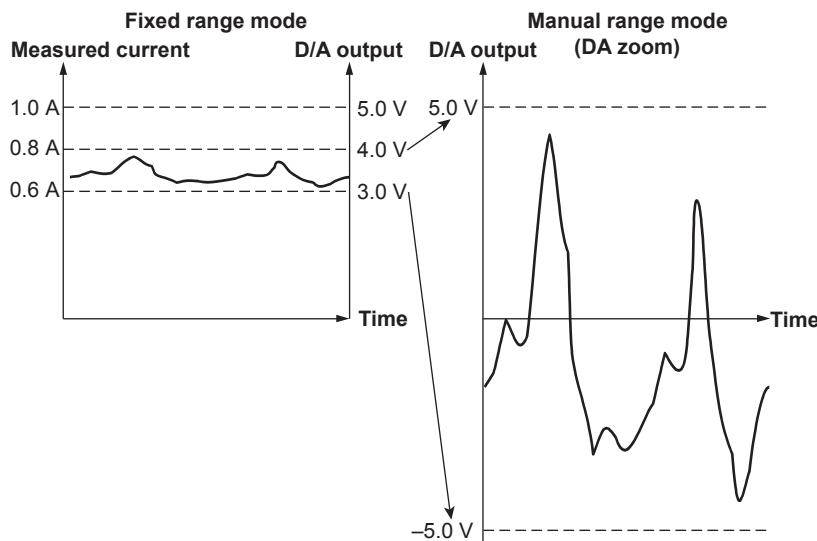
Fixed (Fixed range mode) The mode of the D/A output before firmware version 1.03

When a measurement function's rated value is received, +5 V is output. For details, see "Relationship between Output Items and the D/A Output Voltage" on page 5-9.

Manual (Manual range mode)

You can set which measurement function values result in a D/A output of -5 V, and which result in a D/A output of +5 V. By doing so, you can enlarge or reduce (zoom) the D/A output of each channel. For example, if you are measuring a current that fluctuates between 0.6 A and 0.8 A with a measurement range of 1 A, when the D/A output range mode is Fixed, the D/A output voltage will fluctuate between 3.0 V and 4.0 V. When you want to observe the fluctuations more closely, you can use the D/A zoom feature. If you set the D/A output range mode to Manual and set the minimum value to 0.6 and the maximum value to 0.8, the WT1800 will produce -5 V when the measured current value is 0.6 A and +5 V when the measured current value is 0.8 A.

5.3 Producing D/A Output



Compare (Comparator Mode)

By comparing with the comparator limits, the WT300 series outputs +5 V, 0 V, or -5 V. To replace the output with a relay contact output, like the WT210/WT230 comparator function, provide your own relay and relay driving circuit.

- Below the lower limit: -5 V output
- Greater than or equal to the lower limit and less than the upper limit: 0 V output
- Greater than or equal to the upper limit: +5 V output

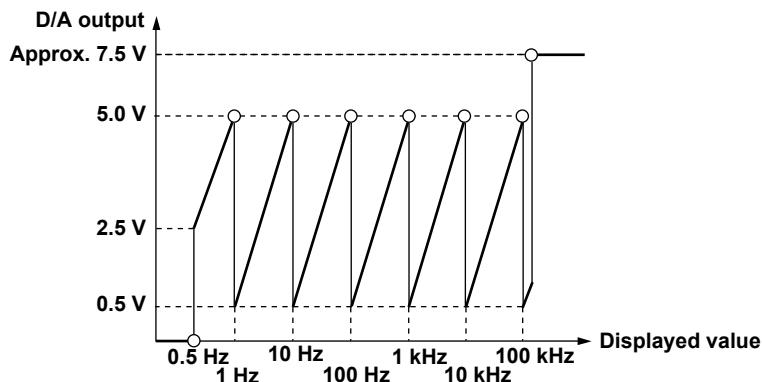
Maximum and Minimum Values in Manual Range Mode and Comparison Upper and Lower Limits in Comparator Mode

You can select a value between -9.999E+12 and 9.999E+12.

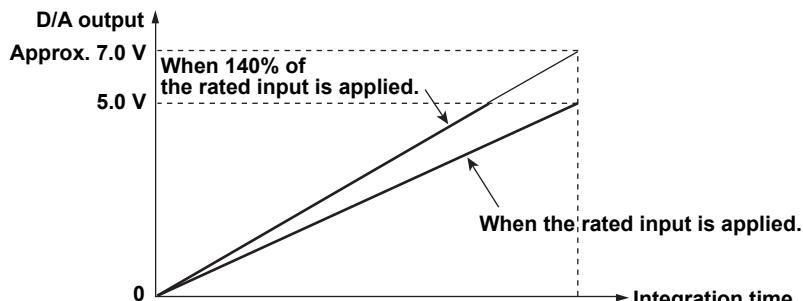
The default settings are shown below.

Manual Range Mode	Maximum Value	100.0
	Minimum Value	-100.0
Comparator Mode	Comparison Upper Limit	100.0
	Comparison Lower Limit	-100.0

Relationship between Output Items and D/A Output Voltage Frequency

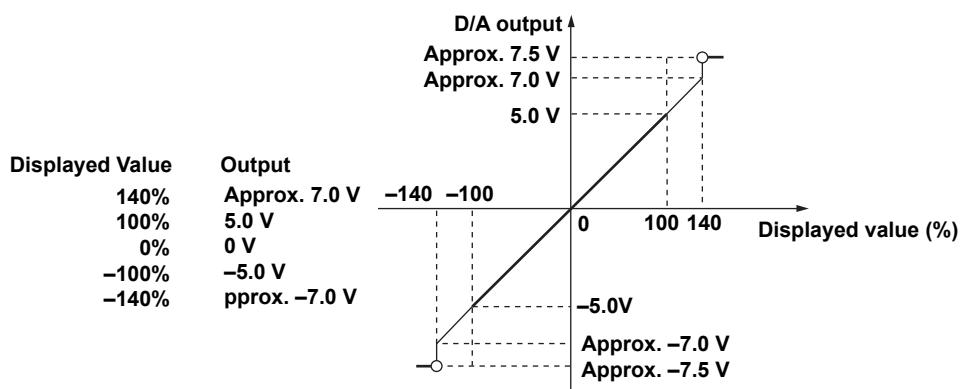


Integrated Value



t_0 : Rated integration time

Other Items



- The range between +5 to +7 V and -5 to -7 V is not output for λ and Φ . When an error occurs, the output is approximately ± 7.5 V.
- For the efficiency math function, +5 V represents 100%.
- For Upk and Ipk, ± 5 V represents the application of 3 times the rated range value (6 times the rated range value when the crest factor is 6).
- When the selected output function is “---” or there is no numerical data, the output is 0 V.

Examples of D/A Output

Voltage

When the voltage range is set to 150 V and 150 V (the rated range value) is applied, the D/A output is +5 V.

When 100 V is applied, the output is $100 \text{ V}/150 \text{ V} \times 5 \text{ V} = 3.3 \text{ V}$.

Power

When the voltage range is set to 150 V and the current range is set to 5 A, the rated power range is $150 \text{ V} \times 5 \text{ A} = 750 \text{ W}$.

If the measured power value is 750 W, the D/A output is +5 V.

When the measured power value is 300 W, the output is $300 \text{ W}/750 \text{ W} \times 5 \text{ V} = 2.0 \text{ V}$.

Three-Phase Power (WT332/WT333)

When the voltage range is set to 150 V, the current range is set to 5 A, and a three-phase, three-wire system is connected to elements 1 and 3, the rated power range of wiring unit Σ will be as follows.¹

$$(\text{Rated power range of element 1}) + (\text{rated power range of element 3})$$

$$= 150 \text{ V} \times 5 \text{ A} + 150 \text{ V} \times 5 \text{ A}$$

$$= 1500 \text{ W}$$

If the measured power value for Σ is 1500 W, the D/A output is +5 V.

When the measured power value is 600 W, the output is $600 \text{ W}/1500 \text{ W} \times 5 \text{ V} = 2.0 \text{ V}$.

- 1 For information about the power range of wiring unit Σ , see the table of Σ function expressions on the second page of the appendix in the User's Manual, IM WT310-01EN (PDF). This table shows the expressions that the WT332/WT333 uses to internally calculate the measured values. This table also shows how to think about wiring unit measurement ranges. In this example, $P\Sigma$ in the table corresponds to $P1 + P3$ in the three-phase, three-wire (3P3W) column.

Integrated Power Values

When the voltage range is set to 150 V and the current range is set to 5 A, the rated power range is $150 \text{ V} \times 5 \text{ A} = 750 \text{ W}$. In manual integration mode, when the rated integration time is set to 1 hour, the rated electrical energy value is $750 \text{ W} \times 1 \text{ h} = 750 \text{ Wh}$.

If you perform integration for 1 hour and the measured electrical energy is 750 W, the D/A output one hour after integration starts is +5 V.

If the measured electrical energy over 1 hour is 300 Wh, the output one hour after integration starts is $300 \text{ Wh}/750 \text{ Wh} \times 5 \text{ V} = 2.0 \text{ V}$.

The output 30 minutes after integration starts is $150 \text{ Wh}/750 \text{ Wh} \times 5 \text{ V} = 1.0 \text{ V}$.

6.1 Troubleshooting

Faults and Corrective Actions

- If an error code appears on the 7-segment LED display, see section 5.2. Also, for information about communication error messages, see the appendix of the Communication Interface User's Manual, IM WT310-17EN.
- If servicing is necessary, or if the instrument does not operate properly even after you have attempted to deal with the problem according to the instructions in this section, contact your nearest YOKOGAWA dealer.

Problems and Solutions	Refer To
Nothing appears on the 7-segment LED display when you turn on the power.	
Securely connect the power cord to the WT300 series and to the power outlet.	2.3
Set the supply voltage and frequency to within the permitted range.	2.3
The displayed data is not correct.	
Confirm that the ambient temperature and humidity are within their specified ranges.	2.2
Confirm that the display is not being affected by noise.	2.1, 2.5
Check the measurement cable wiring.	2.8 to 2.11
Check the wiring system. (Applies to the WT332/WT333.)	2.8 to 2.11, 2.2 ¹
Confirm that the line filter is off.	2.9 ¹
Check the measurement period settings.	2.8 ¹
Check the FAQ at the following URL. http://tmi.yokogawa.com/	—
Turn the power off and then on again.	2.4
Keys do not work.	
Check the REMOTE indicator. If the REMOTE indicator is illuminated, press SHIFT (LOCAL) to turn it off.	—
Confirm that the keys are not locked.	8.5 ¹
Unable to make harmonic measurements.	
Check the PLL source settings.	6.3 ¹
Confirm that the input signal that you have selected as the PLL source meets the specifications.	6.3 ¹
Unable to configure or control the instrument through the communication interface.	
Check to make sure that the GP-IB address setting matches the specifications.	— ²
Check to make sure that the TCP/IP settings match the specifications.	— ²
Check to make sure that the serial (RS-232) interface parameter settings match the specifications.	— ²
Confirm that the interface meets the electrical and mechanical specifications.	— ²

1 See the User's Manual, IM WT310-01EN.

2 See the Communication Interface User's Manual, IM WT310-17EN.

6.2 Error Code Descriptions and Corrective Actions

Information That Is Displayed When the Power Is Turned On (Display: Code.##)

Code	Description	Corrective Action	Refer To
3	You turned on the power while holding SET, so all the settings have been initialized.		3.3
80	The system structure has changed, so all the settings have been initialized.		—
87	The WT310/WT310HC/WT330 firmware has changed, so all the settings have been initialized.		—

Setting and Execution Errors (Display: Err.###)

Code	Description	Corrective Action	Refer To
759	Network initialization failed.	Check the network settings.	Chapter 4 ¹
812	The setting or command is not available during data storage.		—
813	The setting is not available when an integration operation is being carried out or aborted.	Reset the integration operation.	5.3 ²
823	Cannot be changed during CAL.	Wait until CAL finishes.	8.3 ²
832	You tried to load an empty setup parameter file.	Select a file that has had setup parameters saved to it.	7.2 ²
840	The setting or command is not available when auto range is on.		
841	You tried to start integration after the integration time reached the specified timer time.	Reset the integration operation.	5.3 ²
842	You tried to start integration during an integration operation.		5.3 ²
843	The integrated value overflowed during integration or ended abnormally because of power failure or some other reason.	Reset the integration operation.	5.3 ²
844	You tried to stop integration when no integration operation was taking place.		5.3 ²
845	You tried to reset integration when the mode was not integration mode or during integration.		5.3 ²
846	You tried to start integration despite a peak overrange.		—
847	When you tried to start integration in continuous integration mode, the integration timer time was set to zero.	Set the integration timer correctly.	5.2 ²
865	The setting is not available when an integration operation is being carried out.	Abort or reset the integration operation.	5.3 ²

System Errors (Display: Err.###)

Code	Description	Corrective Action	Refer To
901	The setup data could not be backed up, and the settings have been initialized.	The battery for backing up the setup data may have worn out. Servicing is required.	—
915	This is an EEPROM SUM error.	The EEPROM may be corrupted. Servicing is required.	—
919	The currently installed modules and the setup data conflict with each other. The setup data has been initialized.	Servicing is required.	—

1 Communication Interface User's Manual, IM WT310-17EN

2 User's Manual, IM WT310-01EN

6.3 Recommended Part Replacement

Contact your nearest YOKOGAWA dealer to have parts replaced.

Part Name	Recommended Replacement Interval
Current input relay (only for the WT310)	A relay for switching the current input circuit. The relay's specifications indicated below. • Electrical life: Approximately 50,000 operations (at the rated capacity) • Mechanical life: Approximately 1,000,000 operations
Backup battery (lithium)	3 years

6.4 Calibration and Adjustment

For calibration and adjustment, contact your nearest YOKOGAWA dealer.

7.1 Input

Item	Specifications
Input terminal type	<p>Voltage Plug-in terminal (safety terminal)</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input: Large binding post • External current sensor input (option): isolated BNC connector
Input format	<p>Voltage Floating input through resistive voltage divider</p> <p>Current Floating input through shunt</p>
Measurement range	<p>Voltage Crest factor 3: 15 V, 30 V, 60 V, 150 V, 300 V, 600 V Crest factor 6: 7.5 V, 15 V, 30 V, 75 V, 150 V, 300 V</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input • Crest factor 3: <ul style="list-style-type: none"> • WT310/WT332/WT333: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A • WT310 Only: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA • WT310HC: 1 A, 2 A, 5 A, 10 A, 20 A, 40 A • Crest factor 6: <ul style="list-style-type: none"> • WT310/WT332/WT333: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A • WT310 Only: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA • WT310HC: 0.5 A, 1 A, 2.5 A, 5 A, 10 A, 20 A • External current sensor input (/EX1, /EX2) <ul style="list-style-type: none"> • Crest factor 3: <ul style="list-style-type: none"> EX1 "2.5 V, 5 V, 10 V" or EX2 "50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V" • Crest factor 6: <ul style="list-style-type: none"> EX1 "1.25 V, 2.5 V, 5 V" or EX2 "25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V"
Input impedance	<p>Voltage Input resistance: Approx. 2 MΩ, input capacitance: Approx. 13 pF in parallel with the resistance</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input • WT332/WT333 Crest factor 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A Crest factor 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A Input resistance: Approx. 6 mΩ, input inductance : Approx.0.1 μH in series with the resistance • WT310 Crest factor 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A Crest factor 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A Input resistance: Approx. 6 mΩ + 10 mΩ (max)* Factory setting Input inductance: Approx. 0.1 μH in series with the resistance • WT310 Crest factor 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA Crest factor 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA Input resistance: Approx. 500 mΩ, input inductance : Approx.0.1 μH in series with the resistance • WT310HC Crest factor 3: 1 A, 2 A, 5 A, 10 A, 20 A, 40 A Crest factor 6: 0.5 A, 1 A, 2.5 A, 5 A, 10 A, 20 A Input resistance: Approx. 5 mΩ, input inductance : Approx.0.1 μH in series with the resistance • External current sensor input (/EX1): <ul style="list-style-type: none"> Crest factor 3: 2.5 V, 5 V, 10 V Crest factor 6: 1.25 V, 2.5 V, 5 V Input resistance: Approx. 100 kΩ • External current sensor input (/EX2): <ul style="list-style-type: none"> Crest factor 3: 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V Crest factor 6: 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V Input resistance: Approx. 20 kΩ

7.1 Input

Item	Specifications
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"> • Direct input <ul style="list-style-type: none"> WT310/WT332/WT333 <ul style="list-style-type: none"> Crest factor 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A Crest factor 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A Peak value of 450 A or RMS value of 300 A, whichever is less WT310 <ul style="list-style-type: none"> Crest factor 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA Crest factor 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA Peak value of 150 A or RMS value of 100 A, whichever is less WT310HC <ul style="list-style-type: none"> Crest factor 3: 1 A, 2 A, 5 A, 10 A, 20 A, 40 A Crest factor 6: 0.5 A, 1 A, 2.5 A, 5 A, 10 A, 20 A Peak value of 450 A or RMS value of 300 A, whichever is less External current sensor input Peak value less than or equal to 10 times the rated range
Instantaneous maximum allowable input (for 1 s)	<p>Voltage Peak value of 2 kV or RMS value of 1.5 kV, whichever is less</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input <ul style="list-style-type: none"> WT310/WT332/WT333 <ul style="list-style-type: none"> Crest factor 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A Crest factor 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A Peak value of 150 A or RMS value of 40 A, whichever is less WT310 <ul style="list-style-type: none"> Crest factor 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA Crest factor 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA Peak value of 30 A or RMS value of 20 A, whichever is less WT310HC <ul style="list-style-type: none"> Crest factor 3: 1 A, 2 A, 5 A, 10 A, 20 A, 40 A Crest factor 6: 0.5 A, 1 A, 2.5 A, 5 A, 10 A, 20 A Peak value of 150 A or RMS value of 44 A, whichever is less External current 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 kV, whichever is less</p> <p>Current</p> <ul style="list-style-type: none"> • Direct input <ul style="list-style-type: none"> WT310/WT332/WT333 <ul style="list-style-type: none"> Crest factor 3: 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A Crest factor 6: 0.25 A, 0.5 A, 1 A, 2.5 A, 5 A, 10 A Peak value of 100 A or RMS value of 30 A, whichever is less WT310 <ul style="list-style-type: none"> Crest factor 3: 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, 200 mA Crest factor 6: 2.5 mA, 5 mA, 10 mA, 25 mA, 50 mA, 100 mA Peak value of 30 A or RMS value of 20 A, whichever is less WT310HC <ul style="list-style-type: none"> Crest factor 3: 1 A, 2 A, 5 A, 10 A, 20 A, 40 A Crest factor 6: 0.5 A, 1 A, 2.5 A, 5 A, 10 A, 20 A Peak value of 100 A or RMS value of 44 A, whichever is less External current sensor input Peak value less than or equal to 5 times the rated range
Continuous maximum common-mode voltage (during 50/60 Hz input)	600VrmsCAT II

Item	Specifications
Influence of common mode voltage	When 600 Vrms is applied between the input terminal and case with the voltage input terminals shorted, current input terminals open and external current sensor input terminals shorted. Double the following values when the crest factor is set to 6.
	<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) 0.01% of range or more. f is frequency of input signal in kHz. 15 V, 30 V, 60 V, 150 V, 300 V, 600 V ranges, 0.5 A, 1 A, 2 A, 5 A, 10 A, 20 A ranges of WT310/WT332/WT333, 1 A, 2 A, 5 A, 10 A, 20 A, 40A ranges of WT310HC and, external current sensor input (/EX2 Option) $\text{Within } \pm \left\{ \frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.001 \times f\% \text{ of range} \right\}$ <p>The maximum rated range is 600 V for the voltage input terminal and 20 A for the current input of WT310/WT332/WT333 and 40 A for the current input terminal of WT310HC and 2 V for option /EX2.</p> 5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges of WT310 $\text{Within } \pm \left\{ \frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.0002 \times f\% \text{ of range} \right\}$ <p>The maximum rated range is 20 A.</p> External current sensor input (/EX1 Option) ranges $\text{Within } \pm \left\{ \frac{(\text{Maximum rated range})}{(\text{Rated range})} \times 0.01 \times f\% \text{ of range} \right\}$ <p>The maximum rated range is 10V.</p>
Line filter	Select OFF or ON (cutoff frequency at 500 Hz).
Frequency filter	Select OFF or ON (cutoff frequency at 500 Hz).
A/D converter	Simultaneous conversion of voltage and current inputs. Resolution: 16 bits Maximum conversion rate: Approx. 10 μ s

7.2 Measurement Items

Item	Specifications					
Displayed items						
During normal measurement						
Item	Indicator	Displayed On	Meaning			
U	V	A, B, C, D	voltage			
I	A	A, B, C, D	current			
P	W	A, B, C, D	active power			
S	VA	A	apparent power			
Q	var	A	reactive power			
TIME	TIME	A	elapsed integration time			
λ	PF	B, D	power factor			
Φ	$^\circ$	B	phase angle			
U+pk	V pk	C	Maximum voltage			
U-pk	V pk	C	Minimum voltage			
I+pk	A pk	C	Maximum current			
I-pk	A pk	C	Minimum current			
P+pk	W pk	C	Maximum active power			
P-pk	W pk	C	Minimum active power			
WP	W h	C	sum of watt hours			
WP+	W h \pm	C	positive watt hour			
WP-	W h \pm	C	negative watt hour			
q	A h	C	sum of ampere hours			
q+	A h \pm	C	positive ampere hour			
q-	A h \pm	C	negative ampere hour			
MATH	MATH	C	Result of efficiency computation, crest factor computation, four arithmetic operations, and average active power during integration			
fU	V Hz	D	voltage frequency			
fI	A Hz	D	current frequency			
Uthd	THD V %	D	total harmonic distortion of voltage			
Ithd	THD A %	D	total harmonic distortion of current			
During harmonic measurement						
Item	Indicator	Displayed On	Meaning			
U	V	A, B, C, D	harmonic voltage			
I	A	A, B, C, D	harmonic current			
P	W	A, B, C, D	harmonic active power			
K	or. (in 7 segment display)	A	harmonic order			
Uhdf	V %	B	relative harmonic content of each harmonic voltage			
Ihdf	A %	B	relative harmonic content of each harmonic current			
Phdf	W %	B	relative harmonic content of each harmonic power			
Φ_U	V°	B	phase angle of each harmonic component of voltage			
Φ_I	A°	B	phase angle of each harmonic component of current			
λ	PF	D	power factor of fundamental signal			
fU	V Hz	D	frequency of the voltage set to be the PLL synchronization source			
fI	A Hz	D	frequency of the current set to be the PLL synchronization source			
Uthd	THD V %	D	total harmonic distortion of voltage			
Ithd	THD A %	D	total harmonic distortion of current			
Element	Select the input element or Σ on the WT332/WT333. Displays the display item of the selected element.					

7.3 Accuracy

7.3.1 Voltage and Current Accuracy

Item	Specifications		
Accuracy	<p>Requirements</p> <ul style="list-style-type: none"> Temperature: $23 \pm 5^\circ\text{C}$ Humidity: 30 to 75%RH Input waveform: Sine wave Crest factor: 3 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 zero-level compensation or after measurement range is changed 		
Accuracy (at 12 months)			
(The accuracy shown below is the sum of reading and range errors.)			
* f in the read error equation is the input signal frequency in kHz.			
	WT310/WT332/WT333 (Voltage/Current)	WT310HC (Voltage, Current EXT sensor input)	WT310HC (Direct current input)
DC	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$
$0.5 \text{ Hz} \leq f < 45 \text{ Hz}$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$
$45 \text{ Hz} \leq f \leq 66 \text{ Hz}$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$
$66 \text{ Hz} < f \leq 1 \text{ kHz}$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$
$1 \text{ kHz} < f \leq 10 \text{ kHz}$	$\pm\{(0.07 \times f)\% \text{ of reading} + 0.3\% \text{ of range}\}$	$\pm\{(0.07 \times f)\% \text{ of reading} + 0.3\% \text{ of range}\}$	$\pm\{(0.13 \times f)\% \text{ of reading} + 0.3\% \text{ of range}\}$
$10 \text{ kHz} < f \leq 20 \text{ kHz}$			$\pm\{(0.13 \times f)\% \text{ of reading} + 0.5\% \text{ of range}\}$
$10 \text{ kHz} < f \leq 100 \text{ kHz}$	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range})$ $\pm[(0.04 \times (f-10))\% \text{ of reading}]$	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range})$ $\pm[(0.04 \times (f-10))\% \text{ of reading}]$	

- Influence of temperature changes after zero-level compensation or range change

Add 0.02% of range/ $^\circ\text{C}$ to the DC voltage accuracy.

Add the following value to the DC current accuracies.

WT310 (5mA/10mA/20mA/50mA/100mA/200mA ranges): $5 \mu\text{A}/^\circ\text{C}$

WT310 (0.5A/1A/2A/5A/10A/20A ranges) and WT332/WT333 direct current input: $500 \mu\text{A}/^\circ\text{C}$

WT310HC direct current input: $1 \text{ mA}/^\circ\text{C}$

External current sensor input (/EX1): $1 \text{ mV}/^\circ\text{C}$

External current sensor input (/EX2): $50 \mu\text{V}/^\circ\text{C}$

- Accuracy of the waveform display data, Upk and Ipk

Add the following value to the above accuracy (reference value).

The effective input range is within $\pm 300\%$ of range (within $\pm 600\%$ for crest factor 6)

Voltage input: $1.5 \times \sqrt{15/\text{range}} \text{ % of range}$

Direct current input range:

WT310 (5mA/10mA/20mA/50mA/100mA/200mA range): $3 \times \sqrt{0.005/\text{range}} \text{ % of range}$

WT310 (0.5A/1A/2A/5A/10A/20A range) and WT332/WT333 direct current input: $3 \times \sqrt{0.5/\text{range}} \text{ % of range}$

WT310HC direct current input: $3 \times \sqrt{1/\text{range}} \text{ % of range}$

External current sensor input range:

/EX1 Option: $3 \times \sqrt{2.5/\text{range}} \text{ % of range}$

/EX2 Option: $3 \times \sqrt{0.05/\text{range}} \text{ % of range}$

7.3 Accuracy

- Influence of self-generated heat caused by voltage input
Add $0.000001 \times U^2\%$ of reading to the AC voltage accuracies.
Add $0.000001 \times U^2\%$ of reading + $0.000001 \times U^2\%$ of range to the DC current accuracies. U is the voltage reading (V).

Influence of self-generated heat caused by voltage input lasts until falling the temperature of the input resistor even if voltage input decreases.

- Influence of self-generated heat caused by current input

WT310:

Add $0.00013 \times I^2\%$ of reading to the AC current accuracies.

Add $0.00013 \times I^2\%$ of reading + $0.004 \times I^2$ mA (0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges) or $0.00013 \times I^2\%$ of reading + $0.00004 \times I^2$ mA (5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges) to the DC current accuracies.

I is the current reading (A).

WT310HC:

Add $0.00006 \times I^2\%$ of reading to the AC current accuracies.

Add $0.00006 \times I^2\%$ of reading + $0.001 \times I^2$ mA to the DC current accuracies.

I is the current reading (A).

WT332/WT333:

Add $0.00013 \times I^2\%$ of reading to the AC current accuracies.

Add $0.00013 \times I^2\%$ of reading + $0.002 \times I^2$ mA to the DC current accuracies.

I is the current reading (A).

Influence of self-generated heat caused by current input lasts until falling the temperature of the shunt resistor even if current input decreases.

- Accuracy changes caused by data update interval

When the data update interval is 100 ms, add 0.05% of reading to the 0.5 Hz to 1 kHz accuracies.

- Guaranteed accuracy ranges for frequency, voltage, and current (direct input)

All accuracy figures for 0.5 Hz to 10 Hz are reference values.

The current accuracy figures for DC, 10 Hz to 45 Hz, and 400 Hz to 30 kHz when the current exceeds 20 A are reference values.

WT310 only

The maximum current input is 6 A when the frequency is over 30 kHz up to 100 kHz.

Input range	1 to 130% with respect to the rated range of voltage or current. (It displays up to 140%). (Add the reading error $\times 0.5$ to above accuracies for the range of 110% to 130% of the rated range.) WT310HC: 40 A Range Only 1 to 100% (display is 110%) The synchronization source level must meet the frequency measurement input signal level.	
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Measurement frequency range	Data update interval	Measurement Frequency Range
	0.1 s	DC, 25 Hz $\leq f \leq$ 100 kHz
	0.25 s	DC, 10 Hz $\leq f \leq$ 100 kHz
	0.5 s	DC, 5 Hz $\leq f \leq$ 100 kHz
	1 s	DC, 2.5 Hz $\leq f \leq$ 100 kHz
	2 s	DC, 1.5 Hz $\leq f \leq$ 100 kHz
	5 s	DC, 0.5 Hz $\leq f \leq$ 100 kHz

Only for direct current input of WT310HC, the maximum measurement range is 20kHz.

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.
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Temperature coefficient	Add $\pm 0.03\%$ of reading/ $^{\circ}\text{C}$ within the range of 5 to 18°C or 28 to 40°C .
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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.
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7.3.2 Active Power Accuracy

Item	Specifications																								
Accuracy	<p>Requirements Same as the conditions for voltage and current.</p> <ul style="list-style-type: none"> Power factor: 1 <p>Accuracy (at 12 months) (The accuracy shown below is the sum of reading and range errors.)</p> <p>* f in the read error equation is the input signal frequency in kHz.</p> <table border="1"> <thead> <tr> <th></th> <th>WT310/WT332/WT333 WT310HC (Current EXT sensor input)</th> <th>WT310HC (Direct current input)</th> </tr> </thead> <tbody> <tr> <td>DC</td> <td>$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$</td> <td>$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$</td> </tr> <tr> <td>0.5 Hz \leq f \leq 45 Hz</td> <td>$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$</td> <td>$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$</td> </tr> <tr> <td>45 Hz \leq f \leq 66 Hz</td> <td>$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$</td> <td>$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$</td> </tr> <tr> <td>66 Hz $<$ f \leq 1 kHz</td> <td>$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$</td> <td>$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$</td> </tr> <tr> <td>1 kHz $<$ f \leq 10 kHz</td> <td>$\pm(0.1\% \text{ of reading} + 0.3\% \text{ of range})$ $\pm[(0.067 \times (f-1))\% \text{ of reading}]$</td> <td>$\pm((0.13 \times f)\% \text{ of reading} + 0.3\% \text{ of range})$</td> </tr> <tr> <td>10 kHz $<$ f \leq 20 kHz</td> <td></td> <td>$\pm((0.13 \times f)\% \text{ of reading} + 0.5\% \text{ of range})$</td> </tr> <tr> <td>20 kHz $<$ f \leq 100 kHz</td> <td>$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range})$ $\pm[(0.09 \times (f-10))\% \text{ of reading}]$</td> <td></td> </tr> </tbody> </table>		WT310/WT332/WT333 WT310HC (Current EXT sensor input)	WT310HC (Direct current input)	DC	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$	0.5 Hz \leq f \leq 45 Hz	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$	45 Hz \leq f \leq 66 Hz	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$	66 Hz $<$ f \leq 1 kHz	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$	1 kHz $<$ f \leq 10 kHz	$\pm(0.1\% \text{ of reading} + 0.3\% \text{ of range})$ $\pm[(0.067 \times (f-1))\% \text{ of reading}]$	$\pm((0.13 \times f)\% \text{ of reading} + 0.3\% \text{ of range})$	10 kHz $<$ f \leq 20 kHz		$\pm((0.13 \times f)\% \text{ of reading} + 0.5\% \text{ of range})$	20 kHz $<$ f \leq 100 kHz	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range})$ $\pm[(0.09 \times (f-10))\% \text{ of reading}]$	
	WT310/WT332/WT333 WT310HC (Current EXT sensor input)	WT310HC (Direct current input)																							
DC	$\pm(0.1\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$																							
0.5 Hz \leq f \leq 45 Hz	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.3\% \text{ of reading} + 0.2\% \text{ of range})$																							
45 Hz \leq f \leq 66 Hz	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$	$\pm(0.1\% \text{ of reading} + 0.1\% \text{ of range})$																							
66 Hz $<$ f \leq 1 kHz	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$	$\pm(0.2\% \text{ of reading} + 0.2\% \text{ of range})$																							
1 kHz $<$ f \leq 10 kHz	$\pm(0.1\% \text{ of reading} + 0.3\% \text{ of range})$ $\pm[(0.067 \times (f-1))\% \text{ of reading}]$	$\pm((0.13 \times f)\% \text{ of reading} + 0.3\% \text{ of range})$																							
10 kHz $<$ f \leq 20 kHz		$\pm((0.13 \times f)\% \text{ of reading} + 0.5\% \text{ of range})$																							
20 kHz $<$ f \leq 100 kHz	$\pm(0.5\% \text{ of reading} + 0.5\% \text{ of range})$ $\pm[(0.09 \times (f-10))\% \text{ of reading}]$																								

- Influence of temperature changes after zero-level compensation or range change
Add the product of the voltage influence and the current influence listed below to the DC power accuracies.

DC voltage accuracy: 0.02% of range/ $^{\circ}\text{C}$

DC current accuracies

WT310 (5mA/10mA/20mA/50mA/100mA/200mA ranges): 5 $\mu\text{A}/^{\circ}\text{C}$

WT310 (0.5A/1A/2A/5A/10A/20A ranges) and WT332/WT333 direct current input: 500 $\mu\text{A}/^{\circ}\text{C}$

WT310HC direct current input: 1mA/ $^{\circ}\text{C}$

External current sensor input (/EX1): 1mV/ $^{\circ}\text{C}$

External current sensor input (/EX2): 50 $\mu\text{V}/^{\circ}\text{C}$

- Influence of self-generated heat caused by voltage input
Add $0.0000001 \times U^2\%$ of reading to the AC power accuracies.
Add $0.0000001 \times U^2\%$ of reading + $0.0000001 \times U^2\%$ of range to the DC power accuracies. U is the voltage reading (V).

Influence of self-generated heat caused by voltage input lasts until falling the temperature of the input resistor even if voltage input decreases.

- Influence of self-generated heat caused by current input

WT310:

Add $0.00013 \times I^2\%$ of reading to the AC power accuracies.

Add $0.00013 \times I^2\%$ of reading + $0.004 \times I^2$ mA (0.5 A, 1 A, 2 A, 5 A, 10 A, and 20 A ranges) or $0.00013 \times I^2\%$ of reading + $0.00004 \times I^2$ mA (5 mA, 10 mA, 20 mA, 50 mA, 100 mA, and 200 mA ranges) to the DC power accuracies.

I is the current reading (A).

WT310HC:

Add $0.00006 \times I^2\%$ of reading to the AC power accuracies.

Add $0.00006 \times I^2\%$ of reading + $0.001 \times I^2$ mA to the DC power accuracies.

I is the current reading (A).

WT332/WT333:

Add $0.00013 \times I^2\%$ of reading to the AC power accuracies.

Add $0.00013 \times I^2\%$ of reading + $0.002 \times I^2$ mA to the DC power accuracies.

I is the current reading (A).

Influence of self-generated heat caused by current input lasts until falling the temperature of the shunt resistor even if current input decreases.

- Accuracy changes caused by data update interval

When the data update interval is 100 ms, add 0.05% of reading to the 0.5 Hz to 1 kHz accuracies.

- Guaranteed accuracy ranges for frequency, voltage, and current (direct input)

All accuracy figures for 0.5 Hz to 10 Hz are reference values.

The power accuracy figures for DC, 10 Hz to 45 Hz, and 400 Hz to 30 kHz when the current exceeds 20 A are reference values.

WT310 only

The maximum current input is 6 A when the frequency is over 30 kHz up to 100 kHz.

7.3 Accuracy

Item	Specifications
Power factor influence	<p>When power factor (λ) = 0 (S: apparent power)</p> <ul style="list-style-type: none"> • $\pm 0.2\%$ of S for $45 \text{ Hz} \leq f \leq 66 \text{ Hz}$. • $\pm \{(0.2 + 0.2 \times f)\% \text{ of } S\}$ for up to 100 kHz as reference data. f is frequency of input signal in kHz. <p>When $0 < \lambda < 1$ (ϕ: phase angle of the voltage and current) $(\text{power reading}) \times [(\text{power reading error \%}) + (\text{power range error \%}) \times (\text{power range/indicated apparent power value}) + \{\tan\phi \times (\text{influence when } \lambda = 0)\% \}]$</p>
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
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 apparent power S	Voltage accuracy + current accuracy
Accuracy of reactive power Q	Accuracy of apparent power $+ (\sqrt{(1.0004 - \lambda^2)} - \sqrt{(1 - \lambda^2)}) \times 100\% \text{ of range}$
Accuracy of power factor λ	$\pm[(\lambda - \lambda/1.0002) + \cos\phi - \cos\{f + \sin^{-1}\{\text{influence from the power factor when } \lambda = 0\% / 100\}\}] \pm 1 \text{ digit}$ when voltage and current are at the measurement range rated input
Accuracy of phase difference ϕ	$\pm[\phi - \cos^{-1}(\lambda/1.0002) + \sin^{-1}\{\text{influence from the power factor when } \lambda = 0\% / 100\}] \text{ deg} \pm 1 \text{ digit}$ when voltage and current are at the measurement range rated input

7.4 Functions

7.4.1 Voltage, Current, and Active Power Measurements

Item	Specifications
Measurement method	Digital sampling method
Crest factor	3 or 6
Wiring system	WT310, WT310HC (One element model) Single-phase, two-wire (1P2W) WT332 (Two element model) Select single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); or three-phase, three-wire (3P3W). WT333 (Three element model) Select single-phase, two-wire (1P2W); single-phase, three-wire (1P3W); three-phase, three-wire (3P3W); three-phase, four-wire (3P4W); or three-voltage, three-current (3V3A).
Range select	Select manual or auto ranging.
Auto range	Range increase The range is increased when any of the following conditions is met. <ul style="list-style-type: none"> • Urms or Irms exceeds 130% of the currently set measurement range. • Crest factor 3: Upk , Ipk value of the input signal exceeds 300% of the currently set measurement range. • Crest factor 6: Upk , Ipk value of the input signal exceeds 600% of the currently set measurement range. <p>On the WT332/WT333, when any of those input elements meets the above condition, the range is increased the next time the measured value is updated.</p>
Range decrease	Range decrease The range is decreased when all of the following conditions are met. <ul style="list-style-type: none"> • Urms or Irms is less than or equal to 30% of the measurement range. • Urms or Irms is less than or equal to 125% of the next lower measurement range. • Crest factor 3: Upk , Ipk value of the input signal exceeds 300% of the currently set measurement range. • Crest factor 6: Upk , Ipk value of the input signal exceeds 600% of the currently set measurement range. <p>On the WT332/WT333, when all of the input elements meet the above conditions, the range is decreased the next time the measured value is updated.</p>
Display mode switching	Select 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), or DC (simple average of voltage and current).
Measurement synchronization source	Select voltage, current, or the entire period of the data update interval for the signal used to achieve synchronization during measurement.
Line filter	Select OFF or ON (cutoff frequency at 500 Hz).
Peak measurement	Measures the peak (max, min) value of voltage, current, or power from the instantaneous voltage, instantaneous current, or instantaneous power that is sampled.
Zero-level compensation	Removes the internal offset of the WT300 series.

7.4 Features

7.4.2 Frequency Measurement

Item	Specifications														
Measured item	Voltage and current frequencies applied to the selected input element can be measured.														
	WT332 (two element model) Select voltage (U1)/current (I1) of input element 1 or voltage (U3)/current (I3) of input element 3.														
	WT333 (three element model) Select voltage (U1)/current (I1) of input element 1, voltage (U2)/current (I2) of input element 2 or voltage (U3)/current (I3) of input element 3.														
Method	Reciprocal method														
Frequency measuring range	Varies depending on the data update interval (see description given later) as follows:														
	<table> <thead> <tr> <th>Data Update Interval</th> <th>Measurement Range</th> </tr> </thead> <tbody> <tr> <td>0.1 s</td> <td>25 Hz ≤ f ≤ 100 kHz</td> </tr> <tr> <td>0.25 s</td> <td>10 Hz ≤ f ≤ 100 kHz</td> </tr> <tr> <td>0.5 s</td> <td>5 Hz ≤ f ≤ 100 kHz</td> </tr> <tr> <td>1 s</td> <td>2.5 Hz ≤ f ≤ 100 kHz</td> </tr> <tr> <td>2 s</td> <td>1.5 Hz ≤ f ≤ 50 kHz</td> </tr> <tr> <td>5 s</td> <td>0.5 Hz ≤ f ≤ 20 kHz</td> </tr> </tbody> </table>	Data Update Interval	Measurement Range	0.1 s	25 Hz ≤ f ≤ 100 kHz	0.25 s	10 Hz ≤ f ≤ 100 kHz	0.5 s	5 Hz ≤ f ≤ 100 kHz	1 s	2.5 Hz ≤ f ≤ 100 kHz	2 s	1.5 Hz ≤ f ≤ 50 kHz	5 s	0.5 Hz ≤ f ≤ 20 kHz
Data Update Interval	Measurement Range														
0.1 s	25 Hz ≤ f ≤ 100 kHz														
0.25 s	10 Hz ≤ f ≤ 100 kHz														
0.5 s	5 Hz ≤ f ≤ 100 kHz														
1 s	2.5 Hz ≤ f ≤ 100 kHz														
2 s	1.5 Hz ≤ f ≤ 50 kHz														
5 s	0.5 Hz ≤ f ≤ 20 kHz														
Measurement range	Only for the direct current input of the WT310HC, the maximum measurement range is 20 kHz.														
Frequency filter	Auto switching among six types: 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 100 kHz														
Accuracy	Select OFF or ON (cutoff frequency at 500 Hz).														
	Requirements <ul style="list-style-type: none"> When the input signal level is 30% or more of the measurement range if the crest factor is set to 3 (60% or more if the crest factor is set to 6) Frequency filter is ON when measuring voltage or current of 200 Hz or less. 														
	Accuracy: ±(0.06% of reading)														

7.4.3 Computation

Item	Specifications				
Computing equation of apparent power (S), reactive power (Q), power factor (λ), and phase angle (Φ)					
i : Input element number					
	Single-Phase, Three-Wire (1P3W) Three-Phase, Three-Wire (3P3W) Three-Phase, Three-Wire (3V3A) Three-Phase, Four-Wire (3P4W)				
$U_{\Sigma}[V]$	$(U_1+U_3)/2$	$(U_1+U_2+U_3)/3$			
$I_{\Sigma}[A]$	$(I_1+I_3)/2$	$(I_1+I_2+I_3)/3$			
$P_{\Sigma}[W]$	P_1+P_3		$P_1+P_2+P_3$		
$S_{\Sigma}[VA]$	$S_i = U_i \times I_i$	S_1+S_3	$\frac{\sqrt{3}}{2} (S_1+S_3)$	$\frac{\sqrt{3}}{3} (S_1+S_2+S_3)$	$S_1+S_2+S_3$
$Q_{\Sigma}[var]$	$Q_i = \sqrt{S_i^2 - P_i^2}$	Q_1+Q_3			$Q_1+Q_2+Q_3$
λ_{Σ}	$\lambda_i = P_i/S_i$	$\frac{P_{\Sigma}}{S_{\Sigma}}$			
Φ°	$\Phi_i = \cos^{-1}\left(\frac{P_i}{S_i}\right)$	$\cos^{-1}\left(\frac{P_{\Sigma}}{S_{\Sigma}}\right)$			

- On the WT300 series, S, Q, λ , and Φ are derived through the computation of the measured values of voltage, current, and active power. Therefore, for distorted signal input, the value obtained on the WT300 series may differ from that obtained on other instruments that use a different method.
- 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 S or Q, and error is displayed for λ and Φ .
- For $Q_{\Sigma}[var]$, when the current leads the voltage, the Q value is displayed as a negative value; when the current lags the voltage, the Q value is displayed as a positive value. The value of Q_{Σ} may be negative, because it is calculated from the Q of each element with the signs included.

Lead and lag detection (Phase angle Φ 's D (lead) and G (lag))	The lead and lag of the voltage and current inputs can be detected correctly for the following: <ul style="list-style-type: none"> • Sine waves • When the measured value is 50% or more (100% or more when the crest factor is 6) of the measurement range • Frequency: 20 Hz to 2 kHz(WT310HC: to 1 kHz) • Phase difference: $\pm(5^\circ$ to $175^\circ)$
Scaling	Set the current sensor transformation ratio, VT ratio, CT ratio, and power factor when applying the external current sensor, VT, or CT output to the instrument. <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 WT332/WT333.
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.

7.4.4 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 or minimum displayable integration value (999999M or -99999M). ¹ 1 WP: 999999 MWh/-99999 MWh, q: 999999 MAh/-99999 MAh
Accuracy	\pm (Power accuracy (or current accuracy) + 0.1% of reading) (fixed range) * In the case of auto range, the measurement is not carried out during a range change. The first measurement data after the range change is added for the period which measurement was not carried out.
Range setting	Auto range or fixed range for Integration is available. For details on range switching, see section 7.4.1, "Voltage, Current, and Active Power Measurements."
Valid Frequency Ranges for Integration	Active power DC to 45 kHz Current When the measurement mode is RMS: DC, lower limit frequency determined by the data update interval to 45 kHz When the measurement mode is VOLTAGE MEAN: DC, lower limit frequency determined by the data update interval to 45 kHz When the measurement mode is DC: DC to 45 kHz
Timer accuracy	\pm 0.02%
Remote control	Start, stop, and reset operations are available using an external remote signal. (applies to products with the /DA4 or /DA12 option)

7.4 Features

7.4.5 Harmonic Measurement (/G5 Option)

Item	Specifications																								
Measured item	All installed elements																								
Method	PLL synchronization method																								
Frequency range	Fundamental frequency of the PLL source is in the range of 10 Hz to 1.2 kHz.																								
PLL source	<ul style="list-style-type: none"> • Select voltage or current of each input element. • Input level 50% or more of the rated measurement range when the crest factor is 3. 100% or more of the rated measurement range when the crest factor is 6. • The frequency filter must be turned on when the fundamental frequency is less than or equal to 200Hz. 																								
FFT data length	1024																								
Window function	Rectangular																								
Sample rate, window width, and upper limit of harmonic analysis	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Fundamental Frequency</th> <th>Sample Rate</th> <th>Window Width</th> <th>Upper Limit of Harmonic Analysis*</th> </tr> </thead> <tbody> <tr> <td>10 Hz to 75 Hz</td> <td>f×1024</td> <td>1</td> <td>50</td> </tr> <tr> <td>75 Hz to 150 Hz</td> <td>f×512</td> <td>2</td> <td>32</td> </tr> <tr> <td>150 Hz to 300 Hz</td> <td>f×256</td> <td>4</td> <td>16</td> </tr> <tr> <td>300 Hz to 600 Hz</td> <td>f×128</td> <td>8</td> <td>8</td> </tr> <tr> <td>600 Hz to 1200 Hz</td> <td>f×64</td> <td>16</td> <td>4</td> </tr> </tbody> </table>	Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis*	10 Hz to 75 Hz	f×1024	1	50	75 Hz to 150 Hz	f×512	2	32	150 Hz to 300 Hz	f×256	4	16	300 Hz to 600 Hz	f×128	8	8	600 Hz to 1200 Hz	f×64	16	4
Fundamental Frequency	Sample Rate	Window Width	Upper Limit of Harmonic Analysis*																						
10 Hz to 75 Hz	f×1024	1	50																						
75 Hz to 150 Hz	f×512	2	32																						
150 Hz to 300 Hz	f×256	4	16																						
300 Hz to 600 Hz	f×128	8	8																						
600 Hz to 1200 Hz	f×64	16	4																						

f in the equation is the input fundamental frequency.

* The upper limit of harmonic order can be decreased.

Accuracy

(The accuracy shown below is the sum of reading and range errors.)

When Line Filter is OFF

<WT310/WT332/WT333>

Frequency	Voltage	Current	Power
10 Hz ≤ f < 45 Hz	0.15% of reading +0.35% of range	0.15% of reading +0.35% of range	0.35% of reading +0.50% of range
45 Hz ≤ f ≤ 440 Hz	0.15% of reading +0.35% of range	0.15% of reading +0.35% of range	0.25% of reading +0.50% of range
440 Hz < f ≤ 1 kHz	0.20% of reading +0.35% of range	0.20% of reading +0.35% of range	0.40% of reading +0.50% of range
1 kHz < f ≤ 2.5 kHz	0.80%+ of reading +0.45% of range	0.80%+ of reading +0.45% of range	1.56% of reading +0.60% of range
2.5 kHz < f ≤ 5 kHz	3.05% of reading +0.45% of range	3.05% of reading +0.45% of range	5.77% of reading +0.60% of range

<WT310HC>

Frequency	Voltage	Current	Power
10 Hz ≤ f < 45 Hz	0.15% of reading +0.35% of range	0.15% of reading +0.35% of range	0.35% of reading +0.50% of range
45 Hz ≤ f ≤ 440 Hz	0.15% of reading +0.35% of range	0.15% of reading +0.35% of range	0.25% of reading +0.50% of range
440 Hz < f ≤ 1 kHz	0.20% of reading +0.35% of range	0.20% of reading +0.35% of range	0.40% of reading +0.50% of range
1 kHz < f ≤ 2.5 kHz	0.80%+ of reading +0.45% of range	0.95%+ of reading +0.45% of range	1.68% of reading +0.60% of range
2.5 kHz < f ≤ 5 kHz	3.05% of reading +0.45% of range	3.35% of reading +0.45% of range	6.05% of reading +0.60% of range

- When the crest factor is set to 3.
- When λ (the power factor) is 1.
- Power figures that exceed 1.2 kHz are reference values.
- For a direct current range, add 10 μ A to the current accuracy and $(10 \mu\text{V}/\text{direct current range}) \times 100\%$ of range to the power accuracy.
- For the external current sensor range, add 100 μ A to the current accuracy and $(100 \mu\text{V}/\text{external current sensor range rating}) \times 100\%$ of range to the power accuracy.
- For nth harmonic component input, add $(n/(m+1))/50\%$ of (the nth harmonic reading) to the n + mth harmonic and n - mth harmonic of the voltage and current, and add $(n/(m+1))/25\%$ of (the nth harmonic reading) to the n + mth harmonic and n - mth harmonic of the power.
- Add $(n/500)\%$ of reading to the nth component of the voltage and current, and add $(n/250)\%$ of reading to the nth component of the power.
- The accuracy when the crest factor is 6 is the same as the accuracy when the crest factor is 3 after doubling the measurement range.
- The guaranteed accuracy ranges for frequency, voltage, and current, are the same as the guaranteed ranges for ordinary measurement. If the amplitude of the high frequency component is large, influence of approximately 1% may appear in certain harmonics. Because the influence depends on the size of the frequency component, if the frequency component is small with respect to the range rating, the influence is also negligible.

7.4.6 Display

Item	Specifications		
Display type	7-segment LED		
Simultaneous display	4 items		
Maximum display (display range)	During normal measurement		
		Displayed item	When the number of displayed digits is 5
		U, I, P, S*, Q*	99999
		λ^*	1.0000 to -1.0000
		Φ^*	G180.0 to d180.0
		fU*, fl*	99999
		WP, WP \pm , q, q \pm	
		When the unit is MWh or MAh	99999 (-99999 for negative watt hour and ampere hour.)
		When the unit is other than MWh or MAh	99999
		TIME	Elapsed integration time 0 to 99 hours 59 minutes 59 seconds 100 hours to 9999 hours 59 minutes 59 seconds 10000 hours
		Efficiency (WT332/WT333 only)	0.00 to 99.99 to 100.00 to 999.99% 0.00 to 99.99 to 100.0 to 999.9%
		Crest factor	99999
		Four arithmetic operation	99999
		Average active power	99999
		Voltage peak	99999
		Current peak	99999
		Power peak	99999
* The computation accuracy (the value calculated from the measured value) is one-half the display resolution.			
Maximum display (display range)	During harmonic measurement		
		Displayed item	When the number of displayed digits is 5
		U, I, P	99999
		λ	1.0000 to -1.0000
		Uhdf, Ihdf, Phdf	0.00 to 99.99 to 100.00 to 999.99% 0.00 to 99.99 to 100.0 to 999.9%
		Uthd, lthd	0.00 to 99.99 to 100.00 to 999.99% 0.00 to 99.99 to 100.0 to 999.9%
		$\Phi_{U, \Phi}$	
		Phase angle of the fundamental current with respect to the fundamental voltage	G180.0 to d180.0
		Phase angle of the 2nd harmonic and higher harmonics of voltage with respect to the fundamental voltage	-180.0 to 180.0
		Phase angle of the 2nd harmonic and higher harmonics of current with respect to the fundamental current	-180.0 to 180.0
Unit symbols	m, k, M, V, A, W, VA, var, °, Hz, h \pm , TIME, %		

7.4 Features

Number of displayed digits	Select 5 or 4 digits.
Data update interval	Select 0.1 s, 0.25 s, 0.5 s, 1 s, 2 s, or 5 s.
Response time	Data update rate \times 2 or less (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	Overrange “--- oL ---” is displayed for the following conditions. When the measured value exceeds 140% of the rated range * WT310HC:40 A range When the measured value exceeds 110% of the rated range
Hold	Holds the displayed value.
Single update	Updates the displayed value once each time the SINGLE key is pressed during Hold.
MAX hold	Holds the maximum displayed value of U, I, P, S, Q, U \pm pk, I \pm pk, and P \pm pk.

7.4.7 Internal Memory

Item	Specifications		
Measured data	Recall the stored measurement data by a communication command. Storage interval Data update interval or in the range of 1 s to 99 hrs 59 min 59 s. There is no backup function for stored measurement data.		
Setup information	Saves/Loads four patterns of setup information.		
Number of blocks which can be stored			
	Model	normal measurement	normal +harmonic measurement
	WT310/WT310HC	9000	700
	WT332	4000	300
	WT333	3000	200
* Harmonic Measurement (/G5 Option) Harmonic measurement function is turned ON.			

7.5 External Current Sensor Input (/EX1 and /EX2 options)

Item	Specifications
Allows input of voltage output type current sensor signal. For detailed input specifications, see section 7.1, “Input.”	<ul style="list-style-type: none">Measurement range of the /EX1 option Crest factor 3: 2.5 V, 5 V, 10 V Crest factor 6: 1.25 V, 2.5 V, 5 VMeasurement range of the /EX2 option Crest factor 3: 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V Crest factor 6: 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V

7.6 D/A Output (/DA4, /DA12 Options)

Item	Specifications
Output voltage	± 5 V FS (approx. ± 7.5 V maximum) against each rated value
Number of output channels	4 outputs for products with the /DA4; 12 outputs for products with the /DA12 option
Output items	Set for each channel. U, I, P, S, Q, λ , Φ , fU, fI, Upk, Ipk, WP, WP \pm , q, q \pm , MATH
Accuracy	\pm (accuracy of each measurement item + 0.2% of FS) (FS = 5 V)
D/A conversion resolution	16 bits
Minimum load	100 k Ω
Update interval	Same as the data update interval.
Temperature coefficient	$\pm 0.05\%/{^\circ}\text{C}$ of FS

7.7 Remote Control Input/Output Signal (/DA4, /DA12 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

7.8 GP-IB Interface (Standard on -C1)

Item	Specifications
Usable devices	National Instruments Corporation <ul style="list-style-type: none"> • PCI-GPIB or PCI-GPIB+ • PCIe-GPIB or PCIe-GPIB+ • PCMCIA-GPIB or PCMCIA-GPIB+ (not supported on Windows Vista or Windows 7.) • GPIB-USB-HS Use driver NI-488.2M Ver. 2.8.1 or later.
Electrical and mechanical	Complies with IEEE St'd 488-1978 (JIS C 1901-1987)
Functional specifications	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
Protocol	Complies with IEEE St'd 488.2-1992
Code	ISO (ASCII) codes
Mode	Addressable mode
Addresses	0 to 30
Clear remote mode	Press LOCAL to clear remote mode (except during Local Lockout).

7.9 Serial (RS-232) Interface (Standard on -C2)

Item	Specifications
Connector type	D-Sub 9-pin (plug)
Electrical specifications	Complies with EIA-574 (EIA-232 (RS-232) standard for 9-pin)
Connection	Point to point
Transmission mode	Full duplex
Synchronization	Start-stop synchronization
Baud rate	Select from 1200, 2400, 4800, 9600, 19200, 38400 or 57600 bps.

7.10 USB PC Interface

Item	Specifications
Number of ports	1
Connector	Type B connector (receptacle)
Electrical and mechanical specifications	Complies with USB Rev. 2.0
Supported transfer modes	HS (High Speed; 480 Mbps) and FS (Full Speed; 12 Mbps)
Supported protocols	USBTMC-USB488 (USB Test and Measurement Class Ver. 1.0)
PC system requirements	A PC with a USB port, running the English or Japanese version of Windows 7 (32 bit/64bit), Windows Vista (32 bit), or Windows XP (32 bit, SP2 or later)

7.11 Ethernet Interface(/C7 Option)

Item	Specifications
Ports	1
Connector type	RJ-45
Electrical and mechanical specifications	Complies with IEEE802.3
Transmission system	Ethernet (100BASE-TX/10BASE-T)
Transfer rate	100 Mbps max.
Communication protocol	TCP/IP
Supported services	DHCP, remote control (VXI-11)

7.12 Safety Terminal Adapter

Item	Specifications
Maximum allowable current	36 A
Dielectric strength	1000 V CATIII
Contact resistance	10 mΩ or less
Contact section	Nickel plating on brass or bronze
Insulator	Polyamide
Maximum core wire diameter	1.8 mm
Maximum insulation diameter	3.9 mm

7.13 General Specifications

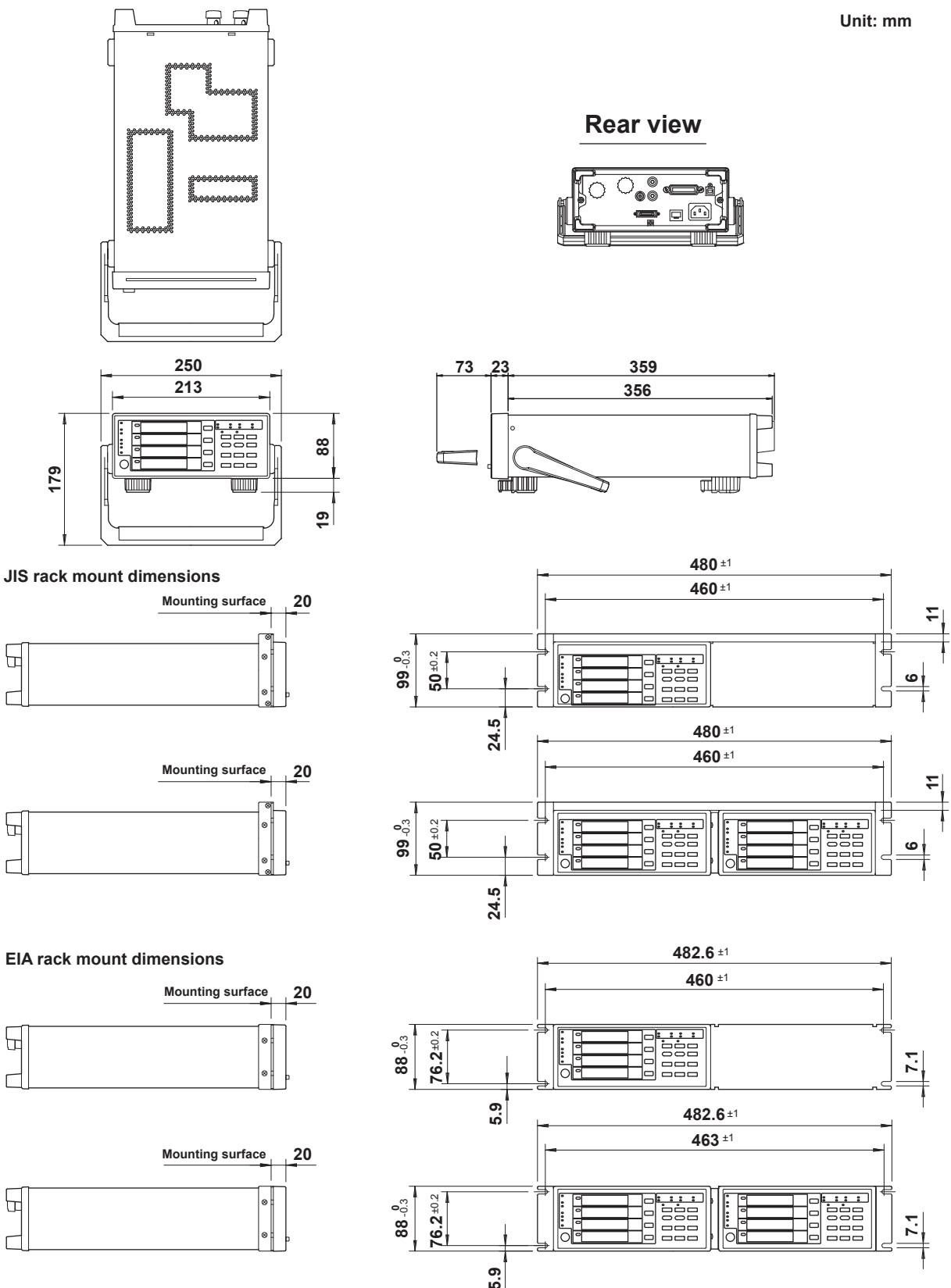
Item	Specifications
Warm-up time	Approx. 30 minutes
Operating environment	Temperature: 5°C to 40°C Humidity: 20%RH to 80%RH (no condensation) Elevation: 2000 m or less
Installation location	Indoors
Storage environment	Temperature: -25°C to 60°C Humidity: 20%RH to 80%RH (no condensation)
Rated supply voltage	100 VAC to 240 VAC
Permitted supply voltage range	90 VAC to 264 VAC
Rated supply frequency	50/60 Hz
Permitted supply voltage frequency range	48 Hz to 63 Hz
Maximum power consumption	WT310, WT310HC: 50 VA, WT332/WT333: 70 VA
External dimensions (excluding protrusions)	WT310, WT310HC: Approx. 213 (W) × 88 (H) × 379 (D) mm WT332/WT333: Approx. 213 (W) × 132 (H) × 379 (D) mm
Weight	WT310, WT310HC: Approx. 3 kg WT332/WT333: Approx. 5 kg
Battery backup	Setup parameters are backed up with a lithium battery.
Standard accessories	<ul style="list-style-type: none"> • Power cord: 1 piece • D/A cable: 1 piece (included in products with the /DA4, /DA12 options) • Current input protection cover: 1 piece that matches the main unit • Hind feet rubber: 1 set • User's manual: 1 piece (this manual) • Safety terminal adapter: WT310, WT310HC: Red/Black 1 set WT332: Red/Black 2 sets WT333: Red/Black 3 sets
Safety standard ¹	Compliant standard: EN61010-1, EN61010-2-030 Installation category (overvoltage category) CAT II ² Measurement Category CAT II ³ Pollution degree 2 ⁴
Emission ¹	Compliant standards EN61326-1 Class A EN55011 ClassA, Group1 EN61000-3-2 EN61000-3-3 EMC Regulatory Arrangement in Australia and New Zealand EN 55011 Class A, Group 1 Korea Electromagnetic Conformity Standard (한국 전자파적합성기준) 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 will be required to correct the interference. Cable conditions <ul style="list-style-type: none"> • Serial (RS-232) interface connector Use shielded serial cables.⁵ • GP-IB interface connector Use shielded GP-IB cables.⁵ • USB port (PC) Use shielded USB cables.⁵ • Ethernet port Use category 5 or better Ethernet cables (STP).⁶ • D/A output terminal Use shielded cables.⁵ • Connecting cables may cause radio interference in which case the user is required to correct the interference.

7.13 General Specifications

Item	Specifications
Immunity ¹	Compliant standard EN61326-1 Table 2 (for industrial locations) Influence in the immunity environment Measurement input: within ±30% of range (When the crest factor is set to 6, within ±60% of range.) D/A output: within ±30% of FS; FS = 5 V Cable conditions Same as the cable conditions for emission above.
Environmental standard ¹	Compliant standard EN50581 Monitoring and control instruments

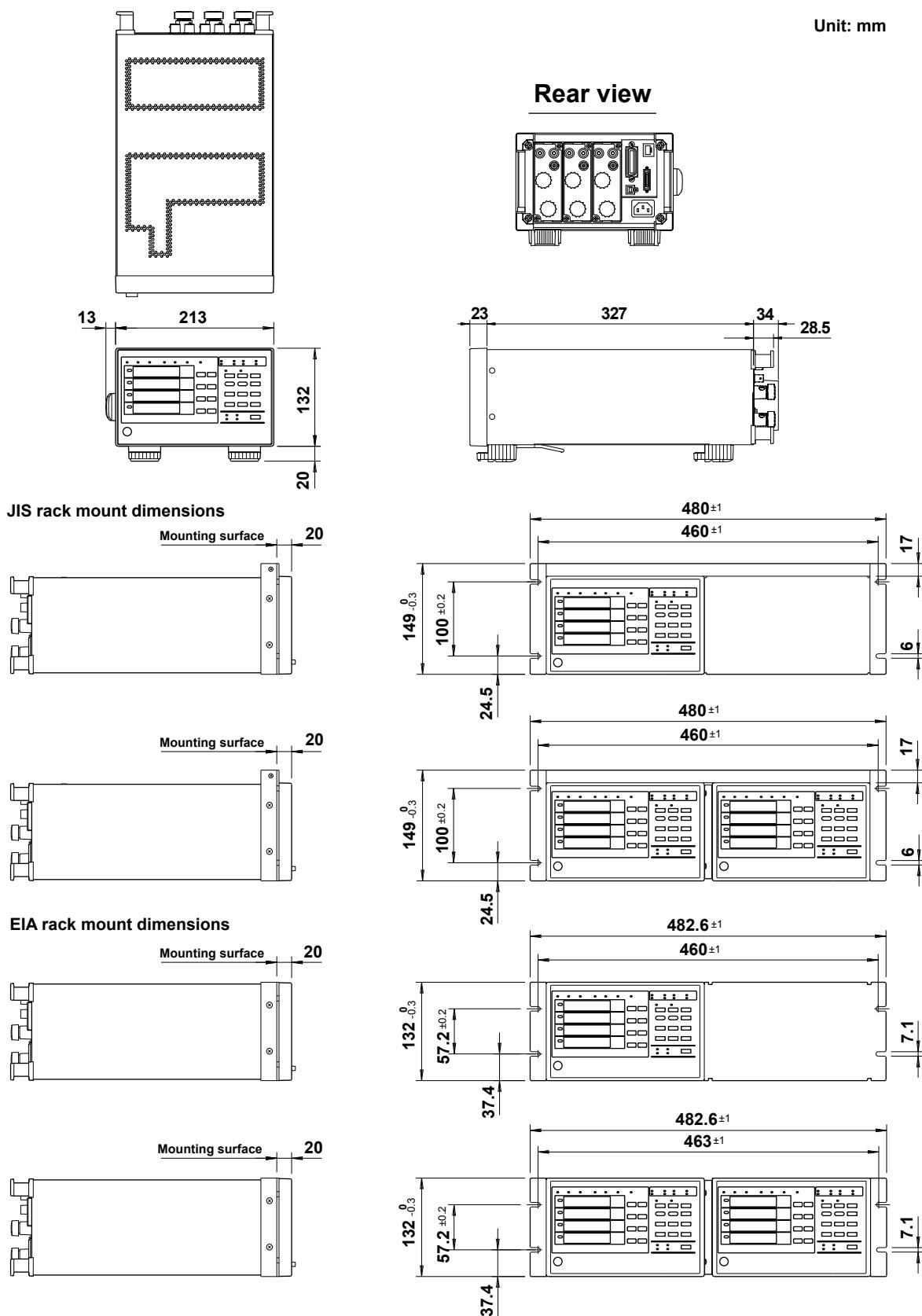
- 1 Applies to products with CE marks. For information on other products, contact your nearest YOKOGAWA dealer.
- 2 The overvoltage category (installation category) is a value used to define the transient overvoltage condition and includes the rated impulse withstand voltage. CAT II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board.
- 3 This instrument is measurement category II product. Do not use for Measurement Categories III and IV.
Measurement category O applies to measurement of other circuits that are not directly connected to a main power source.
Measurement Category II applies to electrical equipment that is powered through a fixed installation, such as a wall outlet wired to a distribution board, and to measurement performed on such wiring.
Measurement category III applies to measurement of facility circuits, such as distribution boards and circuit breakers.
Measurement category IV applies to measurement of power source circuits, such as entrance cables to buildings and cable systems, for low-voltage installations.
- 4 Pollution Degree applies to the degree of adhesion of a solid, liquid, or gas that deteriorates withstand voltage or surface resistivity.
Pollution Degree 2 applies to normal indoor atmospheres (with only non-conductive pollution).
- 5 Use cables of length 3 m or less.
- 6 Use cables of length 30m or less.

7.14 External Dimensions



Unless otherwise specified, tolerances are $\pm 3\%$ (however, tolerances are ± 0.3 mm when below 10 mm).

7.14 External Dimensions



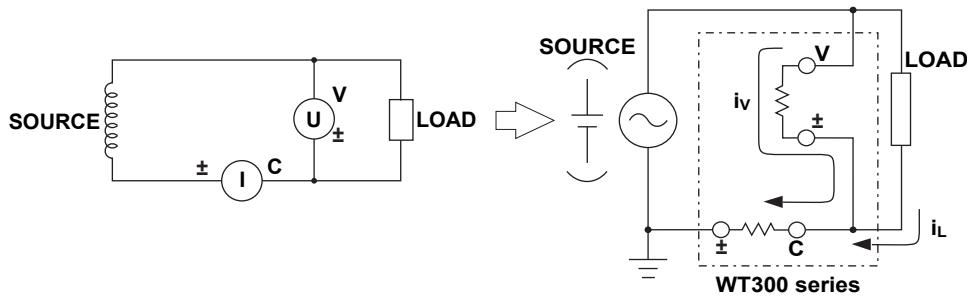
Appendix 1 How to Make Accurate Measurements

Effects of Power Loss

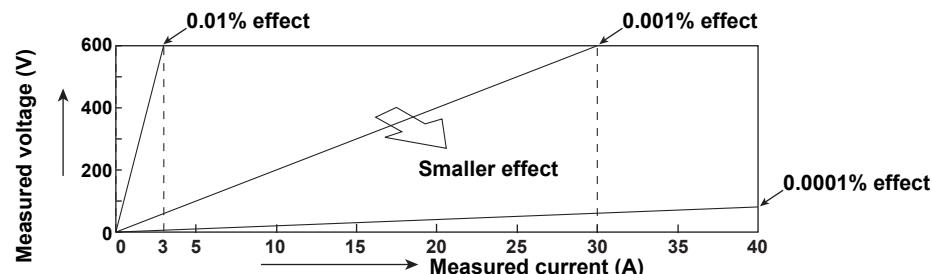
By wiring a circuit to match the load, you can minimize the effects of power loss on measurement accuracy. We will discuss the wiring of the DC power supply (SOURCE) and a load resistance (LOAD) below.

When the Measured Current Is Relatively Large

Connect the voltage measurement circuit between the current measurement circuit and the load. The current measurement circuit measures the sum of i_L and i_V . i_L is the current flowing through the load of the circuit under measurement, and i_V is the current flowing through the voltage measurement circuit. Because the current flowing through the circuit under measurement is i_L , only i_V reduces measurement accuracy. The input resistance of the voltage measurement circuit of the WT300 series is approximately $2\text{ M}\Omega$. If the input voltage is 600 V , i_V is approximately 0.3 mA ($600\text{ V}/2\text{ M}\Omega$). If the load current i_L is 3 A or more (the load resistance is 200Ω or less), the effect of i_V on the measurement accuracy is 0.01% or less. If the input voltage is 100 V and the current is 5 A , $i_V = 0.05\text{ mA}$ ($100\text{ V}/2\text{ M}\Omega$), so the effect of i_V on the measurement accuracy is 0.001% ($0.05\text{ mA}/5\text{ A}$).

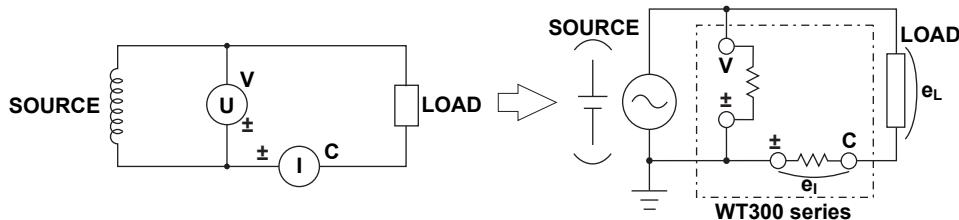


As a reference, the relationships between the voltages and currents that produce effects of 0.01% , 0.001% , and 0.0001% are shown in the figure below.



When the Measured Current Is Relatively Small

Connect the current measurement circuit between the voltage measurement circuit and the load. In this case, the voltage measurement circuit measures the sum of e_L and e_I . e_L is the load voltage, and e_I is the voltage drop across the current measurement circuit. Only e_I reduces measurement accuracy. For example, the input resistance of the current measurement circuit of the WT332/WT333 is approximately $6\text{ m}\Omega$. If the load resistance is 600Ω , the effect on the measurement accuracy is approximately 0.001% ($6\text{ m}\Omega/600\Omega$). For the input resistances of the WT310 and WT310HC, see chapter 7.



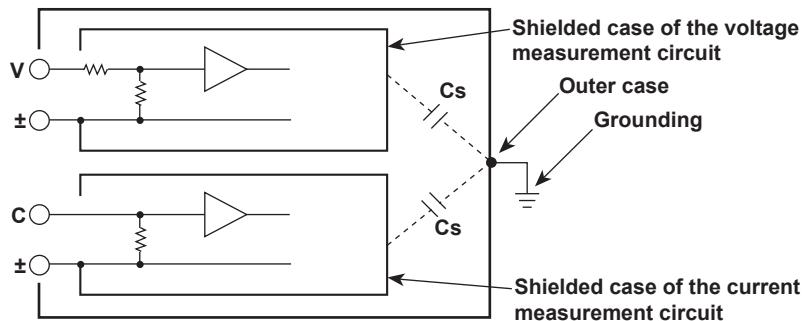
Effects of Stray Capacitance

The effects of stray capacitance on measurement accuracy can be minimized by connecting the WT300 series current input terminal to the side of the power supply (SOURCE) that is closest to its earth potential.

The internal structure of the WT300 series is explained below.

The voltage and current measurement circuits are each enclosed in shielded cases. These shielded cases are contained within an outer case. The shielded case of the voltage measurement circuit is connected to the positive and negative voltage input terminals, and the shielded case of the current measurement circuit is connected to the positive and negative current input terminals.

Because the outer case is insulated from the shielded cases, there is stray capacitance, which is expressed as C_s . C_s is approximately 40 pF. The current generated by stray capacitance C_s causes errors.

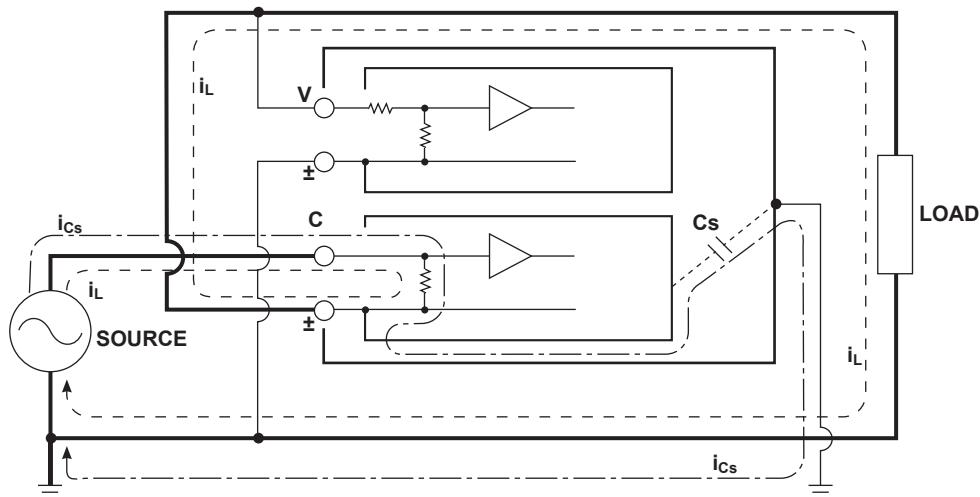


As an example, we will consider the case when the outer case and one side of the power supply are grounded.

In this case, there are two conceivable current flows, i_L and i_{Cs} . i_L is the load current, and i_{Cs} is the current that flows through the stray capacitance. i_L flows through the current measurement circuit, then through the load, and returns to the power supply (shown with a dotted line). i_{Cs} flows through the current measurement circuit, the stray capacitance, and the earth ground of the outer case, and then returns to the power supply (shown with a dot-dash line).

Therefore, the current measurement circuit ends up measuring the sum of i_L and i_{Cs} , even if the objective is just to measure i_L . Only i_{Cs} reduces measurement accuracy. If the voltage applied to C_s is V_{Cs} (common mode voltage), i_{Cs} can be found using the equation shown below. Because the phase of i_{Cs} is ahead of the voltage by 90°, the effect of i_{Cs} on the measurement accuracy increases as the power factor gets smaller.

$$i_{Cs} = V_{Cs} \times 2\pi f \times C_s$$



Appendix 1 How to Make Accurate Measurements

Because the WT300 series measures high frequencies, the effects of i_{CS} cannot be ignored.

If you connect the WT300 series current input terminal to the side of the power supply (SOURCE) that is close to its earth potential, the WT300 series current measurement circuit positive and negative terminals are close to the earth potential, so V_{CS} becomes approximately zero and very little i_{CS} flows. This reduces the effect on measurement accuracy.

App

Appendix